

1.0 INTRODUCTION

1.1 Background

FCC Environment (FCC) has undertaken a review of the concentrations of gases in all perimeter boreholes at Pen-Y-Bont Landfill site (Permit No. GP3830BG) using the last 3 years of monitoring data in order to set action limits for Carbon Dioxide at each borehole. The review was undertaken with reference to the industry guidance document, "Perimeter Soils Gas Emissions Criteria and Associated Management".

The ICoP was produced in January 2011, following a consultation between the Environment Agency and members of the waste management industry and sets out standard methods for the derivation of background concentrations of both Methane and Carbon Dioxide around the perimeter of landfill sites.

In section one, the site conceptual setting will be summarised, before a review of the data will be completed. It is the intention of FCC to establish conservative, yet realistic action and limits for CO₂ that reassure Natural Resources Wales that any potential, realistic risk of lateral, subsurface migration is dealt with in a prompt and practical manner.

Tabulated data has been produced at the end of this report.

1.2 Site Location and Surrounding Land-use

The site is approximately 18 hectares in extent and is located on a North East to South South West trending spur within an incised meander of the River Dee about 500m north of the hamlet of Pentre. It is bounded to the east and south by agricultural land while to the west it is separated from the B5605 (formerly the A483[T]) road by 5 dwellings near its entrance, a sloping field and Pen-y-Bont Farm. On its north-west side, there is a narrow tract of river terrace land alongside the river.

The surrounding land use is primarily agricultural.

1.3 Site History and Development

Landfilling operations commenced in 1997 under the ownership of Shanks & McEwan Midlands Waste and was subsequently transferred to Waste Recycling Group (now FCC) who took over the waste management of the site in 2004.

The site is permitted to accept non-hazardous waste.

Pen-Y-Bont Landfill development has proceeded in three cells;

The landfilled area is roughly triangular in shape with the three points located in the South, West and East of the site. Therefore all cells run North to South. Cell 1 constitutes the Western part of the site where landfilling activities are mostly complete. Cell 2 is wedged inbetween cells 1 and 3, whilst Cell 3 occupies the Eastern most part of the site and (as with Cell 1) is now mostly capped.

Landfilling is continually moving around the centre of the site in order to produce the final dome shape profile, whilst the flanks are being gradually capped and restored

1.4 Geology

In summary, the geology at Pen-Y-Bont Landfill consists of surface deposits of alluvium (with sands and gravels) or made ground due to the various industrial activities which have taken place in the area. The made ground varies in thickness between 1 to 5m but is known to be as great as 15m in places on the floodplain to the East. The alluvial deposits are generally between 2 and 10m thick with some localised glacial till. These superficial layers are underlain by Ruabon Marl which is between 2m and 50m thick. The marl in turn overlies Carboniferous Middle Coal Measures Sands and silts which contain local organic layers.

2.0 DETERMINING BACKGROUND CONCENTRATIONS

In 2011, an industry code of practice (ICoP) was released, following consultation between the Environment Agency and members of the waste management industry. The aim of this ICoP was to introduce standard methodologies for establishing background levels for methane and carbon dioxide, using a pragmatic, risk based approach, agreed by both the industry and the Environment Agency. The recommended approach for establishing background levels of soils gases is as follows:

- Desktop study of the site conceptual setting (Section 1);
 - Desktop review of the datasets to establish trends and stability of the data;
 - Establish an adequate dataset that can be standardised by removal of anomalies and outliers;
 - Propose background levels and therefore action and compliance limits using the methods proposed within the ICoP, but taking site specific information into consideration.
- Update the site 'Landfill Gas Management Plan (LFGMP)' to incorporate these levels once agreed with the Environment Agency.

2.1 Review of the Dataset

Datasets covering the last 3 years (01/12/09 to 30/11/12) of landfill gas monitoring results for each perimeter borehole have been used for the statistical analysis in order to produce the revised limits. The ICoP recommends using a dataset containing a minimum of 24 to 30 readings (the datasets used by FCC contain around 36 readings in most cases), using data recorded after waste deposition commenced. Results obtained between 2009 and 2012 that contain anomalous spikes will not be used in determining background levels and calculations will standardise the dataset, by removing outliers.

A review of the calculated dataset reveals;

- A review of the gas data from the last three years reveals a number of anomalous spikes in both Methane and Carbon Dioxide concentrations that could indicate historic potential migration events, or one-off erroneous results, making this data unsuitable for establishing background levels;
- Over the last three years the highest levels of CO₂ have occurred in boreholes T10 and T11. In the case of T10, unlike T11, there has been no associated presence of methane. The proposed action levels for these two boreholes reflects the high background levels of CO₂ recorded over the review period.
- Calculations have also been carried out, as a matter of course, for levels of methane in the boreholes but no revised compliance or action limits are being proposed. The compliance level (trigger level) will remain at 1%.
- Boreholes which have shown concentrations of methane above the compliance limit in the last three years are T8 and T11. The migration events at T8 are thought to be linked to fluctuations in groundwater levels, although methane was not detected in T8 at all during 2012. The continual detection of flammable gas in borehole T11 has previously been investigated and is considered to be unrelated to landfill gas.

2.2 Standardising the Dataset

The Industry Code of Practice recommends statistical analysis that can be utilised in standardising a dataset to enable stable background concentrations to be established. In an attempt to ensure accuracy, the chosen three year dataset has been processed using the T_{max} method to establish appropriate action and compliance limits that are suited to the site specific requirements of Pen-Y-Bont Landfill site. The methodologies are summarised below.

The T_{max} Method

This is also known as the P1-471 outlier test, and is based on methods outlined in the Environment Agency Technical Report 'Techniques for the Interpretation of Landfill Monitoring Data, Ref. P1-471'. The general aim of this method is for 'cleaning up' data to estimate baseline statistics, by removal of outliers.

The method works as follows:

- Select an appropriate data set;
- Calculate the mean and standard deviation for the whole dataset;
- Standardise the data values by subtracting the mean and dividing by the standard deviation, which gives the Z value;
- Sort the Z values into increasing order, and compare the maximum reading against critical values contained in Table A.1 of the above Technical report.
- If the Z value is greater than the critical value, it is concluded that the corresponding data value is an outlier;
- The maximum data value within the range of the critical value is the T_{max}, and in accordance with the ICoP, this value can be used as the maximum background concentration.

3.0 SUMMARY

FCC Environment has compiled this report utilising the recommendations contained within the aforementioned ICoP, to generate pragmatic, risk based concentrations for Carbon Dioxide that would represent appropriate background levels.

Action limits only have been proposed for Carbon Dioxide, based on the methodologies outlined in the ICoP and these are contained in the table below.

Action Limits for Carbon Dioxide calculated using the Tmax method

Tmax Method			
Borehole	Tmax (%v/v)	Compliance Limit (%v/v)	Action Limit (%v/v)
	CO2	CO2	CO2
PBGB00G1	2.22	n/a	3.22
PBGB00G2	2.21	n/a	3.21
PBGB00G3	1.91	n/a	2.91
PBGB00G4	1.57	n/a	2.57
PBGB00G5	1.53	n/a	2.53
PBGB00G6	1.77	n/a	2.77
PBGB00G7	2.36	n/a	3.36
PBGB00G8	2.62	n/a	3.62
PBGB00G9	2.48	n/a	3.48
PBGB00G10	1.76	n/a	2.76
PBGB00G11	1.72	n/a	2.72
PBGB00G12	2.33	n/a	3.33
PBGB00G13	1.28	n/a	2.28
PBGB00G14	1.82	n/a	2.82
PBGB00G15	1.27	n/a	2.27
PBGB00G16	1.18	n/a	2.18
PBGB00G17	2.19	n/a	3.19
PBT00001	1.86	n/a	2.86
PBT00002	1.90	n/a	2.90
PBT00003	2.49	n/a	3.49
PBT00004	3.99	n/a	4.99
PBT00005	2.85	n/a	3.85
PBT00006	2.69	n/a	3.69
PBT00007	1.91	n/a	2.91
PBT00008	2.50	n/a	3.50
PBT00009	2.90	n/a	3.90
PBT00010	1.40	n/a	2.40
PBT00011	1.27	n/a	2.27
PBT00012	1.71	n/a	2.71
PBT00013	1.96	n/a	2.96

See spreadsheet 'Pen-Y-Bont Perimeter Gas Soils Gas Emissions Calcs_CO2' for details of how the CO2 action limits were calculated.