

Environmental Monitoring Data Report

Llanddulas Landfill Site,

PPC PERMIT BU0800IZ

ANNUAL ENVIRONMENTAL MONITORING REPORT

1st February 2015 – 31st January 2016



**FCC Environment,
Llanddulas Landfill Site,
Abergele Road,
Llanddulas
Conwy,
LL18 8HP**

May 2016



TABLE OF CONTENTS

1.0 INTRODUCTION.....	1
1.1 Background	
1.2 Site Location & Surrounding Land Use	
1.3 Site History & Development	
1.4 Geology	
1.5 Hydrogeology	
1.6 Hydrology	
2.0 LANDFILL GAS REVIEW.....	4
2.1 Landfill Gas Data Summary	
2.2 Landfill Gas Management	
3.0 GROUNDWATER REVIEW.....	7
3.1 Groundwater Levels	
3.2 Groundwater Quality	
4.0 LEACHATE REVIEW.....	10
4.1 Leachate Levels	
4.2 Leachate Quality	
4.3 Leachate Disposal	
5.0 SURFACE WATER REVIEW.....	12
6.0 EMISSIONS TO AIR.....	14
6.1 FID Surveys	
6.2 Flux Box Surveys	
7.0 MONITORING AMENDMENTS AND FUTURE MONITORING REQUIREMENTS.....	15

DRAWINGS

Drawing No. 1 Environmental Monitoring Plan

APPENDICIES

Appendix 1 Engine/Flare Emissions and Trace Gas Analysis
Appendix 2 Flux Box Survey

1.0 INTRODUCTION

1.1 Background

FCC Environment (FCC) has undertaken a review of site monitoring data for Llanddulas Landfill site. The report has been compiled in order to comply with Condition 4.2.1a of the site's EP Permit BU0800 and Permit Variations CP3332LG and BG3734XX.

All monitoring data has been reported separately within quarterly data submissions, therefore only selected data is repeated here, as required to illustrate trends and support discussion. This report concentrates on those aspects of the monitoring that have been given trigger levels/emission limits by Natural Resources Wales (NRW) and/or are indicators of landfill impact. It does not attempt to present all data collected throughout the monitoring period but instead, it assesses whether or not the landfill is having an environmental impact and whether the monitoring results are as expected.

The data presented and reviewed within this report was collected over a one year period from 1st February 2015 to 31st January 2016.

1.2 Site Location and Surrounding Land-use

The Llanddulas Landfill (centred at National Grid Reference: SH 904 775) is located to the immediate south-west of Llanddulas village, approximately 5 km to the east of Colwyn Bay.

Llanddulas Landfill is located on an east/north-east sloping hillside with surface elevations falling from approximately 180mAOD, at the site's southern corner, to 120mAOD at the sites entrance tunnel beneath Pentregwyddel Road in the north. To the east of the quarry, the ground level falls steeply away to elevations of between 25 and 30mAOD, which are associated with the Afon Dulas Valley (sometimes referred to as the 'Dulas Gap').

The surrounding land use is agricultural grassland and open pasture which lies immediately adjacent to the site's western and southern boundaries, while development associated with Llanddulas village is present along the site's north-eastern boundary. Much of the eastern site boundary lies adjacent to limestone crags that form the upper slopes to the steep valley of the Afon Dulas. This area lies within the 'Llanddulas Limestone and Grwyth Castle Wood' Site of Special Scientific Interest (SSSI), which is of special interest for its limestone grassland, heath and woodland communities.

A worked-out quarry (the 'Lower Quarry') is located to the immediate north-west of the landfill site. This quarry is no longer operational and now holds a series of lagoons. Historically these lagoons were used to treat effluent generated by the on-site mineral processing plant. However, following the cessation of mineral extraction, their operational use has been limited to providing water for dust suppression activities.

1.3 Site History and Development

Quarry operations at Llanddulas have been on-going for over 100 years, with operations beginning within the Lower Quarry located to the immediate south of the old A55 Coast Road. Mineral extraction moved progressively southwards, with the area to the south of Pentregwyddel Road being developed subject to a number of planning approvals.

Phase 1 of the Llanddulas Landfill was developed by Colwyn Borough Council during 1985 and landfilling within Phase 1 was initially completed during 1994. However, further re-profiling occurred within Phase 1C during the latter part of 2001 in order to increase the height of the site and to correspond to the appropriate restoration contours. These operations allowed the capping and restoration of previously unrestored areas of this phase. During 2010, a total of 1000m² of temporary capping was installed on the North flank of cell 3a and 6000m² of permanent HDPE capping installed to Phase 3a southern flank plus 1m of restoration soils.

Historically Phase 2 operations began in 1994 while Phase 3 was developed during 2002. Phase 2 capping was completed in 2002. Phase 3 is also capped. During the reporting period the Central area of Phase 3A was operational, the North Western, North Eastern area and the southern half are now all capped.

1.4 Geology

The superficial deposits present within the vicinity of the landfill are located to the east and north-east of the site and comprise Boulder Clay. These materials are present within the base of the Afon Dulas valley as well as the western and eastern valley sides. It is anticipated that the greatest depth of this material is located within the Afon Dulas valley, although there is no direct evidence to confirm this. In addition to the Boulder Clay, River Terrace Deposits and Alluvium are also associated with the water course.

The solid geology comprises limestones deposited within the Carboniferous Limestone Series. More specifically, the site is located in the Dyserth Limestone Group. Below the Dyserth Limestone Group and outcropping several hundred metres to the south of the site are the Carboniferous Limestone Basement Beds, which comprise a variable sequence of limestones, sandstones and conglomerates. The local dip of the limestone beds is approximately 15 degrees towards the north-north-east.

There are four main faults located within the vicinity of the site, the details of which are as follows; the Llysfaen and Plas Farm Faults are orientated approximately east to west and traverse the quarry. Both faults dip towards the south at approximately 45 degrees and have around 40m of displacement to the south.

The Llysfaen fault is located to the immediate south of Phases 1 and 3 and north of Phase 2. The Plas Farm Fault effectively defines the southern extent of the currently consented landfill area. The Dulas Gap Fault is orientated north to south and is near vertical with a downthrow of approximately 75m to the east.

The geological map information for the area suggests that this fault truncates the eastern ends of the Llysfaen and Plas Farm Faults. It is probable that the Llysfaen Fault is downthrown by the Dulas Gap Fault. If this is the case, then the surface manifestation of the truncated Llysfaen Fault could be in the location of the Dulas Spring, owing to the dip of the Llysfaen Fault to the south and the 75m downthrow to the east of the Dulas Gap Fault.

The Tyn-y-Caeau Fault located to the east of the Dulas Gap Fault, is near vertical and has a 120m throw to the west. It intersects the Dulas Gap Fault to the north of the quarry. In addition to the above, smaller unnamed faults are present to the south of Llanddulas Landfill within the southern end of the quarry. Two sets of vertical joints, parallel to the geological strike are also present.

1.5 Hydrogeology

The site is located within the Carboniferous Limestone Series, which is classified as a “principal aquifer” within the Groundwater protection policy, 2010, owing to the rock potentially possessing significant fracturing and extensive well-developed joint system and the potential for high bulk permeability. This classification is confirmed by the Groundwater Vulnerability Map¹ for the area.

The Carboniferous Limestone aquifer is a hard rock where primary porosity is low (less than 1%) and flow through open cavities, such as fractures, fissures and joints, is dominant. The Carboniferous Limestone is mechanically strong, but can undergo solutional weathering (karstification) which, under some circumstances, can produce caves (conduits) through which groundwater can flow preferentially.

Even though preferential routes exist within the Carboniferous Limestone aquifer, an extremely large volume of aquifer will still consist of rock that possesses tight fractures where water flow is extremely slow (i.e. the diffuse zone). The diffuse zone of the Carboniferous Limestone aquifer is generally highly anisotropic, that is to say that hydraulic conductivities vary significantly with direction. Groundwater flow within a karstified Carboniferous Limestone aquifer usually occurs along bedding planes, which are laterally continuous within the rock.

1.6 Hydrology

The main watercourse within the vicinity of Llanddulas Landfill is the Afon Dulas, located approximately 200 to 400m to the east of the site. This watercourse flows in a northerly direction and discharges into the Irish Sea approximately 1.3km to the north-east of the site. The coastline lies approximately 600m and 300m to the north of Phase 1 and the Lower Quarry areas respectively. An unnamed tributary of the Afon Dulas, which flows in an easterly direction, is located over 1km to the south of the site.

Llanddulas Landfill does not lie within any indicative floodplain.

¹ Groundwater Vulnerability Map, Sheet No.15, North Wales Coast

2.0 LANDFILL GAS REVIEW

Routine monitoring for off-site landfill gas was undertaken on a weekly basis within 54 perimeter monitoring boreholes and monthly in a further 22 in accordance with the requirements of Table S4.5 of the site Permit. Methane, Carbon Dioxide, Oxygen, relative pressure and atmospheric pressure are all recorded.

The locations of monitoring points are shown on the site monitoring plan, Drawing No. 1.

The trigger levels for landfill gas concentrations are those submitted and agreed with NRW in accordance with improvement condition S1.3.13, agreed with the then EA Wales in November 2012 (CAR form RDR/121105).

The new trigger limit for methane is 1% (action limit of 0.5%), with the exception being 2.5% in borehole Bh40 which has an action limit of 1.5%. Specific actions to be taken if the limits are breached are detailed in the latest version of the site Landfill Gas Management Plan. Borehole specific CO₂ action limits were also agreed.

2.1 Landfill Gas Data Summary

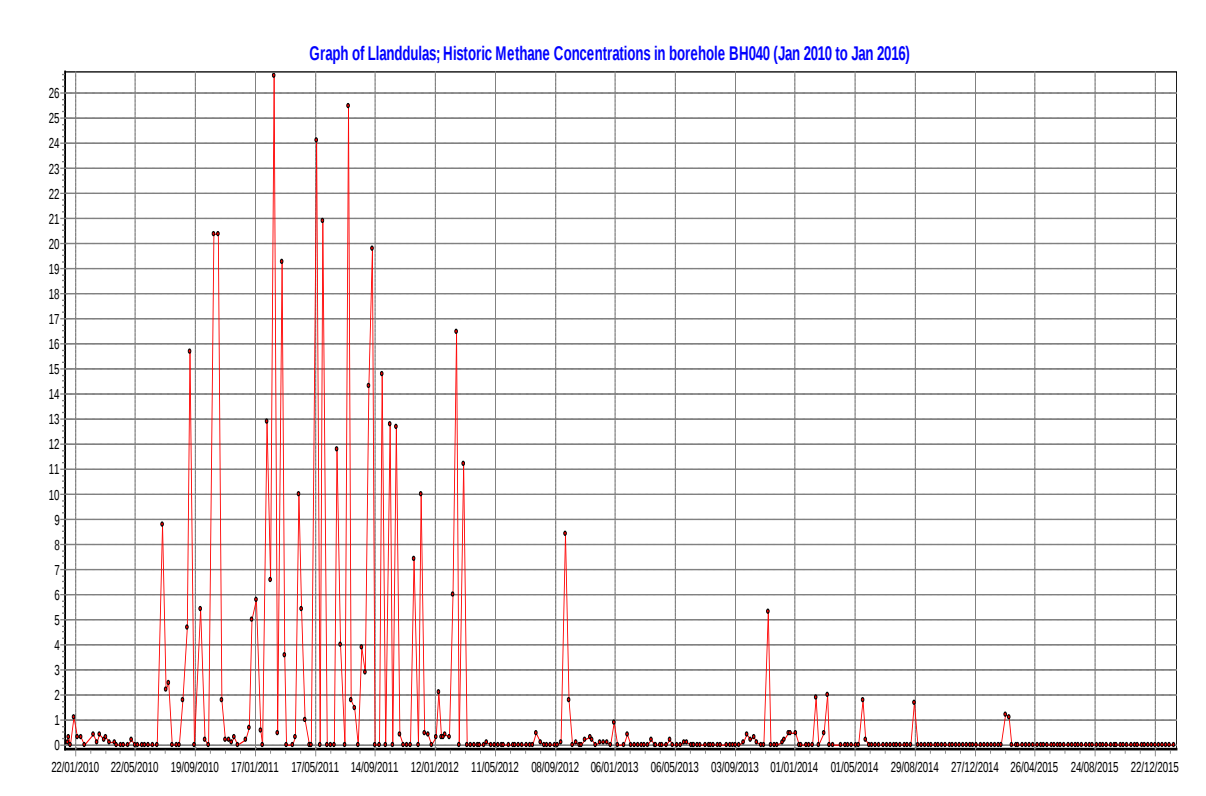
A review of the gas quality data indicates the following;

There were no breaches of the current methane trigger limit of 1.0%(v/v) throughout the reporting period.

The borehole which, in previous years, had recorded the most breaches was borehole BH40, however, there were 2 instances when methane was detected in the 12 month period with levels of 1.2% (26/02/15) and 1.1%v/v (05/03/15) recorded.

On each occasion the gas wells opposite Bh40 were rebalanced to re-establish gas control.

Graph 1: Historical Methane Levels in borehole BH40 (Jan 2010 to Jan 2016)



Borehole bh40 is not situated on the site boundary and is not considered to reflect evidence of off-site gas migration but is used as a control measure and any breaches of the methane trigger level are reported accordingly. This borehole was included in Improvement Condition IC13 of the PPC permit and following the submission of the above IC borehole BH40 now has a methane trigger level of 2.5% and action level of 1.5%.

Active measures are in place to discourage gas migration towards borehole Bh40 from the adjacent Phase 1, whereby suction is being applied at a constant rate to the two nearest gas wells. It can be seen (in Graph 1 above) that the number of methane breaches and general background levels of gas in Bh40 have much reduced in the last few years.

Since November 2012 (following the agreement of CO₂ Action Limits, as part of the IC13 submission), Carbon Dioxide has no longer been used as a landfill gas migration indicator in the absence of methane.

To summarise, there are no trends of elevated Methane within the perimeter boreholes that would indicate ongoing lateral migration of landfill gas beyond the site perimeter. Elevated readings of Carbon Dioxide are thought to be present because of the localised geology.

2.2 Landfill Gas Management

The landfill gas control system was monitored in accordance with Tables S4.7 of the site Permit. Capping of the Northern section of Phase 3A was completed during 2015 and this, along with the drilling of further gas wells and the proactive installation of pin wells in the uncapped areas of Phase 3A, has enhanced the gas capture at the site and assisted in the control of fugitive emissions.

Reports for trace gas analysis and engine emissions data are appended at the end of this report.

After a review of the gas well monitoring data, the following observations can be made.

- Average methane concentration for the gas extraction wells (from 4734 readings) during the 12 month period was 44.4%(v/v).
- Average carbon dioxide concentrations were observed to be 31.9%(v/v) within the gas wells for the duration of the review period.
- Oxygen readings averaged 2.5%(v/v).
- Suctions within the field averaged -28.9mbar for the duration of the review period.

Landfill gas is currently extracted and utilised at the site from Phases 1, 2, 3 and 3A.

The LFG utilisation plant, located on site, comprises of three Jenbacher engines capable of producing 2 x 1000kW and 1x 1065kW respectively.

The total flaring capacity on site consists of one 2000m³ high temperature flare and one 1000m³ high temperature flare commissioned in September 2008. These are capable of sufficient gas control in the event of the engines being unavailable.

Llanddulas produced an average of approximately 2500kW of exportable energy per month during 2014. The gas quality at the engine inlet averaged 43.4% methane, 1.7% oxygen, - 82.4mb differential pressure and an average flow of 1346m³/h.

Gas volumes predicted within the most recent Landfill Gas Risk Assessment (SLR Ref.404.0197.00529 August 2009) quote gas generation volumes in excess of 2000m³/hr, however, this was calculated based on waste inputs of 160,000t/yr, whereas during 2015,

waste inputs at Llanddulas totalled less than a quarter of the above projected figure at 39,253t, 25% of which would be classed as non-biodegradable.

Monitoring of the flare and gas engine emissions and trace gas analysis was undertaken during December 2015 in accordance with Table S4.2 of the site permit. The results are contained in Appendix 1 of this report.

Table 1: Engine and Flaring Capacity at Llanddulas Landfill Site 2015

Site	Flares			Engines			
	No.	Total Capacity (m3/hr)	Total Volume to Flare (Nm3)	No.	Total Capacity (MW)	Total Capacity (m3/hr)	Total Volume to Engines (Nm3)
Llanddulas	2	3000	848,000	3	3.07	1800	12,117,000

Emissions from engines 1 and 3 remained within the overall uncertainty limit for NO_x and met the standard for CO and TVOCs. Engine 2 was compliant with the standard. – see notes 1 – 7 of the attached report (Appendix 1).

As the main flare ran for more than 10% of the time the flare emissions were also tested (see Appendix 1) and were compliant with the standard.

With regard to the inlet trace gas.

- Compared with the results from last year, most component concentrations have decreased; 1,1 Dichloroethane; 1,2 Dichloroethene; 1-Pentene; Chloroethane; Chloroethene; Ethyl butyrate; Styrene and Trichloroethene were detected last year, but were not detected this year. 1,2 Dichloroethene was not detected last year, but was detected this year.
- Hydrogen Sulphide and Methanal (Formaldehyde) were detected above the national UK database average (within an order of magnitude of the database average). All other detected components were below the database average.
- Hydrogen sulphide concentration has decreased to a level typical for all sites

The effectiveness of the gas management system is tested by monitoring gas compositions at the gas collection and extraction wells. Monitoring of the gas extraction system is carried out in accordance with the requirements of Tables S4.2 and S4.7 of the site Permit.

Table S4.7 specifies that where oxygen levels exceed 5%(v/v), or where the addition of Carbon Dioxide and Methane percentages is less than 80%, an assessment of air ingress shall be undertaken. Also, where the concentration of Carbon Monoxide exceeds 100ppm, then further investigations shall be carried out. A review of the gas well data in relation to the above control limits would indicate the following.

There were a total of 4734 readings obtained during the review period and of these, there were 1863 results which showed a total percentage of Carbon Dioxide and Methane of less than 80%(v/v) which was 39.4% of the readings. A total of 723 results showed O₂ in excess of 5% which was 15.3% of the total readings for 2015. Assessments of these wells showed that the majority of readings led to the valves at these points being closed or significantly reduced, to prevent any potential oxygen ingress, yet maintaining a degree of gas control. Investigations are actioned when the control limits specified within Table S4.7 of the Site Permit are exceeded and corresponding remedial actions promptly instigated by our gas contractors.

There were fourteen exceedences of the 100ppm control limit for Carbon Monoxide during the review period mostly recorded at gas well D211 with the highest value reported at 501ppm.

During the last few years there have been various reviews of the effectiveness of the gas extraction system, including NRW gas audits. Remedial works have taken place as a result including decommissioning of redundant gas wells and the installation of a significant number of new wells. Both permanent and temporary capping has also taken place and the removal of elevated liquid levels contained within some gas wells continues.

3.0 GROUNDWATER REVIEW

3.1 Groundwater Levels

Groundwater levels are recorded on a monthly basis within the sampling boreholes specified in Table S4.10 of the site Permit and locations are indicated on Drawing No.1.

Following a review of the data the following conclusions may be drawn;

The groundwater level beneath the site varied between 11.83mAOD in borehole GWBH24 (downstream of groundwater flow across the site) located in Llanddulas village to the north-east of the site and 79.38mAOD in GWBH36 (downstream) on the Eastern site boundary. The boreholes displaying the minimum and maximum AOD levels are the same as in previous years with values close to those generally recorded. The maximum water level in GWBH36 was 8m higher than in 2014 which probably reflects the large amounts of rainfall experienced in late 2015 and the beginning of 2016. The wide variation in groundwater levels is in part a function of the wide variation in topography across the site ranging between 180mAOD to the south and 30mAOD in the north. It is also possible that proximity to the sea could give rise to tidal fluctuations within the aquifer, especially in the more northerly boreholes. Wide groundwater fluctuations are typical of karstic aquifers and their response to recharge events.

The range in groundwater levels (mAOD) within individual boreholes varied from 1.59m in GWBH2 to maximum of 40.65m in GWBH36. It is common to observe a wide variation because the nature of recharge event response varies depending on the degree of fissuring or solution cavity exposed to the screened section of the monitoring well.

To summarise, groundwater levels observed within the perimeter monitoring boreholes are generally consistent with historic results.

3.2 Groundwater Quality

Groundwater samples are taken from the locations and at frequencies as specified in Tables S4.4 and S4.10 of the site Permit.

A review of the groundwater monitoring data for 2015, in relation to the compliance limits specified within the Site Permit and assessment criteria stated within the most recent approved HRA (SLR – Ref 404-0197-00529, December 2008) indicates the following;

Ammoniacal Nitrogen and Chloride concentrations remained below the trigger level throughout the review period in boreholes with trigger limits applied.

Elevated NH₃N readings were recorded in borehole GWBH26b (which has no trigger limit) on four occasions, to a maximum of 5.5mg/l. During dry weather this borehole becomes almost dry with stagnant silty/sludgy deposits at the base which when sampled produces elevated Ammonium results at the laboratory. Technicians have found difficulty retrieving a sample from the borehole and often reported an 'oily' or 'fishy' smell when sampling. There have been no other elevated readings of any other substance analysed from these samples. There was no breach of the 250mg/l trigger limit for Chloride during the review period. The highest value recorded was 159mg/l in borehole GWBH6R.

There were a number of breaches of the **Potassium** trigger limit in borehole GWBH36, ranging from 18mg/l to 39mg/l.

In 2014 we reviewed the Potassium data for GWBH04 which had showed concentrations breaching the trigger level of 12mg/l regularly over the last 5 years. We are continuing to fully purge this borehole during routine groundwater sampling each month which has had the effect of reducing the level of potassium.

Borehole GWBH36 is one of the deeper boreholes on site (120m to base) which it was agreed (through correspondence with NRW) that it is not necessary to purge prior to sampling. However, due to the persistent breaches of the Potassium trigger level, we arranged for 'passive sampling' to be carried out at various depths within borehole GWBH36.

The amount of Potassium detected in GWBH36 reduced during the year and was noted to have further decreased when we received results of 'passive sampling' carried out by external monitoring contractors on our behalf. Water samples were taken on 16th June 2015 at depths of 105m (28mg/l Potassium), 115m (29mg/l) and just above the borehole base at 125m (32mg/l). The most recent results have confirmed the downward trend in concentration of potassium in this borehole (22mg/l).

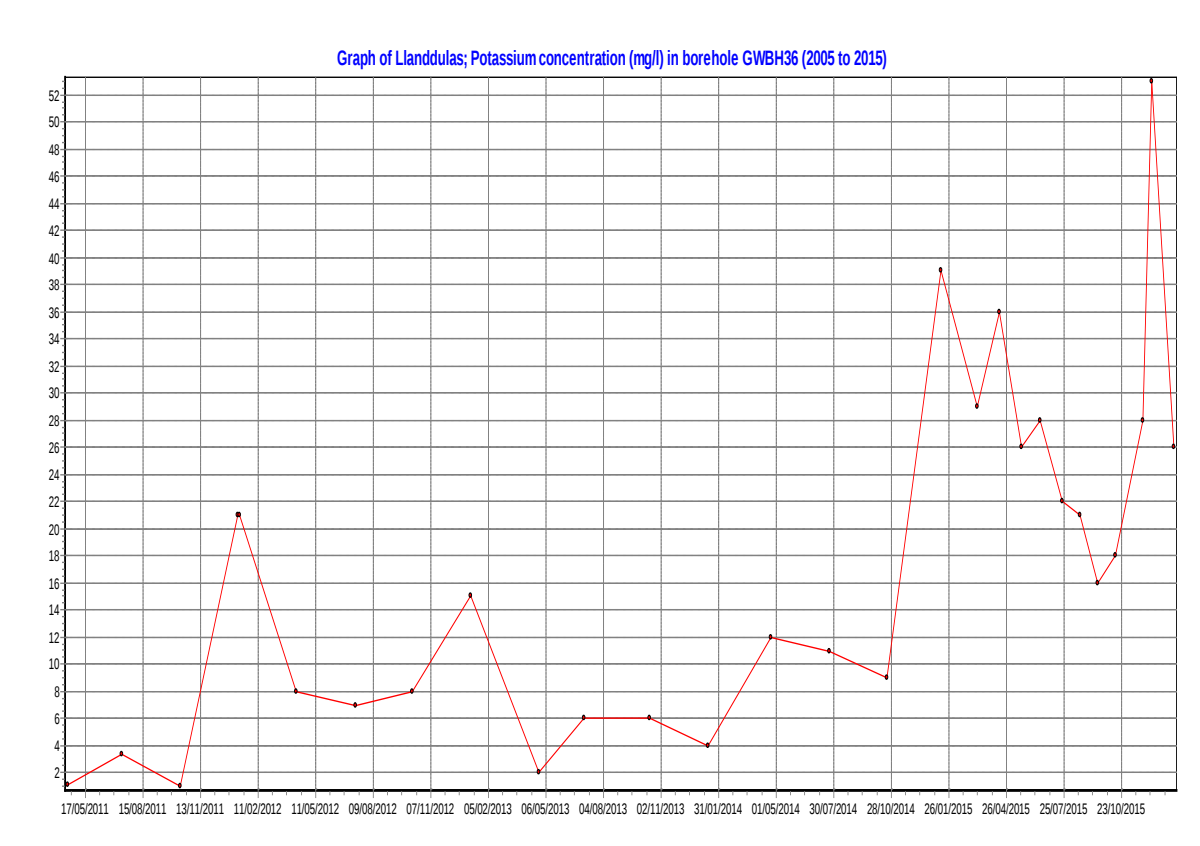
At time of writing this report, Potassium levels in GWBH36 have dropped below the 12mg/l trigger limit, with a value of 10mg/l reported for the sample collected in April.

All other determinands (and key indicator pollutants) tested for in GWBH36 have been graphed and none of them exceed their trigger limits or show elevated levels or upward trending levels. For example, Ammoniacal Nitrogen is generally at <0.01mg/l and the Chloride concentration between 55 to 65mg/l which is well below the 250mg/l limit.

Looking at historical data there have been spikes of Potassium in borehole GWBH36 previously but levels have returned to background concentrations within a few months.

Borehole GWBH36 is positioned upstream of the **Dulas Valley Spring** which has shown no deterioration in water quality during the last 12 months.

Graph 2: Potassium concentrations in groundwater borehole GWBH36 (2005 to 2015)



There were no breaches of the **Mecoprop** trigger limit for the fourth year in a row which is an improvement on previous years when there were several breaches across a number of boreholes.

There were no breaches of the **Mercury** trigger limit.

Table 2: Maximum background concentrations of substances in groundwater boreholes (HRA, table 6, 2008) versus 2015 average concentrations.

Determinand	Ammonium	Chloride	Lead	Mercury	Mecoprop	Cadmium
HRA 2008	0.84	62	0.013	0.001	0.14	0.0005
Maximum	5.5	159	0.01	<0.0001	0.13	<0.0001
Minimum	0.01	13	0.00	<0.0001	0.02	<0.0001
Average	0.09	52	0.01	<0.0001	0.02	<0.0001

The Annual screen for hazardous substances was completed in October 2015 and from 436 results returned there were no positive detections.

To summarise, groundwater quality is generally considered to be consistent with historic review periods. There are no trends evident within the data sets that would indicate a potential failure in the site containment system. There were occasional, isolated, slightly, elevated results, but none that would indicate a potential risk to the surrounding environment. An assessment has also been made against the most recent HRA and background results tend to be consistent with the Environmental assessment limits.

4.0 LEACHATE REVIEW

Leachate levels are recorded on a weekly basis in accordance with Table S4.1 of the site Permit. Leachate samples are collected on a quarterly basis as agreed in writing (April 2013) with Natural Resources Wales.

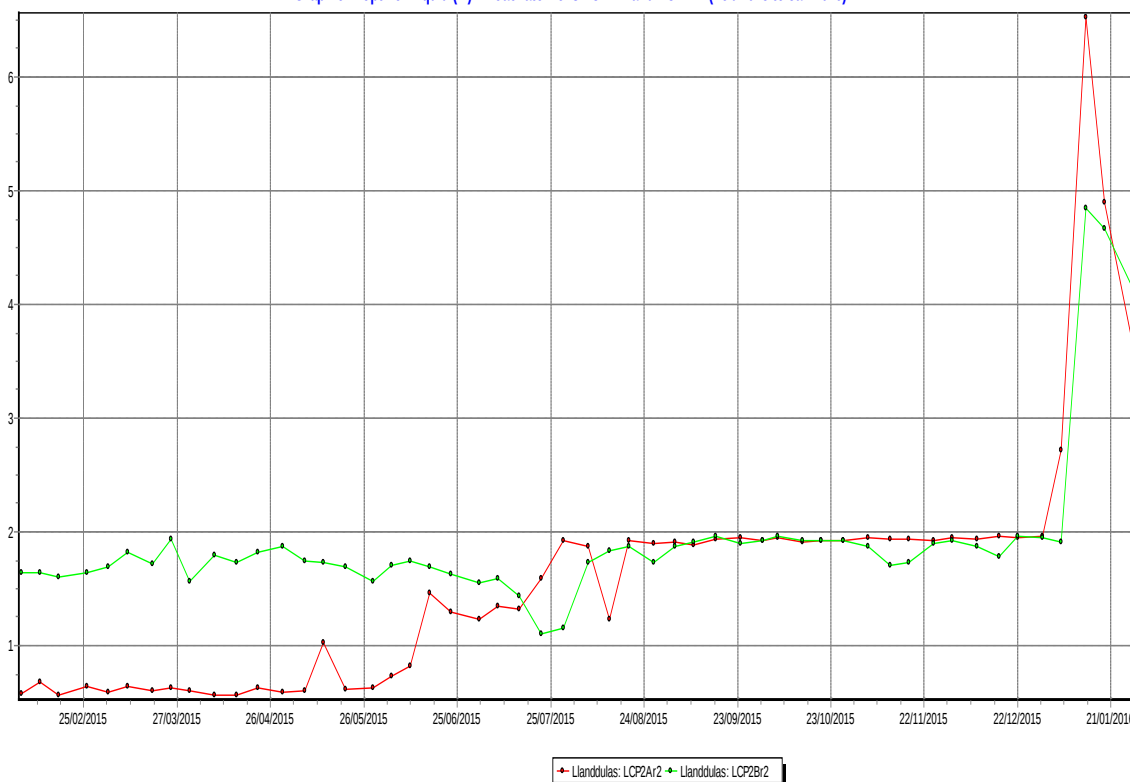
4.1 Leachate Levels

Leachate monitoring within restored and active phases currently occurs at 7 leachate extraction and 7 leachate monitoring points in accordance with the requirements of Table S4.1 of the site Permit.

A review of the leachate level data indicates the following:

Leachate levels in Phase 2 were severely affected by the prolonged and persistent rainfall experienced in the last few months of 2015 and the beginning of 2016. Levels in leachate chambers LC2Ar2 (Phase 2, Cell A) and LC2Br2 (Phase 2, Cell B) both rose markedly and exceeded the compliance limit of 2m specified within Table S4.1 of the Site Permit

Graph of Depth of Liquid (m) in leachate wells LC2Ar2 and LC2Br2 (Feb 2015 to Jan 2016)



4.2 Leachate Quality

Leachate is sampled in the 7 leachate collection chambers (across Phases 1, 2, 3 and 3A) specified in Table S4.8 of the site Permit.

Following a review of the results compared to the source term data stated in Table HR4 of the Site HRA, the following comments can be made:

Ammoniacal Nitrogen concentrations ranged from a minimum of 72.9mg/l in LCP1AR (the oldest leachate well on site), to 2650mg/l in LCP3A with an overall average of 1,406mg/l (a slight increase on 2014). The maximum value is within the range of the source term concentrations modelled in the HRA.

Concentrations of **Chloride** ranged from 191mg/l in LCP1Ar to 3780mg/l recorded in LCP2Cr, which is around 200mg/l higher than the maximum figure in 2014. The overall average of 2326mg/l is slightly up on the 2014 total and significantly lower than the maximum source term concentration of 3900mg/l.

Lead concentrations ranged from below detection limits in the majority of chambers, to a maximum of 0.04mg/l in both LCP1C and LCP3, which is significantly below the source term maximum of 120mg/l.

Table 3: Concentrations of major contaminants in leachate at Llanddulas (2015)

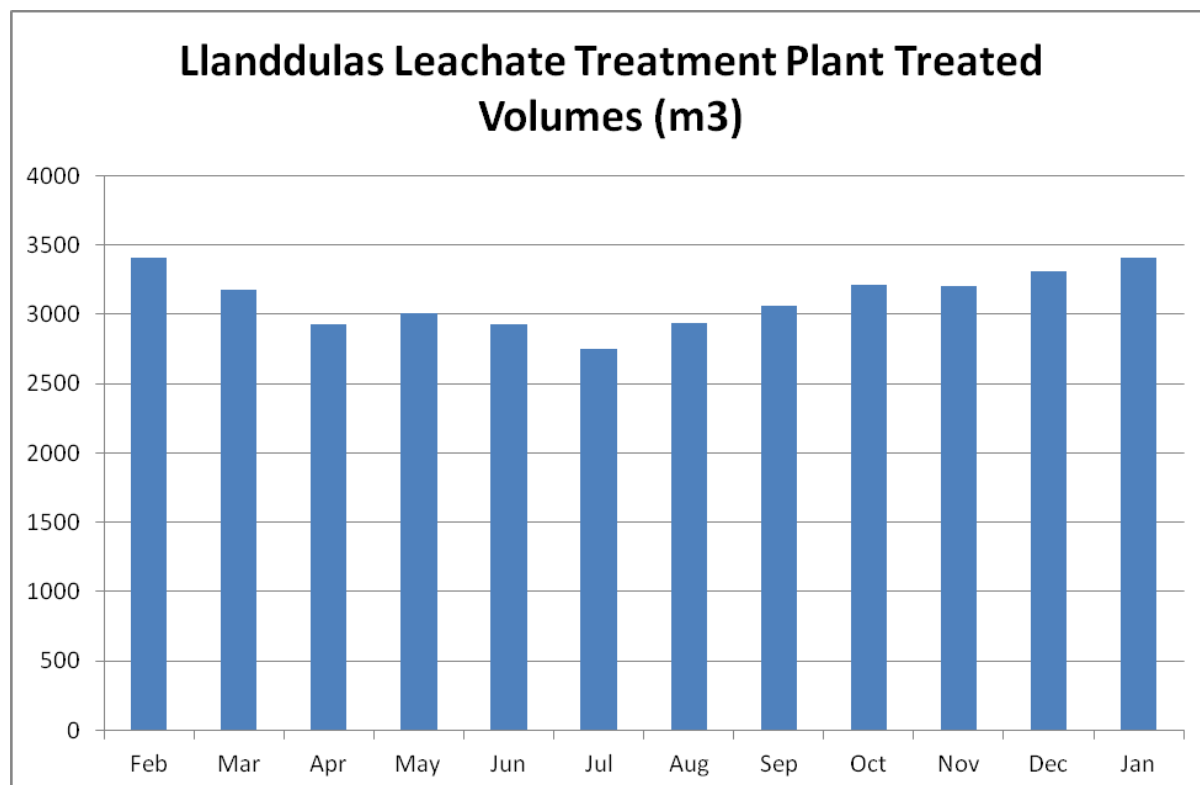
Determinand	Ammonium (mg/l)	Chloride (mg/l)	COD (mg/l)	BOD (mg/l)	Conductivity (us/cm)	Lead (mg/l)	Mecoprop (ug/l)
Max Value	2650	3780	12900	17442	34554	0.04	83.3
Min Value	72.9	191	130	3.5	2610	0.01	4.8
Average	1406	2326	4314	1255	17290	0.01	32

To summarise, leachate quality is similar in strength to historic reports and is of a typical composition for a non-hazardous landfill site receiving municipal solid waste. All results obtained were generally within the ranges of the Source Term Concentrations stated in Table HRA4 of the most recently approved HRA.

4.3 Leachate Disposal

A total of 37,340m³ of leachate was treated at the on-site treatment plant during 2015. This total includes imported leachate from either other FCC sites or from landfill sites on Anglesey. Leachate is pumped from 7 collection chambers, 6 monitoring points and in addition a series of pumped 'pots' which range in depth from 10m to 15m. Leachate is also pumped to the LTP from a number of gas wells. Priority is always given to the treatment of on-site leachate when the plant is at full capacity of 150m³/day.

See graph below of monthly leachate treated volumes excluding imported leachate.



5.0 SURFACE WATER REVIEW

Surface water is sampled in accordance with the requirements of Tables S4.3 and S4.9 of the site Permit.

After a review of the surface water quality, the following conclusions can be made;

There were no emissions through discharge point W1 for the duration of the review period, although the location was sampled throughout the period. Water quality analysis from this location is provided on a quarterly basis.

Concentrations of **Ammoniacal Nitrogen** in the Dulas Valley Spring and River Dulas sampling locations, ranged from 0.01mg/l to a maximum result of 1.00mg/l recorded from the River Dulas downstream sampling location. Average concentrations were calculated at 0.09mg/l across the period which is 0.02mg/l lower than the previous review period and 0.05mg/l lower than 2013.

Chloride concentrations averaged 37mg/l in all sampling locations, with a maximum observed concentration of 55mg/l recorded at the Dulas Valley Spring. These concentrations are slightly higher than the previous review period but the results remained significantly beneath the UK DWS of 250mg/l.

Results for **Lead** and **Mercury** were all below detection limits for the duration of the review period.

Mecoprop concentrations averaged 0.03ug/l for the 3 surface water sampling locations, with a maximum observed concentration of 0.18ug/l recorded in the Dulas Valley spring. This

concentration is 0.1mg/l lower than in the previous review period with the average concentrations below the UK DWS of 0.1ug/l.

The Annual Hazardous Substance screen required by Table S4.9 was completed in October 2015 with no positive detections.

To summarise, there has been no emissions of site derived surface water run off through the discharge point W1 during the review period. All other sampling locations have been monitored in accordance with the site permit, and there is no evidence to suggest any kind of environmental impact on the localised water courses that could be attributed to landfilling activities at Llanddulas.

6.0 EMISSIONS TO AIR

Emissions to air are monitored in accordance with the requirements of Tables S4.6 and S4.11 of the site Permit.

6.1 FID Surveys

Walkover FID surveys, both across all phases of the site and at the perimeter are completed on a monthly basis in accordance with the requirements of Table S4.11 of the site Permit. Results generated by these surveys are reported on a quarterly basis to NRW.

In addition, there is an ongoing program of fortnightly FID surveys, to identify areas or point sources of fugitive emissions, followed by remedial works to resolve any issues identified.

A perimeter survey is also carried out monthly using a 'Jerome' unit which measures hydrogen sulphide in parts per billion.

6.2 Flux Box Surveys

A full site flux box survey was carried out in September 2014 (in accordance with Table S4.6 of the site Permit) however there was an intermittent failure of the instrument used for the surface emissions testing. As a result of the instrument failure, although most results were below the guidance limit, many were deemed to be not representative or inconclusive. The consultants attempted to re-do the survey in October but met with poor weather conditions so the whole survey was carried out again in the summer of 2015.

The EA Guidance sets standards for gas emissions from a landfill surface which is expressed as the average flux of methane from the surface of the cap in each zone.

The relevant emission standards are:

Permanently capped zone: 0.001 mg/m²/second;

Temporarily capped zone: 0.1 mg/m²/second

From the results collated during the survey (see the full report in Appendix 2), the average flux of methane from the surface of the cap in zones 4 and 5 was within the EA standards detailed above.

Zone 1, 2 and 3 only just exceeded the EA standards for Permanent capping.

When removing locations Z1/32, Z1/35; Z2/19; Z3/02, Z3/07, Z3/11 from the respective calculations each zone would meet the standard.

The six locations identified above were marked with spray paint on plastic capping or staked out and picked up during the next scheduled fortnightly FID remediation and repaired such that emissions from these points were eliminated.

New permanent capping took place in the North East corner of Phase 3A during 2015. In addition, FID surveys, with follow up sealing works have continued to be carried out across all areas of the site on a fortnightly basis.

7.0 Monitoring Amendments and Future Monitoring Requirement

- A flux box survey will take place during 2016 to assess areas capped in 2015.
- Proposals were submitted by FCC to Natural Resources Wales on 20th April 2015 for monitoring reductions in line with recommendations within Agency guidance.
- The above monitoring reductions will come into force with the next Permit Variation which is being processed by the NRW permitting team at time of writing this report.
- Proactive monitoring of emissions (FID surveys) are to continue on a fortnightly basis during 2015.

APPENDIX 1

Engine Emissions & Trace Gas Analysis

- Trace Gas Analysis
- Engine Emissions Data
- Flare Emissions Data

Infinis Energy Services Limited

Periodic monitoring of raw landfill gas

Llanddulas Landfill Site

Report	LNO12693-TG
Date	15 January 2016
Version	1





PERIODIC MONITORING OF RAW LANDFILL GAS

LLANDDULAS LANDFILL SITE

Report prepared for

Infinis Energy Services Limited
500 Pavilion Drive
Northampton Business Park
Northamptonshire
NN4 7YJ

Report prepared by

ESG
Unit D
Bankside Business Park
Cirencester
Gloucestershire
GL7 1YT

Approved Dr N Ford

N Ford

Issue history

Version	Date	Approved	
LNO12693-TG, 1	15 January 2016	N Ford	N Ford
First issue			

1 Introduction

Infinis Energy Services Limited (Infinis) contracted Environmental Scientifics Group (ESG) to undertake monitoring of the landfill gas supply to its combustion operations at the Llanddulas Landfill site.

2 Test methodology

Infinis requested that duplicate samples of landfill gas be collected and analysed for the priority trace components (LFGTGN04, Table 1.1) specified in Environment Agency guidance (Guidance for monitoring trace components in landfill gas – LFGTGN04 v3.0, 2010). The test methodology should be in accordance with that specified within LFGTGN04.

Based on LFGTGN04 the priority trace gas components are sampled using a combination of four sampling media as shown in Table 1.

Table 1 Sampling media and analytical methods

Trace component	CAS number	Sampling method	Analytical method
1,1-dichloroethane	75-34-3	Dual solid sorbent	ATD-GC-MS
1,2-dichloroethane	107-06-2	Dual solid sorbent	ATD-GC-MS
1,1-dichloroethene	75-35-4	Dual solid sorbent	ATD-GC-MS
1,2-dichloroethene	540-59-0	Dual solid sorbent	ATD-GC-MS
1,3-butadiene	106-99-0	Dual solid sorbent	ATD-GC-MS
1-butanethiol	109-79-5	Dual solid sorbent	ATD-GC-MS
1-pentene	109-67-1	Dual solid sorbent	ATD-GC-MS
1-propanethiol	107-03-9	Dual solid sorbent	ATD-GC-MS
2-butoxyethanol	111-76-2	Dual solid sorbent	ATD-GC-MS
Arsenic (as As)	7440-38-2	Charcoal	ICP-MS
Benzene	71-43-2	Dual solid sorbent	ATD-GC-MS
Butyric acid	107-92-6	Dual solid sorbent	ATD-GC-MS
Carbon disulphide	75-15-0	Dual solid sorbent	ATD-GC-MS
Chloroethane	75-00-3	Dual solid sorbent	ATD-GC-MS
Chloroethene (vinyl chloride)	75-01-4	Dual solid sorbent	ATD-GC-MS
Dichloromethane	75-09-2	Dual solid sorbent	ATD-GC-MS
Dimethyl disulphide	624-92-0	Dual solid sorbent	ATD-GC-MS
Dimethyl sulphide	75-18-3	Dual solid sorbent	ATD-GC-MS
Ethanal (acetaldehyde)	75-07-0	Silica gel/2,4 DNPH	HPLC-DAD
Ethanethiol	75-08-1	Dual solid sorbent	ATD-GC-MS
Ethyl butyrate	105-54-4	Dual solid sorbent	ATD-GC-MS
Furan (1,4-epoxy-1,3-butadiene)	110-00-9	Dual solid sorbent	ATD-GC-MS
Hydrogen sulphide	7783-06-4	Charcoal	IC
Methanal (formaldehyde)	50-00-0	Silica gel/2,4 DNPH	HPLC-DAD
Methanethiol	74-93-1	Dual solid sorbent	ATD-GC-MS
Styrene	100-42-5	Dual solid sorbent	ATD-GC-MS
Tetrachloromethane	56-23-5	Dual solid sorbent	ATD-GC-MS
Toluene	108-88-3	Dual solid sorbent	ATD-GC-MS
Trichloroethene	79-01-6	Dual solid sorbent	ATD-GC-MS

ATD – automated thermal desorption

GC-MS – gas chromatography and mass spectrometry

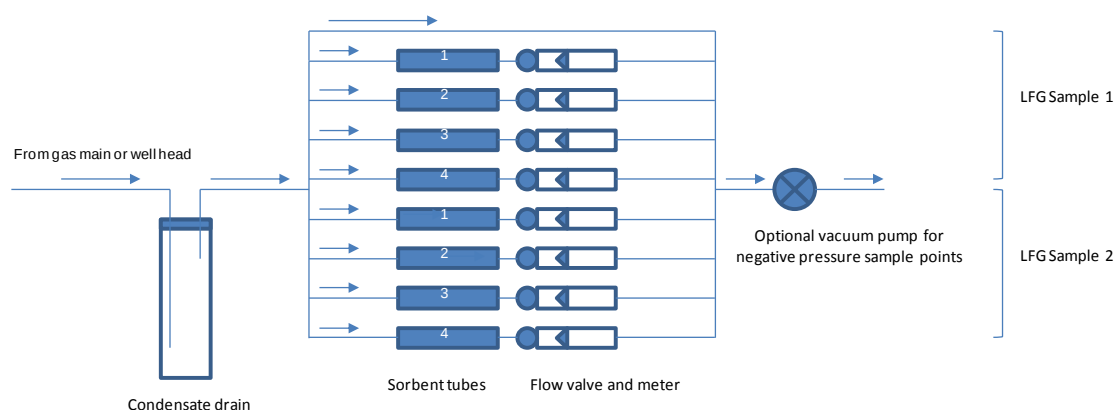
ICP-MS – inductively couple plasma/mass spectrometry

HPLC-DAD – high performance liquid chromatography and diode array detection

IC – ion chromatography

Sampling for all components is undertaken simultaneously using a multiple stream sampler as shown in Figure 1.

Figure 1 Landfill gas sampling arrangement



A sample is taken from either the gas main or well head and passed through a condensate drain to remove excess moisture. The sample gas is then split to pass through a series of eight regulated rotameters arranged in two banks of four. There is also a bypass stream for excess sample. This allows the duplicate simultaneous sampling at regulated flow rates onto four sampling media. The flow rates and sampling duration are set in accordance with LFGTGN04 requirements as summarised in Table 2.

Table 2 Sampling media and analytical methods

Media	Target species	Sampling rate (ml/min)	Sampling duration (min)	Sample volume (l)
Dual solid sorbent (Tenax/Sulficarb)	VOCs	20	10	0.2
Silica gel and 2,4 DNPH (SKC 226-119)	Aldehydes	20	50	1.0
Activated carbon 1 (SKC 226-09)	Arsenic	100	50	5.0
Activated carbon 2 (SKC 226-09)	Hydrogen sulphide	100	50	5.0

In the case of negative pressure sources it is necessary to employ a vacuum pump at the sampler's common outlet. This is not normally required with positive pressure systems

This results in two duplicate samples of landfill gas with each sample comprising the four sub-samples above covering all of the priority trace components within Table 1.

The samples are subject to the analytical procedures described in Table 1 to provide a mass on the collected sample which can then be related to the volume of gas sampled to provide a component concentration in the sampled landfill gas.

The sampling followed internal procedure GAS15 and is accredited under test certificate 1015.

3 Site information

Sample point details			
Date	17 December 2015	Site	Llanddulas landfill site
Ambient temperature	14°C	Atmospheric pressure	100.9 kPa
Monitoring organisation	ESG UKAS 1015	Analytical laboratory	ESG UKAS 1015
Location of sampling point	Gas main to compound After blower	Area of influence of collection system sampled	All
Type of sample point	1/4" Tefen	Temperature of gas	35°C
Pressure at sample point	225 mb	Type of waste	Not recorded
Status of gas system	Active	Age of waste	Not recorded

4 Preliminary checks and field measurements

Parameter	Concentration
Methane %	43
Carbon dioxide %	32
Oxygen %	1.8
Nitrogen (by difference) %	23.2
Hydrogen sulphide ppmv	>150
Carbon monoxide ppmv	<1

*carbon monoxide is measured with a hydrogen sulphide filter in the sampling line.

Preliminary bulk gas measurements were undertaken using a Gasdata LMSxi electrochemical cell analyser (no 1957). Reported measurements are spot readings following gas sampling for a period of 5 minutes.

5 Results of landfill gas analysis

The results of the sampling and analysis are summarised in Table 3 below.

Table 3 Priority trace component measurement results

Parameter	Concentration ($\mu\text{g}/\text{m}^3$,STP)
1 Pentene	<106
1,1-Dichloroethane	<32
1,1-Dichloroethylene	<48
1,2-Dichloroethane	<53
1,2-Dichloroethylene	53
1,3-Butadiene	<37
1,4 epoxy 1,3 butadiene	370
1-Propanethiol	<106
2-butoxyethanol	<106
Benzene	370
Butyric acid	<211
Carbon disulphide	2852
Carbon tetrachloride	<53
Chloroethane	<53
Dichloromethane	<53
Dimethyl disulphide	211
Dimethyl sulphide	317
Ethyl butyrate	<48
Ethyl mercaptan	<158
Methyl mercaptan	<528
N-Butyl mercaptan	<158
Styrene	<53
Toluene	211
Trichloroethylene	<53
Vinyl chloride monomer	<158
Arsenic	40
Hydrogen sulphide	217612
Acetaldehyde	*
Formaldehyde	*

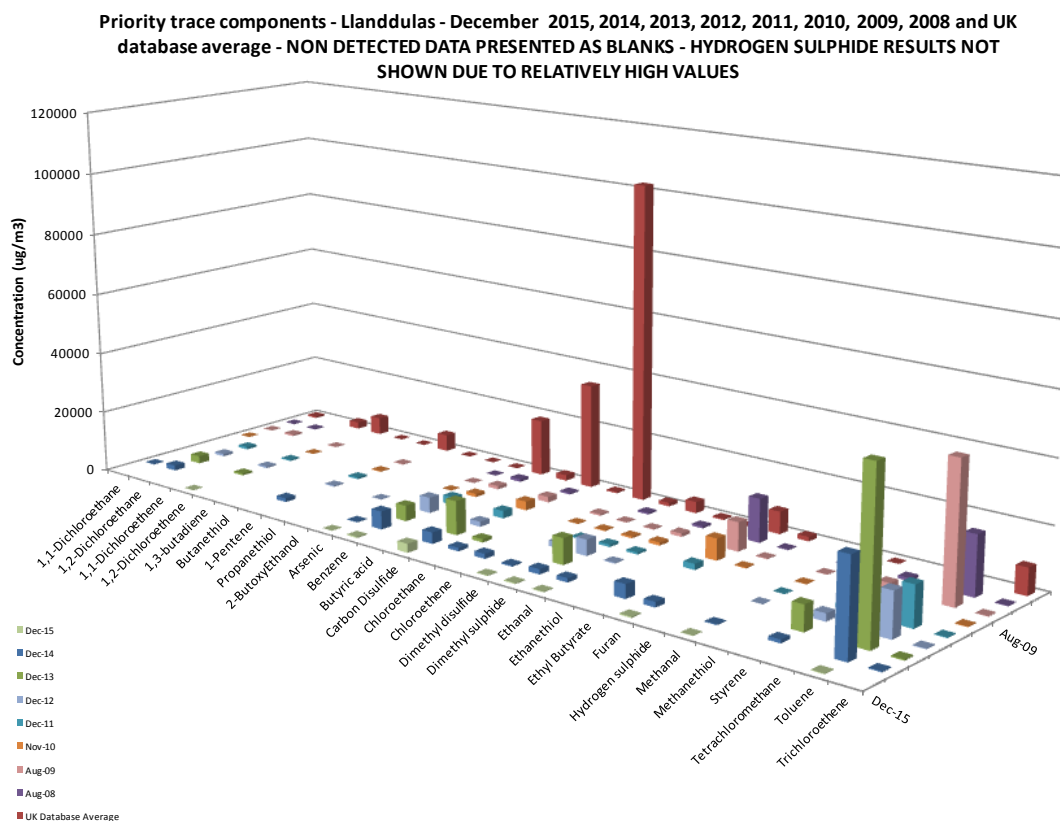
* indicates result is UKAS accredited

< indicates result is below the method limit of detection

The above reported results are the maximum concentrations measured for each parameter in two samples.

The maximum results of the current analyses are compared with historical data and the UK database average in Figure 2.

Figure 2 Historical priority trace component analysis results at Llanddulas



6 NOTES

Sampling of landfill gas was undertaken in accordance with ESG procedure GAS15 and is UKAS accredited under certificate 1015.

Analysis of collected samples was undertaken by ESG's Bretby laboratory. The analytical results which fall within ESG's scope of accreditation under certificate 1015 are identified in Table 3.

The priority component measurements which can be considered to be within the scope of UKAS accreditation are identified in Table 3.

Any interpretations and opinions expressed are outside of the scope of UKAS accreditation.

Contact:

Dr Nick Ford
ESG
Unit D
Bankside Business Park
Cirencester
Gloucestershire
GL7 1YT

T: 07768 257628

E: nick.ford@esg.co.uk



Site: Llanddulas
Permit: BP 3734 XX
Reporting period: 6th February 2015 - 6th February 2016
Test date: 17th December 2015

Engine Emission Data

Engine 1 (A2)	Species	Method description	Measurement uncertainty (+ or - %)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence BS EN 14792	2.9	815	30	1060	571	650
	CO	IR BS EN 15058	3.1	1394	20	1673	1115	1500
	TVOC	FID BS EN 12619	2.8	1263	40	1768	758	1750

Engine 2 (A3)	Species	Method description	Measurement uncertainty (+ or - %)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence BS EN 14792	3.0	641	30	833	449	650
	CO	IR BS EN 15058	3.0	1181	20	1417	945	1500
	TVOC	FID BS EN 12619	2.6	1462	40	2047	877	1750

Engine 3 (A4)	Species	Method description	Measurement uncertainty (+ or - %)	Average measured emission concentration (mg/Nm3)	LFTGN08 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence BS EN 14792	2.9	658	30	855	461	650
	CO	IR BS EN 15058	3.1	1235	20	1482	988	1500
	TVOC	FID BS EN 12619	2.7	1447	40	2026	868	1750

Note 1 All data is expressed as mg/Nm3 at 273K, 101.3kPa, dry gas, corrected to an oxygen content of 5%. Average measured emissions concentration is calculated from data collected over a one hour period.

Note 2 The monitoring and reporting were carried out by ESG, an MCERTS accredited contractor. ESG staff attending: C Briggs Team Leader Level 2 with TE1, TE2, TE3 and TE4. M Derbyshire Technician Level 1.

Note 3 Measurement uncertainty is shown. Overall site uncertainty could not be deduced from available data - maximum uncertainty values set out in LFTGN08 have therefore been applied.

Note 4 Emissions from engines #1 and #3 remained within the overall uncertainty limit for NOx and met the standard for CO and TVOC. Emissions from engines #1 and #3 are therefore 'approach to the limit' and deemed compliant.

Note 5 Emissions from engine #2 are compliant with the standard.

Note 6 Flare #2 (lead flare) has run for more than 10% of the time over the previous 12 months, so the emissions have been tested - see separate sheet.

Site: Llanddulas
Permit: BP 3734 XX
Reporting period: 6th February 2015 - 6th February 2016
Date: 18th December 2015

Flare Emission Data

Flare 2 (A7)	Species	Method description	Measurement uncertainty (+ or - %)	Average measured emission concentration (mg/Nm3)	LFTGN05 overall uncertainty (+ or - %)	Maximum emission including uncertainty (mg/Nm3)	Minimum emission including uncertainty (mg/Nm3)	Permit emission standard (mg/Nm3)
	NOx	Chemiluminescence BS EN 14792	4.9	82.0	30	106.6	57.4	150
	CO	IR BS EN 15058	400	1.0	20	1.2	0.8	50
	TVOC	FID BS EN 12619	200	1.0	40	1.4	0.6	10

Note 1 All data is expressed as mg/Nm3 at 273K, 101.3kPa, dry gas, corrected to an oxygen content of 3%. Average measured emissions concentration is calculated from data collected over a one hour period.

Note 2 The monitoring and reporting were carried out by ESG, an MCERTS accredited contractor. ESG staff attending: C Briggs Team Leader Level 2 with TE1, TE2, TE3 and TE4. M Derbyshire Technician Level 1.

Note 3 Measurement uncertainty is shown. Overall site uncertainty could not be deduced from available data - maximum uncertainty values set out in LFTGN05 have therefore been applied.

Note 4 The emissions have been monitored in line with the EA interim guidance. Emissions have been sampled from a single location via a port towards the top of the flare.

Note 5 Over the past 12 months, flare #2 (which is the lead flare) has run for more than 10% of the time - emissions testing was therefore required.

Note 6 Flare #2 emissions are compliant with the standard.

Llanddulas flare hours			
Date	Flare 1 counter reading	Flare 2 counter reading	
29/09/14	1,466	8,860	
28/09/15	2,012	10,079	
	546	1,219	totals
	6.2%	14.0%	run

APPENDIX 2

Surface Emissions/Flux Box Survey

Phase 2 Surface Emissions Survey Report

Llanddulas Landfill Site

September 2014

Approval Sheet

Customer: FCC Environment

Site: Llanddulas Landfill Site

Project title: Phase 2 Surface Emissions Survey

Project Manager: S. Dean

Project Staff: P. Jones, V. Sanders

Address: enifial
Enterprise Drive
Four Ashes
Wolverhampton
WV10 7DE

Tel: 01902 798798

Fax: 01902 798711

Issue	Status	Date	Prepared By	Signature	Date
2	Final	08/07/15	V. Sanders	V. Sanders	08/11/15
			Approved By	Signature	Date
			S. Dean		08/07/15

Foreword

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

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

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

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

Contents

<i>Approval Sheet, Foreword and Contents</i>	<i>2-4</i>
1. Introduction	5
2. Survey Summary	
2.1 Phase 2 Surface Emissions Survey	6
3. Results Summary	
3.1 Phase 2 Surface Emissions Survey Results	7
3.2 Notes on Calculation of Flux and Average Q Values	8
4. Field Log	
4.1 Weather Conditions and Meteorological Data	9
4.2 Site Personnel and Equipment	9

Appendix

- A. Phase 2 Surface Emissions Survey Results
- B. Phase 2 Surface Emissions Survey Plan

1.0 Introduction

enital were commissioned by FCC Environment to undertake a Surface Emissions Phase 2 (Flux box) Survey at their Llanddulas Landfill Site in September 2014. Llanddulas Landfill Site is located on the north coast of Wales, approximately 10 miles West of Rhyl. The site is currently operational and accepting waste inputs. Parts of the site have been permanently capped and restored or temporarily capped.

A desktop study was undertaken prior to the Phase 2 Surface Emissions Survey by collecting information supplied by FCC in the form of drawings of capping areas, up to date topography and information regarding capping type and gas extraction / leachate infrastructure details. Five zones were identified as requiring Surface Emissions Phase 2 testing: Zone 1, 2 and 3 comprising of permanent welded membrane capping with restored grasslands and Zone 4 and 5 comprising of temporary capping.

2.0 Survey Summary

2.1 Phase 2 Surface Emissions Survey

The Phase 2 Surface Emissions Survey was undertaken on the 22nd, 23rd, 24th, 25th, 26th, 29th, 30th September 2014 and included the areas of the landfill site as indicated on the plan contained in Appendix B. Further tests were undertaken in April 2015 due to data anomalies encountered in the initial testing. A Gas-Tec Flame Ionisation Detector (FID) device was used to undertake the survey which measures hydrocarbons in parts per million by volume (ppmv) on a scale of 0 to 10,000.

The required number of test locations was calculated during the desktop study as detailed in the Environment Agency Guidance on Monitoring Landfill Gas Surface Emissions LFTGN 07 – September 2004 (EA Guidance). Co-ordinates were generated for each test and each location was set out by the use of a handheld GPS with a typical accuracy of up to 3m. Where a test location was not accessible or unsuitable, the nearest practical location was used and the revised co-ordinates recorded. The flux box used was constructed as detailed in the EA Guidance, consisting of a white plasterer's bath with a quick release monitoring point connected to internal t-bar tubing. An activated carbon filter and balancing valve was fitted opposite to the monitoring point. Where required, each location was cleared of vegetation and / or levelled using hand tools prior to the test being undertaken. The flux box was then placed onto the surface and adequately sealed in addition to placing a weight on top of the flux box. Each location was tested for a duration of 15 minutes by connecting the Gas-Tec FID to the flux box with any concentration increases recorded at 30 second intervals during the first 5 minutes and at 60 seconds for the remainder of the test period. Where it became evident that an adequate seal was not present due to fluctuating readings, the flux box was resealed and the test restarted.

3.0 Results Summary

3.1 Phase 2 Surface Emissions Survey Results

A full set of Phase 2 Surface Emissions Survey results are presented in Appendix A along with a plan showing the location of each test in Appendix B.

The EA Guidance sets standards for gas emissions from a landfill surface which is expressed as the average flux of methane from the surface of the cap in each zone. The relevant emission standards are:

Permanently capped zone: 0.001 mg/m²/second;

Temporarily capped zone: 0.1 mg/m²/second

As can be seen from the table below, the average flux of methane from the surface of the cap in zone 4 and zone 5 is within the EA standards detailed above.

Zone	Capping Type	EA Standard for Capping Type (mg/m ² /sec)	Average Q Value for Zone (mg/m ² /sec)	Within EA Standard (Y/N)
1	Permanent	0.001	0.00161	N
2	Permanent	0.001	0.00133	N
3	Permanent	0.001	0.00202	N
4	Temporary	0.1	0.00072	Y
5	Temporary	0.1	0.00027	Y

Zone 1, 2 and 3 only just exceeded the EA standards for Permanent capping. When removing locations Z1/32, Z1/35; Z2/19; Z3/02, Z3/07, Z3/11 from the respective calculations each zone would meet the standard.

3.2 Notes on Calculation of Flux and Average Q Values

Data points used in the calculation of the Q values are shown as highlighted yellow in the tables presented in Appendix A. The concentration change is converted into mg/m³ by multiplying the ppmv value by 0.714 (source - EA Guidance). The volume of the flux box used is 0.16m³ with a basal area of 0.65m².

For the data to be considered acceptable, a correlation co-efficient of $r^2 > 0.8$ is required. If required, data points are removed (first from the last data collected and then initial readings as detailed in Section 7.2 of the EA Guidance), following data removal, as soon as the r^2 value is > 0.8 and more than 5 data points remain, the data is considered acceptable.

Where no elevated readings are detected (or the change in concentration is zero, or a negative change in concentration is recorded at locations when an initial zero reading cannot be attained due to elevated background readings), the location is reported as being less than the lower detection limit value of 5×10^{-5} mg/m²/second for the flux box used (<LOD).

Where data is 'at the limit of detection' of the flux box used, i.e. the r^2 value of > 0.8 could not be attained following data point removal, the data with the highest r^2 value or most representative data is used, subject to the possibility of retesting the location depending on the overall / average Q value for that zone, i.e. if the emission rate for that location is not likely to significantly affect the overall average Q value of the zone then retesting is not deemed necessary.

4.0 Field Log

4.1 Weather Conditions and Meteorological Data

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

Date and Time		Weather Conditions	Ground Conditions	Temp (°C)	Atm (mbar)	Wind Speed (mph)	Wind Direction
Start:	22.09.14 AM	sunny	dry	17.0	1019.0	5	NW
Finish:	22.09.14 PM	sunny	dry	20.0	1020.0	4	SW
Start:	23.09.14 AM	overcast	dry	14.0	1018.0	7	NE
Finish:	23.09.14 PM	overcast	dry	15.0	1017.0	7	NW
Start:	23.09.14 AM	overcast	wet	12.0	1020.0	8	NW
Finish:	23.09.14 PM	overcast	dry	15.0	1017.0	17	ESE
Start:	24.09.14 AM	overcast	dry	1.0	1016.0	10	SSW
Start:	29.09.14 AM	sunny	dry	14.0	1020.0	4	ESE
Finish:	29.09.14 PM	overcast	dry	16.0	1019.0	5	ENE
Start:	30.09.14 AM	sunny	dry	15.0	1020.0	9	SSW
Finish:	30.09.14 PM	sunny	dry	18.0	1019.0	12	NW
Start:	22.04.15 AM	sunny	dry	15.0	1020.0	9	SSW
Finish:	22.04.15 PM	sunny	dry	18.0	1019.0	12	NW
Start:	23.04.15 AM	sunny	dry	15.0	1020.0	9	SSW
Finish:	23.04.15 PM	sunny	dry	18.0	1019.0	12	NW

4.2 Site Personnel and Equipment

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

Date	Personnel	Instrument Type	Instrument Serial Number	Calibration Due	Calibration Check (100ppm)	Flux Box Reference
25-26.09.14	P Jones	FID	8258	12.11.14	N/A	3
22-30.09.14	J. Forster	FID	12	08.03.15	N/A	1
22-23.04.14	J Crawford	FID	8217	09.07.15	N/A	3

Appendix A

Phase 2 Surface Emissions Survey Results

ID	Date	Location		Concentration in mg/m³ over time in seconds																				Linear Regression		V/A (V = 0.16m³, A = 0.65m²)	Flux (Q) in mg/m²/second d (Q = V/A x (dc/dt))	Comments	
		E	N	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840	900	r² value				dc/dt
Z1/01	22.04.15	290092	377928	0.0	0.0	0.0	0.7	1.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.808	0.009	0.246	0.00218	r2 > 0.8	
Z1/02	22.09.14	290112	377888	2.1	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)	
Z1/03	22.04.15	290152	377888	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)	
Z1/04	22.09.14	290192	377888	2.1	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.500	0.005	0.246	0.00117	At limit of detection *	
Z1/05	22.04.15	290132	377848	0.0	0.7	0.7	0.7	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	14.3	0.785	0.004	0.246	0.00101	At limit of detection *		
Z1/06	22.09.14	290172	377848	12.1	12.1	12.1	12.1	12.1	11.4	11.4	11.4	11.4	11.4	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)	
Z1/07	22.09.14	290212	377848	13.6	13.6	12.1	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.0	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/08	22.04.15	290252	377848	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	0.00000	Below limit of detection	
Z1/09	22.04.15	290157	377808	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	14.3	0.750	0.007	0.246	0.00176	At limit of detection *		
Z1/10	22.04.15	290192	377808	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.0	0.7	0.7	0.7	0.7	0.0	0.7	0.7	0.7	0.7	0.771	0.006	0.246	0.00151	At limit of detection *
Z1/11	22.04.15	290232	377808	0.7	0.7	1.4	0.7	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.750	0.007	0.246	0.00176	At limit of detection *	
Z1/12	23.09.14	290272	377808	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/13	23.09.14	290312	377808	12.9	10.7	9.3	9.3	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/14	23.09.14	290212	377768	10.7	9.3	8.6	8.6	8.6	8.6	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/15	23.09.14	290252	377768	13.6	12.9	10.7	10.0	10.0	9.3	9.3	9.3	9.3	9.3	8.6	8.6	7.1	7.1	7.1	7.1	7.1	7.1	7.1	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/16	23.09.14	290292	377768	12.9	10.7	7.9	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	6.4	6.4	6.4	6.4	6.4	6.4	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/17	23.09.14	290332	377768	12.9	10.0	9.3	8.6	8.6	7.9	7.9	7.9	7.9	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/18	23.09.14	290372	377768	10.0	8.6	8.6	7.9	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/19	22.04.15	290252	377728	0.7	1.4	1.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.840	0.010	0.246	0.00234	r2 > 0.8		
Z1/20	22.04.15	290292	377728	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)		
Z1/21	22.04.15	290332	377728	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.771	0.006	0.246	0.00151	At limit of detection *		
Z1/22	22.04.15	290372	377728	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	0.00000	Below limit of detection	
Z1/23	23.09.14	290412	377728	10.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	8.6	8.6	8.6	8.6	8.6	8.6	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/24	23.09.14	290452	377728	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/25	24.09.14	290212	377688	10.7	10.7	10.7	10.7	10.7	10.7	10.7	12.1	13.6	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	14.3	0.801	0.012	0.246	0.00287	r2 > 0.8		
Z1/26	24.09.14	290252	377688	2.9	2.9	2.9	2.9	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	8.6	0.7	0.500	0.024	0.246	0.00586	At limit of detection *			
Z1/27	24.09.14	290292	377688	2.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/28	24.09.14	290332	377688	2.1	2.1	2.1	2.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/29	24.09.14	290372	377688	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/30	24.09.14	290412	377688	2.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/31	22.04.15	290452	377688	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.771	0.006	0.246	0.00151	At limit of detection *		
Z1/32	25.09.14	290492	377688	9.3	7.1	4.3	1.4	3.6	3.6	4.3	11.4	14.3	17.1	14.3	12.9	8.6	11.4	7.9	2.9	2.9	2.1	2.1	0.869	0.078	0.246	0.01925	r2 > 0.8		
Z1/33	25.09.14	290232	377648	3.6	2.1	2.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.000	0.000	0.246	0.00000	0.00000	0.00000	No concentration increase (<LOD)	
Z1/34	22.04.15	290272	377648	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.500	0.010	0.246	0.00234	At limit of detection *		
Z1/35	25.09.14	290312	377648	4.3	4.3	3.6	3.6	3.6	5.0	14.3	14.3	17.9	17.9	14.3	10.7	5.0	4.3	2.9	2.9	2.9	3.6	2.9	0.824	0.072	0.246	0.01767	r2 > 0.8		
Z1/36	23.09.14	290352	377648	2.1	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/37	23.09.14	290392	377648	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	0.00000	Below limit of detection	
Z1/38	22.04.15	290432	377648	0.7	0.7	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.771	0.006	0.246	0.00151	At limit of detection *		
Z1/39	22.04.15	290472	377648	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/40	22.04.15	290232	377608	0.0	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.813	0.007	0.246	0.00160	r2 > 0.8		
Z1/41	25.09.14	290272	377608	2.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/42	25.09.14	290312	377608	4.3	3.6	2.9	2.9	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	N/A	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/43	25.09.14	290352	377608	5.7	5.0	4.3	5.0	5.0	5.0	6.4	6.4	7.1	8.6	10.7	2.9	4.3	4.3	3.6	2.9	2.9	3.6	2.9	0.802	0.020	0.246	0.00486	r2 > 0.8		
Z1/44	22.04.15	290392	377608	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	0.00000	No concentration increase (<LOD)	
Z1/45	22.04.15	290432	377608	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.000	0.000	0.246	0.00000	0.00000	0.00000	No concentration increase (<LOD)
Z1/46	22.04.15	290252	377568	0.7	0.7	0.7	0.7	4.3	2.9	3.6	5.0	6.4	4.3	5.0	5.7	6.4	7.9	10.0	11.4	10.0	10.7	12.9	0.916	0.014	0.246	0.00341	r2 > 0		

ID	Date	Location		Concentration in mg/m ³ over time in seconds																				Linear Regression r ² value	V/A (V = 0.16m ³ , A = 0.65m ²) dc/dt	Flux (Q) in mg/m ² /secon d (Q = V/A x (dc/dt))	Comments		
				E	N	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720					780	840
Z1/47	22.04.15	290292	377568	1.4	1.4	1.4	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.771	0.006	0.246	0.00151	At limit of detection *

Co-ordinates shown in blue denote monitoring point moved from original design GPS co-ordinates to nearest suitable location

Zone 1 (Permanent Cap) Average Q Value **0.00161** mg / m² / second

*Refer to notes on Linear Regression Calculations and Final Q Values and:

Where data is 'at the limit of detection' of the flux box used, i.e. the r² value of >0.8 could not be attained following data point removal, the data with the highest r² value or data that is considered most representative of the overall test is used following assessment of such data

ID	Date	Location		Concentration in mg/m³ over time in seconds																				Linear Regression		V/A (V = 0.16m³, A = 0.65m²)	Flux (Q) in mg/m²/second d (Q = V/A x (dc/dt))	Comments	
		E	N	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840	900	r² value				dc/dt
Z2/01	25.09.14	290440	377584	4.3	3.6	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/02	25.09.14	290470	377584	3.6	3.6	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/03	25.09.14	290500	377584	3.6	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/04	29.09.14	290443	377554	7.9	7.1	6.4	6.4	6.4	5.7	5.7	5.7	5.7	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/05	29.09.14	290470	377554	4.3	4.3	4.3	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/06	23.04.15	290500	377554	1.4	1.4	1.4	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.500	0.005	0.246	0.00117	At limit of detection *
Z2/07	29.09.14	290470	377524	12.1	11.4	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	N/A	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/08	29.09.14	290500	377524	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/09	29.09.14	290470	377494	11.4	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/10	23.04.15	290500	377494	1.4	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	0.500	0.010	0.246	0.00234	At limit of detection *
Z2/11	29.09.14	290530	377494	12.9	12.1	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/12	29.09.14	290500	377464	13.6	13.6	12.9	12.1	12.1	12.9	12.1	12.1	12.1	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	11.4	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/13	29.09.14	290530	377464	14.3	12.1	11.4	11.4	11.4	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/14	23.04.15	290500	377434	0.7	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.500	0.005	0.246	0.00117	At limit of detection *
Z2/15	29.09.14	290530	377434	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.3	9.3	9.3	9.3	9.3	9.3	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/16	29.09.14	290500	377404	10.7	10.7	10.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/17	29.09.14	290530	377404	10.0	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/18	23.04.15	290410	377374	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.750	0.007	0.246	0.00176	At limit of detection *
Z2/19	30.09.14	290440	377374	21.4	28.6	21.4	27.8	32.1	29.3	37.8	30.7	21.4	20.7	18.6	20.0	13.6	14.3	30.0	16.4	18.6	22.8	21.4	15.7	17.9	0.814	0.114	0.246	0.02812	r2 > 0.8
Z2/20	29.09.14	290470	377374	14.3	13.6	12.1	11.4	11.4	11.4	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/21	29.09.14	290500	377374	14.3	12.9	12.1	12.1	11.4	11.4	10.7	10.7	10.0	10.0	10.0	10.0	10.0	10.0	10.0	9.3	9.3	9.3	9.3	9.3	9.3	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/25	23.04.15	290380	377344	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z2/26	23.04.15	290410	377344	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.805	0.005	0.246	0.00117	r2 > 0.8
Z2/27	30.09.14	290440	377344	12.1	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	10.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/28	23.04.15	290470	377347	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.771	0.006	0.246	0.00151	At limit of detection *
Z2/29	23.04.15	290260	377314	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.000	0.000	0.246	0.00000	No concentration increase (<LOD)
Z2/30	23.04.15	290290	377314	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z2/31	23.04.15	290320	377314	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	No concentration increase (<LOD)

Co-ordinates shown in blue denote monitoring point moved from original design GPS co-ordinates to nearest suitable location

*Refer to notes on Linear Regression Calculations and Final Q Values and:

Where data is 'at the limit of detection' of the flux box used, i.e. the r2 value of >0.8 could not be attained following data point removal, the data with the highest r2 value or data that is considered most representative of the overall test is used following assessment of such data

Zone 2 (Permanent Cap) Average Q Value **0.00133** mg / m² / second

ID	Date	Location		Concentration in mg/m³ over time in seconds																				Linear		V/A (V = 0.16m³, A = 0.65m²)	Flux (Q) in mg/m²/second d (Q = V/A x (dc/dt))	Comments	
				E	N	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840				900
Z4/01	14.11.14	290401	377579	1.4	1.4	0.7	2.1	0.0	0.0	2.9	8.6	1.4	1.4	2.1	1.4	0.0	0.0	0.0	1.4	4.3	1.4	2.1	2.1	2.1	0.721	0.017	0.246	0.00410	At limit of detection *
Z4/02	15.11.14	290429	377579	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/03	14.11.14	290373	377547	4.3	8.6	5.7	1.4	12.9	1.4	1.4	0.7	1.4	0.0	0.0	2.9	1.4	0.7	7.1	0.0	1.4	4.3	2.9	2.9	2.9	0.524	0.019	0.246	0.00464	At limit of detection *
Z4/04	23.04.15	290401	377551	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.750	0.007	0.246	0.00176	At limit of detection *
Z4/05	15.11.14	290429	377551	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/06	14.11.14	290345	377523	6.4	12.9	5.0	5.7	14.3	21.4	17.9	12.9	10.7	15.7	8.6	10.7	22.8	10.7	12.9	28.6	8.6	10.7	12.9	15.7	14.3	0.837	0.027	0.246	0.00674	r2 > 0.8
Z4/07	14.11.14	290373	377523	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.750	0.007	0.246	0.00176	At limit of detection *
Z4/08	14.11.14	290401	377523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/09	15.11.14	290429	377523	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/10	15.11.14	290429	377495	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/11	15.11.14	290457	377495	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/12	14.11.14	290429	377467	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/13	14.11.14	290457	377467	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/14	14.11.14	290429	377439	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/15	14.11.14	290457	377439	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.750	0.007	0.246	0.00176	At limit of detection *
Z4/16	18.11.14	290307	377404	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/17	14.11.14	290345	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/18	14.11.14	290373	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/19	14.11.14	290401	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/20	14.11.14	290429	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/21	15.11.14	290457	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/22	15.11.14	290483	377411	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/23	18.11.14	290289	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/24	18.11.14	290317	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/25	18.11.14	290345	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/26	14.11.14	290373	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/27	14.11.14	290401	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/28	23.04.15	290484	377383	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z4/29	18.11.14	290289	377355	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection

Co-ordinates shown in blue denote monitoring point moved from original design GPS co-ordinates to nearest suitable location

*Refer to notes on Linear Regression Calculations and Final Q Values and:

Where data is 'at the limit of detection' of the flux box used, i.e. the r2 value of >0.8 could not be attained following data point removal, the data with the highest r2 value or data that is considered most representative of the overall test is used following assessment of such data

Zone 4 (Temporary Cap) Average Q Value **0.00072** mg / m² / second

ID	Date	Location		Concentration in mg/m³ over time in seconds																				Linear Regression		V/A (V = 0.16m³, A = 0.65m²)	Flux (Q) in mg/m²/second d (Q = V/A x (dc/dt))	Comments		
				E	N	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840				900	r² value
Z5/01	18.11.14	290224	377425	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	1.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.827	0.005	0.246	0.00118	r2 > 0.8
Z5/02	23.04.15	290242	377425	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/03	18.11.14	290224	377407	5.7	6.4	7.9	13.6	13.6	13.6	13.6	12.9	13.6	10.7	7.9	7.9	7.1	7.9	8.6	9.3	9.3	10.0	10.0	10.0	10.0	10.0	0.846	0.005	0.246	0.00122	r2 > 0.8
Z5/04	23.04.15	290242	377407	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/05	18.11.14	290224	377389	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/06	18.11.14	290242	377389	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/07	18.11.14	290242	377371	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/08	18.11.14	290242	377353	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection
Z5/09	18.11.14	290242	377335	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	Below limit of detection

Co-ordinates shown in blue denote monitoring point moved from original design GPS co-ordinates to nearest suitable location

*Refer to notes on Linear Regression Calculations and Final Q Values and:

Where data is 'at the limit of detection' of the flux box used, i.e. the r2 value of >0.8 could not be attained following data point removal, the data with the highest r2 value or data that is considered most representative of the overall test is used following assessment of such data

Zone 5 (Temporary Cap) Average Q Value **0.00027** mg / m² / second

Appendix B

Phase 2 Surface Emissions Survey Plans

DRAWING

