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Fletcher Bank Quarry Landfill Site

Landfill Gas Risk Assessment

Churchill Enviro Limited

Report No. K0047-ST-R001-00
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Contents

1 Introduction

1.1 Background

Churchill Enviro Limited operate Fletcher Bank Quarry Landfill Site (the Site) under Environmental Permit reference EPR/GP3733FE/V002. This Landfill Gas Risk Assessment (LFGRA) has been prepared to support a permit variation to increase waste inputs from 150,000 tonnes to 350,000 tonnes per year and to discharge Improvement Condition (IC) 1 listed in Table S1.3 of the Environmental Permit. IC1 has been reproduced below for reference:

A revised Landfill Gas Risk assessment shall be submitted to the Environment Agency for approval. The risk assessment shall consider the installation as identified in Schedule 2 of this permit and shall be based on the waste types listed in Schedule 3 of this permit. The report shall include a revised Gas Sim model and contain any necessary revisions to the procedures for the monitoring and management of landfill gas at the site.

Reference has been made to the following previous documents:

- TerraConsult Limited Fletcher Bank Landfill Gas Risk Assessment referenced 3338/R/02/01 (November 2014)

1.2 Site Details

The Site is located in the larger Fletcher Bank Quarry complex, near Bury in the northwest of England. The Site occupies an area of approximately 15.5 ha at an elevation of between 180 mOD to 230 mOD. The complex is located approximately 8 km to the north of Bury and 13 km to the northwest of Rochdale. Outside the quarry area are agricultural fields, isolated farmhouses and interspersed dwellings that lie to the north, east and south of the site. Moorland dominates land to the east and pockets of woodland can be found to the south of the site. To the west of the quarry is the town of Ramsbottom and to the north is the village of Shuttleworth.

The Site was founded in the 1880's and has been subject to sandstone and gritstone quarrying. The site was acquired by Marshalls Mono Ltd in 1969 when they purchased Richard Wild and Company. The quarry also accommodates a substantial concrete products manufacturing plant operated by Marshalls. These works, located in the southwest of the site consist of plant and manufacturing buildings, water and sludge management ponds, stocking yards, offices and car parks.

The Site is a substantial minerals extraction operation which is being progressively restored with a combination of minerals wastes and imported wastes under a separate restoration scheme. The Site is located in existing quarry void and is indicated by the green boundary on Drawing No. 1772/3/013 Rev D, attached as Appendix A. The landfill forms a constituent part of the larger restoration scheme for the quarry.

The landfill area Environmental Permit was transferred from Marshalls to Churchill Enviro Limited in March 2011. The Environmental Permit was varied and consolidated permit issued in modern condition format in August 2020 by the Environment Agency.

The Landfill Directive (1999/31/EC) and the Environmental Permitting (England and Wales) Regulations 2016 (as amended) that transpose the Directive into UK law, require that preventative measures be taken to minimise the negative effects of landfilling on the environment and human health. In particular, Annex 1 of the Directive, requires appropriate measures are taken in order to control the accumulation and migration of landfill gas.

Gaseous emissions from permitted landfill sites will be regulated according to site-specific risk management practices to minimise the impact on:

- human health, from trace components and combustion products;
- the local environment, by odour and vegetation stress; and
- global atmosphere, by ozone depletion and global warming.

The Site is classed as non-hazardous. However, the waste types accepted are predominantly inert in composition with a very low proportion of biodegradable material. The permitted waste types are listed in Table S2.1 of the Environmental Permit and includes concrete, bricks, tiles and ceramics, and soil and stones.

Environment Agency Guidance LFTGN03[1] states that biodegradable fraction (mainly cellulose and hemicellulose) is the portion of the waste which will undergo microbiological degradation to produce gas and liquids, although not all of this will be available for degradation. Inert landfills by their nature will have a minimal organic (biodegradable) content to the waste. Section 4.4.1 of the above guidance references the degree to which waste composition can influence the generation of significant volumes of landfill gas. It states that a site that contains 75 % or more inorganic wastes will produce minimal volumes of landfill gas (although this may still represent an environmental impact).

Consequently, risk assessment of sites which have accepted or will accept a low proportion of organic wastes is not expected to extend beyond the risk screening stage. The guidance recommends that the emphasis of a risk assessment be placed on rigorous waste acceptance procedures to control the nature of the wastes accepted to the site.

Although the Site is classified as non-hazardous, the waste types listed effectively exclude the readily biodegradable wastes normally associated with non-hazardous landfill sites. The bulk of the materials to be deposited will be excavated soils which typically having been in the ground for many years and would not contain any significant residual quantities of readily biodegradable materials. Some residual Total Organic Carbon (TOC) is expected but this will tend to comprise of "hard" organic compounds such as resins and lignins which do not give rise to significant landfill gas production.

[1] Environment Agency (2004). LFTGN03: Guidance on the Management of Landfill Gas.

As such, a risk screening and hazard identification approach has been adopted to provide an assessment of potential impacts on local environment, health and amenity by:

- developing an understanding of the landfill in its environmental setting (the conceptual model), including the identification of the possible sources of a risk, the pathways and the potential receptors; and,
- consideration of the sensitivity of receptors.

The GasSim modelling software has been used primarily to characterise the source term in this assessment.

1.3 Conceptual Site Model

The Conceptual Site Model (CSM) as used for this LFGRA is built on the site design, waste types and environmental setting data provided in the original Environmental Setting and Installation Design (ESID) report and the November 2014 LFGRA. A Source-Pathway-Receptor philosophy is used to establish whether gas emissions from the proposed site pose a risk to the surrounding environment.

2 Landfill Gas Risk Assessment

2.1 The Nature of the Landfill Gas Risk Assessment

Due to the low biodegradable content of the waste a screening exercise has been developed to assess the risk from landfill gas utilising a source-pathway-receptor approach. Although the waste acceptance protocols will prohibit the disposal of waste with a significant organic content, a Tier 1 modelling exercise using the GasSim modelling software has been carried out to gauge the volumes of gas likely to be generated by the site.

2.2 Source

The source is any gas generated from the waste deposited at the site. Landfill gas is produced by the microbial breakdown of wastes in a complex series of reactions. In a modern landfill accepting large quantities of readily biodegradable material, the decomposition processes are mainly anaerobic and typically produce a gas mixture comprising predominantly of carbon dioxide and methane. Other minor constituents that are present in gas collected from a landfill include nitrogen, oxygen, water, higher alkanes, hydrogen and trace substances such as hydrogen sulphide, organo-sulphur compounds, esters, alcohols, low molecular weight aromatic and aliphatic hydrocarbons. The trace compounds are normally only present at levels which do not cause harm, however some substances are highly odorous and can be detected even at extremely low concentrations. Gas production varies significantly depending on a wide range of factors including:

- composition of the waste (e.g. organic content, presence of inhibitors);
- method of landfilling (e.g. degree of compaction);
- leachate level control;
- unsaturated moisture content (through rainfall or recirculation of leachate);
- temperature;
- pH; and,
- ingress of oxygen

The waste the site will receive will predominantly be inert in nature with a low biodegradable content. This will be very similar in nature to the material deposited at waste recovery sites and comprise mainly a mixture of excavated natural soils and made ground. The main components in these wastes will be clay, soil, silt, rock, brick, concrete, and sand, as determined by the waste acceptance documentation.

Gas generation from any waste is associated with the proportion of organic matter which can be broken down by microorganisms.

The organic content of natural soils varies greatly as described in the British Standard for Soil Descriptions BS 5930:2015+A1:2020 paragraph 33.4.6 of the standard provides details of the typical organic content of soils. Table 1 below describes the range between slightly organic and very organic soils.

Table 1 – Terms for description of secondary organic matter in an inorganic soil

Term	Typical Colour	Organic Content	Weight % of dry mass [based on BS EN ISO 14688-2]
Slightly Organic	Grey	Low Organic Content	2 - 6
Organic	Dark Grey	Medium Organic Content	6 - 30
Very Organic	Black	High Organic Content	>30

One method of measuring the organic content of soils is the assessment of the TOC as determined by laboratory testing. TOC analytical technique however does not accurately reflect the organic component of a soil that is readily biodegradable. The method first involves quantification of the proportion of inorganic carbon in the material by acidification. A separate sample of the same material is then subject to high temperature combustion and catalytic oxidation with quantification of the organic carbon by measurement of the liberated carbon dioxide. The inorganic proportion is accounted for in subsequent calculations prior to the TOC value being reported. The TOC testing will not give an indication of the readily biodegradable potential of the material nor can it be used to determine how much gas will be produced. The TOC test is therefore likely to be an overestimate of the gassing potential of the waste and should not be considered in isolation.

A CL:AIRE research bulletin[2] also discussed TOC in natural soils. It describes the prevalence of large complex organic compounds (stabilised organic matter) such as resins, lignins, waxes or heavy molecular weight hydrocarbons which few microbes can degrade. Other more degradable compounds are bound up in the soil structure and cannot be reached by microbes. These compounds can be exposed during ground disturbance and could explain initial high concentrations of methane recorded from boreholes after they have been recently drilled. These concentrations subsequently reduce to negligible values which are more reflective of the low gas generation potential ground they were installed into.

TerraConsult Ltd (now ByrneLooby) carried out a review of waste testing data from site investigations undertaken across the northwest of England from 2002 to 2014. This data is considered to be representative of the demolition and excavation waste typically available to a landfill or recovery activity of this type. 280 TOC values had associated Dissolved Organic Carbon (DOC) values (from 2:1, 8:1 and 10:1 leachability tests expressed as mg/l). Figure 2.1 shows the frequency distribution of TOC values recorded.

[2] CL:AIRE (2012). A Pragmatic Approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17. November 2012.

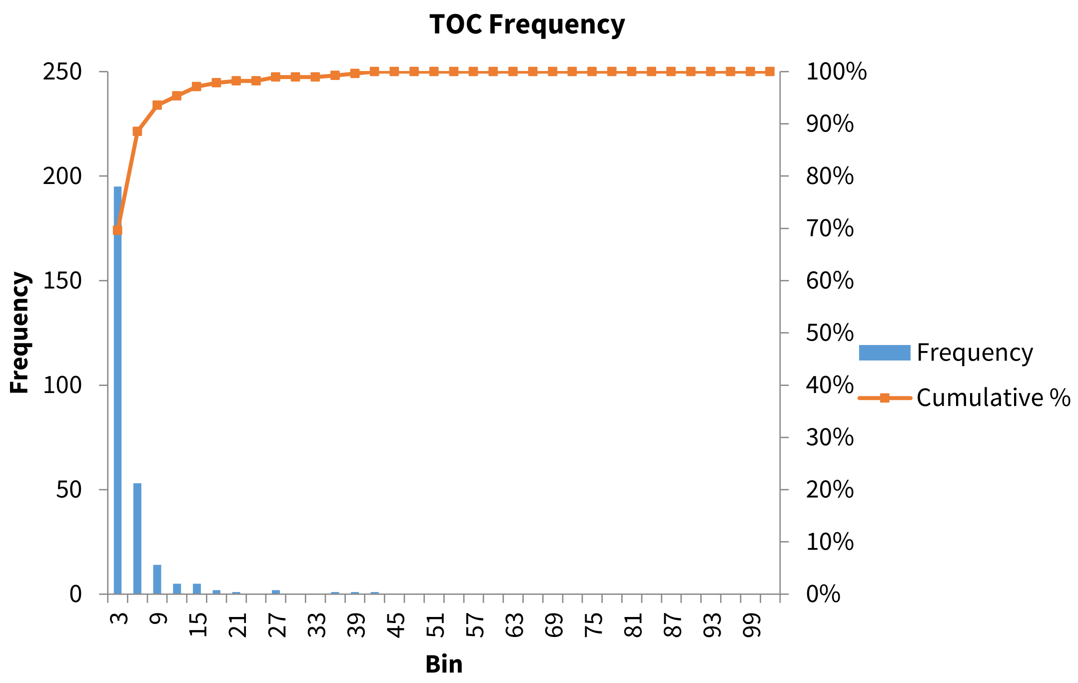


Figure 2.1 – TOC Frequency

The significant majority of TOC values are less than 3 % (WAC for inert landfill sites) at 70 % of the sample group and 93 % were less than 10 %. The most likely value to be recorded was 2 % or less (53 % of the sample group). The highest TOC recorded was 41.2 %. The majority of TOC values recorded are comparable with the figures for naturally occurring slightly organic material given in Table 1. A much smaller proportion compare well with organic material.

Based on the data from the TerraConsult review, it is likely that the type of material likely to be brought to site will have a TOC of less than 10 %. This material is likely to have a low DOC potential and would meet the WAC for inert landfill sites (even where the TOC would not).

2.2.1 DOC and TOC

Figure 2 shows the relationship between TOC and DOC where appropriate data was available. Leachable DOC concentrations are largely comparable up to 10 % TOC within each liquid to solid ratio (L/S) data set. DOC (mg/l) was lower at the higher TOC values. The highest total leachable DOC (10:1 L/S mg/kg) was half the WAC limit for inert landfill sites and appeared to reduce at concentrations higher than 10 % TOC, although this may reflect the size of the data set. It is likely that if the TOC content of the soils accepted at site was limited to 10 % the DOC value will meet the WAC limit for inert landfill sites.

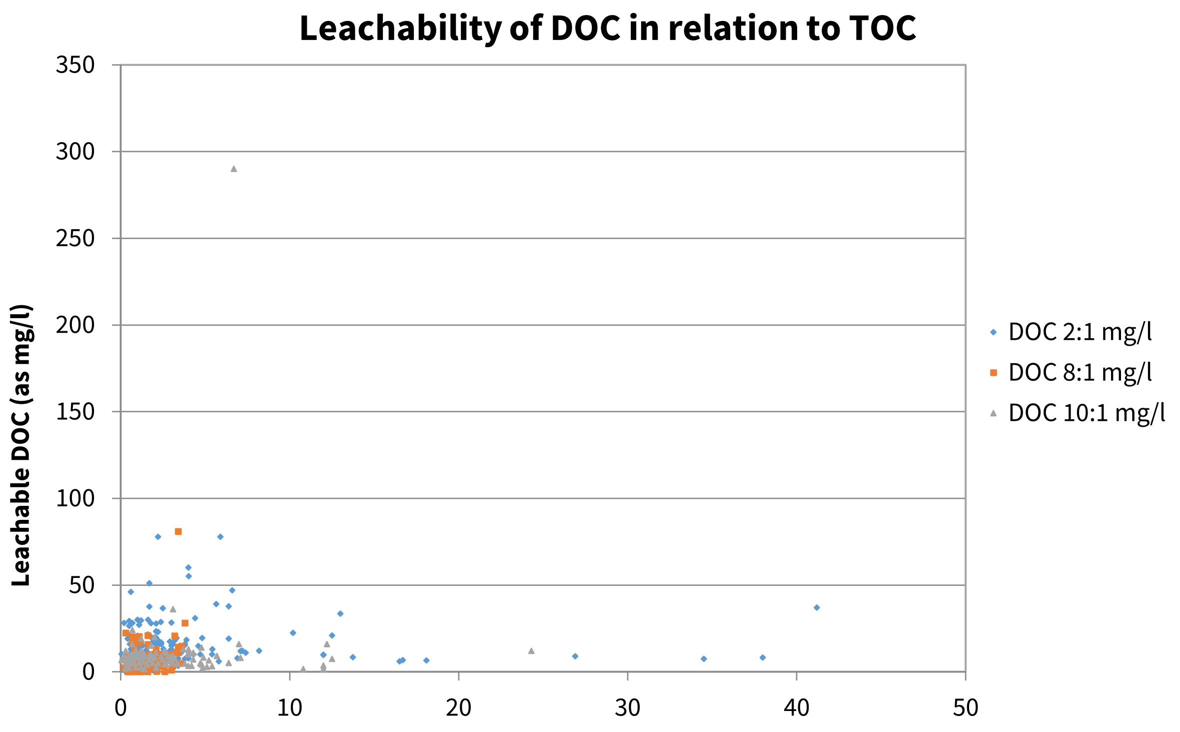


Figure 2.2 – Leachability of DOC in relation to TOC

A study[3] reviewed the gas generation potential of Mechanical Biological Treatment (MBT) wastes. This material had previously been subject to biological treatment (e.g. composting or anaerobic digestion) resulting in a stabilised material with a lower biodegradable potential. This material was then placed in Lysimeters under a variety of conditions to establish how much methane may be produced when landfilled. Although the age and type of waste will be different, the stabilised MBT residue is considered to be a very conservative representation of gas generation from excavated soils.

The study found that waste with a TOC of ≤ 18 % and DOC of ≤ 300 mg/l were inhibited from producing significant volumes of gas. Water content was the primary limiting factor, followed by TOC / DOC and other factors such as temperature. The calorific value of the gas produced from MBT residue was found to be very low and it was suggested conventional techniques for gas reatment may not be economical. Simple oxidation of the gas through the cap or soil layers was proposed as a sustainable solution for oxidation of gas produced from landfills containing MBT or old landfills.

DOC represents the readily soluble proportion of the tested material released under quite aggressive laboratory conditions i.e. mechanical size reduction and subsequent continual

[3] S. Bohn And J. Jager (2011). Low Gas Emissions Of Mechanically And Biologically Treated Waste And Microbial Methane Oxidation As An Adapted Method For Mitigation Of Emissions. Proceedings Sardinia 2011, Thirteenth International Waste Management and Landfill Symposium S. Margherita di Pula, Cagliari, Italy; 3 - 7 October 2011

agitation. Its solubility means it may be more susceptible to microbiological assimilation and biodegradation, which under anaerobic conditions may result in methane generation. The absence of a strong relationship between increasing TOC and DOC from excavated soils suggests gas generation from these types of waste may be low due to the low leachability and otherwise biodegradable DOC.

The evidence from landfill sites taking mainly excavated soils with comparable TOCs to the above data is that they do not give rise to significant gas production. Average bulk gas flows recorded from boreholes installed in a hazardous landfill site (Eardswick Hall) and a soils site (Sea View Farm 2) were 0.5 to 0.6 l/hr. The hazardous landfill WAC limits TOC in waste inputs to Eardswick to 5 %. Sea View Farm 2 was permitted to accept inert waste with no more than 5 % in any one load of materials with a biodegradable potential such as wood or wood products.

To validate the modelling exercise undertaken at Fletcher Bank the flow rate from these sites has been extrapolated up to the proposed size of Fletcher Bank (155,000 m^2). Assuming a uniform depth, a gas well zone of influence of 5 m radius (area 78 m^2) and a flow rate of 0.0006 m^3/hr, it can be predicted that Fletcher Bank will produce 1.2 m^3/hr of bulk landfill gas. If the maximum flow rate recorded at both sites was used (0.028 m^3/hr at Eardswick) this gives a site total of 55 m^3/hr. Although it is considered that this is a conservative calculation as the reading at Eardswick was likely influenced by atmospheric conditions as equivalent or greater negative flow rates have been recorded.

In the light of the above, the waste acceptance criteria for the installation will include for a number of restrictions to exclude readily biodegradable wastes at the site. The full criteria are set out in the operators Waste Acceptance Criteria with respect to the LFGRA the relevant restrictions are as follows:

- exclusion of readily biodegradable wastes using EWC codes;
- on-site rejection procedures to visually identify and exclude waste loads that appear to contain cellulose based materials (paper, wood, vegetation, topsoil, cardboard); and,
- imposition of a conservative 10 % TOC maximum limit on waste soils accepted at the site.

It is also intended to adopt the additional restrictions on “active” wastes types as relevant to the Landfill Tax (Qualifying Materials) Order 2011 (as amended) which will further control the biodegradable content of wastes deposited at the site.

Adoption of these controls will ensure that the readily biodegradable (or gas forming component) of the waste will be very low. This has been incorporated into the GasSim2.5 gas production model which provides for a waste stream of 90 to 99.9% (most likely 99 %) inert waste with the corresponding non-inert fraction i.e., the TOC represented as 5 % moderate and 95 % slowly degradable content.

Additional factors have been included in the GasSim 2.5 model, summarised as follows:

- 0.75 m thick clay cap (permeability of <1E-8m/s);

- 0.5 m thick basal liner (permeability of <1E-8m/s);
- the site is expected to receive approximately 4 million tonnes of waste in total. Commencing in December 2020, approximately 350,000 tonnes of waste will be deposited per year with completion required by the end of December 2036 in accordance with the planning permission. Capping is expected to take place in 2037 with restoration to be completed by 2038 in accordance with the planning permission; and
- no leachate drainage layer has been specified.

The GasSim 2.5 model details are included in Appendix B and an electronic copy of the relevant files in Appendix D.

Figure 1 in Appendix D shows the calculated bulk landfill gas production from the site. This shows peak production of landfill gas would be in 2029 with 56 m^3/hr, 27 m^3/hr of which is methane, being generated (based on 50% percentile). A predicted methane flow (Q) that exceeds a simplistic benchmark value of 50–100 m^3 / hour provides an initial indication that flaring or utilisation will be required. The methane flow is below the lower end of the benchmark level of 50-100 m^3hr^{-1} suggested in Environment Agency document LFTGN03 below which active gas control and treatment is not required. Based on data from similar sites and previous studies on MBT waste, it is likely that volume of gas produced will be significantly lower than this.

2.3 Landfill Gas

Limits for methane and carbon dioxide are specified in the permit for boreholes BEL1, BEL2, SLR2 and SLR3, however of those four monitoring points only SLR2 is monitored. The remainder have been damaged or lost due to site activities since they were nominated as part of the original permit application. Gas readings are taken on a monthly basis at six perimeter boreholes (SLR2, FB11/01, FB11/02, FB11/02A, FB104R, and BH803). Regularisation of the revised landfill gas monitoring regime and proposals for new action and compliance limits are in the accompanying Landfill Gas Report referenced K0047-ST-R002 submitted to address IC 2.

Appendix C details the gas monitoring data recorded from perimeter boreholes located around the vicinity of the landfill area between 2017 to 2021.

The gas monitoring data is summarised in Table 2.

Table 2 – Landfill Gas Concentrations

Borehole	Methane			Carbon Dioxide		
	Max	Min	Avg	Max	Min	Avg
BH803	0.1	0.1	0.1	0.6	0.1	0.1
FB104R	0.1	0.1	0.1	1.5	0.1	0.7
FBE 11-01	0.1	0.1	0.1	1.8	0.1	0.8
FBE 11-02	1.9	0.1	0.1	2.9	0.1	1.4
FBE 11-02A	0.1	0.1	0.1	1.6	0.1	0.7
SLR2	0.1	0.1	0.1	0.7	0.1	0.3

With the exception of FBE 11-02, methane has not been detected above the limit of detection in any of the boreholes. Methane was detected once at 1.9 %v/v in FBE 11-02 in July 2021 and is likely anomalous. The November 2014 LFGRA noted the presence of thin bands of coal interbedded within the gritstone series geology of the quarry in previous face surveys. It is possible that the methane could be occurring naturally and is associated with coal measures.

Carbon dioxide is detected at relatively low concentrations in all boreholes. There is no strong association with the occurrence of methane in FBE11-02 or the boreholes directly adjacent to the landfill wastes. The concentrations detected are likely to be representative of background. Proposed compliance limits for methane and assessment levels for carbon dioxide are detailed in Landfill Gas Report referenced K0047-ST-R002.

2.4 Pathways

The pathways are defined as the environmental transport processes by which the pollutants move from the source to the receptors. In the case of landfill gas there are two transport processes that should be considered: atmospheric dispersion and lateral migration.

Atmospheric dispersion of landfill gas emitted from the site is controlled by the prevailing wind direction and speed. Fugitive landfill gas emissions from uncapped wastes, exposed flanks or failures in an active landfill gas management system (pipework, gas wells, flare or gas engines) are most likely to be conveyed to receptors along this pathway. Wind velocity and direction will affect the distance a fugitive gas emission travels and where it travels to. The presence of undulating topography, large structures, bunds and woodland in the vicinity of a site will increase the effective surface roughness i.e. turbulence. Higher wind speeds will also aid beneficial dispersion of emissions.

Disposal operations will be below ground level and behind existing perimeter screening bunds for the majority of the sites operational lifespan. The deposited low permeability wastes will be comparable in nature to conventional capping materials and therefore serve to limit surface emissions. The site will not require an active gas extraction system and emissions from pipework, gas wells or other plant will not occur. Good operational practice will also minimise the tipping area and exposed wastes.

Lateral migration describes the transverse migration of landfill gas through an unsaturated subsurface by advection and diffusion. This could potentially occur at the proposed site through the basal unsaturated zone or via the fractured sandstone / mudstone strata laterally adjacent to the side walls. As described above, the wastes to be deposited will be of low permeability and should restrict movement of landfill gas. An engineered basal and sidewall liner of low permeability clays will further prevent lateral gas migration. The emplaced wastes are expected to generate negligible volumes of gas and the mechanism gas migration by positive gas pressure is unlikely. Gas movement is therefore likely to be limited to passive advective flow influenced primarily by fluctuations in atmospheric pressure. Limited diffusion of gas from the landfill may also be expected but this mechanism will not result in significant volumes of gas escaping from the site.

2.5 Receptors

A number of potential receptors need to be considered with respect to landfill gas. The generic categories are listed below:

- domestic dwellings;
- other occupied buildings (offices, public buildings, schools etc);
- sensitive habitats and environmental areas e.g. SSSIs;
- public footpaths or bridleways;
- major highways and minor roads;
- open spaces, parks and farmland (crop damage); and,
- air quality management zones.

This Site is located in a predominantly rural area. Table 3 below shows the proximity of the potential receptors within 250 m to the site boundary.

Table 3 – Potential Receptors

Receptor No	Receptor	Approx Distance from Site boundary (m)	Direction from Centre of Site	Grid Reference
DR1	Farm and residential buildings off Bury Old Road	220	N	380433 417676
DR 2	Terraced houses off Bamford Road	205	NNE	380564 417532
DR 3	Cross Bank Brook	120	NE	380588 417382

Receptor No	Receptor	Approx Distance from Site boundary (m)	Direction from Centre of Site	Grid Reference
DR 4	Green Hill Farm	175	NE	380674 417412
DR 5	Harden Moor	<10	E & SSE	380735 417132
DR 6	Bennetts MOT Centre	90	WSW	380050 416790
DR 7	Marshall's Quarry / Manufacturing Complex	<10	S	380231 417023
DR 8	Public Footpath	<10	SW & N	380614 417258
DR 9	Earnst Platt Industrial Unit	50	W	380042 416960
DR 10	A56 / Whalley Road/M66	155	W	380004 417082
DR 11	Residential houses, Place of Worship, and Recycling site located off Whalley Road and A56	130	WSW to NW	380112 417344
DR 12	Cross Plant Hire, Bank Hill Farm and Wood Hill Farm	230	NW	380002 417569
DR 13	Residential Properties off Bye Road	100	N	380189 417536
DR 14	Public byway, bridleway, right of way	<10	All directions	380302 417461
DR 15	Twine Valley Farm	85	N	380205 417602
DR 16	Harden Brook and associated sinks, issues, waterfall and springs	105	N to ESE	380853 417132
DR 18	Priority habitat (deciduous woodland)	20	All directions	380168 417087
DR 19	Priority habitat (Upland Heathland & Blanket Bog)	110	E to SE	380947 416847
DR 21	Priority habitat (Lowland Fens & Lowland Heath)	110	N to NE	380321 417586

2.6 Risks to the Environment and Human Health

GasSim2.5 has been used to quantify the emissions from the landfill site. The results indicate that landfill gas production will be very low and peak at the end of landfilling activities in 2037. The peak gas production rate for the entire site is 56 m^3/hr (50th percentile) of which 27 m^3/hr is methane. This indicates that there is insufficient gas to require active gas control (Appendix B).

The model outputs predict that bulk gas volumes will reduce to less than 10 m^3/hr by 2066 and 1 m^3/hr by 2116. However, experience of similar landfill sites would indicate even these low gas volumes to be a conservative representation of the likely gas production at Fletcher Bank as discussed in Section 2.2. The monitoring data shows that although methane and carbon dioxide concentrations are elevated the overall volumes of landfill gas produced are extremely low. In risk assessment terms therefore the potential for environmental harm from this site is very low and in this respect the conditions are such that the criteria for permit surrender would be met.

The data recorded from the Eardswick and Sea View Farm sites indicates that the gas volumes predicted by the GasSim2.5 model for Fletcher Bank are a very conservative estimate of landfill gas production. It is therefore not only likely that gas production will rapidly decline prior to the point predicted by the model, but it will also be to a level where within 10 years of closure, the site will fulfil the criteria for permit surrender (as set out in Environment Agency document Landfill (EPR 5.02) and other permanent deposits of waste: How to surrender your environmental permit. V2. December 2012).

The Tier 1 modelling exercise predicted likely concentrations of surface emissions at the site boundary to be negligible and as a result, further Tier 2 quantitative assessment of atmospheric migration and lateral migration from the site has not been carried out. It is concluded that landfill gas does not pose a significant risk to the surrounding environment.

The low volumes of landfill gas produced are not considered to give rise to any significant contribution to the effects of global warming or ozone depletion.

Assessment of the potential for an odour nuisance is more subjective. Experience to date has shown that the existing deposited wastes are not giving rise to odorous emissions and the low fraction of biodegradable materials present in the incoming wastes mean that an odour nuisance is very unlikely. Experience of other similar landfill sites also confirms that odour nuisance will not occur.

3 Conclusions

An assessment of potential impacts on local environment, health and amenity of landfill gas from the site has been carried out using a risk screening and hazard identification approach. This assessed what the potential consequences would be of increasing the annual waste inputs from 150,000 tonnes to 350,000 tonnes.

GasSim2.5 has been used to provide a quantitative assessment of the likely volumes of landfill gas that may be produced at the site. The waste will contain low levels of biodegradable waste and as such the expected volumes of landfill gas are small. The calculated peak production for bulk landfill gas is comparable with the benchmark which indicates that active management of landfill gas is not required, and data from similar sites suggests that gas production will be much lower.

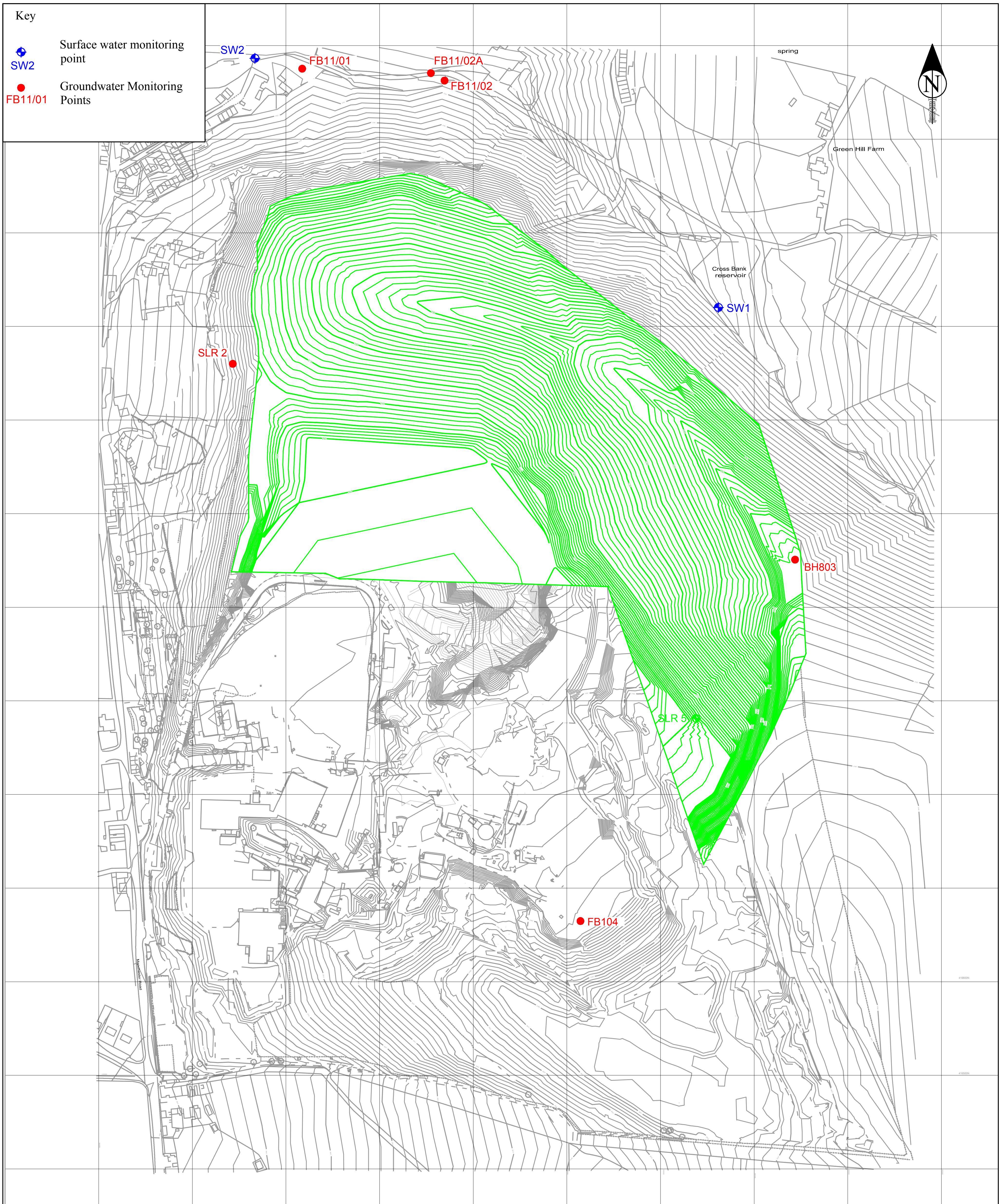
Reference has been made to post-closure gas monitoring data recorded from a completed site filled with wastes similar to that deposited at Fletcher Bank and gas monitoring data undertaken at Fletcher Bank. Actual gas production was found to be negligible and therefore the gas volumes predicted by the GasSim model is likely to be very conservative. It is likely that gas production at the site will have reduced sufficiently to allow surrender of the permit within 10 years of commencement of the site aftercare phase.

A number of receptors have been identified, however due to the negligible volumes of gas being produced it is concluded that landfill gas does not pose a significant risk to the surrounding environment.

The potential for odours arising the placement of wastes is very small.

A gas management plan has been outlined in the Landfill Gas Report referenced K0047-ST-R002 submitted in conjunction with this report and reflects the low risk the site poses to the surrounding environment in that no gas flaring or utilisation will be required. Provision is included for monitoring of the site to ensure that gas concentrations in the monitoring boreholes are recorded to be able to monitor gas production from the site and assess any potential risk to surrounding receptors.

Appendix A – Drawings



TerraConsult

Bold Business Centre, Bold Lane, Sutton, St Helens WA9 4TX

Client

Churchill Enviro Ltd.

Site

Fletcher Bank Landfill Site

Title

Environmental Monitoring Plan

Scale	1:4,000	@ A3	
Drawing No.	1772/3/013		
Rev	Date	Description	
A	25/04/16	Added Leachate points	
B	23/08/16	Added Eastern BH Mon location	
C	24/08/16	Added Western BH Mon location	
D	30/09/16	Groundwater Monitoring Points Added	
File	17723013envmonplan Rev D.dwg		
Date	09/16	Engineer	RB
Drawn	PG	Checked	RB

Appendix B – GasSim Model Inputs and Outputs

Year of Interest: All

		Short Term EQS or EAL µg/m3	Long Term EQS or EAL µg/m3	Background Concentration µg/m3
Carbon disulphide - surface	2027	100	64	0
Carbon disulphide - surface	2028	100	64	0
Carbon disulphide - surface	2029	100	64	0
Hydrogen sulphide - surface	2023	150	140	0
Hydrogen sulphide - surface	2024	150	140	0
Hydrogen sulphide - surface	2025	150	140	0
Hydrogen sulphide - surface	2026	150	140	0
Hydrogen sulphide - surface	2027	150	140	0
Hydrogen sulphide - surface	2028	150	140	0
Hydrogen sulphide - surface	2029	150	140	0
Hydrogen sulphide - surface	2030	150	140	0
Hydrogen sulphide - surface	2031	150	140	0
Hydrogen sulphide - surface	2032	150	140	0

	Short Term				Long term			
	Predicted Boundary Concentration µg/m3	Predicted Nearest Receptor Concentration µg/m3	Is the emission rate Insignificant?	Is detailed modelling required?	Predicted Boundary Concentration µg/m3	Predicted Nearest Receptor Concentration µg/m3	Is the emission rate Insignificant?	Is detailed modelling required?
Carbon disulphide - surface - 2027	2.04026(134703m)	10.8814(14.1421m)	Yes (at boundary)	No	0.0136017(134703m)	0.224428(14.1421m)	Yes	No
Carbon disulphide - surface - 2028	2.20194(134703m)	11.7437(14.1421m)	Yes (at boundary)	No	0.0146796(134703m)	0.242214(14.1421m)	Yes	No
Carbon disulphide - surface - 2029	2.2106(134703m)	11.7899(14.1421m)	Yes (at boundary)	No	0.0147373(134703m)	0.243166(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2023	2.99672(134703m)	15.9825(14.1421m)	Yes (at boundary)	No	0.0199781(134703m)	0.329639(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2024	3.8247(134703m)	20.3984(14.1421m)	Yes (at boundary)	No	0.025498(134703m)	0.420717(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2025	4.4965(134703m)	23.9813(14.1421m)	Yes (at boundary)	No	0.0299767(134703m)	0.494615(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2026	5.04162(134703m)	26.8886(14.1421m)	Yes (at boundary)	No	0.0336108(134703m)	0.554578(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2027	5.48397(134703m)	29.2478(14.1421m)	Yes (at boundary)	No	0.0365598(134703m)	0.603236(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2028	5.84294(134703m)	31.1623(14.1421m)	Yes (at boundary)	No	0.0389529(134703m)	0.642723(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2029	5.76504(134703m)	30.7469(14.1421m)	Yes (at boundary)	No	0.0384336(134703m)	0.634154(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2030	4.71549(134703m)	25.1493(14.1421m)	Yes (at boundary)	No	0.0314366(134703m)	0.518704(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2031	3.82641(134703m)	20.4075(14.1421m)	Yes (at boundary)	No	0.0255094(134703m)	0.420905(14.1421m)	Yes	No
Hydrogen sulphide - surface - 2032	3.06527(134703m)	16.3481(14.1421m)	Yes (at boundary)	No	0.0204352(134703m)	0.33718(14.1421m)	Yes	No

Not Modelled:

1,1,1,2-Tetrafluorochloroethane
1,1,1-Trichlorotrifluoroethane
1,1,2-Trichloroethane
1,1-Dichloroethene
1,1-Dichlorotetrafluoroethane
1,2-Dichloropropane
1,2-Dichlorotetrafluoroethane
1-butanethiol
1-Chloro-1,1-difluoroethane
2-butoxy ethanol
2-Chloro-1,1,1-trifluoroethane
2-Propanol
Arsenic
Bromodichloromethane
Butene isomers
Butyric acid
Carbonyl sulphide
Chlorofluorocarbons (CFCs) (Total)
Chlorofluoromethane
Chlorotrifluoromethane
Diethyl disulphide
Dimethyl disulphide
Dimethyl sulphide
Dioxins and furans (modelled as 2,3,7,8-TCDD)
Ethane
Ethyl butyrate
Ethyl toluene (all isomers)
Ethylene
Ethylene dibromide
Ethylene dichloride
Fluorotrichloromethane
Freon 113
Furan
Halons
Hexachlorocyclohexane (all isomers)
Hydrochlorofluorocarbons (HCFCs) (Total)
Hydrofluorocarbons (HFCs) (Total)
Limonene
Methyl ethyl ketone (2-butanone)
Methyl isobutyl ketone
Nitrogen dioxide (NO2)
Nitrogen monoxide (NO)
Odour Units (Predicted)

Pentane

Not Modelled:

Pentene (all isomers)
Perfluorocarbons (PFCs) (Total)
Propane
Propanethiol
Sulphide, total simulations with H2S
Sulphide, total simulations without H2S
Tetrachloroethane (modelled as 1,1,2,2-Tetrachloroethane)
Total non-methane volatile organic compounds (NMVOCs)
Total volatile organic compounds (VOCs)
Trichlorobenzene (all isomers)
Trichlorotrifluoroethane

Appendix C – Fletcher Bank Quarry Landfill Site Monitoring Data

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
BH803	26/06/17	982	0.1	0.1	0.1	0.1	20.8	1	1
BH803	14/07/17	987	0.1	0.1	0.1	0.1	21	1	1
BH803	17/08/17	976	0.1	0.1	0.1	0.6	19.9	1	1
BH803	08/09/17	966	0.1	0.1	0.1	0.6	19.9	1	1
BH803	13/10/17	983	0.1	0.1	0.1	0.4	20.2	1	1
BH803	09/11/17	988	1.68	1.62	0.1	0.5	20.1	1	1
BH803	07/12/17	973	0.1	0.1	0.1	0.1	20.4	1	1
BH803	24/01/18	972	0.01	0.1	0.1	0.1	19	1	1
BH803	26/02/18	1018	0.01	0.1	0.1	0.1	19.1	1	1
BH803	26/03/18	990	0.01	0.1	0.1	0.1	20.4	1	1
BH803	09/04/18	979	0.01	0.1	0.1	0.1	20.5	1	1
BH803	15/05/18	998	0.01	0.1	0.1	0.1	20.2	1	1
BH803	08/06/18	987	0.01	0.1	0.1	0.1	20.8	1	1
BH803	06/07/18	994	0.01	0.1	0.1	0.1	20.5	1	1
BH803	29/08/18	803	0.01	0.1	0.1	0.1	20.4	1	1
BH803	10/09/18	991	0.01	0.1	0.1	0.1	20.4	1	1
BH803	05/10/18	985	0.01	0.1	0.1	0.1	20.4	1	1
BH803	02/11/18	993	0.01	0.1	0.1	0.1	20.4	1	1
BH803	05/12/18	965	-0.03	-0.4	0.1	0.1	19.8	1	1
BH803	09/01/19	1007	0.01	0.1	0.1	0.1	20.1	1	1
BH803	20/02/19	986	0.08	1.2	0.1	0.1	19	1	1
BH803	27/03/19	1004	0.01	0.1	0.1	0.1	19.2	1	1
BH803	16/04/19	990	0.01	0.1	0.1	0.2	19.3	1	1
BH803	14/05/19	1009	0.01	0.1	0.1	0.1	20	1	1
BH803	04/06/19	982	0.01	0.1	0.1	0.1	20.2	1	1
BH803	17/07/19	986	0.01	0.1	0.1	0.1	20.3	1	1
BH803	13/08/19	987	-0.2	-14	0.1	0.1	20.8	1	1
BH803	10/09/19	989	0.1	0.1	0.1	0.1	20.9	1	1
BH803	14/10/19	985	0.1	0.1	0.1	0.1	20.1	1	1
BH803	14/11/19	988	0.1	0.1	0.1	0.1	19.1	1	1
BH803	03/12/19	980	0.01	0.1	0.1	0.1	20.2	1	1
BH803	13/01/20	982	0.01	0.1	0.1	0.1	20.1	1	1
BH803	18/02/20	983	-1.7	-2.4	0.1	0.1	20.6	1	1
BH803	16/03/20	973	-1.95	-12.7	0.1	0.1	20.2	1	1
BH803	08/04/20	989	0.01	0.1	0.1	0.1	20.5	1	1
BH803	21/05/20	978	0.01	0.1	0.1	0.1	20.2	1	1
BH803	23/06/20	993	0.01	0.1	0.1	0.1	21.3	1	1
BH803	21/07/20	992	0.01	0.1	0.1	0.1	20.8	1	1
BH803	11/08/20	991	0.01	0.1	0.1	0.1	19.8	1	1
BH803	22/09/20	982	0.01	0.1	0.1	0.1	20.7	1	1
BH803	14/10/20	999	0.01	0.1	0.1	0.1	19.7	1	1
BH803	10/11/20	992	0.01	0.1	0.1	0.1	18.1	1	1
BH803	02/12/20	988	0.01	0.1	0.1	0.1	20.0	1	1
BH803	18/01/21	987	0.01	0.1	0.1	0.1	20.1	1	1
BH803	16/02/21	974	0.01	0.1	0.1	0.1	20.1	1	1
BH803	25/03/21	986	0.01	0.1	0.1	0.1	20	1	1
BH803	30/04/21	991	0.01	0.1	0.1	0.1	20	1	1
BH803	20/05/21	979	0.01	0.1	0.1	0.1	20.1	1	1
BH803	30/06/21	1010	0.01	0.1	0.1	0.1	20.4	1	1
BH803	22/07/21	993	0.01	0.1	0.1	0.1	20.6	1	1
FB104R	09/04/15	986	-0.12	-1.2	0.1	0.8	18	1	1
FB104R	26/06/17	989	0.1	0.1	0.1	0.1	21.1	1	1
FB104R	14/07/17	995	0.1	0.1	0.1	1.5	9.1	1	1
FB104R	17/08/17	982	0.1	0.1	0.1	0.7	10.2	1	1
FB104R	08/09/17	977	0.1	0.1	0.1	0.3	12.1	1	1

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
FB104R	13/10/17	993	0.1	0.1	0.1	0.2	14.6	1	1
FB104R	09/11/17	988	-0.47	-3.7	0.1	0.9	12.8	1	1
FB104R	07/12/17	978	0.1	0.1	0.1	0.4	11.9	1	1
FB104R	24/01/18	980	0.01	0.1	0.1	0.2	16.1	1	1
FB104R	26/02/18	1020	0.18	2.4	0.1	0.9	10	1	1
FB104R	26/03/18	1000	0.01	0.1	0.1	1.4	10.9	1	1
FB104R	15/05/18	997	-0.07	-1.3	0.1	0.5	17.8	1	1
FB104R	08/06/18	993	0.01	0.1	0.1	0.1	20.7	1	1
FB104R	06/07/18	999	-0.13	-3.1	0.1	0.8	12.4	1	1
FB104R	29/08/18	995	-0.17	-3.5	0.1	0.7	16	1	1
FB104R	10/09/18	997	0.01	0.3	0.1	0.9	12.7	1	1
FB104R	05/10/18	990	0.01	0.1	0.1	1.2	12	1	1
FB104R	02/11/18	1000	0.01	0.1	0.1	0.4	16.1	1	1
FB104R	05/12/18	970	-1.43	-16.8	0.1	1.2	17.7	1	1
FB104R	09/01/19	1009	-0.01	-0.2	0.1	0.8	15.8	1	1
FB104R	20/02/19	991	-0.04	-0.5	0.1	0.8	18.1	1	1
FB104R	27/03/19	1011	-0.17	-2.2	0.1	0.8	15.3	1	1
FB104R	16/04/19	994	-0.01	-0.4	0.1	0.9	15.6	1	1
FB104R	14/05/19	1013	0.01	0.1	0.1	1	15.2	1	1
FB104R	04/06/19	980	0.01	0.1	0.1	0.2	20.1	1	1
FB104R	17/07/19	986	0.01	0.1	0.1	1	20.3	1	1
FB104R	13/08/19	987	0.01	0.1	0.1	0.1	20.4	1	1
FB104R	10/09/19	989	0.01	0.1	0.1	1.4	20.8	1	1
FB104R	14/10/19	985	0.01	0.1	0.1	1.5	20.2	1	1
FB104R	14/11/19	988	0.01	0.1	0.1	1.1	19.7	1	1
FB104R	03/12/19	980	0.01	0.1	0.1	1	20.2	1	1
FB104R	18/02/20	983	0.01	0.1	0.1	1.3	15.5	1	1
FB104R	16/03/20	980	-2.33	-14.8	0.1	1	15.1	1	1
FB104R	08/04/20	994	0.01	0.1	0.1	0.8	15.1	1	1
FB104R	21/05/20	987	0.01	0.1	0.1	0.8	15.0	1	1
FB104R	23/06/20	998	0.01	0.1	0.1	0.1	21.3	1	1
FB104R	21/07/20	998	0.01	0.1	0.1	0.1	20.8	1	1
FB104R	22/09/20	986	0.01	0.1	0.1	1.2	17.9	1	1
FB104R	14/10/20	1003	0.01	0.1	0.1	0.1	17.4	1	1
FB104R	10/11/20	998	0.01	0.1	0.1	0.1	18.0	1	1
FB104R	02/12/20	992	0.01	0.1	0.1	0.8	18.2	1	1
FB104R	18/01/21	993	0.01	0.1	0.1	0.9	16.9	1	1
FB104R	16/02/21	981	0.01	0.1	0.1	0.8	16.6	1	1
FB104R	25/03/21	990	0.01	0.1	0.1	0.7	17.8	1	1
FB104R	30/04/21	990	0.01	0.1	0.1	0.1	20.1	1	1
FB104R	20/05/21	983	0.01	0.1	0.1	0.1	19.8	1	1
FB104R	30/06/21	1013	0.01	0.1	0.1	0.4	19.1	1	1
FB104R	22/07/21	998	0.01	0.1	0.1	0.2	0	1	1
FBE 11-01	19/05/17	989	0.1	0.1	0.1	0.4	20.0	1	1
FBE 11-01	26/06/17	994	0.1	0.1	0.1	0.9	19.6	1	1
FBE 11-01	14/07/17	1000	0.1	0.1	0.1	0.9	11.5	1	1
FBE 11-01	17/08/17	988	0.1	0.1	0.1	0.3	20.5	1	1
FBE 11-01	08/09/17	977	0.1	0.1	0.1	0.9	19.7	1	1
FBE 11-01	13/10/17	993	0.1	0.1	0.1	0.4	19.9	1	1
FBE 11-01	09/11/17	1001	0.1	0.1	0.1	1.7	18.9	1	1
FBE 11-01	07/12/17	985	-3	-0.3	0.1	1.8	18.2	1	1
FBE 11-01	24/01/18	977	0.01	0.1	0.1	0.1	20.2	1	1
FBE 11-01	26/02/18	1024	0.01	0.1	0.1	0.6	19.4	1	1
FBE 11-01	26/03/18	1000	0.01	0.1	0.1	0.3	20.4	1	1
FBE 11-01	09/04/18	991	0.01	0.1	0.1	0.9	19.9	1	1

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
FBE 11-01	15/05/18	1003	9.51	66.3	0.1	1.1	19.8	1	1
FBE 11-01	08/06/18	1000	0.01	0.1	0.1	1.8	18.9	1	1
FBE 11-01	06/07/18	1003	0.01	0.1	0.1	0.5	20.3	1	1
FBE 11-01	29/08/18	1000	0.01	0.1	0.1	1.1	18.9	1	1
FBE 11-01	10/09/18	1002	0.01	0.1	0.1	1.3	18.8	1	1
FBE 11-01	05/10/18	995	0.01	0.1	0.1	0.7	19.4	1	1
FBE 11-01	02/11/18	1005	0.01	0.1	0.1	0.5	18.9	1	1
FBE 11-01	05/12/18	975	-1.21	-15.3	0.1	0.7	19.1	1	1
FBE 11-01	09/01/19	1014	0.01	0.1	0.1	1.3	14.6	1	1
FBE 11-01	20/02/19	997	-0.02	-0.2	0.1	0.3	18.9	1	1
FBE 11-01	27/03/19	1015	0.01	0.1	0.1	1.2	14.8	1	1
FBE 11-01	16/04/19	998	0.01	0.1	0.1	0.5	19.5	1	1
FBE 11-01	14/05/19	1023	0.01	0.1	0.1	0.8	19.1	1	1
FBE 11-01	04/06/19	983	0.01	0.1	0.1	0.1	19.9	1	1
FBE 11-01	17/07/19	986	0.01	0.1	0.1	1.5	19.4	1	1
FBE 11-01	13/08/19	987	0.01	0.1	0.1	0.7	19.3	1	1
FBE 11-01	10/09/19	990	0.01	0.1	0.1	0.7	20.8	1	1
FBE 11-01	14/10/19	985	0.01	0.1	0.1	0.6	20.1	1	1
FBE 11-01	14/11/19	988	0.01	0.1	0.1	0.9	18.4	1	1
FBE 11-01	03/12/19	980	0.01	0.1	0.1	0.5	18.9	1	1
FBE 11-01	13/01/20	982	0.01	0.1	0.1	0.8	18.2	1	1
FBE 11-01	18/02/20	993	-2.1	-14	0.1	0.4	20.3	1	1
FBE 11-01	16/03/20	987	-1.7	-11.3	0.1	0.2	19.9	1	1
FBE 11-01	08/04/20	1001	0.01	0.1	0.1	0.3	20.4	1	1
FBE 11-01	21/05/20	987	0.01	0.1	0.1	0.6	20.1	1	1
FBE 11-01	23/06/20	1004	0.01	0.1	0.1	0.9	20	1	1
FBE 11-01	21/07/20	1004	0.01	0.1	0.1	0.8	19.8	1	1
FBE 11-01	11/08/20	994	0.01	0.1	0.1	0.5	20.6	1	1
FBE 11-01	22/09/20	988	0.01	0.1	0.1	1.1	18.9	1	1
FBE 11-01	14/10/20	1009	-0.07	-1.0	0.1	0.5	14.6	1	1
FBE 11-01	10/11/20	1003	0.01	0.1	0.1	0.5	17.2	1	1
FBE 11-01	02/12/20	998	0.01	0.1	0.1	0.7	19.5	1	1
FBE 11-01	16/02/21	984	0.01	0.1	0.1	0.4	19.8	1	1
FBE 11-01	25/03/21	995	0.01	0.1	0.1	1.1	19.5	1	1
FBE 11-01	30/04/21	997	0.01	0.1	0.1	1.3	19.4	1	1
FBE 11-01	20/05/21	993	0.01	0.1	0.1	1.2	19.2	1	1
FBE 11-01	30/06/21	1011	0.01	0.1	0.1	0.7	18.7	1	1
FBE 11-01	22/07/21	1001	0.01	0.1	0.1	0.6	20.2	1	1
FBE 11-02	19/05/17	988	0.1	0.1	0.1	1	19.7	1	1
FBE 11-02	26/06/17	994	4	0.7	0.1	1.7	17.2	1	1
FBE 11-02	14/07/17	998	0.1	0.1	0.1	1.9	16.1	1	1
FBE 11-02	17/08/17	988	-1	-0.1	0.1	2.2	14.4	1	1
FBE 11-02	08/09/17	976	0.1	0.1	0.1	2.4	15.0	1	1
FBE 11-02	13/10/17	993	-1	-0.1	0.1	1.6	16.6	1	1
FBE 11-02	09/11/17	1001	0.1	0.1	0.1	2.1	15.5	1	1
FBE 11-02	07/12/17	985	-3	-0.4	0.1	1.5	16.0	1	1
FBE 11-02	24/01/18	975	0.01	0.1	0.1	0.6	19.4	1	1
FBE 11-02	26/02/18	1024	0.01	0.1	0.1	0.6	19.1	1	1
FBE 11-02	26/03/18	1000	0.01	0.1	0.1	0.4	19.9	1	1
FBE 11-02	09/04/18	991	0.01	0.1	0.1	1.4	17.8	1	1
FBE 11-02	15/05/18	1002	0.01	0.1	0.1	1.7	15.8	1	1
FBE 11-02	08/06/18	998	0.01	0.1	0.1	2.0	15.0	1	1
FBE 11-02	06/07/18	1003	0.01	0.1	0.1	2.3	13.3	1	1
FBE 11-02	29/08/18	1000	0.01	0.1	0.1	2.9	9.6	1	1
FBE 11-02	10/09/18	1002	0.01	0.1	0.1	1.4	15.5	1	1

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
FBE 11-02	05/10/18	995	-0.02	-0.3	0.1	2.6	10.8	1	1
FBE 11-02	02/11/18	1004	0.03	0.3	0.1	1.8	12.3	1	1
FBE 11-02	05/12/18	974	-3.61	-36.9	0.1	2.0	10.7	1	1
FBE 11-02	09/01/19	1015	0.01	0.1	0.1	1.1	14.8	1	1
FBE 11-02	20/02/19	996	-0.02	-0.3	0.1	1.4	13.0	1	1
FBE 11-02	27/03/19	1015	0.01	0.1	0.1	1.0	15.2	1	1
FBE 11-02	16/04/19	998	0.01	0.1	0.1	2.0	14.1	1	1
FBE 11-02	14/05/19	1023	0.01	0.1	0.1	2.0	13.6	1	1
FBE 11-02	04/06/19	981	0.01	0.1	0.1	0.2	20.1	1	1
FBE 11-02	17/07/19	986	0.01	0.1	0.1	2.8	12.5	1	1
FBE 11-02	13/08/19	987	0.01	0.1	0.1	2.2	13.8	1	1
FBE 11-02	10/09/19	989	0.01	0.1	0.1	1.6	20.8	1	1
FBE 11-02	14/10/19	985	0.01	0.0	0.1	1.2	20.1	1	1
FBE 11-02	14/11/19	988	0.01	0.1	0.1	1.1	20.1	1	1
FBE 11-02	03/12/19	980	0.01	0.1	0.1	0.7	19.4	1	1
FBE 11-02	13/01/20	982	0.01	0.1	0.1	1.5	18.8	1	1
FBE 11-02	18/02/20	992	0.01	0.1	0.1	0.4	20.1	1	1
FBE 11-02	16/03/20	984	0.01	0.1	0.1	0.8	18.8	1	1
FBE 11-02	08/04/20	1000	0.01	0.1	0.1	0.9	17.7	1	1
FBE 11-02	21/05/20	987	0.01	0.1	0.1	1.8	14.1	1	1
FBE 11-02	23/06/20	1003	0.05	0.7	0.1	2.2	12.3	1	1
FBE 11-02	21/07/20	1003	0.01	0.1	0.1	1.8	13.3	1	1
FBE 11-02	11/08/20	994	0.01	0.1	0.1	2.0	14.2	1	1
FBE 11-02	22/09/20	988	0.01	0.1	0.1	2.6	13.7	1	1
FBE 11-02	14/10/20	1008	-0.48	-4.8	0.1	0.8	17.2	1	1
FBE 11-02	10/11/20	1003	-1.32	-9.3	0.1	0.1	18.1	1	1
FBE 11-02	02/12/20	998	0.01	0.1	0.1	0.7	17.8	1	1
FBE 11-02	18/01/21	999	0.01	0.1	0.1	0.6	18.1	1	1
FBE 11-02	16/02/21	986	0.01	0.1	0.1	1.1	15.4	1	1
FBE 11-02	25/03/21	994	0.01	0.1	0.1	0.9	16.6	1	1
FBE 11-02	30/04/21	996	0.01	0.1	0.1	0.8	17.5	1	1
FBE 11-02	20/05/21	991	0.01	0.1	0.1	1.4	14.9	1	1
FBE 11-02	30/06/21	1014	0.01	0.1	0.1	0.1	16.4	1	1
FBE 11-02	22/07/21	1001	0.01	0.1	1.9	0.0	14.5	1	1
FBE 11-02A	19/05/17	988	0.1	0.1	0.1	0.3	20.7	1	1
FBE 11-02A	26/06/17	993	0.1	0.1	0.1	0.4	20.6	1	1
FBE 11-02A	14/07/17	998	0.1	0.1	0.1	0.5	20.0	1	1
FBE 11-02A	17/08/17	988	0.1	0.1	0.1	0.1	20.5	1	1
FBE 11-02A	08/09/17	977	0.1	0.1	0.1	0.4	20.1	1	1
FBE 11-02A	13/10/17	993	0.1	0.1	0.1	0.2	20.4	1	1
FBE 11-02A	09/11/17	1001	0.1	0.1	0.1	0.6	19.6	1	1
FBE 11-02A	07/12/17	985	0.1	0.1	0.1	0	20.1	1	1
FBE 11-02A	24/01/18	975	-0.05	-0.9	0.1	0.7	19.0	1	1
FBE 11-02A	26/02/18	1024	0.01	0.1	0.1	1.6	18.9	1	1
FBE 11-02A	26/03/18	1000	0.01	0.1	0.1	0.2	20.4	1	1
FBE 11-02A	09/04/18	991	0.01	0.1	0.1	1.0	19.6	1	1
FBE 11-02A	15/05/18	1002	0.01	0.1	0.1	0.1	20.5	1	1
FBE 11-02A	08/06/18	998	0.01	0.1	0.1	0.9	19.5	1	1
FBE 11-02A	06/07/18	1003	0.01	0.1	0.1	1.5	18.3	1	1
FBE 11-02A	29/08/18	999	0.01	0.1	0.1	0.1	20.1	1	1
FBE 11-02A	10/09/18	1002	0.01	0.1	0.1	1	19.5	1	1
FBE 11-02A	05/10/18	995	0.03	0.5	0.1	0.6	19.3	1	1
FBE 11-02A	02/11/18	1004	-0.12	-2.1	0.1	1	18.3	1	1
FBE 11-02A	05/12/18	974	0.01	0.1	0.1	0.1	19.9	1	1
FBE 11-02A	09/01/19	1015	0.01	0.1	0.1	1.1	15.7	1	1

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
FBE 11-02A	20/02/19	995	0.04	0.7	0.1	0.9	13.8	1	1
FBE 11-02A	27/03/19	1015	0.03	0.5	0.1	1.4	14.2	1	1
FBE 11-02A	16/04/19	998	0.01	0.1	0.1	1.3	14.8	1	1
FBE 11-02A	14/05/19	1022	0.01	0.1	0.1	0.8	16.5	1	1
FBE 11-02A	04/06/19	980	0.01	0.1	0.1	0.1	20.1	1	1
FBE 11-02A	17/07/19	986	0.01	0.1	0.1	1.3	17.8	1	1
FBE 11-02A	13/08/19	987	0.01	0.1	0.1	0.1	20.1	1	1
FBE 11-02A	10/09/19	989	0.01	0.1	0.1	0.4	20.4	1	1
FBE 11-02A	14/10/19	985	0.01	0.1	0.1	0.3	19.9	1	1
FBE 11-02A	14/11/19	988	0.01	0.1	0.1	0.2	19.1	1	1
FBE 11-02A	03/12/19	980	0.01	0.1	0.1	0.7	18.9	1	1
FBE 11-02A	13/01/20	982	0.01	0.1	0.1	0.5	19.2	1	1
FBE 11-02A	16/03/20	985	-1.98	-12.9	0.1	0.6	19.3	1	1
FBE 11-02A	08/04/20	1000	0.01	0.1	0.1	0.2	20.5	1	1
FBE 11-02A	21/05/20	987	0.01	0.1	0.1	0.3	19.9	1	1
FBE 11-02A	23/06/20	1003	0.01	0.1	0.1	1.1	12.9	1	1
FBE 11-02A	21/07/20	1003	0.01	0.1	0.1	0.9	16.8	1	1
FBE 11-02A	11/08/20	994	0.01	0.1	0.1	1.3	18.1	1	1
FBE 11-02A	22/09/20	989	0.01	0.1	0.1	1.1	18.9	1	1
FBE 11-02A	14/10/20	1007	0.01	0.1	0.1	0.9	15.8	1	1
FBE 11-02A	10/11/20	1003	0.01	0.1	0.1	0.9	17.6	1	1
FBE 11-02A	02/12/20	997	0.72	8.1	0.1	0.7	16.7	1	1
FBE 11-02A	18/01/21	999	0.01	0.1	0.1	0.8	16.4	1	1
FBE 11-02A	16/02/21	985	0.01	0.1	0.1	0.7	18.4	1	1
FBE 11-02A	25/03/21	994	0.01	0.1	0.1	0.5	19.4	1	1
FBE 11-02A	30/04/21	996	0.01	0.1	0.1	0.8	19.6	1	1
FBE 11-02A	20/05/21	990	0.01	0.1	0.1	1.1	19	1	1
FBE 11-02A	30/06/21	1012	0.01	0.1	0.1	0.7	18.7	1	1
FBE 11-02A	22/07/21	1001	0.01	0.1	0.1	0.5	20.1	1	1
FBE 11-02A	1802/20	992	0.01	0.1	0.1	0.3	20.5	1	1
SLR2	19/05/17	985	0.1	0.1	0.1	0.2	20.6	1	1
SLR2	26/06/17	989	0.1	0.1	0.1	0.3	20.8	1	1
SLR2	14/07/17	992	2	0.4	0.1	0.2	21.0	1	1
SLR2	17/08/17	982	-4	-0.6	0.1	0.1	20.7	1	1
SLR2	08/09/17	972	0.1	0.1	0.1	0.2	20.5	1	1
SLR2	13/10/17	988	0.1	0.1	0.1	0.2	20.6	1	1
SLR2	09/11/17	995	0.1	0.1	0.1	0.4	20.1	1	1
SLR2	07/12/17	978	0.24	3.1	0.1	0.4	19	1	1
SLR2	24/01/18	970	0.01	0.1	0.1	0.4	20.4	1	1
SLR2	26/02/18	1020	0.01	0.1	0.1	0.4	18.9	1	1
SLR2	26/03/18	995	-0.02	-0.6	0.1	0.4	19.7	1	1
SLR2	09/04/18	984	0.01	0.1	0.1	0.3	20.0	1	1
SLR2	15/05/18	998	0.01	0.1	0.1	0.4	19.8	1	1
SLR2	08/06/18	993	0.01	0.1	0.1	0.2	20.5	1	1
SLR2	06/07/18	1000	0.01	0.1	0.1	0.1	20.5	1	1
SLR2	29/08/18	995	0.01	0.1	0.1	0.1	20.2	1	1
SLR2	10/09/18	997	0.01	0.1	0.1	0.1	20.5	1	1
SLR2	05/10/18	992	0.01	0.1	0.1	0.2	20.0	1	1
SLR2	02/11/18	999	0.02	0.3	0.1	0.1	19.5	1	1
SLR2	05/12/18	973	0.05	0.7	0.1	0.2	19.3	1	1
SLR2	09/01/19	1009	0.07	1.2	0.1	0.5	18.1	1	1
SLR2	20/02/19	992	0.06	0.9	0.1	0.2	19.4	1	1
SLR2	27/03/19	1011	0.03	0.4	0.1	0.2	19.2	1	1
SLR2	16/04/19	991	0.01	0.1	0.1	0.3	18.9	1	1
SLR2	14/05/19	1016	0.01	0.1	0.1	0.3	19.5	1	1

Location	Date	Atmospheric Pressure (mbar)	Relative Pressure	Steady Flow (l/h)	CH_4 (% v/v)	CO_2 (% v/v)	O_2 (% v/v)	CO (ppm)	H_2S (ppm)
SLR2	04/06/19	982	0.01	0.1	0.1	0.1	20.2	1	1
SLR2	17/07/19	986	0.01	0.1	0.1	0.1	20.7	1	1
SLR2	13/08/19	987	0.01	0.1	0.1	0.1	21.0	1	1
SLR2	10/09/19	989	0.01	0.1	0.1	0.3	20.9	1	1
SLR2	14/10/19	985	0.01	0.1	0.1	0.4	20.4	1	1
SLR2	14/11/19	988	0.01	0.1	0.1	0.7	20.1	1	1
SLR2	03/12/19	980	0.01	0.1	0.1	0.3	19.8	1	1
SLR2	13/01/20	982	0.01	0.1	0.1	0.5	19.5	1	1
SLR2	18/02/20	983	0.01	0.1	0.1	0.3	20.0	1	1
SLR2	16/03/20	980	0.01	0.1	0.1	0.4	19.6	1	1
SLR2	08/04/20	988	0.01	0.1	0.1	0.3	20.0	1	1
SLR2	21/05/20	986	0.01	0.1	0.1	0.1	20.2	1	1
SLR2	23/06/20	998	0.01	0.1	0.1	0.1	21.4	1	1
SLR2	21/07/20	998	0.01	0.1	0.1	0.1	20.7	1	1
SLR2	11/08/20	992	0.01	0.1	0.1	0.2	20.1	1	1
SLR2	14/10/20	1001	0.01	0.1	0.1	0.2	18.6	1	1
SLR2	10/11/20	998	0.01	0.1	0.1	0.3	18.2	1	1
SLR2	02/12/20	993	0.01	0.1	0.1	0.3	19.5	1	1
SLR2	18/01/21	996	0.01	0.1	0.1	0.2	19.7	1	1
SLR2	16/02/21	981	0.01	0.1	0.1	0.4	19.7	1	1
SLR2	25/03/21	995	0.01	0.1	0.1	0.3	19.5	1	1
SLR2	30/04/21	992	0.01	0.1	0.1	0.2	19.4	1	1
SLR2	20/05/21	987	0.01	0.1	0.1	0.2	19.7	1	1
SLR2	30/06/21	1012	0.01	0.1	0.1	0.1	20.1	1	1
SLR2	22/07/21	998	0.01	0.1	0.1	0	20.6	0	0

Appendix D – Electronic copy of GasSim files

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