

Caulmert Limited

Engineering, Environmental & Planning
Consultancy Services

Brookhill Landfill Site

Flintshire County Council

Closure Report

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**BROOKHILL LANDFILL SITE
CLOSURE REPORT****TABLE OF CONTENTS**

1.0	PRELIMINARIES.....	1
1.1	Site History.....	1
1.2	Amendment Procedure	1
2.0	AREA OF CLOSURE	2
2.1	Site Engineering	2
3.0	SITE STABILITY AND FINAL LANDFORM	3
3.1	Stability of the Landfill Site	3
3.2	Topographical Surveys	3
4.0	MANAGEMENT AND MONITORING	4
4.1	Site Infrastructure	4
4.2	Landfill Gas Management Infrastructure.....	4
4.3	Landfill Gas Monitoring and Reporting.....	4
4.4	Landfill Gas Action Plan.....	6
4.5	Groundwater Monitoring and Reporting.....	8
4.6	Groundwater Quality Action Plan.....	9
4.7	Surface Water Management	9
4.8	Surface Water Monitoring and Reporting	10
4.9	Surface Water Action Plan	10
4.10	Leachate Management Infrastructure.....	11
4.12	Leachate Level Action Plan	13
4.13	Leachate Treatment Plant.....	14
5.0	MAINTAINING AND SUBMITTING RECORDS	15
5.1	Security and Availability of Records.....	15
6.0	REPORTING OF SIGNIFICANT EFFECTS	16
6.1	Site Inspection.....	16
6.2	Inspection of Restored Surface.....	16
6.3	Inspection of boreholes	17
6.4	Inspection of cap.....	17

DRAWINGS

2231.EMP.01 – Brookhill Landfill Site, Environmental Monitoring Plan

APPENDICES**Appendix 1** Inspection Pro Forms

1.0 PRELIMINARIES

1.1 Site History

- 1.1.1 Brookhill Landfill Site is located approximately 1.5km north of Buckley, Flintshire, North Wales at NGR SJ278656. The site is accessed via the Pinfold Industrial Estate, Pinfold Lane, which is located off the A494 Mold to Ewloe Road.
- 1.1.2 The site is bound to the east by a wooded, disused railway leading to open grassland. Agricultural land lies to the west of the site. The Pinfold Industrial Estate and a number of residential properties (on the outskirts of Buckley, approximately 400 m away) are situated to the south of the site. A restored refuse tip (Ewloe Barn Landfill) lies to the north of the site, which is currently used for rough grassland leading to open grazing land and some woodland.
- 1.1.3 Brookhill Landfill Site has been developed in a former quarry, which was worked for Buckley Fireclay and the siltstones and mudstones beneath the Fireclay (known as the Warrant) for use in the manufacturing of bricks and tiles. In 1997, in preparation for the engineering of the landfill site, further Fireclay was removed together with a quantity of coal in the quarry base under agreement with the Coal Authority. Brookhill landfill site started accepting waste in 1999. The wastes permitted at the site were stipulated within the Environmental Permit (EP). The general waste streams which were permitted at the site through its history can be summarised as:
- Domestic food and organic wastes – approximately 60%
 - Non-hazardous industrial wastes, (including plastic, paper, cardboard, wood, stone and sand, etc.) – approximately 40%
 - Most special wastes (allowed until June 2004)
- 1.1.4 The special wastes which were tipped at the site were accepted pre-June 2004 (under the WML for the site). This indicates that they would have been deposited predominantly within Cell 1, and the lower parts of Cells 2, 3 and 4. It is likely that none of the waste tipped in Cells 5 and 6 contains any 'special waste' waste streams.
- 1.1.5 The site ceased accepting waste in late 2007. The final capping and restoration phases were undertaken during 2010.

1.2 Amendment Procedure

- 1.2.1 Flintshire County Council (FCC) shall give notice to Natural Resources Wales (NRW) in writing of any changes to the Closure Report. Implementation of any changes will only be put into effect and incorporated into the Closure Report when approval of a risk assessed approach and subsequent approval of the proposal have been received in writing, where necessary, from NRW.

2.0 AREA OF CLOSURE

2.1 Site Engineering

- 2.1.1 The site comprises six separate cells. The engineering details and the formation levels of the cells are indicated in Table 1.

Table 1: Engineering details of the cells at Brookhill Landfill Site

Cell	Year of construction	Base level mAOD	Base area m ²	Engineering - Base	Engineering – Sides	Leachate Drainage system
1	1999 - 2001	117	3324	0.6m EML, 2.0mm HDPE	1.0m EML, 2.00mm HDPE up to 7m	300mm thick granular leachate drainage blanket
2	1999 - 2001	113	3234	1.0m EML	1.0m EML	As in Cell 1
3	2001 - 2003	112	2160	1.0m EML	1.25m EML	As in Cell 1
4	2002 - 2004	112	2808	1.0m EML	1.25m EML	As in Cell 1 and a HDPE leachate collection system
5	2002 - 2004	113	2408	1.0m EML	1.25m EML	As in Cell 4
6	2003 - 2005	120	2672	2.0m EML	2.0m EML	As in Cell 4

EML - Engineered Mineral Liner

- 2.1.2 An under-liner drainage system was installed to remove groundwater from below the cell basal and side wall lining and prevent the build-up of hydrostatic head (as detailed in the CQA plans for the site prepared by Symonds in 2001) and allowed construction of the cells below the water table.
- 2.1.3 The final capping and restoration phases were undertaken during 2010. The capping details of the site are a flexible membrane cap, installed onto a protective geotextile layer and restored with cover soils (specific capping specifications are detailed in capping CQA plans for the site).

3.0 SITE STABILITY AND FINAL LANDFORM

3.1 Stability of the Landfill Site

- 3.1.1 A Stability Risk Assessment report for the site was prepared by EDGE Consultants UK Ltd in September 2003, ref. 544.2B-030828.R1.6-SRA. The report concludes that the stability and integrity of the basal and side-slope sub-grades, basal and side slope linings, waste mass and capping system are adequate.
- 3.1.2 A Settlement Review for the site was prepared by Egniol Ltd in August 2005. The aim of this report was to examine the appropriateness of the post-settlement contours in planning permission reference 4/0/21554, and make recommendations for the final, pre-settlement levels to which waste can be tipped, and the site restored in such a way that in the fullness of time the extant post-settlement contours would be achieved.
- 3.1.3 The Settlement Review predicted a long-term settlement allowance of between 35 and 40 %, or more. Based on extant planning permission post-settlement levels, this would result in compounded (i.e. 40 % of the post-settlement waste depth, plus 40 % of the pre-settlement allowance, to allow for settlement within the unsettled waste, and so-on *ad infinitum*) levels rising to a peak of some 158 mAOD. Were they existed, i.e. where tipping had reached final levels, pre-settlement levels were within this range.
- 3.1.4 Final capping and restoration phases were undertaken at the site during 2010. Capping and restoration CQA Validation Reports were submitted for all phases and it is not considered that there will be any long term slope stability problems at the site.
- 3.1.5 In order to verify the stability of the landfill, annual topographical surveys will be undertaken over the aftercare period and annual inspections will check the condition of the restored surface. In the event that topographical surveys show evidence of significant settlement, an investigation into the cause will be instigated and the findings reported to NRW.

3.2 Topographical Surveys

- 3.2.1 A post closure topographical survey is presented on the enclosed Environmental Monitoring Plan.
- 3.2.2 Stable, permanent survey control stations have been established and shall be maintained for the control of all survey work around the Site. The stations are referenced to Survey grid co-ordinates, the grid alignment to within +/-1metre and levels referenced to mAOD.
- 3.2.3 A topographic survey will be carried out at annual intervals throughout the post closure phase. The scale will adequately show surveyed features and be at least 1:1250. The surveys will be sufficient to produce plans that include all roads, structures, boundaries, monitoring points and all other relevant site features. The results of the topographical survey shall be presented as a plan, which will be submitted to NRW annually.

4.0 MANAGEMENT AND MONITORING

4.1 Site Infrastructure

- 4.1.1 The site comprises a closed non-hazardous landfill site and associated installations, accessed via a road from Pinfold Industrial Estate. The landfill forms most of the site area and is generally covered with vegetation, mostly grass with some shrubs and trees. A fence surrounding the whole landfill site prevents unauthorised access to the site.
- 4.1.2 There are several installations in the south west corner of the site including a waste transfer area, oil stores and other containers, a leachate treatment plant, a landfill gas utilisation plant, a landfill gas flare and compound, leachate storage tanks, a site office and weighbridge, and a green waste storage area.
- 4.1.3 The landfill has both an active landfill gas extraction system and an active leachate extraction system; comprised of a number of wells and buried pipework across the landfill surface connected to the landfill gas utilisation and leachate treatment plants.

4.2 Landfill Gas Management Infrastructure

- 4.2.1 Gas extraction is currently undertaken via 39 gas extraction wells and 15 leachate extraction wells with the extracted gas being utilised for power generation or burnt in a flare. The gas plant at the site comprises one engine of 560kW electrical output and a high temperature 1000m³/h back-up flare.

4.3 Landfill Gas Monitoring and Reporting

- 4.3.1 Routine landfill gas monitoring is carried out on a weekly basis by FCC staff at perimeter boreholes BH1, BH3-BH21 and BH23-BH25 in accordance with the requirements of the EP. Landfill gas migration results are statistically analysed and reported on a quarterly basis and in greater detail on an annual basis, to identify any trends in methane and carbon dioxide, as required by the EP.
- 4.3.2 The requirements in Annex III of the EU Landfill Directive regarding the frequency for landfill gas sampling are displayed in Table 2 below.

Table 2 - EU Landfill Directive: Annex III – Landfill Gas Sampling Frequency

Test type and monitoring points	Parameters	Frequency	
		Operating Phase	After-care Phase ⁽³⁾
Landfill gas monitoring points	Potential Gas Emissions and atmospheric pressure ⁽⁴⁾ (CH ₄ , CO ₂ , O ₂ , H ₂ S, H ₂ etc.)	Monthly ⁽³⁾⁽⁵⁾	Every Six Months ⁽⁶⁾

⁽³⁾ If evaluation data indicates longer intervals are equally effective, they may be adapted.

⁽⁴⁾ These measurements are related mainly to the content of organic material in the waste.

⁽⁵⁾ CH₄, CO₂, O₂ regularly, other gases as required according to the composition of the waste deposited, with a view to reflecting its leaching properties.

⁽⁶⁾ Efficiency of the gas extraction system must be checked regularly.

4.3.3 Annex III requires monthly monitoring of landfill gas monitoring points during the operational phase, down to every six months during the after-care phase. Brookhill Landfill Site is currently in the after-care phase, yet perimeter boreholes are still being monitored on a weekly basis. It is proposed that perimeter landfill gas monitoring be reduced to monthly, as detailed in Table 3 below. In the event of a trigger limit exceedance, the action plan detailed in Section 4.4 will be implemented, which includes an increase in monitoring frequency to daily.

Table 3 - Perimeter Landfill Gas Monitoring

Monitoring locations	Monitoring Frequency	Parameters	Trigger Limits (%v/v)
BH1	Monthly	Methane	1.0
		Carbon	8.8
		Oxygen	-
BH3	Monthly	Methane	1.0
		Carbon	3.1
		Oxygen	-
BH4	Monthly	Methane	1.0
		Carbon	5.1
		Oxygen	-
BH5	Monthly	Methane	1.0
		Carbon	1.5
		Oxygen	-
BH6	Monthly	Methane	1.0
		Carbon	1.5
		Oxygen	-
BH7	Monthly	Methane	1.0
		Carbon	10.0
		Oxygen	-
BH8	Monthly	Methane	32.2
		Carbon	3.6
		Oxygen	-
BH9	Monthly	Methane	29.6
		Carbon	10.4
		Oxygen	-
BH10	Monthly	Methane	1.0
		Carbon	3.9
		Oxygen	-
BH11	Monthly	Methane	1.0
		Carbon	6.5
		Oxygen	-
BH12	Monthly	Methane	1.0
		Carbon	6.6
		Oxygen	-
BH13	Monthly	Methane	1.0
		Carbon	9.4
		Oxygen	-
BH14	Monthly	Methane	1.0
		Carbon	3.5
		Oxygen	-
BH15	Monthly	Methane	1.0
		Carbon	17.6
		Oxygen	-
BH16	Monthly	Methane	1.0
		Carbon	11.4
		Oxygen	-
BH17	Monthly	Methane	1.0
		Carbon	12.9
		Oxygen	-
BH18	Monthly	Methane	3.5
		Carbon	10.0
		Oxygen	-
BH19	Monthly	Methane	1.0
		Carbon	11.2
		Oxygen	-
BH23	Monthly	Methane	1.0
		Carbon	7.3
		Oxygen	-
BH24	Monthly	Methane	1.0
		Carbon	1.5
		Oxygen	-
BH25	Monthly	Methane	1.0
		Carbon	9.9
		Oxygen	-

- 4.3.4 The gas field at Brookhill is currently monitored and balanced on a monthly basis by FCC staff. Methane, carbon dioxide, oxygen, balance, relative pressure, hydrogen sulphide and carbon monoxide are recorded on each visit.
- 4.3.5 It is proposed that the gas field monitoring and balancing is continued on a monthly basis, as detailed in Table 4 below.

Table 4 - In-Waste Landfill Gas Monitoring

Parameters	Monitoring locations	Monitoring Frequency	Other Specifications
Methane, Carbon Dioxide, Carbon Monoxide, differential pressure, gas flow rate/suction, oxygen, temperature, meteorological data	In-waste monitoring boreholes	Monthly	Where the oxygen level exceeds 5 % or where the addition of the carbon monoxide and methane percentage is less than 80 %, an assessment of air ingress to the system shall be undertaken. Where the concentration of carbon monoxide exceeds 100 ppm further investigation shall be undertaken.
Trace Gas Analysis	Input to Flare	Annually	-

4.4 Landfill Gas Action Plan

- 4.4.1 This action plan establishes the steps required to be taken in the event of two key events relating to the control and monitoring of landfill gas at Brookhill Landfill Site. These are:
- Failure of any part of the gas control system; and
 - The breach of a trigger limit for methane or carbon dioxide in any of the perimeter landfill gas monitoring points.
- 4.4.2 In the event that the results of the perimeter borehole monitoring indicate that landfill gas concentrations are above the trigger limits, appropriate measures will be undertaken, as detailed in Table 5.

Table 5: Landfill Gas Action Plan

Incident	Action
Failure of Gas Plant	1. Inform NRW immediately of the failure. Use the emergency number outside working hours; 2. Identify cause of failure; 3. If electric supply has failed, contact emergency electrician or if mains electricity supply has failed contact electrical contractor; 4. If flare unit has broken down contact the equipment suppliers, or the nominated service engineer; 5. If gas engine unit has broken down contact the equipment suppliers, or the nominated service engineer; 6. If the condensate pumping system has failed, contact the nominated service engineer; 7. If it is deemed likely that the system will not be operational within 48 hours then make arrangements for alternative hire/replacement equipment to be provide as soon as possible; 8. If elevated levels of methane are identified in perimeter monitoring boreholes then the action plan below should be instigated.
Trigger limit exceedance	Methane 1. Monitoring Technician to inform Energy & Compliance Manager immediately & monitor in-borehole gas pressure; 2. Inform NRW, forward results by e-mail; 3. Immediately begin investigation regarding the reason and nature of the exceedance. Carry out a review of the gas control system and instigate immediate measures to remediate any identified problems. If gas control system has failed instigate 'Failure of Gas Plant' action plan. 4. Whilst investigation is underway, the following measures will be implemented to reduce the methane to within the trigger limit; • The borehole will be passive vented in order to relieve any gas pressure; • The borehole shall then be monitored daily until the gas is below the agreed trigger limit. All results will be forwarded to NRW; • Gas quality within the in-waste gas wells in the vicinity of the affective boreholes will be monitored; • If excessive amounts of oxygen are being drawn into the system, oxygen ingress will be reduced through adjustment of individual wells or parts of the system; • Increased suction will be applied where possible to wells in the vicinity of the affected borehole. Carbon Dioxide 1. Instigate daily monitoring until carbon dioxide concentration reduces to below trigger limit. Results to be forwarded to NRW 2. If after 14 days of non-compliance, carbon dioxide concentration is not reducing, or a reason for gas migration is not evident, inform NRW. Take gas samples as soon as practicable for confirmatory landfill gas chromatography analysis for bulk landfill gases. A review of off-site monitoring measures should also be undertaken. 3. A review of existing gas control measures should also be carried out.

4.5 Groundwater Monitoring and Reporting

- 4.5.1 No groundwater abstraction is conducted in the area surrounding the landfill and no sensitive receptor has been identified within 500 m of the Site. The EP requires monitoring of the groundwater quality to identify any potential pollution from landfill leachate.
- 4.5.2 Groundwater is currently monitored via 13 perimeter boreholes. Groundwater levels are recorded on a monthly basis by FCC staff at groundwater monitoring boreholes GW1, GW2A, GW3A, GW4, GW5A, GW6, GW7 and GW8, in accordance with the EP. Levels are also recorded in GW1A (also referred to as GW1.1), GW2.1 and GW3.1 and in two piezometers, which are located at shallower horizons at GW4 and GW6 and are referred to as GW4.1 and GW6.1 respectively. Groundwater monitoring locations are presented on the enclosed Environmental Monitoring Plan.
- 4.5.3 Samples are taken monthly from the 8 groundwater boreholes, GW1 – GW8, and these are sent to an accredited laboratory for analysis in accordance with the EP. Groundwater levels and quality are reported in accordance with the EP.
- 4.5.4 The current monitoring schedule, including the parameters for the analysis of groundwater quality, is displayed in Table 6 below.

Table 6 – EP Groundwater Monitoring Requirements

Parameters	Monitoring locations	Monitoring Frequencies	Trigger Limits and Units
Water levels	GW1, GW2, GW3, GW4, GW5, GW6, GW7, GW8	Monthly	-
pH	GW1, GW2, GW3, GW4, GW5, GW6, GW7, GW8	Monthly	-
Electrical Conductivity			-
Ammoniacal Nitrogen			1.7 mg/l
Chloride			60 mg/l
Dissolved Oxygen			-
Alkalinity	GW1, GW2, GW3, GW4, GW5, GW6, GW7, GW8	Quarterly	-
Cadmium			-
Calcium			-
Chemical Oxygen Demand			-
Chromium			-
Copper			-
Iron			-
Lead			-
Magnesium			-
Manganese			-
Nickel			0.15 mg/l
Potassium			-
Sodium			-
Sulphate			-
Toluene			0.004 mg/l
Total Alkalinity			-
Total Organic Carbon			-
Total Organic Nitrogen			-
Total Xylenes			0.003 mg/l
Zinc			0.254 /l

- 4.5.5 The requirements in Annex III of the EU Landfill Directive regarding the frequency for groundwater monitoring are displayed in Table 7 below.

Table 7 – EU Landfill Directive Annex III - Groundwater Monitoring Requirements

Test type and monitoring points	Frequency	
	Operating Phase	After-care Phase
Levels of Groundwater	Every six months ⁽¹⁾	Every six months ⁽¹⁾
Groundwater Composition	Site-Specific Frequency ^{(2) (3)}	Site-Specific Frequency ^{(2) (3)}

⁽¹⁾ If there are fluctuating groundwater levels, the frequency must be increased.

⁽²⁾ The frequency must be based on possibility for remedial actions between two samplings if a trigger level is reached, i.e. the frequency must be determined on the basis of knowledge and the evaluation of the velocity of groundwater flow.

⁽³⁾ When a trigger level is reached, verification is necessary by repeating the sampling. When the level has been confirmed, a contingency plan (laid down in the permit) must be followed.

- 4.5.6 The Site is subject to a four-yearly Hydrological Risk Assessment (HRA), where the groundwater contours and quality trends are critically reviewed alongside the leachate levels and quality. The frequency for groundwater monitoring shall be reviewed as part of the next HRA review, which is due for submission in 2016.

4.6 Groundwater Quality Action Plan

- 4.6.1 Should a groundwater quality trigger limit be exceeded on three consecutive routine surveys the actions stipulated in Table 8 will be instigated.

Table 8 – Groundwater Quality Action Plan

Incident	Action
Groundwater Quality Trigger Limit exceedance	1. Inform NRW within 24 hours of analytical certificate receipt; 2. Increase monitoring frequency for substance to monthly, within 1 month; 3. Undertake site investigation work in cases of uncertainty, within 6 months; 4. Report to NRW on re-appraisal of risks and options for corrective measures, within 12 months; 5. If risks are acceptable: re-evaluated assessment criteria If risks are unacceptable: implement corrective measures, within 18 months.

4.7 Surface Water Management

Surface Water Management Infrastructure

- 4.7.1 Surface water samples are currently collected at three locations, SW2, P2 and P4.
- 4.7.2 Water flows in a northerly direction alongside the outside perimeter fence of the western boundary of the site and accumulates in a pond at SW2 before slowly seeping through a manmade underground bypass drain which runs along the outside of the site towards the northern boundary. P2 is a pond to the west, which collects surface water run-off from the

landfill. P4 is located in a field to the north west of the site, beyond landfill gas monitoring borehole BH10. In the event of any trigger limit breaches in the surface water collection pond P2, the surface water is not discharged, but instead sent to the onsite leachate treatment plant.

4.8 Surface Water Monitoring and Reporting

- 4.8.1 Location P2 is subject to monitoring for assessment against the trigger limits as specified in Table 9.

Table 9 – EP Surface Water Monitoring Requirements

Parameters	Monitoring location	Monitoring Frequency	Trigger Limits and Units
Ammoniacal Nitrogen	P2	Sampled when there is the likelihood of an overflow to the discharge point (as agreed with NRW)	1.6 mg/l
COD			100 mg/l
Chloride			250 mg/l
pH			>6 - <9
Suspended solids			100 mg/l

- 4.8.2 The requirements for Annex III of the Landfill Directive regarding the frequency for surface water monitoring are displayed in Table 10 below.

Table 10 – EU Landfill Directive: Annex III – Surface Water Monitoring Requirements

Test type and monitoring points	Frequency	
	Operating Phase	After-care Phase
Volume and composition of surface water ⁽⁷⁾	quarterly ⁽³⁾	every six months

⁽³⁾ If the evaluation of data indicates that longer intervals are equally effective, they may be adapted.

⁽⁷⁾ On the basis of the characteristics of the landfill site, the competent authority may determine that these measurements are not required, and will report accordingly in the way laid down in Article 15 of the Directive.

- 4.8.3 It is proposed that surface water monitoring continues at P2 only, on a 6-monthly basis, as per the requirements of the Landfill Directive. The monitoring strategy will be kept under review.

4.9 Surface Water Action Plan

- 4.9.1 Should a surface water quality trigger limit be exceeded the actions stipulated in Table 11 will be instigated.

Table 11 – Surface Water Quality Action Plan

Incident	Action
Surface Water Quality Trigger Limit exceedance	1. Inform NRW within 24 hours of analytical certificate receipt; 2. Increase monitoring frequency for substance to monthly, within 1 month; 3. Undertake site investigation work in cases of uncertainty, within 6 months; 4. Report to NRW on re-appraisal of risks and options for corrective measures, within 12 months; 5. If risks are acceptable: re-evaluated assessment criteria If risks are unacceptable: implement corrective measures, within 18 months.

4.10 Leachate Management Infrastructure

System Overview

- 4.10.1 Leachate extraction has been undertaken at Brookhill since the early years of its active life. Leachate wells are drilled into the waste mass, and pumps installed in the leachate wells pump the leachate via surface laid pipework to the leachate treatment plant.
- 4.10.2 In 2001, a leachate treatment plant was constructed on site. The leachate treatment plant is a Sequential Batch Reactor (SBR), which treats the leachate by biological treatment. The leachate treated in the SBR is discharged to sewer for further treatment in a wastewater treatment plant under discharge consent with Welsh Water. The maximum daily discharge volume is 150 m³/day.
- 4.10.3 The leachate treatment plant also treats leachate from nearby Standard Landfill which is delivered to site by tractor and bowser.

Leachate Extraction System and Infrastructure

- 4.10.4 Leachate extraction wells have been installed into the waste mass, and remote leachate monitoring points are installed in each of the six landfill cells. During the construction of the site, each cell had one leachate extraction point (leachate chamber, LC) and one remote leachate monitoring point (Remote, R). Over the years, some additional chambers and remote monitoring points have been retro drilled, and some of the remote points have also been fitted with pumps to increase the leachate extraction capacity from the site. Table 12 shows the leachate extraction and monitoring pumps on site at present, and also which type of pump is installed. Cells 1, 2, 4 and 6 have remote monitoring points, which remain as dipping points only. The leachate extraction and monitoring points can be seen on the enclosed Environmental Monitoring Plan.

Table 12: Leachate Extraction and Monitoring Points

Cell	Chamber	Pump
1	LC1	Air
	LC1b	Electric
	R1b	Air
	R1	Dip only
2	LC2b	Electric
	R2b	Air
	R2	Dip only
3	LC3	Air
	R3	Air
4	LC4	Air
	LC4b	Electric
	R4b	Air
	R4	Dip only
5	LC5	Electric
	R5	Air
6	LC6	Electric
	R6B	Air
	R6	Dip only

4.10.5 As can be seen in Table 12, the landfill site currently has 14 extraction points, 9 of which are currently fitted with air pumps and 5 are fitted with electrical pumps. The site also has 4 monitoring points dedicated to dipping and sampling.

4.11 Leachate Monitoring

4.11.1 The EP requirements for leachate levels and quality are presented below in Table 13.

Table 13 – EP Leachate Monitoring Requirements

Parameters	Monitoring locations	Monitoring Frequency	Trigger Limit
Leachate Level	LC1 & LC6	Monthly	2.0 m above cell base
	LC2, R3, LC4 & LC5	Monthly	3.0 m above cell base
	R1, R2, R4, R5 & R6	Monthly	-
Depth to Base of Monitoring Point	LC1, LC2, LC3, LC4, LC5, LC6	Annually	-
Alkalinity	LC1, LC2, LC3, LC4, LC5, LC6	Quarterly	-
pH			
Ammoniacal Nitrogen			
Calcium			
Chloride			
Magnesium			
Potassium			
Sodium			
Sulphate			
BOD			
COD			
TOC			
TON			
Cadmium	LC1, LC2, LC3, LC4, LC5, LC6	Annually	-
Chromium			

Parameters	Monitoring locations	Monitoring Frequency	Trigger Limit
copper			
Iron			
Lead			
Manganese			
Nickel			
Zinc			
List 1 (Hazardous Substances) Parameters	LC1, LC2, LC3, LC4, LC5, LC6	Annually	-

4.11.2 Following an assessment of the lowest achievable leachate levels for each landfill cell, new EP limits were proposed for Cells 2, 3, 4 and 5. These levels, detailed in Table 14 below, were agreed in a meeting between Alison Soper of the Environment Agency (now NRW) and representatives from AD Waste Ltd (now Flintshire County Council Waste Management Services) and Caulmert on the 17th of September 2009.

Table 14 – Revised Leachate Level Trigger Limits

Landfill Cell	Monitoring Points	Revised EP Limit (m)
Cell 1	LC1B & R1	2
Cell 2	LC2B & R2	3
Cell 3	LC3 & R3	5.5
Cell 4	LC4B & R4	3
Cell 5	LC5 & R5	3
Cell 6	LC6B & R6	2

4.12 Leachate Level Action Plan

4.12.1 Should leachate levels be found to be above the relevant cell specific compliance levels the actions stipulated in Table 15 will be instigated.

Table 15 – Leachate Level Action Plan

Incident	Action
Revised EP Leachate Level Limit exceedance	1. Inform NRW within 24 hours; 2. Check efficiency of leachate removal system within 7 days; 3. Instigate Contingency Action Plan (see below); 4. Report to NRW on options for corrective measures (e.g. increase pumping to reduce levels within 1 month; 5. If corrective measures not efficient - review system, arrange for repair, replacement or remediation of leachate infrastructure within 6 months.

Contingency Action Plan

4.12.2 The monitoring of leachate levels is undertaken monthly. They are recorded as metres below top of well, and are subsequently converted to mAOD based on the most recent survey levels of the top of the leachate chambers. The obtained mAOD readings are then compared to the mAOD reading for the base of the respective cells to assess compliance.

4.12.3 Actions if leachate level trigger levels are exceeded:

1. Within 24 hours, the sensitivity of the dip tape will be checked to ensure that the results are valid for true leachate levels rather than foam/froth which may have developed in the well;
2. The leachate well will be re-dipped at 3 different points around the well to ensure a true reading. Again this should prevent any erroneous reading from lips on the pipe work or obstructions within the well.
3. The second leachate well in the same Cell shall be dipped, for comparison.
4. The leachate pump will be investigated to identify if it is operational. If the pump has failed, maintenance of the pump shall be implemented;
5. Neighbouring groundwater wells will also be dipped to establish the relationship between the leachate and groundwater levels;
6. If the pump is operational and the leachate levels remain above the compliance level, then the level data will be reviewed to establish the presence of any trends or patterns. The relationship between the surrounding groundwater levels and the leachate levels will be described and forwarded to NRW within 10 working days;
7. If a downward trend is identified, no further action will be taken with the exception of increasing the monitoring to weekly until the trigger level is no longer exceeded;
8. If no trend is discernible or an upward trend is apparent further investigations in to the source of the additional leachate will be undertaken in conjunction with NRW. This is likely to comprise an investigation into the efficiency of the pumping system and the effectiveness of the containment barrier in the specific area. Remedial actions will be proposed together with timescales for implementation.

4.13 Leachate Treatment Plant

- 4.13.1 The leachate treatment plant accepts leachate from Brookhill and the nearby Standard landfill site. The treated effluent is discharged to public sewer and is thereby subject to a trade effluent agreement (discharge consent, DC). The DC concentration requirements are presented in Table 16.

Table 16 – Treated Leachate Discharge Consent

Parameters	Monitoring locations	Monitoring Frequency	Discharge Consent
Ammoniacal Nitrogen	FD	Weekly	50 mg/l
pH			>5<10
COD			1000 mg/l
Suspended Solids			500 mg/l
Chromium			2 mg/l
Copper			2 mg/l
Lead			2 mg/l
Nickel			2 mg/l
Zinc			2 mg/l

5.0 MAINTAINING AND SUBMITTING RECORDS

5.1 Security and Availability of Records

5.1.1 FCC will make and keep records of a number of activities that form part of the operation of the Site. These records are summarised below:

- damage to fences and gates;
- damage to sampling points;
- groundwater monitoring results;
- surface water monitoring results;
- gas monitoring results;
- survey of restored surface and cap integrity;
- surveys during post-closure phase.

5.1.2 The records detailed above will be kept at the nearby FCC office in Alltami during the anticipated 30 year Aftercare Management period for the Site.

6.0 REPORTING OF SIGNIFICANT EFFECTS

6.1 Site Inspection

- 6.1.1 The Site will be inspected by FCC, on a six monthly basis, to check the condition of any security fencing and whether there is any evidence of illegal tipping or vandalism and the general condition of the Site. Such findings of such inspections will be recorded in the Inspection Pro Forms located within Appendix 1.
- 6.1.2 An additional inspection shall be carried out after any incident that may compromise the security of the Site. Damage to fencing and gates or perimeter barriers that are found to be in poor condition will be temporarily repaired as soon as practicable, and permanently repaired within two weeks of the inspection. A record of all inspections, damage and repairs will be maintained in the Brookhill Landfill Site – Six Monthly Closed Site Inspection Pro Forms (Appendix 1) and details of inspections and any maintenance carried out will be forwarded to NRW.

6.2 Inspection of Restored Surface

- 6.2.1 At least once a year, the entire Site will be inspected by FCC to check the condition of the restored surface. The inspection will follow the Brookhill Landfill Site – Closed Site Restored Surface Inspection Pro Forms presented in Appendix 1. This will take the form of a visual (non-intrusive) inspection to check for evidence of potential damage or wear to the restoration soils and cap as a result of for example desiccation/cracking, soil erosion, excessive differential settlement or accidental damage.
- 6.2.2 Details of inspections and any maintenance carried out will be forwarded to NRW.
- 6.2.3 Additionally, a surface emissions survey (Table 17) is also required by the EP to assess the integrity of the cap and its ability to avoid emissions of landfill gas to the atmosphere.

Table 17 – Surface Emissions Survey Monitoring

Monitoring locations	Parameter	Monitoring Frequency	Other Specifications	Monitoring Standard or method
Permanently capped area	Average methane flux	Annually	where a rate of 0.001 mg/m ² /second is exceeded appropriate measures must be taken to reduce the rate	Flame ionisation detector walkover, flux box or as otherwise agreed in writing by the Agency*
Temporarily capped area			where a rate of 0.1 mg/m ² /second is exceeded appropriate measures must be taken to reduce the rate	Flame ionisation detector walkover, flux box or as otherwise agreed in writing by the Agency*

* If a cap has previously been shown compliant and there have been no significant physical changes to the gas management during the year, a detailed walkover survey with an FID can be used to demonstrate that the surface emissions are under control. If this survey shows no change in pattern of methane emissions, it may be used as the annual survey. The values for flux total methane emissions measured previously may be reported and a fresh flux box survey is not necessary. If the zone remains stable the results of a full walkover survey may be accepted as the site report for a period of four years before a further quantitative flux box survey is required.

6.3 Inspection of boreholes

- 6.3.1 Maintenance of borehole headworks, locks, signs / identification labels and dedicated sampling installations shall be the responsibility of FCC. Leachate extraction wells will also be dipped to base once a year as required by the EP.
- 6.3.2 Any lost or damaged sampling equipment e.g. gas taps, dedicated sampling equipment etc. shall be repaired or replaced within reasonable timescales. Sufficient spares should be carried to allow maintenance to be undertaken during routine monitoring visits. Details of all maintenance will be recorded in the Closed Site Inspection Pro Forms located within Appendix 1.
- 6.3.3 At all times installations shall be clearly visible. Vegetation should be cut as necessary from around both flush and raised headworks.
- 6.3.4 An identified need for maintenance of a particular installation should not reasonably prevent routine sampling and monitoring data being obtained.

6.4 Inspection of cap

- 6.4.1 At least once a year, the entire site will be inspected to check the condition of the engineered capping layer. The inspection will follow the form presented in Appendix 1. This will take the form of a visual (non-intrusive) inspection to check for evidence of potential damage or wear to the capping layer as a result of for example desiccation/cracking (clay cap), soil erosion, excessive differential settlement, accidental damage or fire.

DRAWINGS

2231.EMP.01

Brookhill Landfill Site

Environmental Monitoring Plan

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- NOTES
1. SURVEY INFORMATION PROVIDED BY SOUTH STAFFS SURVEYS. TITLE: UPDATE SURVEY, REF: 4839a.dwg. DATE: 07.08.2015.
- LEGEND
- BH14 GAS BOREHOLE
 - GW GAS EXTRACTION WELL
 - GW5 GROUND WATER MONITORING BOREHOLE
 - LC5 LEACHATE WELL
 - SW2 SURFACE WATER MONITORING POINT
 - CV COAL VENT
 - Leachate Monitoring Point

REV	MODIFICATIONS	BY	CH	AP	DATE
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FLINTSHIRE COUNTY
COUNCIL WASTE
MANAGEMENT SERVICES

BROOKHILL LANDFILL SITE

ENVIRONMENTAL
MONITORING PLAN

DRAWN BY	RWG	DATE	01.03.2016
CHECKED BY	JM	SCALE @ A1	1:750
APPROVED BY	JM	ISSUE	Fn
		REVISION	-

DRAWING NUMBER
2231.EMP.01





APPENDIX 1

Inspection Pro Forms

Brookhill Landfill Site – Six Monthly Closed Site Inspection Pro Forma

Date:	
Arrival Time:	
Departure Time:	
Inspection By:	
Weather:	

Site Status

Access Gates:	
Perimeter Fencing:	
Site Sign Board:	
Evidence of Fly Tipping:	
Evidence of Trespassing:	
Evidence of Vandalism:	
Compound Area:	
Other Relevant Information:	

Brookhill Landfill Site – Annual Closed Site Restored Surface Inspection Pro Forma

Date:	
Arrival Time:	
Departure Time:	
Inspection By:	
Weather:	
Progress of Restoration:	

Site Status

Desiccation/cracking:	
Soil erosion:	
Differential settlement of surface:	
Presence of objects which may obstruct cultivation/mowing:	
Area of willow/ash scrub encroachment:	
Area of vegetation stress/dieback:	
Vegetation description / height:	
Other Relevant Information:	



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