Ruabon (Gardden Lodge) Landfill Site
Near Wrexham, Denbighshire, North Wales

Site Licences WMBC/L50 & WMBC/L82

ANNUAL ENVIRONMENTAL MONITORING REPORT

1st April 2014 – 31st March 2015

Environment

June 2015



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1.0 INTRODUCTION

FCC Environment (FCC) has undertaken a review of the environmental monitoring data for Ruabon Landfill site (Gardden Lodge) near Wrexham, Denbighshire, North Wales. Historically, annual reviews have been submitted at varying frequencies, with agreement of the Regulator. The site Working Plan which forms part of the Waste Management Licence (EAWML37014 Ref: WMBC/L50) contains Condition 2.4 which states the following:

"An annual interpretative report of all post closure monitoring results, incorporating the results and a description of the trends in the results of the monitoring will be forwarded to the Environment Agency within two months of the period end, commencing year end March 2002."

On 18th November 2013, Natural Resources Wales agreed via email to the submission of this Annual Monitoring Review by 30th June each year.

The waste management licence EAWML37109, ref:WMBCL/82 issued on 6th July 1994 is also relevant to the landfill site and relates to the extension of the site (cells 10 and 11).

The data reviewed within this report was collected during the period 1st April 2014 to 31st March 2015. This review comprises a factual report of the monitoring data and where no trigger limits are specified within the site documentation, interpretation will be assessed against known standards such as UK DWS and EQS. Appropriate recommendations and conclusions are presented in Section 6.0.

2.0 LANDFILL GAS REVIEW

2.1 Introduction

Routine landfill perimeter borehole gas monitoring was scheduled to be carried out on a weekly basis at 48 boreholes and 33 gas probes installed around the perimeter of the site. Methane, Carbon Dioxide, Oxygen, Carbon Monoxide, relative pressure and atmospheric pressure were all recorded. Condition J29 of the WML modification (1995) requires that reported data be reviewed against specific trigger limits for perimeter boreholes contained in annex B of the Working Plan.

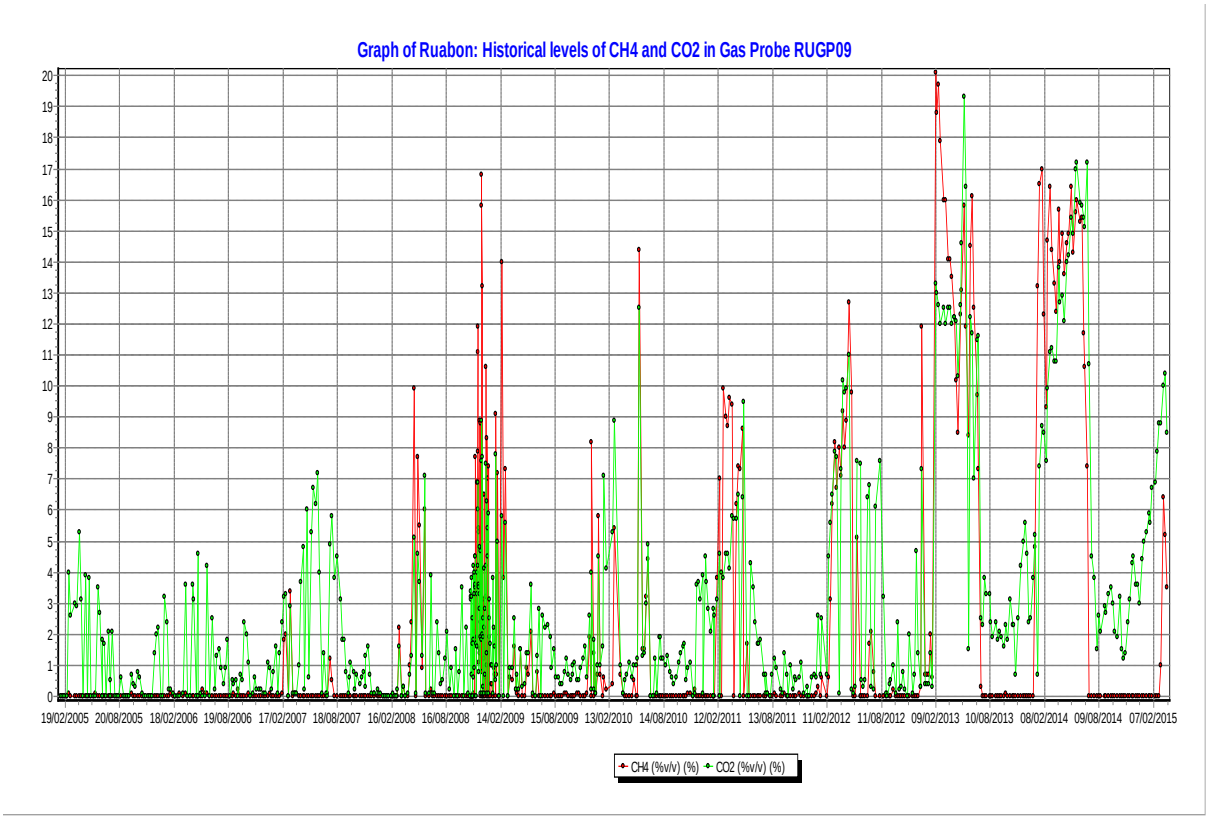
2.2 Off-Waste Landfill Gas Data

A review of the off-site landfill gas monitoring data indicates the following:

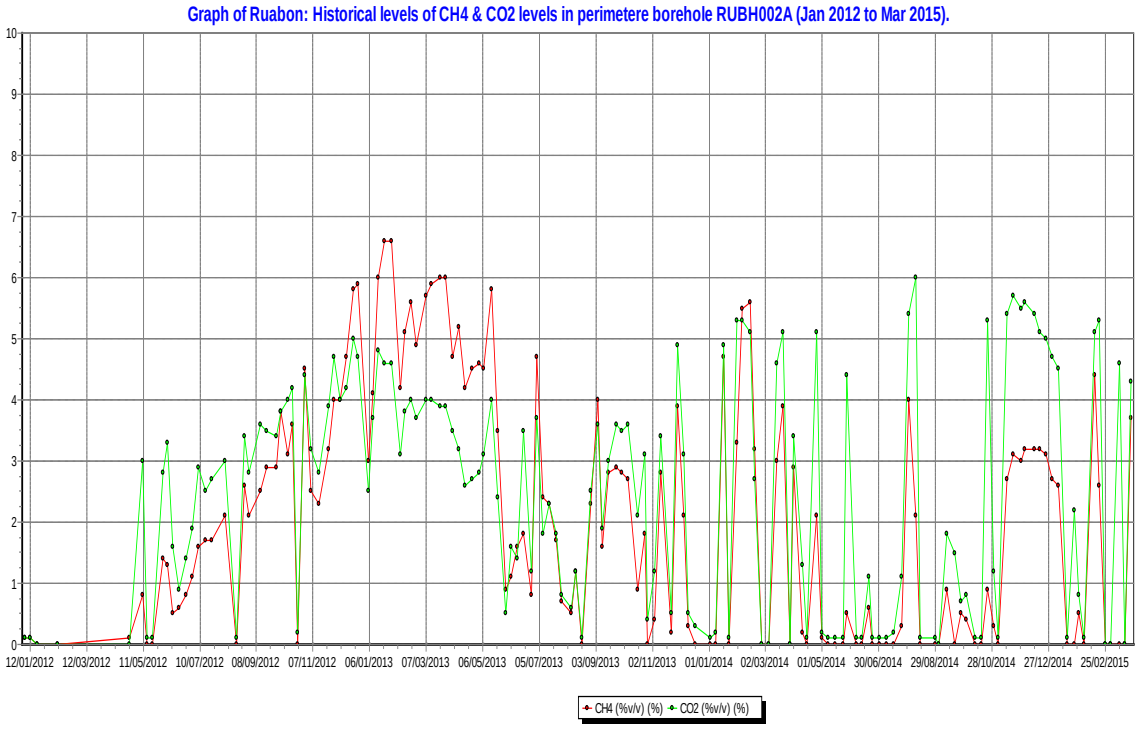
Methane

- Of the 3895 gas readings recorded in all perimeter infrastructure monitored during the review period the trigger limit for methane of 1.0%(v/v) was breached on 154 occasions which amounts to 4% of all readings.

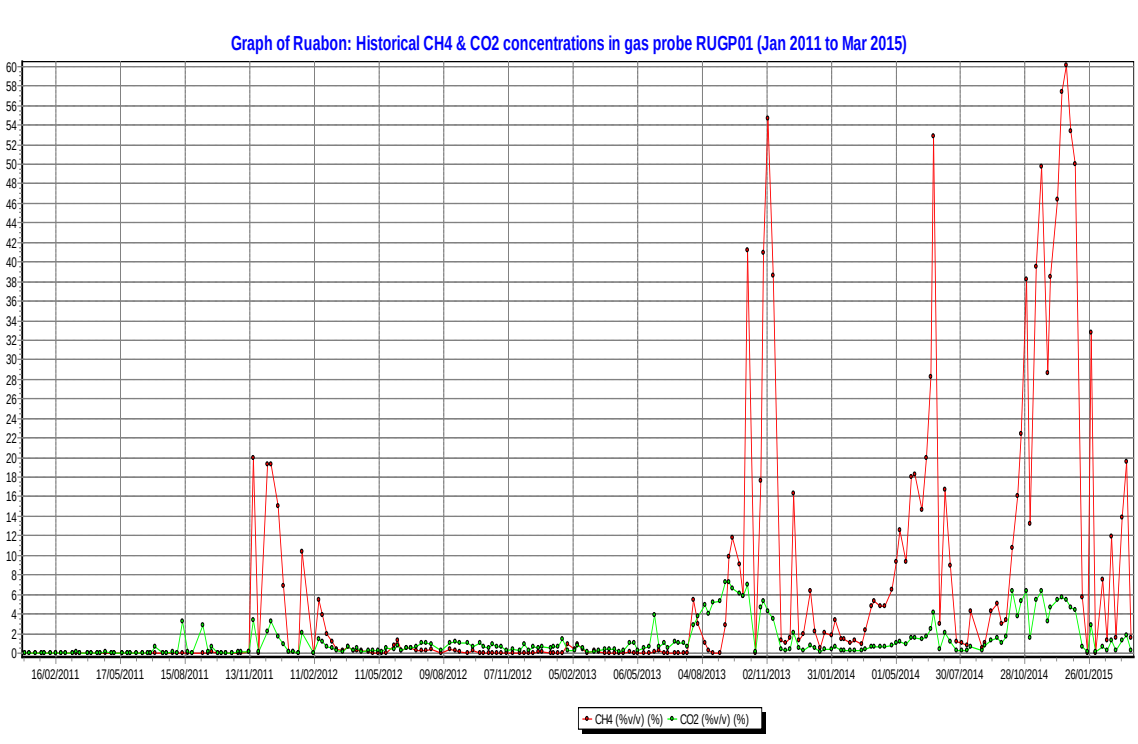
- Breaches of the 1.0%(v/v) methane trigger level were recorded on 16 occasions (21 fewer than in 2014) in gas probe GP09 during the review period. The maximum concentration recorded was 16.4%(v/v) on 7th May 2014, with an average concentration during the reporting period of 3.9%(v/v).
  Seasonal elevated concentrations of methane have been evident in this monitoring point for over a decade (see graph below) and have historically been attributed to its close proximity to a low pressure Transco cast iron gas pipeline, which traverses the site in very close proximity to GP09. The location of the pipeline in relation to borehole BH2A and gas probes 1 and 9 can be seen on the site services plan (appended).



Borehole **BH02A** breached the flammable gas trigger level on 15 occasions (32 fewer than in 2014) with an average concentration during the year of 1.0%(v/v) and a peak reading of 4.4%(v/v) in February 2015. Borehole BH2A is installed at a similar shallow depth to GP9 above and again is in the vicinity of the gas pipeline. No methane has been detected (during the previous 4 years) in the deeper borehole BH2B, at the same location.



- Gas probe **GP01** recorded 47 breaches of the methane trigger level with an average concentration of 17.5%(v/v) (see graph below – last 4 years data).

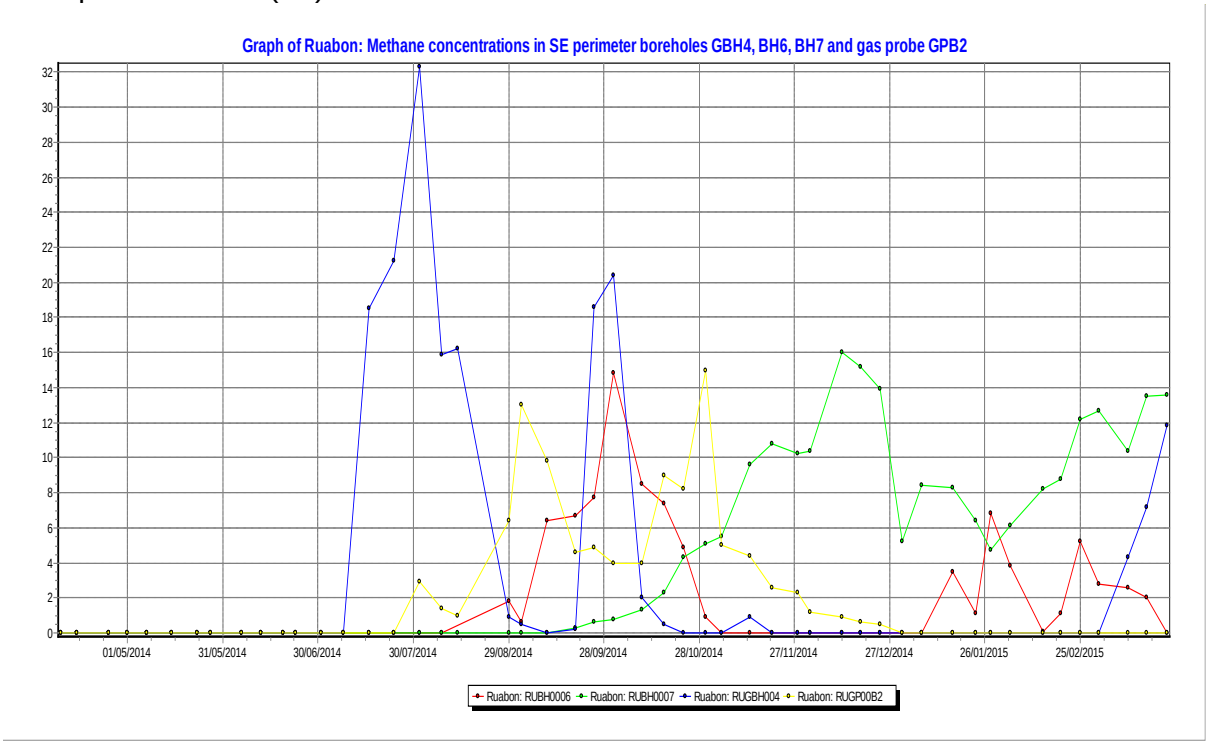


- Breaches of the 1.0%(v/v) methane trigger level were recorded on 25 occasions in borehole BH7 during the review period. The maximum concentration recorded was 16.0%(v/v) on 12th December 2014, with an average concentration during the reporting period of 4.5%(v/v).

- Breaches of the 1.0%(v/v) methane trigger level were recorded on 17 occasions in borehole BH6 during the review period. The maximum concentration recorded was 14.8%(v/v) on 7th May 2014, with an average concentration during the reporting period of 1.8%(v/v).

- Breaches of the 1.0%(v/v) methane trigger level were recorded on 11 occasions in borehole GBH4 during the review period. The maximum concentration recorded was 32.3% on 1st August 2014, with an average concentration during the reporting period of 3.4%(v/v).

- Breaches of the 1.0%(v/v) methane trigger level were recorded on 17 occasions in gas probe GPB2 during the review period. The maximum concentration recorded was 15.0%(v/v) on 30th October 2014, with an average concentration during the reporting period of 2.0%(v/v).



There was also single of breaches in boreholes GBH6 (2.5%), GBH3 (6.6%) and gas probe GPA2 (2.3%) with 4 other breaches of the methane trigger level in borehole GBH5 with a concentration of between 1.1 to 2.3%v/v and a one off value of 32.2%v/v recorded on 17/10/14.

Additional gas wells and shallower pin wells have been installed to attempt to draw the migrating gas back in to site from the boreholes in the SE of the site. Pumps have been installed in gas wells in the SE corner of the site to remove liquid and enhance gas extraction. Our gas contractors continually manage the gas field have responded to this gas migration event by carrying out increased field balancing of gas wells adjacent to the breaching boreholes. Due to the actions above, at the time of writing this report, of the 8 perimeter monitoring points which have breached 1% methane, only BH7 is now being reported above the trigger limit.

Carbon Dioxide

- The revised trigger levels for Carbon Dioxide agreed in 2010 have been used when reviewing data for this report.

There were 3896 Carbon Dioxide readings recorded during 2014. The trigger level was exceeded 891 times in total, on 550 occasions in 25 boreholes and on 341 occasions in 12 gas probes during the review period, with a maximum concentration of 17.2%(v/v) recorded in gas probe GP9 on both the 27th May and 1st July 2014

To summarise, the review of data collected from perimeter gas boreholes generally shows a minimal number of breaches and therefore a low environmental impact. Historical landfilling and other activities carried out at the locality, such as coal mining and colliery spoil tipping may have contributed to elevated concentrations of both Methane and Carbon Dioxide, present in localised soils and strata, which must be considered when interpreting data for potential migration from the licensed landfilling activities.

2.3 In-Waste Landfill Gas Data

There are 72 vertical gas wells on site (5 additional wells were drilled in March 2015) from which 1424 landfill gas readings were taken during the review period.

Average suction across the gas field was -14.3mb with an average methane concentration of 41.6%v/v (0.8% less than the previous 12 month period) and an average oxygen content at 2.7%. There were two readings of Carbon Monoxide greater than 100ppm recorded in gas wells RUAGW21 at 395ppm (in Sept 2014) and RUAGW26r at 177ppm (4th March 2015) Hydrogen Sulphide levels are generally low with no readings in excess of 50ppm. The elevated level of CO in GW21 was not repeated in subsequent months and more recently CO levels in this gas well have been in single figures or zero. By the end of the March Carbon Monoxide concentration in GW26r was recorded at 1ppm.

Gas control on site is provided by one gas engine with a capacity of 1Mw electricity output, with a standby flare of 1,500m3 capacity – see table below of gas data from the engine.

Table 1: Gas Engine Data (Average) April 2014 to March 2015

Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (%v/v)	Balance Gas (%)	Vacuum (mbar)	Flow (m3/h)	Engine Output (kW)
44.1	29.8	1.2	24.9	-46.7	179	321

Comparing the engine data to 2013, methane (2.4%) and carbon dioxide (1.4%) have both decreased with an increase in oxygen by 0.1% and balance gas (by 0.7%). Average vacuum decreased by 0.7mb and there was a small increase in flow by 9m3/h.

2.4 Surface Emissions

A survey was undertaken in July 2014 to assess the site for gaseous fugitive surface emissions via flux box testing.
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;

As can be seen from the table below, the average flux of methane from the surface of the cap was within the EA standards detailed above.

Capping Type	EA Standard for Capping Type (mg/m/sec)	Average Q Value for Zone (mg/m/sec)	Within EA Standard (Y/N)
Permanent	0.001	0.00069	Y

The surface emissions report, referred to above is appended at the end of this Annual review.

3.0 GROUNDWATER REVIEW

3.1 Introduction

The geological setting of the site consists of the underlying impermeable Ruabon Marl. Cells 1 to 7 reportedly have no basal drainage system or basal drainage layer medium such as gravel but are lined with reworked Ruabon Marl, 1m thick with a permeability of $1x10^{-9}$ m/s.

Groundwater levels were recorded on a monthly basis within the 9 dedicated groundwater monitoring boreholes (WBH2A, 2B, 2C, 2D, 3A, 4A, 5A, 5B and borehole BH13) in accordance with Condition 1.4 of the Working Plan.

Groundwater samples are scheduled to be collected monthly from the 9 monitoring boreholes, as detailed on the current monitoring schedule in accordance with Condition I5 of the Working Plan.

Groundwater samples were analysed for the following determinands;

- pH, dissolved oxygen, suspended solids, BOD, COD, ammoniacal-nitrogen, electrical conductivity, chloride, potassium, calcium, iron, manganese, sulphate, alkalinity, TON, magnesium, sodium, TOC, cadmium, chromium, copper, nickel, lead and zinc.

3.2 Groundwater Levels

A review of the groundwater level data indicates the following;

- During the review period groundwater levels ranged from 111.35mAOD in borehole WBH02B to 136.67mAOD, upgradient, in borehole BH13. Groundwater levels were generally higher than in 2013 and slightly higher than in previous years. These results are consistent with historic groundwater levels reported in previous reviews in that higher levels are always reported to the West of the site (generally in BH13), reducing to the East.

- The minimum seasonal groundwater fluctuation ranged between 0.19m in WB2C and a maximum fluctuation in level of 3.14m in borehole WB5B.

- Groundwater flow direction is from west to east across the site.

3.3 Groundwater Quality

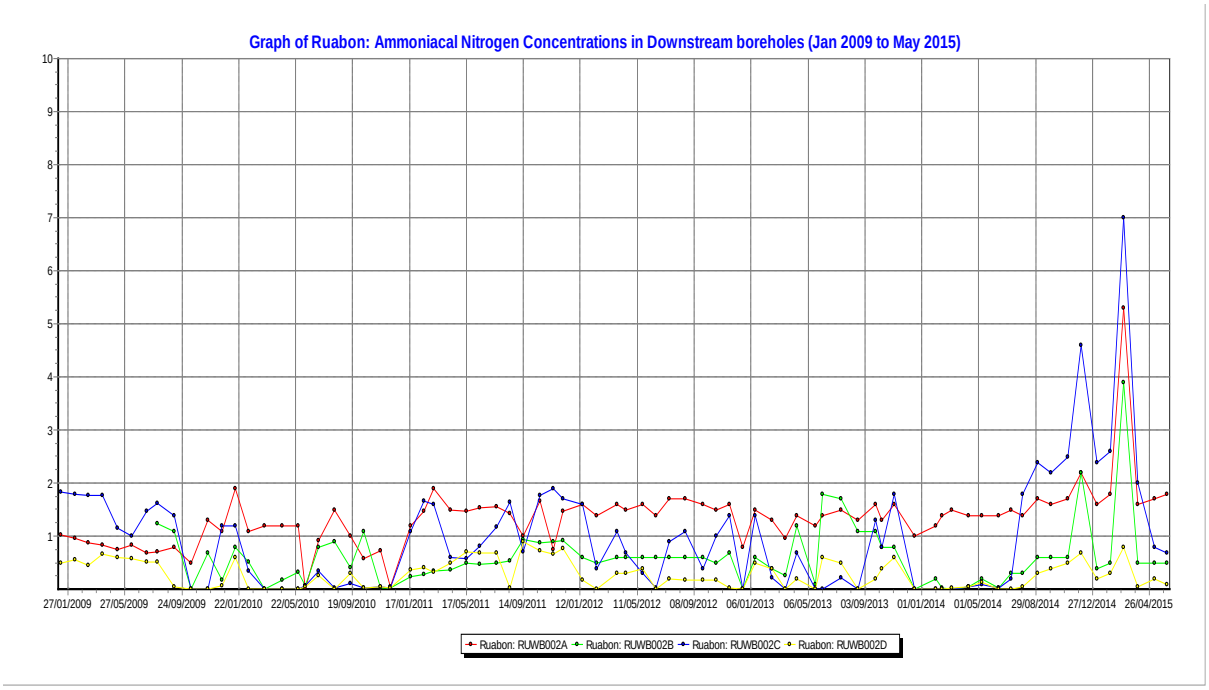
No trigger levels for groundwater quality are specified in the WML; however a schedule comprising regular analyses of selected hazardous substance determinands is outlined in the WML and the sites Working Plan.

A review of the groundwater quality data indicates the following:

Ammoniacal Nitrogen

Downstream; a summary of Ammoniacal Nitrogen concentrations shows an average level of 1.3mg/l in the downstream boreholes (0.6mg/l more than the previous year) with a maximum reading of 7.0mg/l reported in downstream borehole WBH2C during the 12 month period. However, there have been some issues with laboratory analysis errors which have shown up in upstream as well as downstream boreholes. This is noticeable particularly in the data from March 2015 and also December 2014.

Historical levels (Jan 2009 to May 2015) of Ammoniacal Nitrogen for the downstream boreholes are shown in the graph below. Elevated peaks can be seen for all 4 downstream boreholes in December 2014 and March 2015 with values inbetween (Jan and Feb 2015) dropping back to more 'normal' levels with the same reduction in concentrations again seen in April and May 2015.

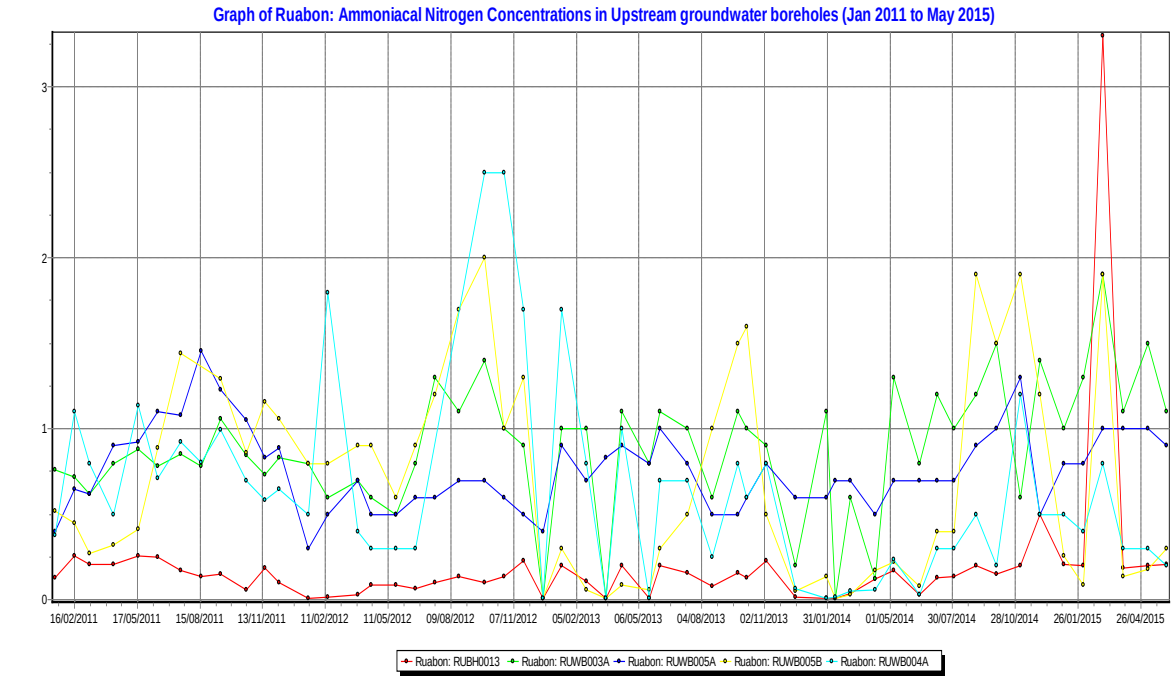


Other sites within FCC had reported higher than normal NH3N values in their groundwater and surface water samples and our contract laboratory investigated the reason for the elevated Ammonia readings and issued a statement to FCC as below.

"*We have concluded that the most probable root cause of the elevated NH3N values would be airborne cross contamination facilitated by the inconsistent sealing of sample tubes combined with extended storage time in the laboratory. This conclusion is based only on observations and cannot be wholly substantiated by the standard and most robust practice of repeat analysis due to the labile nature of Ammonia. Having said this*

we will attempt to carry out some laboratory simulations in order to confirm this possibility.
All sample tubes will, from this point, be individually capped to guarantee an effective seal immediately after the filtration step and the caps will only be removed when the instrument is loaded."

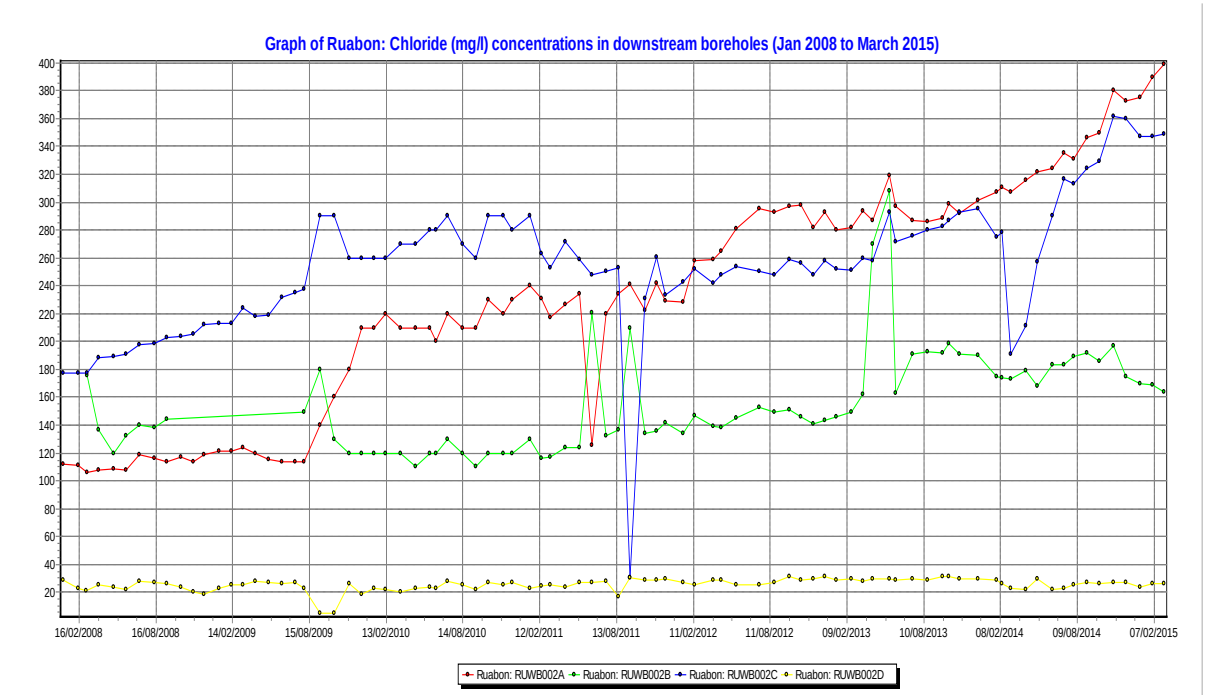
Upstream: A maximum Ammoniacal Nitrogen value of 3.3mg/l was recorded in upstream borehole BH13 which was 2.2mg/l higher than in the previous 12 months and is again due to laboratory contamination error as explained above.
Maximum NH3N values in other upstream boreholes were also higher than in previous years. The graph below shows a distinct spike in the NH3N data in March 2015 in all upstream boreholes except WB5A, then NH3N returning to more 'normal' levels in April and May.



Chloride

- Chloride concentrations show an average level of 33mg/l in upstream boreholes (6mg/l higher than in 2013) and 219mg/l in downstream groundwater infrastructure (a 28mg/l increase on the previous year). Average levels are generally below the limits for drinking water standards (250mg/l). The maximum concentration for chloride of 399mg/l was recorded in downstream borehole WBH02A (80mg/l higher than the previous year) on 3rd March 2015.
  In the graph below, levels of chloride can be seen to have been climbing steadily in three downstream boreholes; WBH02A (from 2010 to present) WBH02B (since 2011) and WBH02C (since 2007).
  These 3 boreholes are situated very close together on the Eastern boundary of the site and are located much nearer 'Ruabon Road' than they are to the edge of the landfilled area. It is possible that in recent years there has been some influence from salt rich surface waters sourced from the road with the extreme colder and rainier winters experienced. WBH02C is nearest to the road and experienced an increase in Chloride earlier than the other 2 boreholes.

Borehole WBH02D is on the edge of the landfill with much lower, steady, Chloride levels detected in this borehole.
Boreholes WBH02A and WBH02D were both installed to a deeper level (both at 21m) and are around 10m distant but show completely different Ammonia and Chloride levels. The borehole nearest the landfill (WBH02D) shows the lower concentrations of chemicals. Boreholes 2B and 2C are fairly shallow at 10m and 7m respectively.
Chloride levels in 2A and 2C are still increasing whilst concentrations in 2B have begun to tail off.



Other Determinands

- A review of the last 7 years of all analytical results (ie since the earliest increase in Chloride was observed in WABH02C) has been carried out for the 3 boreholes and reveals the following;
  Average levels of Potassium have increased across the 3 boreholes (by 4 to 14mg/l) and Sodium (by 20 to 213 mg/l) concurrently with the increase in Chloride. Mean levels of Magnesium increased from 14 to 21mg/l with Calcium increasing from 107 to 113mg/l. Additionally, coinciding with the increase in Chloride from 2010, Alkalinity reduced from 504 to 458mg/l, BOD increased marginally from 6 to 7mg/l, conductivity from 1161 to 1600mg/l and suspended solids from 444 to 2080mg/l. Other readings observed for the remaining determinands are consistent with the historical data and previous industrial activities in the locality.

4.0 LEACHATE REVIEW

4.1 Introduction

Leachate levels were recorded on a monthly basis throughout the review period. Condition I.4 of the Working Plan requires that these levels be taken within 10 leachate monitoring points and extraction wells.

Leachate samples were collected quarterly from the leachate eductor tank LT01 in accordance with condition I.7 of the Working Plan. These were analysed for the following determinands;

- pH, dissolved oxygen, BOD, COD, ammoniacal-nitrogen, electrical conductivity, chloride, potassium, calcium, iron, manganese, sulphate, alkalinity, TON, magnesium, sodium, TOC, cadmium, chromium, copper, nickel, lead and zinc.

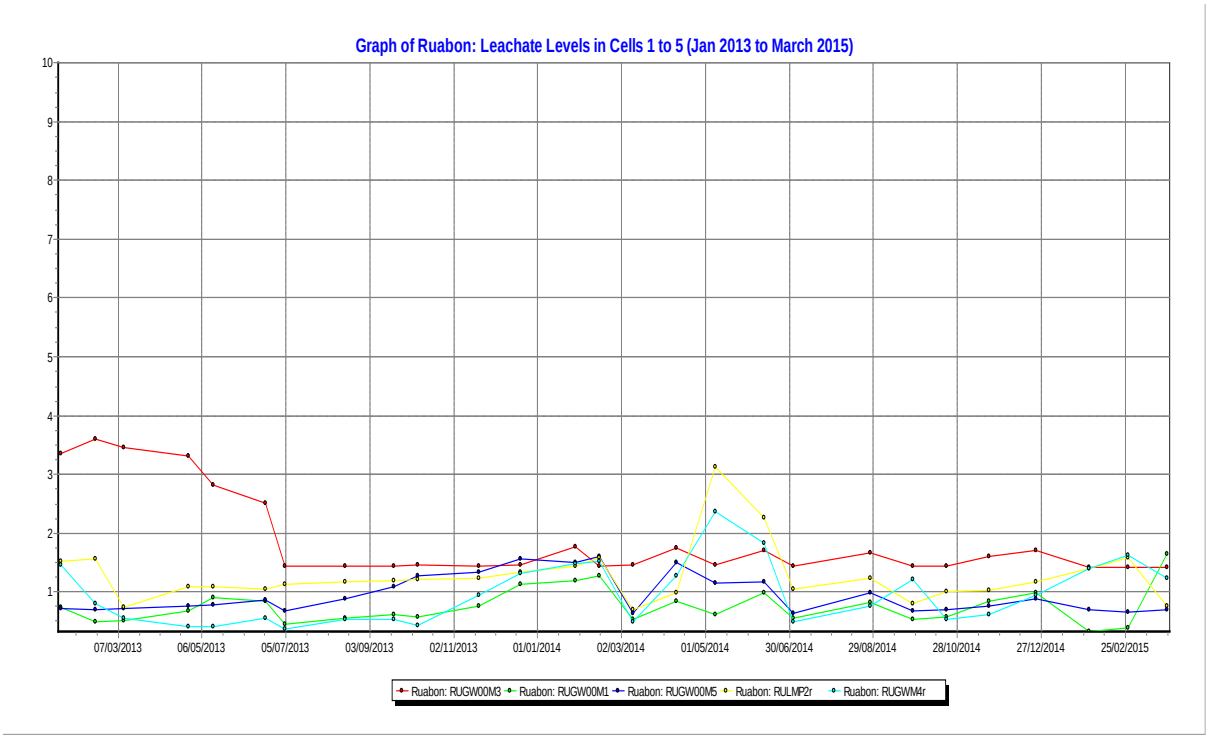
The locations of all leachate monitoring points are shown in Drawing No.1.

4.2 Leachate Levels

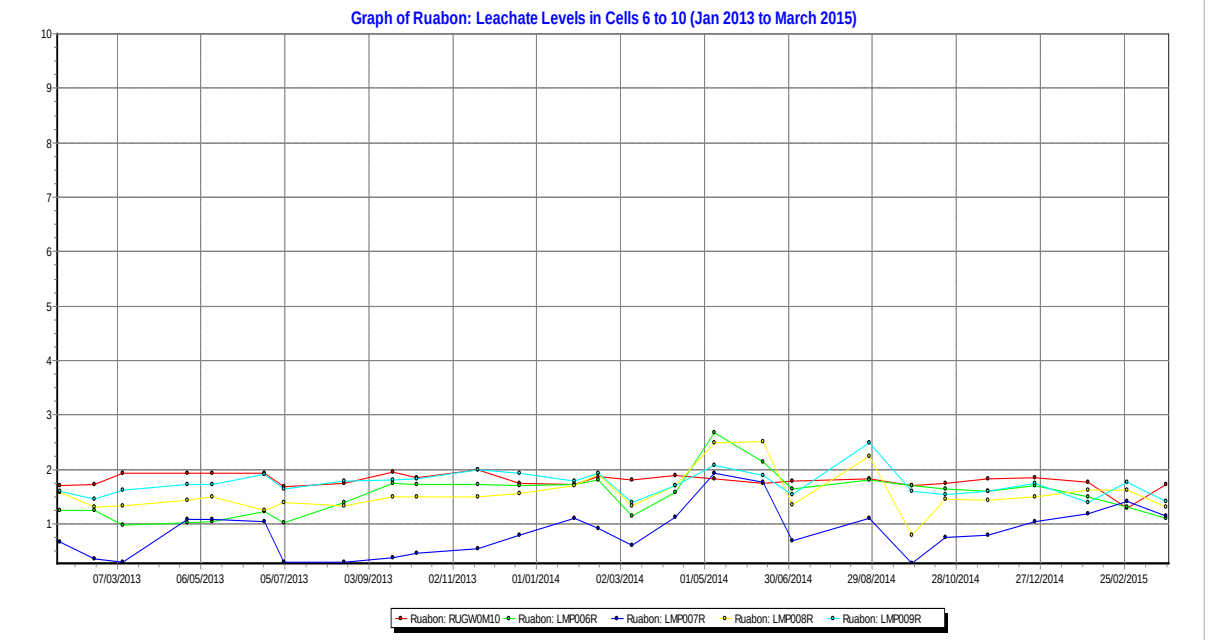
The leachate head trigger level is set at 2m in accordance with Condition I.8 of the Working Plan. In the first 6 months of 2013 compliance was at 90% with just one of the 10 leachate compliance wells showing levels above the 2m limit. The well, GWM3 was constricted at it's base, making it difficult to install a pump low enough to reduce the leachate below 2m. However, by July 2013 a smaller pump had been procured and installed at the base of GWM3 enabling levels to be pumped down to below the permitted limit. During the review period leachate levels were mostly kept below 2m with a only a few exceptions.

Leachate levels recorded on a monthly basis are shown graphically below;

Leachate levels in Cells 1 to 5



Leachate levels in Cells to 6 to 10



4.3 Leachate Quality

Leachate is currently sampled from the eductor tank LT01 on a quarterly basis.

A summary of leachate quality for the review period for the major determinands; Ammoniacal Nitrogen, Chloride, BOD and COD, reveals;

A review of the leachate quality monitoring data indicates the following:

- Ammoniacal Nitrogen concentrations ranged from 742mg/l to 1120mg/l with an average concentration of 1006mg/l which shows a gradual reduction in leachate strength.

- Chloride concentrations have ranged between 2120mg/l and 3110mg/l with an average concentration of 2695mg/l being consistent with historical results and a reduction on the levels over the previous 3 years.

- Electrical Conductivity ranged from 19,000µS/cm to 23,500µS/cm during the review period. The maximum reading and average result of 20,375µS/cm showing a reduction on the previous 3 years results.

- A review of the other analysed parameters indicates that the leachate is of methanogenic origin with relatively low Ammonia and COD concentrations and very low BOD when compared to the UK average for leachates. In general the leachate is typical of a landfill that has received biodegradable wastes.

5.0 SURFACE WATER

Surface water monitoring at Ruabon Landfill has been undertaken on a monthly basis since February 2005 from monitoring point WP04A in accordance with the site Working Plan. This monitoring point is shown on Drawing No.1.

The site discharge consent for the controlled discharge of surface water drainage specifies the following limits:

- 1.3mg/l Ammoniacal Nitrogen;
- 50mg/l Suspended Solids (measured after drying at 105ºC);
- 250mg/l Chloride;
- pH between 6 and 9; and
- No visible oil or grease.

The surface water samples were analysed for the following determinands;

- pH, Dissolved Oxygen, Suspended Solids, BOD, COD, Ammoniacal-Nitrogen, Electrical Conductivity and Chloride.

A summary of the surface water quality data for the review period, including time series plots for Ammoniacal Nitrogen and Chloride are presented in Appendix 6.

Review of the surface water quality data indicates the following:

- Ammoniacal Nitrogen concentrations breached the limits stipulated within the discharge consent on 5 occasions, with a maximum concentration of 4.1mg/l being recorded during the reporting period and an overall average through the year of 1.05mg/l.
- Chloride concentrations have consistently remained well below the trigger level stipulated in the discharge consent and DWS of 250mg/l on all occasions during the review period, with a maximum of 70mg/l recorded which is more than 50mg/l lower than in the previous 12 months.
- pH readings obtained were within the limits set out within the working plan. The maximum reading being 9.4.
- High levels of dissolved oxygen were maintained at WP4a with an average concentration of 7.2mg/l during the review period.

Suspended solids results were generally within the limit (50mg/l) specified within the discharge consent, apart from 1 occasion when the solids were recorded at 77mg/l in October 2014. This can occur when a sample is bailed from the bottom of the sampling point (rather than in the free flowing liquid) and excess solids are collected.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

FCC has undertaken a review of environmental monitoring data for Ruabon Landfill site covering the period April 2014 to March 2015.

Results of perimeter borehole monitoring data suggest that in the main there is minimal risk of lateral migration of flammable gas to receptors surrounding the landfill site and slightly elevated concentrations in perimeter boreholes are deemed to be the result of localised geochemical processes or historical land use.

Gas readings in borehole BH2A and gas probes GP1 and GP9 to the North of the site will continue to be monitored closely and actions taken in the gas field to address any migration issues.

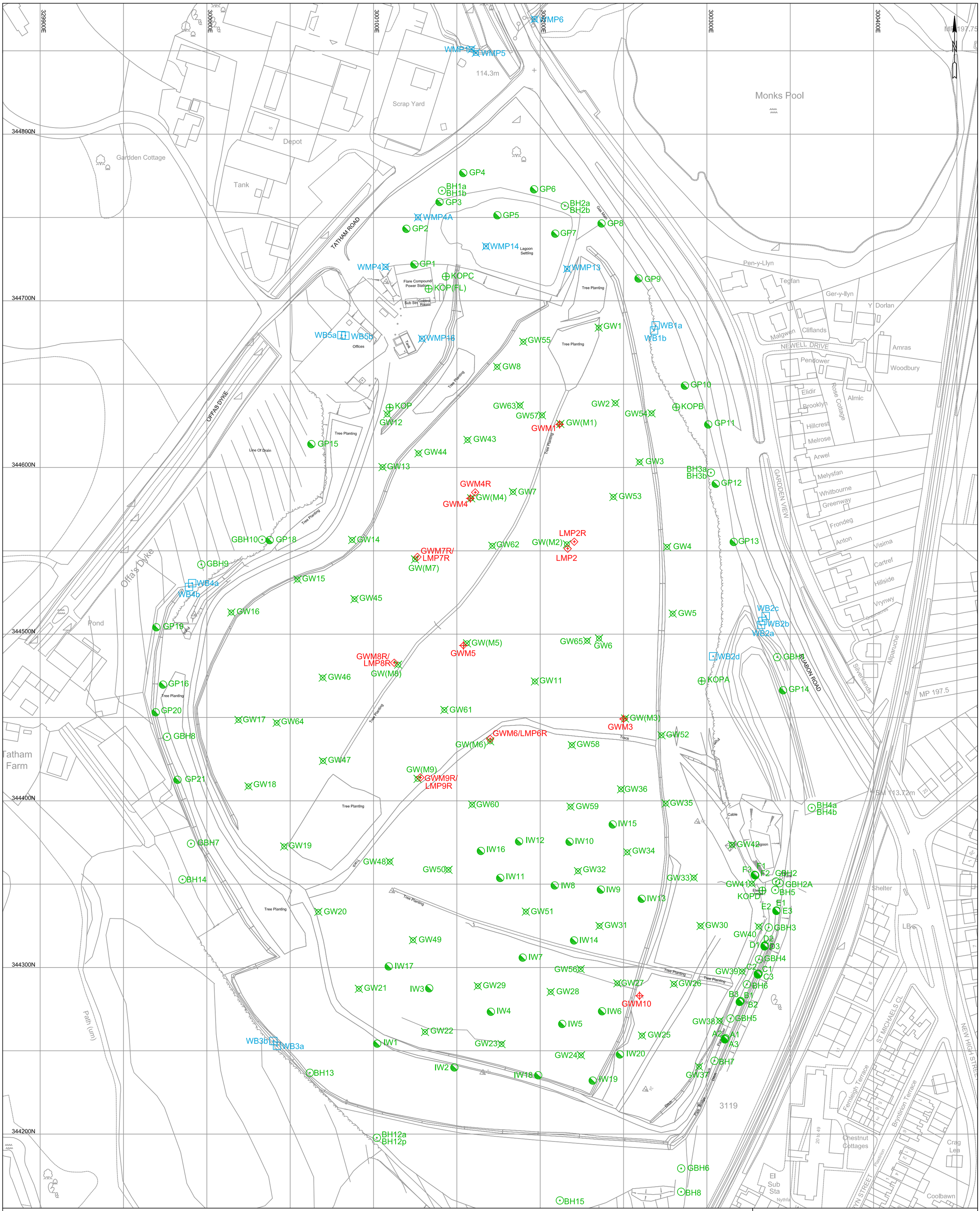
Levels of methane will also be closely tracked in the perimeter boreholes along the South East corner with intensive gas field balancing maintained in order to continue the decreasing trend of gas concentrations in these boreholes.

Groundwater levels observed were consistent with previous interpretative reviews with the environmental impact on groundwater considered to be low. The increasing Chloride trend in two of the downstream boreholes will continue to be tracked.

Leachate quality is of methanogenic origin and typical of a landfill that has received a variety of waste types.

DRAWINGS

Environmental Monitoring Plan



LEGEND

- Ownership Boundary
- Landfill Gas Monitoring Borehole
- Landfill Gas Surface Monitoring Point
- Combined Gas/ Groundwater Monitoring Point
- Landfill Gas Extraction Point
- Surface Gas Probe
- Gas Flare Stack
- Landfill Gas Extraction/ Leachate Monitoring Point
- Condensate Unit (Knock-out Pot)
- Gas Manifold
- Groundwater Monitoring Borehole
- Groundwater Pumping Point
- Surface Water Monitoring Point
- Leachate Collection Point
- Leachate Monitoring Point
- Leachate Recirculation Point
- Leachate Collection Sump
- Leachate Discharge Sampling Point
- Leachate Detection Point
- As-built Cell Footprint

Files Used:

Information taken from the Co-ordinated Surveys drawing CS5634 dated 28th September 2005.

REVISIONS				
No	Description	By	Chk'd	Date

Project:

RUABON
LANDFILL SITE

Title:

Environmental Monitoring Plan

Drawn By	LH	Date	10.04.13
Chk'd By	GF	Date	10.04.13
Scale 1:	1500	Sheet Size	A2

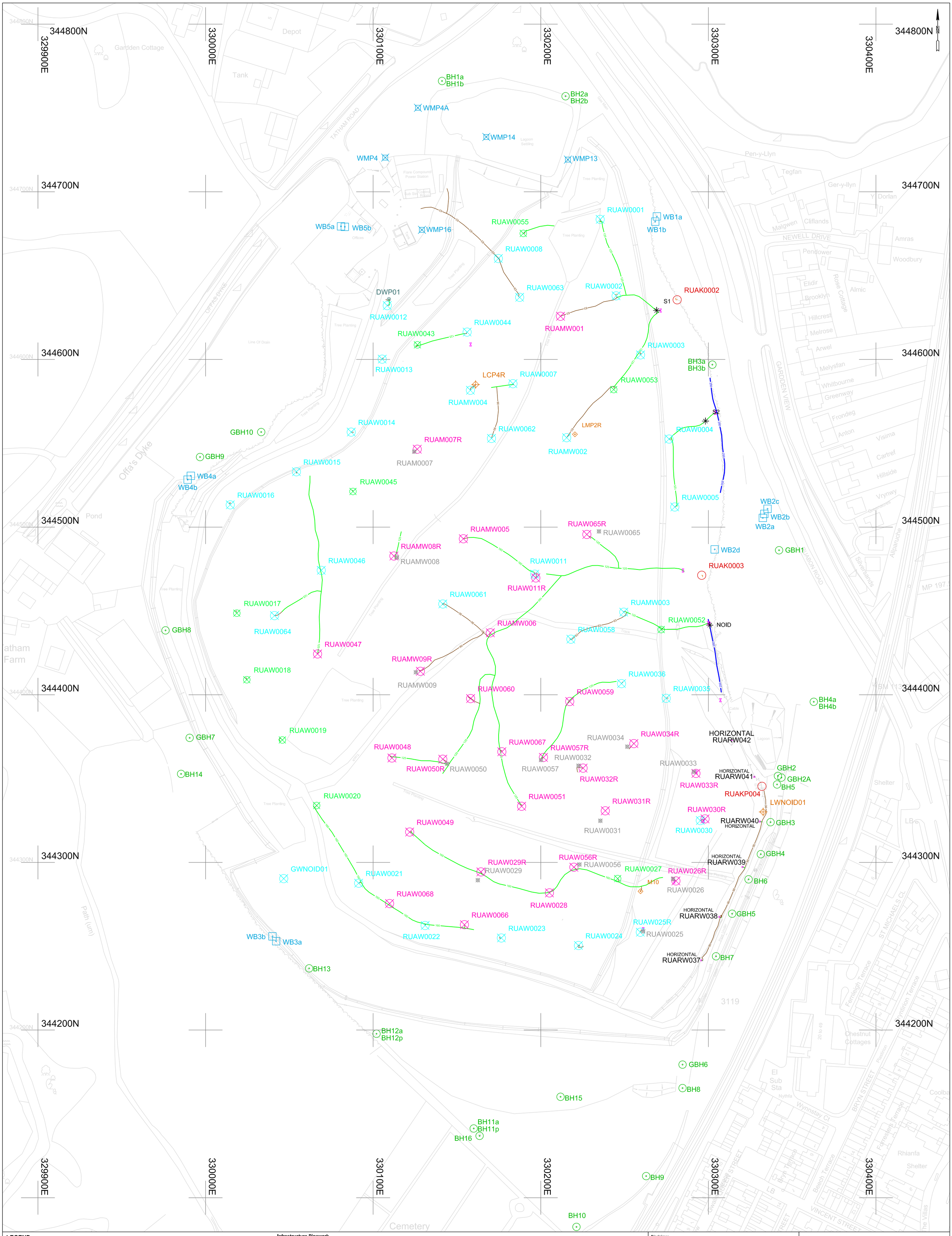
FCC Environment (UK Limited)
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White Rose Way
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FCC Environment
FCC Environment (UK Limited)
3 Sidings Court, White Rose Way, Doncaster. DN4 5NU

Drawing No
478M028

Plan 4A

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LEGEND

Monitoring Points

- Landfill Gas Monitoring Borehole
- Landfill Gas Surface Monitoring Point
- Combined Gas/ Groundwater Monitoring Point
- Gas Flare Stack
- Landfill Gas Extraction/ Leachate Monitoring Point
- Condensate Unit (Knock-out Pot)
- Groundwater Monitoring Borehole
- Groundwater Pumping Point
- Surface Water Monitoring Point
- Leachate Collection Point
- Leachate Monitoring Point
- Leachate Recirculation Point
- Valve
- KOP
- PEG
- Manifold
- Finn Drains
- Pinwell

Gas Wells

- Gas Well 63Ø
- Gas Well 90Ø
- Gas Well 110Ø
- Gas Well 120Ø
- Gas Well 160Ø
- Gas Well 180Ø
- Gas Well 225Ø
- Gas Well 250Ø >
- Proposed Gas Well
- Assumed Gas Well

Infrastructure Pipework

Above ground Pipe	Underground Pipe	Above ground Pipe	Underground Pipe	Above ground Pipe
32mm Gas Pipe		280mm Gas Pipe		Condensate Pipe
55mm Gas Pipe		315mm Gas Pipe		Leachate Recirculation Pipe
63mm Gas Pipe		355mm Gas Pipe		Assumed Pipe
90mm Gas Pipe		400mm Gas Pipe		
110mm Gas Pipe		450mm Gas Pipe		
120mm Gas Pipe		500mm Gas Pipe		
125mm Gas Pipe		650mm Gas Pipe		
160mm Gas Pipe		Leachate Pipe		
180mm Gas Pipe		Airline Pipe		
200mm Gas Pipe		Air and Discharge Pipe		
250mm Gas Pipe		Discharge Pipe		

Notes:

1. All dimensions are in metres unless otherwise stated.
2. All survey co-ordinates related to National Grid co-ordinates system (OSTN02) derived from the national GPS network - positions and levels checked against site control.
3. For ground levels and top of well levels please refer to spreadsheet: 5761_GI - Ruabon - Gas Well Co-ordinates and levels - March 2013.xls
4. Background mapping copied from plan: '478M027.dwg'

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StarNet Geospatial & Telecom solutions

GARD ID Prefix: RUA

Files/ Information used:

Project: **RUABON** LANDFILL SITE

Title: Gas Infrastructure Plan

REVISIONS

No	Description	By	Chk'd	Date

Drawn By AM Date 28/03/13

Chk'd By PF Date 28/03/13

Scale 1: 1000 Sheet Size A1

Infinis Limited
First Floor
500 Pavilion Drive
Northampton Business Park
Northampton
NN4 7YJ

infinis

Drawing No 5761_GI

Surface Emissions Flux Box Survey

Phase 2 Surface Emissions Survey Report

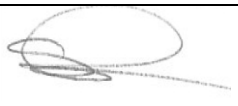
Ruabon Landfill Site

July 2014

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Approval Sheet

Customer:	FCC Environment
Site:	Ruabon Landfill Site
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Foreword

enitial 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.

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

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A. Phase 2 Surface Emissions Survey Results

B. Phase 2 Surface Emissions Survey Plan

1.0 Introduction

enitial were commissioned by FCC Environment to undertake a Surface Emissions Phase 2 (Fluxbox) Survey at their Ruabon Landfill Site in July 2014. Ruabon Landfill Site is located approximately 5 miles east of Llangollen and 2 miles south of Cefn-Mawr.

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. One zone was identified as requiring Surface Emissions Phase 2 testing: Zone 1 comprising of a permanent cap with established vegetation.

2.0 Survey Summary

2.1 Phase 2 Surface Emissions Survey

The Phase 2 Surface Emissions Survey was undertaken on the 10th, 21st, 28th and 29th July 2014 and included the capped areas of the landfill site as indicated on the plan contained in Appendix B. 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 monitoring point, 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/m^2/second;

As can be seen from the table below, the average flux of methane from the surface of the cap in zone 1is 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	0.00069	Y

Test locations detected low emission values

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/m^3 by multiplying the ppmv value by 0.714 (source - EA Guidance). The volume of the flux box used is 0.16m^3 with a basal area of 0.65m^2.

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 x 10^{-5} mg/m^2/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 / Time Period	Weather Conditions	Ground Conditions	Temp (°C)	Atmospheric Pressure (mbar)	Wind Direction / Speed (mph)	
10/07/2014 10:15	Sunny/hot	Dry	21.0	1002.0	6	SW
10/07/2014 14:00	Sunny/hot	Dry	27.0	1005.0	9	SW
21/07/2014 14:20	Sunny/hot	Dry	22.0	1021.0	8	NW
21/07/2014 17:00	Sunny/hot	Dry	23.0	1021.0	10	NNW
28/07/2014 10:20	Cloudy	Moist	18.0	1017.0	5	E
28/07/2014 15:00	Cloudy	Dry	21.0	1018.0	10	NW
29/07/2014 08:45	Cloudy	Moist	16.0	1018.0	1	SE
29/07/2014 14:20	Cloudy	Dry	20.0	1017.0	9	E

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	Flux Box Reference
10/07/2014	D. Beeston / A. Moore	Fid/flux box	90135 2279 & 2011120001	18/09/2014 & 06/08/2014	1& 4
21/07/2014	A. Moore	Fid/flux box	10365 2618	08/01/2015	1
28/07/2014	A. Moore	Fid/flux box	10365 2618	08/01/2015	1
29/07/2014	A. Moore / R. Clark-Williams	Fid/flux box	10365 2618	08/01/2015	1

Appendix A

Phase 2 Surface Emissions Survey Results

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Summary

Zone	Test Ref	Date	Tech	Location		FID Reference	Flux Box Reference	Ground Type / Veg	Sealing Method	Test Start Time	ppmv at Start	Test End Time	ppmv at End	Fieldsheet Ref	Comments
				Easting	Northing										
Z1	01	29/07/14	AM/RCW	330231	344723	103652618	1	short grass	weight	12:25	0	12:41	0		
Z1	02	29/07/14	AM/RCW	330139	344677	103652618	1	short grass	weight	11:25	0	11:41	0		
Z1	03	29/07/14	AM/RCW	330185	344677	103652618	1	short grass	weight	11:45	0	12:01	1		
Z1	04	29/07/14	AM/RCW	330231	344677	103652618	1	short grass	weight	12:05	0	12:21	0		
Z1	05	29/07/14	AM/RCW	330139	344631	103652618	1	short grass	weight	11:05	0	11:21	0		
Z1	06	29/07/14	AM/RCW	330185	344631	103652618	1	short grass	weight	10:45	0	11:01	1		
Z1	07	29/07/14	AM/RCW	330231	344631	103652618	1	short grass	weight	12:45	0	13:01	0		
Z1	08	29/07/14	AM/RCW	330277	344631	103652618	1	short grass	weight	13:05	0	13:21	0		
Z1	09	29/07/14	AM/RCW	330093	344585	103652618	1	short grass	weight	09:45	0	10:01	1		
Z1	10	29/07/14	AM/RCW	330139	344585	103652618	1	short grass	weight	10:05	0	10:21	0		
Z1	11	29/07/14	AM/RCW	330185	344585	103652618	1	short grass	weight	10:25	0	10:41	0		
Z1	12	29/07/14	AM/RCW	330231	344585	103652618	1	short grass	weight	14:00	0	14:16	0		
Z1	13	29/07/14	AM/RCW	330277	344585	103652618	1	short grass	weight	13:25	0	13:41	0		
Z1	14	29/07/14	AM/RCW	330047	344539	103652618	1	short grass	weight	09:25	0	09:41	0		
Z1	15	29/07/14	AM/RCW	330093	344539	103652618	1	Long grass	weight	09:05	0	09:21	0		
Z1	16	29/07/14	AM/RCW	330139	344539	103652618	1	short grass	weight	08:45	0	09:01	0		
Z1	17	10/07/14	DB	330185	344539	901352279	4	short grass	weight	13:00	0	13:16	0		
Z1	18	10/07/14	DB	330231	344539	901352279	4	short grass	weight	13:20	0	13:36	0		
Z1	19	10/07/14	DB	330277	344539	901352279	4	short grass	weight	13:40	0	13:56	0		
Z1	20	28/07/14	AM	330001	344493	103652618	1	Long grass	weight	13:40	0	13:56	0		
Z1	21	28/07/14	AM	330047	344493	103652618	1	short grass	weight	14:00	0	14:16	5		
Z1	22	28/07/14	AM	330093	344493	103652618	1	short grass	weight	14:20	0	14:36	0		
Z1	23	10/07/14	DB	330139	344493	901352279	4	short grass	weight	12:40	0	12:56	0		
Z1	24	10/07/14	DB	330185	344493	901352279	4	short grass	weight	12:20	0	12:36	0		
Z1	25	10/07/14	DB	330231	344493	901352279	4	short grass	weight	12:00	0	12:16	0		
Z1	26	10/07/14	DB	330277	344493	901352279	4	short grass	weight	11:40	0	11:56	0		
Z1	27	28/07/14	AM	330001	344447	103652618	1	Long grass	weight	13:20	0	13:36	0		
Z1	28	28/07/14	AM	330047	344447	103652618	1	short grass	weight	13:00	0	13:16	1		
Z1	29	28/07/14	AM	330093	344447	103652618	1	short grass	weight	12:40	2	12:56	0		
Z1	30	10/07/14	DB	330139	344447	901352279	4	short grass	weight	10:15	0	10:31	0		

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Summary

Zone	Test Ref	Date	Tech	Location		FID Reference	Flux Box Reference	Ground Type / Veg	Sealing Method	Test Start Time	ppmv at Start	Test End Time	ppmv at End	Fieldsheet Ref	Comments
				Easting	Northing										
Z1	31	10/07/14	DB	330185	344447	901352279	4	short grass	weight	10:35	0	10:51	0		
Z1	32	10/07/14	DB	330231	344447	901352279	4	short grass	weight	10:56	0	11:11	0		
Z1	33	10/07/14	DB	330277	344447	901352279	4	short grass	weight	12:20	0	11:36	0		
Z1	34	10/07/14	AM	330047	344401	2011120001	1	Long grass	Weight	12:45	0	13:01	1		
Z1	35	10/07/14	AM	330093	344401	2011120001	1	Long grass	weight	13:10	1	13:26	0		
Z1	36	10/07/14	AM	330139	344401	2011120001	1	Long grass	weight	13:30	0	13:46	0		
Z1	37	10/07/14	AM	330185	344401	2011120001	1	Long grass	weight	13:50	0	14:06	0		
Z1	38	10/07/14	AM	330231	344401	2011120001	1	short grass	weight	14:10	0	14:26	0		
Z1	39	10/07/14	AM	330277	344401	2011120001	1	short grass	weight	14:30	0	14:46	0		
Z1	40	10/07/14	AM	330047	344355	2011120001	1	short grass	weight	12:20	0	12:36	0		
Z1	41	10/07/14	AM	330093	344355	2011120001	1	Long grass	weight	12:00	0	12:16	0		
Z1	42	10/07/14	AM	330139	344355	2011120001	1	short grass	weight	11:40	0	11:56	0		
Z1	43	10/07/14	AM	330185	344355	2011120001	1	short grass	weight	10:20	0	10:36	1		
Z1	44	10/07/14	AM	330231	344355	2011120001	1	Long grass	weight	10:40	2	10:56	0		
Z1	45	10/07/14	AM	330277	344355	2011120001	1	Long grass	weight	11:15	0	11:31	0		
Z1	46	21/07/14	AM	330093	344309	103652618	1	short grass	weight	14:20	0	14:36	0		
Z1	47	21/07/14	AM	330139	344309	103652618	1	short grass	weight	14:40	0	14:56	2		
Z1	48	21/07/14	AM	330185	344309	103652618	1	short grass	weight	15:00	2	15:16	2		
Z1	49	21/07/14	AM	330231	344309	103652618	1	Long grass	weight	15:20	0	15:36	1		
Z1	50	21/07/14	AM	330277	344309	103652618	1	short grass	weight	15:40	0	15:56	0		
Z1	51	21/07/14	AM	330323	344309	103652618	1	short grass	weight	16:00	0	16:16	3		
Z1	52	28/07/14	AM	330093	344263	103652618	1	short grass	weight	12:20	1	12:36	0		
Z1	53	28/07/14	AM	330139	344263	103652618	1	short grass	weight	12:00	0	12:16	0		
Z1	54	28/07/14	AM	330185	344263	103652618	1	short grass	weight	11:40	0	11:56	0		
Z1	55	21/07/14	AM	330231	344263	103652618	1	short grass	weight	16:40	0	16:56	0		
Z1	56	21/07/14	AM	330277	344263	103652618	1	short grass	weight	16:20	2	16:36	4		
Z1	57	28/07/14	AM	330139	344217	103652618	1	short grass	weight	11:20	1	11:36	0		
Z1	58	28/07/14	AM	330185	344217	103652618	1	short grass	weight	11:00	0	11:16	0		
Z1	59	28/07/14	AM	330231	344217	103652618	1	Long grass	weight	10:40	0	10:56	0		
Z1	60	28/07/14	AM	330277	344217	103652618	1	Long grass	weight	10:20	0	10:36	0		

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Results

Test Ref	Concentration in ppmv over time in seconds																			
	0	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00
	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840	900
Z1/01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/02	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0
Z1/03	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Z1/04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/05	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Z1/06	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1
Z1/07	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Z1/08	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Z1/10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/13	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0
Z1/14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/18	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
Z1/20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/21	0	0	0	1	5	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5
Z1/22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/23	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0
Z1/24	0	0	0	0	0	0	2	2	1	1	1	0	0	0	1	0	0	0	0	0	0
Z1/25	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0
Z1/26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/27	0	0	0	1	1	1	0	1	1	1	1	1	1	1	1	0	0	0	0	1	0
Z1/28	0	0	0	0	0	0	1	1	0	1	0	0	1	2	1	2	1	0	1	1	1
Z1/29	2	3	2	0	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0
Z1/30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Results

Test Ref	Concentration in ppmv over time in seconds																			
	0	00:30	01:00	01:30	02:00	02:30	03:00	03:30	04:00	04:30	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00
	0	30	60	90	120	150	180	210	240	270	300	360	420	480	540	600	660	720	780	840	900
Z1/31	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/34	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Z1/35	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0
Z1/36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/41	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/42	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/43	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Z1/44	2	2	2	2	2	2	2	2	1	1	1	0	0	0	0	0	0	0	0	0	0
Z1/45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	2	1	0	0	0	0
Z1/47	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	2
Z1/48	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	2	2	2	1	2
Z1/49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
Z1/50	0	0	0	0	0	0	0	1	1	1	2	2	2	2	2	1	0	0	2	1	0
Z1/51	0	0	0	0	0	0	3	3	3	2	2	0	0	3	5	5	5	4	5	5	3
Z1/52	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/56	2	2	2	1	0	0	1	1	2	2	1	0	0	1	3	3	4	2	3	3	4
Z1/57	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Z1/59	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Z1/60	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Results and Calculation of Flux

ZONE 1

ID	Date	Location		Concentration in mg/m^3 over time in seconds																				Linear Regression		V/A (V = 0.16m^3, A = 0.65m^2)	Flux (Q) in mg/m^2/second (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	r^2 value	dc/dt			
Z1/01	29/07/2014	330231	344723	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/02	29/07/2014	330139	344677	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.7	0.0	0.0	0.0	0.500	0.005	0.246	0.00117	At limit of detection *
Z1/03	29/07/2014	330185	344677	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	0.7	0.500	0.005	0.246	0.00117	At limit of detection *
Z1/04	29/07/2014	330231	344677	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/05	29/07/2014	330139	344631	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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	0.525	0.003	0.246	0.00068	At limit of detection *
Z1/06	29/07/2014	330185	344631	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	0.737	0.002	0.246	0.00038	At limit of detection *
Z1/07	29/07/2014	330231	344631	0.0	0.0	0.0	0.7	0.7	0.7	0.7	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.771	0.006	0.246	0.00151	At limit of detection *
Z1/08	29/07/2014	330277	344631	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/09	29/07/2014	330093	344585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.750	0.004	0.246	0.00088	At limit of detection *
Z1/10	29/07/2014	330139	344585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/11	29/07/2014	330185	344585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/12	29/07/2014	330231	344585	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/13	29/07/2014	330277	344585	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	0.0	0.737	0.002	0.246	0.00038	At limit of detection *
Z1/14	29/07/2014	330047	344539	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/15	29/07/2014	330093	344539	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/16	29/07/2014	330139	344539	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/17	10/07/2014	330185	344539	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/18	10/07/2014	330231	344539	0.0	0.7	0.7	0.7	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	0.500	0.005	0.246	0.00117	At limit of detection *
Z1/19	10/07/2014	330277	344539	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.750	0.004	0.246	0.00088	At limit of detection *
Z1/20	28/07/2014	330001	344493	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/21	28/07/2014	330047	344493	0.0	0.0	0.0	0.7	3.6	4.3	4.3	4.3	4.3	4.3	4.3	4.3	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	3.6	0.800	0.020	0.246	0.00504	r^2 > 0.8
Z1/22	28/07/2014	330093	344493	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/23	10/07/2014	330139	344493	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.623	0.007	0.246	0.00172	At limit of detection *
Z1/24	10/07/2014	330185	344493	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	0.7	0.7	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.750	0.014	0.246	0.00352	At limit of detection *
Z1/25	10/07/2014	330231	344493	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.500	0.005	0.246	0.00117	At limit of detection *
Z1/26	10/07/2014	330277	344493	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/27	28/07/2014	330001	344447	0.0	0.0	0.0	0.7	0.7	0.7	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	0.7	0.0	0.771	0.006	0.246	0.00151	At limit of detection *
Z1/28	28/07/2014	330047	344447	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.7	0.0	0.0	0.7	1.4	0.7	1.4	0.7	0.0	0.7	0.7	0.7	0.700	0.005	0.246	0.00117	At limit of detection *
Z1/29	28/07/2014	330093	344447	1.4	2.1	1.4	0.0	0.7	0.7	0.0	0.0	0.7	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.457	0.004	0.246	0.00100	At limit of detection *
Z1/30	10/07/2014	330139	344447	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/31	10/07/2014	330185	344447	0.0	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	0.153	0.000	0.246	0.00000	At limit of detection *
Z1/32	10/07/2014	330231	344447	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/33	10/07/2014	330277	344447	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/34	10/07/2014	330047	344401	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	0.7	0.500	0.005	0.246	0.00117	At limit of detection *
Z1/35	10/07/2014	330093	344401	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	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	No concentration increase
Z1/36	10/07/2014	330139	344401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/37	10/07/2014	330185	344401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/38	10/07/2014	330231	344401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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

Ruabon Landfill Site

Surface Emissions Survey - July 2014

Flux Box Survey Results and Calculation of Flux

ZONE 1

ID	Date	Location		Concentration in mg/m^3 over time in seconds																				Linear Regression		V/A (V = 0.16m^3, A = 0.65m^2)	Flux (Q) in mg/m^2/second (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	r^2 value	dc/dt			
Z1/39	10/07/2014	330277	344401	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/40	10/07/2014	330047	344355	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/41	10/07/2014	330093	344355	0.0	0.0	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	0.083	0.002	0.246	0.00059	At limit of detection *
Z1/42	10/07/2014	330139	344355	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/43	10/07/2014	330185	344355	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 *
Z1/44	10/07/2014	330231	344355	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	0.7	0.7	0.7	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
Z1/45	10/07/2014	330277	344355	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/46	21/07/2014	330093	344309	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	1.4	0.7	0.0	0.0	0.0	0.0	0.613	0.008	0.246	0.00205	At limit of detection *
Z1/47	21/07/2014	330139	344309	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.0	0.0	0.7	1.4	0.781	0.006	0.246	0.00146	At limit of detection *
Z1/48	21/07/2014	330185	344309	1.4	0.7	0.7	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	1.4	1.4	1.4	0.7	1.4	0.771	0.006	0.246	0.00151	At limit of detection *
Z1/49	21/07/2014	330231	344309	0.0	0.0	0.0	0.0	0.0	0.0	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	0.758	0.002	0.246	0.00044	At limit of detection *
Z1/50	21/07/2014	330277	344309	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	0.7	0.0	0.0	1.4	0.7	0.0	0.833	0.004	0.246	0.00089	r^2 > 0.8
Z1/51	21/07/2014	330323	344309	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.1	2.1	1.4	1.4	0.0	0.0	2.1	3.6	3.6	3.6	2.9	3.6	3.6	2.1	0.840	0.014	0.246	0.00352	r^2 > 0.8
Z1/52	28/07/2014	330093	344263	0.7	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	N/A	0.000	0.246	0.00000	No concentration increase
Z1/53	28/07/2014	330139	344263	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/54	28/07/2014	330185	344263	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/55	21/07/2014	330231	344263	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/56	21/07/2014	330277	344263	1.4	1.4	1.4	0.7	0.0	0.0	0.7	0.7	1.4	1.4	0.7	0.0	0.0	0.7	2.1	2.1	2.9	1.4	2.1	2.1	2.9	0.926	0.011	0.246	0.00259	r^2 > 0.8
Z1/57	28/07/2014	330139	344217	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	N/A	0.000	0.246	0.00000	No concentration increase
Z1/58	28/07/2014	330185	344217	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Z1/59	28/07/2014	330231	344217	0.0	0.0	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	0.0	0.0	0.0	0.0	0.0	0.0	0.750	0.007	0.246	0.00176	At limit of detection *
Z1/60	28/07/2014	330277	344217	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	0.0	0.0	0.0	0.0	0.0	0.0	0.703	0.002	0.246	0.00046	At 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

Zone 1 (Permanent Cap) Average Q Value **0.00069** **mg / m^2 / second**

Appendix B

Phase 2 Surface Emissions Survey Plans



LEGEND

Fluxbox Survey Zone Boundary

Z1/01 — Fluxbox Test Location & Reference (locations shown in blue denote monitoring point moved from original design GPS co-ordinates to nearest suitable location)

ZONE 1 - PERMANENT CAP	
AREA:	127,378m2
TESTS REQUIRED:	60
TEST SPACING:	46m

FCC Environment

RUABON LANDFILL SITE

FLUX BOX SURVEY
TEST LOCATION PLAN
JULY 2014

DRAWN BY	CK	DATE	30/06/2014
APPROVED BY	SD	SCALE @ A3	1:2000
DRAWING No	2014/RUA/FB1	STATUS	DRAFT

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