

# Caulmert Limited

Engineering, Environmental & Planning  
Consultancy Services

## Brookhill Landfill Site

Flintshire County Council Waste Management Services

## Annual Monitoring Review 2018

### Prepared by:

#### Caulmert Limited

InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG

**Tel:** 01248 672666

**Fax:** 01248 672601

**Email:** dianabrookshaw@caulmert.com

**Web:** www.caulmert.com

**Document Reference:** 3444-CAU-XX-XX-RP-V-0311.A0-C1

January 2019



## **APPROVAL RECORD**

**Site:** Brookhill Landfill Site

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

**Project Title:** Environmental Management

**Document Title:** Annual Monitoring Review 2018

**Document Ref:** 3444-CAU-XX-XX-RP-V-0311

**Report Status:** Final

**Project Director:** Andy Stocks

**Project Manager:** Diana Brookshaw

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

**Tel:** 01248 672666

|                 |                 |             |            |
|-----------------|-----------------|-------------|------------|
| <b>Author</b>   | Harry Caulfield | <b>Date</b> | 29/01/2019 |
| <b>Reviewer</b> | Diana Brookshaw | <b>Date</b> | 30/01/2019 |
| <b>Approved</b> | Diana Brookshaw | <b>Date</b> | 31/01/2019 |

## **DISCLAIMER**

This report has been prepared by Caulmert Limited with all reasonable skill, care and diligence in accordance with the instruction of the above named client and within the terms and conditions of the Contract with the Client.

The report is for the sole use of the above named Client and Caulmert Limited shall not be held responsible for any use of the report or its content for any purpose other than that for which it was prepared and provided to the Client.

Caulmert Limited accepts no responsibility of whatever nature to any third parties who may have been made aware of or have acted in the knowledge of the report or its contents.

No part of this document may be copied or reproduced without the prior written approval of Caulmert Limited.

**BROOKHILL LANDFILL SITE - ANNUAL MONITORING REVIEW 2018****TABLE OF CONTENTS**

|             |                                              |           |
|-------------|----------------------------------------------|-----------|
| <b>1.0</b>  | <b>INTRODUCTION .....</b>                    | <b>1</b>  |
| 1.1         | Background .....                             | 1         |
| 1.2         | Site Location and Surrounding Land-use ..... | 1         |
| <b>2.0</b>  | <b>ENVIRONMENTAL CONTEXT .....</b>           | <b>3</b>  |
| 2.1         | Geology .....                                | 3         |
| 2.2         | Hydrogeology .....                           | 3         |
| 2.3         | Hydrology .....                              | 4         |
| <b>3.0</b>  | <b>LANDFILL GAS .....</b>                    | <b>5</b>  |
| 3.1         | Monitoring regime .....                      | 5         |
| 3.2         | In waste Boreholes .....                     | 5         |
| 3.3         | Trace Gas Monitoring .....                   | 5         |
| 3.4         | Engine and Flare Emission Monitoring .....   | 6         |
| 3.5         | Perimeter Boreholes .....                    | 7         |
| <b>4.0</b>  | <b>LEACHATE .....</b>                        | <b>8</b>  |
| 4.1         | Introduction .....                           | 8         |
| 4.2         | Leachate Levels .....                        | 8         |
| 4.3         | Leachate Quality .....                       | 10        |
| 4.4         | Emissions to sewer .....                     | 11        |
| <b>5.0</b>  | <b>GROUNDWATER .....</b>                     | <b>13</b> |
| 5.1         | Introduction .....                           | 13        |
| 5.2         | Groundwater Levels .....                     | 13        |
| 5.3         | Groundwater Quality .....                    | 14        |
| <b>6.0</b>  | <b>SURFACE WATER .....</b>                   | <b>17</b> |
| 6.1         | Introduction .....                           | 17        |
| 6.2         | Surface Water Quality .....                  | 17        |
| <b>7.0</b>  | <b>FUGITIVE EMISSIONS .....</b>              | <b>19</b> |
| <b>8.0</b>  | <b>ANNUAL PRODUCTION/TREATMENT .....</b>     | <b>21</b> |
| <b>9.0</b>  | <b>PERFORMANCE PARAMETERS .....</b>          | <b>22</b> |
| <b>10.0</b> | <b>TOPOGRAPHICAL SURVEY .....</b>            | <b>23</b> |
| <b>11.0</b> | <b>SUMMARY .....</b>                         | <b>24</b> |
| 11.1        | Landfill gas .....                           | 24        |
| 11.2        | Leachate .....                               | 24        |
| 11.3        | Groundwater .....                            | 25        |
| 11.4        | Surface Water .....                          | 26        |
| 11.5        | Fugitive emissions to air .....              | 26        |
| 11.6        | Dust .....                                   | 26        |

**DRAWINGS**

|                                |                               |
|--------------------------------|-------------------------------|
| 3031-CAU-XX-XX-DR-O-1802.A0-C1 | Environmental Monitoring Plan |
| 9877a Brookhill 30-04-2018     | Topographical site survey     |

**APPENDICES**

- Appendix 1:** Perimeter Landfill Gas Monitoring Summary Table, Landfill Gas Time-Series Graphs, In Waste Gas Monitoring Summary Table, Dust monitoring results, Surface Emissions Report
- Appendix 2:** Leachate Level and Quality Summary Tables and Time-Series Graphs
- Appendix 3:** Groundwater Level and Quality Summary Tables and Time-Series Graphs
- Appendix 4:** Surface Water Quality Summary Table and Time-Series Graphs
- Appendix 5:** Deposited Dust Monitoring results

## **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 1<sup>st</sup> January 2018 to 31<sup>st</sup> December 2018.
- 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 1<sup>st</sup> of January 2009 and the 31<sup>st</sup> of December 2017 has also been included in visual representation of the data as requested by Natural Resources Wales. This allows recent data to be viewed in the context of longer-term trends.

### **1.2 Site Location and Surrounding Land-use**

- 1.2.1 Brookhill Landfill Site is located approximately 1.5 km north of Buckley, Flintshire, North Wales at NGR SJ278656. The site is accessed via the Pinfold Industrial Estate, Pinfold Lane, which is located off the A494 Mold to Ewloe Road.
- 1.2.2 The site is bound to the east by a wooded, disused railway leading to open grassland. Agricultural land lies to the west of the site. The Pinfold Industrial Estate and a number of residential properties (on the outskirts of Buckley, approximately 400 m away) are situated to the south of the site. A restored refuse tip (Ewloe Barn Landfill) lies to the north of the site. It is currently used for rough grassland leading to open grazing land and some woodland.
- 1.2.3 Brookhill Landfill Site has been developed in a former quarry, which was worked for Buckley Fireclay and the siltstones and mudstones beneath the Fireclay (known as the Warrant) for use in the manufacturing of bricks and tiles.
- 1.2.4 In 1997, in preparation for the engineering of the landfill site, further Fireclay was removed together with a quantity of coal in the quarry base under agreement with the Coal Authority.
- 1.2.5 Brookhill Landfill Site started accepting waste in 1999. The wastes permitted at the site were stipulated within the site permit. The general waste streams which were permitted at the site through its history can be summarised as:
- Domestic food and organic wastes – approximately 60%
  - Non-hazardous industrial wastes, (including plastic, paper, cardboard, wood, stone and sand, etc) – approximately 40%
  - Most special wastes (allowed until June 2004).

- 1.2.6 The special wastes which were tipped at the site were accepted pre-June 2004 (under the WML for the site). Therefore, they would have been deposited predominantly within Cell 1, and the lower parts of Cells 2, 3 and 4. It is likely that none of the waste tipped in Cells 5 and 6 contains any 'special waste' waste streams.
- 1.2.7 The site ceased accepting waste in late 2007. The final capping and restoration phases were undertaken during 2010.

## 2.0 ENVIRONMENTAL CONTEXT

### 2.1 Geology

- 2.1.1 Brookhill Landfill is situated within the Buckley Formation part of the Middle Coal Measures. Strata visible in the quarry walls prior to waste emplacement consist of the Warrant siltstone, overlain with the mudstone of the Buckley Fireclay, overlain with Buckley Fireclay Sandstones. The strata generally dip approximately 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 updated in the Brookhill Landfill Hydrogeological Review (2014) prepared by RukHydro Ltd for Natural Resources Wales.

## **2.3 Hydrology**

- 2.3.1 Topographic falls and corresponding surface water flows are in a north-easterly direction, towards Wepre Brook, approximately 2 km from the site boundary. The Brook runs into the River Dee which is approximately 5 km from the site.
- 2.3.2 During and following wet weather periods, surface water run-off to the south and west of the site is channelled around the western site perimeter before flowing overland to the Wepre Brook.

## 3.0 LANDFILL GAS

### 3.1 Monitoring regime

- 3.1.1 The in-waste gas field at Brookhill is monitored on a regular basis, and the gas wells are regulated to balance the gas field to ensure that the gas plant is supplied with landfill gas of high calorific content and low oxygen concentration. A summary table of the in-waste data is included in Appendix 1.
- 3.1.2 Routine landfill gas monitoring around the site perimeter is carried out on a weekly basis at boreholes BH1, BH3-BH21 and BH23-BH25. Methane, carbon dioxide, oxygen, relative pressure and atmospheric pressure were recorded on each visit.
- 3.1.3 Perimeter borehole locations are shown on Drawing 3031-CAU-XX-XX-DR-O-1802.A0-C1. Appendix 1 contains a landfill gas monitoring data summary table, and. Methane and carbon dioxide data from all boreholes is also displayed in time-series graphs in Appendix 1. The time-series graphs show methane and carbon dioxide concentrations in the perimeter boreholes recorded between January 2009 and December 2018. The perimeter landfill gas data obtained during the review period was compared with the EP limits.

### 3.2 In waste Boreholes

- 3.2.1 The gas field at Brookhill is monitored and balanced on a regular basis. Methane, carbon dioxide, oxygen, balance, relative pressure, hydrogen sulphide and carbon monoxide were recorded on each visit. In accordance with Condition 4.2.2 of the EP for the site, monitoring data for the in waste boreholes is submitted to the NRW monthly. Quarterly results are listed and discussed in quarterly reviews for the site. Here, the data collected between the 1<sup>st</sup> January 2018 and 31<sup>st</sup> December 2018 is summarised in Appendix 1.
- 3.2.2 Landfill gas quality is relatively similar throughout the site. Methane concentration was on average 44.67%, varying between 2.1% (at GV 13) and 66.6% (at GV 3). The maximum average methane concentration increased slightly when compared to the previous review (60 %). This suggests the recent improvements within the gas extraction system (removal of leachate from within the wells) has been beneficial in terms of landfill gas management. Most boreholes (except e.g. GV13 and PW1) had sufficient levels of methane and low O<sub>2</sub>, making them suitable for extraction. GV19 was not monitored during the review period as it is due for decommissioning. The average methane concentration at the 'flare' (gas compound) was 52.5% indicating that gas extraction from the site was managed efficiently.

### 3.3 Trace Gas Monitoring

- 3.3.1 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 4<sup>th</sup> of June 2018 (see report included in Appendix 1). The sample point was

described as 'Inlet Line to Utilisation Plant'. The ambient temperature was 22 °C and the atmospheric pressure, 1003 mbar.

3.3.2 Bulk landfill gas was sampled for methane, carbon dioxide and oxygen and was reported to contain the following concentrations (similar to the average for this location):

- Methane 57.2 % v/v
- Carbon dioxide 39.8 % v/v
- Oxygen 0.03 % 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, 12 were detected. These were arsenic (as As), acetaldehyde (ethanal), formaldehyde (Methanal), 1-pentene, 1,2-dichloroethylene, benzene, carbon disulphide, dimethyl sulphide, styrene, toluene, trichloroethylene and hydrogen sulphide (see report included in Appendix 1). This is an increase in the previous year where only 9 trace gasses were detected (arsenic (as As), acetaldehyde (ethanal), 1,2-dichloroethylene, benzene, carbon disulphide, dimethyl sulphide, styrene, toluene and hydrogen sulphide

### 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 4<sup>th</sup> of June 2018. Engine and flare exhausts were both sampled for oxides of nitrogen (as NO<sub>2</sub>), carbon monoxide (CO), volatile organic compounds (VOCs as carbon), moisture and oxygen in accordance with the requirements in Table S4.2 in the EP.

3.4.2 Concentrations of NO<sub>2</sub> for the engine exceeded the compliance limit for the engine (500 mg(N)m<sup>-3</sup>) with a concentration of 654 ±28 mg(N)m<sup>-3</sup>. The concentration of NO<sub>2</sub> at the flare was below the flare emission limit value of 150 mg(N)m<sup>-3</sup>. Concentrations of CO were below the respective emission limits for both the flare and engine. VOC concentration at the engine exceeded the emission limit value of 1000 mg(N)m<sup>-3</sup> with a concentration of 1356 ±48 mg(N)m<sup>-3</sup>. The NO<sub>x</sub> and VOC results on the engine were reported above the permit limits, but are within the overall uncertainties as detailed in LFTGN08, and are therefore considered as being compliant. The flare VOC concentration was below the emission limit for the flare.

### **3.5 Perimeter Boreholes**

#### **Methane**

- 3.5.1 As with the previous review, all perimeter gas boreholes had methane concentrations below their respective EP limits during 2018.
- 3.5.2 Methane concentrations have remained below 1.0 % in all locations except BH8 and BH9. Average concentrations ranged from 0.02 % in BH7 to 16.12% in BH9 during 2018.
- 3.5.3 Methane concentrations in BH8 and BH9 remain relatively high but have shown a decreasing trend over the current review period.

#### **Carbon Dioxide**

- 3.5.4 Carbon Dioxide was detected in all perimeter boreholes, but remained below the relevant EP limits throughout the review period.
- 3.5.5 Concentrations throughout the site fluctuated during the review period. These fluctuations were not accompanied by increase in methane concentrations at those locations and is therefore unlikely to reflect lateral emissions of landfill gas from the site. Ongoing monitoring will continue to be reviewed in accordance with the permit, and these trends will be reassessed.
- 3.5.6 Average concentrations across the site ranged from 0.49 % in BH14 to 7.82 % in BH9. No overall increases in CO<sub>2</sub> were noted in any other boreholes around the site.

## 4.0 LEACHATE

### 4.1 Introduction

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

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

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

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

4.1.4 Samples collected from the leachate chambers in December 2018 were also analysed for the annual suite below:

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

4.1.5 Well locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.A0-C1.

### 4.2 Leachate Levels

4.2.1 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.

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

4.2.3 Leachate levels recorded during 2018 are summarised in Table 2 below.

4.2.4 As discussed in correspondence with NRW throughout 2017, the leachate dips collected at the site in 2017 represent 'pumped' leachate levels, where the level is recorded after up to 4 hours of pumping cessation. The reported leachate levels remained below the EP limits in R3

throughout the review period. On average, levels reported for LC2B were also below the respective compliance limits.

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

| Landfill Cell | Monitoring Point | Leachate Head (m above cell base) |         |         | Compliance Limit |
|---------------|------------------|-----------------------------------|---------|---------|------------------|
|               |                  | Minimum                           | Average | maximum |                  |
| Cell 1        | BK LC 1B         | 2.46                              | 2.62    | 3.47    | 2.0              |
|               | BK R1            | 2.57                              | 2.89    | 3.63    |                  |
| Cell 2        | BK LC 2B         | 2.08                              | 2.34    | 3.94    | 3.0              |
|               | BK R2            | 4.05                              | 4.94    | 6.02    |                  |
| Cell 3        | BK R3*           | 1.17                              | 1.45    | 2.46    | 3.0              |
| Cell 4        | BK LC 4B*        | 1.24                              | 3.17    | 4.27    | 3.0              |
|               | BK R4            | 3.70                              | 4.06    | 4.77    |                  |
| Cell 5        | BK R5            | 3.11                              | 3.15    | 3.19    | 3.0              |
| Cell 6        | BK LC 6B         | 3.63                              | 3.98    | 5.52    | 2.0              |
|               | BK R6            | 1.46                              | 2.07    | 5.32    |                  |

- 4.2.5 In 2018, two cessation tests were undertaken, as part of ongoing leachate dynamics investigation and improvement actions (leachate extraction from gas wells trial). The recorded rest levels from the March cessation trial (prior to commencement of the extraction trial) were reported in correspondence reference 3448-CAU-XX-XX-CO-V-9103.A0-C1. The results of the August trial are included in the extraction trial interpretative report, due to be submitted by the end of February 2018. For comparison, the results are summarised in Table 3 below:

**Table 3: Leachate Head Data – rest levels after cessation tests (exceedances highlighted in yellow)**

| Landfill Cell | Monitoring Point | Leachate Head (m above cell base) |             | Compliance Limit |
|---------------|------------------|-----------------------------------|-------------|------------------|
|               |                  | March 2018                        | August 2018 |                  |
| Cell 1        | BK LC 1B         | 7.57                              | 2.97        | 2.0              |
|               | BK R1            | 7.31                              | 3.24        |                  |
| Cell 2        | BK LC 2B         | 7.64                              | 3.24        | 3.0              |
|               | BK R2            | 8.48                              | 5.38        |                  |
| Cell 3        | BK R3*           | 7.73                              | 2.29        | 3.0              |
| Cell 4        | BK LC 4B*        | 6.55                              | 3.88        | 3.0              |
|               | BK R4            | 8.93                              | 5.23        |                  |
| Cell 5        | BK R5            |                                   |             | 3.0              |
| Cell 6        | BK LC 6B         | 8.35                              | 4.48        | 2.0              |
|               | BK R6            | 7.49                              | 2.99        |                  |

- 4.2.6 The results show a significant decrease in the rest level leachate head in all of the wells included in Tables 2 and 3, between March and August, with R3 showing rest levels in compliance with the Permit Level for this Cell in the August cessation test. This information is considered further in the extraction trial interpretative report, in the context of additional

extraction trial data to date, cessation test completed in January 2019 (to review ongoing trends), and achievable depths within leachate wells across the site (verified by a hard-rod dip of the leachate wells, also completed in January 2019). The interpretative report will include proposed actions and timescales for their completion.

- 4.2.7 Graphs shown in Appendix 3 relate the reported leachate levels to the surrounding groundwater level. It can be seen that for all cells operated on the principle of hydraulic containment (Cells 2-6), all of the reported pumped leachate levels represent conditions of hydraulic containment throughout the review period. The rest levels will be reviewed in terms of hydraulic containment as part of the interpretative report for the site, due to be completed by the end of February 2019.
- 4.2.8 The protocols for obtaining leachate levels that can be considered representative for the site, hydrogeological risks posed by the site, and how leachate is managed are currently under review, in discussion with NRW and will be formalised in the HRA review and updated leachate management plan for the site, which are to be completed in 2019 upon completion of additional works at the site.

### **4.3 Leachate Quality**

- 4.3.1 A summary of the leachate quarterly quality analysis from 2018 is shown in Table 2 in Appendix 2 along with graphs showing trends in leachate quality between January 2009 and December 2018.
- 4.3.2 Average ammoniacal nitrogen concentration in the leachate across the site increased every year between 2009 and 2012. In 2009 the average was 1863 mg/l, and it reached 2775 mg/l in 2012. This is likely to represent the peak leachate strength. Concentrations appeared to plateau between 2014 and 2017, with average ammoniacal nitrogen concentrations of 2205 mg/l, 2008 mg/l, 2301 mg/l, 1988 mg/l respectively. The overall average ammoniacal nitrogen concentration for the site as a whole in 2018 was 1816 mg/l. Average concentrations at each location showed a decrease in 2018, with the exception of LC5 which has shown a gradual increase over the past 3 years. These results suggest that leachate strength at the site may now be starting to decrease.
- 4.3.3 Average chloride concentration in the leachate in 2018 were 2006 mg/l, a slight decrease on the average of 2638 mg/l in 2017. This is lower than the peak chloride concentration recorded in 2011 (3464 mg/l) and is consistent with an interpretation of leachate strength decreasing since 2011-2012.
- 4.3.4 Yearly averages of Calcium, pH, COD and TOC have continued the decreasing trend seen since 2012. Concentrations of magnesium, potassium, sodium sulphide and TON have remained

relatively stable with the exception of LC3 which showed a decreasing trend in magnesium and potassium concentrations.

### ***Annual Suite***

- 4.3.5 No free cyanide was detected in the leachate chambers. Total cyanide was recorded in LC5 with a concentration of 0.079 mg/l, but was below the detection limit elsewhere.
- 4.3.6 No mercury was detected at any of the leachate locations.
- 4.3.7 Mineral Oils (>C10 to C40) were detected in all locations with the exception of LC3. Concentrations ranged from 0.17 mg/l in LC6 to 0.503 mg/l in LC5.
- 4.3.8 Semi-Volatile Organic Compounds (SVOCs) 2-Methylphenol (aq) and bis(2-Ethylhexyl) phthalate (aq) were detected within LC2. Bis(2-Ethylhexyl) phthalate (aq) was also detected within LC4.
- 4.3.9 Out of the 66 Volatile Organic Compounds (VOCs), 14 of these have been detected in the leachate annual suite. Leachate quality tables are presented in Appendix 3.
- 4.3.10 The pesticide/herbicides Azinphos ethyl was detected in LC4 and p,p'-DDT was detected in LC5. Dibutyl tin and tributyl tin was detected in LC5. Dibutyl tin was also detected within LC4.

## **4.4 Emissions to sewer**

- 4.4.1 The leachate treatment plant at the site accepts leachate from Brookhill and the nearby Standard landfill site. The treated effluent is discharged to public sewer and is thereby subject to a trade effluent agreement (discharge consent, DC).
- 4.4.2 The treated leachate discharge (Final Discharge, FD) is monitored on a weekly basis for:

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

### ***Ammoniacal Nitrogen***

- 5.4.1 The ammoniacal nitrogen discharge consent limit (50 mg/l) was not exceeded in 2018, with a maximum concentration of 3.54 mg/l recorded on the 30<sup>th</sup> of August 2018. An annual average of 1.57 mg/l was calculated for 2018, a considerable improvement over the past two reviews (10.9 mg/l in 2017 and 9.8mg/l in 2016).

### ***Chemical Oxygen Demand (COD)***

- 5.4.2 COD exceeded the discharge consent limit of 2000 mg/l twice in 2018, with concentrations of 2020 mg/l and 2310 mg/l recorded September and October respectively. All other concentrations were below this limit, giving an annual average of 1431 mg/l, a slight increase than the previous year's average of 1297 mg/l.

***Suspended Solids***

- 5.4.3 The suspended solids discharge consent limit (500 mg/l) was exceeded in April, August, September and October with a maximum concentration of 1440 mg/l, but the average suspended solids concentration of 496 mg/l was below the consent limit. The recorded average suspended solids concentration represents an increase when compared to the previous year's average of 263 mg/l.
- 5.4.4 The increase in suspended solids was due to accumulation of sediment/sludge within the discharge tank. Subsequently, the tank was emptied and sediment pumped back into the SBR for reprocessing.

## 5.0 GROUNDWATER

### 5.1 Introduction

5.1.1 During the review period groundwater levels were recorded on a monthly basis in groundwater monitoring boreholes GW1, GW2A, GW3A, GW4, GW5A, GW6, GW7 and GW8 (also referred to as GW1-GW8 for chemical analysis). Levels were also recorded in GW1A (also referred to as GW1.1), and in two piezometers, which are located at shallower horizons at GW4 and GW6 and are referred to as GW4.1 and GW6.1 respectively. Borehole locations are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.A0-C1.

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

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

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

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

Plus, the following annual hazardous substances screen:

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

### 5.2 Groundwater Levels

5.2.1 Groundwater levels were recorded monthly during the review period. The seasonal trend noted in the previous annual reviews is also evident in 2018, with seasonal decrease from March to September and highest levels being recorded in the winter months. When averaged for the year, groundwater levels in most boreholes were comparable to those in 2017 or showed an increase and return to averages similar to those reported in 2016 (e.g. GW1, GW2, GW3, GW6 and GW8). These trends will be reviewed in the context of site management as part of the hydrogeological risk assessment for the site.

### 5.3 Groundwater Quality

- 5.3.1 Monthly groundwater sampling was undertaken at groundwater points GW1-GW8, as per the schedule outlined above. In March, June, September and December samples were analysed for the quarterly suite, and in December for the annual hazardous substances screen. Tables 1 and 2 in Appendix 3 summarise monthly and quarterly monitoring data from 2018. Time-series graphs for all parameters between 2009 and 2018 are also included in Appendix 2.
- 5.3.2 GW2A, GW3A and GW4 have EP limits for ammoniacal nitrogen, chloride, nickel, zinc, total xylenes and toluene, as these boreholes are regarded as being down-gradient of the site. The groundwater regime around the site has been under discussions during recent years, and revised EP limits have been discussed. For the purpose of this report, the current EP limits have been used.

#### ***Ammoniacal Nitrogen***

- 5.3.3 The groundwater EP limit for ammoniacal nitrogen (1.7 mg/l) was exceeded in GW2A and GW3A throughout 2018. Concentrations increased throughout the review period in both GW2A and GW3 until quarter 4 where concentrations started to decrease. The groundwater EP limit was also exceeded in GW4 during the second half of the review period, with concentrations gradually increasing throughout the review period.
- 5.3.4 As in the previous year, concentrations were highest in GW3A, where ammoniacal nitrogen was on average 43.19 mg/L comparable to 60 mg/L in 2015, 40 mg/L in 2016 and 53.8 mg/l in 2017. The maximum concentration recorded there was 124 mg/L, reported in October. This was similar to concentrations seen in 2015 and 2016 (132 mg/l and 114 mg/l respectively). It is noted that even though there is an annual trend of increase in ammoniacal nitrogen during August/September, the results for GW3A reported for October 2018 include uncharacteristic peaks in other parameters (TOC, toluene), and may suggest contamination of the sample had occurred, which could have affected the concentration of ammoniacal nitrogen as well.
- 5.3.5 Concentrations in GW4 were on average 3.58 mg/L, lower than the 2017 average of 15.78 mg/L. Concentrations in GW2A increased slightly compared to 2017 with an average of 18.08 mg/l but remained below maximum historical average of 31.64 mg/l in 2014.
- 5.3.6 Average concentrations within the remaining groundwater boreholes ranged between 0.33 mg/l in GW6 and 19.62 mg/l in GW8.
- 5.3.7 As in the 2017 review, GW3A consistently contained the highest concentrations of ammoniacal nitrogen of the groundwater locations. The observed trends will be reviewed further as part of improvement works and the hydrogeological risk assessment of the site.

**Chloride**

- 5.3.8 As in 2017 and 2016, the chloride EP limit (60 mg/l) was exceeded in GW2A and GW3A throughout 2018. At GW4 concentrations increased throughout the review period but remained below the EP limit. For these boreholes, highest chloride concentrations were detected in GW3A, with a maximum of 179 mg/l, a decrease from the previous year's maximum concentration of 361 mg/l.
- 5.3.9 Average chloride concentrations in GW2A, GW3A and GW4 were 128.64 mg/l, 151.14 mg/l and 33.61 mg/l respectively, lower than those in 2017 (149.69 mg/l, 185.46 mg/l and 109.18 mg/l respectively), but comparable to the 2016 results.
- 5.3.10 In GW1, GW.1.1, GW6, GW7 and GW8 the average chloride concentrations were 176.04 mg/l, 226.03 mg/l, 36.4 mg/l, 136.02 mg/l and 134.43 mg/l respectively, similar to 2016 and 2017. Concentrations of chloride at GW5A were considerably lower than the previous year, with an average of 76.37 mg/l.

**Nickel**

- 5.3.11 The compliance limit for nickel (0.15 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2018. The graph in Appendix 3 shows that nickel concentrations in these locations have been below the trigger level since July 2010.

**Zinc**

- 5.3.12 Similarly, to the previous years, the compliance limit for zinc (0.254 mg/l) was not exceeded at GW2A, GW3A or GW4 during 2018. A graph in Appendix 3 shows that this trigger level was not exceeded on any occasion between January 2009 and December 2018.

**Toluene**

- 5.3.13 Toluene was detected above the compliance limit once, in location GW3A only. The concentration, detected in GW3, was 1.13 mg/l during October, however this value exceeds the reported concentrations for all locations at the site in 2018 (and at this location since 2009) by 3 orders of magnitude. The concentration recorded in December was 0.00353 mg/l, below the compliance limit of 0.004 mg/l. It is therefore considered that the toluene concentration for GW3 reported in October is not representative of the concentration at this location, and does not indicate a new pollution event at the site.

**Xylenes**

- 5.3.14 No xylenes were detected in boreholes GW2A, GW3A and GW4, or any of the other groundwater monitoring points between January 2009 and December 2018.

***Benzene***

- 5.3.15 As in the past two reviews, no benzene was detected at any location on any monitoring visit in 2018.

***Annual Suite***

- 5.3.16 Mineral Oil (>C10-C40) was detected in GW3A and GW4 at 0.306 mg/l and 0.144 mg/l respectively. No mineral oils were detected anywhere around the site in 2017, and no other hazardous substances were detected at these two locations. It is recommended that further investigation is carried out to verify if these results are representative.
- 5.3.17 Carbon tetrachloride was detected within GW8 at a concentration of 0.00581 mg/l. None of the other annual screen parameters were detected in any of the groundwater monitoring locations in December 2018. Carbon tetrachloride remained undetected within the leachate suggesting a possible off site source.

## 6.0 SURFACE WATER

### 6.1 Introduction

- 6.1.1 Surface water samples are routinely taken from three locations; SW2, P2 and P4 which are shown on Drawing Number 3031-CAU-XX-XX-DR-O-1802.A0-C1.
- 6.1.2 Water flows in a northerly direction alongside the outside perimeter fence of the western boundary of the site and accumulates in a pond at SW2 before slowly seeping through a man-made underground bypass drain which runs along the outside of the site towards the northern boundary. P2 is a pond to the west, which collects surface water run-off from the landfill. P4 is located in a field to the north west of the site, beyond landfill gas monitoring borehole BH10.
- 6.1.3 No samples have been collected from P2 during this review period.
- 6.1.4 Surface water samples are analysed on a monthly basis for:  
*ammoniacal nitrogen, chloride, chemical oxygen demand (COD), pH and total suspended solids.*
- 6.1.5 In the EP, Table S4.3 requires that only location P2 be controlled by chemical quality limits. As agreed with NRW, water in P2 is only sampled when there is the likelihood of an overflow to the discharge point<sup>1</sup>.
- 6.1.6 A table displaying a summary of the laboratory analysis of the surface water samples from P2, P4 and SW2 collected during 2017 is presented in Appendix 4. Time-series graphs for all parameters between January 2009 and December 2017 are also included in Appendix 4.

### 6.2 Surface Water Quality

#### ***Ammoniacal Nitrogen***

- 6.2.1 The average ammoniacal nitrogen concentration in P4 in 2018 was 4.4 mg/l, a decrease compared to the 2017 average of 5.63 mg/l.
- 6.2.2 SW2 was sampled once during this review period, ammoniacal nitrogen concentration were lower than previous reviews with a concentration of 0.26 mg/L

#### ***Chemical Oxygen Demand (COD)***

- 6.2.3 COD in P4 ranged between 49.3 mg/l and 113 mg/l, a decrease compared to the previous review (2017) where COD concentrations ranged from 81.2 mg/L to 193 mg/L.
- 6.2.4 The COD concentration in SW2 was 46.3 mg/l, similar to the results obtained in 2014 and 2015.

---

<sup>1</sup> E-mail correspondence, 14.07.2014, Alison Soper (NRW) to Phil Mulhall (FCC).

***Chloride***

6.2.5 Concentrations varied between 60.1 mg/L and 86 mg/L in P4. Concentrations slightly increased when compared to the previous review were concentrations ranged from 40 mg/l and 76 mg/l.

6.2.6 A chloride concentration of 139 mg/L was detected in SW2.

***pH***

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

***Suspended Solids***

6.2.8 Average concentrations in these locations during 2018 were 34.5 mg/l and 17.2 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 and flux box survey was undertaken by Caulmert in August 2018. The report is enclosed in Appendix 2.
- 7.2.2 Overall, fewer point source emissions were detected during this survey, 13, than during the previous surface emissions monitoring survey in April 2017, where 24 emissions were recorded. Of the 13 emissions recorded in this survey, none were at the maximum level of detection compared to 14 PSEs which were recorded at the maximum limit in the 2017 survey.
- 7.2.3 Upon remediation of the identified point source emissions identified in the report, the surveyed areas would be compliant with the emission standards in LFTGN07.

### 7.3 Particulates Monitoring

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

**Table 3: Results from dust monitoring at Brookhill**

| Period                                      | Mar-18 | Jun-18 | Sep-18 | Dec-18 | Permit Level |
|---------------------------------------------|--------|--------|--------|--------|--------------|
| Dust Concentration (mg/m <sup>2</sup> /day) |        |        |        |        |              |
| Location 1: Site perimeter                  | <7.06  | 296.40 | 62.63  | 7.76   | 200          |
| Location 2: Industrial estate               | <7.06  | 69.68  | <8.82  | <7.06  | 200          |
| Location 3: Oaks farm                       | <7.06  | 272    | <8.82  | <7.06  | 200          |

- 7.3.2 During the June monitoring round, Algal growth was noted in all the samples collected and particularly at these two locations where a breach of the compliance limit was recorded. This is likely due to the long period of direct sunshine observed during the monitoring period. As such, these results are not considered representative of any impact from the site.
- 7.3.3 All other monitoring results were significantly below the Permit level, and often below the detection limit of the method. This is consistent with the results obtained last year.

## **7.4 Fugitive emissions to water and sewer**

- 7.4.1 Fugitive emissions of substances to water or sewer were controlled by the site ensuring, that all monitored parameters in leachate were below the site EP limits and that leachate levels were kept as low as possible. Groundwater, surface water and any discharges to sewer were monitored for more parameters than required by the EP. The additional parameters analysed are discussed above in the relevant sections of this report.
- 7.4.2 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant was similar to that in 2017. 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 2018 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                         |                                      |
|-----------------------------------------------------|--------------------------------------|
| <b>Leachate:</b>                                    | <b>Cubic metres/year:</b>            |
| Disposed of offsite;                                | 0                                    |
| Disposed of to any onsite effluent treatment plant; | 21,931                               |
| Recirculated into the waste mass.                   | 0                                    |
| <b>Surface water and/or groundwater:</b>            | <b>Cubic metres/year:</b>            |
| Disposed of offsite;                                | 0                                    |
| Disposed of to any onsite effluent treatment plant. | 0                                    |
| <b>Landfill gas:</b>                                | <b>Normalised cubic metres/year:</b> |
| Combustion in flares;                               | 102,500                              |
| Combustion in gas engines;                          | 2,093,500                            |
| Other methods of gas utilisation.                   | 0                                    |

## 9.0 PERFORMANCE PARAMETERS

### 9.1 Introduction

- 9.1.1 The performance parameters at Brookhill during the period 3<sup>rd</sup> of January 2018 and the 3<sup>rd</sup> of January 2019 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<br>(including for leachate treatment) | Annually                | 285.8        | MWh of Electricity |

- 9.1.2 It should be noted that 274.8 MWh of the energy used onsite was energy generated onsite. In addition, a further 2239.69 MWh of energy was exported from the site during the same time period.

## 10.0 TOPOGRAPHICAL SURVEY

### 10.1 Introduction

10.1.1 The latest topographical survey for the site was conducted on the 30<sup>th</sup> April 2018 (survey number 9877a Brookhill) and is appended for reference. Using this survey, and the survey completed in April 2017 an estimate of the settlement was made. The difference between the two surveys was approximately 2,939m<sup>3</sup> over the 12 months between the two surveys. In the preceding 9 months, the settlement was 1,677 m<sup>3</sup> (reported in the 2017 annual review). The data suggests greater settlement in 2018 compared to the previously-reported period. It is noted that the 2018 survey was completed approximately 1 month after the initiation of the leachate extraction from gas wells trial at the site, and may reflect settlement due to increased leachate removal from these wells.

## 11.0 SUMMARY

### 11.1 Landfill gas

11.1.1 Landfill gas in most in-waste boreholes was of good quality for utilisation, with average methane concentration of 45.2 % across the site. Of the 15 new gas extraction wells installed at the site in September/October 2015, GV35 – GV49 the majority are performing well and have a high concentration of methane and low oxygen. The concentration of methane at the utilisation plant was on average higher than that in the in-waste boreholes, suggesting efficient extraction methods.

11.1.2 Annual trace gas monitoring was carried out by Envirodat Air Quality and Environmental Consultants on 4th of June 2017. Of the 29 trace gases, 12 were detected. These were arsenic (as As), acetaldehyde (ethanal), formaldehyde (Methanal), 1-pentene, 1,2-dychloroethylene, benzene, carbon disulphide, dimethyl sulphide, styrene, toluene, trichloroethylene and hydrogen sulphide (see report included in Appendix 1).

11.1.3 Monitoring of the emissions from the flare and landfill gas engine was carried out on the 4<sup>th</sup> of June 2018. Concentrations of NO<sub>2</sub> exceeded the engine emissions limit, but the flare emissions were below the flare emissions limit. CO concentrations at the flare and engine and VOC emissions at the flare were below their respective compliance limits. The VOC concentrations at the engine were recorded as marginally above their respective compliance limits.

11.1.4 Landfill gas concentration were monitored in perimeter monitoring boreholes around the site on a weekly basis. None of the monitored perimeter gas boreholes were in breach of their respective methane compliance limits during 2018. Similarly, carbon dioxide concentrations were below their respective EP limits at all locations.

### 11.2 Leachate

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

11.2.2 In 2018, two cessation tests were undertaken, as part of ongoing leachate dynamics investigation and improvement actions (leachate extraction from gas wells trial). The recorded rest levels from the March cessation test (prior to commencement of the extraction trial) were reported in correspondence reference 3448-CAU-XX-XX-CO-V-9103.A0-C1. The results of the

August trial are included in the extraction trial interpretative report, due to be submitted by the end of February 2018

- 11.2.3 The results from the cessation test show a significant improvement to the resting leachate levels between March and August. These results, their relationship to the surrounding groundwater, and their impact on ongoing leachate management at the site will be considered in detail within the extraction trial interpretation report, due to be completed by the 28<sup>th</sup> February 2019.
- 11.2.4 Leachate samples were analysed quarterly. Leachate quality in LC1B - LC6B during this review period was similar to that during 2017 and 2016. Average ammoniacal nitrogen concentration across the leachate wells appears to have stabilised at concentrations similar to those recorded in 2017, which is consistent with the interpretation of peak leachate strength having been reached in 2011/2012 and leachate strength now decreasing.
- 11.2.5 The chemical analysis of the Final Discharge (FD) from the leachate treatment plant indicates that the efficiency of the leachate treatment plant improved through 2018 with the exception of suspended solid concentrations. Suspended solid concentrations remained below historical maxima, this reflects the improvements made to the operation and infrastructure of the plant in 2016, and adequate ongoing management.

### **11.3 Groundwater**

- 11.3.1 As in 2017, 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 2018. Groundwater levels appear to have increased slightly and are now similar to those reported for 2016.
- 11.3.2 The EP limit for ammoniacal nitrogen of 1.7 mg/l was exceeded in locations GW2A, GW3A and on occasion at GW4 during 2018. Concentrations remained below historic maxima for the site and followed a similar pattern of seasonal variation.
- 11.3.3 The chloride EP limit (60 mg/l) was exceeded in GW2A and GW3A throughout 2018. At GW4, chloride concentrations increased throughout the review period but remained below the EP limit.
- 11.3.4 Zinc and Nickel concentrations remained below the trigger limits in GW2A, GW3 and GW4 throughout 2018. As previously, no xylene, cyanide, mercury was detected in any of the samples.
- 11.3.5 The concentration of toluene at GW3A in October was reported as being above the detection limit. The data for this location on this monitoring round is not consistent with the typical concentrations recorded at this location (including significantly higher TOC concentrations,

toluene concentrations 3 orders of magnitude higher than on any other monitoring occasion, and higher than normal ammoniacal nitrogen). These results suggest that this sample may have been contaminated, and are not considered representative of the overall quality at this location. Mineral Oils (>C10-C40) were also detected in GW3A and GW4, it is recommended that further investigation is carried out to verify if these results are representative.

- 11.3.6 Carbon tetrachloride was detected within GW8, this was not detected within the leachate suggesting a possible off site source. None of the other annual screen parameters were detected in any of the groundwater monitoring locations in December 2018.

#### **11.4 Surface Water**

- 11.4.1 No water quality data was reported at P2.

- 11.4.2 The surface water quality parameters within P4 and SW4 decreased slightly when compared to that in 2017 with the exception of chloride. Chloride concentrations increased slightly but not significantly.

#### **11.5 Fugitive emissions to air**

- 11.5.1 Fugitive emissions to air were monitored by way of an FID Walkover survey and flux box monitoring, completed in August 2018. The report is enclosed in Appendix 2.

#### **11.6 Dust**

- 11.6.1 Dust monitoring results show that dust emissions in the first and third quarter of the year were very low, significantly below the compliance limit of 200 mg/m<sup>2</sup>/day. During the June monitoring round, Algal growth was noted in all the samples collected and particularly at these two locations where a breach of the compliance limit was recorded. This is likely due to the long period of direct sunshine observed during the monitoring period. As such, these results are not considered representative of any impact from the site.

- 11.6.2 All other results were very low, significantly below the compliance limit for the site, as has been reported in recent years.



**DRAWINGS**

3031-CAU-XX-XX-DR-O-1802.A0-C1

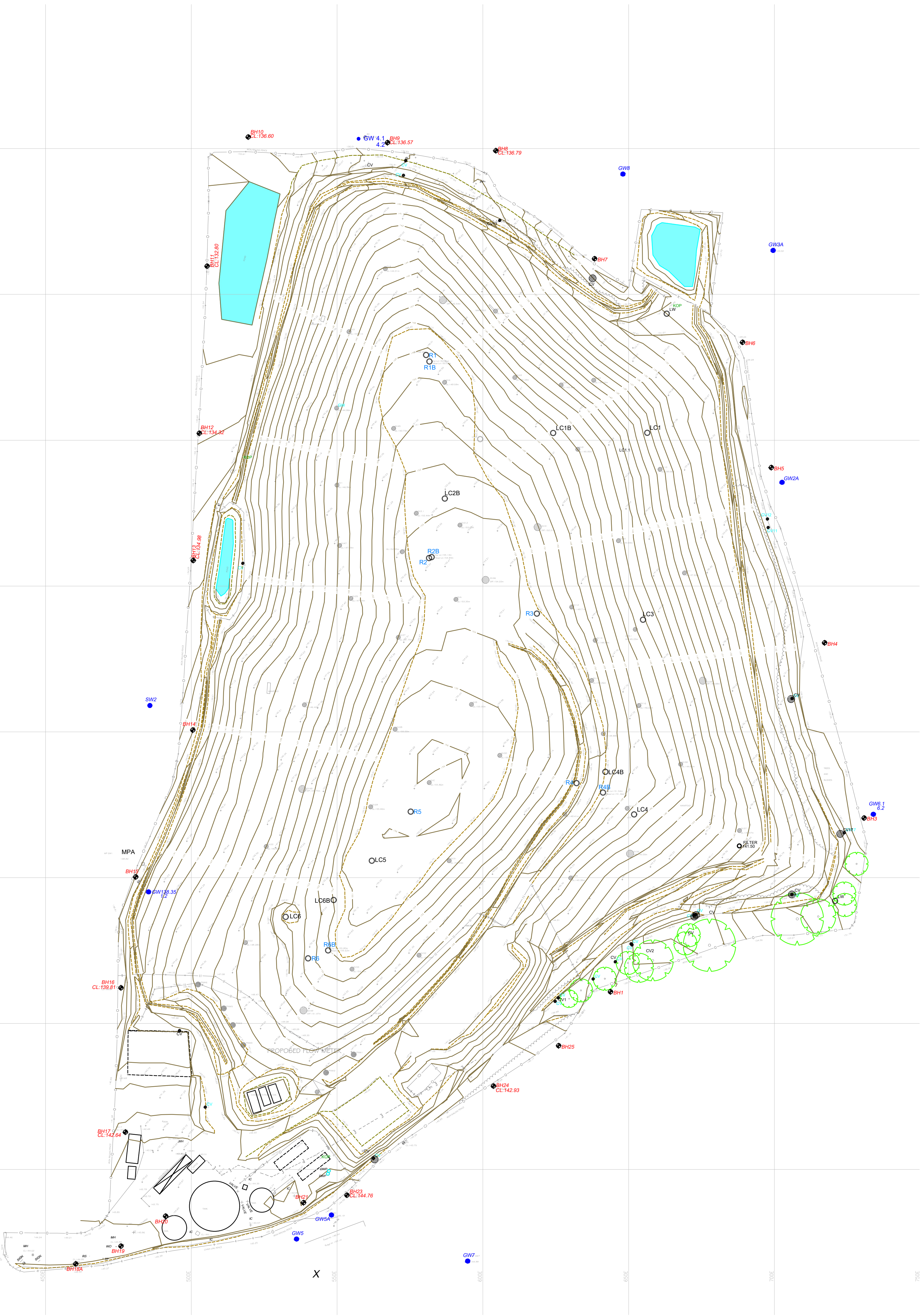
**Environmental Monitoring Plan**

9877a Brookhill 30-04-2018

**2018 topographical survey**

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

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



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

FLINTSHIRE COUNTY  
COUNCIL WASTE  
MANAGEMENT SERVICES

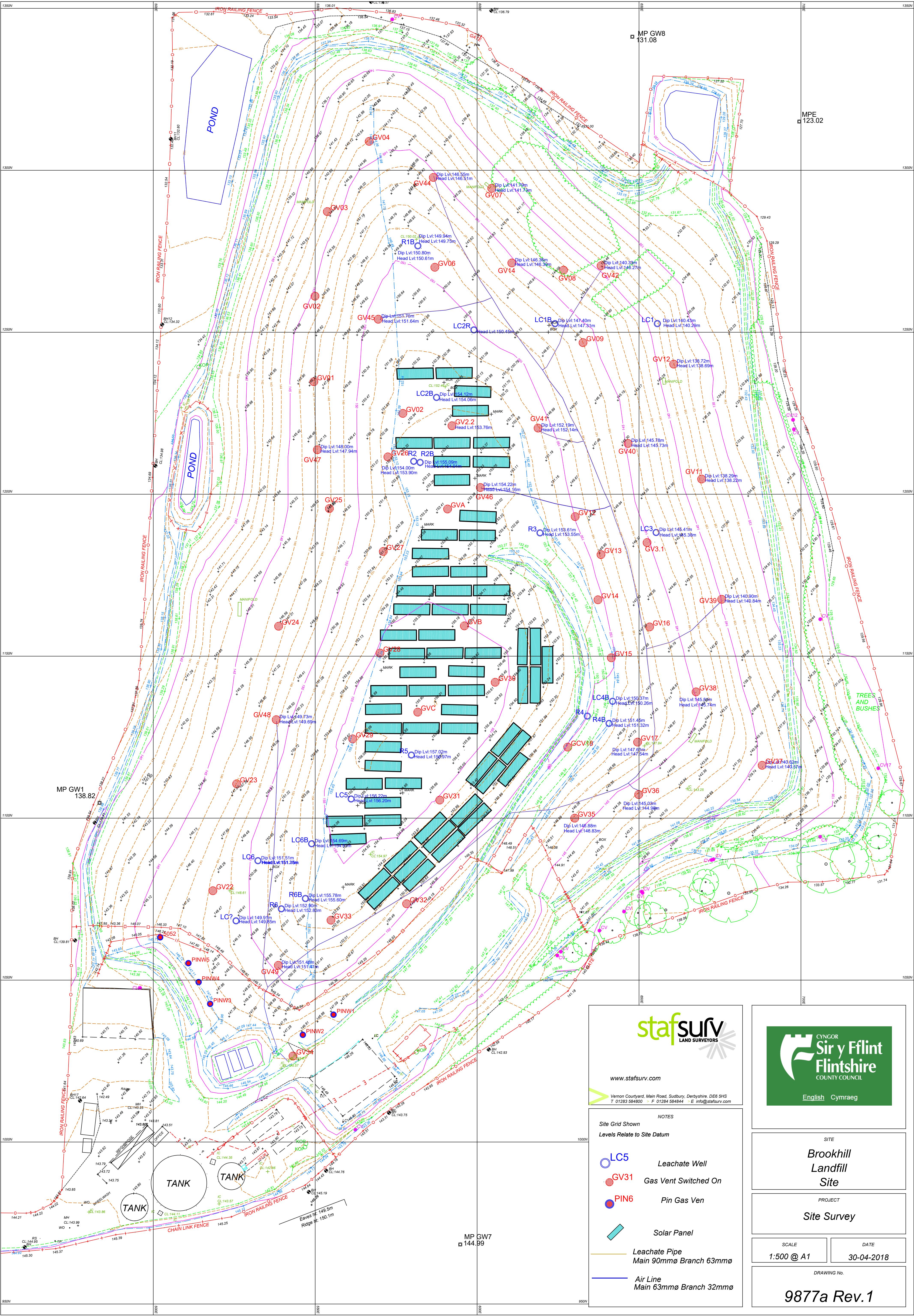
BROOKHILL LANDFILL SITE

ENVIRONMENTAL  
MONITORING PLAN

|             |     |          |             |
|-------------|-----|----------|-------------|
| DRAWN BY    | EJD | DATE     | 30.01.2018  |
| CHECKED BY  | DB  | SCALE    | A1<br>1:750 |
| APPROVED BY | DB  | ISSUE    | S1          |
|             |     | REVISION | P1          |

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





www.stafsurv.com

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

NOTES

Site Grid Shown

Levels Relate to Site Datum

- LC5 Leachate Well
- GV31 Gas Vent Switched On
- PIN6 Pin Gas Ven
- Solar Panel
- Leachate Pipe Main 90mmø Branch 63mmø
- Air Line Main 63mmø Branch 32mmø

English Cymraeg

SITE

Brookhill Landfill Site

PROJECT

Site Survey

SCALE

1:500 @ A1

DATE

30-04-2018

DRAWING No.

9877a Rev.1



**APPENDIX 1**

**Perimeter Landfill Gas Monitoring Summary Table**

**Landfill Gas Time-Series Graphs**

**In Waste Gas Monitoring Summary Table**

**Report number R18202 – Emissions to Air from the Landfill Gas Engine and Flare Stack Located at  
Brookhill Landfill Site, Buckley**

**Report number R18202TG – Analysis of the trace landfill gas**

**Surface Emissions Report (sent separately due to large file size)**

**APPENDIX 1 – LANDFILL GAS**
**Table 1: In-Waste Landfill Gas**

| Location        | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|-----------------|---------|---------|----------------|--------|-----------------|-------------------|
|                 |         | %       | %              | %      | ppm             | ppm               |
| B+CManifold     | Min     | 50.80   | 22.90          | 0.70   | 0.00            | 0.00              |
|                 | Max     | 52.20   | 35.80          | 0.70   | 2.00            | 8.00              |
|                 | Average | 51.50   | 29.35          | 0.70   | 1.00            | 4.00              |
|                 | Count   | 2.00    | 2.00           | 2.00   | 2.00            | 2.00              |
| Flare           | Min     | 50.00   | 35.40          | 0.30   | 0.00            | 0.00              |
|                 | Max     | 53.40   | 36.90          | 0.60   | 2.00            | 2.00              |
|                 | Average | 52.50   | 36.05          | 0.50   | 0.67            | 0.50              |
|                 | Count   | 6.00    | 6.00           | 6.00   | 6.00            | 6.00              |
| GV1             | Min     | 0.00    | 6.50           | 0.00   | 0.00            | 0.00              |
|                 | Max     | 67.80   | 37.30          | 19.00  | 1.00            | 0.00              |
|                 | Average | 35.99   | 26.57          | 8.47   | 0.29            | 0.00              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
| GV10            | Min     | 34.90   | 21.70          | 0.40   | 0.00            | 0.00              |
|                 | Max     | 54.50   | 35.90          | 2.50   | 0.00            | 4.00              |
|                 | Average | 47.66   | 31.10          | 1.40   | 0.00            | 0.50              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 8.00            | 8.00              |
| GV11            | Min     | 24.30   | 25.40          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 57.30   | 35.40          | 2.30   | 1.00            | 2.00              |
|                 | Average | 39.51   | 31.40          | 1.00   | 0.10            | 0.20              |
|                 | Count   | 10.00   | 10.00          | 10.00  | 10.00           | 10.00             |
| GV12            | Min     | 50.70   | 36.80          | 0.10   | 0.00            | 0.00              |
|                 | Max     | 67.00   | 43.30          | 1.10   | 3.00            | 1.00              |
|                 | Average | 58.38   | 40.06          | 0.40   | 0.45            | 0.09              |
|                 | Count   | 11.00   | 11.00          | 11.00  | 11.00           | 11.00             |
| GV12+R3Manifold | Min     | 51.90   | 36.50          | 0.40   | 2.00            | 0.00              |
|                 | Max     | 51.90   | 36.50          | 0.40   | 2.00            | 0.00              |
|                 | Average | 51.90   | 36.50          | 0.40   | 2.00            | 0.00              |
|                 | Count   | 1.00    | 1.00           | 1.00   | 1.00            | 1.00              |
| GV13            | Min     | 0.10    | 3.00           | 7.00   | 0.00            | 0.00              |
|                 | Max     | 11.40   | 19.40          | 19.00  | 1.00            | 0.00              |
|                 | Average | 2.08    | 8.15           | 16.02  | 0.08            | 0.00              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| GV14            | Min     | 52.10   | 36.00          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 61.20   | 44.10          | 0.90   | 2.00            | 6.00              |
|                 | Average | 56.94   | 40.12          | 0.18   | 0.54            | 1.38              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| GV15            | Min     | 51.90   | 36.90          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 60.80   | 44.80          | 2.00   | 2.00            | 8.00              |
|                 | Average | 57.77   | 40.79          | 0.52   | 0.54            | 0.62              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| GV16            | Min     | 21.10   | 11.30          | 0.40   | 0.00            | 0.00              |
|                 | Max     | 57.30   | 40.50          | 14.20  | 2.00            | 4.00              |
|                 | Average | 36.97   | 25.77          | 7.24   | 0.50            | 0.29              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 14.00           | 14.00             |
| GV17            | Min     | 51.20   | 25.10          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 73.60   | 41.20          | 3.90   | 2.00            | 2.00              |
|                 | Average | 64.11   | 35.21          | 0.58   | 0.29            | 0.14              |

**APPENDIX 1 – LANDFILL GAS**

| Location        | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|-----------------|---------|---------|----------------|--------|-----------------|-------------------|
|                 |         | %       | %              | %      | ppm             | ppm               |
|                 | Count   | 13.00   | 13.00          | 13.00  | 14.00           | 14.00             |
| GV18            | Min     | 52.60   | 36.50          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 60.70   | 44.60          | 1.00   | 3.00            | 2.00              |
|                 | Average | 58.62   | 41.60          | 0.22   | 0.77            | 0.23              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| GV2.1           | Min     | 2.50    | 4.70           | 0.90   | 0.00            | 4.00              |
|                 | Max     | 45.90   | 35.40          | 18.00  | 0.00            | 5.00              |
|                 | Average | 17.10   | 15.10          | 11.80  | 0.00            | 4.33              |
|                 | Count   | 3.00    | 3.00           | 3.00   | 3.00            | 3.00              |
| GV2.2           | Min     | 12.60   | 15.90          | 4.00   | 0.00            | 0.00              |
|                 | Max     | 40.00   | 28.70          | 22.30  | 2.00            | 7.00              |
|                 | Average | 26.30   | 22.30          | 13.15  | 1.00            | 3.50              |
|                 | Count   | 2.00    | 2.00           | 2.00   | 2.00            | 2.00              |
| GV202           | Min     | 42.50   | 29.00          | 0.40   | 0.00            | 0.00              |
|                 | Max     | 48.90   | 33.00          | 0.70   | 0.00            | 0.00              |
|                 | Average | 46.28   | 31.55          | 0.58   | 0.00            | 0.00              |
|                 | Count   | 4.00    | 4.00           | 4.00   | 4.00            | 4.00              |
| GV21            | Min     | 40.00   | 23.50          | 0.10   | 0.00            | 0.00              |
|                 | Max     | 64.40   | 41.30          | 5.90   | 3.00            | 0.00              |
|                 | Average | 53.13   | 31.40          | 2.30   | 0.75            | 0.00              |
|                 | Count   | 4.00    | 4.00           | 4.00   | 4.00            | 4.00              |
| GV22            | Min     | 0.00    | 6.80           | 0.00   | 0.00            | 0.00              |
|                 | Max     | 70.00   | 37.80          | 16.90  | 2.00            | 0.00              |
|                 | Average | 51.87   | 30.64          | 3.16   | 0.38            | 0.00              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 8.00            | 8.00              |
| GV23            | Min     | 0.00    | 2.40           | 0.00   | 0.00            | 0.00              |
|                 | Max     | 63.70   | 37.90          | 19.10  | 2.00            | 0.00              |
|                 | Average | 23.86   | 20.55          | 8.43   | 0.18            | 0.00              |
|                 | Count   | 11.00   | 11.00          | 11.00  | 11.00           | 11.00             |
| GV24            | Min     | 55.40   | 35.20          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 66.60   | 38.60          | 0.80   | 3.00            | 8.00              |
|                 | Average | 61.60   | 37.14          | 0.31   | 0.67            | 0.89              |
|                 | Count   | 9.00    | 9.00           | 9.00   | 9.00            | 9.00              |
| GV25            | Min     | 46.60   | 33.00          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 59.50   | 36.00          | 1.00   | 3.00            | 8.00              |
|                 | Average | 52.49   | 34.66          | 0.40   | 0.57            | 1.14              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
| GV26            | Min     | 54.90   | 35.80          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 63.80   | 40.50          | 0.50   | 2.00            | 7.00              |
|                 | Average | 58.69   | 37.72          | 0.13   | 0.50            | 0.58              |
|                 | Count   | 12.00   | 12.00          | 12.00  | 12.00           | 12.00             |
| GV26+27Manifold | Min     | 54.20   | 36.00          | 0.20   | 1.00            | 5.00              |
|                 | Max     | 54.20   | 36.00          | 0.20   | 1.00            | 5.00              |
|                 | Average | 54.20   | 36.00          | 0.20   | 1.00            | 5.00              |
|                 | Count   | 1.00    | 1.00           | 1.00   | 1.00            | 1.00              |
| GV27            | Min     | 52.00   | 34.00          | 0.10   | 0.00            | 0.00              |
|                 | Max     | 66.00   | 41.60          | 0.50   | 1.00            | 2.00              |
|                 | Average | 59.04   | 38.37          | 0.26   | 0.29            | 0.43              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |

**APPENDIX 1 – LANDFILL GAS**

| Location        | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|-----------------|---------|---------|----------------|--------|-----------------|-------------------|
|                 |         | %       | %              | %      | ppm             | ppm               |
| GV28            | Min     | 0.10    | 1.30           | 0.50   | 0.00            | 0.00              |
|                 | Max     | 56.70   | 42.30          | 19.60  | 2.00            | 1.00              |
|                 | Average | 18.26   | 15.92          | 12.48  | 0.23            | 0.08              |
|                 | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| GV28+29Manifold | Min     | 49.80   | 36.00          | 0.50   | 1.00            | 3.00              |
|                 | Max     | 49.80   | 36.00          | 0.50   | 1.00            | 3.00              |
|                 | Average | 49.80   | 36.00          | 0.50   | 1.00            | 3.00              |
|                 | Count   | 1.00    | 1.00           | 1.00   | 1.00            | 1.00              |
| GV29            | Min     | 52.70   | 32.80          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 66.80   | 43.00          | 0.80   | 1.00            | 1.00              |
|                 | Average | 57.74   | 37.97          | 0.22   | 0.18            | 0.18              |
|                 | Count   | 11.00   | 11.00          | 11.00  | 11.00           | 11.00             |
| GV3             | Min     | 60.30   | 29.20          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 74.60   | 36.30          | 0.40   | 1.00            | 2.00              |
|                 | Average | 66.63   | 34.53          | 0.17   | 0.14            | 0.29              |
|                 | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
| GV30            | Min     | 45.90   | 35.30          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 62.70   | 41.30          | 1.10   | 4.00            | 0.00              |
|                 | Average | 56.48   | 38.02          | 0.24   | 0.93            | 0.00              |
|                 | Count   | 14.00   | 14.00          | 14.00  | 14.00           | 14.00             |
| GV301           | Min     | 14.30   | 10.80          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 65.20   | 41.00          | 11.50  | 3.00            | 1.00              |
|                 | Average | 53.83   | 34.29          | 2.18   | 0.50            | 0.06              |
|                 | Count   | 16.00   | 16.00          | 16.00  | 16.00           | 16.00             |
| GV31            | Min     | 48.00   | 30.60          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 60.90   | 39.20          | 0.80   | 5.00            | 2.00              |
|                 | Average | 54.95   | 35.61          | 0.44   | 0.90            | 0.20              |
|                 | Count   | 10.00   | 10.00          | 10.00  | 10.00           | 10.00             |
| GV32            | Min     | 46.90   | 35.40          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 60.30   | 42.10          | 3.10   | 2.00            | 3.00              |
|                 | Average | 56.14   | 39.76          | 0.71   | 0.88            | 0.38              |
|                 | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
| GV33            | Min     | 38.60   | 30.20          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 65.50   | 42.20          | 1.40   | 8.00            | 5.00              |
|                 | Average | 52.77   | 37.69          | 0.40   | 0.80            | 0.33              |
|                 | Count   | 15.00   | 15.00          | 15.00  | 15.00           | 15.00             |
| GV34            | Min     | 20.00   | 16.10          | 1.40   | 0.00            | 0.00              |
|                 | Max     | 44.20   | 35.60          | 1.90   | 2.00            | 2.00              |
|                 | Average | 28.57   | 22.90          | 1.63   | 0.67            | 0.67              |
|                 | Count   | 3.00    | 3.00           | 3.00   | 3.00            | 3.00              |
| GV35            | Min     | 35.60   | 33.50          | 0.20   | 0.00            | 0.00              |
|                 | Max     | 61.40   | 44.50          | 1.50   | 2.00            | 0.00              |
|                 | Average | 55.15   | 39.04          | 0.59   | 0.14            | 0.00              |
|                 | Count   | 22.00   | 22.00          | 22.00  | 22.00           | 22.00             |
| GV36            | Min     | 28.10   | 24.70          | 0.00   | 0.00            | 0.00              |
|                 | Max     | 70.10   | 37.00          | 5.70   | 3.00            | 0.00              |
|                 | Average | 50.89   | 31.76          | 0.77   | 0.16            | 0.00              |
|                 | Count   | 19.00   | 19.00          | 19.00  | 19.00           | 19.00             |
| GV37            | Min     | 22.90   | 21.70          | 0.00   | 0.00            | 0.00              |

**APPENDIX 1 – LANDFILL GAS**

| Location | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|----------|---------|---------|----------------|--------|-----------------|-------------------|
|          |         | %       | %              | %      | ppm             | ppm               |
|          | Max     | 67.60   | 37.60          | 2.80   | 4.00            | 3.00              |
|          | Average | 52.87   | 32.99          | 1.01   | 0.29            | 0.18              |
|          | Count   | 17.00   | 17.00          | 17.00  | 17.00           | 17.00             |
|          | Min     | 36.40   | 30.40          | 0.00   | 0.00            | 0.00              |
| GV38     | Max     | 66.40   | 39.10          | 1.70   | 1.00            | 2.00              |
|          | Average | 57.20   | 35.36          | 0.75   | 0.11            | 0.11              |
|          | Count   | 19.00   | 19.00          | 19.00  | 19.00           | 19.00             |
|          | Min     | 1.70    | 3.00           | 0.00   | 0.00            | 0.00              |
| GV39     | Max     | 68.80   | 36.30          | 16.10  | 2.00            | 1.00              |
|          | Average | 51.09   | 30.54          | 2.22   | 0.24            | 0.12              |
|          | Count   | 17.00   | 17.00          | 17.00  | 17.00           | 17.00             |
|          | Min     | 32.10   | 21.50          | 0.70   | 0.00            | 0.00              |
| GV4      | Max     | 71.40   | 33.60          | 6.70   | 3.00            | 0.00              |
|          | Average | 61.11   | 28.98          | 2.23   | 0.50            | 0.00              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 46.30   | 31.40          | 0.00   | 0.00            | 0.00              |
| GV40     | Max     | 57.50   | 37.50          | 2.90   | 1.00            | 1.00              |
|          | Average | 52.11   | 34.64          | 0.86   | 0.06            | 0.06              |
|          | Count   | 18.00   | 18.00          | 18.00  | 18.00           | 18.00             |
|          | Min     | 48.50   | 30.90          | 0.00   | 0.00            | 0.00              |
| GV41     | Max     | 63.30   | 41.20          | 2.00   | 5.00            | 4.00              |
|          | Average | 59.08   | 38.62          | 0.61   | 1.20            | 0.27              |
|          | Count   | 14.00   | 14.00          | 14.00  | 15.00           | 15.00             |
|          | Min     | 0.00    | 3.60           | 1.40   | 0.00            | 0.00              |
| GV42     | Max     | 66.70   | 31.10          | 19.50  | 0.00            | 0.00              |
|          | Average | 32.94   | 16.03          | 10.44  | 0.00            | 0.00              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 26.70   | 18.40          | 0.10   | 0.00            | 0.00              |
| GV43     | Max     | 65.10   | 37.80          | 9.80   | 1.00            | 0.00              |
|          | Average | 52.08   | 31.95          | 1.99   | 0.13            | 0.00              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 12.70   | 21.30          | 0.00   | 0.00            | 0.00              |
| GV44     | Max     | 57.10   | 35.90          | 4.90   | 2.00            | 2.00              |
|          | Average | 37.39   | 27.59          | 1.71   | 0.13            | 0.13              |
|          | Count   | 15.00   | 15.00          | 15.00  | 15.00           | 15.00             |
|          | Min     | 25.20   | 18.10          | 0.00   | 0.00            | 0.00              |
| GV45     | Max     | 64.50   | 40.80          | 11.10  | 1.00            | 0.00              |
|          | Average | 47.26   | 33.37          | 1.49   | 0.06            | 0.00              |
|          | Count   | 17.00   | 17.00          | 17.00  | 17.00           | 17.00             |
|          | Min     | 28.30   | 22.40          | 0.00   | 0.00            | 0.00              |
| GV46     | Max     | 60.90   | 45.50          | 8.30   | 5.00            | 5.00              |
|          | Average | 50.55   | 37.88          | 1.61   | 0.94            | 0.28              |
|          | Count   | 18.00   | 18.00          | 18.00  | 18.00           | 18.00             |
|          | Min     | 0.00    | 2.30           | 0.00   | 0.00            | 0.00              |
| GV47     | Max     | 55.00   | 53.80          | 19.10  | 7.00            | 0.00              |
|          | Average | 35.08   | 30.25          | 4.55   | 1.50            | 0.00              |
|          | Count   | 6.00    | 6.00           | 6.00   | 6.00            | 6.00              |
|          | Min     | 47.50   | 33.60          | 0.00   | 0.00            | 0.00              |
| GV48     | Max     | 68.10   | 40.00          | 3.80   | 2.00            | 2.00              |

**APPENDIX 1 – LANDFILL GAS**

| Location | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|----------|---------|---------|----------------|--------|-----------------|-------------------|
|          |         | %       | %              | %      | ppm             | ppm               |
| GV49     | Average | 59.97   | 36.79          | 1.51   | 0.60            | 0.60              |
|          | Count   | 10.00   | 10.00          | 10.00  | 10.00           | 10.00             |
|          | Min     | 37.40   | 27.00          | 0.00   | 0.00            | 0.00              |
|          | Max     | 61.80   | 42.90          | 2.40   | 2.00            | 0.00              |
| GV6      | Average | 53.96   | 37.77          | 0.64   | 0.28            | 0.00              |
|          | Count   | 18.00   | 18.00          | 18.00  | 18.00           | 18.00             |
|          | Min     | 0.10    | 5.20           | 1.10   | 0.00            | 0.00              |
|          | Max     | 62.50   | 36.40          | 18.50  | 4.00            | 1.00              |
| GV7      | Average | 30.19   | 22.49          | 8.31   | 0.57            | 0.14              |
|          | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
|          | Min     | 18.80   | 22.40          | 0.10   | 0.00            | 0.00              |
|          | Max     | 65.20   | 35.90          | 1.30   | 0.00            | 3.00              |
| GV8      | Average | 52.91   | 31.28          | 0.66   | 0.00            | 0.38              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 15.20   | 11.90          | 0.20   | 0.00            | 0.00              |
|          | Max     | 34.30   | 34.60          | 13.30  | 8.00            | 2.00              |
| GV9      | Average | 26.57   | 19.74          | 8.54   | 1.71            | 0.29              |
|          | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
|          | Min     | 40.00   | 30.90          | 0.00   | 0.00            | 0.00              |
|          | Max     | 63.50   | 39.70          | 2.00   | 6.00            | 0.00              |
| GVA      | Average | 57.46   | 35.52          | 0.59   | 0.53            | 0.00              |
|          | Count   | 17.00   | 17.00          | 17.00  | 17.00           | 17.00             |
|          | Min     | 23.20   | 19.50          | 0.70   | 0.00            | 0.00              |
|          | Max     | 62.60   | 39.30          | 7.00   | 18.00           | 0.00              |
| GVB      | Average | 36.21   | 26.38          | 4.51   | 4.33            | 0.00              |
|          | Count   | 9.00    | 9.00           | 9.00   | 9.00            | 9.00              |
|          | Min     | 52.10   | 34.70          | 0.00   | 0.00            | 0.00              |
|          | Max     | 63.40   | 41.50          | 1.70   | 1.00            | 0.00              |
| GVC      | Average | 58.28   | 36.79          | 0.51   | 0.38            | 0.00              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 58.40   | 35.40          | 0.00   | 0.00            | 0.00              |
|          | Max     | 67.60   | 42.90          | 0.70   | 2.00            | 1.00              |
| LC1B     | Average | 61.36   | 39.83          | 0.21   | 0.89            | 0.11              |
|          | Count   | 9.00    | 9.00           | 9.00   | 9.00            | 9.00              |
|          | Min     | 0.00    | 2.20           | 2.50   | 0.00            | 0.00              |
|          | Max     | 37.50   | 34.20          | 20.70  | 1.00            | 4.00              |
| LC2B     | Average | 5.20    | 7.71           | 15.88  | 0.08            | 0.31              |
|          | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
|          | Min     | 0.80    | 3.10           | 2.50   | 0.00            | 0.00              |
|          | Max     | 69.00   | 34.20          | 18.10  | 2.00            | 4.00              |
| LC2R     | Average | 22.98   | 16.68          | 10.19  | 0.17            | 0.33              |
|          | Count   | 12.00   | 12.00          | 12.00  | 12.00           | 12.00             |
|          | Min     | 44.00   | 31.60          | 0.10   | 0.00            | 0.00              |
|          | Max     | 63.20   | 36.50          | 0.60   | 3.00            | 1.00              |
| LC3      | Average | 57.14   | 33.50          | 0.28   | 0.50            | 0.25              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
|          | Min     | 4.00    | 6.20           | 2.00   | 0.00            | 0.00              |
|          | Max     | 55.00   | 37.10          | 18.20  | 2.00            | 1.00              |
|          | Average | 28.84   | 16.79          | 11.18  | 0.15            | 0.08              |

**APPENDIX 1 – LANDFILL GAS**

| Location | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|----------|---------|---------|----------------|--------|-----------------|-------------------|
|          |         | %       | %              | %      | ppm             | ppm               |
| LC3.1    | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
|          | Min     | 36.80   | 35.00          | 1.20   | 0.00            | 0.00              |
|          | Max     | 48.60   | 36.90          | 2.30   | 1.00            | 2.00              |
|          | Average | 40.80   | 35.70          | 1.83   | 0.33            | 0.67              |
|          | Count   | 3.00    | 3.00           | 3.00   | 3.00            | 3.00              |
| LC4      | Min     | 0.00    | 7.20           | 0.10   | 0.00            | 0.00              |
|          | Max     | 64.40   | 49.00          | 14.70  | 48.00           | 4.00              |
|          | Average | 32.86   | 27.16          | 5.78   | 11.64           | 0.29              |
|          | Count   | 14.00   | 14.00          | 14.00  | 14.00           | 14.00             |
| LC4B     | Min     | 34.50   | 28.60          | 0.00   | 0.00            | 0.00              |
|          | Max     | 60.50   | 43.80          | 6.80   | 3.00            | 1.00              |
|          | Average | 51.25   | 38.32          | 2.10   | 0.79            | 0.07              |
|          | Count   | 12.00   | 12.00          | 12.00  | 14.00           | 14.00             |
| LC5      | Min     | 0.50    | 6.10           | 1.90   | 0.00            | 0.00              |
|          | Max     | 62.00   | 40.40          | 17.60  | 1.00            | 5.00              |
|          | Average | 31.54   | 25.77          | 7.00   | 0.23            | 0.38              |
|          | Count   | 13.00   | 13.00          | 13.00  | 13.00           | 13.00             |
| LC6      | Min     | 0.10    | 2.90           | 0.00   | 0.00            | 0.00              |
|          | Max     | 60.10   | 42.20          | 20.20  | 0.00            | 0.00              |
|          | Average | 25.63   | 23.87          | 7.78   | 0.00            | 0.00              |
|          | Count   | 10.00   | 10.00          | 10.00  | 10.00           | 10.00             |
| LC6B     | Min     | 45.20   | 33.60          | 0.00   | 0.00            | 0.00              |
|          | Max     | 64.30   | 44.10          | 2.70   | 5.00            | 5.00              |
|          | Average | 56.25   | 39.18          | 0.56   | 0.42            | 0.26              |
|          | Count   | 19.00   | 19.00          | 19.00  | 19.00           | 19.00             |
| PW1      | Min     | 0.00    | 2.30           | 7.90   | 0.00            | 0.00              |
|          | Max     | 25.50   | 13.00          | 20.30  | 0.00            | 6.00              |
|          | Average | 7.96    | 6.45           | 15.35  | 0.00            | 0.75              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
| PW2      | Min     | 4.50    | 6.30           | 1.40   | 0.00            | 0.00              |
|          | Max     | 51.20   | 32.90          | 19.90  | 2.00            | 5.00              |
|          | Average | 18.77   | 14.85          | 12.27  | 0.33            | 0.83              |
|          | Count   | 6.00    | 6.00           | 6.00   | 6.00            | 6.00              |
| PW3      | Min     | 1.30    | 7.60           | 3.90   | 0.00            | 0.00              |
|          | Max     | 42.20   | 20.00          | 17.20  | 0.00            | 0.00              |
|          | Average | 17.17   | 13.71          | 11.04  | 0.00            | 0.00              |
|          | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
| PW4      | Min     | 4.20    | 10.50          | 0.50   | 0.00            | 0.00              |
|          | Max     | 39.90   | 26.20          | 28.00  | 0.00            | 0.00              |
|          | Average | 24.17   | 21.61          | 11.07  | 0.00            | 0.00              |
|          | Count   | 7.00    | 7.00           | 7.00   | 7.00            | 7.00              |
| PW5      | Min     | 8.70    | 16.60          | 0.00   | 0.00            | 0.00              |
|          | Max     | 64.60   | 38.50          | 10.60  | 0.00            | 1.00              |
|          | Average | 46.24   | 30.64          | 1.76   | 0.00            | 0.13              |
|          | Count   | 8.00    | 8.00           | 8.00   | 8.00            | 8.00              |
| PW6      | Min     | 4.50    | 8.50           | 4.50   | 0.00            | 0.00              |
|          | Max     | 22.40   | 30.90          | 12.60  | 1.00            | 0.00              |
|          | Average | 12.40   | 17.46          | 9.94   | 0.20            | 0.00              |
|          | Count   | 5.00    | 5.00           | 5.00   | 5.00            | 5.00              |

**APPENDIX 1 – LANDFILL GAS**

| Location       | Data    | Methane | Carbon Dioxide | Oxygen | Carbon Monoxide | Hydrogen Sulphide |
|----------------|---------|---------|----------------|--------|-----------------|-------------------|
|                |         | %       | %              | %      | ppm             | ppm               |
| R1             | Min     | 39.60   | 28.30          | 0.00   | 0.00            | 0.00              |
|                | Max     | 68.50   | 37.20          | 2.80   | 1.00            | 1.00              |
|                | Average | 53.65   | 33.45          | 1.16   | 0.18            | 0.09              |
|                | Count   | 11.00   | 11.00          | 11.00  | 11.00           | 11.00             |
| R1+R1BManifold | Min     | 54.00   | 29.80          | 0.60   | 0.00            | 0.00              |
|                | Max     | 65.50   | 36.90          | 1.40   | 2.00            | 2.00              |
|                | Average | 59.90   | 34.23          | 0.87   | 0.67            | 0.67              |
|                | Count   | 3.00    | 3.00           | 3.00   | 3.00            | 3.00              |
| R1B            | Min     | 39.40   | 30.30          | 0.20   | 0.00            | 0.00              |
|                | Max     | 72.10   | 38.80          | 1.30   | 3.00            | 3.00              |
|                | Average | 55.56   | 34.50          | 0.72   | 0.31            | 0.19              |
|                | Count   | 16.00   | 16.00          | 16.00  | 16.00           | 16.00             |
| R2B            | Min     | 52.10   | 32.90          | 0.00   | 0.00            | 0.00              |
|                | Max     | 69.40   | 41.50          | 2.80   | 1.00            | 5.00              |
|                | Average | 62.41   | 36.81          | 0.64   | 0.08            | 0.42              |
|                | Count   | 12.00   | 12.00          | 12.00  | 12.00           | 12.00             |
| R3             | Min     | 0.00    | 3.00           | 0.00   | 0.00            | 0.00              |
|                | Max     | 65.10   | 38.40          | 19.60  | 3.00            | 0.00              |
|                | Average | 37.22   | 24.40          | 6.26   | 0.50            | 0.00              |
|                | Count   | 18.00   | 18.00          | 18.00  | 18.00           | 18.00             |
| R4B            | Min     | 43.50   | 30.50          | 0.00   | 0.00            | 0.00              |
|                | Max     | 66.40   | 41.60          | 6.00   | 2.00            | 2.00              |
|                | Average | 57.11   | 37.92          | 0.74   | 0.46            | 0.15              |
|                | Count   | 12.00   | 12.00          | 12.00  | 13.00           | 13.00             |
| R5             | Min     | 0.50    | 6.50           | 0.20   | 0.00            | 0.00              |
|                | Max     | 35.90   | 30.00          | 18.50  | 1.00            | 0.00              |
|                | Average | 13.78   | 16.00          | 7.47   | 0.10            | 0.00              |
|                | Count   | 10.00   | 10.00          | 10.00  | 10.00           | 10.00             |
| R6B            | Min     | 51.70   | 33.60          | 0.00   | 0.00            | 0.00              |
|                | Max     | 62.70   | 43.40          | 0.90   | 2.00            | 3.00              |
|                | Average | 57.39   | 39.79          | 0.26   | 0.42            | 0.25              |
|                | Count   | 12.00   | 12.00          | 12.00  | 12.00           | 12.00             |

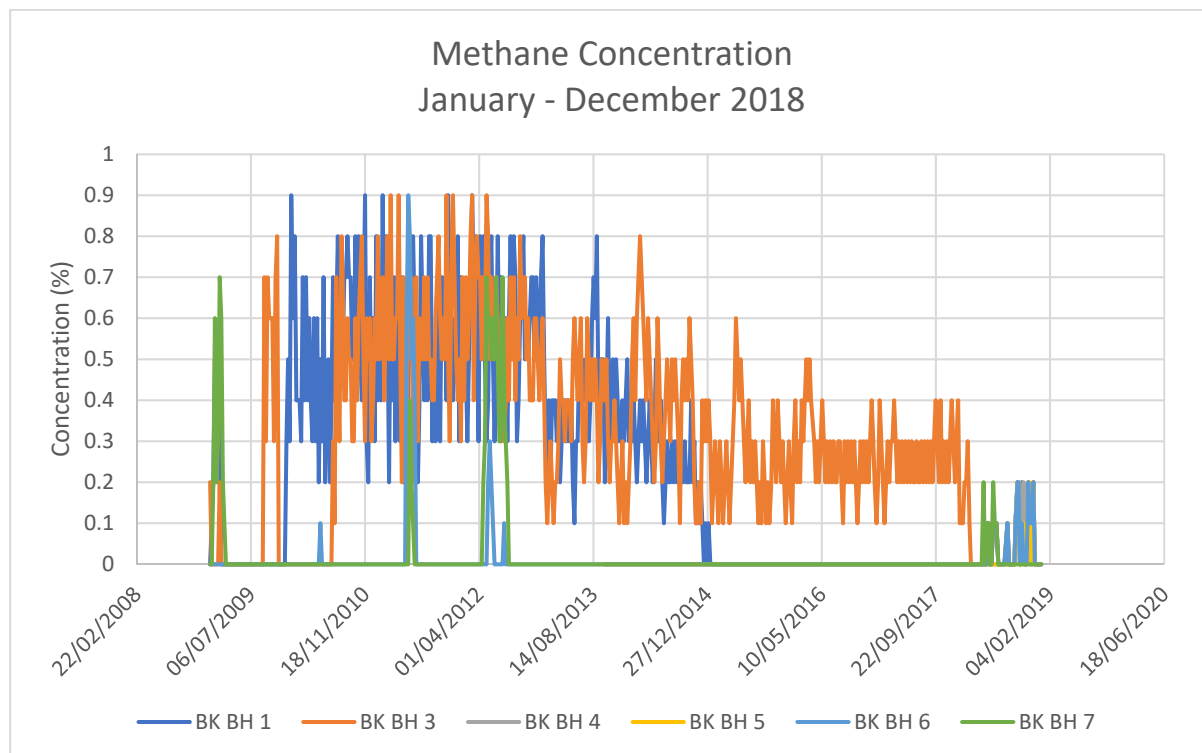
**APPENDIX 1 – LANDFILL GAS**
**Table 2: Perimeter Landfill Gas (% v/v)**

| Location | Data    | CH4 (%v/v) | Trigger (%v/v) | CO2 (%v/v) | Trigger (%v/v) |
|----------|---------|------------|----------------|------------|----------------|
| BK BH 1  | Min     | 0.00       | 1              | 0.00       | 8.8            |
|          | Average | 0.04       |                | 0.67       |                |
|          | Max     | 0.20       |                | 1.80       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 3  | Min     | 0.00       | 1              | 0.00       | 3.1            |
|          | Average | 0.06       |                | 1.27       |                |
|          | Max     | 0.30       |                | 2.60       |                |
|          | Count   | 50.00      |                | 50.00      |                |
| BK BH 4  | Min     | 0.00       | 1              | 0.00       | 5.1            |
|          | Average | 0.06       |                | 2.98       |                |
|          | Max     | 0.20       |                | 5.00       |                |
|          | Count   | 23.00      |                | 23.00      |                |
| BK BH 5  | Min     | 0.00       | 1              | 0.20       | 1.5            |
|          | Average | 0.04       |                | 0.94       |                |
|          | Max     | 0.20       |                | 1.40       |                |
|          | Count   | 30.00      |                | 30.00      |                |
| BK BH 6  | Min     | 0.00       | 1              | 0.10       | 1.5            |
|          | Average | 0.03       |                | 0.80       |                |
|          | Max     | 0.20       |                | 1.40       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 7  | Min     | 0.00       | 1              | 0.00       | 10             |
|          | Average | 0.02       |                | 1.04       |                |
|          | Max     | 0.20       |                | 2.50       |                |
|          | Count   | 48.00      |                | 48.00      |                |
| BK BH 8  | Min     | 0.50       | 32.2           | 0.40       | 3.6            |
|          | Average | 10.08      |                | 2.64       |                |
|          | Max     | 28.60      |                | 3.50       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 9  | Min     | 5.80       | 29.6           | 2.90       | 10.4           |
|          | Average | 16.12      |                | 7.82       |                |
|          | Max     | 27.90      |                | 10.30      |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 10 | Min     | 0.00       | 1              | 0.00       | 3.9            |
|          | Average | 0.02       |                | 1.00       |                |
|          | Max     | 0.20       |                | 1.90       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 11 | Min     | 0.00       | 1              | 0.20       | 6.5            |
|          | Average | 0.04       |                | 2.09       |                |
|          | Max     | 0.20       |                | 5.30       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 12 | Min     | 0.00       | 1              | 0.30       | 6.6            |
|          | Average | 0.04       |                | 3.02       |                |
|          | Max     | 0.20       |                | 6.20       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 13 | Min     | 0.00       | 1              | 0.20       | 9.4            |
|          | Average | 0.04       |                | 1.90       |                |
|          | Max     | 0.20       |                | 4.20       |                |
|          | Count   | 51.00      |                | 51.00      |                |

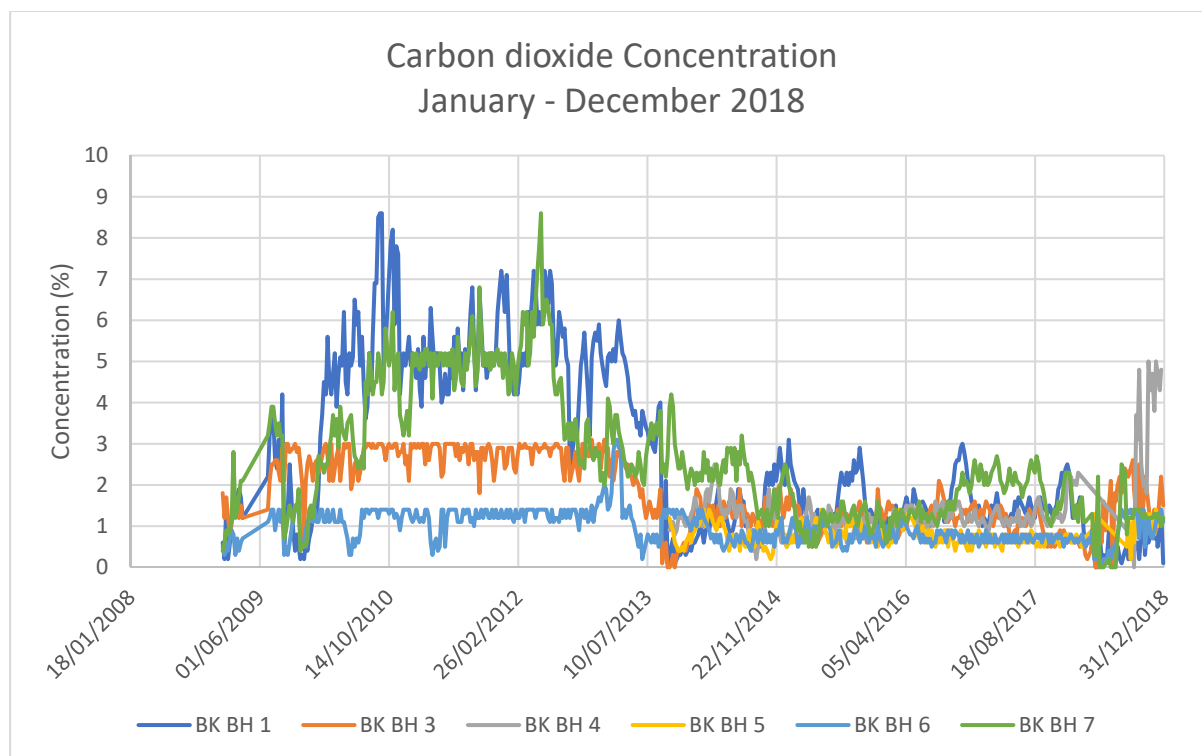
**APPENDIX 1 – LANDFILL GAS**

| Location | Data    | CH4 (%v/v) | Trigger (%v/v) | CO2 (%v/v) | Trigger (%v/v) |
|----------|---------|------------|----------------|------------|----------------|
| BK BH 14 | Min     | 0.00       | 1              | 0.00       | 3.5            |
|          | Average | 0.04       |                | 0.49       |                |
|          | Max     | 0.30       |                | 1.70       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 15 | Min     | 0.00       | 1              | 0.00       | 17.6           |
|          | Average | 0.03       |                | 0.67       |                |
|          | Max     | 0.20       |                | 2.90       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 16 | Min     | 0.00       | 1              | 0.00       | 11.4           |
|          | Average | 0.15       |                | 1.54       |                |
|          | Max     | 0.80       |                | 6.00       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 17 | Min     | 0.00       | 1              | 0.00       | 12.9           |
|          | Average | 0.06       |                | 0.87       |                |
|          | Max     | 0.30       |                | 3.00       |                |
|          | Count   | 49.00      |                | 49.00      |                |
| BK BH 18 | Min     | 0.00       | 1              | 0.00       | 21.2           |
|          | Average | 0.09       |                | 2.75       |                |
|          | Max     | 0.80       |                | 10.30      |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 19 | Min     | 0.00       | 1              | 0.00       | 11.2           |
|          | Average | 0.10       |                | 1.21       |                |
|          | Max     | 0.80       |                | 3.40       |                |
|          | Count   | 51.00      |                | 51.00      |                |
| BK BH 20 | Min     | 0.00       | 1              | 0.90       | 10.7           |
|          | Average | 0.04       |                | 4.11       |                |
|          | Max     | 0.20       |                | 9.30       |                |
|          | Count   | 14.00      |                | 13.00      |                |
| BK BH 21 | Min     | 0.00       | 1              | 0.40       | 21.7           |
|          | Average | 0.08       |                | 3.23       |                |
|          | Max     | 0.40       |                | 9.80       |                |
|          | Count   | 46.00      |                | 46.00      |                |
| BK BH 23 | Count   | 0.00       | 1              | 0.60       | 7.3            |
|          | Min     | 0.04       |                | 3.78       |                |
|          | Average | 0.20       |                | 5.90       |                |
|          | Max     | 51.00      |                | 51.00      |                |
| BK BH 24 | Count   | 0.00       | 1              | 0.00       | 1.5            |
|          | Min     | 0.03       |                | 0.68       |                |
|          | Average | 0.20       |                | 1.40       |                |
|          | Max     | 51.00      |                | 51.00      |                |
| BK BH 25 | Count   | 0.00       | 1              | 0.00       | 9.9            |
|          | Min     | 0.04       |                | 1.62       |                |
|          | Average | 0.20       |                | 3.70       |                |
|          | Max     | 51.00      |                | 51.00      |                |

**APPENDIX 1 – LANDFILL GAS**

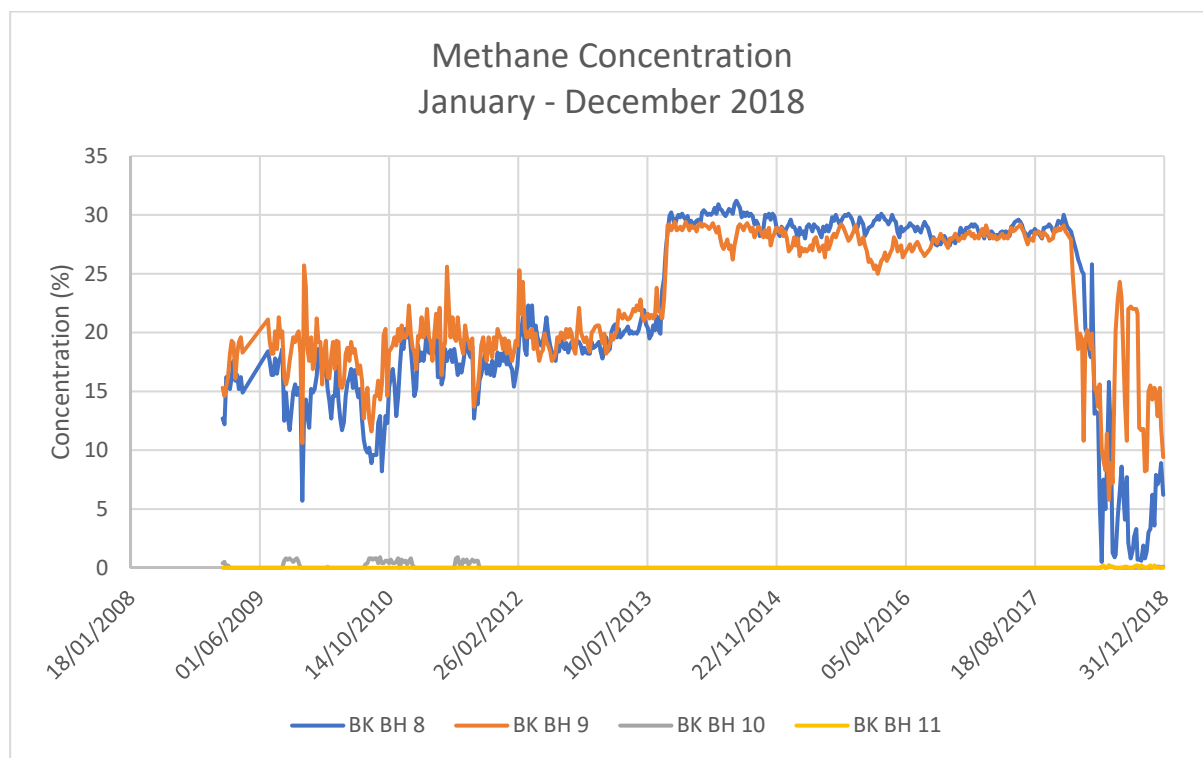


**Graph 1a: Perimeter Landfill Gas - Methane concentration in BH1, BH3, BH4, BH5, BH6 and BH7**

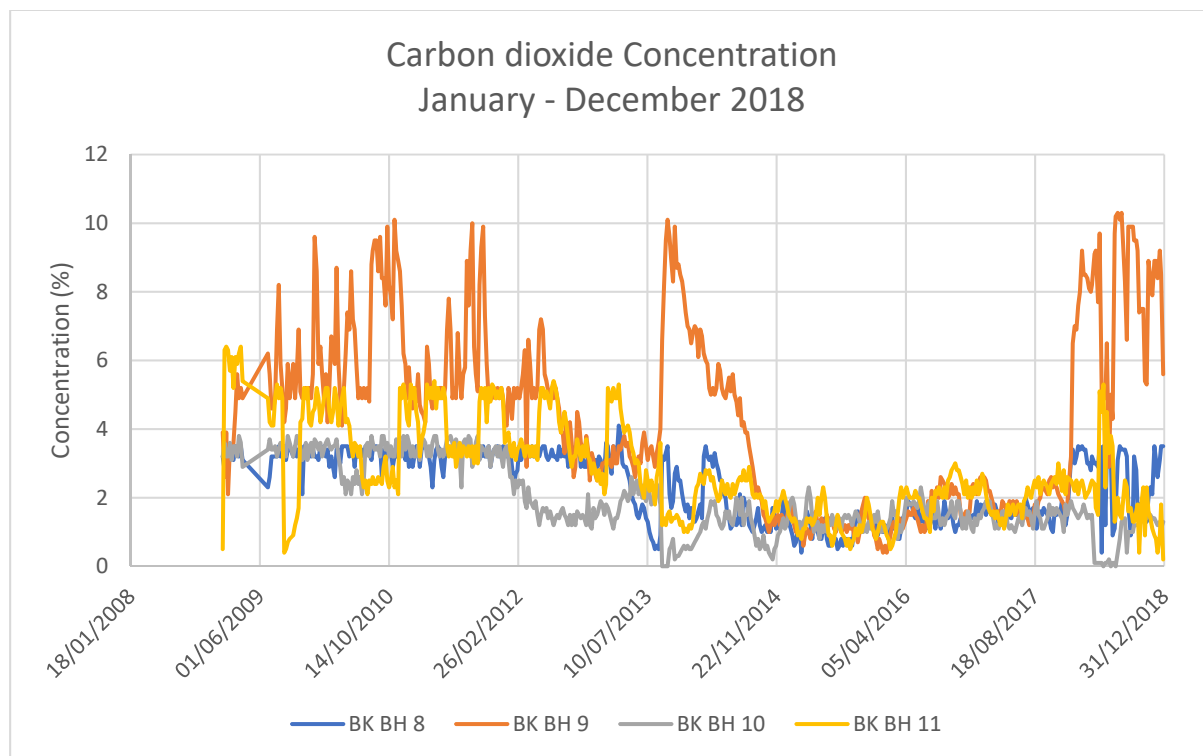


**Graph 1b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH1, BH3, BH4, BH5, BH6 and BH7**

**APPENDIX 1 – LANDFILL GAS**

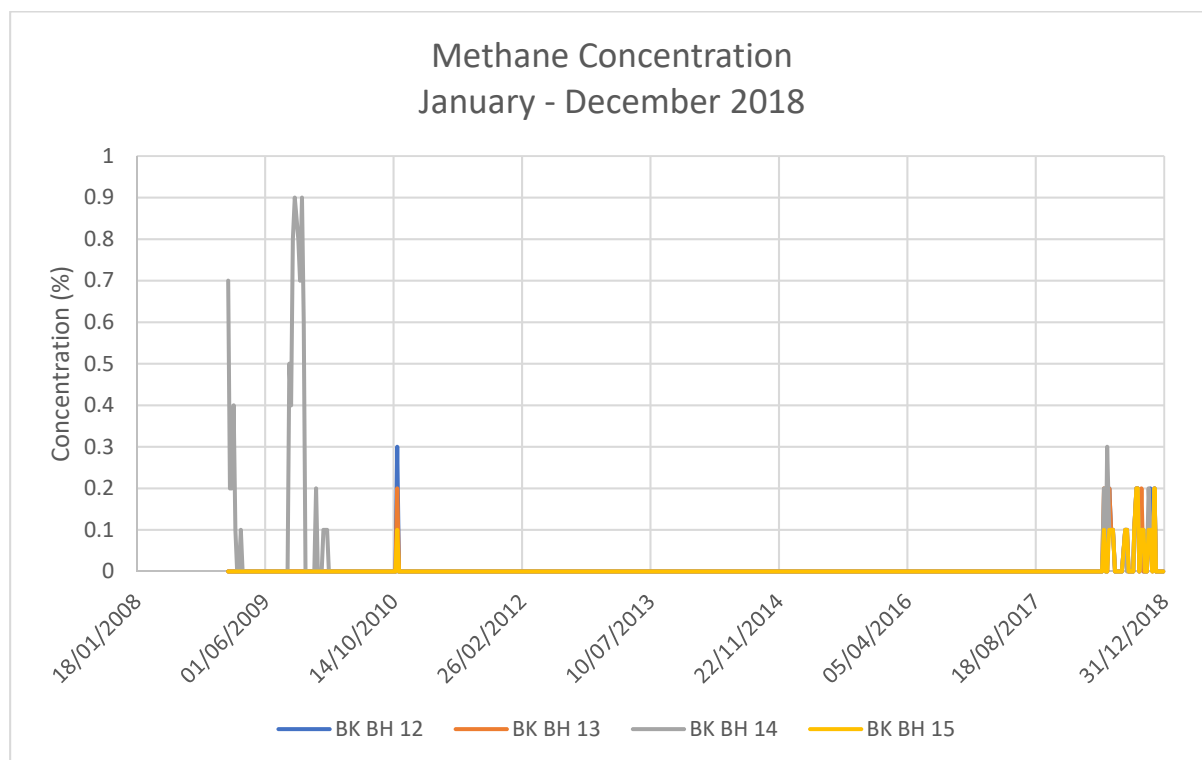


**Graph 2a: Perimeter Landfill Gas - Methane concentration in BH08, BH09, BH10 and BH11**

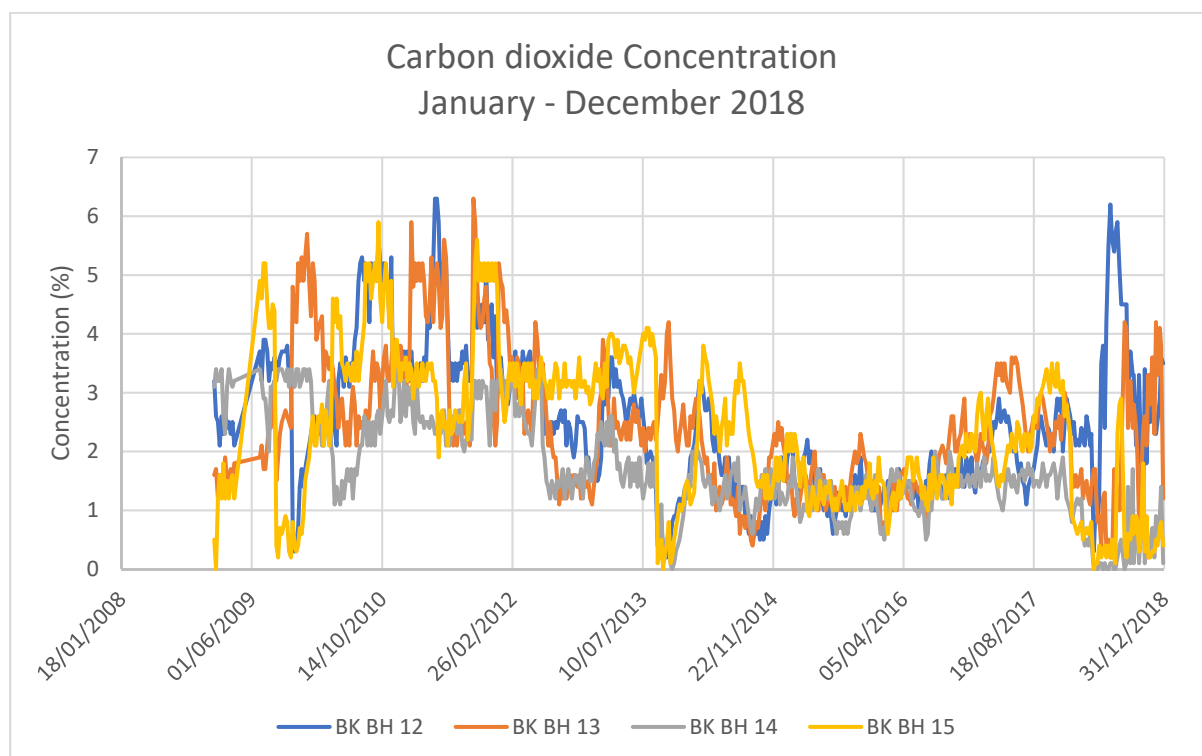


**Graph 2b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH08, BH09, BH10 and BH11**

**APPENDIX 1 – LANDFILL GAS**

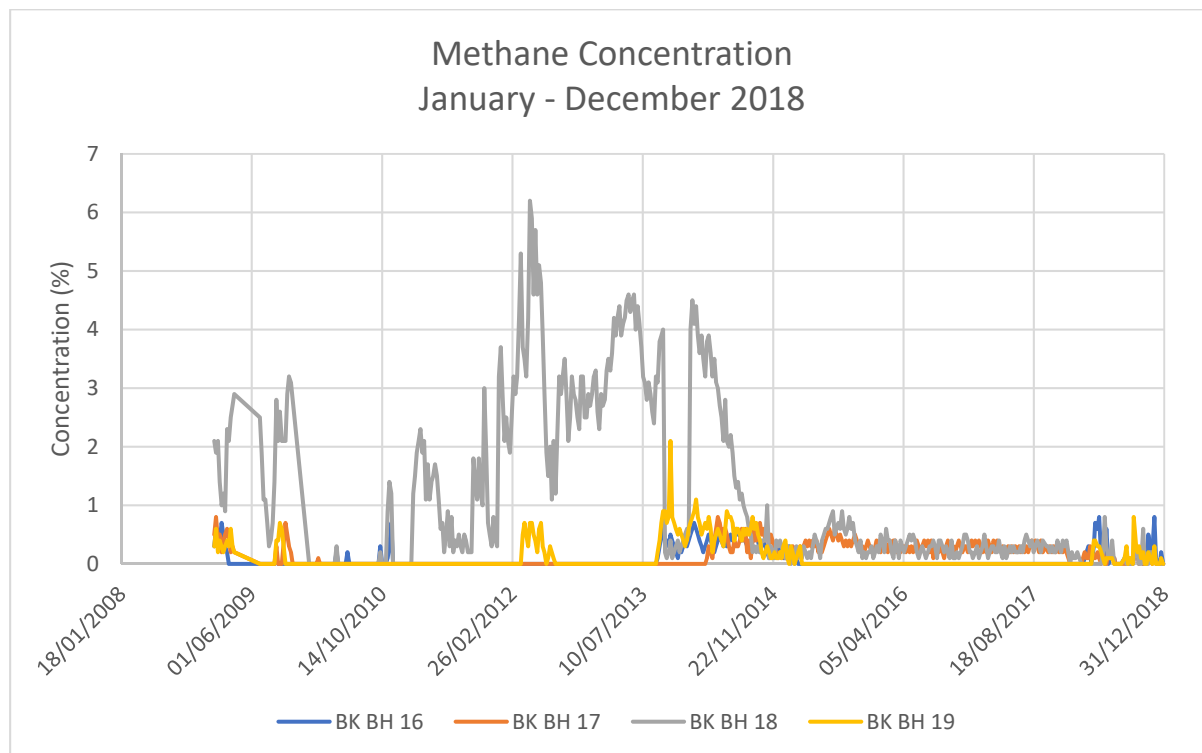


**Graph 3a: Perimeter Landfill Gas - Methane concentration in BH12, BH13, BH14 and BH15**

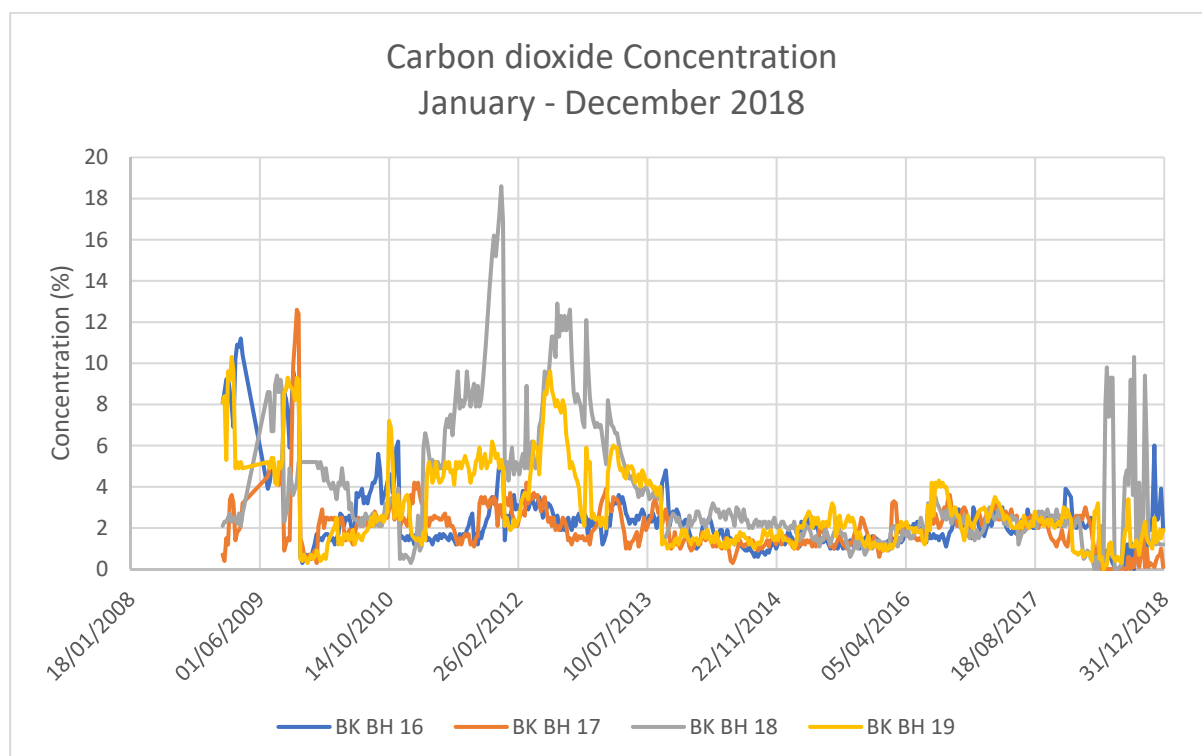


**Graph 3b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH12, BH13, BH14 and BH15**

**APPENDIX 1 – LANDFILL GAS**

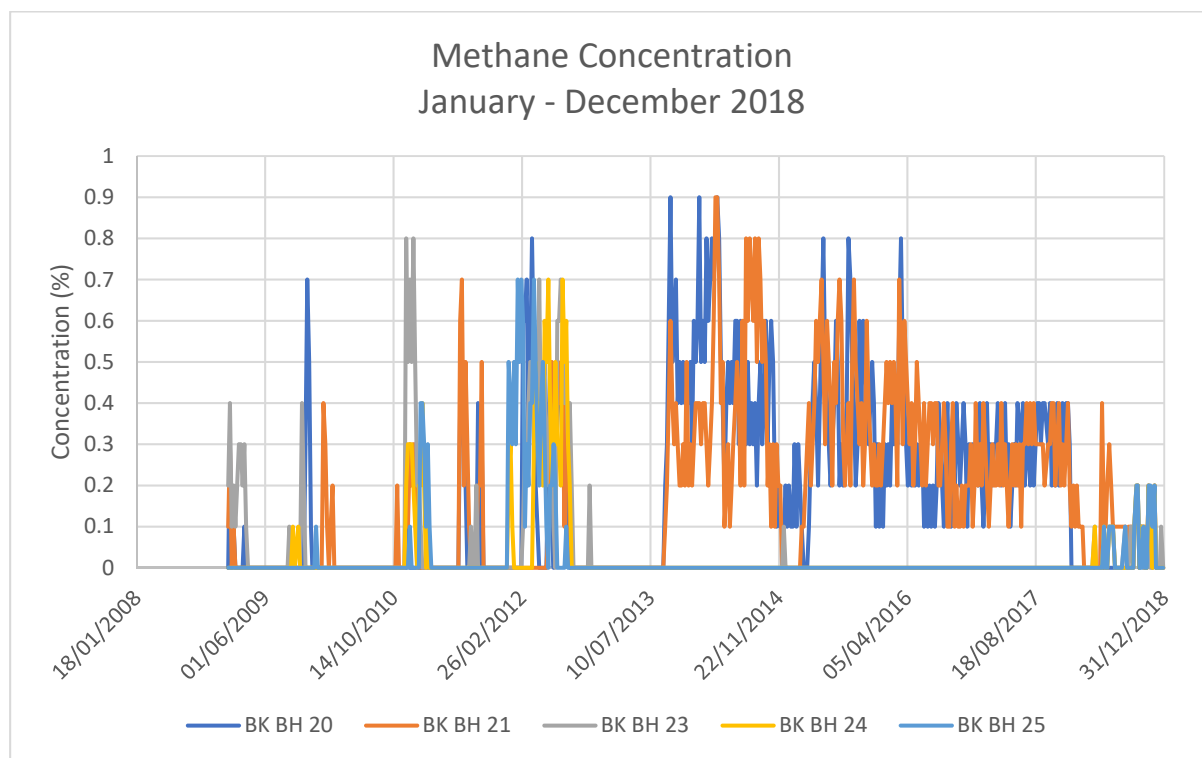


**Graph 4a: Perimeter Landfill Gas - Methane concentration in BH16, BH17, BH18 and BH19**

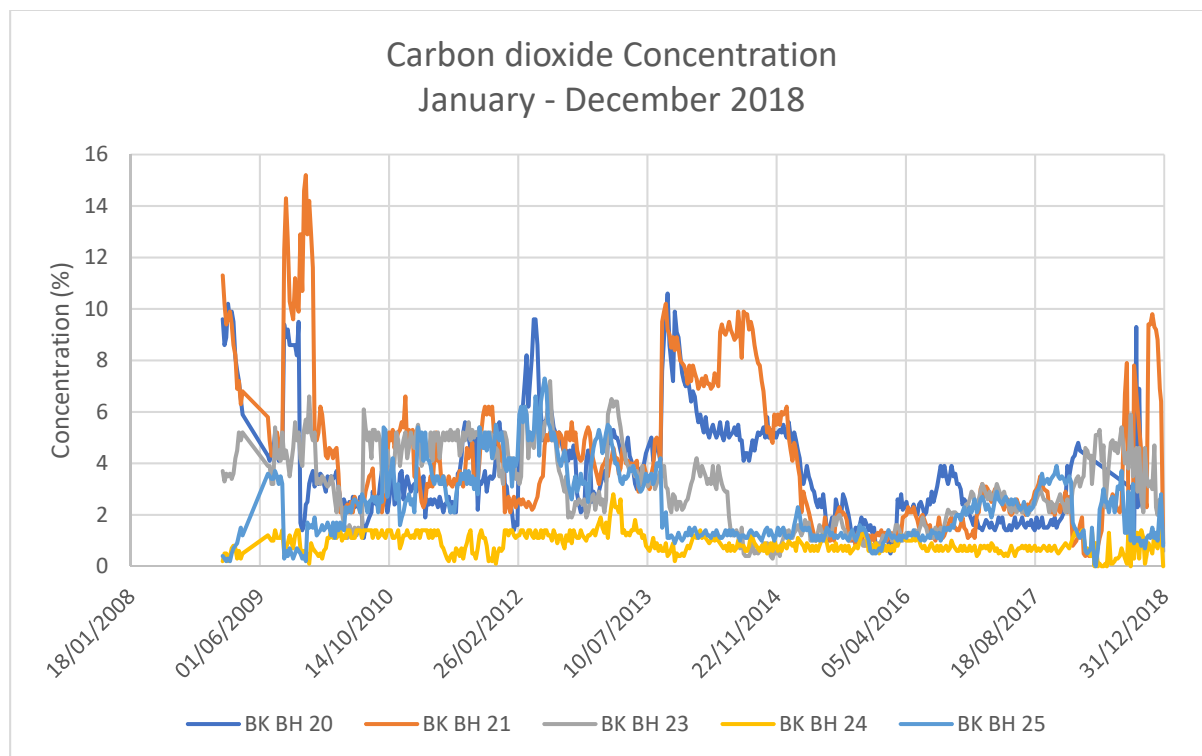


**Graph 4b: Perimeter Landfill Gas - Carbon Dioxide concentration in BH16, BH17, BH18 and BH19**

**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 (YP3835MJ)

Operator: Flintshire County Council

Installation: Brookhill Landfill Site (Engine & Flare)



4251

Monitoring dates: 4<sup>th</sup> June 2018

Job Number: **R18202**

Version: 1

Address: **Flintshire County Council**  
Brookhill Landfill Site  
Brookhill Way, Pinfold Industrial Estate  
Flintshire, CH7 3PL

Monitoring Organisation: **EnviroDat Ltd**

Address: Science & Technology Centre  
Earley Gate  
Whiteknights Road  
Reading, RG6 6BZ

Date of Report: 29<sup>th</sup> June 2018

Report Approved By: David Littlewood

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

Function: Operations Manager (Team Leader)

Signed:

**CONTENTS**

|                                                                     | <b>Page No.</b> |
|---------------------------------------------------------------------|-----------------|
| <b>Part 1: Executive Summary</b>                                    |                 |
| <b>1.1 Monitoring Objectives</b>                                    | <b>3</b>        |
| <b>1.2 Monitoring Results</b>                                       | <b>4</b>        |
| <b>1.3 Operating Information</b>                                    | <b>6</b>        |
| <b>1.4 Monitoring Deviations</b>                                    | <b>6</b>        |
| <br><b>Part 2: Supporting Information</b>                           |                 |
| <b>2.1 Appendix I: General Information</b>                          | <b>7</b>        |
| <b>2.2 Appendix II: Emission Point Reference Data &amp; Results</b> | <b>10</b>       |
| <b>2.3 Appendix III: Uncertainty Calculations</b>                   | <b>19</b>       |
| <b>2.4 Appendix IV: Moisture Calculations</b>                       | <b>23</b>       |

## 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 |             |
|------------------------------------------|-------------------------------|-------------|
|                                          | Engine                        | Flare Stack |
| Oxides of Nitrogen (as NO <sub>2</sub> ) | ✓                             | ✓           |
| Carbon Monoxide                          | ✓                             | ✓           |
| Volatile Organic Compounds (VOCs)        | ✓                             | ✓           |
| Oxygen (for correction)                  | ✓                             | ✓           |
| Moisture (for correction)                | ✓                             | ✓           |
| Special requirements                     | None requested                |             |

## 1.2 Monitoring Results

| Emission Point Reference | Substance to be Monitored                   | Emission Limit Value | Periodic Monitoring Result | Estimate of Uncertainty (2σ at 95% confidence) | Units                | Reference Conditions               | Date of Sampling | Start and End Times | Monitoring Method Reference | Accreditation for use of Method (see note below) | Operating Status |
|--------------------------|---------------------------------------------|----------------------|----------------------------|------------------------------------------------|----------------------|------------------------------------|------------------|---------------------|-----------------------------|--------------------------------------------------|------------------|
| Engine                   | Oxides of Nitrogen (as NO <sub>2</sub> )    | 500                  | 654                        | ±28                                            | mg(N)m <sup>-3</sup> | 101.3kPa, 273K, dry gas, 5% Oxygen | 04/06/2018       | 10:20-11:20         | BS EN 14792                 | A                                                | At 63% MCR       |
|                          | Carbon Monoxide                             | 1400                 | 838                        | ±47                                            | mg(N)m <sup>-3</sup> |                                    |                  |                     | BS EN 15058                 | A                                                |                  |
|                          | Volatile Organic Compounds (VOCs as carbon) | 1000                 | 1356                       | ±48                                            | mg(N)m <sup>-3</sup> |                                    |                  |                     | BS EN 12619                 | A                                                |                  |
|                          | Moisture                                    | -                    | 10.5                       | n/a                                            | %                    | 101.3kPa, 273K, dry gas            |                  |                     | BS EN 14790                 | A                                                |                  |
|                          | Oxygen                                      | -                    | 6.50                       | ±0.39                                          | %                    |                                    |                  |                     | 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 <sub>2</sub> )    | 150                  | 96.0                       | ±3.7                                           | mg(N)m <sup>-3</sup> | 101.3kPa, 273K, dry gas, 3% Oxygen | 04/06/2018       | 12:19-13:19         | BS EN 14792                 | A                                                | 40% MCR          |
|                          | Carbon Monoxide                             | 50                   | 4.4                        | ±3.2                                           | mg(N)m <sup>-3</sup> |                                    |                  |                     | BS EN 15058                 | A                                                |                  |
|                          | Volatile Organic Compounds (VOCs as carbon) | 10                   | 1.6                        | ±0.3                                           | mg(N)m <sup>-3</sup> |                                    |                  |                     | BS EN 12619                 | A                                                |                  |
|                          | Moisture                                    | -                    | 7.8                        | n/a                                            | %                    | 101.3kPa, 273K, dry gas            |                  |                     | BS EN 14790                 | A                                                |                  |
|                          | Oxygen                                      | -                    | 10.75                      | ±0.54                                          | %                    |                                    |                  |                     | 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                   | 04/06/2018 | Combustion   | Continuous       | Landfill Gas | N/A       | None      | Producing 250kWe (63% MCR)              | N/A                                                         | N/A          | N/A                         | N/A   |
| Flare Stack              | 04/06/2018 | Combustion   | Continuous       | Landfill Gas | N/A       | None      | Burning 400m <sup>3</sup> /hr (40% 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  
Technician, Dean Kyle – MCerts Level II (TE3 &4)                      MM12 1188

#### 2.1.2 Monitoring method details

| Parameter                                | Standard Reference Method/Alternative | EnviroDat Procedure | MCerts Accreditation |
|------------------------------------------|---------------------------------------|---------------------|----------------------|
| Oxides of Nitrogen (as NO <sub>2</sub> ) | BS EN 14792                           | SP14792             | MCerts               |
| Carbon Monoxide (CO)                     | BS EN 15058                           | SP15058             | MCerts               |
| Volatile Organic Compounds (VOCs)        | BS EN 12619                           | SP12619             | MCerts               |
| Moisture (H <sub>2</sub> O)              | BS EN 14790                           | SP14790             | MCerts               |
| Oxygen (O <sub>2</sub> )                 | BS EN 14789                           | SP14789             | MCerts               |

**2.1.3 Monitoring organisation equipment and gas check list references**

| <b>EQUIPMENT</b>                               |                  |                        |                |
|------------------------------------------------|------------------|------------------------|----------------|
| <b>Item</b>                                    | <b>Reference</b> | <b>Calibration Due</b> | <b>PAT Due</b> |
| Portable Gas Analyser                          | PGA#05           | 05-Jul-18              | Sep-18         |
| Flame Ionisation Detector Analyser             | FID#05           | 19-Sep-18              | Sep-18         |
| Gas Conditioner                                | COND#02          | 01-Mar-19              | Sep-18         |
| Data Logger                                    | DL#05            | 03-Nov-18              | Sep-18         |
| Digital Barometer                              | DB#20            | 29-Jun-18              | -              |
| NOx Converter                                  | CONV#01          | 09-Nov-18              | Sep-18         |
| Balance                                        | BAL#03           | 28-Mar-19              | -              |
| Heated Line <sup>1</sup>                       | HL#03B           | 02-Jan-19              | -              |
| Heated Line <sup>2</sup>                       | HL#05            | 02-Jan-19              | -              |
| Heated Line Controller <sup>1</sup>            | HLC#06           | 02-Jan-19              | Sep-18         |
| Heated Line Controller <sup>2</sup>            | HLC#04           | 02-Jan-19              | Sep-18         |
| Heated Filter Holder                           | HFH#02           | 04-Feb-19              | Sep-18         |
| 'Apex' Kit                                     | Apex#01          | See each item          | Sep-18         |
| Dry Gas Meter ('Apex')                         | DGM#15           | 13-Sep-18              | -              |
| Thermocouple Reader <sup>1</sup> ('Apex')      | TCR#06           | 13-Sep-18              | -              |
| Thermocouple Reader <sup>2</sup> ('Apex')      | TCR#07           | 13-Sep-18              | -              |
| Thermocouple Reader <sup>3</sup> ('Apex')      | TCR#08           | 13-Sep-18              | -              |
| Thermocouple Reader <sup>4</sup>               | TCR#15           | 22-Oct-18              | -              |
| Manometer ('Apex' Orange)                      | MAN#02           | 13-Sep-18              | -              |
| Manometer ('Apex' Red)                         | MAN#03           | 13-Sep-18              | -              |
| Timepiece <sup>1</sup> ('Apex')                | TP#06            | 13-Sep-18              | -              |
| Timepiece <sup>2</sup>                         | TP#08            | 02-Jan-19              | -              |
| Thermocouple <sup>1</sup> ('Apex' Dogleg Exit) | TC#03            | 21-Nov-18              | -              |

|                                                  |       |           |   |
|--------------------------------------------------|-------|-----------|---|
| Thermocouple <sup>2</sup> ('Apex' Dry Gas Meter) | TC#05 | 13-Sep-18 | - |
| Thermocouple <sup>3</sup>                        | TC#27 | 03-Jan-19 | - |
| Thermocouple <sup>4</sup>                        | TC#56 | 01-Jan-19 | - |
| Thermocouple <sup>5</sup>                        | TC#37 | 06-Feb-19 | - |
| Thermocouple <sup>6</sup>                        | TC#28 | 01-Oct-18 | - |
| Tape Measure                                     | TM#07 | 02-Nov-18 | - |
| Flow meter <sup>1</sup>                          | FM#05 | 21-Jan-19 | - |

| GAS CYLINDERS               |                 |                                        |           |
|-----------------------------|-----------------|----------------------------------------|-----------|
|                             | Certificate No. | Level (ppm)                            | Validity  |
| 'Zero' Gas (%) <sup>1</sup> | VC2928135       | 99.999%                                | -         |
| 'Zero' Gas (%) <sup>3</sup> | N10000018       | 8.11% O <sub>2</sub> in N <sub>2</sub> | -         |
| Oxygen Span Gas (%)         | VC062261        | 8.08                                   | 02-Nov-18 |
| VOC Span Gas                | VC062261        | 604                                    | 02-Nov-18 |
| Carbon Monoxide Span Gas    | VC9936B         | 1211                                   | 08-Mar-19 |
| Nitrogen Dioxide Span Gas   | VC9936B         | 261.5                                  | 08-Mar-19 |
| Oxygen Span Gas (%)         | VC60187         | 8.11                                   | 02-Nov-18 |
| VOC Span Gas                | VC60187         | 8.03                                   | 02-Nov-18 |
| Carbon Monoxide Span Gas    | EM41XDJ         | 157.5                                  | 20-Nov-18 |
| Nitrogen Dioxide Span Gas   | EM41XDJ         | 96.0                                   | 20-Nov-18 |

## 2.2 Appendix II: Emission Point Reference Data & Results

### 2.2.1 Photograph of Sampling Location on Engine



Engine sampled from 10mm turbo port within engine container on vertical section of approx. 0.25m diameter stack.

### 2.2.2 Photograph of Sampling Location on Flare



Approx. 1.5m diameter Flare sampled from ground level using Envirodat Mast System.

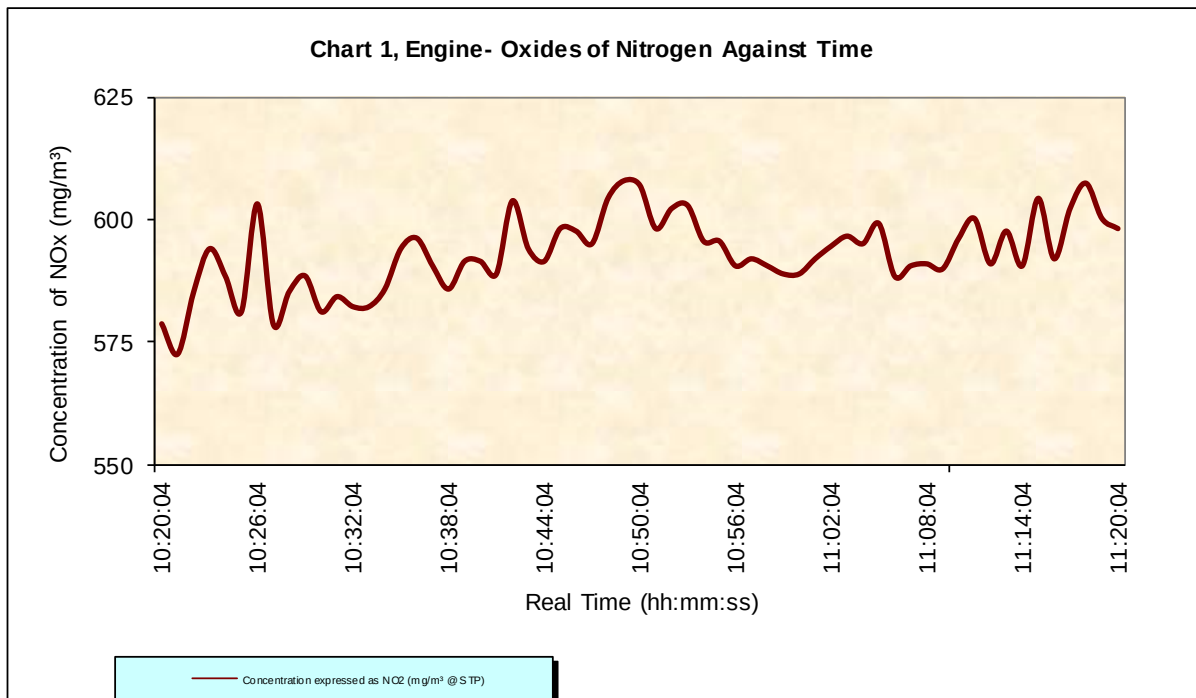
### 2.2.3 Homogeneity testing

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  $\text{mgm}^{-3}$  @ STP and is uncorrected for  $\text{O}_2$ . In addition, VOC results are expressed as carbon equivalent. This data was subsequently converted to reference oxygen concentrations (Section 1.2) with the addition of moisture correction for VOCs. Analyser calibration data is shown in Tables 3 & 4.



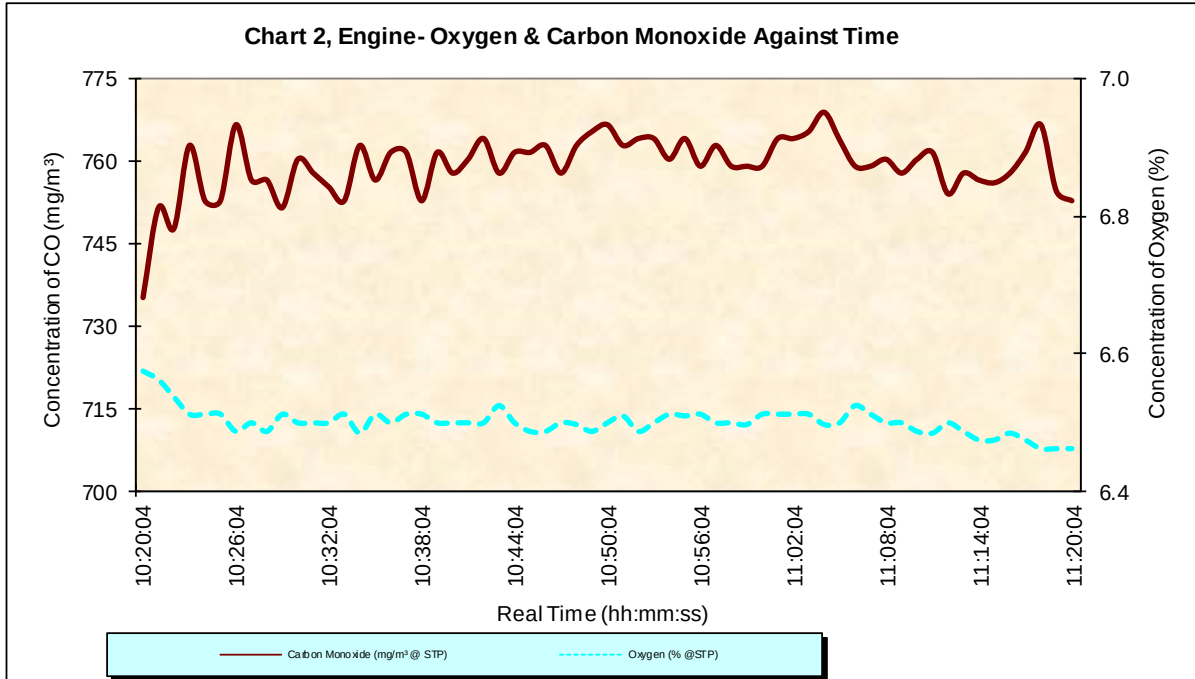
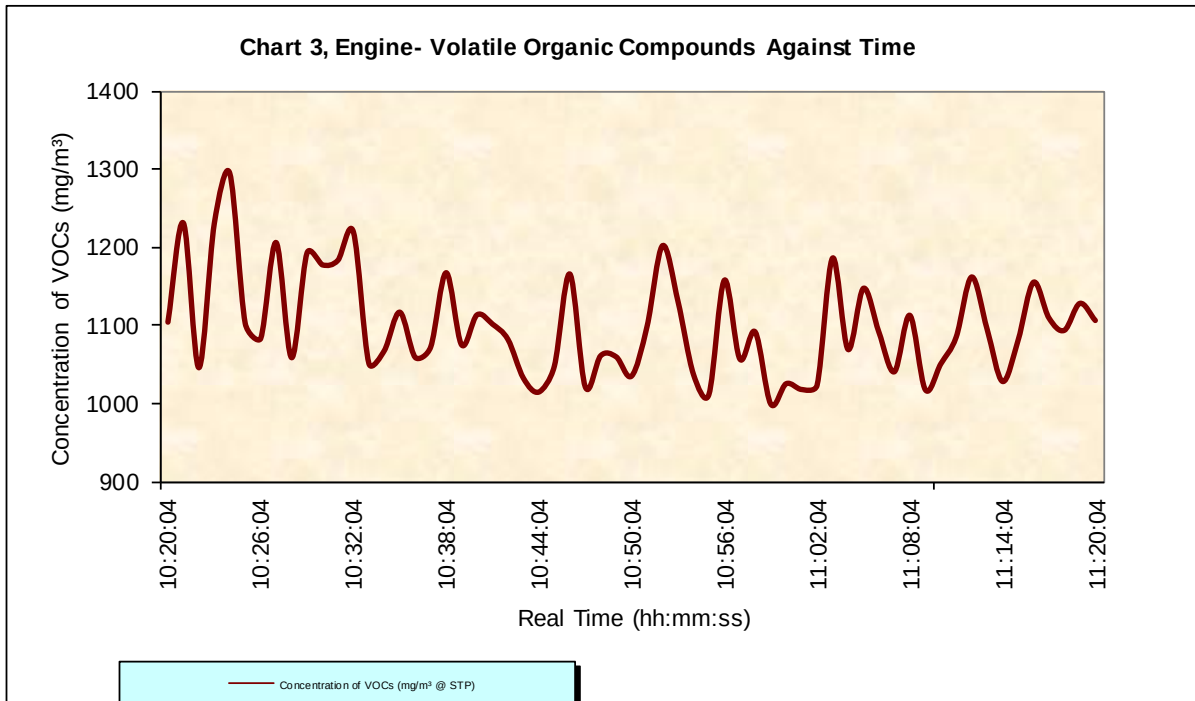


Chart 4, Flare- Oxides of Nitrogen Against Time

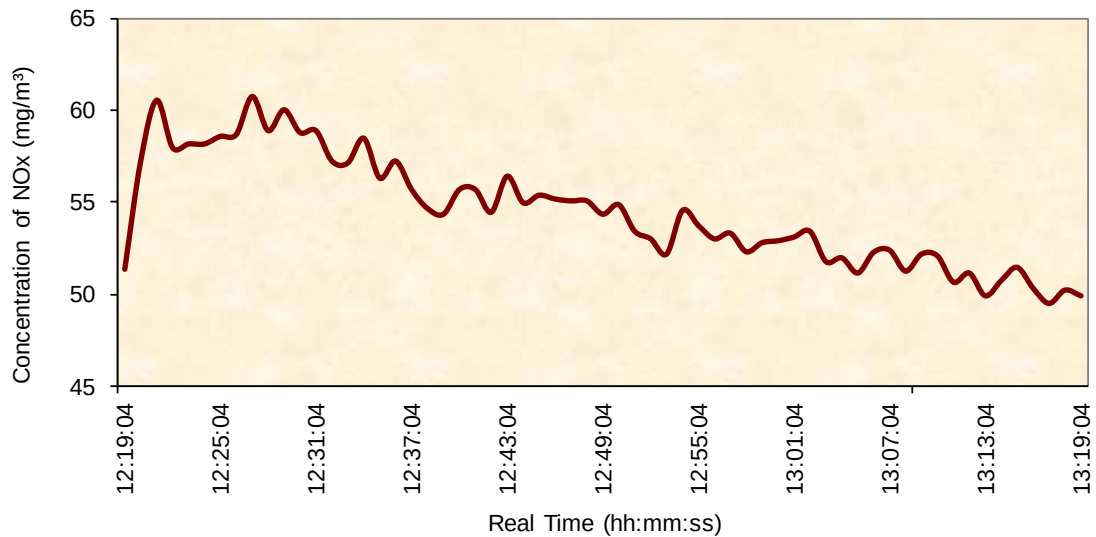
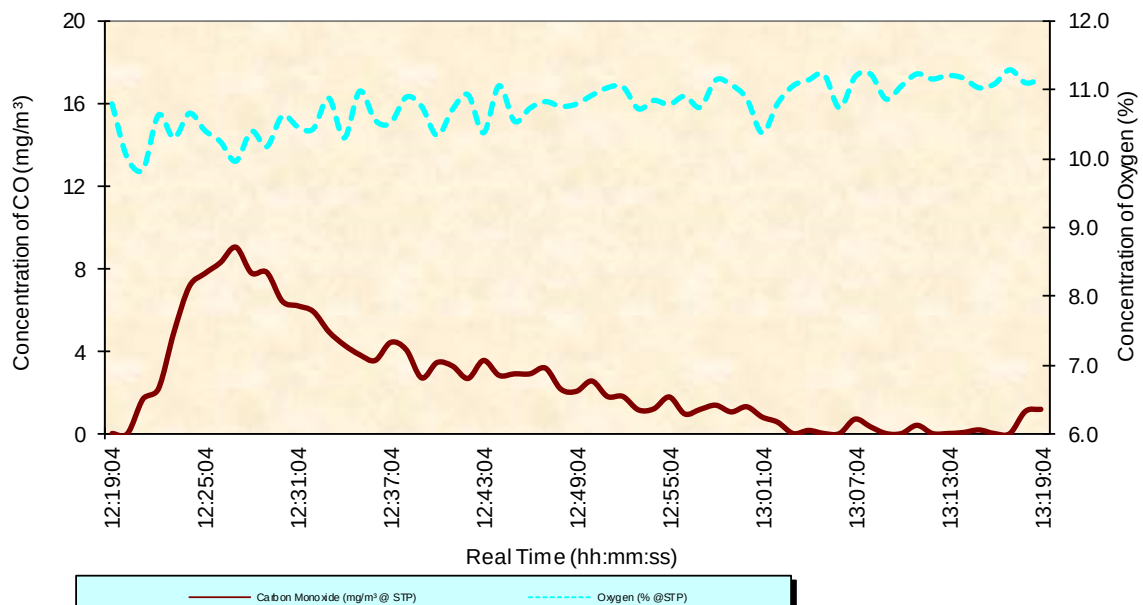
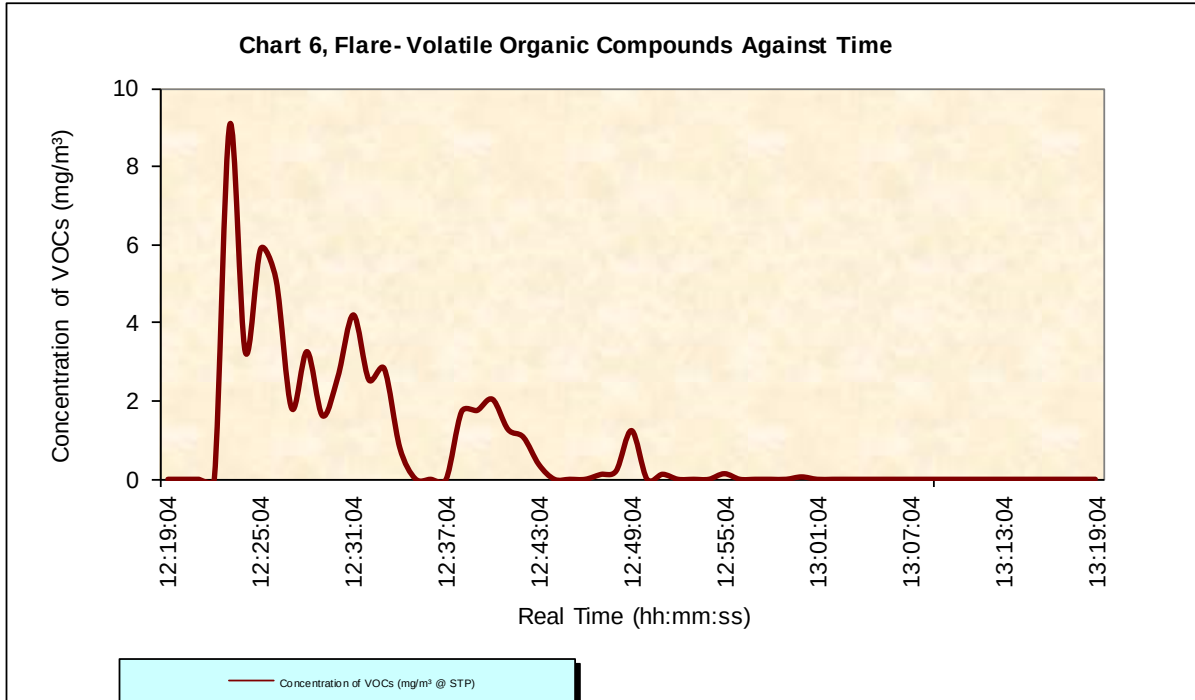


Chart 5, Flare- Oxygen &amp; Carbon Monoxide Against Time



**Table 1 – Engine, Raw Data**

| Time     | Oxygen (%) | VOC (mgC/m³) | CO (mg/m³) | Nox (mg/m³) | Comment |
|----------|------------|--------------|------------|-------------|---------|
| 10:20:04 | 6.6        | 1104.1       | 735.3      | 578.6       |         |
| 10:21:04 | 6.6        | 1230.8       | 751.5      | 572.4       |         |
| 10:22:04 | 6.5        | 1045.8       | 747.8      | 585.1       |         |
| 10:23:04 | 6.5        | 1230.1       | 762.8      | 593.9       |         |
| 10:24:04 | 6.5        | 1294.4       | 752.8      | 588.2       |         |
| 10:25:04 | 6.5        | 1102.5       | 752.8      | 581.1       |         |
| 10:26:04 | 6.5        | 1083.1       | 766.5      | 603.0       |         |
| 10:27:04 | 6.5        | 1205.8       | 756.5      | 578.5       |         |
| 10:28:04 | 6.5        | 1058.6       | 756.5      | 585.2       |         |
| 10:29:04 | 6.5        | 1192.5       | 751.5      | 588.3       |         |
| 10:30:04 | 6.5        | 1177.2       | 760.3      | 581.1       |         |
| 10:31:04 | 6.5        | 1183.2       | 757.8      | 584.1       |         |
| 10:32:04 | 6.5        | 1219.3       | 755.3      | 582.1       |         |
| 10:33:04 | 6.5        | 1051.4       | 752.8      | 582.1       |         |
| 10:34:04 | 6.5        | 1067.6       | 762.8      | 585.7       |         |
| 10:35:04 | 6.5        | 1116.8       | 756.5      | 593.9       |         |
| 10:36:04 | 6.5        | 1058.9       | 761.5      | 596.0       |         |
| 10:37:04 | 6.5        | 1072.3       | 761.5      | 590.4       |         |
| 10:38:04 | 6.5        | 1167.3       | 752.8      | 585.7       |         |
| 10:39:04 | 6.5        | 1075.0       | 761.5      | 591.3       |         |
| 10:40:04 | 6.5        | 1113.4       | 757.8      | 591.3       |         |
| 10:41:04 | 6.5        | 1101.5       | 760.3      | 588.8       |         |

| Time     | Oxygen (%) | VOC (mgC/m <sup>3</sup> ) | CO (mg/m <sup>3</sup> ) | Nox (mg/m <sup>3</sup> ) | Comment |
|----------|------------|---------------------------|-------------------------|--------------------------|---------|
| 10:42:04 | 6.5        | 1081.9                    | 764.0                   | 603.6                    |         |
| 10:43:04 | 6.5        | 1032.4                    | 757.8                   | 593.9                    |         |
| 10:44:04 | 6.5        | 1014.8                    | 761.5                   | 591.3                    |         |
| 10:45:04 | 6.5        | 1047.7                    | 761.5                   | 598.0                    |         |
| 10:46:04 | 6.5        | 1165.7                    | 762.8                   | 597.5                    |         |
| 10:47:04 | 6.5        | 1021.5                    | 757.8                   | 594.9                    |         |
| 10:48:04 | 6.5        | 1061.2                    | 762.8                   | 604.2                    |         |
| 10:49:04 | 6.5        | 1059.8                    | 765.3                   | 607.8                    |         |
| 10:50:04 | 6.5        | 1035.2                    | 766.5                   | 606.8                    |         |
| 10:51:04 | 6.5        | 1098.6                    | 762.8                   | 598.0                    |         |
| 10:52:04 | 6.5        | 1201.8                    | 764.0                   | 602.1                    |         |
| 10:53:04 | 6.5        | 1130.6                    | 764.0                   | 602.7                    |         |
| 10:54:04 | 6.5        | 1037.4                    | 760.3                   | 595.4                    |         |
| 10:55:04 | 6.5        | 1011.5                    | 764.0                   | 595.4                    |         |
| 10:56:04 | 6.5        | 1157.6                    | 759.0                   | 590.4                    |         |
| 10:57:04 | 6.5        | 1057.0                    | 762.8                   | 591.8                    |         |
| 10:58:04 | 6.5        | 1091.4                    | 759.0                   | 590.4                    |         |
| 10:59:04 | 6.5        | 999.5                     | 759.0                   | 588.8                    |         |
| 11:00:04 | 6.5        | 1025.4                    | 759.0                   | 588.8                    |         |
| 11:01:04 | 6.5        | 1018.0                    | 764.0                   | 591.8                    |         |
| 11:02:04 | 6.5        | 1023.4                    | 764.0                   | 594.4                    |         |
| 11:03:04 | 6.5        | 1185.9                    | 765.3                   | 596.5                    |         |
| 11:04:04 | 6.5        | 1069.2                    | 768.8                   | 594.9                    |         |
| 11:05:04 | 6.5        | 1147.3                    | 763.8                   | 599.0                    |         |
| 11:06:04 | 6.5        | 1091.3                    | 759.0                   | 588.2                    |         |
| 11:07:04 | 6.5        | 1040.6                    | 759.0                   | 590.4                    |         |
| 11:08:04 | 6.5        | 1112.8                    | 760.3                   | 590.8                    |         |
| 11:09:04 | 6.5        | 1017.8                    | 757.8                   | 589.8                    |         |
| 11:10:04 | 6.5        | 1050.6                    | 760.3                   | 595.9                    |         |
| 11:11:04 | 6.5        | 1085.0                    | 761.5                   | 600.1                    |         |
| 11:12:04 | 6.5        | 1161.8                    | 754.0                   | 590.8                    |         |
| 11:13:04 | 6.5        | 1095.1                    | 757.8                   | 597.5                    |         |
| 11:14:04 | 6.5        | 1028.3                    | 756.5                   | 590.4                    |         |
| 11:15:04 | 6.5        | 1080.5                    | 756.0                   | 604.2                    |         |
| 11:16:04 | 6.5        | 1155.1                    | 757.8                   | 591.8                    |         |
| 11:17:04 | 6.5        | 1109.4                    | 761.5                   | 602.1                    |         |
| 11:18:04 | 6.5        | 1093.7                    | 766.5                   | 607.2                    |         |
| 11:19:04 | 6.5        | 1128.1                    | 754.5                   | 600.1                    |         |
| 11:20:04 | 6.5        | 1106.2                    | 752.8                   | 598.0                    |         |

**Table 2 – Flare Stack, Raw Data**

| Time     | Oxygen (%) | VOC (mgC/m <sup>3</sup> ) | CO (mg/m <sup>3</sup> ) | Nox (mg/m <sup>3</sup> ) | Comment |
|----------|------------|---------------------------|-------------------------|--------------------------|---------|
| 12:19:04 | 10.8       | 0.0                       | 0.0                     | 51.4                     |         |
| 12:20:04 | 10.0       | 0.0                       | 0.0                     | 57.2                     |         |
| 12:21:04 | 9.8        | 0.0                       | 1.7                     | 60.5                     |         |
| 12:22:04 | 10.6       | 0.0                       | 2.2                     | 57.9                     |         |
| 12:23:04 | 10.3       | 9.0                       | 4.9                     | 58.1                     |         |
| 12:24:04 | 10.6       | 3.3                       | 7.2                     | 58.1                     |         |
| 12:25:04 | 10.4       | 5.9                       | 7.8                     | 58.5                     |         |
| 12:26:04 | 10.2       | 5.1                       | 8.3                     | 58.7                     |         |
| 12:27:04 | 9.9        | 1.8                       | 9.1                     | 60.7                     |         |
| 12:28:04 | 10.4       | 3.3                       | 7.8                     | 58.9                     |         |
| 12:29:04 | 10.2       | 1.6                       | 7.8                     | 60.0                     |         |
| 12:30:04 | 10.6       | 2.6                       | 6.4                     | 58.8                     |         |
| 12:31:04 | 10.5       | 4.2                       | 6.2                     | 58.9                     |         |
| 12:32:04 | 10.4       | 2.5                       | 5.9                     | 57.2                     |         |
| 12:33:04 | 10.9       | 2.8                       | 5.0                     | 57.1                     |         |
| 12:34:04 | 10.3       | 0.8                       | 4.3                     | 58.4                     |         |
| 12:35:04 | 11.0       | 0.0                       | 3.8                     | 56.3                     |         |
| 12:36:04 | 10.5       | 0.0                       | 3.6                     | 57.2                     |         |
| 12:37:04 | 10.5       | 0.0                       | 4.4                     | 55.7                     |         |
| 12:38:04 | 10.9       | 1.7                       | 4.1                     | 54.6                     |         |
| 12:39:04 | 10.7       | 1.8                       | 2.7                     | 54.3                     |         |
| 12:40:04 | 10.3       | 2.0                       | 3.5                     | 55.7                     |         |
| 12:41:04 | 10.7       | 1.3                       | 3.3                     | 55.7                     |         |
| 12:42:04 | 10.9       | 1.1                       | 2.7                     | 54.4                     |         |
| 12:43:04 | 10.4       | 0.4                       | 3.6                     | 56.4                     |         |
| 12:44:04 | 11.1       | 0.0                       | 2.8                     | 55.0                     |         |
| 12:45:04 | 10.5       | 0.0                       | 2.9                     | 55.4                     |         |
| 12:46:04 | 10.7       | 0.0                       | 2.9                     | 55.2                     |         |
| 12:47:04 | 10.8       | 0.1                       | 3.2                     | 55.1                     |         |
| 12:48:04 | 10.7       | 0.2                       | 2.2                     | 55.1                     |         |
| 12:49:04 | 10.8       | 1.2                       | 2.1                     | 54.3                     |         |
| 12:50:04 | 10.9       | 0.0                       | 2.6                     | 54.9                     |         |
| 12:51:04 | 11.0       | 0.1                       | 1.8                     | 53.4                     |         |
| 12:52:04 | 11.0       | 0.0                       | 1.8                     | 53.0                     |         |
| 12:53:04 | 10.7       | 0.0                       | 1.2                     | 52.2                     |         |
| 12:54:04 | 10.8       | 0.0                       | 1.2                     | 54.5                     |         |
| 12:55:04 | 10.8       | 0.1                       | 1.8                     | 53.7                     |         |
| 12:56:04 | 10.9       | 0.0                       | 1.0                     | 53.0                     |         |
| 12:57:04 | 10.7       | 0.0                       | 1.2                     | 53.3                     |         |
| 12:58:04 | 11.1       | 0.0                       | 1.4                     | 52.3                     |         |
| 12:59:04 | 11.1       | 0.0                       | 1.1                     | 52.8                     |         |
| 13:00:04 | 10.9       | 0.1                       | 1.3                     | 52.9                     |         |
| 13:01:04 | 10.4       | 0.0                       | 0.8                     | 53.1                     |         |
| 13:02:04 | 10.8       | 0.0                       | 0.6                     | 53.4                     |         |
| 13:03:04 | 11.1       | 0.0                       | 0.0                     | 51.8                     |         |

| Time     | Oxygen (%) | VOC (mgC/m <sup>3</sup> ) | CO (mg/m <sup>3</sup> ) | Nox (mg/m <sup>3</sup> ) | Comment |
|----------|------------|---------------------------|-------------------------|--------------------------|---------|
| 13:04:04 | 11.1       | 0.0                       | 0.2                     | 52.0                     |         |
| 13:05:04 | 11.2       | 0.0                       | 0.0                     | 51.2                     |         |
| 13:06:04 | 10.7       | 0.0                       | 0.0                     | 52.3                     |         |
| 13:07:04 | 11.2       | 0.0                       | 0.7                     | 52.4                     |         |
| 13:08:04 | 11.2       | 0.0                       | 0.3                     | 51.3                     |         |
| 13:09:04 | 10.9       | 0.0                       | 0.0                     | 52.2                     |         |
| 13:10:04 | 11.0       | 0.0                       | 0.0                     | 52.1                     |         |
| 13:11:04 | 11.2       | 0.0                       | 0.4                     | 50.7                     |         |
| 13:12:04 | 11.1       | 0.0                       | 0.0                     | 51.2                     |         |
| 13:13:04 | 11.2       | 0.0                       | 0.0                     | 49.9                     |         |
| 13:14:04 | 11.2       | 0.0                       | 0.1                     | 50.7                     |         |
| 13:15:04 | 11.0       | 0.0                       | 0.2                     | 51.5                     |         |
| 13:16:04 | 11.1       | 0.0                       | 0.0                     | 50.3                     |         |
| 13:17:04 | 11.3       | 0.0                       | 0.0                     | 49.5                     |         |
| 13:18:04 | 11.1       | 0.0                       | 1.1                     | 50.2                     |         |
| 13:19:04 | 11.1       | 0.0                       | 1.2                     | 49.9                     |         |

**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.      | VC2928135                 |                           |                           | N10000018/<br>Scrubbed Air |
| Span Gas                    | Cylinder No.      | VC9936B                   | VC9936B                   | VC062261                  | VC062261                   |
|                             | Certified Value   | 261.5                     | 1211                      | 8.08                      | 604                        |
| Zero Check                  | Value             | 0.6                       | 2                         | 0.p02                     | 0                          |
| <2 x repeatability (Yes/No) |                   | YES                       | YES                       | YES                       | YES                        |
| Down Line Zero & Span Check |                   |                           |                           |                           |                            |
| Zero Gas                    | Value             | 0.6                       | 2                         | 0.1                       | -1                         |
|                             | <2% of span       | YES                       | YES                       | YES                       | YES                        |
| Span Gas                    | Value             | 261.1                     | 1209                      | 8.07                      | 602                        |
|                             | Within 2% of span | YES                       | YES                       | YES                       | YES                        |
| Post Sampling Drift Check   |                   |                           |                           |                           |                            |
| Zero Gas                    | Value             | 2                         | 7                         | 0.05                      | 3                          |
|                             | Drift (%)         | 0.5                       | 0.4                       | 0.6                       | 0.7                        |
|                             | Validation        | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required  |
| Span Gas                    | Value             | 260.4                     | 1200                      | 8.04                      | 610                        |
|                             | Drift (%)         | 0.3                       | 0.7                       | 0.4                       | 1.3                        |
|                             | Validation        | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required | No Correction<br>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.      | VC2928135                 |                           |                           | N10000018/<br>Scrubbed Air |
| Span Gas                    | Cylinder No.      | EM41XDJ                   | EM41XDJ                   | VC60187                   | VC60187                    |
|                             | Certified Value   | 96                        | 157.5                     | 8.11                      | 8.03                       |
| Zero Check                  | Value             | 0.2                       | 0.8                       | -0.03                     | -0.01                      |
| <2 x repeatability (Yes/No) |                   | YES                       | YES                       | YES                       | YES                        |
| Down Line Zero & Span Check |                   |                           |                           |                           |                            |
| Zero Gas                    | Value             | 0.4                       | -0.3                      | 0.06                      | -0.02                      |
|                             | <2% of span       | YES                       | YES                       | YES                       | YES                        |
| Span Gas                    | Value             | 95.2                      | 157.7                     | 8.06                      | 8                          |
|                             | Within 2% of span | YES                       | YES                       | YES                       | YES                        |
| Post Sampling Drift Check   |                   |                           |                           |                           |                            |
| Zero Gas                    | Value             | 0.3                       | 1.1                       | 0.1                       | 0                          |
|                             | Drift (%)         | 0.1                       | 0.9                       | 0.5                       | 0.2                        |
|                             | Validation        | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required  |
| Span Gas                    | Value             | 95.6                      | 158.8                     | 8.12                      | 8                          |
|                             | Drift (%)         | 0.4                       | 0.7                       | 0.7                       | 0.0                        |
|                             | Validation        | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required | No Correction<br>Required  |

## 2.3 Appendix III: Uncertainty Calculations

### 2.3.1 Engine, Uncertainty Calculations

| NOx - Measurement performance related to stationary conditions |                                             |        |                        |                               |
|----------------------------------------------------------------|---------------------------------------------|--------|------------------------|-------------------------------|
| Performance characteristic                                     |                                             |        | Uncertainty            | Value of uncertainty quantity |
| Standard deviation of repeatability at zero                    |                                             |        | U <sub>r0</sub>        | 0.80                          |
| Standard deviation of repeatability at span level              |                                             |        | U <sub>rs</sub>        | 0.10                          |
| Lack of fit                                                    |                                             |        | U <sub>rit</sub>       | 2.37                          |
| Drift                                                          |                                             |        | U <sub>odr</sub>       | 9.34                          |
| volume or pressure flow dependence                             |                                             |        | U <sub>spres</sub>     | 0.06                          |
| atmospheric pressure dependence                                |                                             |        | U <sub>apres</sub>     | 0.59                          |
| ambient temperature dependence                                 |                                             |        | U <sub>temp</sub>      | 0.46                          |
| NH3 (20 mg/m3)                                                 |                                             |        | U <sub>interf</sub>    | 0.14                          |
| CO2 (15%)                                                      |                                             |        | -                      | 0.02                          |
| H2O (30%)                                                      |                                             |        | -                      | 0.01                          |
| Error in logger voltage                                        |                                             |        | -                      | 0.50                          |
| Dependence on voltage                                          |                                             |        | U <sub>vdt</sub>       | 0.03                          |
| Converter efficiency                                           |                                             |        | U <sub>ceff</sub>      | 2.74                          |
| losses in the line (leak)                                      |                                             |        | U <sub>leak</sub>      | 6.84                          |
| Uncertainty of calibration gas                                 |                                             |        | U <sub>calib</sub>     | 6.84                          |
|                                                                |                                             |        |                        |                               |
| NOx Measurement uncertainty                                    |                                             | Result | 592.74                 | mg/m <sup>3</sup>             |
| Combined uncertainty                                           |                                             |        | 13.96                  | mg/m <sup>3</sup>             |
| Expanded uncertainty                                           | k = 2                                       |        | 27.92                  | mg/m <sup>3</sup>             |
| Uncertainty corrected to std conds                             |                                             |        | 27.92                  | mg.m-3 (corrected)            |
| Expanded uncertainty                                           | expressed with a level of confidence of 95% |        | 5.58 % ELV             |                               |
| Expanded uncertainty                                           | expressed with a level of confidence of 95% |        | 27.92 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 <sub>r0</sub>     | 0.80                               |
| Standard deviation of repeatability at span level             |  |                                             | U <sub>rs</sub>     | 0.10                               |
| Lack of fit                                                   |  |                                             | U <sub>rit</sub>    | 5.77                               |
| Drift                                                         |  |                                             | U <sub>odr</sub>    | 18.82                              |
| volume or pressure flow dependence                            |  |                                             | U <sub>spres</sub>  | 0.00                               |
| atmosphseric pressure dependence                              |  |                                             | U <sub>apres</sub>  | 1.15                               |
| ambient temperature dependence                                |  |                                             | U <sub>temp</sub>   | 0.00                               |
| CO2 (15%)                                                     |  |                                             | U <sub>interf</sub> | 0.00                               |
| N2O (40mgm3)                                                  |  |                                             | -                   | 0.00                               |
| CH4 (57mgm3)                                                  |  |                                             | -                   | 0.00                               |
| H2O (1%)                                                      |  |                                             | -                   | 0.00                               |
| Dependence on voltage                                         |  |                                             | U <sub>vdt</sub>    | 0.03                               |
| Error in Logger reading                                       |  |                                             | -                   | 2.00                               |
| losses in the line (leak)                                     |  |                                             | U <sub>leak</sub>   | 8.77                               |
| Uncertainty of calibration gas                                |  |                                             | U <sub>calib</sub>  | 8.77                               |
|                                                               |  |                                             |                     |                                    |
| CO Measurement uncertainty                                    |  |                                             | Result              | 759.26                             |
|                                                               |  |                                             |                     | mg/m <sup>3</sup>                  |
| Combined uncertainty                                          |  |                                             |                     | 23.38                              |
|                                                               |  |                                             |                     | mg/m <sup>3</sup>                  |
| Expanded uncertainty                                          |  | k = 2                                       |                     | 46.75                              |
|                                                               |  |                                             |                     | mg/m <sup>3</sup>                  |
| Uncertainty corrected to std conds                            |  |                                             |                     | 46.75                              |
|                                                               |  |                                             |                     | mg.m-3 (corrected)                 |
| Expanded uncertainty                                          |  | expressed with a level of confidence of 95% |                     | 3.34 % ELV                         |
| Expanded uncertainty                                          |  | expressed with a level of confidence of 95% |                     | 46.75 mg.m- <sup>3</sup> of result |

| VOC - Measurement performance related to stationary conditions |     |                                             |                                    |                               |
|----------------------------------------------------------------|-----|---------------------------------------------|------------------------------------|-------------------------------|
| Performance characteristic                                     |     |                                             | Uncertainty                        | Value of uncertainty quantity |
| Standard deviation of repeatability at zero                    |     |                                             | U <sub>r0</sub>                    | 0.80                          |
| Standard deviation of repeatability at span level              |     |                                             | U <sub>rs</sub>                    | 0.10                          |
| Lack of fit                                                    |     |                                             | U <sub>fit</sub>                   | 3.74                          |
| Drift                                                          |     |                                             | U <sub>odr</sub>                   | 15.70                         |
| volume or pressure flow dependence                             |     |                                             | U <sub>spres</sub>                 | 0.00                          |
| atmosphseric pressure dependence                               |     |                                             | U <sub>apres</sub>                 | 0.75                          |
| ambient temperature dependence                                 |     |                                             | U <sub>temp</sub>                  | 0.00                          |
| NH3 (20 mg/m3)                                                 |     |                                             | U <sub>interf</sub>                | 0.00                          |
| CO2 (15%)                                                      |     |                                             | -                                  | 0.00                          |
| H2O (30%)                                                      |     |                                             | -                                  | 0.00                          |
| Error on Logger voltage                                        |     |                                             | -                                  | 1.00                          |
| Dependence on voltage                                          |     |                                             | U <sub>volt</sub>                  | 0.03                          |
| losses in the line (leak)                                      |     |                                             | U <sub>leak</sub>                  | 12.70                         |
| Uncertainty of calibration gas                                 |     |                                             | U <sub>calib</sub>                 | 12.70                         |
|                                                                |     |                                             |                                    |                               |
| VOC Measurement uncertainty                                    |     | Result                                      | 1099.62                            | mg/m <sup>3</sup>             |
| Combined uncertainty                                           |     |                                             | 24.18                              | mg/m <sup>3</sup>             |
| Expanded uncertainty                                           | k = | 2                                           | 48.36                              | mg/m <sup>3</sup>             |
| Uncertainty corrected to std conds                             |     |                                             | 48.36                              | mg.m-3 (corrected)            |
| Expanded uncertainty                                           |     | expressed with a level of confidence of 95% | 4.84 % ELV                         |                               |
| Expanded uncertainty                                           |     | expressed with a level of confidence of 95% | 48.36 mg.m <sup>-3</sup> 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                                                       |  |  | $U_{rit}$                                   | 0.08                          |                 |
| Drift                                                             |  |  | $U_{odr}$                                   | 0.10                          |                 |
| volume or pressure flow dependence                                |  |  | $U_{spres}$                                 | 0.00                          |                 |
| atmospheric pressure dependence                                   |  |  | $U_{apres}$                                 | 0.01                          |                 |
| ambient temperature dependence                                    |  |  | $U_{temp}$                                  | 0.07                          |                 |
| CO2 (15%)                                                         |  |  | -                                           | 0.00                          |                 |
| NO(300)                                                           |  |  | -                                           | 0.06                          |                 |
| NO2(30)                                                           |  |  | -                                           | 0.00                          |                 |
| dependence on voltage                                             |  |  | $U_{volt}$                                  | 0.02                          |                 |
| losses in the line (leak)                                         |  |  | $U_{leak}$                                  | 0.08                          |                 |
| Error in Logger voltage                                           |  |  | -                                           | 0.03                          |                 |
| Uncertainty of calibration gas                                    |  |  | $U_{calib}$                                 | 0.08                          |                 |
|                                                                   |  |  |                                             |                               |                 |
| O2 Measurement uncertainty                                        |  |  | Result                                      | 6.50                          | %vol            |
| Combined uncertainty                                              |  |  | 0.20                                        | %vol                          |                 |
| % of value                                                        |  |  | 3.00                                        | %                             |                 |
| Expanded uncertainty                                              |  |  | expressed with a level of confidence of 95% |                               | 6.01 % of value |
| Expanded uncertainty                                              |  |  | expressed with a level of confidence of 95% |                               | 0.39 % vol      |

### 2.3.2 Flare Stack, Uncertainty Calculations

| NOx - Measurement performance related to stationary conditions |       |                                             |                                   |                               |
|----------------------------------------------------------------|-------|---------------------------------------------|-----------------------------------|-------------------------------|
| Performance characteristic                                     |       |                                             | Uncertainty                       | Value of uncertainty quantity |
| Standard deviation of repeatability at zero                    |       |                                             | U <sub>r0</sub>                   | 0.80                          |
| Standard deviation of repeatability at span level              |       |                                             | U <sub>rs</sub>                   | 0.10                          |
| Lack of fit                                                    |       |                                             | U <sub>fit</sub>                  | 0.47                          |
| Drift                                                          |       |                                             | U <sub>odr</sub>                  | 1.50                          |
| volume or pressure flow dependence                             |       |                                             | U <sub>spres</sub>                | 0.01                          |
| atmospheric pressure dependence                                |       |                                             | U <sub>apres</sub>                | 0.00                          |
| ambient temperature dependence                                 |       |                                             | U <sub>temp</sub>                 | 0.35                          |
| NH3 (20 mg/m3)                                                 |       |                                             | U <sub>interf</sub>               | 0.14                          |
| CO2 (15%)                                                      |       |                                             | -                                 | 0.02                          |
| H2O (30%)                                                      |       |                                             | -                                 | 0.01                          |
| Error in logger voltage                                        |       |                                             | -                                 | 0.10                          |
| Dependence on voltage                                          |       |                                             | U <sub>vdt</sub>                  | 0.03                          |
| Converter efficiency                                           |       |                                             | U <sub>ceff</sub>                 | 0.25                          |
| losses in the line (leak)                                      |       |                                             | U <sub>leak</sub>                 | 0.63                          |
| Uncertainty of calibration gas                                 |       |                                             | U <sub>calib</sub>                | 0.63                          |
|                                                                |       |                                             |                                   |                               |
| NOx Measurement uncertainty                                    |       | Result                                      | 54.52                             | mg/m <sup>3</sup>             |
| Combined uncertainty                                           |       |                                             | 1.87                              | mg/m <sup>3</sup>             |
| Expanded uncertainty                                           | k = 2 |                                             | 3.74                              | mg/m <sup>3</sup>             |
| Uncertainty corrected to std conds                             |       |                                             | 3.74                              | mg.m-3 (corrected)            |
| Expanded uncertainty                                           |       | expressed with a level of confidence of 95% | 2.49 % ELV                        |                               |
| Expanded uncertainty                                           |       | expressed with a level of confidence of 95% | 3.74 mg.m <sup>-3</sup> of result |                               |

| CO - Measurement performance related to stationary conditions |                                             |        |                                   |                               |
|---------------------------------------------------------------|---------------------------------------------|--------|-----------------------------------|-------------------------------|
| Performance characteristic                                    |                                             |        | Uncertainty                       | Value of uncertainty quantity |
| Standard deviation of repeatability at zero                   |                                             |        | U <sub>r0</sub>                   | 0.80                          |
| Standard deviation of repeatability at span level             |                                             |        | U <sub>rs</sub>                   | 0.10                          |
| Lack of fit                                                   |                                             |        | U <sub>fit</sub>                  | 0.58                          |
| Drift                                                         |                                             |        | U <sub>odr</sub>                  | 1.46                          |
| volume or pressure flow dependence                            |                                             |        | U <sub>spres</sub>                | 0.00                          |
| atmospheric pressure dependence                               |                                             |        | U <sub>apres</sub>                | 0.00                          |
| ambient temperature dependence                                |                                             |        | U <sub>temp</sub>                 | 0.00                          |
| CO2 (15%)                                                     |                                             |        | U <sub>interf</sub>               | 0.00                          |
| N2O (40mgm3)                                                  |                                             |        | -                                 | 0.00                          |
| CH4 (57mgm3)                                                  |                                             |        | -                                 | 0.00                          |
| H2O (1%)                                                      |                                             |        | -                                 | 0.00                          |
| Dependence on voltage                                         |                                             |        | U <sub>volt</sub>                 | 0.03                          |
| Error in Logger reading                                       |                                             |        | -                                 | 0.20                          |
| losses in the line (leak)                                     |                                             |        | U <sub>leak</sub>                 | 0.03                          |
| Uncertainty of calibration gas                                |                                             |        | U <sub>calib</sub>                | 0.03                          |
|                                                               |                                             |        |                                   |                               |
| CO Measurement uncertainty                                    |                                             | Result | 2.49                              | mg/m <sup>3</sup>             |
| Combined uncertainty                                          |                                             |        | 1.58                              | mg/m <sup>3</sup>             |
| Expanded uncertainty                                          | k = 2                                       |        | 3.17                              | mg/m <sup>3</sup>             |
| Uncertainty corrected to std conds                            |                                             |        | 3.17                              | mg.m-3 (corrected)            |
| Expanded uncertainty                                          | expressed with a level of confidence of 95% |        | 6.34 % ELV                        |                               |
| Expanded uncertainty                                          | expressed with a level of confidence of 95% |        | 3.17 mg.m <sup>-3</sup> of result |                               |

| VOC - Measurement performance related to stationary conditions |     |                                             |                                   |                               |
|----------------------------------------------------------------|-----|---------------------------------------------|-----------------------------------|-------------------------------|
| Performance characteristic                                     |     |                                             | Uncertainty                       | Value of uncertainty quantity |
| Standard deviation of repeatability at zero                    |     |                                             | U <sub>r0</sub>                   | 0.80                          |
| Standard deviation of repeatability at span level              |     |                                             | U <sub>rs</sub>                   | 0.10                          |
| Lack of fit                                                    |     |                                             | U <sub>fit</sub>                  | 0.04                          |
| Drift                                                          |     |                                             | U <sub>odr</sub>                  | 0.10                          |
| volume or pressure flow dependence                             |     |                                             | U <sub>spres</sub>                | 0.00                          |
| atmosphseric pressure dependence                               |     |                                             | U <sub>apres</sub>                | 0.00                          |
| ambient temperature dependence                                 |     |                                             | U <sub>temp</sub>                 | 0.00                          |
| NH3 (20 mg/m3)                                                 |     |                                             | U <sub>interf</sub>               | 0.00                          |
| CO2 (15%)                                                      |     |                                             | -                                 | 0.00                          |
| H2O (30%)                                                      |     |                                             | -                                 | 0.00                          |
| Error on Logger voltage                                        |     |                                             | -                                 | 0.01                          |
| Dependence on voltage                                          |     |                                             | U <sub>volt</sub>                 | 0.03                          |
| losses in the line (leak)                                      |     |                                             | U <sub>leak</sub>                 | 0.01                          |
| Uncertainty of calibration gas                                 |     |                                             | U <sub>calib</sub>                | 0.01                          |
|                                                                |     |                                             |                                   |                               |
| VOC Measurement uncertainty                                    |     | Result                                      | 0.86                              | mg/m <sup>3</sup>             |
| Combined uncertainty                                           |     |                                             | 0.15                              | mg/m <sup>3</sup>             |
| Expanded uncertainty                                           | k = | 2                                           | 0.30                              | mg/m <sup>3</sup>             |
| Uncertainty corrected to std conds                             |     |                                             | 0.30                              | mg.m-3 (corrected)            |
| Expanded uncertainty                                           |     | expressed with a level of confidence of 95% | 3.04 % ELV                        |                               |
| Expanded uncertainty                                           |     | expressed with a level of confidence of 95% | 0.30 mg.m <sup>-3</sup> 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                                                       |  |                                             | $U_{fit}$       | 0.12                          |
| Drift                                                             |  |                                             | $U_{odr}$       | 0.13                          |
| volume or pressure flow dependence                                |  |                                             | $U_{spres}$     | 0.00                          |
| atmospheric pressure dependence                                   |  |                                             | $U_{apres}$     | 0.00                          |
| ambient temperature dependence                                    |  |                                             | $U_{temp}$      | 0.05                          |
| CO2 (15%)                                                         |  |                                             | -               | 0.00                          |
| NO(300)                                                           |  |                                             | -               | 0.06                          |
| NO2(30)                                                           |  |                                             | -               | 0.00                          |
| dependence on voltage                                             |  |                                             | $U_{volt}$      | 0.02                          |
| losses in the line (leak)                                         |  |                                             | $U_{leak}$      | 0.12                          |
| Error in Logger voltage                                           |  |                                             | -               | 0.03                          |
| Uncertainty of calibration gas                                    |  |                                             | $U_{calib}$     | 0.12                          |
|                                                                   |  |                                             |                 |                               |
| O2 Measurement uncertainty                                        |  | Result                                      | 10.75           | %vol                          |
| Combined uncertainty                                              |  |                                             | 0.27            | %vol                          |
| % of value                                                        |  |                                             | 2.50            | %                             |
| Expanded uncertainty                                              |  | expressed with a level of confidence of 95% | 5.01 % of value |                               |
| Expanded uncertainty                                              |  | expressed with a level of confidence of 95% | 0.54 % vol      |                               |

## 2.4 Appendix IV: Moisture Calculations

### 2.4.1 Engine, Moisture Calculation

|                                               |          |                |                                     |           |                     |  |
|-----------------------------------------------|----------|----------------|-------------------------------------|-----------|---------------------|--|
| Test No                                       | T1       |                | Site                                | FCC       |                     |  |
| Date                                          | 4-6-18   |                |                                     | Brookhill |                     |  |
| pbar (mbar)                                   | 1003     |                | Stack                               | Engine    |                     |  |
| pbar (mmHg)                                   | 752      |                | Job Number:                         | R18202    |                     |  |
| Nozzle Diameter (mm)                          | n/a      |                | Site Team:                          | DL + DK   |                     |  |
| Temp of Meter (in)/(out) deg. C               | 22       |                | Data Entered By:                    | DK        |                     |  |
| $\Delta H_{ave}$ (mmHg)                       | 10.0     |                |                                     |           |                     |  |
| DGM Cal Factor (Y)                            | 0.9952   |                | Enter Data into coloured cells only |           |                     |  |
| Start Volume Reading                          | 104.0820 | m <sup>3</sup> | Start time                          | 10:20     | hr:min              |  |
| End Volume Reading                            | 104.7070 | m <sup>3</sup> | End time                            | 11:20     | hr:min              |  |
| Volume Sampled                                | 0.6220   | m <sup>3</sup> | 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) | 931.2    | 896.7          | 664.8                               | 801.7     | DK                  |  |
| Final Weight of Impingers plus absorber (g)   | 973.9    | 901.6          | 665.7                               | 806.8     | DK                  |  |
| Weight Gain (g)                               | 42.7     | 4.9            | 0.9                                 | 5.1       |                     |  |
| Total Weight Gain (1+2+3+4) (g)               | 53.6     |                |                                     |           |                     |  |
| Gas Volume of water at 0 °C (l)               | 66.73    |                |                                     |           |                     |  |
| Gas Meter volume at 0 °C (l)                  | 571.46   |                |                                     |           |                     |  |
| Moisture content of Gases (%)                 | 10.5     |                |                                     |           |                     |  |

## 2.4.2 Flare Stack, Moisture Calculation

|                                               |          |                |                                     |           |                     |  |
|-----------------------------------------------|----------|----------------|-------------------------------------|-----------|---------------------|--|
| Test No                                       | T2       |                | Site                                | FCC       |                     |  |
| Date                                          | 4-6-18   |                |                                     | Brookhill |                     |  |
| pbar (mbar)                                   | 1003     |                | Stack                               | Flare     |                     |  |
| pbar (mmHg)                                   | 752      |                | Job Number:                         | R18202    |                     |  |
| Nozzle Diameter (mm)                          | n/a      |                | Site Team:                          | DL + DK   |                     |  |
| Temp of Meter (in)/(out) deg. C               | 24       |                | Data Entered By:                    | DK        |                     |  |
| $\Delta H_{ave}$ (mmHg $\pm$ 0)               | 10.0     |                | Enter Data into coloured cells only |           |                     |  |
| DGM Cal Factor (Y)                            | 0.9952   |                |                                     |           |                     |  |
| Start Volume Reading                          | 104.7170 | m <sup>3</sup> | Start time                          | 12:19     | hr:min              |  |
| End Volume Reading                            | 105.3130 | m <sup>3</sup> | End time                            | 13:19     | hr:min              |  |
| Volume Sampled                                | 0.5931   | m <sup>3</sup> | 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) | 973.9    | 901.6          | 665.7                               | 806.8     | DK                  |  |
| Final Weight of Impingers plus absorber (g)   | 1004.1   | 903.7          | 665.9                               | 811.0     | DK                  |  |
| Weight Gain (g)                               | 30.2     | 2.1            | 0.2                                 | 4.2       |                     |  |
| Total Weight Gain (1+2+3+4) (g)               | 36.7     |                |                                     |           |                     |  |
| Gas Volume of water at 0 °C (l)               | 45.69    |                |                                     |           |                     |  |
| Gas Meter volume at 0 °C (l)                  | 540.35   |                |                                     |           |                     |  |
| Moisture content of Gases (%)                 | 7.8      |                |                                     |           |                     |  |



4251

## **ANALYSIS OF THE TRACE LANDFILL GAS**

**AT**

### **Brookhill Landfill Site**

Brookhill Way  
Pinfold Industrial Estate  
Buckley, Flintshire  
CH7 3PL

Commissioned by: Paul Murphy

Of

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

Date of Survey:

4<sup>th</sup> June 2018

Compiled By:

David Littlewood  
*Operations Manager*

# ANALYSIS OF THE TRACE LANDFILL GAS

AT

## Brookhill Landfill Site

Brookhill Way  
Pinfold Industrial Estate  
Buckley, Flintshire  
CH7 3PL

Commissioned by: Paul Murphy

Of

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

Date of Survey: 4<sup>th</sup> June 2018

Compiled By: David Littlewood  
*Operations Manager*  
MCerts Level II (TE1, 2, 3 & 4)

Signed:



Dated: 29<sup>th</sup> June 2018

## CONTENTS

- 1.** INTRODUCTION
- 2.** PLANT DESCRIPTION
- 3.** SAMPLING PROCEDURES
- 4.** RESULTS

### APPENDICES:

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

---

## **1. INTRODUCTION**

---

- 1.1 EnviroDat Limited was commissioned by Paul Murphy, on behalf of Flintshire County Council, to measure the trace gas and siloxane components from landfill gas located at Brookhill Landfill Site. Sampling was performed on the 4<sup>th</sup> June 2018.
- 1.2 The sampling was conducted in response to permit requirements (Permit No. BV7273/ YP3835MJ). Monitoring was conducted with reference to the Environment Agency document 'Guidance for Monitoring Trace Components in Landfill Gas' (LFTGN 04).

---

## **2. PLANT DESCRIPTION**

---

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

---

## **3. SAMPLING PROCEDURES**

---

- 3.1 Trace gas sampling was performed from the fuel gas inlet, with analysis for components identified in Table 1.1 of the EA LFTGN04 guidance note. General site information is presented in Appendix A.
- 3.2 Mixed bed, automated thermal desorption (ATD) tubes were used for sampling of the priority volatile organic species prior to analysis by gas chromatography with mass spectrometry (GC/MS), in accordance with EA recommendations and documented EnviroDat protocol, SPTGN04. The analytical

component of the work was conducted at Concept Life Sciences Ltd (CLS 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 (CLS 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 (CLS Ltd).
- 3.5 Hydrogen sulphide was sampled into a Tedlar bag with analysis by GC/MS (by (CLS Ltd) in accordance with SPTGN04. The results are presented in Appendix B.
- 3.6 Siloxanes sampling was affected using EnviroDat Ltd. documented internal protocol SP SILOX. This involves passing a metered volume of the gas through solid sorbent material whereby the siloxane congeners are captured and concentrated to allow analysis by gas chromatography utilising mass spectrometric detection (GC/MS). The analysis was carried out at (CLS Ltd) and is UKAS accredited for sampling and analysis.

---

## 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 and shown graphically in Appendix C.
- 4.3 Measured concentrations of the siloxane components for the landfill gas are given in Appendix D.

## **APPENDIX A**

### **Site Information & Preliminary Gas Measurements**

**TABLE A: Site Information & Preliminary Gas Measurements**

| Sample Position Details            |                                 |                                                       |                                              |
|------------------------------------|---------------------------------|-------------------------------------------------------|----------------------------------------------|
| <b>Date</b>                        | 04/06/18                        | <b>Site</b>                                           | FCC Brookhill                                |
| <b>Ambient Temperature</b>         | 22°C                            | <b>Atmospheric Pressure</b>                           | 1003mbar                                     |
| <b>Monitoring Organisation (s)</b> | EnviroDat Ltd                   | <b>Analytical Laboratory</b>                          | CLS Ltd                                      |
| <b>Location of Sampling Point</b>  | Inlet Line to Utilisation Plant | <b>Area of Influence of collection system sampled</b> | All capped areas of the site                 |
| <b>Type of Sampling Point</b>      | Nipple & Tap                    | <b>Temperature of gas</b>                             | 24.6°C, at sample flow meter                 |
| <b>Vacuum on Sampling</b>          | None, Positive pressure         | <b>Type of waste</b>                                  | Domestic, Industrial, Commercial & Hazardous |
|                                    |                                 | <b>Age of Waste</b>                                   | -                                            |
| <b>Status of Gas System</b>        | Fully Operational, Steady State | <b>Other</b>                                          | -                                            |
| Parameter                          | Concentration                   | Units                                                 | Comments                                     |
| Methane*                           | 57.2                            | %                                                     | -                                            |
| Carbon Dioxide*                    | 39.8                            | %                                                     | -                                            |
| Oxygen*                            | 0.03                            | %                                                     | -                                            |
| Nitrogen                           | 2.97                            | %                                                     | Assumed to be balance of gas                 |
| Hydrogen Sulphide                  | -                               | ppmv                                                  | See Appendix B                               |
| Carbon Monoxide                    | -                               | ppmv                                                  | Not required                                 |

Notes: \*Raw result obtained from client analyser

## **APPENDIX B**

### **Trace Gas Results**

**TABLE B: Trace Gas Results**

| Trace Gases - Test 1                  |                      |                 |               |                |           |                               |                                |
|---------------------------------------|----------------------|-----------------|---------------|----------------|-----------|-------------------------------|--------------------------------|
|                                       | Test Duration        | Flow Rate       | Flowmeter     | Volume         | Ambient T | Barometric P                  | Volume                         |
|                                       | (min)                | (ml/min)        | CAL Factor    | (l as sampled) | (°C)      | (kPa)                         | (l @ STP)                      |
| Arsenic                               | 60                   | 200             | 0.9717        | 11.66          | 22        | 100.3                         | 10.68                          |
| Aldehydes                             | 20                   | 200             | 0.9717        | 3.89           | 22        | 100.3                         | 3.56                           |
| VOC                                   | 6                    | 50              | 0.926         | 0.28           | 22        | 100.3                         | 0.25                           |
|                                       |                      |                 |               |                |           |                               |                                |
| Compound                              | Mass of TG (ng)      | LoD of TG (ng)  | Concentration |                | Units     | Analysis Notes<br>(See below) | Analysis UKAS Accredited (Y/N) |
| Arsenic (as As)                       | 3000                 | 1000            |               | 281            | µg/m3     | -                             | Y                              |
| Acetaldehyde (Ethanal)                | 200                  | 100             |               | 56             | µg/m3     | a                             | Y                              |
| Formaldehyde (Methanal)               | 300                  | 100             |               | 84             | µg/m3     | a                             | Y                              |
| 1-pentene                             | 12                   | 10              |               | 47             | µg/m3     | -                             | Y                              |
| 1,1-dichloroethane                    |                      | 10              |               | < 39           | µg/m3     | -                             | Y                              |
| 1,1-dichloroethylene                  |                      | 10              |               | < 39           | µg/m3     | -                             | Y                              |
| 1,2-dichloroethane                    |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| 1,2-dichloroethylene                  | 94                   | 30              |               | 369            | µg/m3     | -                             | Y                              |
| 1,3-butadiene                         |                      | 10              |               | < 39           | µg/m3     | -                             | Y                              |
| 1,4-epoxy-1,3-butadiene (Furan)       |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| 1-propanethiol                        |                      | 10              |               | < 39           | µg/m3     | d                             | Y                              |
| 2-butoxyethanol                       |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| Benzene                               | 700                  | 10              |               | 2751           | µg/m3     | -                             | Y                              |
| Butyric acid                          |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| Carbon disulphide                     | 1000                 | 10              |               | 3930           | µg/m3     | -                             | N                              |
| Carbon tetrachloride                  |                      | 10              |               | < 39           | µg/m3     | -                             | Y                              |
| Chloroethane                          |                      | 30              |               | < 118          | µg/m3     | -                             | N                              |
| Dichloromethane                       |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| Dimethyl disulphide                   |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| Dimethyl sulphide                     | 34                   | 10              |               | 134            | µg/m3     | d                             | Y                              |
| Ethyl butyrate                        |                      | 25              |               | < 98           | µg/m3     | -                             | N                              |
| Ethyl Mercaptan (ethanethiol)         |                      | 10              |               | < 39           | µg/m3     | -                             | N                              |
| Methyl Mercaptan (methanethiol)       |                      | 30              |               | < 118          | µg/m3     | -                             | N                              |
| N-Butyl Mercaptan                     |                      | 10              |               | < 39           | µg/m3     | d                             | Y                              |
| Styrene                               | 130                  | 10              |               | 511            | µg/m3     | -                             | N                              |
| Toluene                               | 1200                 | 10              |               | 4715           | µg/m3     | c                             | N                              |
| Trichloroethylene                     | 28                   | 10              |               | 110            | µg/m3     | -                             | Y                              |
| Vinyl chloride monomer (chloroethene) |                      | 10              |               | < 39           | µg/m3     | -                             | Y                              |
| Compound                              | Concentration in ppm | LOD of TG (ppm) | Concentration |                | Units     | Analysis Notes<br>(See below) | Analysis UKAS Accredited (Y/N) |
| Hydrogen sulphide*                    | 27                   | 10              |               | 40982          | µg/m3     | -                             | N                              |

\*H2S value is equivalent to 27 ppm, values in highlighted box are expressed as ppm and not ng

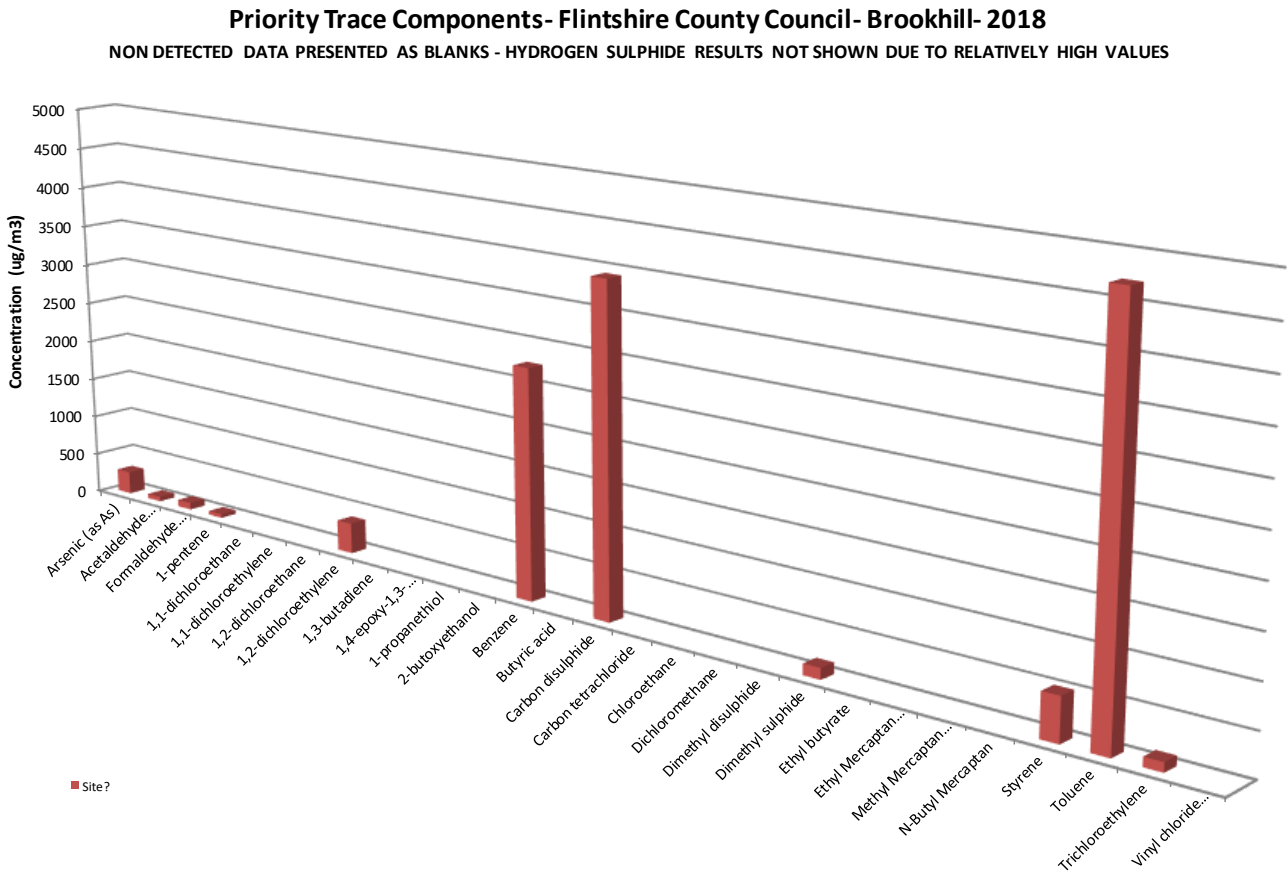
(a) – Results have been blank corrected  
(b) – Results should be considered a minimum due to detector saturation  
(c) – Results should be viewed with caution due to being outside of the instrument calibration range  
(d) - Outside scope of UKAS accreditation

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                              | ✓ | 04/06/2018    |
| Site                              | ✓ | FCC Brookhill |
| Stack                             | ✓ | Fuel Line     |
| Reference Conditions - Oxygen (%) | ✓ | n/a           |
| - Temperature (°C)                |   | 0             |
| - Pressure (kPa)                  |   | 101.3         |
| Job Number                        | ✓ | R18202        |
| Site Team                         | ✓ | DL + DK       |
| Test Conducted By                 | ✓ | DL + DK       |
| Data Entered By                   | ✓ | DK            |

|                                  |   |       |
|----------------------------------|---|-------|
| Test Start Time                  | ✓ | 11:25 |
| Test End Time                    | ✓ | 11:45 |
| 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  |

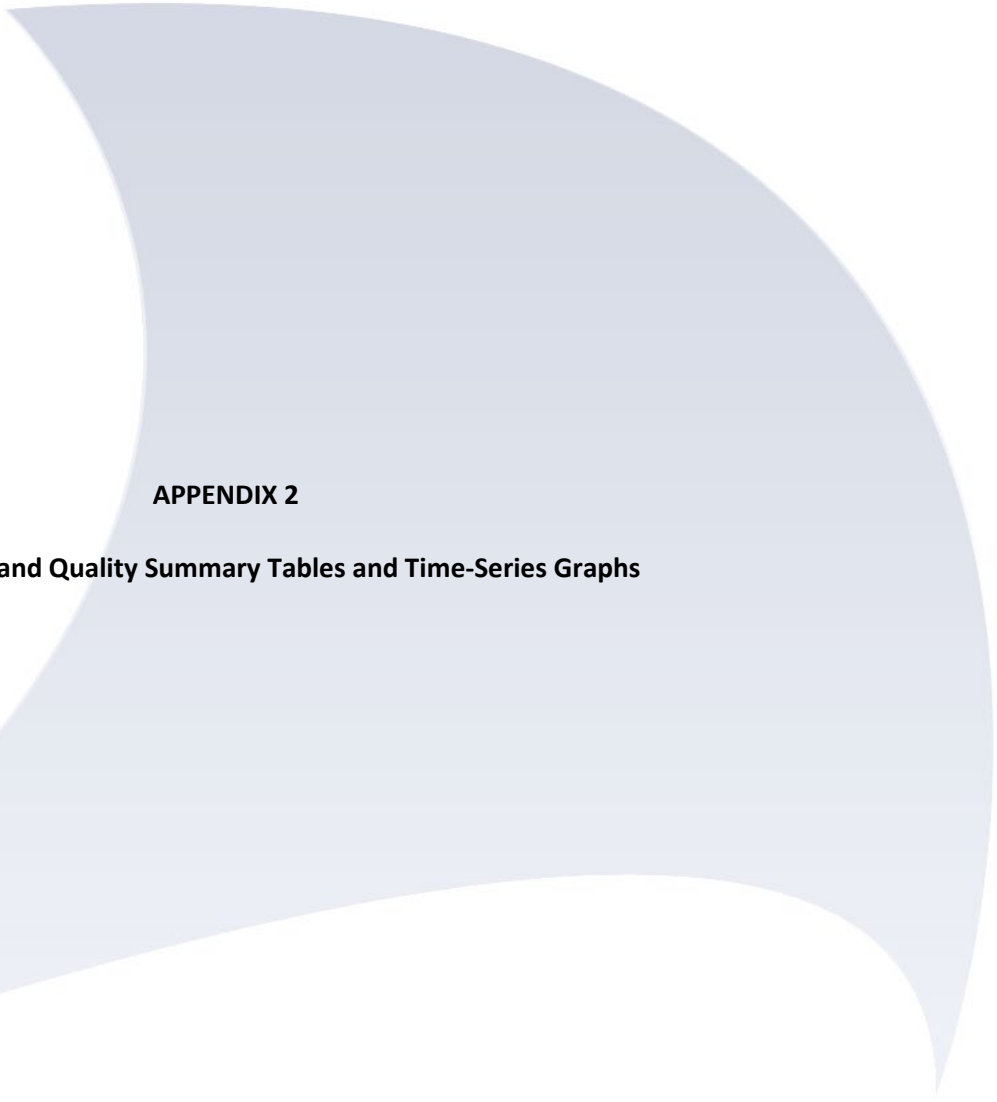
|                                       |   |        |
|---------------------------------------|---|--------|
| Barometric Pressure (kPa)             | ✓ | 100.4  |
| Ambient Temperature (°C)              | ✓ | 24     |
| Flowmeter Calibration Factor (f)      | ✓ | 0.9717 |
| Stack Oxygen Level (%)                | ✓ | n/a    |
| Volume Sampled @ Reference Conditions |   | 3.54   |

|                                               |     |                       |
|-----------------------------------------------|-----|-----------------------|
| Primary Tube Reference Identification Number  | ✓   | 6368652091            |
| Security Tube Reference Identification Number | ✓   | 7009363917            |
| Blank Tube Reference Identification Numbers   | ✓   | 7009363913/7009363420 |
| Mass of Siloxane on Primary Tube (ug)         | ✓   | 325                   |
| Mass of Siloxane on Security Tube (ug)        | < ✓ | 6                     |
| Breakthrough (Reject if > 5%)                 | ✓   | Accepted              |
| Total Mass of Siloxane in Sample (ug)         |     | 331                   |

|                                                                          |  |       |
|--------------------------------------------------------------------------|--|-------|
| Siloxane Concentration (mg/m <sup>3</sup> @ STP and Ref O <sub>2</sub> ) |  | 93.50 |
|--------------------------------------------------------------------------|--|-------|

**TABLE D(ii): Siloxane/Silicon Congener Breakdown**

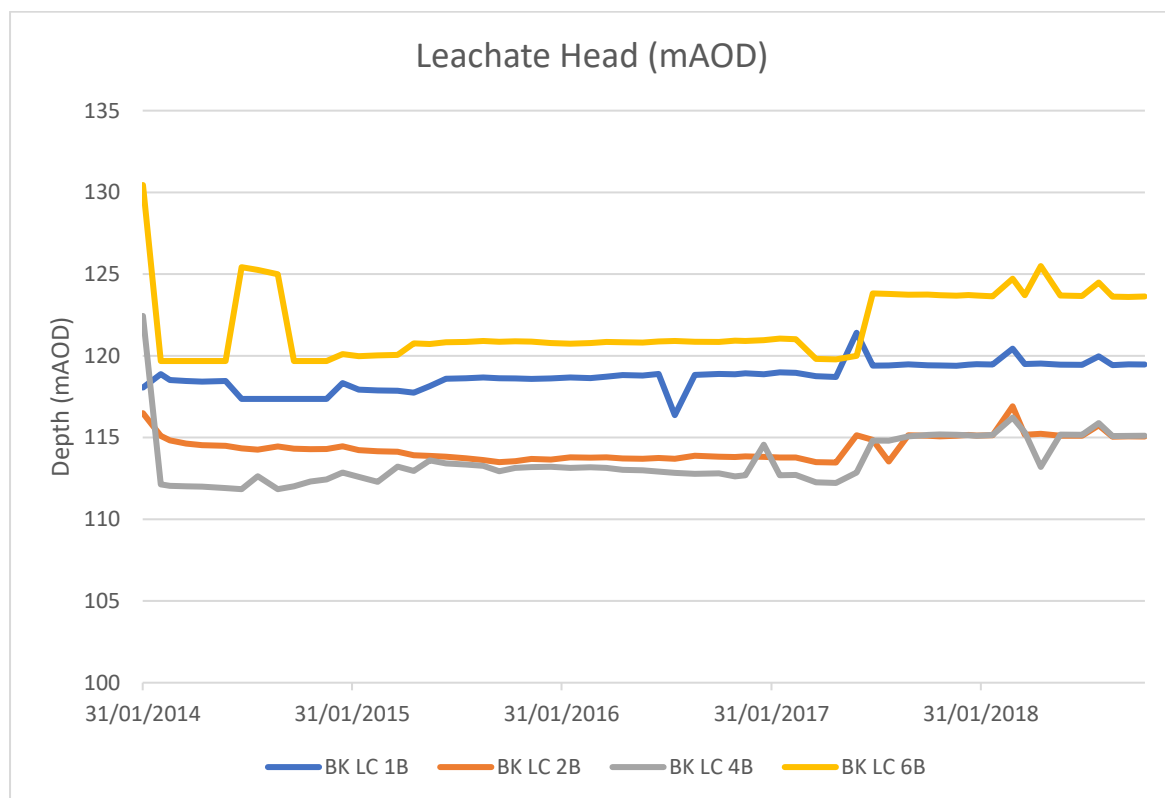
| Siloxane                             | Siloxane Concentration<br>(mg/m <sup>3</sup> @ STP) | Organic Silicon Concentration<br>(mg/m <sup>3</sup> @ STP) |
|--------------------------------------|-----------------------------------------------------|------------------------------------------------------------|
| Decamethylcyclopentasiloxane         | 48.30                                               | 18.30                                                      |
| Decamethyltetrasiloxane              | < 0.56                                              | < 0.20                                                     |
| Hexamethylcyclotrisiloxane           | 1.41                                                | 0.54                                                       |
| Hexamethyldisiloxane                 | 2.82                                                | 0.98                                                       |
| Octamethylcyclotetrasiloxane         | 39.83                                               | 15.09                                                      |
| Octamethyltrisiloxane                | < 0.56                                              | < 0.20                                                     |
| <b>Total Siloxane Concentration:</b> | <b>93.50</b>                                        |                                                            |
| <b>Total Silicon Concentration:</b>  |                                                     | <b>35.32</b>                                               |



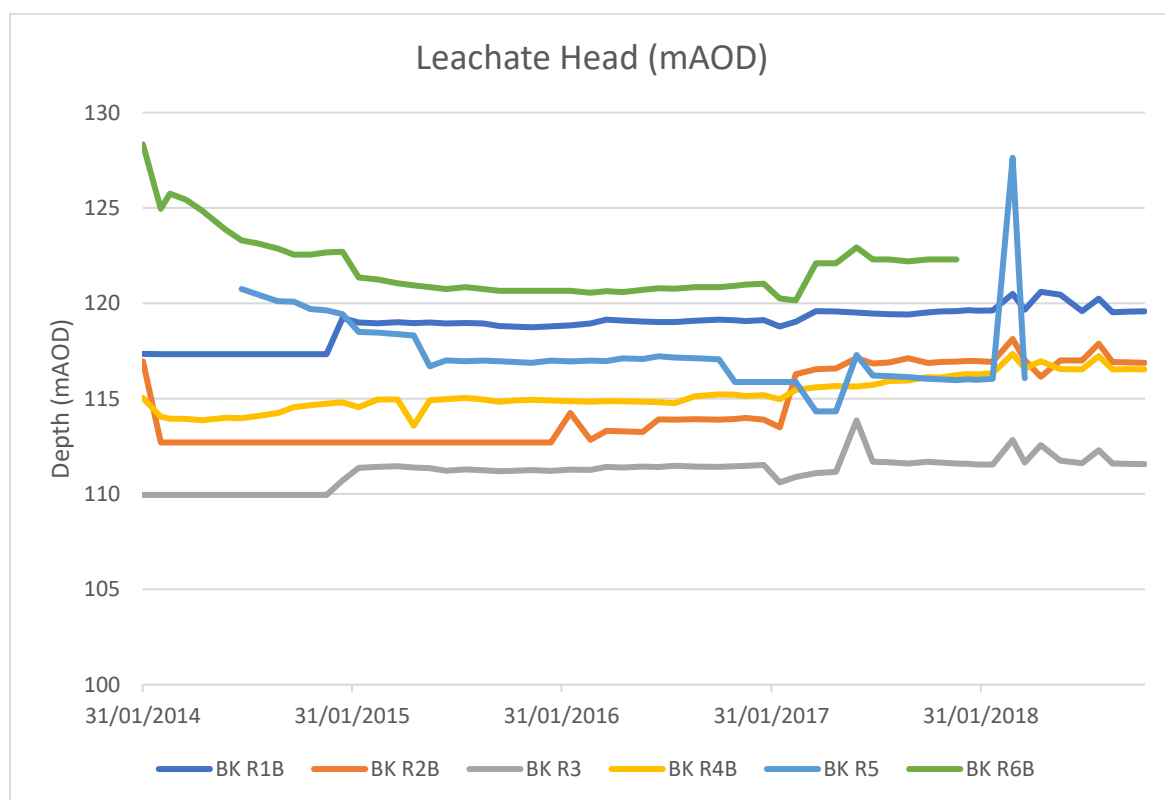
## **APPENDIX 2**

### **Leachate Level and Quality Summary Tables and Time-Series Graphs**

## APPENDIX 2 - LEACHATE

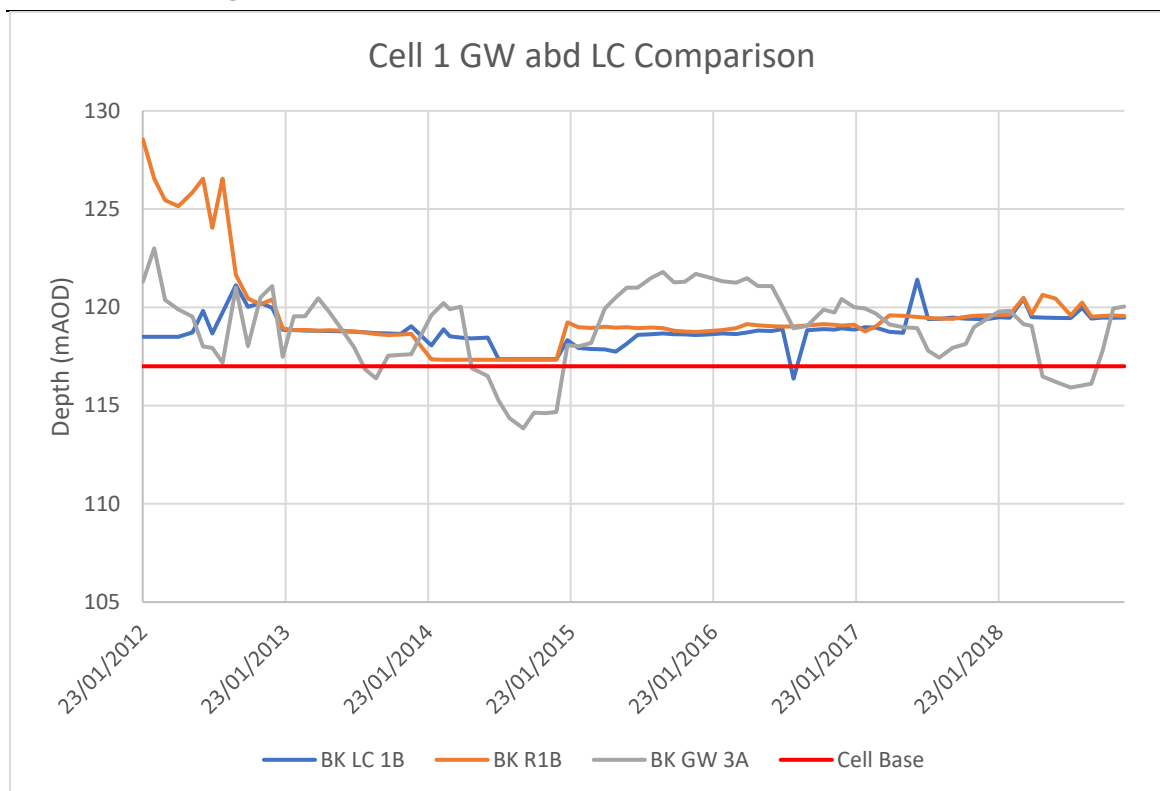


**Graph 1: Leachate Levels as mAOD at LC Series Wells**

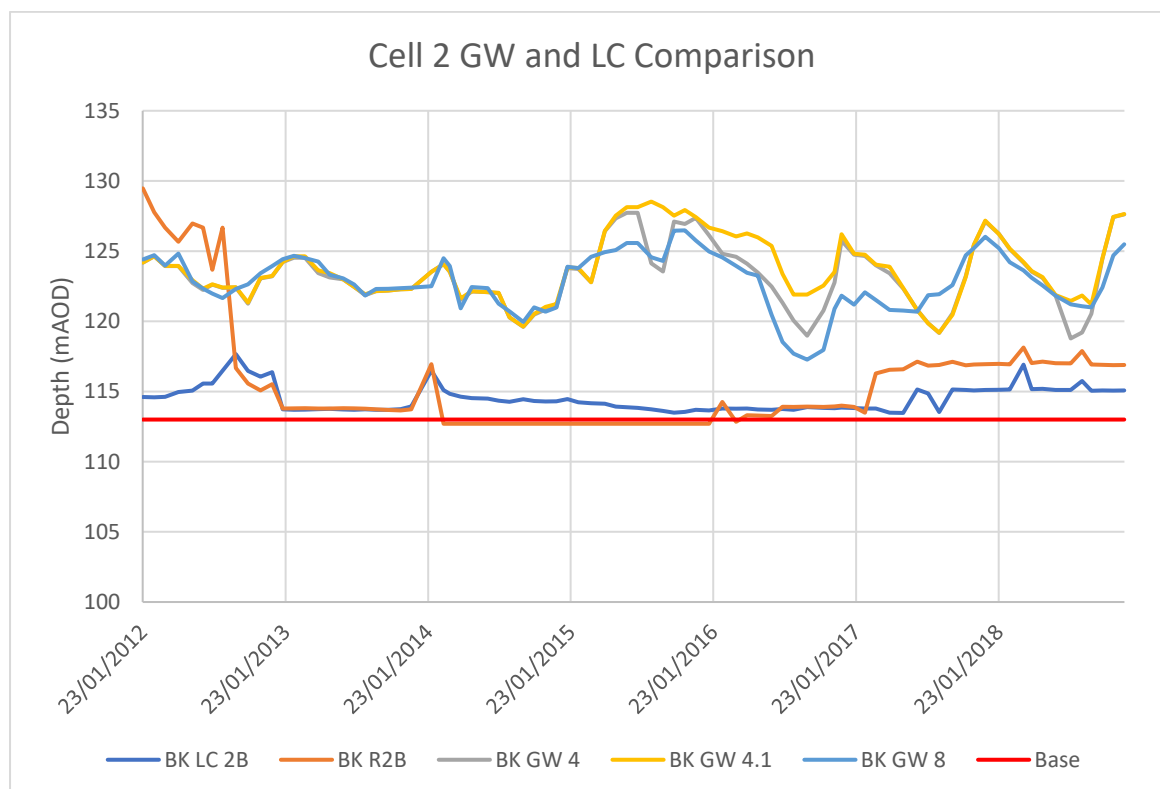


**Graph 2: Leachate Levels as mAOD at Remote Leachate Monitoring Points**

## APPENDIX 2 - LEACHATE

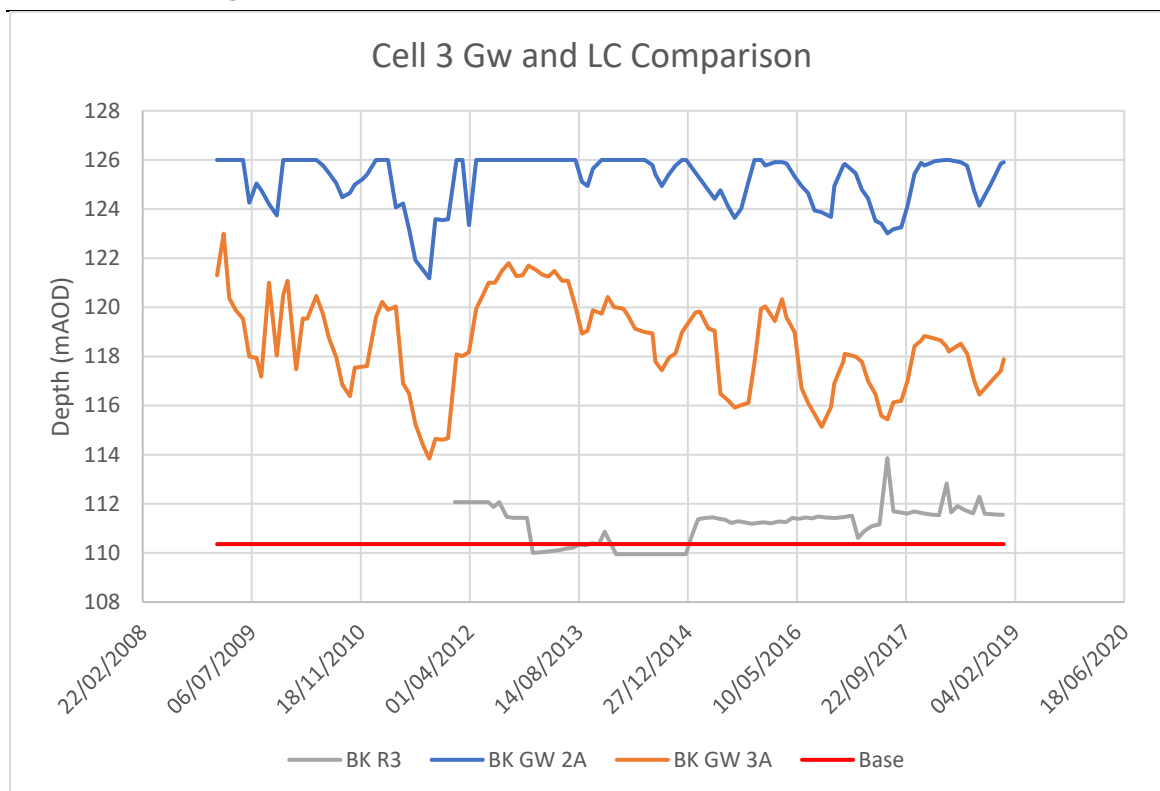


**Graph 3: Groundwater and Leachate level comparison in Cell 1**

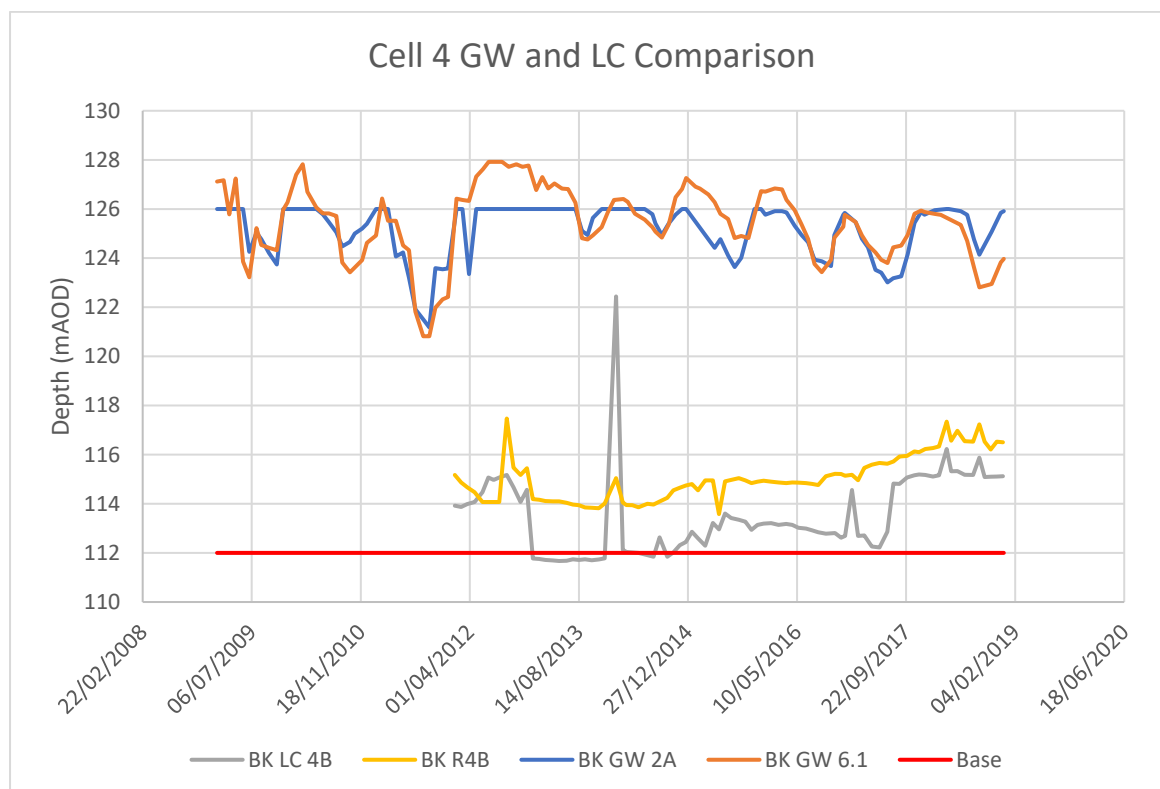


**Graph 4: Groundwater and Leachate level comparison in Cell 2**

## APPENDIX 2 - LEACHATE

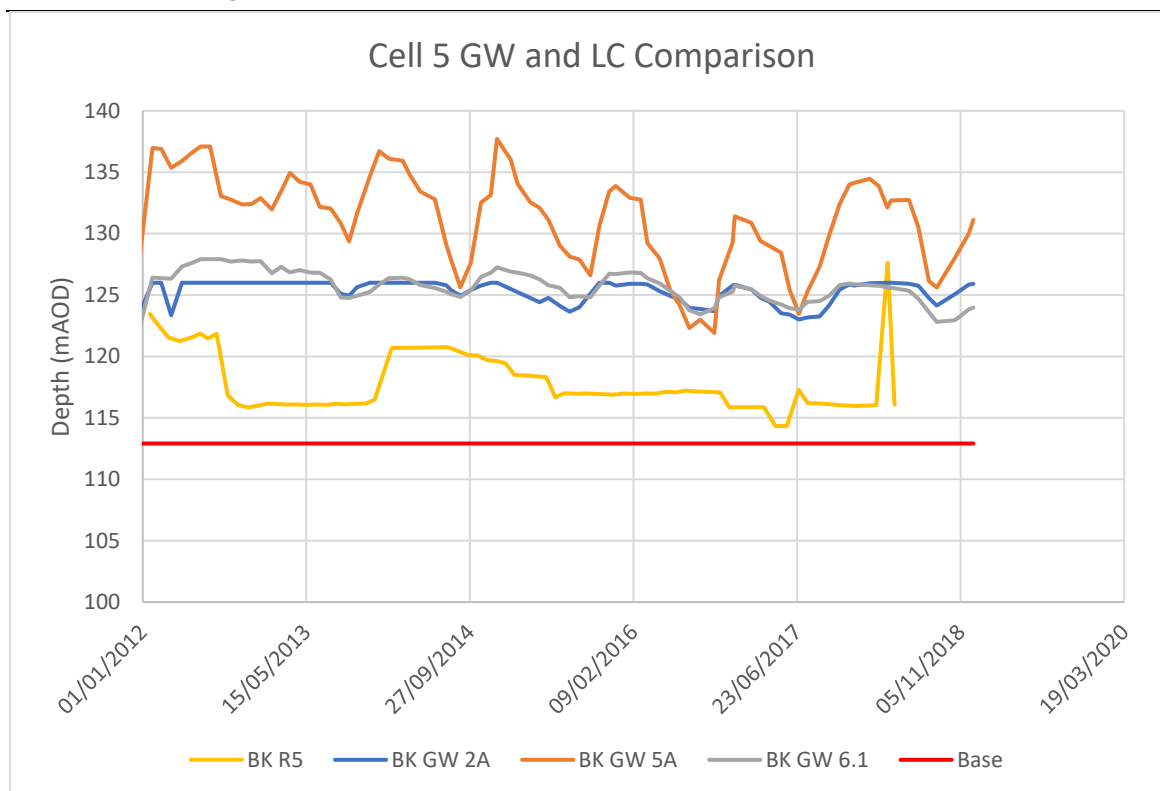


**Graph 5: Groundwater and Leachate level comparison in Cell 3**

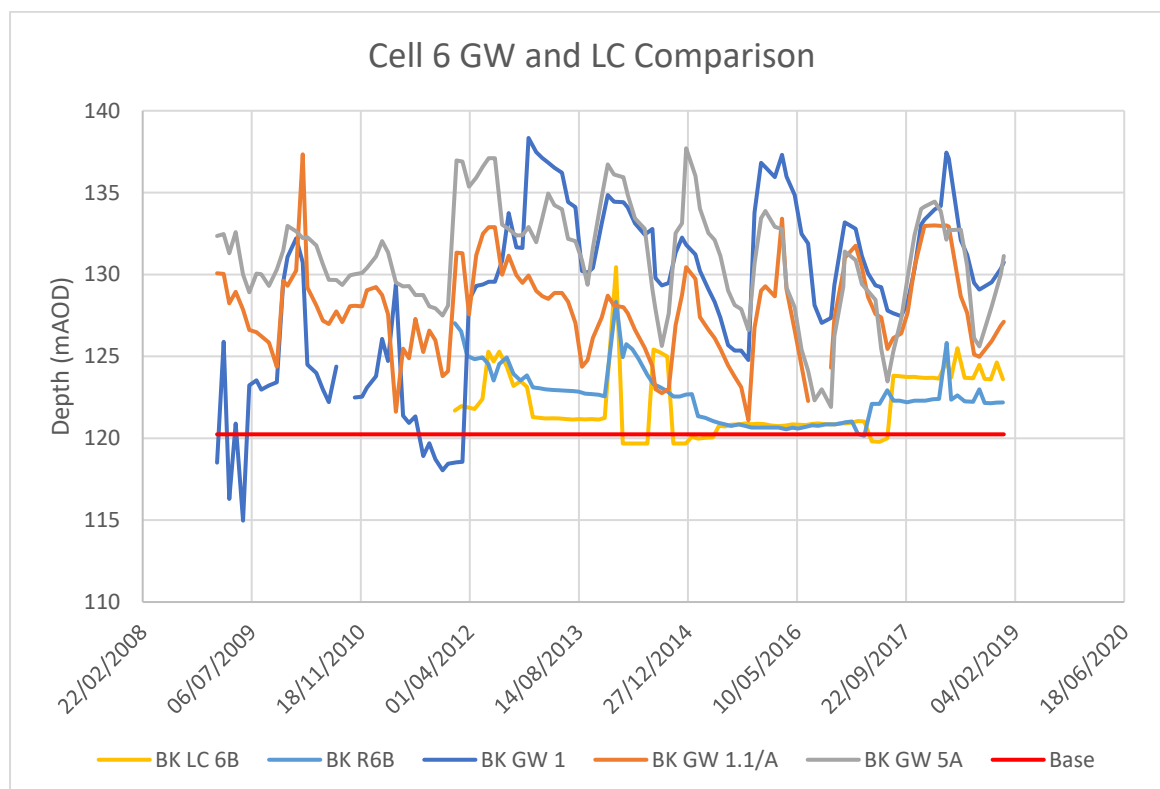


**Graph 6: Groundwater and Leachate level comparison in Cell 4**

## APPENDIX 2 - LEACHATE



**Graph 7: Groundwater and Leachate level comparison in Cell 5**



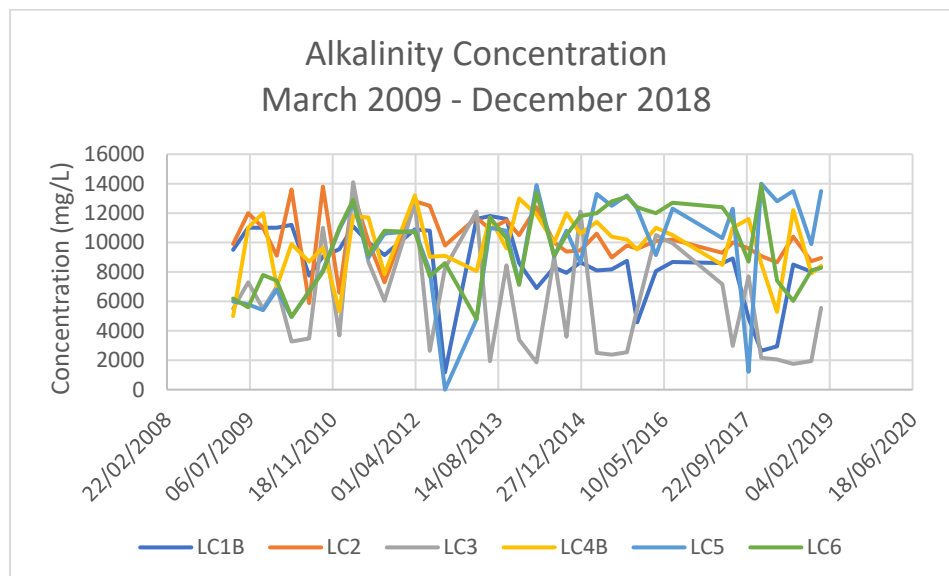
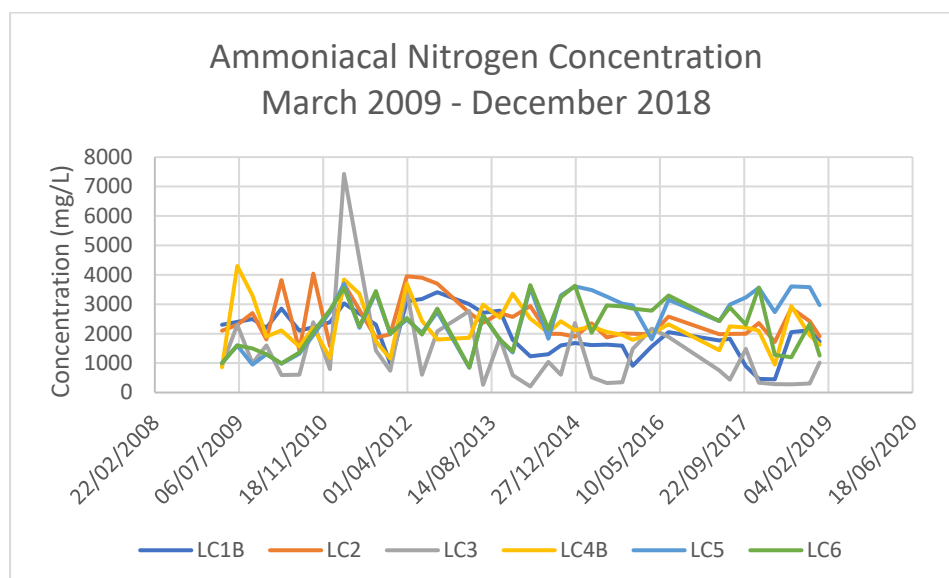
**Graph 8: Groundwater and Leachate level comparison in Cell 6**

## APPENDIX 2 - LEACHATE

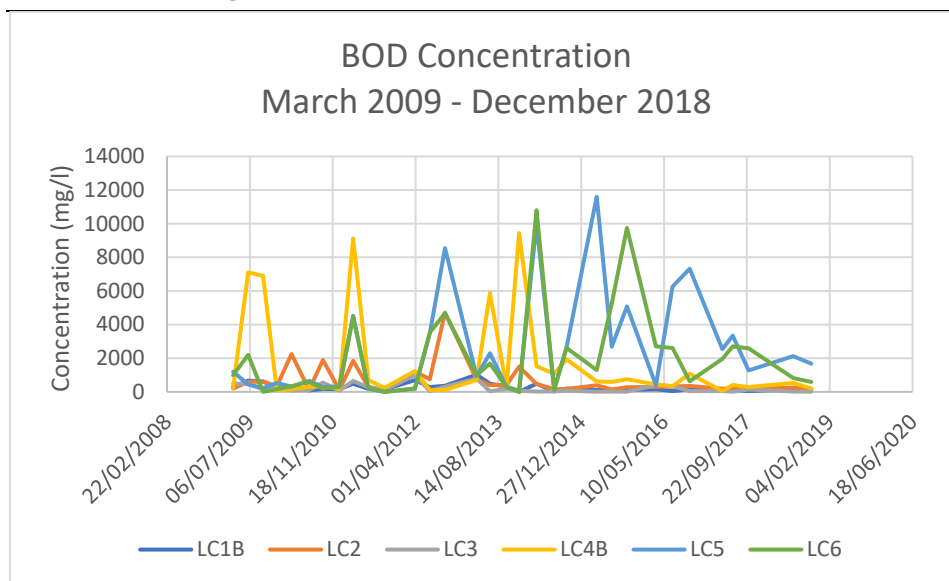
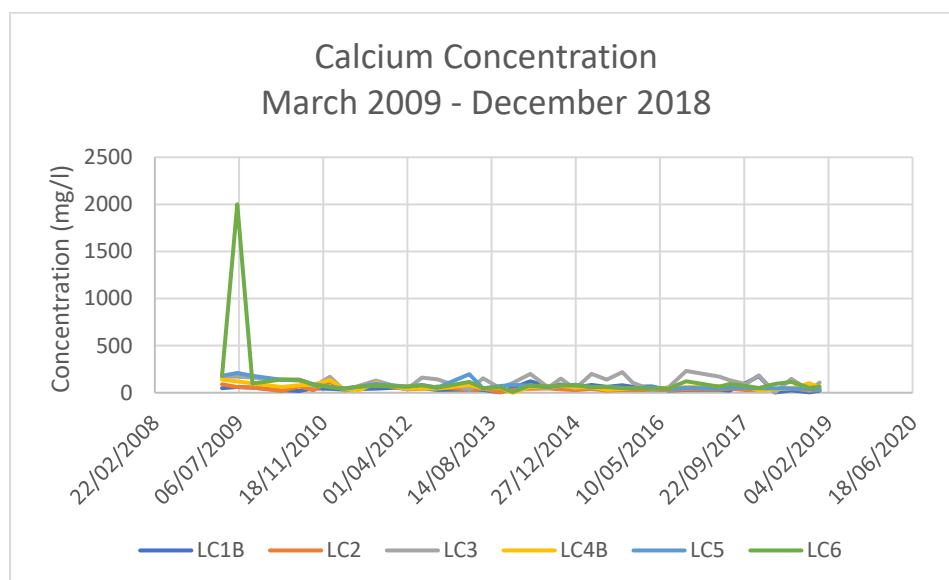
**Table 2: Leachate Quality Summary - Quarterly Suite (all parameters are in mg/l)**

|                                        | LC1B  |       |         | LC2    |       |         | LC3   |       |         |
|----------------------------------------|-------|-------|---------|--------|-------|---------|-------|-------|---------|
| Sample Description                     | Min   | Max   | Average | Min    | Max   | Average | Min   | Max   | Average |
| Alkalinity, Total as CaCO <sub>3</sub> | 2950  | 8500  | 6952.5  | 8650   | 10400 | 9182.5  | 1750  | 5550  | 2822.5  |
| Ammoniacal Nitrogen as N               | 448   | 2120  | 1587    | 1720   | 2870  | 2230    | 277   | 1020  | 472.5   |
| BOD, Unfiltered                        | 109   | 144   | 126.5   | 171    | 252   | 211.5   | 10    | 14.5  | 12.25   |
| Calcium                                | 2.62  | 24.9  | 13.75   | 21.1   | 45.9  | 32.27   | 0.835 | 147   | 69.68   |
| Chloride                               | 747   | 1990  | 1669.25 | 1870   | 2360  | 2082.5  | 353   | 1440  | 678.25  |
| COD, unfiltered                        | 558   | 2210  | 1789.5  | 2250   | 3560  | 3130    | 204   | 1380  | 540.25  |
| Magnesium                              | 0.472 | 99.3  | 49.62   | 33     | 92.9  | 59.9    | 0.379 | 84.5  | 37.51   |
| Organic Carbon, Total                  | 188   | 752   | 608.25  | 716    | 1180  | 1016.5  | 63.7  | 439   | 172.55  |
| pH                                     | 7.31  | 7.8   | 7.64    | 7.64   | 7.94  | 7.84    | 7.04  | 7.69  | 7.3     |
| Potassium                              | 2.62  | 1040  | 702.16  | 820    | 1010  | 883.67  | 8.14  | 498   | 165.78  |
| Sodium                                 | 0.996 | 1840  | 1267.75 | 1360   | 1760  | 1603.33 | 2.53  | 1080  | 353.43  |
| Sulphate                               | 2     | 40    | 13.7    | 2      | 44.5  | 14      | 2     | 2     | 2       |
| Total Oxidised Nitrogen as N           | 0.175 | 2.11  | 0.8     | 0.0402 | 2.33  | 0.71    | 0.117 | 0.894 | 0.41    |
|                                        | LC4B  |       |         | LC5    |       |         | LC6   |       |         |
| Sample Description                     | Min   | Max   | Average | Min    | Max   | Average | Min   | Max   | Average |
| Alkalinity, Total as CaCO <sub>3</sub> | 5280  | 12200 | 8445    | 9880   | 13500 | 12420   | 6030  | 8270  | 7450    |
| Ammoniacal Nitrogen as N               | 949   | 2940  | 1864.75 | 2730   | 3610  | 3222.5  | 1200  | 2330  | 1517.5  |
| BOD, Unfiltered                        | 199   | 534   | 366.5   | 1670   | 2120  | 1895    | 589   | 816   | 702.5   |
| Calcium                                | 34.9  | 101   | 58.8    | 28     | 44.4  | 37.2    | 52.1  | 114   | 80.7    |
| Chloride                               | 1850  | 4750  | 2935    | 2040   | 3480  | 2912.5  | 1560  | 1890  | 1757.5  |
| COD, unfiltered                        | 1590  | 5860  | 3547.5  | 7640   | 9120  | 8542.5  | 1960  | 3850  | 3315    |
| Magnesium                              | 21.3  | 92.2  | 68.4    | 52     | 76.4  | 68.52   | 61.3  | 104   | 82.02   |
| Organic Carbon, Total                  | 523   | 1790  | 1014.25 | 2680   | 2910  | 2797.5  | 502   | 1370  | 818.75  |
| pH                                     | 7.67  | 8.43  | 8       | 8.05   | 8.27  | 8.11    | 7.72  | 8.03  | 7.86    |
| Potassium                              | 166   | 750   | 503.33  | 600    | 1060  | 774     | 458   | 561   | 497.5   |
| Sodium                                 | 1.22  | 2370  | 1337.07 | 1550   | 3370  | 2420    | 1280  | 1690  | 1527.5  |
| Sulphate                               | 3.38  | 60.1  | 27.04   | 0.5    | 63    | 25.4    | 0.5   | 5.38  | 2.93    |
| Total Oxidised Nitrogen as N           | 0.02  | 1.5   | 0.8     | 0.02   | 1.5   | 0.54    | 0.02  | 1.5   | 0.45    |

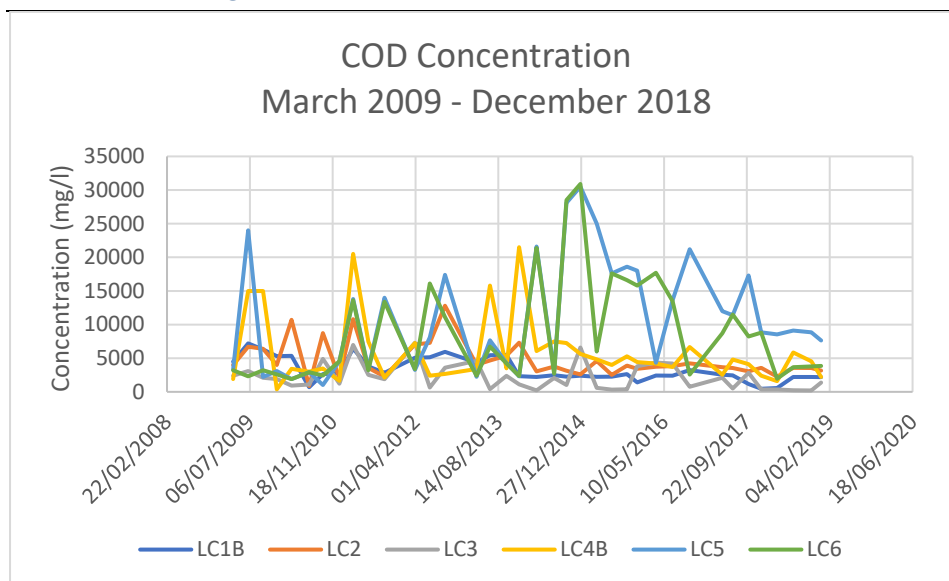
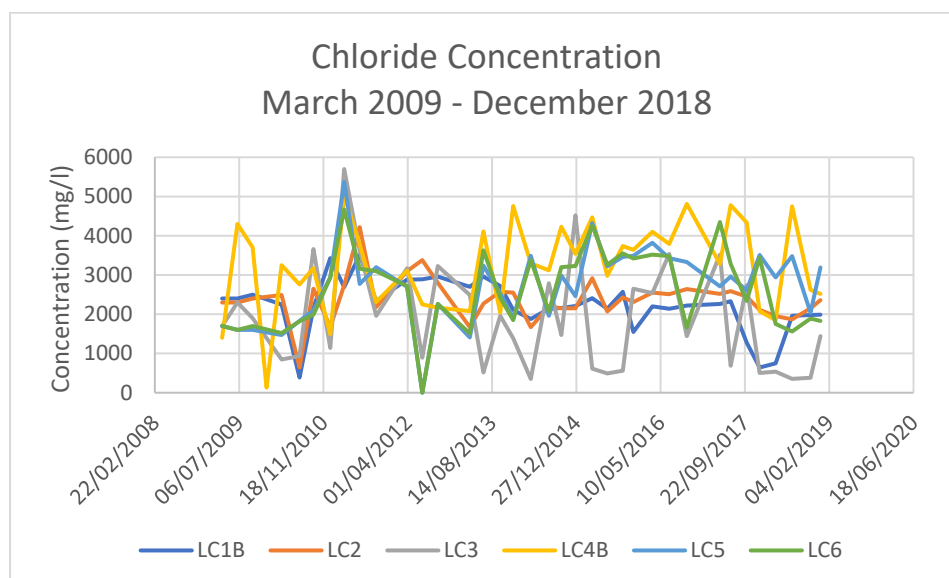
## APPENDIX 2 - LEACHATE



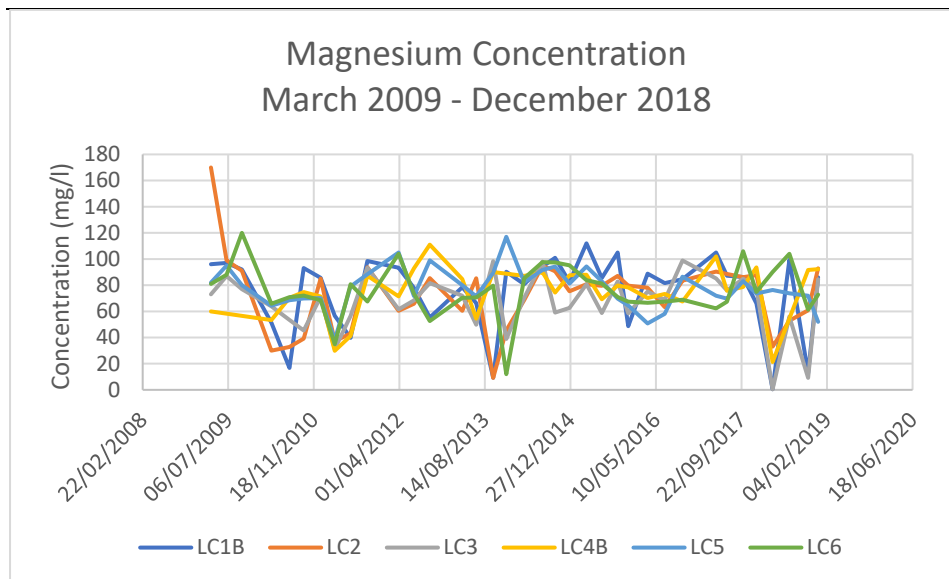
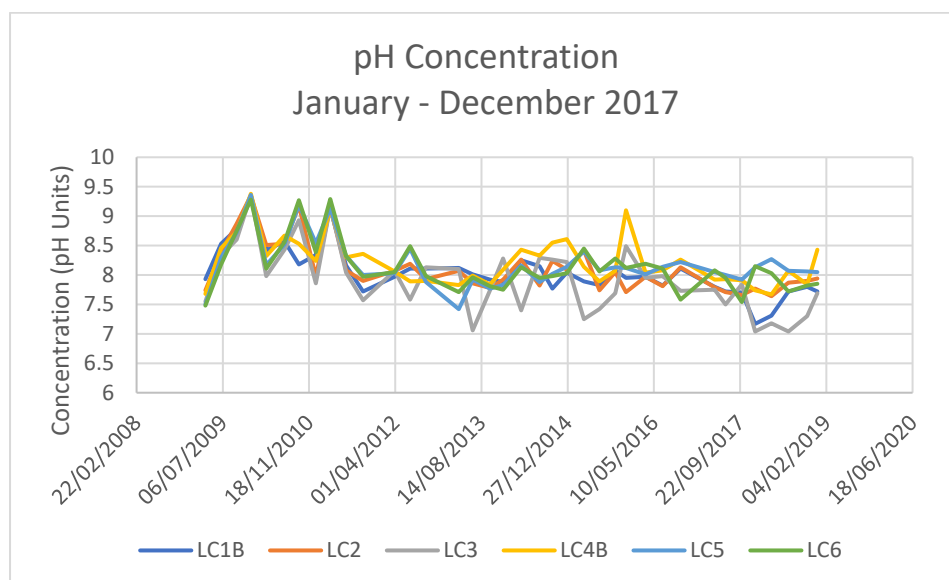
## APPENDIX 2 - LEACHATE



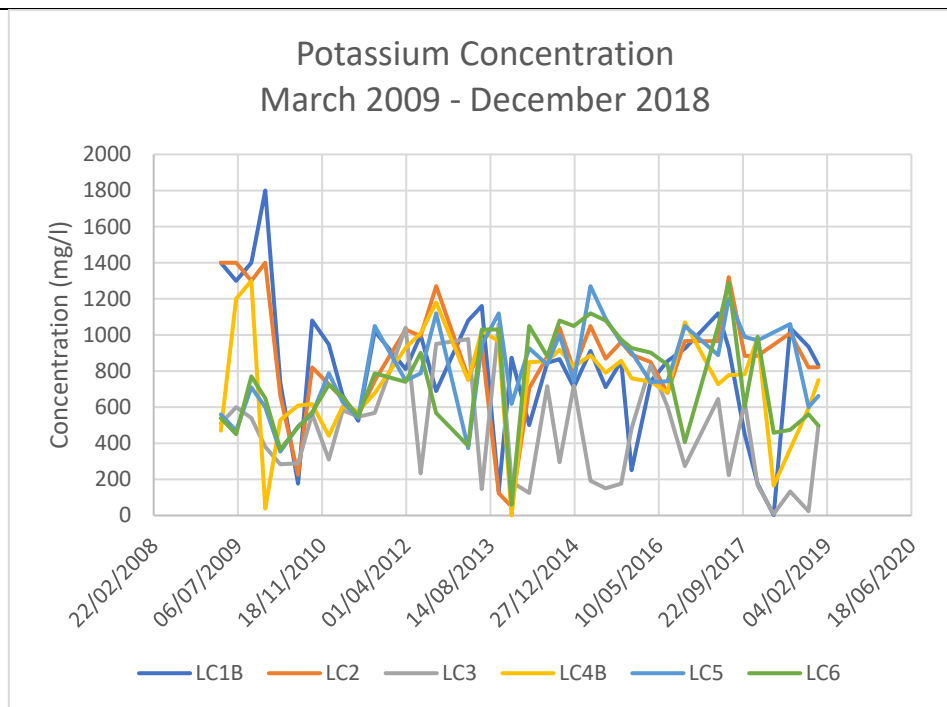
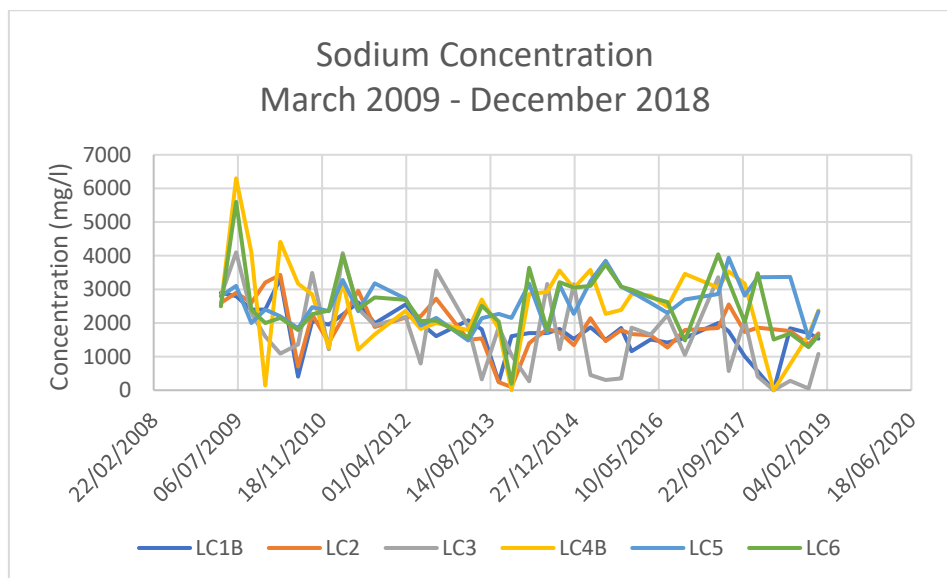
## APPENDIX 2 - LEACHATE



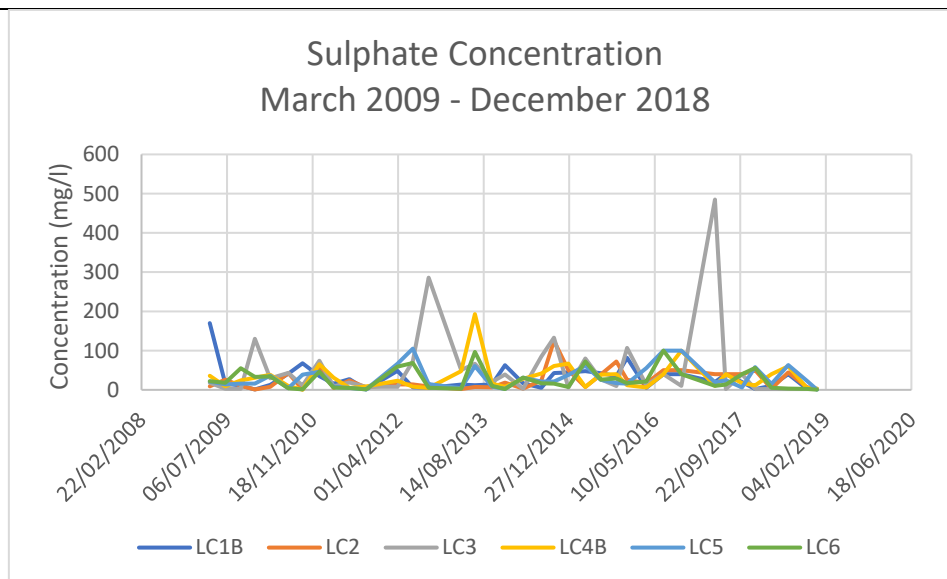
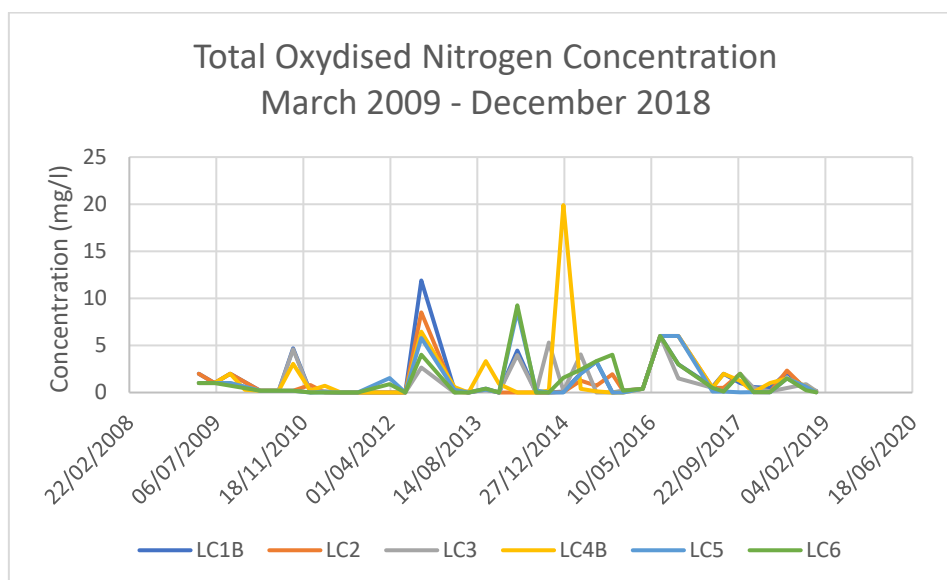
## APPENDIX 2 - LEACHATE



**APPENDIX 2 - LEACHATE**



**APPENDIX 2 - LEACHATE**



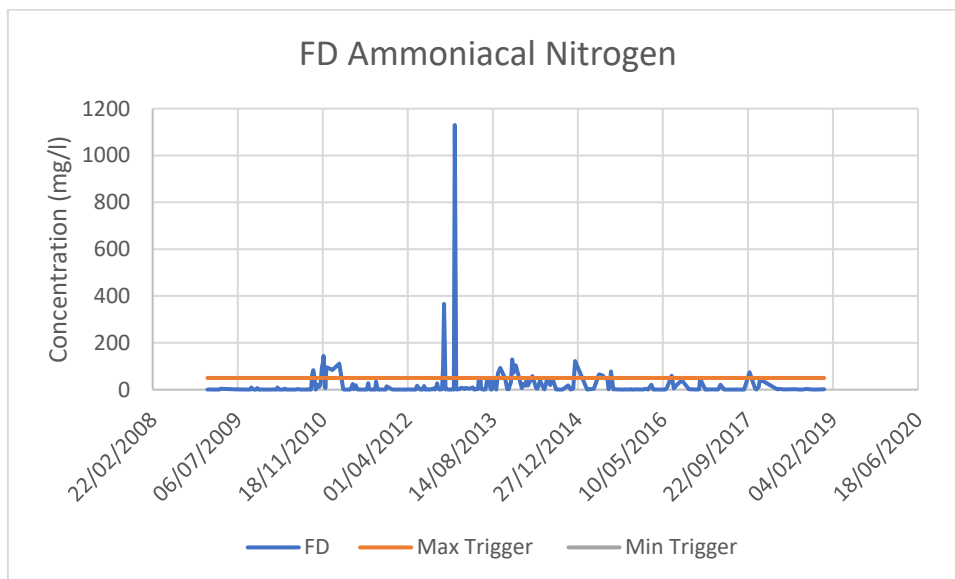
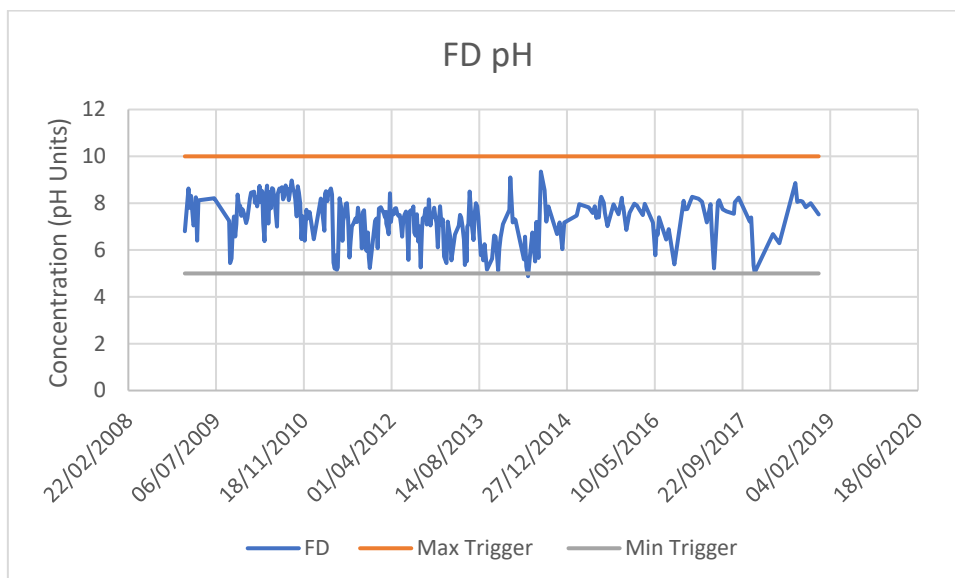
## **APPENDIX 2 - LEACHATE**

---

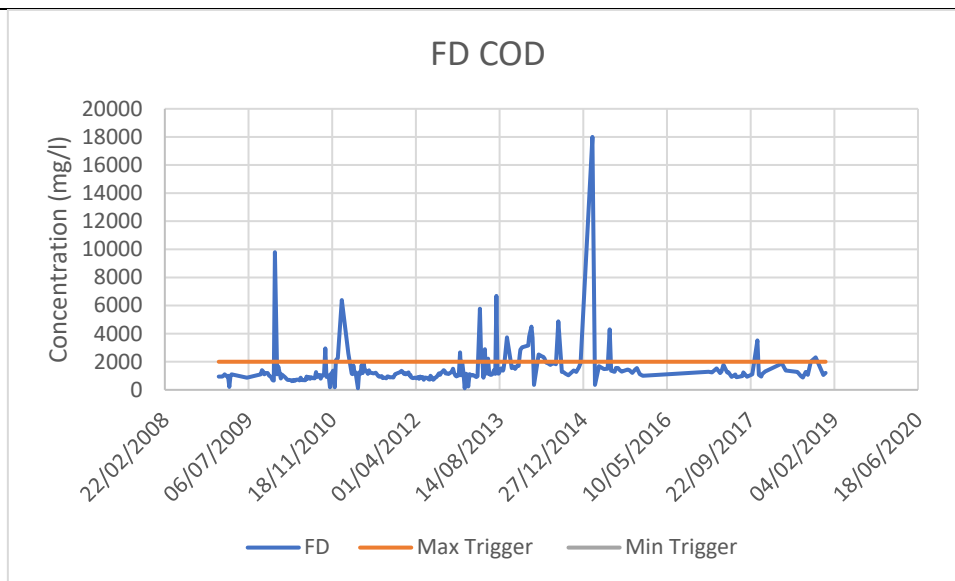
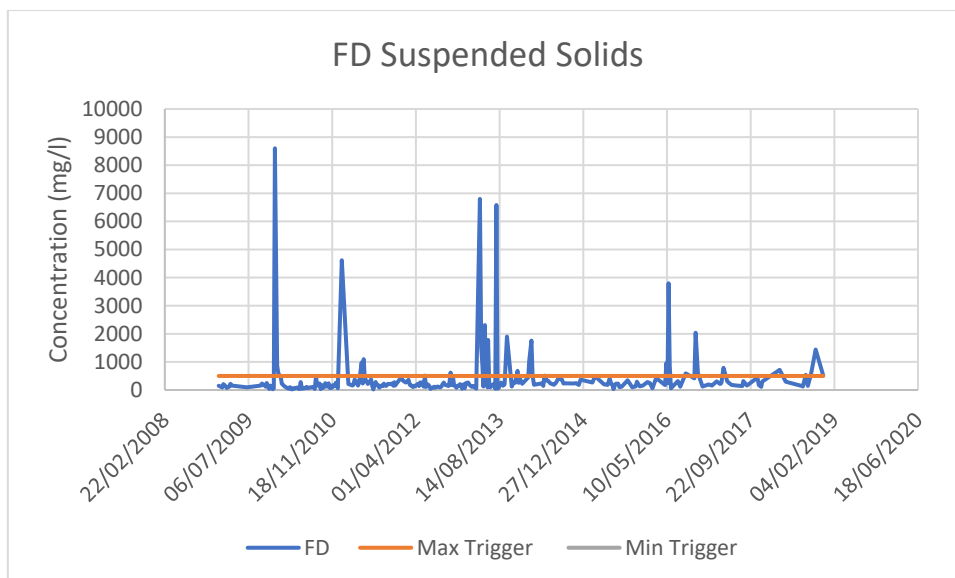
**APPENDIX 2 - LEACHATE****Table 4: Final Discharge Quality Summary**

| Final Discharge | Ammoniacal Nitrogen | pH       | COD     | Suspended Solids | Chromium | Copper | Lead | Nickel | Zinc | Nitrate as N | Nitrite as N | Alkalinity |
|-----------------|---------------------|----------|---------|------------------|----------|--------|------|--------|------|--------------|--------------|------------|
|                 | mg/l                | pH Units | mg/l    | mg/l             | mg/l     | mg/l   | mg/l | mg/l   | mg/l | mg/l         | mg/l         | mg/l       |
| Date / Trigger  | 50                  | >5<10    | 2000    | 500              | 2        | 2      | 2    | 2      | 2    | -            | -            | -          |
| 14/03/2018      | 1.22                | 6.68     | 1800.00 | 717.00           | 0.07     | 0.02   | 0.02 | 0.25   | 0.20 | 1040.00      | 0.43         | 200.00     |
| 26/03/2018      | 2.91                |          | 1920.00 |                  | 0.06     | 0.02   | 0.03 | 0.22   | 0.19 |              | 0.40         | 390.00     |
| 20/04/2018      | 1.18                | 6.29     | 1380.00 | 292.00           | 0.06     | 0.02   | 0.02 | 0.19   | 0.21 | 898.00       | 0.02         | 125.00     |
| 29/06/2018      | 1.82                |          | 1270.00 |                  | 0.08     | 0.04   | 0.03 | 0.25   | 0.24 |              | 0.15         | 1170.00    |
| 20/07/2018      | 0.58                | 8.86     | 978.00  | 153.00           | 0.06     | 0.02   | 0.01 | 0.20   | 0.07 | 901.00       | 0.15         | 750.00     |
| 31/07/2018      | 0.47                | 8.05     | 875.00  | 121.00           |          |        |      |        |      | 891.00       | 0.21         | 350.00     |
| 17/08/2018      | 0.98                | 8.10     | 1280.00 | 541.00           | 0.06     | 0.02   | 0.01 | 0.21   | 0.07 | 894.00       | 0.20         | 714.00     |
| 30/08/2018      | 3.54                | 8.07     | 1070.00 | 148.00           |          |        |      |        |      | 879.00       | 16.60        | 494.00     |
| 17/09/2018      | 2.16                | 7.83     | 2020.00 | 540.00           | 0.07     | 0.02   | 0.01 | 0.23   | 0.09 | 924.00       | 6.42         | 640.00     |
| 16/10/2018      | 0.67                | 8.00     | 2310.00 | 1440.00          |          |        |      |        |      | 951.00       | 0.59         | 660.00     |
| 30/11/2018      | 1.36                | 7.52     | 1060.00 | 508.00           |          |        |      |        |      | 857.00       | 0.99         | 385.00     |
| 14/12/2018      | 1.96                |          | 1210.00 |                  | 0.06     | 0.01   | 0.01 | 0.20   | 0.10 |              | 0.05         | 267.00     |
| min             | 0.47                | 6.29     | 875.00  | 121.00           | 0.06     | 0.01   | 0.01 | 0.19   | 0.07 | 857.00       | 0.02         | 125.00     |
| max             | 3.54                | 8.86     | 2310.00 | 1440.00          | 0.08     | 0.04   | 0.03 | 0.25   | 0.24 | 1040.00      | 16.60        | 1170.00    |
| average         | 1.57                | 7.71     | 1431.08 | 495.56           | 0.06     | 0.02   | 0.02 | 0.22   | 0.15 | 915.00       | 2.18         | 512.08     |
| count           | 12.00               | 9.00     | 12.00   | 9.00             | 8.00     | 8.00   | 8.00 | 8.00   | 8.00 | 9.00         | 12.00        | 12.00      |

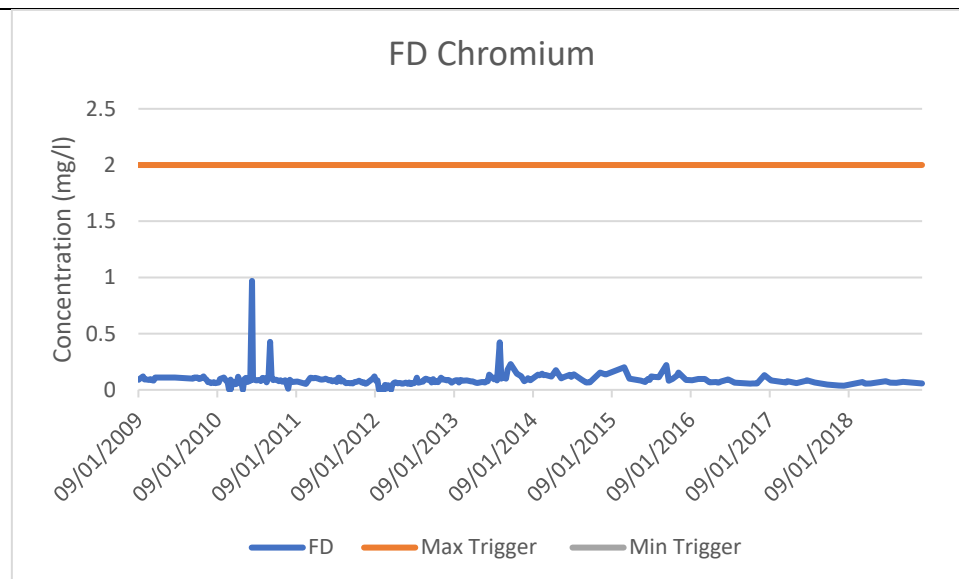
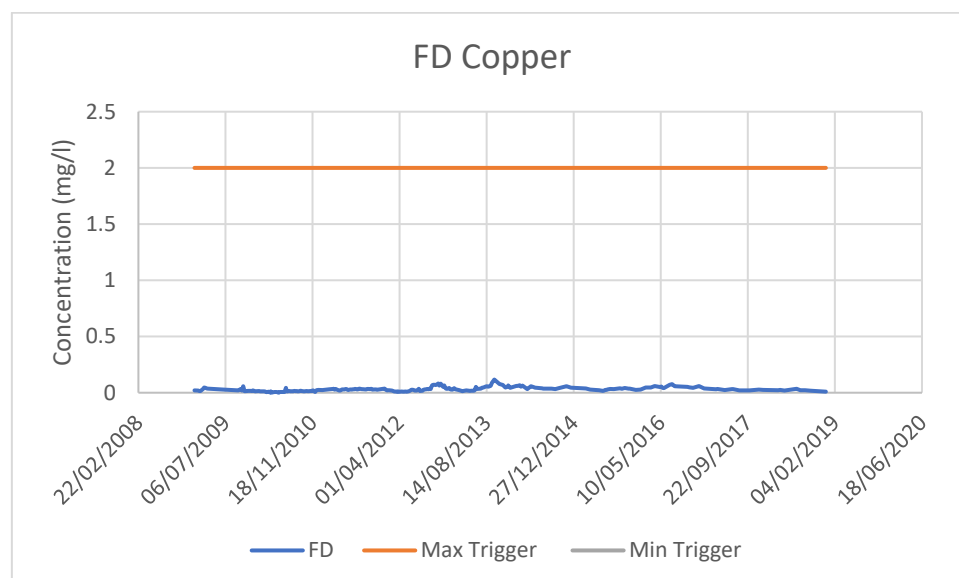
## APPENDIX 2 - LEACHATE



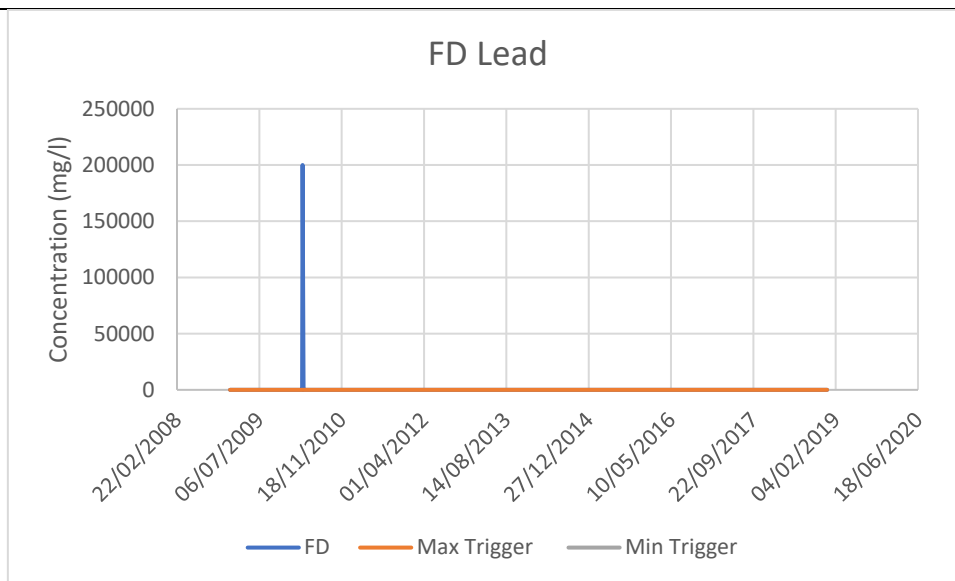
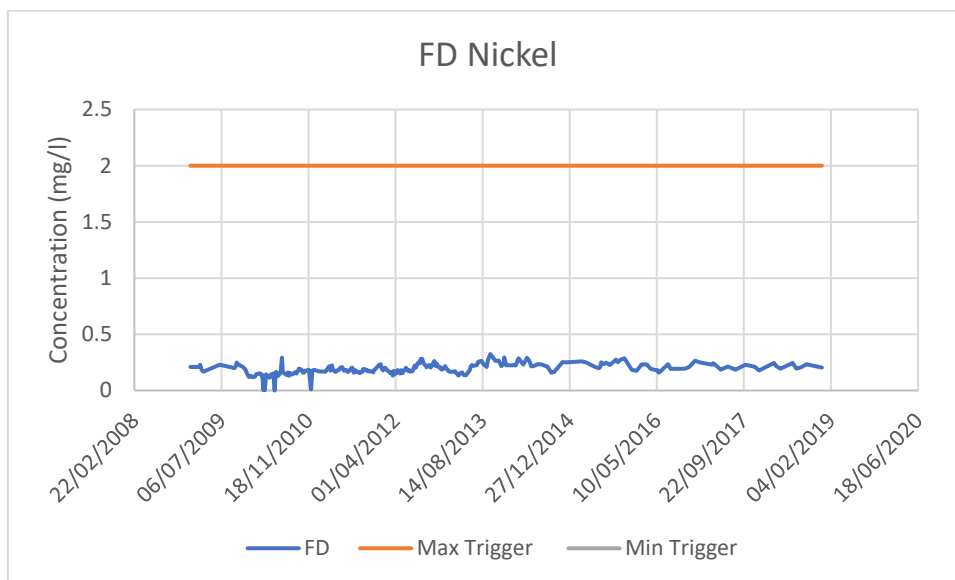
## APPENDIX 2 - LEACHATE



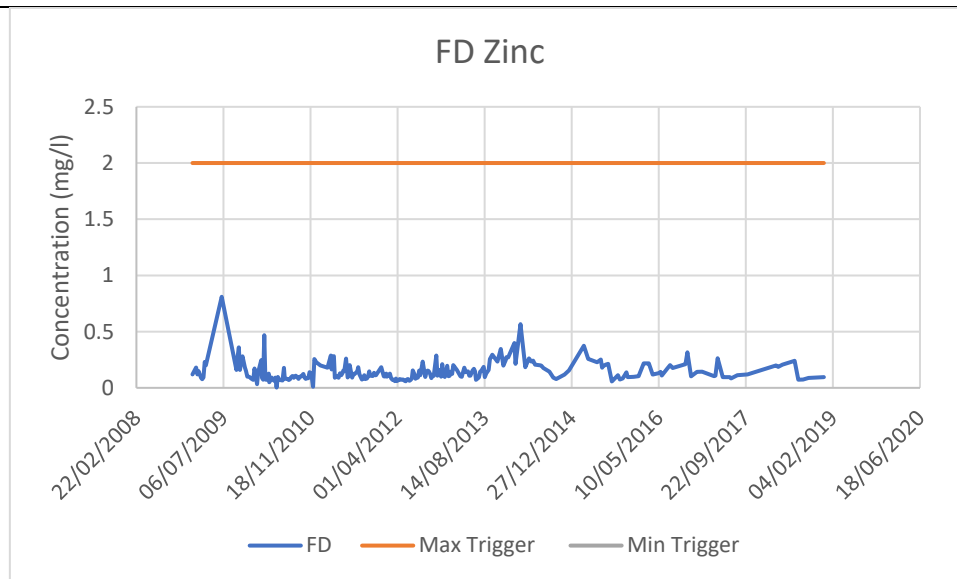
## APPENDIX 2 - LEACHATE

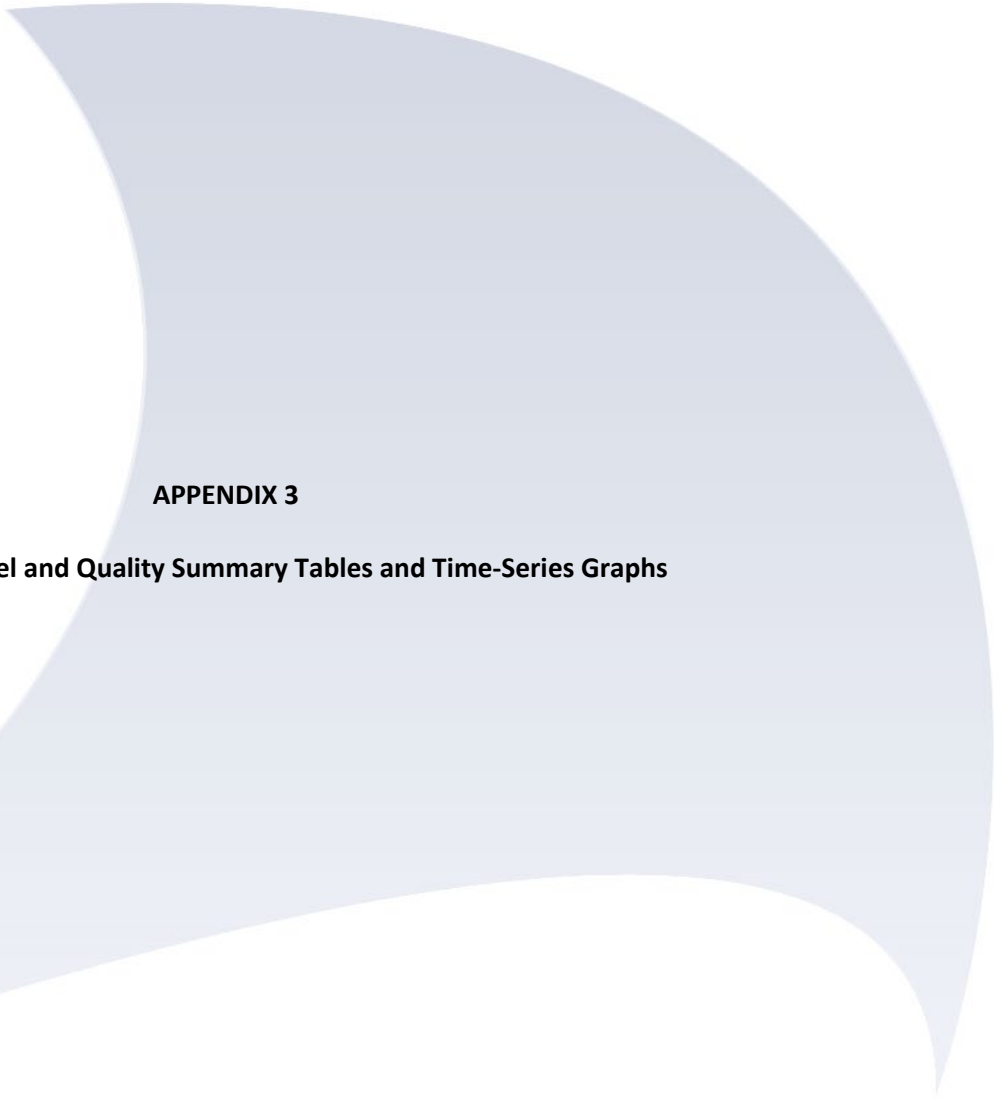


## APPENDIX 2 - LEACHATE



**APPENDIX 2 - LEACHATE**

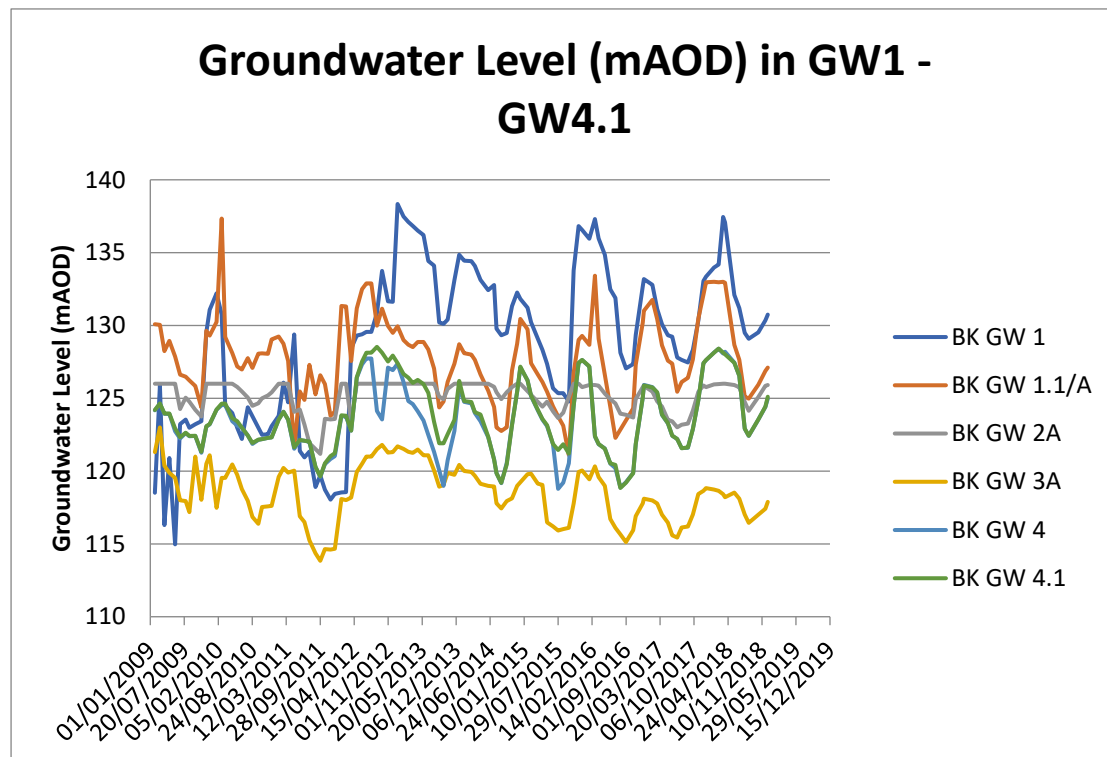




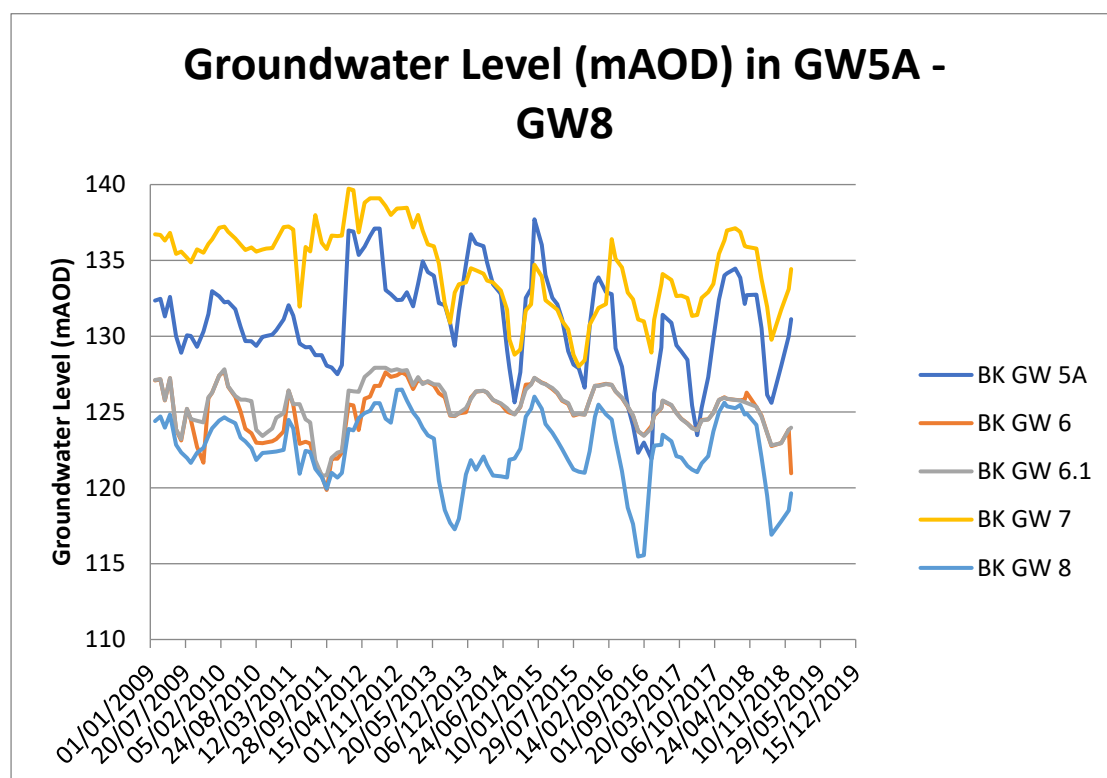
## **APPENDIX 3**

### **Groudwater Level and Quality Summary Tables and Time-Series Graphs**

### APPENDIX 3 - GROUNDWATER



Graph 1A: Groundwater level as metres above Ordnance Datum (2009-2018)



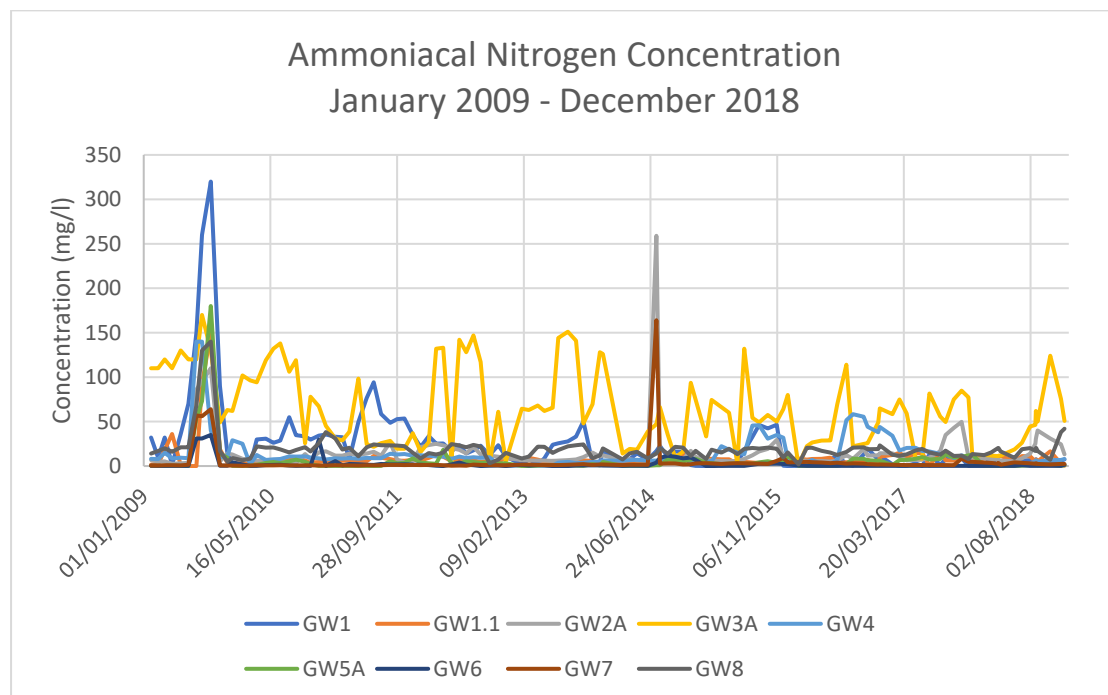
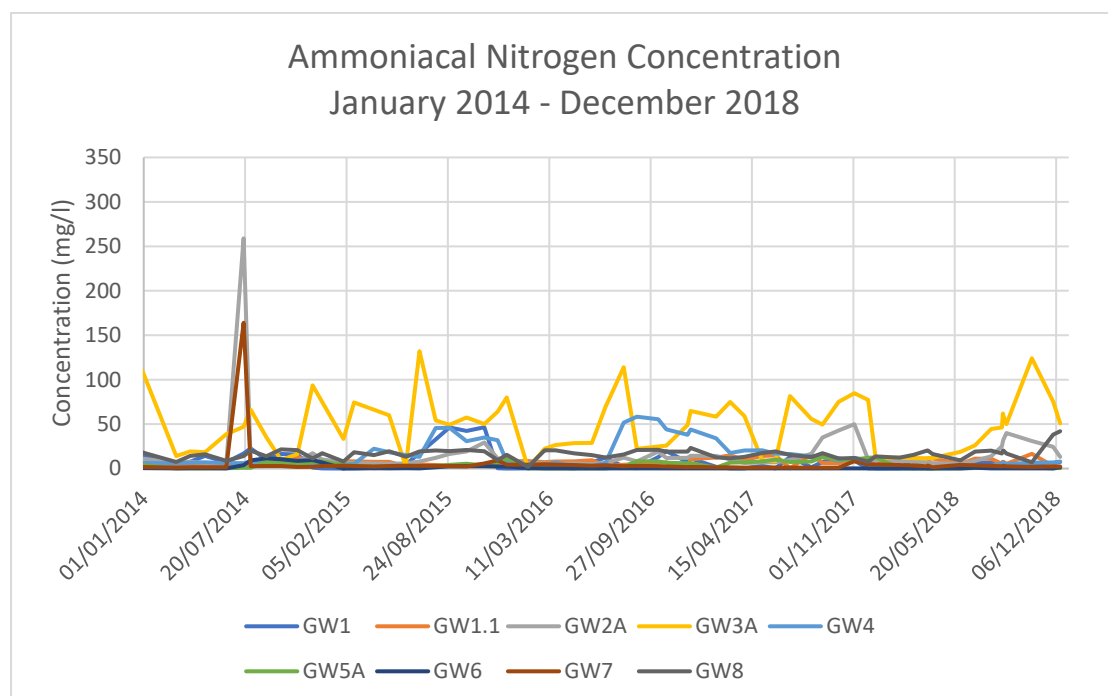
Graph 1B: Groundwater level as metres above Ordnance Datum (2009-2018)

**APPENDIX 3 - GROUNDWATER****Table 1: Groundwater Quality (Monthly) 2018**

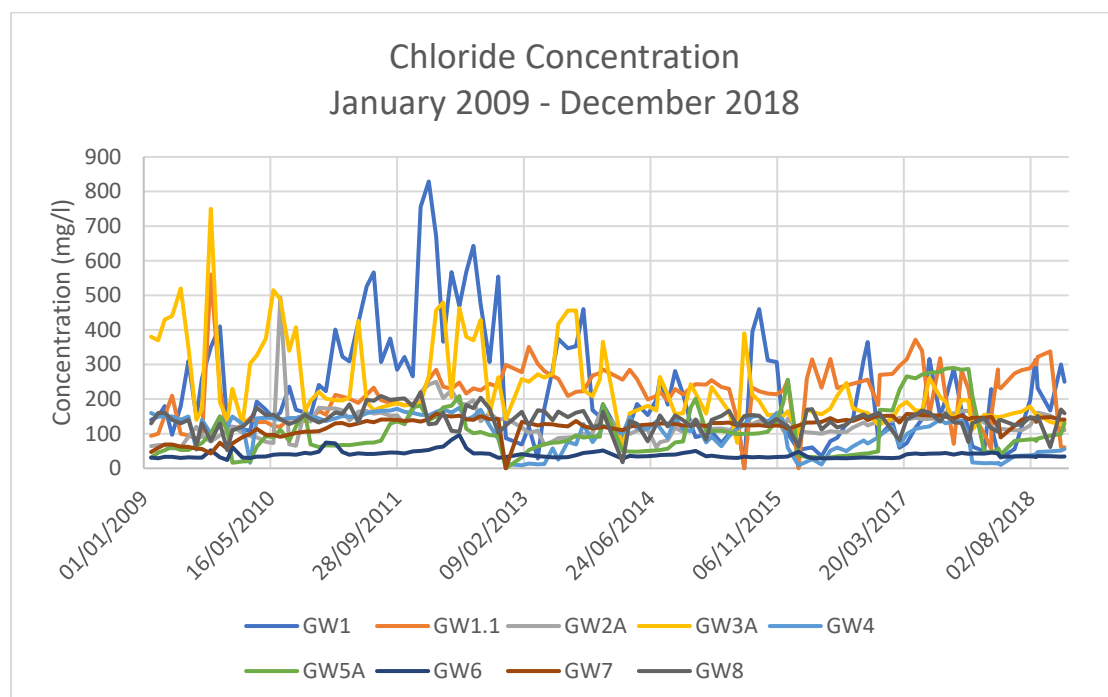
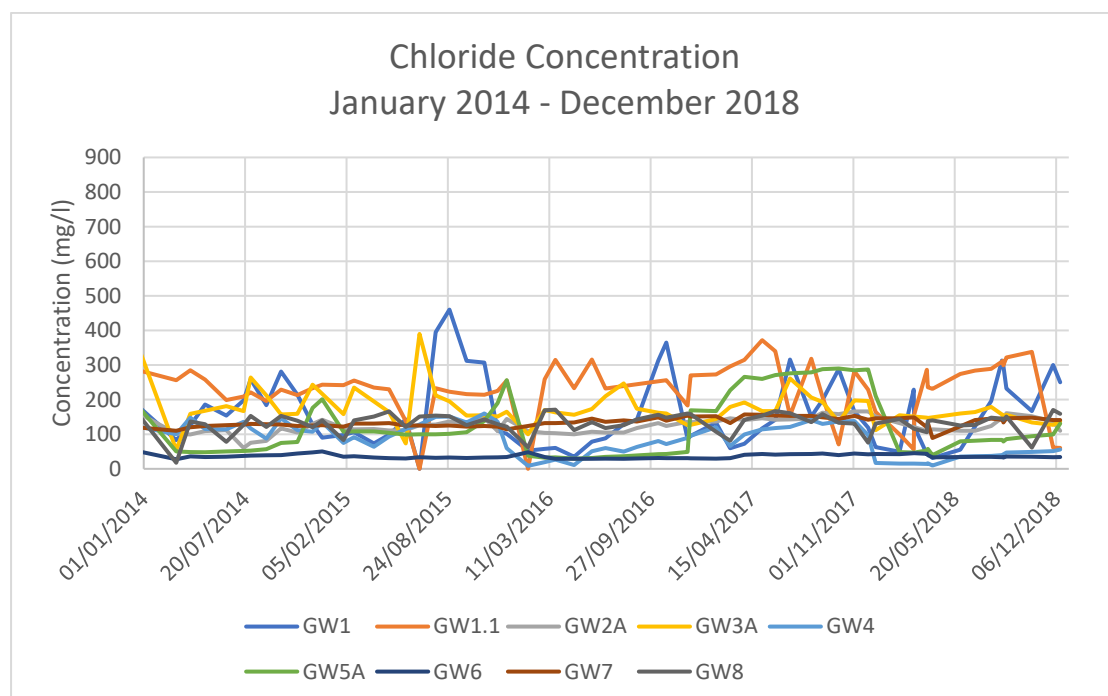
| Sample Description      | Limit (GW2A, GW3A, GW4) | GW1  |      |         | GW1.1 |      |         | GW2A |      |         | GW3A |      |         | GW4   |       |         |
|-------------------------|-------------------------|------|------|---------|-------|------|---------|------|------|---------|------|------|---------|-------|-------|---------|
|                         |                         | Min  | Max  | Average | Min   | Max  | Average | Min  | Max  | Average | Min  | Max  | Average | Min   | Max   | Average |
| Ammoniacal Nitrogen     | 1.7                     | 0.2  | 10.3 | 4.77    | 0.2   | 16.6 | 7.51    | 5.37 | 39.9 | 18.09   | 11.1 | 124  | 43.19   | 0.2   | 7.89  | 3.58    |
| Chloride                | 60                      | 31.1 | 313  | 176.04  | 56.4  | 338  | 226.03  | 107  | 161  | 128.64  | 127  | 179  | 151.14  | 9.4   | 55.9  | 33.61   |
| Conductivity @ 20 deg.C | N/A                     | 1.33 | 2.98 | 2.08    | 1.54  | 3.12 | 1.98    | 1.16 | 1.72 | 1.42    | 1.36 | 1.86 | 1.70    | 0.188 | 0.539 | 0.34    |
| Dissolved Oxygen        | N/A                     | 0.3  | 9.5  | 1.85    | 0.3   | 3.11 | 0.87    | 0.3  | 5.26 | 0.75    | 0.3  | 1.11 | 0.44    | 0.3   | 4.48  | 1.39    |
| pH                      | N/A                     | 6.09 | 7.99 | 7.05    | 6.16  | 7.65 | 6.71    | 6.81 | 8.19 | 7.31    | 6.94 | 8.09 | 7.17    | 6.61  | 7.58  | 7.01    |

| Sample Description      | GW5A  |      |         | GW6   |       |         | GW7  |       |         | GW8  |      |         |
|-------------------------|-------|------|---------|-------|-------|---------|------|-------|---------|------|------|---------|
|                         | Min   | Max  | Average | Min   | Max   | Average | Min  | Max   | Average | Min  | Max  | Average |
| Ammoniacal Nitrogen     | 0.2   | 1.38 | 0.60    | 0.2   | 1.42  | 0.34    | 1.41 | 4.2   | 2.89    | 6.97 | 41.9 | 19.62   |
| Chloride                | 39.7  | 131  | 76.37   | 32.6  | 45    | 36.40   | 89.3 | 149   | 136.02  | 61.4 | 170  | 134.43  |
| Conductivity @ 20 deg.C | 0.604 | 0.97 | 0.77    | 0.671 | 0.833 | 0.73    | 0.65 | 0.783 | 0.73    | 1.07 | 1.47 | 1.29    |
| Dissolved Oxygen        | 1.17  | 6.62 | 3.77    | 1.07  | 6.67  | 3.20    | 0.62 | 3.16  | 1.64    | 0.3  | 2.45 | 1.28    |
| pH                      | 6.32  | 7.81 | 6.74    | 7.29  | 8.39  | 7.70    | 7.49 | 8.21  | 7.78    | 6.65 | 7.78 | 7.03    |

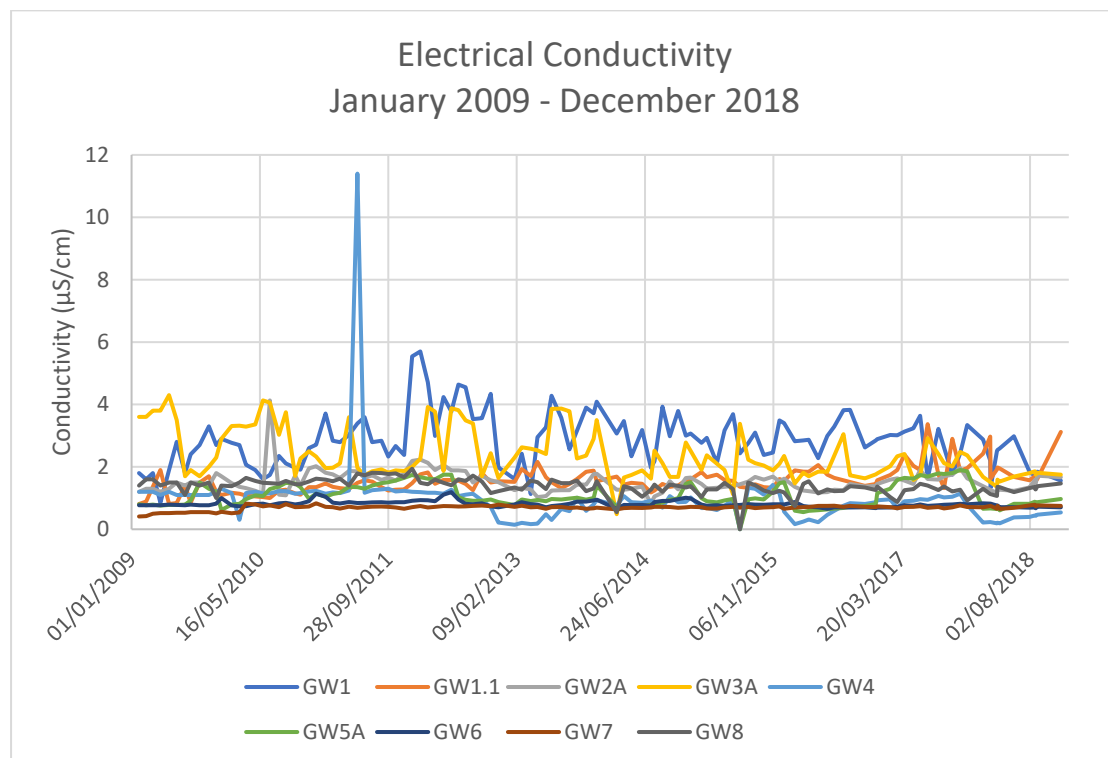
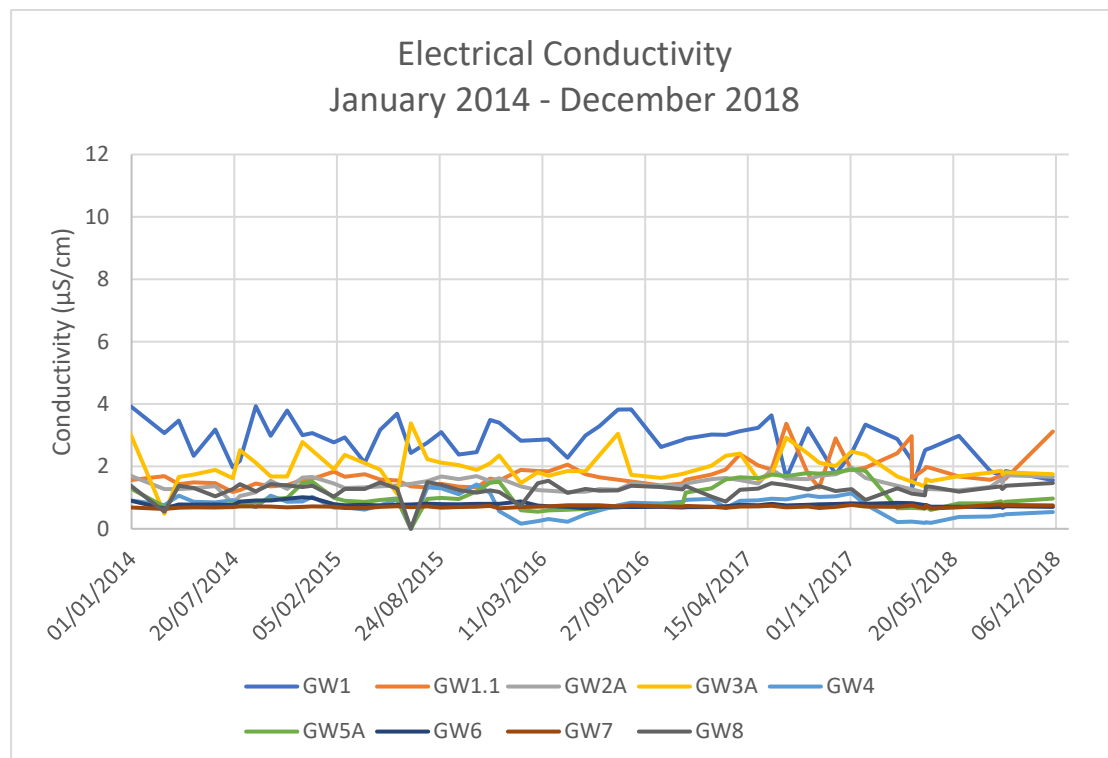
### APPENDIX 3 - GROUNDWATER



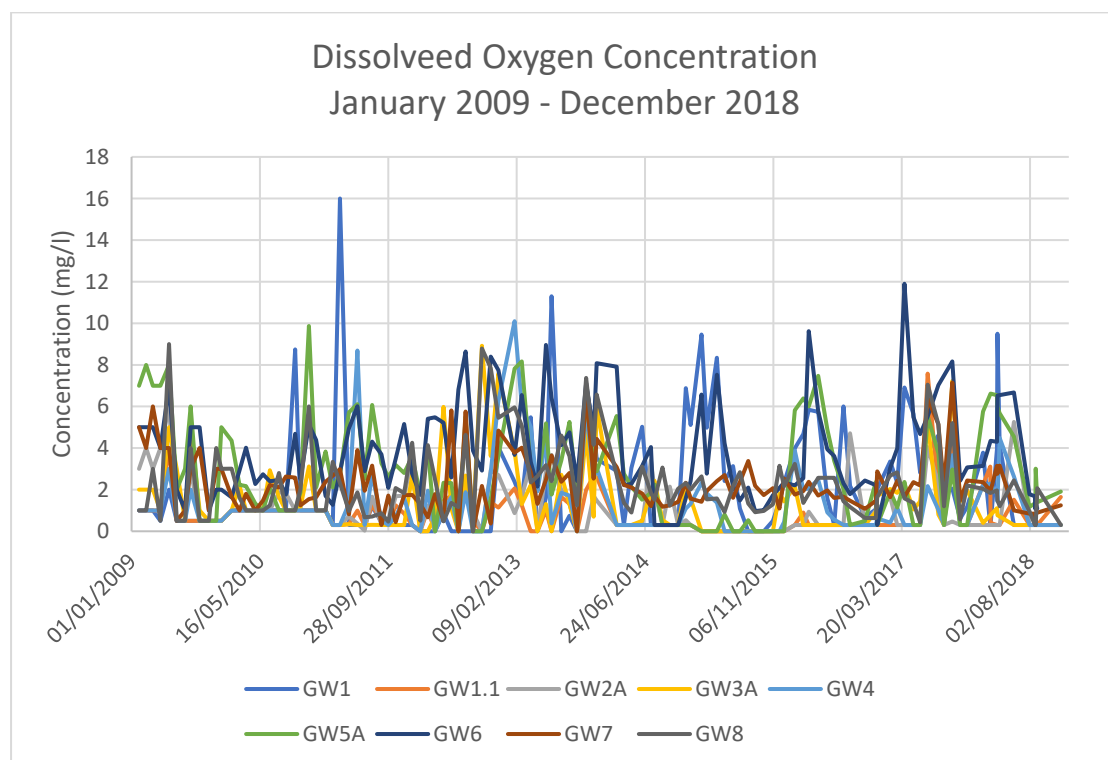
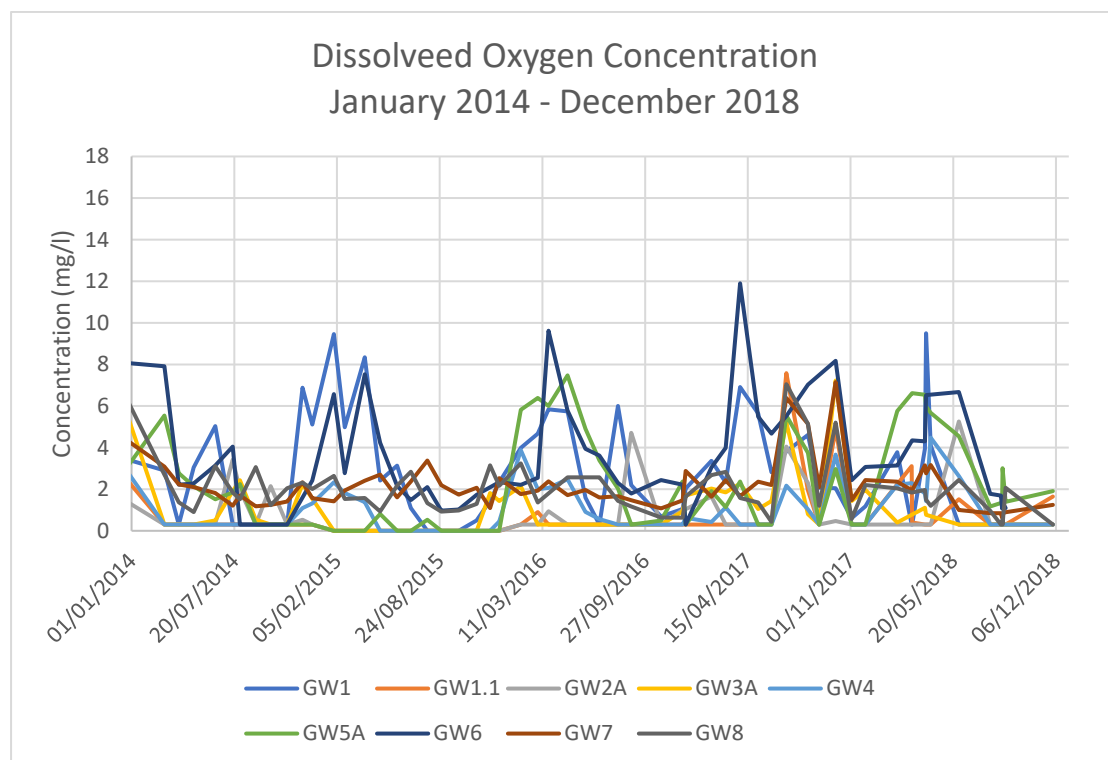
### APPENDIX 3 - GROUNDWATER



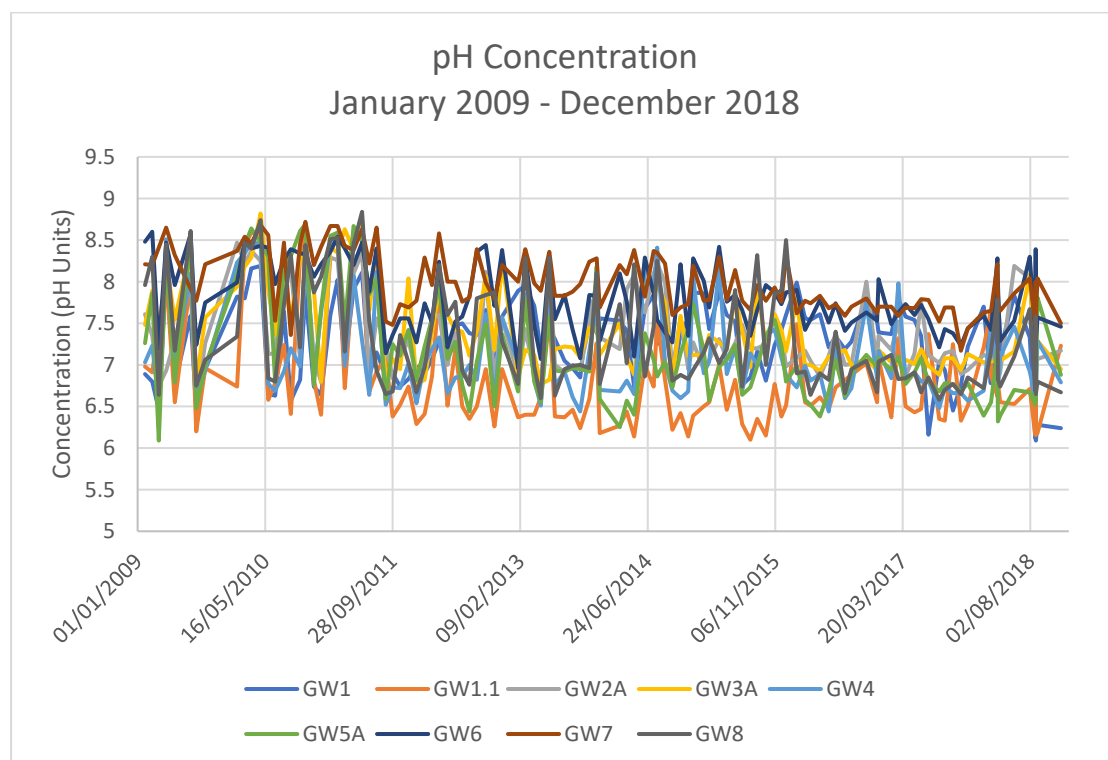
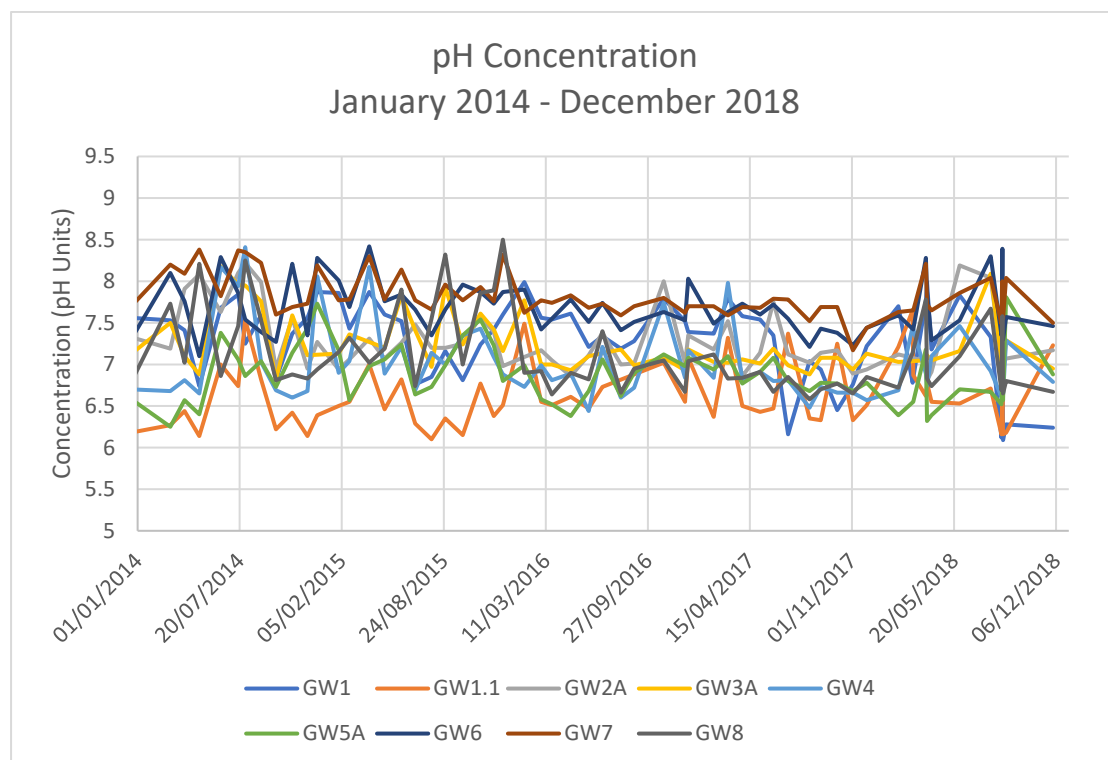
### APPENDIX 3 - GROUNDWATER



### APPENDIX 3 - GROUNDWATER



### APPENDIX 3 - GROUNDWATER



**APPENDIX 2 - GROUNDWATER****Table 2: Groundwater Quality (Quarterly)**

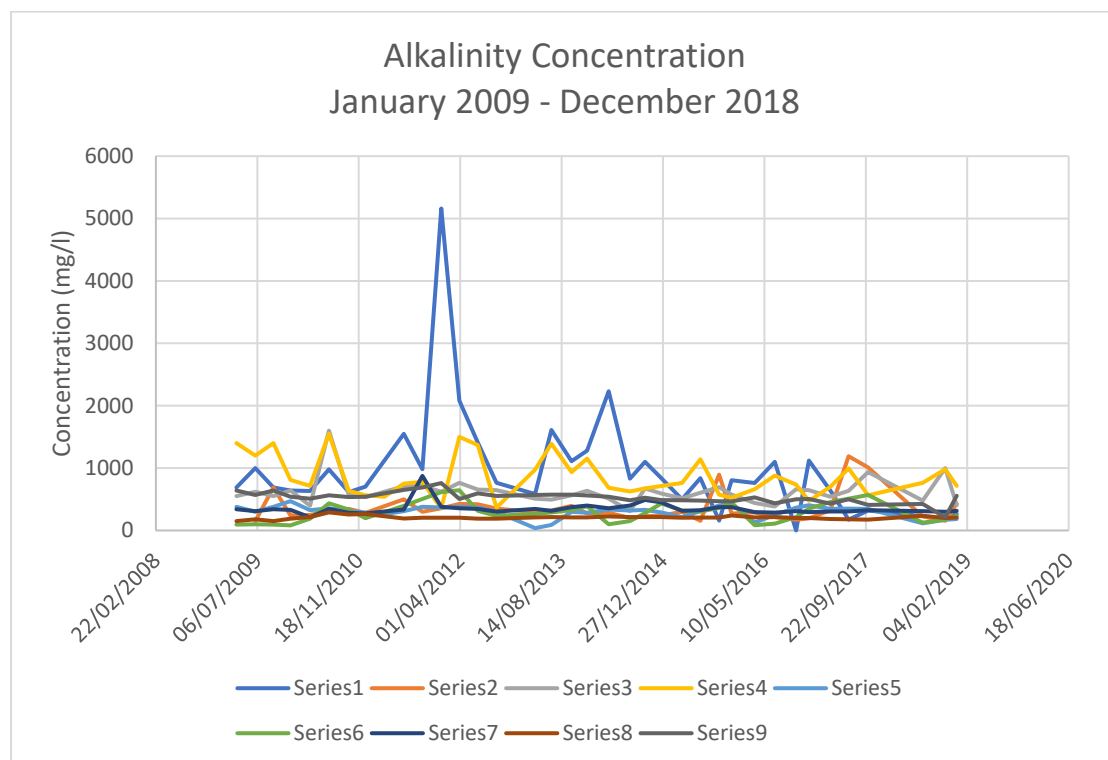
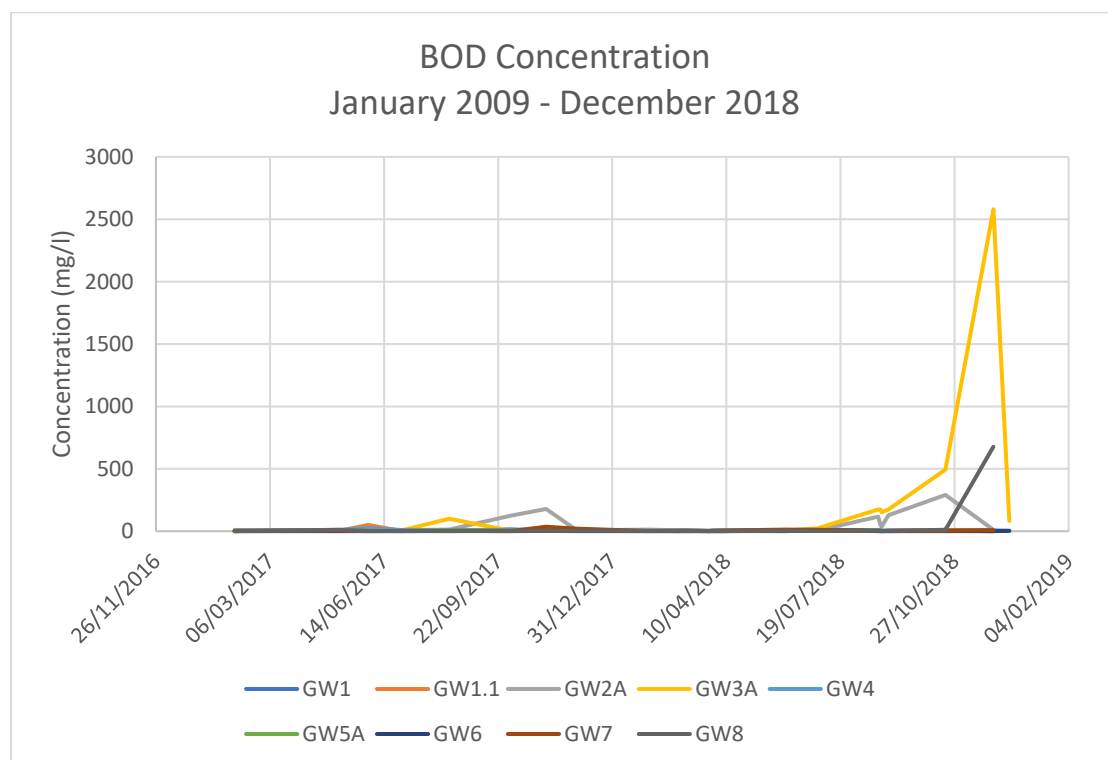
| Sample Description                   |        | GW1      |          |          | GW1.1    |          |          | GW2A     |          |          | GW3A     |          |          | GW4      |          |          |
|--------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                                      |        | Min      | Max      | Average  | Min      | Max      | Average  | Min      | Max      | Average  | Min      | Max      | Average  | Min      | Max      | Average  |
| Alkalinity (mg/l)                    |        | 191.00   | 267.00   | 229.00   | 157.00   | 430.00   | 270.67   | 405.00   | 1000.00  | 628.33   | 716.00   | 981.00   | 820.67   | 115.00   | 185.00   | 157.00   |
| BOD, unfiltered (mg/l)               |        | <1.00    | 8.85     | 4.89     | <1.00    | 10.30    | 3.77     | <2.50    | 291.00   | 55.59    | <1.67    | 2580.00  | 297.40   | <1.00    | 10.70    | 5.23     |
| Cadmium (mg/l)                       |        | <0.00008 | <0.00008 | <0.00008 | <0.00008 | 0.000152 | 0.000104 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Calcium (mg/l)                       |        | 219.0    | 412.0    | 315.5    | 152.0    | 705.0    | 353.0    | 181.0    | 319.0    | 239.7    | 142.0    | 196.0    | 175.3    | 47.4     | 79.8     | 62.3     |
| Chemical Oxygen Demand (COD) (mg/l)  |        | 80.1     | 265.0    | 172.6    | 78.6     | 99.4     | 91.5     | 79.1     | 770.0    | 314.3    | 160.0    | 765.0    | 453.7    | 114.0    | 150.0    | 129.7    |
| Chromium (mg/l)                      |        | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | 0.00206  | 0.001353 | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Copper (mg/l)                        |        | <0.0003  | 0.0012   | 0.0008   | <0.0003  | 0.0112   | 0.0041   | <0.0003  | 0.0008   | 0.0006   | <0.0003  | <0.0003  | <0.0003  | <0.0003  | <0.0003  | <0.0003  |
| Iron (mg/l)                          |        | 17.700   | 33.200   | 25.450   | 0.019    | 76.500   | 41.240   | 4.650    | 5.410    | 5.030    | 0.608    | 5.310    | 2.183    | 5.390    | 12.800   | 8.210    |
| Lead (mg/l)                          |        | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | 0.000252 | 0.000281 | 0.000267 |
| Magnesium (mg/l)                     |        | 58.0     | 58.0     | 58.0     | 57.4     | 64.7     | 59.9     | 40.3     | 49.5     | 45.8     | 44.5     | 54.2     | 48.8     | 10.2     | 13.5     | 12.1     |
| Manganese (mg/l)                     |        | 7.04     | 7.04     | 7.04     | 0.0539   | 8.88     | 4.46695  | 4.92     | 5.65     | 5.285    | 1.21     | 2.33     | 1.77     | 0.624    | 0.915    | 0.7695   |
| Nickel (mg/l)                        | Limit  |          |          |          |          |          |          | 0.15     |          |          | 0.15     |          |          | 0.15     |          |          |
|                                      | Values | 0.0141   | 0.0311   | 0.0226   | 0.0062   | 0.0238   | 0.0156   | 0.0274   | 0.0358   | 0.0304   | 0.0177   | 0.0269   | 0.0225   | 0.0062   | 0.0095   | 0.0079   |
| Potassium (mg/l)                     |        | 32.3     | 106.0    | 69.2     | 19.1     | 135.0    | 58.4     | 33.9     | 43.1     | 38.2     | 32.8     | 40.0     | 35.8     | 9.8      | 14.6     | 12.5     |
| Sodium (mg/l)                        |        | 64.6     | 98.9     | 81.8     | 41.5     | 104.0    | 80.7     | 66.7     | 71.9     | 69.3     | 97.8     | 119.0    | 108.9    | 20.8     | 25.9     | 23.3     |
| Toluene (mg/l)                       | Limit  |          |          |          |          |          |          | 0.004    |          |          | 0.004    |          |          | 0.004    |          |          |
|                                      | Values | <0.001   | <0.004   | <0.003   | <0.001   | <0.004   | <0.003   | <0.001   | <.004    | <0.003   | <0.004   | 1.130*   | 0.285    | <0.001   | <0.004   | <0.003   |
| Total Oxidised Nitrogen (TON) (mg/l) |        | <0.30    | 22.20    | 11.25    | <0.30    | 24.50    | 8.37     | <0.30    | 0.82     | 0.47     | <0.30    | 3.01     | 1.20     | <0.30    | 0.64     | 0.41     |
| Zinc (mg/l)                          | Limit  |          |          |          |          |          |          | 0.254    |          |          | 0.254    |          |          | 0.254    |          |          |
|                                      | Values | 0.0136   | 0.0228   | 0.0182   | 0.0042   | 0.0305   | 0.0149   | 0.0033   | 0.0174   | 0.0081   | 0.0013   | 0.0038   | 0.0023   | 0.0023   | 0.0077   | 0.0052   |
| m,p-Xylene (mg/l)                    | Limit  |          |          |          |          |          |          | 0.011    |          |          | 0.011    |          |          | 0.011    |          |          |
|                                      | Values | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   |

\* This value (obtained in October 2018) is three orders of magnitude higher than reported for any other sample at this location, and so is considered likely to be an error or represent contamination of this sample. This is the only reading that is above the compliance limit, however, due to its high value compared to the other readings, it also skews the average, so that this appears to be above the compliance limit also. It is noted that the concentration of Toluene at this location in the subsequent monitoring round in December, was below the compliance limit, as reported previously.

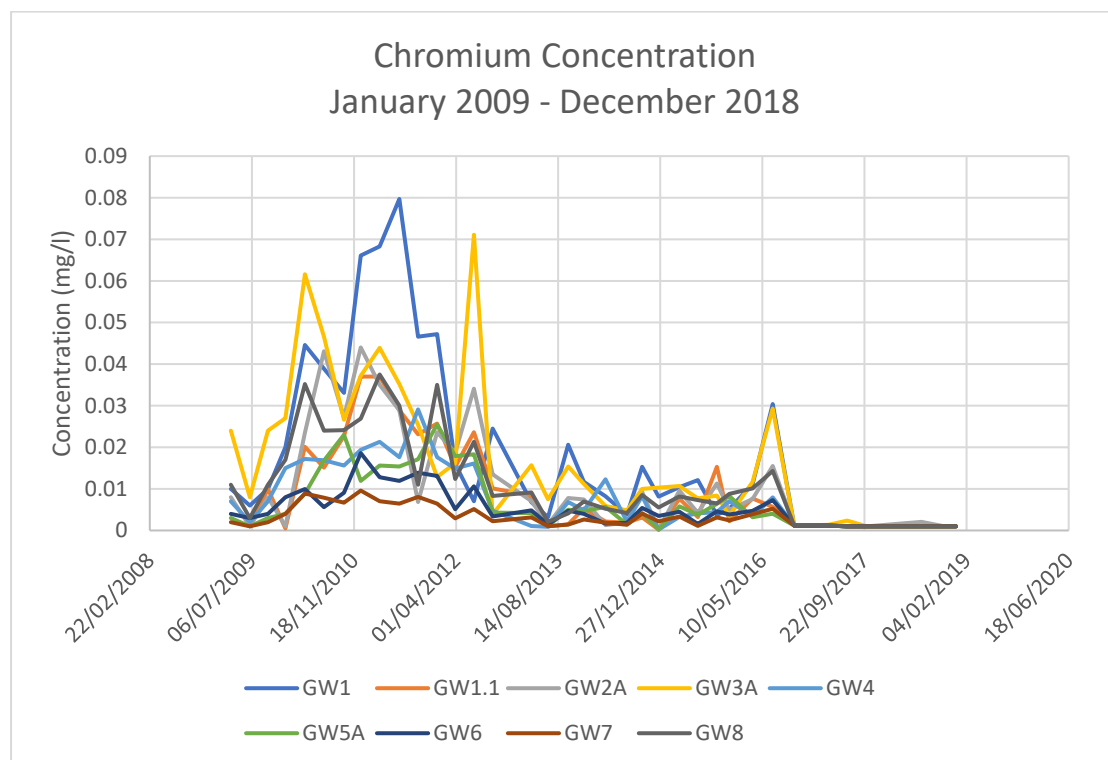
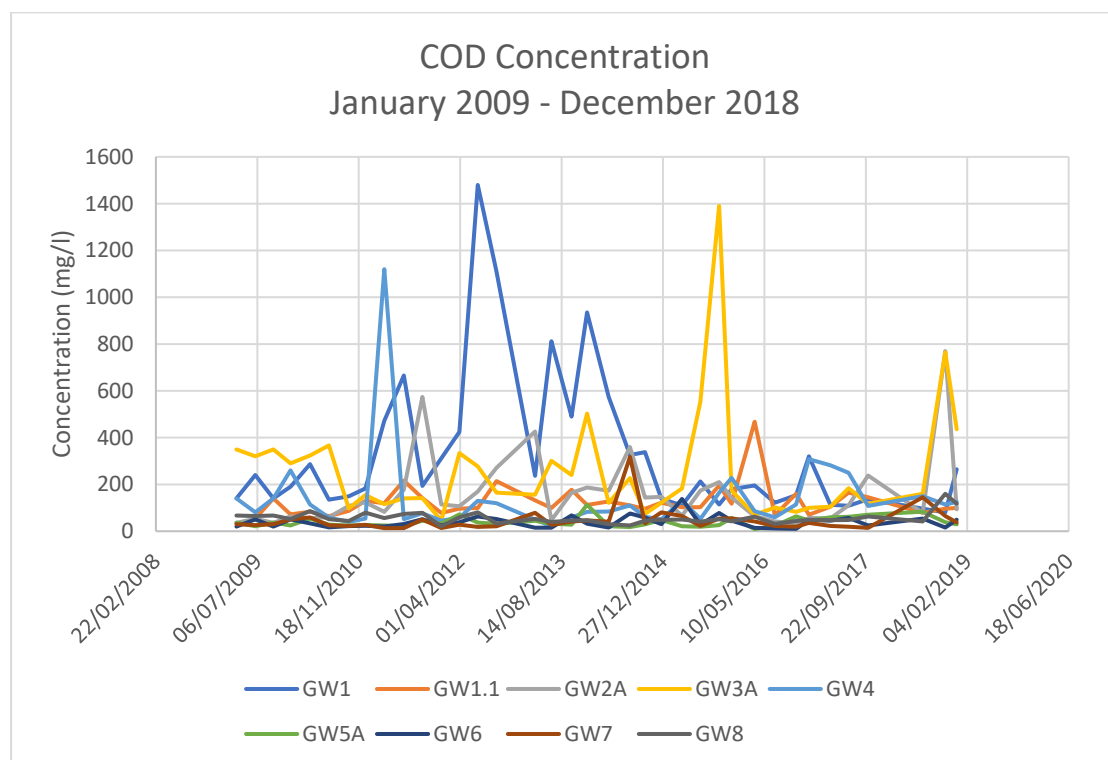
**APPENDIX 2 - GROUNDWATER**

| Sample Description                   | GW5A     |          |          | GW6      |          |          | GW7      |          |          | GW8      |          |          |
|--------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                                      | Min      | Max      | Average  | Min      | Max      | Average  | Min      | Max      | Average  | Min      | Max      | Average  |
| Alkalinity (mg/l)                    | 125.00   | 240.00   | 180.00   | 299.00   | 316.00   | 308.33   | 199.00   | 235.00   | 213.33   | 211.00   | 555.00   | 397.00   |
| BOD, unfiltered (mg/l)               | <1.00    | 5.00     | 1.92     | <1.00    | 8.72     | 1.88     | <1.00    | 13.20    | 4.69     | <1.00    | 677.00   | 54.97    |
| Cadmium (mg/l)                       | 0.000309 | 0.000317 | 0.000314 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 | <0.00008 |
| Calcium (mg/l)                       | 97.6     | 151.0    | 120.9    | 99.0     | 143.0    | 115.0    | 28.5     | 38.4     | 32.7     | 98.8     | 284.0    | 162.6    |
| Chemical Oxygen Demand (COD) (mg/l)  | 29.6     | 83.7     | 50.5     | 15.6     | 54.3     | 39.7     | 37.8     | 145.0    | 82.7     | 42.1     | 160.0    | 106.7    |
| Chromium (mg/l)                      | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Copper (mg/l)                        | 0.0024   | 0.0045   | 0.0035   | 0.0004   | 0.0011   | 0.0008   | <0.0003  | <0.0003  | <0.0003  | <0.0003  | 0.0012   | 0.0006   |
| Iron (mg/l)                          | 0.019    | 0.072    | 0.047    | 0.019    | 0.019    | 0.019    | 0.067    | 0.168    | 0.118    | 0.150    | 0.648    | 0.422    |
| Lead (mg/l)                          | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  | <0.0002  |
| Magnesium (mg/l)                     | 18.5     | 29.8     | 23.5     | 29.7     | 32.6     | 31.1     | 30.4     | 35.9     | 33.3     | 36.5     | 45.8     | 39.9     |
| Manganese (mg/l)                     | 0.016    | 0.305    | 0.1605   | 0.0485   | 0.0518   | 0.05015  | 0.576    | 1.2      | 0.888    | 0.456    | 0.518    | 0.487    |
| Nickel (mg/l)                        | 0.0236   | 0.0280   | 0.0256   | 0.0009   | 0.0012   | 0.0010   | 0.0017   | 0.0022   | 0.0020   | 0.0077   | 0.0271   | 0.0188   |
| Potassium (mg/l)                     | 10.4     | 15.8     | 12.7     | 18.9     | 20.9     | 20.1     | 23.8     | 25.5     | 24.9     | 34.2     | 97.5     | 56.1     |
| Sodium (mg/l)                        | 63.2     | 78.4     | 68.4     | 19.2     | 21.8     | 20.1     | 66.6     | 69.0     | 67.6     | 38.6     | 112.0    | 83.5     |
| Toluene (mg/l)                       | <0.001   | <0.004   | <0.003   | <0.001   | <0.004   | <0.003   | <0.001   | <0.004   | <0.003   | <0.001   | <0.004   | <0.003   |
| Total Oxidised Nitrogen (TON) (mg/l) | 70.40    | 105.00   | 88.93    | 3.76     | 18.40    | 12.72    | 0.64     | 3.64     | 1.64     | 0.50     | 26.90    | 10.29    |
| Zinc (mg/l)                          | 0.0343   | 0.0405   | 0.0367   | 0.0032   | 0.0087   | 0.0061   | 0.0014   | 0.0025   | 0.0018   | 0.0010   | 0.0046   | 0.0026   |
| m,p-Xylene (mg/l)                    | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   | <0.001   | <0.008   | <0.006   |

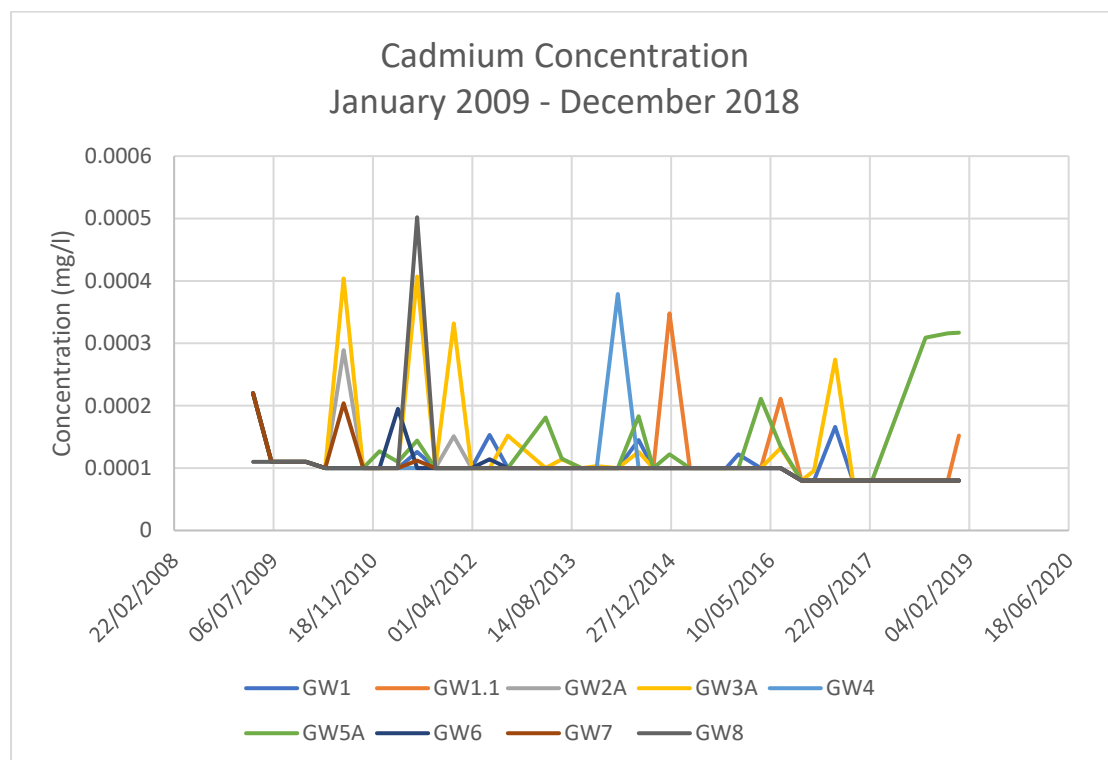
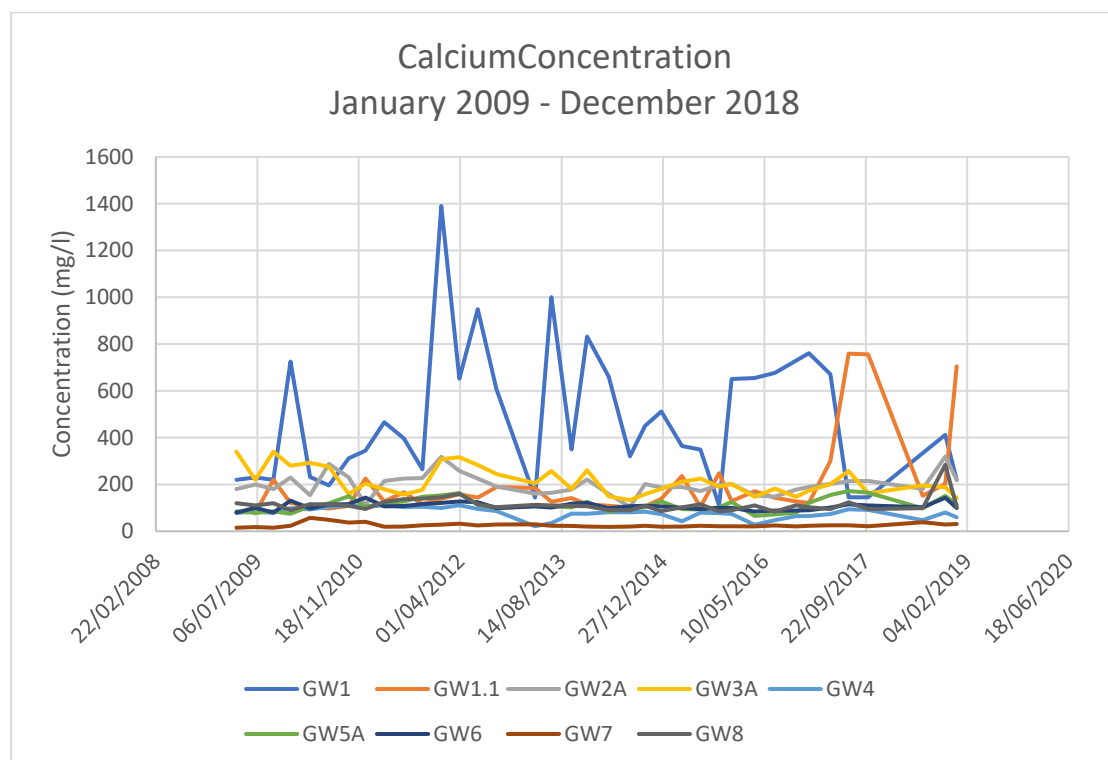
### APPENDIX 3 - GROUNDWATER



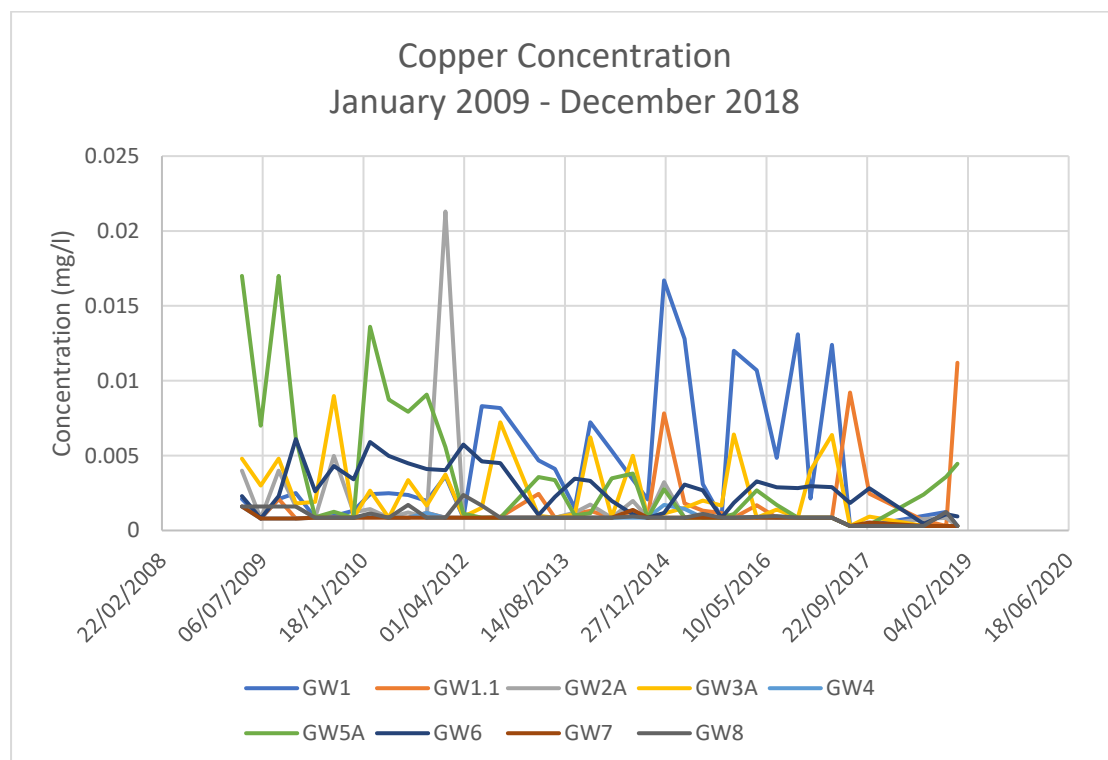
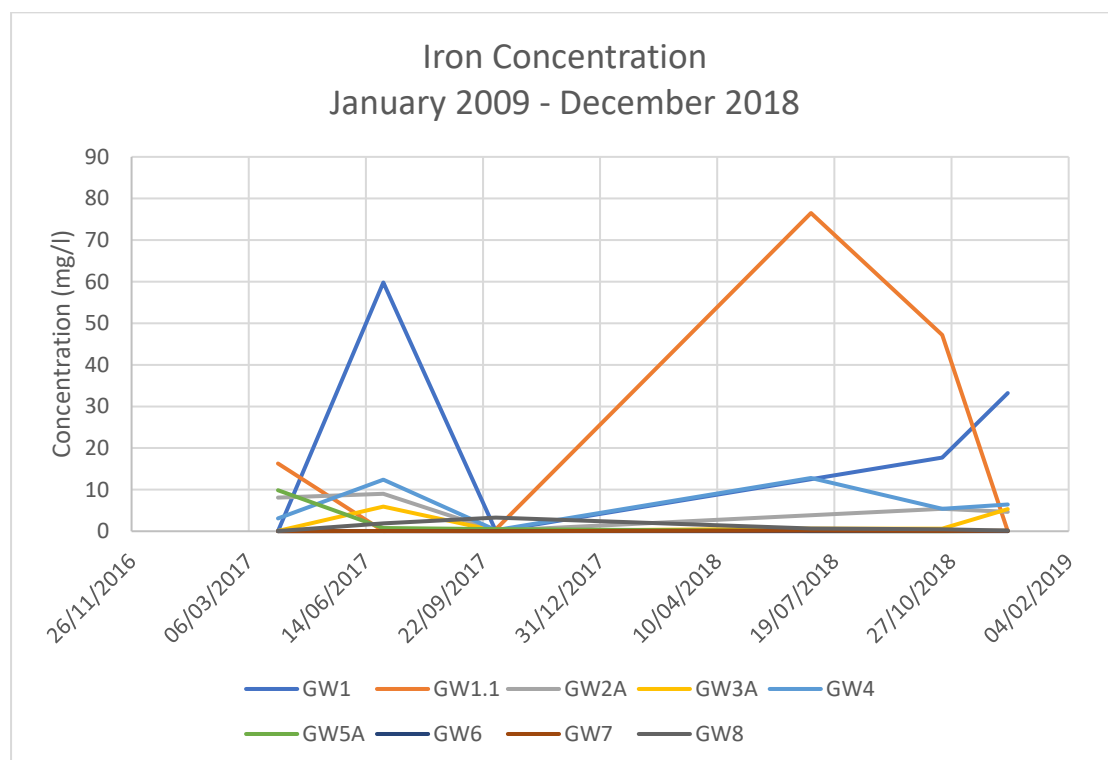
### APPENDIX 3 - GROUNDWATER



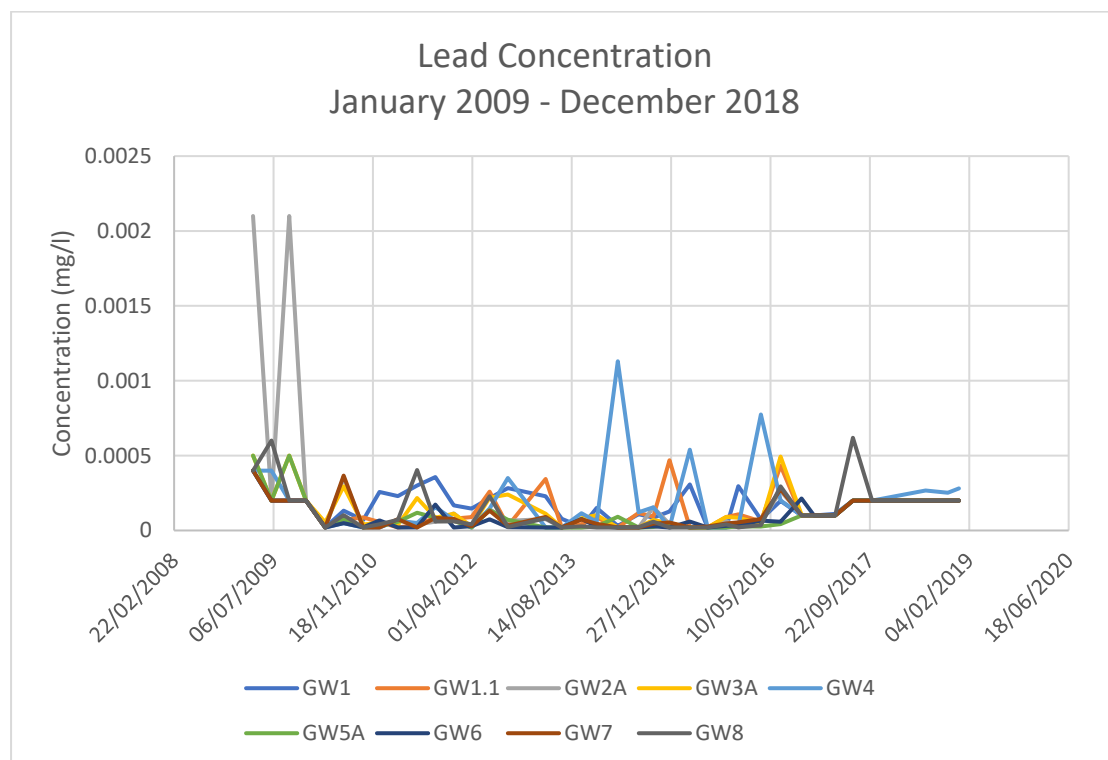
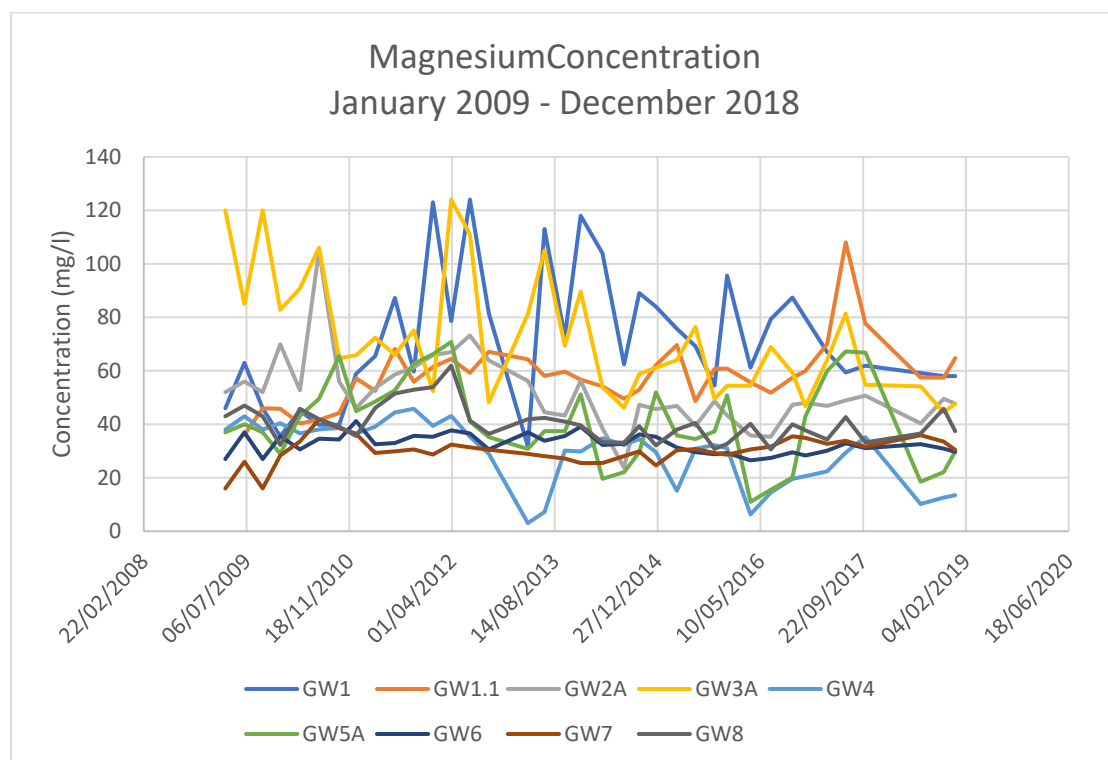
### APPENDIX 3 - GROUNDWATER



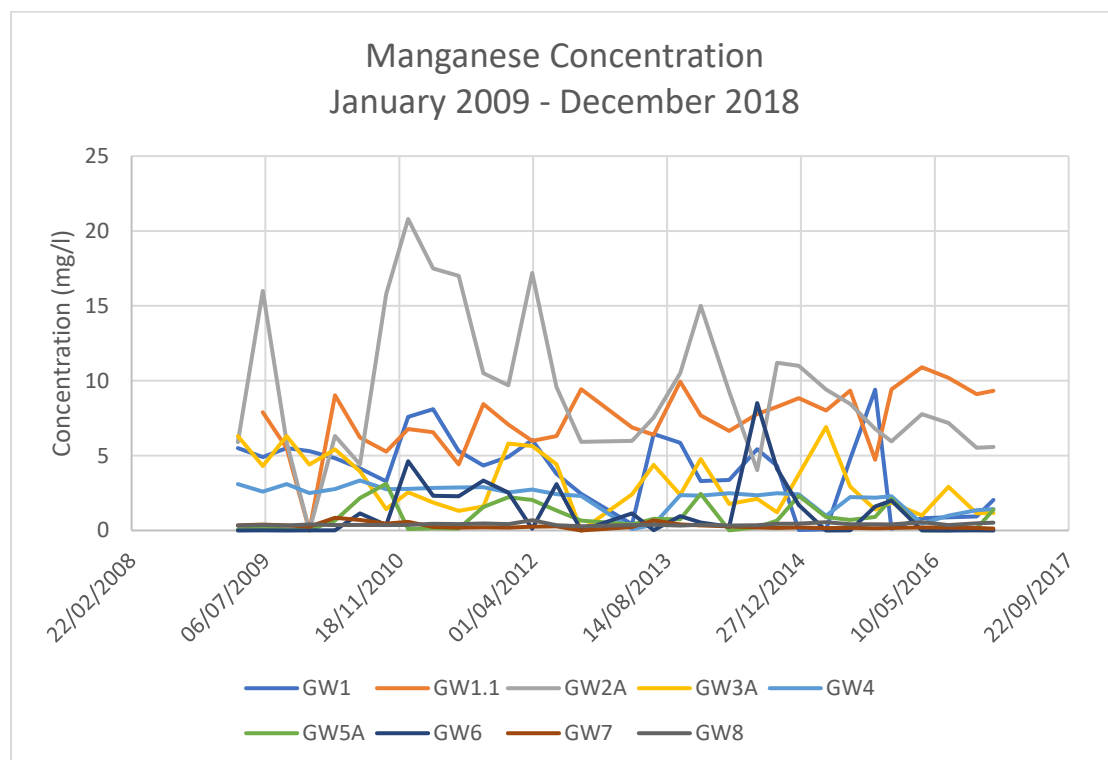
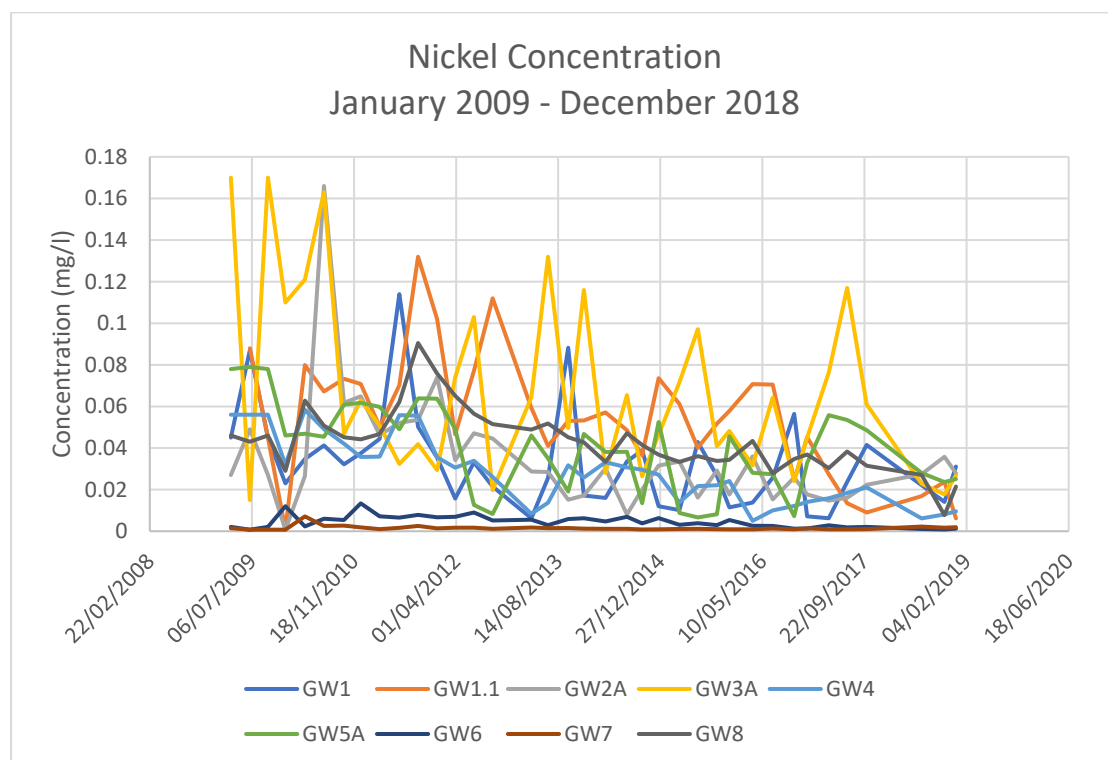
### APPENDIX 3 - GROUNDWATER



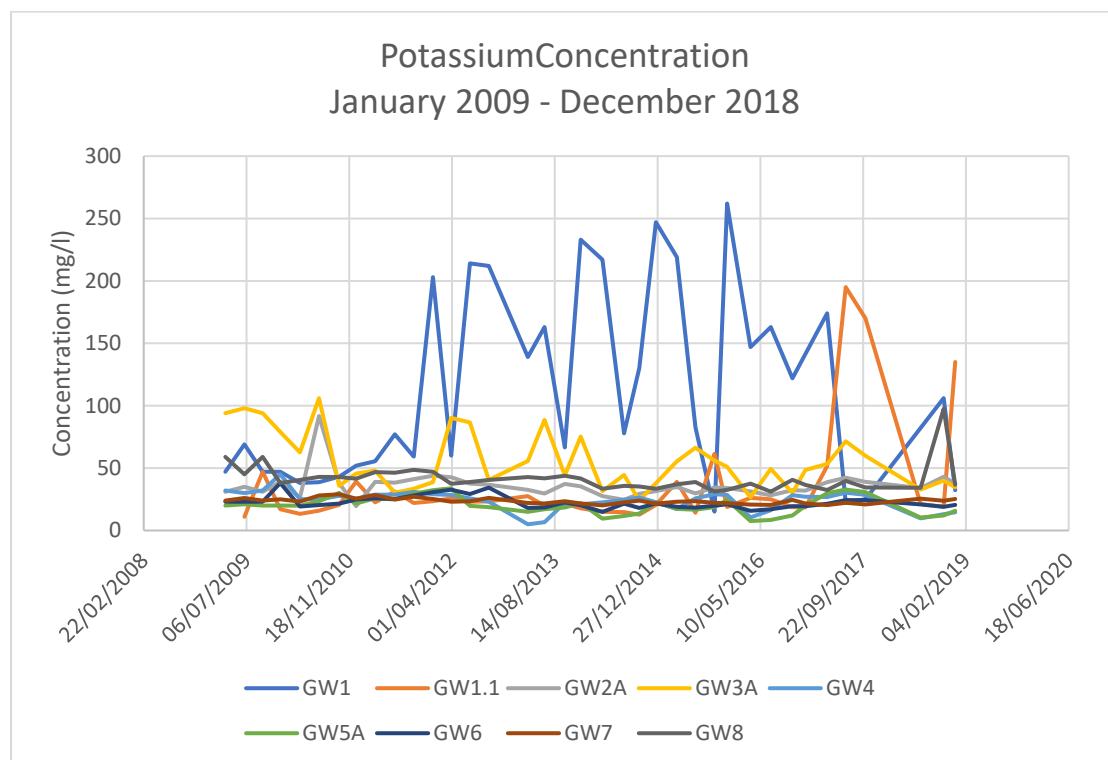
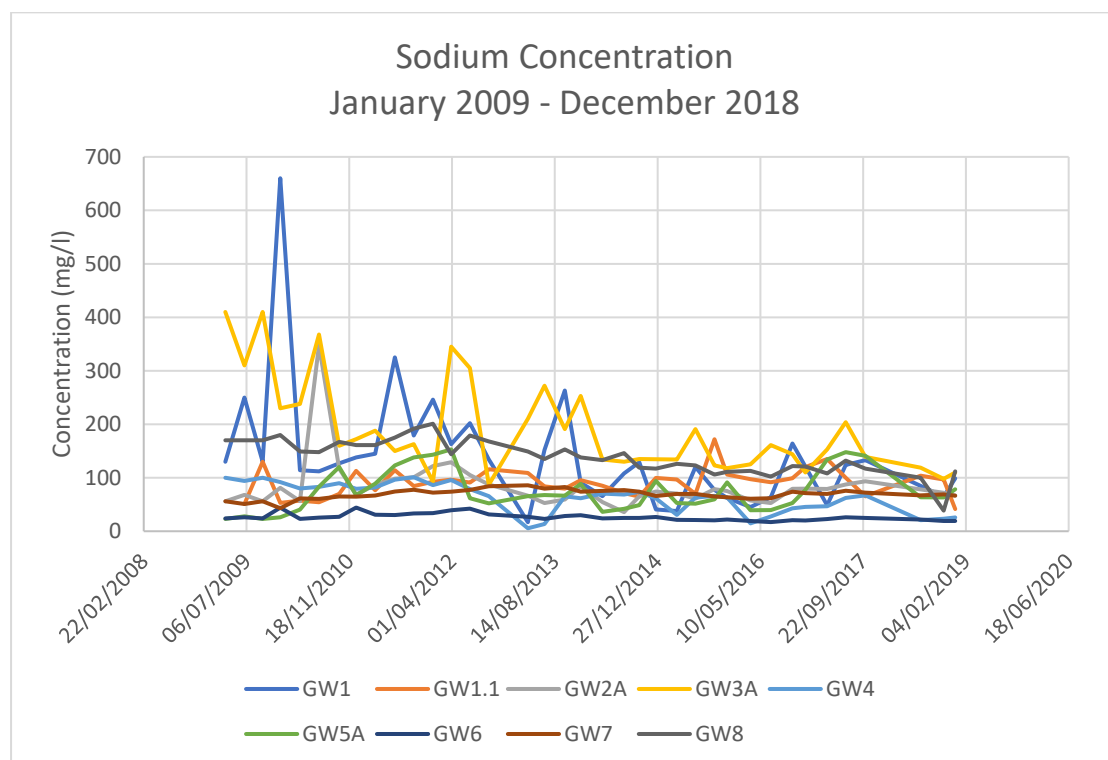
### APPENDIX 3 - GROUNDWATER



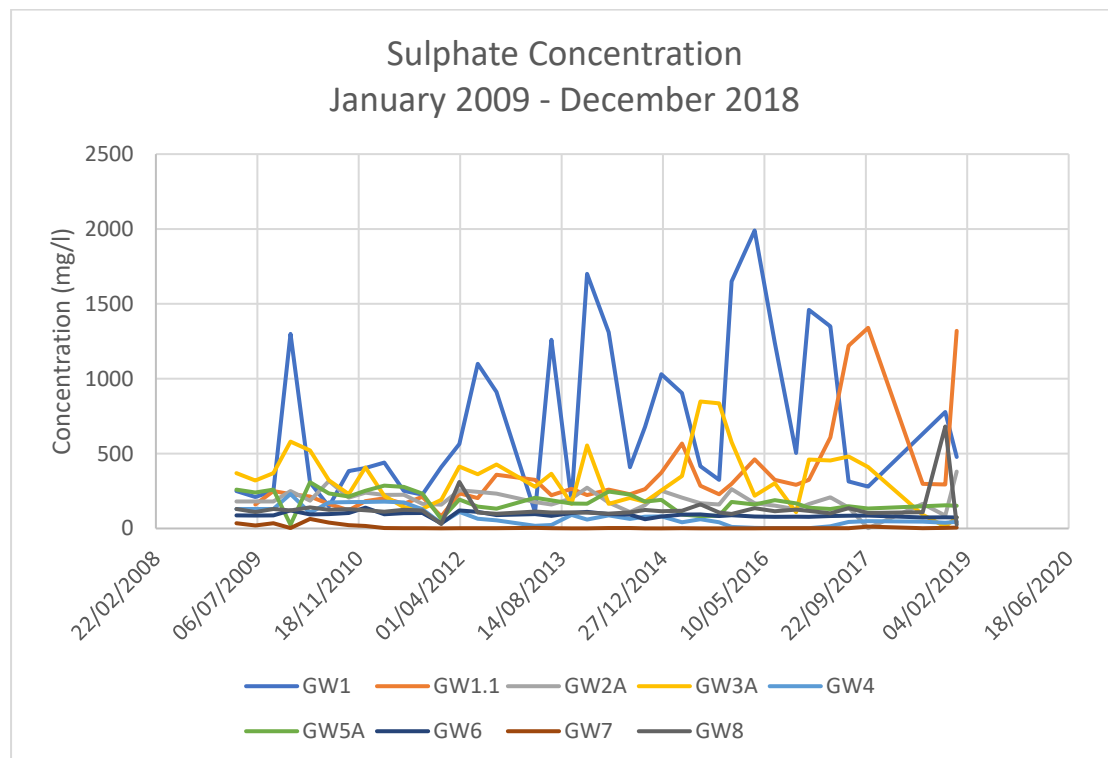
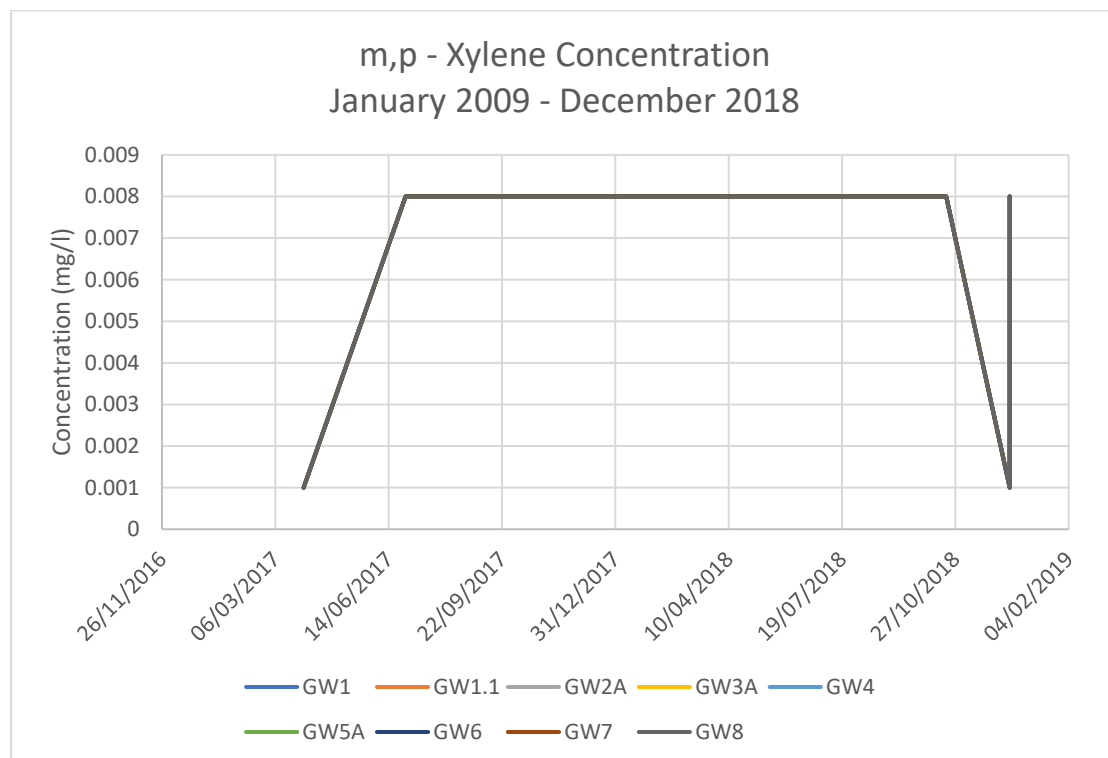
### APPENDIX 3 - GROUNDWATER



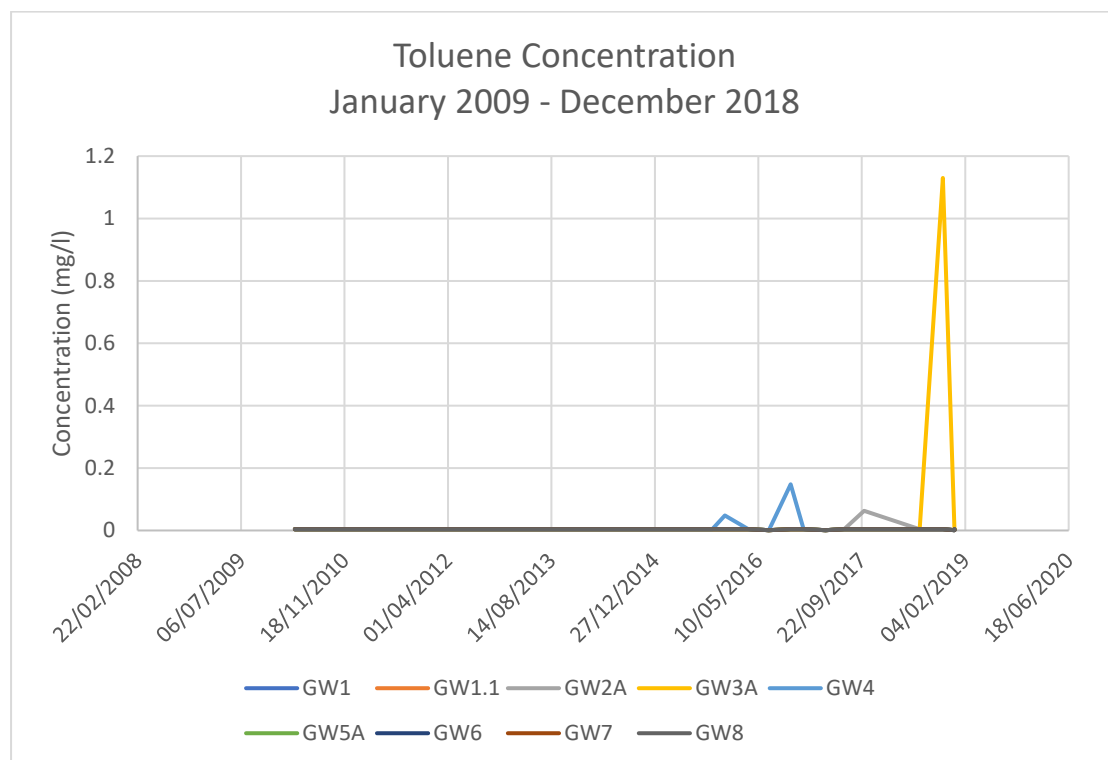
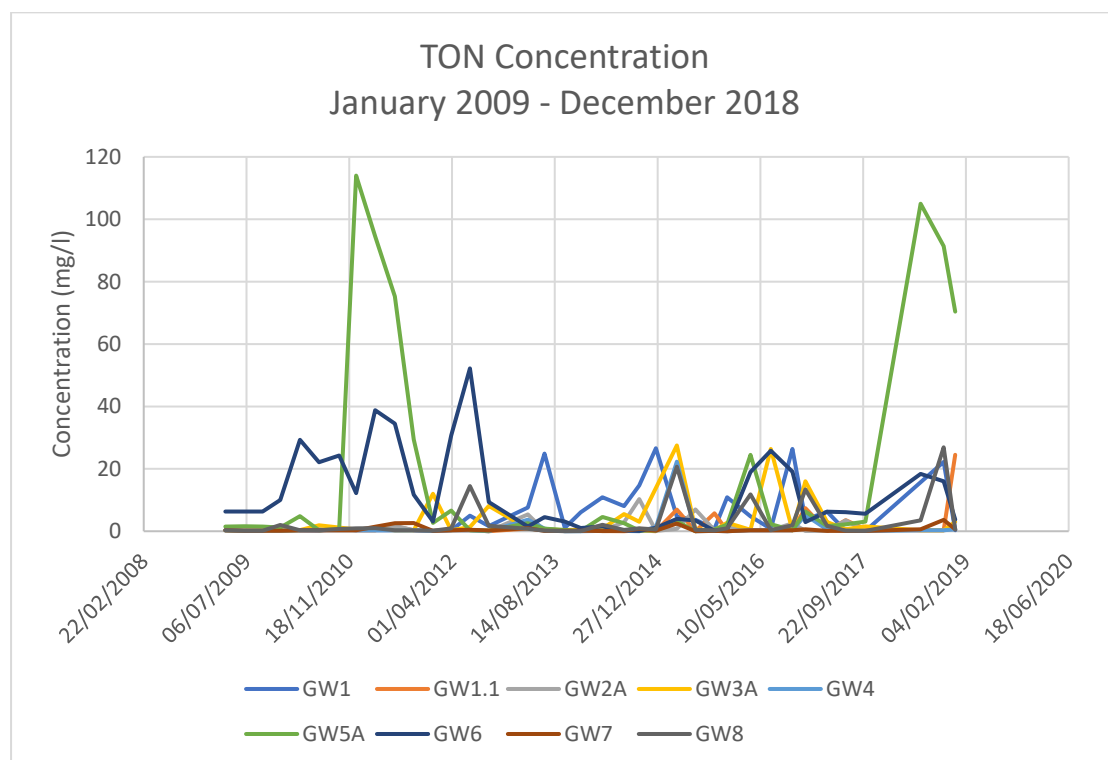
### APPENDIX 3 - GROUNDWATER



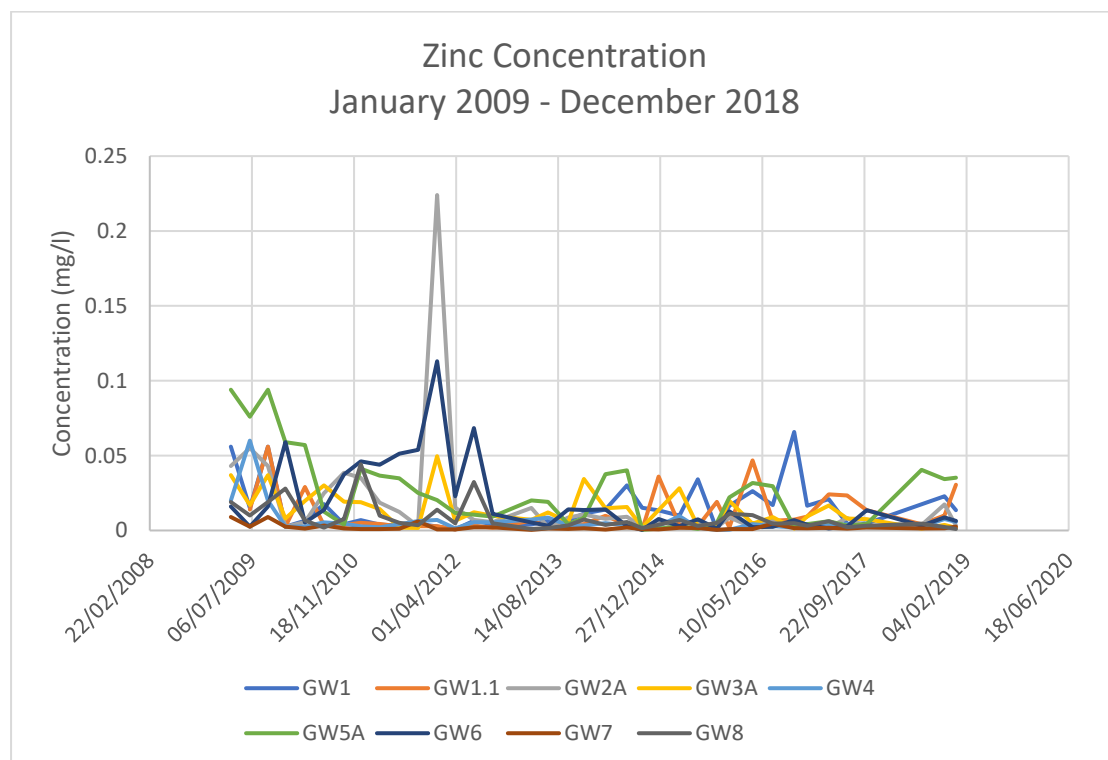
### APPENDIX 3 - GROUNDWATER



### APPENDIX 3 - GROUNDWATER



### APPENDIX 3 - GROUNDWATER



## APPENDIX 2 - GROUNDWATER

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

| Sample Description                          |      | GW1        | GW1.1      | GW2A       | GW3A       | GW4        | GW5A       | GW6        | GW7        | GW8        |
|---------------------------------------------|------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Date Sampled                                |      | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 |
| <b>Inorganics</b>                           |      |            |            |            |            |            |            |            |            |            |
| Cyanide, Free                               | mg/l | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      |
| Cyanide, Total                              | mg/l | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      | <0.05      |
| <b>Filtered (Dissolved) Metals</b>          |      |            |            |            |            |            |            |            |            |            |
| Chromium (diss.filt)                        | mg/l | <0.001     | <0.001     | <0.001     | <0.001     | <0.001     | <0.001     | <0.001     | <0.001     | <0.001     |
| Mercury (diss.filt)                         | mg/l | <0.00001   | <0.00001   | <0.00001   | <0.00001   | <0.00001   | <0.00001   | <0.00001   | <0.00001   | <0.00001   |
| <b>TPH Criteria Working Group (TPH CWG)</b> |      |            |            |            |            |            |            |            |            |            |
| 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     |

| Sample Description                             |      | GW1        | GW1.1      | GW2A       | GW3A       | GW4        | GW5A       | GW6        | GW7        | GW8        |
|------------------------------------------------|------|------------|------------|------------|------------|------------|------------|------------|------------|------------|
| Date Sampled                                   |      | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 | 15/12/2017 |
| <b>Mineral Oil / Oils &amp; Greases</b>        |      |            |            |            |            |            |            |            |            |            |
| Mineral oil >C10 C40 (aq)                      | mg/l | <0.1       | <0.1       | <0.1       | 0.306      | 0.144      | <0.2       | <0.1       | <0.2       | <0.2       |
| <b>Semi-Volatile Organic Compounds (SVOCs)</b> |      |            |            |            |            |            |            |            |            |            |
| 1,2,4-Trichlorobenzene (aq)                    | mg/l | <0.002     | <0.004     | <0.002     | <0.002     | <0.002     | <0.001     | <0.001     | <0.002     | <0.001     |
| 1,2-Dichlorobenzene (aq)                       | mg/l | <0.002     | <0.004     | <0.002     | <0.002     | <0.002     | <0.001     | <0.001     | <0.002     | <0.001     |
| 1,3-Dichlorobenzene (aq)                       | mg/l | <0.002     | <0.004     | <0.002     | <0.002     | <0.002     | <0.001     | <0.001     | <0.002     | <0.001     |
| 1,4-Dichlorobenzene (aq)                       | mg/l | <0.002     | <0.004     | <0.002     | <0.002     | <0.002     | <0.001     | <0.001     | <0.002     | <0.001     |
| 2,4,5-Trichlorophenol (aq)                     | mg/l | <0.002     | <0.004     | <0.002     | <0.002     | <0.002     | <0.001     | <0.001     | <0.002     | <0.001     |

## APPENDIX 2 - GROUNDWATER

|                                |      |        |        |        |        |        |        |        |        |        |
|--------------------------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 2,4,6-Trichlorophenol (aq)     | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2,4-Dichlorophenol (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2,4-Dimethylphenol (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2,4-Dinitrotoluene (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2,6-Dinitrotoluene (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Chloronaphthalene (aq)       | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Chlorophenol (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Methylnaphthalene (aq)       | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Methylphenol (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Nitroaniline (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 2-Nitrophenol (aq)             | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 3-Nitroaniline (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Bromophenylphenylether (aq)  | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Chloro-3-methylphenol (aq)   | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Chloroaniline (aq)           | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Chlorophenylphenylether (aq) | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Methylphenol (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Nitroaniline (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| 4-Nitrophenol (aq)             | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Acenaphthene (aq)              | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Acenaphthylene (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Anthracene (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Azobenzene (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Benzo(a)anthracene (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Benzo(a)pyrene (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Benzo(b)fluoranthene (aq)      | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Benzo(g,h,i)perylene (aq)      | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |

## APPENDIX 2 - GROUNDWATER

|                                  |      |        |        |        |        |        |        |        |        |        |
|----------------------------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Benzo(k)fluoranthene (aq)        | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| bis(2-Chloroethoxy)methane (aq)  | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| bis(2-Chloroethyl)ether (aq)     | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| bis(2-Ethylhexyl) phthalate (aq) | mg/l | <0.004 | <0.008 | <0.004 | <0.004 | <0.004 | <0.002 | <0.002 | <0.004 | <0.002 |
| Butylbenzyl phthalate (aq)       | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Carbazole (aq)                   | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Chrysene (aq)                    | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Dibenzo(a,h)anthracene (aq)      | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Dibenzofuran (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Diethyl phthalate (aq)           | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Dimethyl phthalate (aq)          | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Fluoranthene (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Fluorene (aq)                    | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Hexachlorobenzene (aq)           | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Hexachlorobutadiene (aq)         | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Hexachlorocyclopentadiene (aq)   | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Hexachloroethane (aq)            | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Indeno(1,2,3-cd)pyrene (aq)      | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Isophorone (aq)                  | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Naphthalene (aq)                 | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| n-Dibutyl phthalate (aq)         | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| n-Dioctyl phthalate (aq)         | mg/l | <0.01  | <0.02  | <0.01  | <0.01  | <0.01  | <0.005 | <0.005 | <0.01  | <0.005 |
| Nitrobenzene (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| n-Nitroso-n-dipropylamine (aq)   | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Pentachlorophenol (aq)           | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Phenanthrene (aq)                | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| Phenol (aq)                      | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |

## APPENDIX 2 - GROUNDWATER

|                                          |      |        |        |        |        |        |        |        |        |        |
|------------------------------------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Pyrene (aq)                              | mg/l | <0.002 | <0.004 | <0.002 | <0.002 | <0.002 | <0.001 | <0.001 | <0.002 | <0.001 |
| <b>Volatile Organic Compounds (VOCs)</b> |      |        |        |        |        |        |        |        |        |        |
| 1,1,1,2-Tetrachloroethane                | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1,1-Trichloroethane                    | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1,2,2-Tetrachloroethane                | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1,2-Trichloroethane                    | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1-Dichloroethane                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1-Dichloroethene                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,1-Dichloropropene                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2,3-Trichlorobenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2,3-Trichloropropane                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2,4-Trichlorobenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2,4-Trimethylbenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2-Dibromo-3-chloropropane              | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2-Dibromoethane                        | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2-Dichlorobenzene                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2-Dichloroethane                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,2-Dichloropropane                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,3,5-Trichlorobenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,3,5-Trimethylbenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,3-Dichlorobenzene                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,3-Dichloropropane                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 1,4-Dichlorobenzene                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 2,2-Dichloropropane                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 2-Chlorotoluene                          | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |
| 4-Bromofluorobenzene**                   | %    | 92.7   | 97     | 94.5   | 92.7   | 94.3   | 95.5   | 95.3   | 92.8   | 94.8   |
| 4-Chlorotoluene                          | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 |

## APPENDIX 2 - GROUNDWATER

|                                    |      |        |        |        |        |        |        |        |        |         |
|------------------------------------|------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| 4-iso-Propyltoluene                | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Benzene                            | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Bromobenzene                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Bromochloromethane                 | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Bromodichloromethane               | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Bromoform                          | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Bromomethane                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Carbon disulphide                  | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | 0.00581 |
| Carbontetrachloride                | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Chlorobenzene                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Chloroethane                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Chloroform                         | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Chloromethane                      | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| cis-1,2-Dichloroethene             | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| cis-1,3-Dichloropropene            | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Dibromochloromethane               | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Dibromofluoromethane**             | %    | 108    | 110    | 110    | 110    | 111    | 110    | 110    | 110    | 108     |
| Dibromomethane                     | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Dichlorodifluoromethane            | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Dichloromethane                    | mg/l | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003 | <0.003  |
| Ethylbenzene                       | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Hexachlorobutadiene                | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Isopropylbenzene                   | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| m,p-Xylene                         | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Methyl tertiary butyl ether (MTBE) | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| Naphthalene                        | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |
| n-Butylbenzene                     | mg/l | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001 | <0.001  |

## APPENDIX 2 - GROUNDWATER

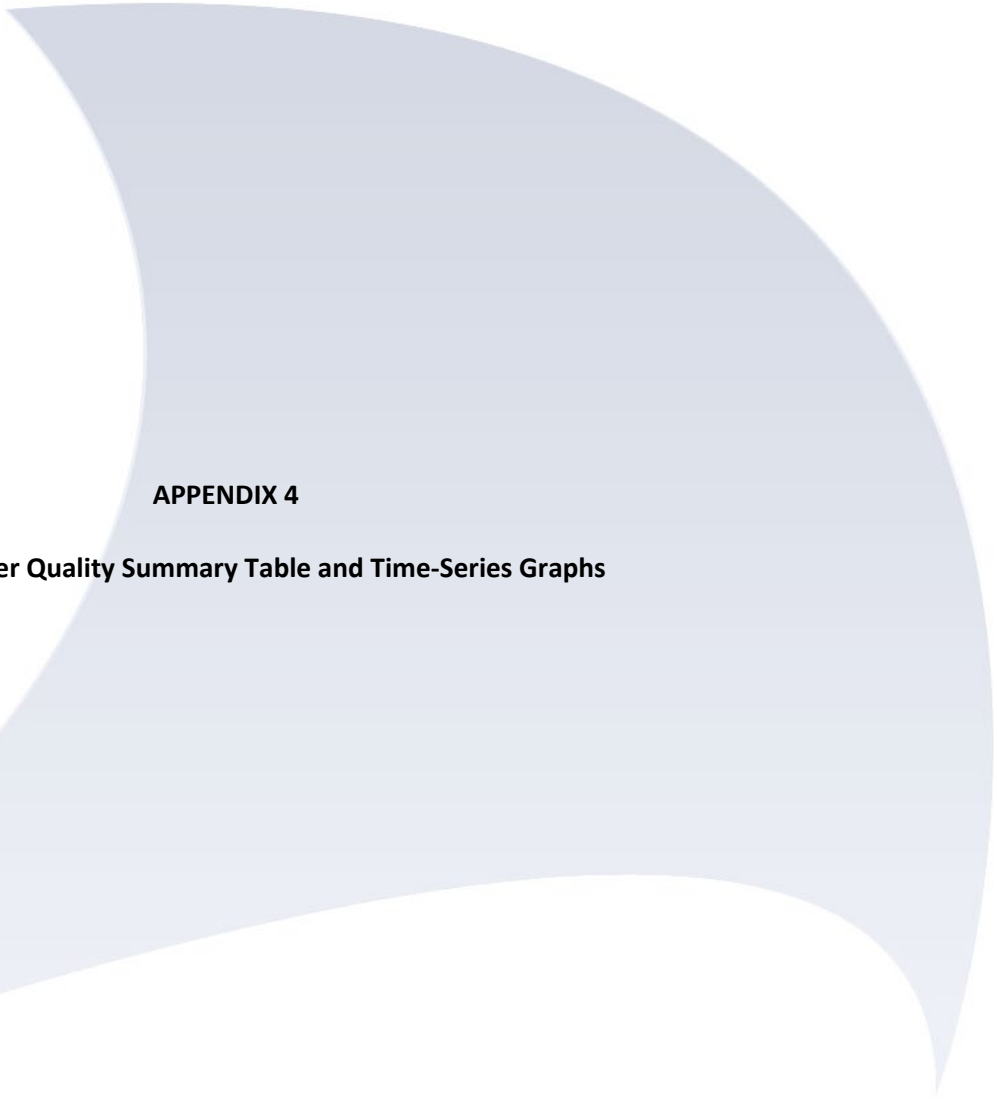
|                                         |      |          |          |          |          |          |          |          |          |          |
|-----------------------------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| o-Xylene                                | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Propylbenzene                           | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| sec-Butylbenzene                        | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Styrene                                 | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| tert-Amyl methyl ether (TAME)           | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| tert-Butylbenzene                       | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Tetrachloroethene                       | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Toluene                                 | mg/l | <0.001   | <0.001   | <0.001   | 0.00353  | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Toluene-d8**                            | %    | 100      | 99.8     | 100      | 99.1     | 99.1     | 100      | 100      | 100      | 101      |
| trans-1,2-Dichloroethene                | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| trans-1,3-Dichloropropene               | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Trichloroethene                         | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Trichlorofluoromethane                  | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| Vinyl chloride                          | mg/l | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   | <0.001   |
| <b>Combined Pesticides / Herbicides</b> |      |          |          |          |          |          |          |          |          |          |
| Aldrin                                  | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| alpha-HCH                               | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Atrazine                                | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Azinphos ethyl                          | mg/l | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 |
| Azinphos methyl                         | mg/l | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 |
| beta-HCH                                | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Carbophenothion                         | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chlorfenvinphos                         | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chlorothalonil                          | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chlorpyriphos                           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Chlorpyriphos-methyl                    | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| cis-Chlordane                           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |

## APPENDIX 2 - GROUNDWATER

|                      |      |          |          |          |          |          |          |          |          |          |
|----------------------|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Diazinon             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Dichlorvos           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Dieldrin             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Dimethoate           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Disulfoton           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Endosulphan I        | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Endosulphan II       | mg/l | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 |
| Endosulphan Sulphate | mg/l | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 | <0.00002 |
| Endrin               | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Ethion               | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Etrimphos            | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Fenitrothion         | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Fenthion             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| gamma-HCH (Lindane)  | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Heptachlor           | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Heptachlor epoxide   | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Hexachlorobenzene    | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Isodrin              | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Malathion            | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Methyl Parathion     | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| Mevinphos            | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| o,p'-DDD (TDE)       | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| o,p'-DDE             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| o,p'-DDT             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| p,p'-DDD (TDE)       | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| p,p'-DDE             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |
| p,p'-DDT             | mg/l | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 | <0.00001 |

**APPENDIX 2 - GROUNDWATER**

|                               |      |           |           |           |           |           |           |           |           |           |
|-------------------------------|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| p,p'-Methoxychlor             | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Parathion                     | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Pendimethalin                 | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Permethrin I                  | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Permethrin II                 | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Phosalone                     | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Pirimiphos-methyl             | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Propetamphos                  | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Quintozene (PCNB)             | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Simazine                      | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Tecnazene                     | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Telodrin                      | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| trans-Chlordane               | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Triadimefon                   | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Triallate                     | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Triazophos                    | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Trifluralin                   | mg/l | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| <b>Miscellaneous Organics</b> |      |           |           |           |           |           |           |           |           |           |
| Dibutyl tin                   | mg/l | <0.000005 | <0.000005 | <0.000005 | <0.000075 | <0.00003  | <0.00001  | <0.00001  | <0.00001  | <0.00001  |
| Surrogate                     | %    | 95.3      | 82.5      | 86.2      | 83.4      | 86.7      | 99        | 95.5      | 104       | 95.2      |
| Tetrabutyl tin                | mg/l | <0.000002 | <0.000002 | <0.000002 | <0.00003  | <0.000012 | <0.000004 | <0.000004 | <0.000004 | <0.000004 |
| Tributyl tin                  | mg/l | <0.000001 | <0.000001 | <0.000001 | <0.000015 | <0.000006 | <0.000002 | <0.000002 | <0.000002 | <0.000002 |
| Triphenyl tin                 | mg/l | <0.000001 | <0.000001 | <0.000001 | <0.000015 | <0.000006 | <0.000002 | <0.000002 | <0.000002 | <0.000002 |



## **APPENDIX 4**

### **Surface Water Quality Summary Table and Time-Series Graphs**

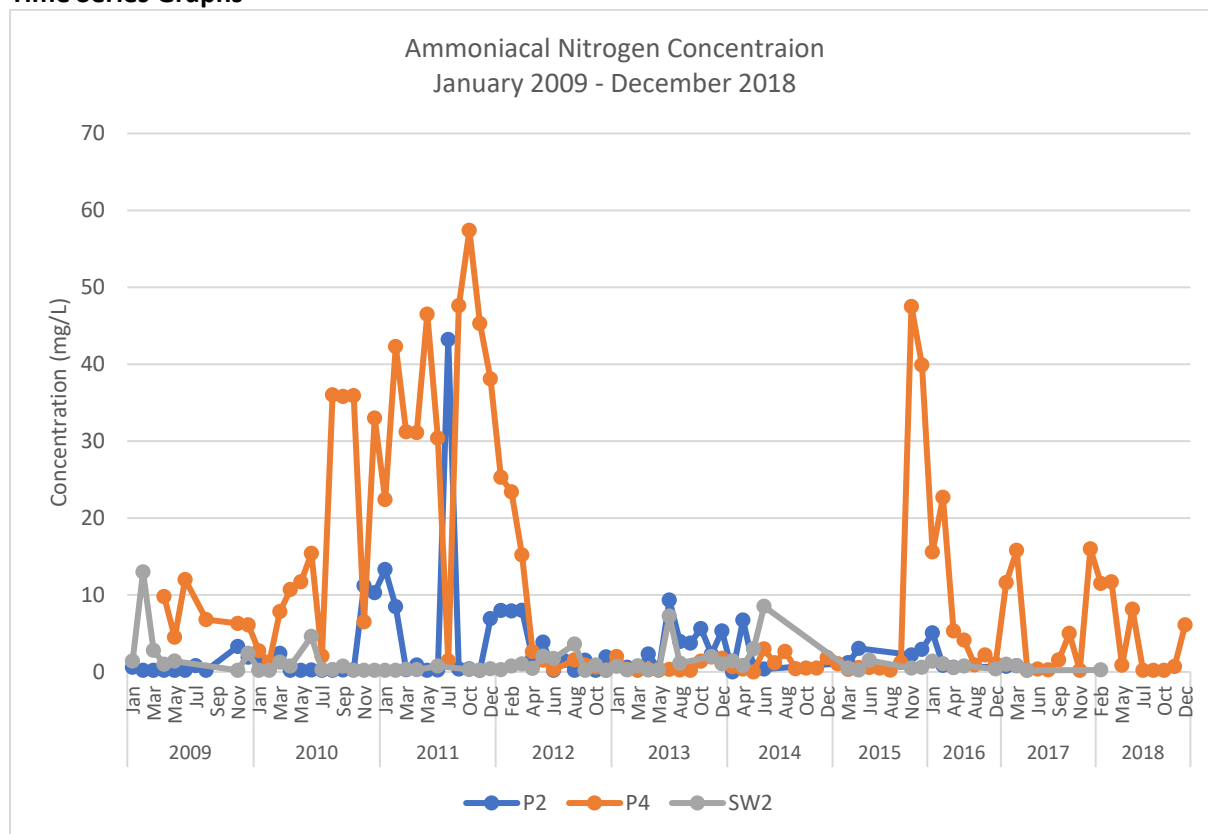
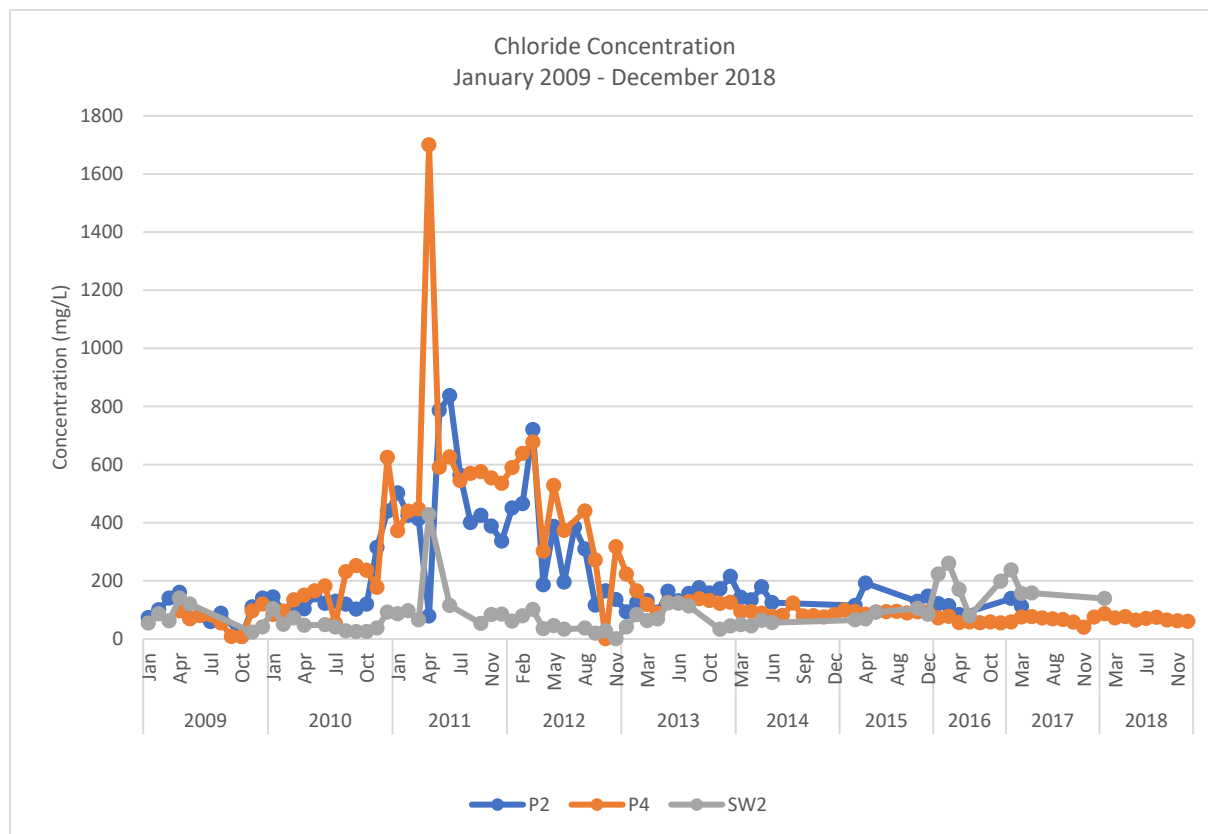
## APPENDIX 4

**Table 1: Monthly Surface Water Quality (2018)**

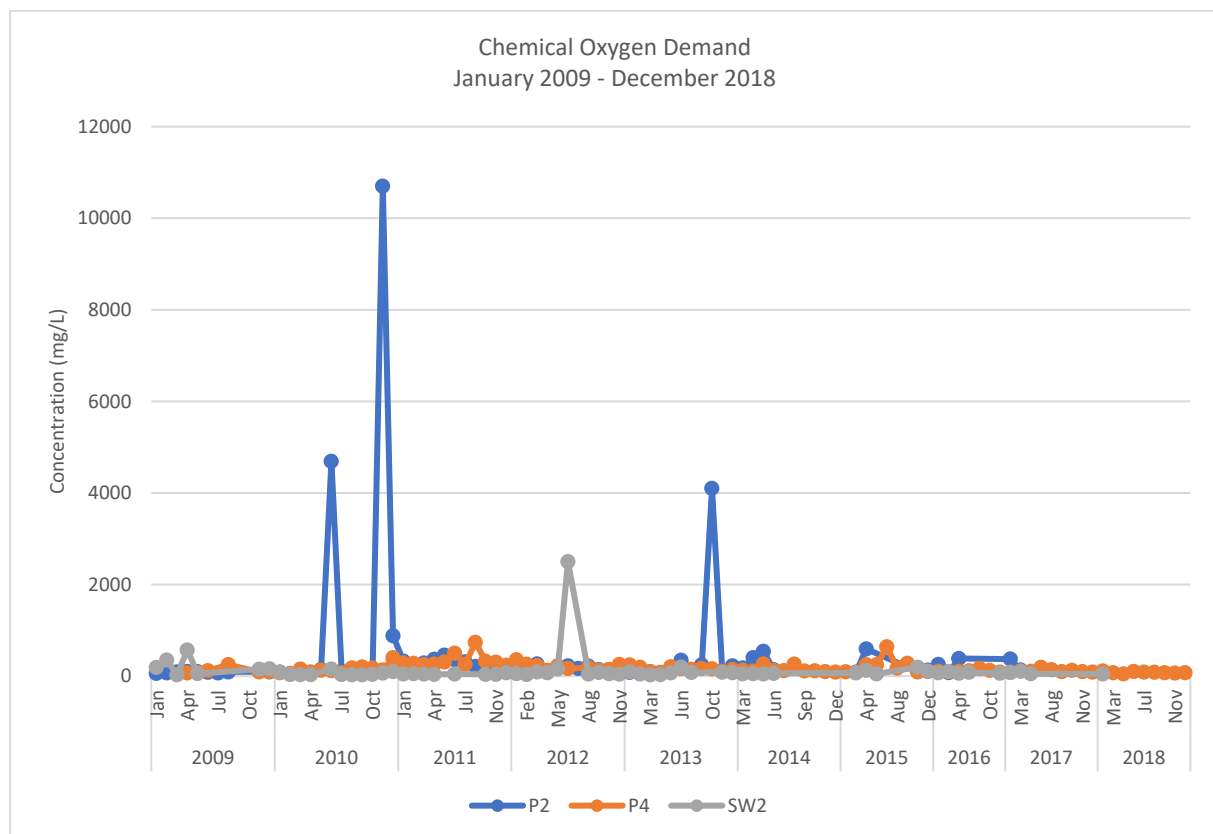
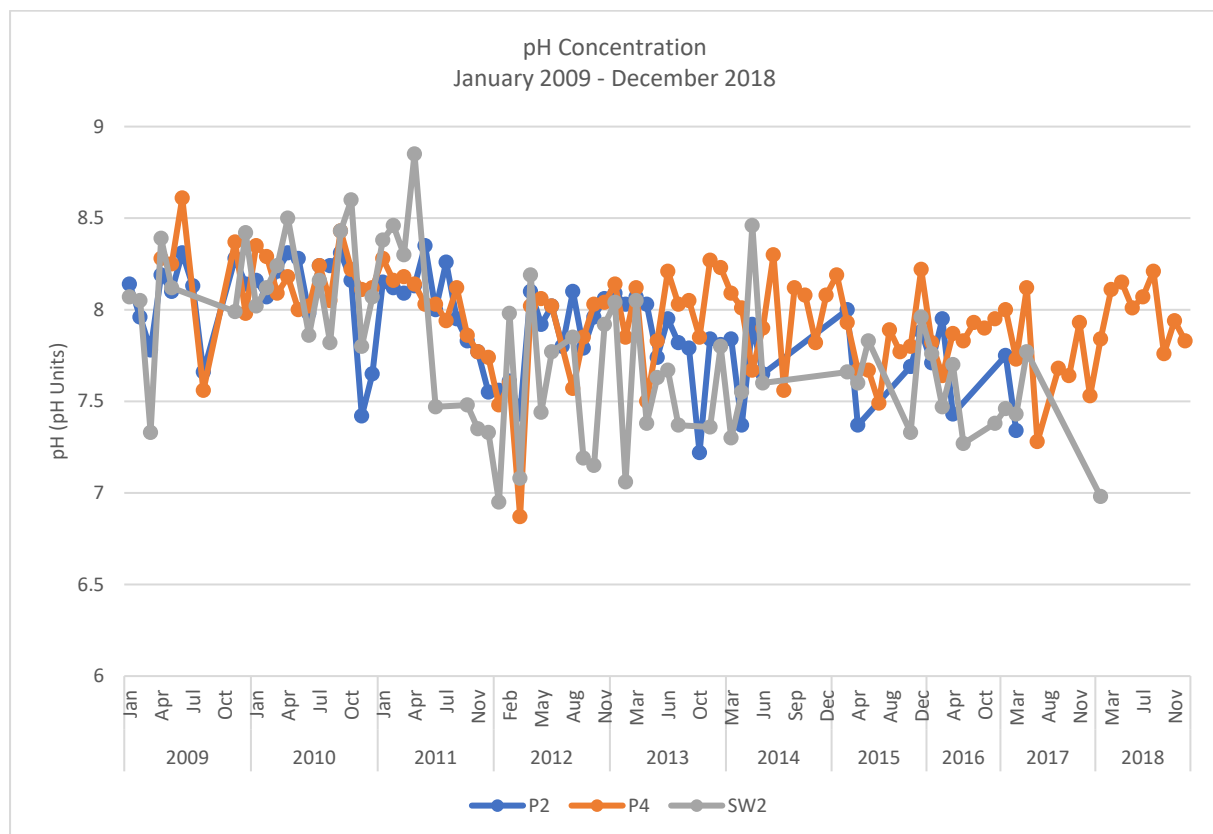
| Location | Ammoniacal Nitrogen as NH |       |         | Chloride |        |         | COD, unfiltered |        |         | pH     |      |         | Suspended solids, Total |        |         |
|----------|---------------------------|-------|---------|----------|--------|---------|-----------------|--------|---------|--------|------|---------|-------------------------|--------|---------|
|          | Min                       | Max   | Average | Min      | Max    | Average | Min             | Max    | Average | Min    | Max  | Average | Min                     | Max    | Average |
| EP Limit | 1.6                       |       |         | 250      |        |         | 100             |        |         | >6 < 9 |      |         | 100                     |        |         |
| P4       | 0.20                      | 11.70 | 4.40    | 60.10    | 86.00  | 69.93   | 49.30           | 113.00 | 80.07   | 7.76   | 8.21 | 7.99    | 2.00                    | 202.00 | 34.53   |
| SW2      | 0.26                      | 0.26  | 0.26    | 139.00   | 139.00 | 139.00  | 46.30           | 46.30  | 46.30   | 6.98   | 6.98 | 6.98    | 17.20                   | 17.20  | 17.20   |

## APPENDIX 4

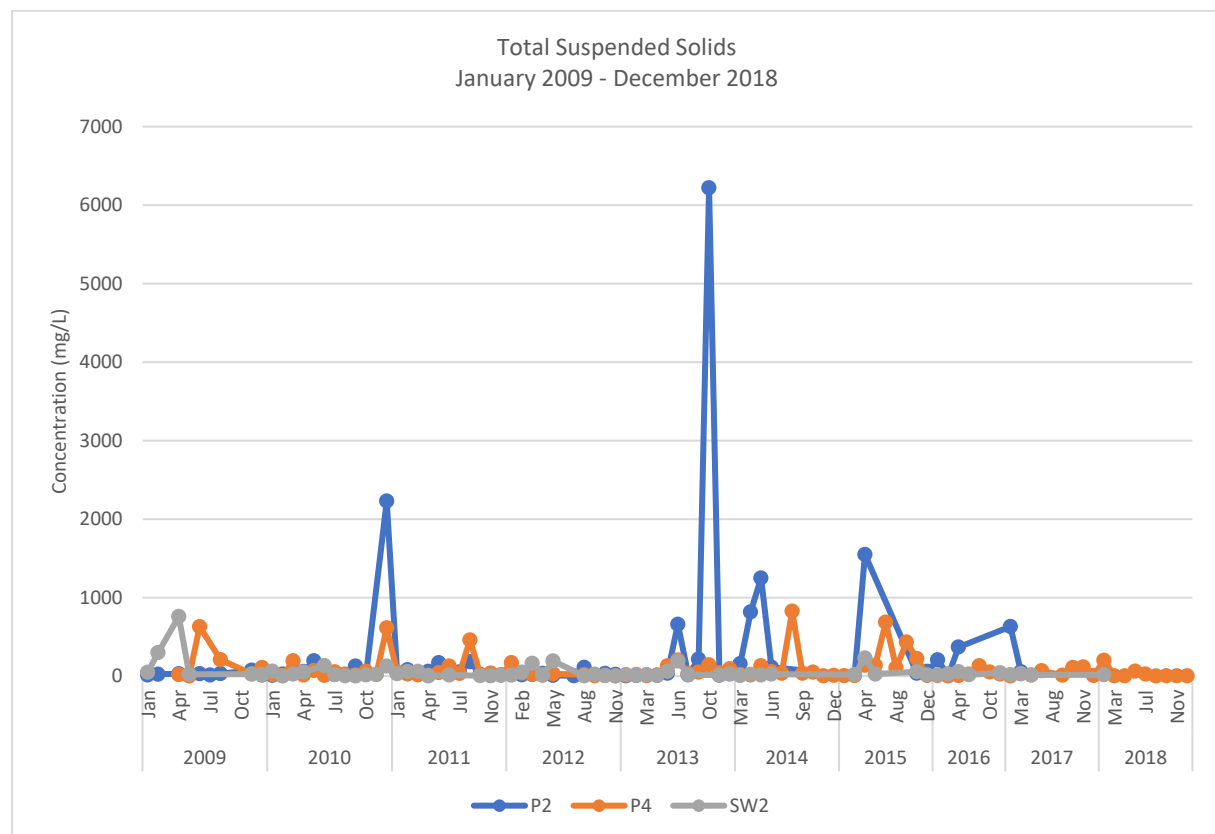
### Time Series Graphs

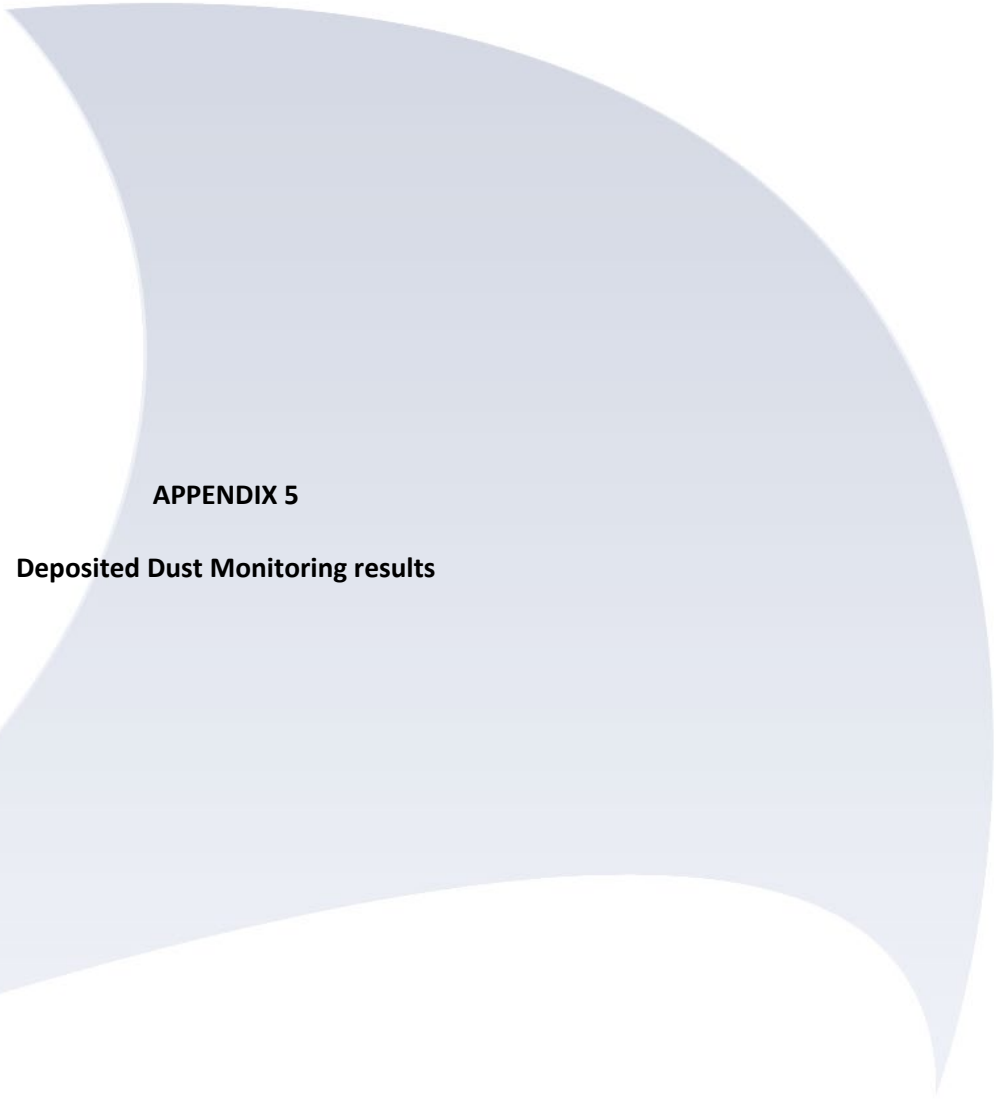


## APPENDIX 4



## 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: 07/03/2018 To: 11/04/2018  
No. of days 35

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          | 3000               | <10                           | <7.06     |
| Location 2          | 2200               | <10                           | <7.06     |
| Location 3          | 2300               | <10                           | <7.06     |

### Comments:

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

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

## Flintshire County Council Deposited Dust Monitoring

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

From: 06/06/2018 To: 06/07/2018  
No. of days 30

Collector: MW

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

Factor (mg deposit to mg/m<sup>2</sup>) 24.7

| Monitoring Location | Sample Volume (ml) | Total Suspended Solids (mg/l) | mg/m <sup>2</sup> /day |
|---------------------|--------------------|-------------------------------|------------------------|
| Location 1          | 420                | 360                           | 296.40                 |
| Location 2          | 460                | 85                            | 69.98                  |
| Location 3          | 430                | 330                           | 272                    |

### Comments:

- Dust analysis carried out by Concept Life Sciences Laboratories, Manchester
- Approx.400ml water added to each dust guage to allow dust particles to be captured due to lack of rainfall during monitoring period
- Algal growth noted in all samples collected, partucuarly Location 1 and Location 3, probably due to high sunshine rates during collection period which will distort figures. Location 2 is a more sheltered location from sunlight

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

## Flintshire County Council Deposited Dust Monitoring

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

From: 10/09/2018 To: 08/10/2018  
No. of days 28

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          | 1200               | 71                            | 62.63     |
| Location 2          | 2300               | <10                           | <8.82     |
| Location 3          | 2200               | <10                           | <8.82     |

### Comments:

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

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

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

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm

## Flintshire County Council Deposited Dust Monitoring

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

From: 04/12/2018 To: 08/01/2019  
No. of days 35

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          | 1200               | 11                            | 7.76      |
| Location 2          | 2300               | <10                           | <7.06     |
| Location 3          | 2200               | <10                           | <7.06     |

### Comments:

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

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

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

Location 2: Industrial Estate Boundary - located on perimeter near electricity meter house

Location 3: Oaks Farm



Registered Office: InTec, Parc Menai, Bangor, Gwynedd, LL57 4FG  
**Tel:** 01248 672666  
**Fax:** 01248 672601  
**Email:** [contact@caulmert.com](mailto:contact@caulmert.com)  
**Web:** [www.caulmert.com](http://www.caulmert.com)