Cyngor Sir Ynys Môn

Penhesgyn Gors Landfill

Annual Environmental Monitoring Report

2022 Review Period

ECL.8826.R03.002 Rev: -

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Prepared for

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1.0 INTRODUCTION

1.0.1 Egniol Consulting Limited (Egniol) of Llys Onnen, Parc Menai, Bangor, Gwynedd have been appointed by Cyngor Sir Ynys Môn as Consultants for undertaking environmental monitoring and reporting works at Penhesgyn Gors Landfill (closed).

1.0.2 The appointment includes environmental reports which should be prepared in compliance with the requirements of the site Environmental Permit (EP) EPR/DP3734DC, as varied in May 2021. Section 4.2 of the Permit lists the following requirements:

4.2.2 A report or reports on the performance of the activities over the previous year shall be submitted to Natural Resources Wales by 31 January (or other date agreed in writing by Natural Resources Wales) each year. The report(s) shall include as a minimum:

(a) a review of the results of the monitoring and assessment carried out in accordance with this permit against the relevant assumptions, parameters and results in the risk assessments submitted in relation to this facility and any agreed amendments thereto;

(b) the annual production/treatment set out in schedule 4 table S4.2;

(c) the topographical surveys required by condition 3.5.3 other than those submitted as part of a CQA validation report;

(d) an assessment of the settlement behaviour of the landfill body based on the difference between the most recent topographical survey and previous annual topographical survey for the areas of the landfill which did not receive waste between the surveys;

1.0.3 The monitoring schedule and emissions limits are listed in EP Schedule 3, with the reporting schedule in Schedule 4.

2.0 SITE LOCATION AND SURROUNDING LAND USE

2.0.1 Penhesgyn Gors Landfill Site (NGR SH 532 74) is located 2km northwest of Menai Bridge on Ynys Môn.

Site Address:

Penhesgyn Waste Transfer and Recycling Centre
Llansadwrn
Menai Bridge
Ynys Môn
LL59 5RY

2.0.2 The overall site covers an area of approximately 21ha, of which, approximately 12ha comprises the closed landfill site with the remaining area utilized as a Waste Transfer Station, an In-Vessel Composting facility, and a Household Waste Recovery Centre (HWRC).

2.0.3 Access to the landfill site is via the weighbridge and through a set of double agricultural type galvanized steel gates. Engineered tracks provide access across the site through the Valley Cell and along the perimeter of Landfill Area 3.

2.0.4 The site is bound by farmland to the east, west and north. The nearest residential properties are Cae Uchaf (320m East), Penhesgyn Isaf (340m East) and Penhesgyn Hall (220m South).

2.0.5 The local topography is gently undulating land which is dissected by the shallow valleys of the Afon Braint to the northeast and an unnamed stream to the southwest. A series of low hills lie in a general northeast to southwest orientation. Immediately to the southwest of the site is an area of lower lying wetland. This is fed by drainage from the surrounding area and in turn drains to the west into the Afon Braint.

3.0 SITE DEVELOPMENT

3.0.1 Prior to the deposition of waste, the site is likely to have been used in a similar way to the surrounding area i.e. rough grazing and wetland.

3.0.2 The landfill part of the site is divided into three main areas. Area 1 has been developed into the HWRC, site offices and has an undeveloped section to the east which continues to be used as agricultural land. Area 2 and Area 3 are closed landfill areas.

3.0.3 Deposition of waste at the site predates 1968, however, there is no documentary information available before this date. Previous site investigations have indicated that both household and commercial waste was deposited.

3.0.3 Documented landfilling at Penhesgyn Gors began in 1968 in Area 2 which is unlined and was operated as a 'Dilute and Disperse' landfill. Area 2 was infilled by 1998 and capped in 2000.

3.0.4 Area 3 has been operated on the principle of engineered containment. Waste was disposed in 4 engineered cells (known as Cell 1, Cell 2, Cell 3 and Valley Cell) between 2000 and 2008. Both areas of the site have been capped and fully restored.

4.0 ENVIRONMENTAL CONTEXT

4.1 Geology

4.1.1 The site is underlain by superficial deposits of Alluvium overlying Glacial Till, which is embedded with layers of sand and gravel. The superficial deposits are underlain by the bedrock of the Mica Schist of the Penmynydd Zone of metamorphism, which forms part of the Mona Complex.

4.1.2 Prior to the land filling of Cell 3 most of the basal area was reported to have contained pockets of peat (Alluvium) overlying the Glacial Till, which was subsequently removed prior to construction works taking place. Schist bedrock was not encountered during the works.

4.2 Hydrogeology

4.2.1 The superficial deposits underlying the site are classified by the Environment Agency as a Secondary (undifferentiated) Aquifer. Beneath the western part of the site the groundwater within sand and gravel layers is confined by the overlying clay. In the east of the site where the clay is absent the groundwater within the sand and gravel layers is unconfined.

4.2.2 The metamorphic bedrock is classified as a Secondary B Aquifer.

4.3 Hydrology

4.3.1 The site and the surrounding agricultural land are served by a network of drainage ditches. The drainage ditch that flows along the eastern boundary of the site flows into a sump leading to a culvert beneath Area which discharges into a lower lying wetland immediately to the southwest of the site. This wetland is fed by drainage ditches from the surrounding area and groundwater. The Afon Braint is drained by two surface water ditches which then flow into the Afon Braint 800m downstream on the site.

5.0 MONITORING ISSUES

5.0.1 During the review period, the following issues were encountered:

- Landfill gas perimeter borehole BH06 was reinstated in the spring and was available for monitoring for the majority of the year.
- BH22 was reinstated in an alternative location as agreed with NRW.
- Borehole BH13 was silted up and not available for monitoring on one occasion.
- Groundwater monitoring borehole BH8/88 was lost and will not be reinstated, as agreed with NRW. This borehole is situated in a field outwith the area owned by the Site Operator. The location is difficult to access by machinery.

6.0 LANDFILL GAS

6.0.1 Routine landfill gas monitoring was carried out in accordance with the relevant provisions of the EP Schedule 3, as follows:

- Table S3.2 Point source emissions to air;
- Table S3.6 Landfill gas in external monitoring boreholes;
- Table S3.7 Landfill gas – other monitoring requirements.

6.0.2 During the review period, landfill gas continued to be actively extracted from both operational areas of the landfill and utilised in the gas combustion engines or treated in the gas flare. The set of combustion engines (Scania SGI12 and SGI13 with electrical output of 159kWe and 189kWe, respectively) were available for operation during the review period, albeit one engine (Scania SGI13) only was utilised, given the low quality and quantity of the gas which was available for utilisation. Scania SGI12 was removed from the site in September 2021.

6.0.3 The gas flare provided a backup gas utilisation when the gas engine was not available during engine maintenance or other engine outages. The flare was utilised during 250 hours in 2021.

6.0.4 The location of the Gas Utilisation Compound (GUC) is shown on Drawing 6170.GA.D04.

6.1 Point Source Emissions to Air

6.1.1 The permit requirements are as follows:

Table 1: Point source emissions to air: landfill gas engines (EP Table S3.2)

Parameter	Limit[1]	Scania SGI 13	MU[2]	Monitoring Frequency
Carbon Monoxide, mg/m³	**None specified**	800	30	Annually
Oxides of Nitrogen, mg/m³	**None specified**	443	17	
Total VOCs, mg/m³	**None specified**	491	17	

1. No specific emission limits are imposed on spark ignition engines (<250kWe) other than the mass release of pollutants from these engines should not exceed the comparable mass release from the engine meeting the emission standards in Table 2.4 of LFTGN08.
2. The Measurement Uncertainty (MU) is calculated from values in LFTGN 08 (2010), at 20% of the result of CO, 30% of the result for NOx and 40% of the result for total VOCs.

Table 2: Point Source Emissions to Air: Landfill gas flares (EP Table S3.2)

Parameter	Limit (hourly mean)	Fixed Gas Flare	Monitoring Frequency*
Oxides of Nitrogen, mg/m³	**150**	Not tested in 2022[3]	Annually
Carbon Monoxide, mg/m³	**50**		
Total VOCs, mg/m³	**10**		

3. Annual monitoring of flares is only required when flare operates in excess of 10% of the time, taken on an annual assessment period.

6.1.2 No emission limits are imposed on spark ignition engines (<250KWe), turbines and micro turbines in reference to Guidance for Monitoring Landfill Gas Engine Emissions LFTGN08 v2 (2010). Section 2.6 states that for such gas engines NRW *"do not intend to impose specific emission limits on these engines other than the mass release of pollutants from these engines should not exceed the comparative mass*

release from an engine meeting the emission standards in Table 2.4".

6.1.3 Annual stack gas emissions testing of the Scania SGI13 engine was carried out on 14th November 2022. An isokinetic testing protocol was used in line with the Monitoring Certification Scheme (MCERT).

6.1.4 The recorded concentration of nitrogen oxides, carbon monoxide and VOCs were below the relevant emission standards of 500mg/m^3, 1400mg/m^3, and 1000mg/m^3 listed in Table 2.4 of LFTGN08.

6.1.5 The stack gas emissions survey is enclosed in Appendix 1.

6.2 Landfill Gas in External Monitoring Points

6.2.1 Perimeter gas is monitored in twenty one gas monitoring boreholes BH01-BH07, BH9-BH20, BH15A and BH16A. Landfill gas monitoring points are shown on drawing 5739.SURV.D03.

6.2.2 The monitoring requirements and compliance limits for the external monitoring boreholes are listed in Table 3 below.

Table 3: Landfill gas in external monitoring boreholes (EP Table S3.6)

Monitoring Point ID	Limit, CH4 (%v/v)	Action Level, CO_2 (%v/v)	Monitoring Frequency
PENBH01	1	5.3	Quarterly
PENBH02	1	5.7	
PENBH03	1	4.4	
PENBH04	1	3.9	
PENBH05	1	14.2	
PENBH06	1	2.8	
PENBH07	1	7.6	
PENBH09	1	7.2	
PENBH10	1	5.4	
PENBH11	1	5.7	
PENBH12	1	4.2	
PENBH13	1	3.1	
PENBH14	1	8.3	
PENBH15	1	7.2	
PENBH15a	1	4.8	
PENBH16	1	5.4	
PENBH16a	1	5.9	
PENBH17	1	4.8	
PENBH18	1	7.0	
PENBH19	1	4.3	
PENBH20	1	10.4	
All monitoring boreholes	Oxygen, Atm. Pressure, Diff. Pressure, Meteorol. data	No limit	

6.2.3 Concentrations of methane in perimeter boreholes were below the compliance limit

(1%v/v) in all monitoring points. Carbon dioxide was detected in low concentrations in all boreholes. Borehole specific action levels were exceeded in in PENBH06 at 2.9 and 3.4% (action level 2.8%), PENBH11 at 6.9% (action level 5.7%), PENBH14 at 11.1% (action level 8.3%), PENBH17 at 4.9% (action level 4.8%), and PENBH18 at 7.5 and 12.1% (action level 7.0%). These exceedances were random and are considered to be insignificant.

6.2.4 This landfill gas monitoring data is summarised in Appendix 2.

6.3 Landfill gas – other monitoring requirements

6.3.1 Other compliance monitoring requirements set out in the site permit comprise the following:

- Gas collection system – 4-weekly monitoring of methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), balance gas, atmospheric pressure, gas flow/suction, carbon monoxide (CO), and hydrogen sulphide (H_2S).
- Input to Gas Utilisation Compound (GUP) – 4-weekly monitoring of methane (CH_4), carbon dioxide (CO_2), oxygen (O_2), balance gas, atmospheric pressure, gas flow/suction, carbon monoxide (CO), and hydrogen sulphide (H_2S).

6.3.2 Landfill gas monitoring in the gas collection system and the GUP is carried out as part of the routine balancing of the gas management system in order to maximise gas flows for extraction.

6.3.3 The quality of raw landfill gas varied during the review period (37.3-54.2% CH_4, 18.5-23.7% CO_2, 0.0-2.8% O_2, 20.1-44.2% Balance gas) with average annual concentrations of methane of 42.4%, carbon dioxide 20.1%, oxygen 1.4% and the remainder being balance and trace gases. Oxygen concentration exceedances (>5%v/v) were recorded on occasions in a small number of in-waste monitoring points. On detecting such exceedances YLEM engineers isolate the affected well(s) and/or sections of the gas system for further investigation in line with the company's gas monitoring action procedures.

6.3.4 Concentrations of carbon monoxide (CO) in the gas collection system remained very low throughout the review period, with average concentrations of 0.8ppm. Hydrogen Sulphide (H_2S) levels in the gas collection system were similarly low across the site, with average concentration 1.0ppm.

6.3.5 Landfill gas quality in the inlet to the GUC was tested at the time of the gas balancing throughout the review period. Concentrations of methane, carbon dioxide, oxygen, balance gas, gas flow rate and suction pressure were recorded. The quality of raw gas on the input to the GUC was 36.4-52.6% CH_4, 20.7-24.6% CO_2. Oxygen concentrations did not exceed 5% v/v and the balance gas did not exceed 20% v/v. The gas quality data collected during 2022 was consistent with the data from 2021. Landfill gas quality data in the collection system and the GUC are enclosed in Appendix 3.

7.0 LANDFILL LEACHATE

7.0.1 Routine leachate monitoring was carried out in accordance with the relevant provisions of the EP Schedule 3, as follows:

- Table S3.1 Leachate levels.
- Table S3.8 Leachate - other monitoring requirements.

7.0.2 A leachate collection and extraction system operates in landfill Area 3 only. Each cell in Area 3 was constructed with a drainage layer above the basal liner coupled with leachate wells/collection pipework. There are no leachate management provisions in Area 2. This area is unlined and is in hydrogeological continuity with the surrounding perched groundwater and surface water.

7.0.3 During the review period leachate levels in the cells of Area 3 were regulated by pumping out leachate for direct recirculation into 'dry' cells. Leachate was periodically pumped out from Cells 2, 3A and 3B and recirculated into Cell 1 and the Valley Cell. There is an ongoing agreement with NRW to facilitate this management option, designed to increase the moisture content of waste in 'dry' cells in order to improve the methanogenic process in Area 3. Leachate recirculation was carried out on an 'as required' basis. Leachate levels in all cells were measured before and after the leachate transfer and the volume of leachate removed recorded.

7.0.4 No leachate was tankered off site for treatment and disposal during the review period.

7.0.5 The locations of leachate wells / monitoring points are shown on Drawing fc37224.

7.1 Leachate Levels

7.1.1 Leachate level monitoring schedule is as follows:

Table 4: Leachate Level Monitoring Schedule (Table S3.1)

Monitoring Point ID	Limit	Monitoring Frequency
Area 2 Leachate Wells: L1, L4, L5, L6, L7	none	Annually
Area 3 Leachate Wells: -Cell 1 (BHL14, BHL15) - Cell 2 (BHL13, L nr 38, L nr 122) - Cell 3 (BHL10, BHMH3A, BHMH3B) - Valley Cell (L16, L17)	2 m above cell base	Quarterly

7.1.2 Leachate levels in landfill Area 3 Cell 1 remained low and on average were in BHL14 0.27m and in BHL15 0.59m (above base). In Cell 2 the recorded levels were variable at c.1m in Lnr38, 2.94m in BHL13 and 4.50m in Lnr122. The compliance limit was exceeded in the latter two monitoring points. In Cell 3, leachate levels were slightly elevated at on average 1.25m in BHL10, 2.28m in BHMH3A and 2.96m in BHMH3B. In Valley Cell the leachate levels remained low at 0.13-0.39m in L16 and 0.20-0.74m in L17 throughout the review period. The levels of leachate recorded during 2022 were generally consistent with those recorded in 2021.

7.1.3 Leachate levels in Area 2 were measured at 1.56-1.97m (above base). This suggests that the leachate levels are consistent across this Area. Judging by the levels of groundwater in the adjacent monitoring points (BH16-BH31), the recorded leachate levels are likely to correspond with the groundwater table downgradient of the site.

7.1.4 Leachate levels monitoring data is presented in Appendix 4.

7.2 Leachate Quality

7.2.1 Leachate quality is assessed in both landfill Area 2 and Area 3. The monitoring requirements are summarised in Table 5 below.

Table 5: Leachate Monitoring Schedule (Table S3.8)

Monitoring Point ID	Total	Frequency	Parameters	Unit
Area 2 L1, L4, L5, L6, L7	5	Annually	pH Electrical Conductivity Ammoniacal Nitrogen Chloride BOD COD Dissolved Oxygen Depth to base, m	pH units µS/cm mg/l
Area 3 - Cell 1 (BHL13) - Cell 2 (BHL14) - Cell 3 (BHMH3A) - Valley Cell (BH60)	4	Annually	pH Electrical Conductivity Ammoniacal Nitrogen Chloride BOD COD Dissolved Oxygen List 1 substances Depth to base, m	pH units µS/cm mg/l
Area 3 - Cell 1 (BHL13) - Cell 2 (BHL14) - Cell 3 (BHMH3A) - Valley Cell (BH60)	4	6-monthly	Sulphates Alkalinity TON TOC Sodium Potassium Calcium Magnesium Iron Manganese Cadmium Chromium Copper Nickel Lead Zinc	mg/l

7.2.1 Ammoniacal nitrogen in leachate samples from Area 2 ranged from 0.61mg/l to 11mg/l (L1). Chloride was detected in concentrations between 13mg/l and 60mg/l (L1). These concentrations are relatively low and are indictive of weak/diluted leachate. The detected levels were similar to those observed in 2021.

7.2.2 Other tested parameters were as follows:

- pH levels were near neutral or slightly alkaline at between 7.2 and 8.0.
- Electrical Conductivity levels varied between 530µs/cm to 1,200µs/cm.
- BOD ranged from <1mg O_2/l to 28mg O_2/l.
- COD levels varied between 15mg O_2/l and 74mg O_2/l.

The detected levels of these parameters were lower than those observed in 2021.

7.2.3 A more extensive leachate testing regime was carried out in landfill Area 3. There, leachate samples were taken every 6 months and analysed for a wider range of parameters. Ammoniacal nitrogen was detected in variable concentrations across

this landfill area. Leachate in Cells 1 and 2 continued to show higher concentrations of NH_3-N (750mg/l in L13 (Cell1) and 1100mg/l in L14 (Cell 2), compared to concentrations of 62mg/l in MH3A (Cell 3) and 180mg/l in BH60 (Valley cell). Similarly, chloride was detected in higher concentrations in Cell 1 (930mg/l) and Cell 2 (2,100mg/l) compared with Cell 3 (630mg/l) and Valley cell (560mg/l).

7.2.4 Other tested inorganic parameters (calcium, potassium, sodium, sulphate) were present in leachate in variable but relatively low concentrations which were similar or lower than those observed in 2021. Heavy metals and non-hazardous substances (cadmium, chromium, copper, iron, magnesium, manganese, nickel, lead, zinc) showed a similar variability. Xylene continued to be detected in negligible concentrations (<1.0-67.6µg/l). Other hazardous substances (mecoprop, tributyltin) were not tested during this review period; these were either not detected or were present in negligible concentrations in 2021.

7.2.5 Levels of Biological Oxygen Demand (BOD) varied significantly (<1-190 mgO_2/l). Chemical Oxygen Demand (COD) levels also varied significantly (540-3,000 mgO_2/l). Both parameters were highest in Cell 2. pH levels of leachate were slightly alkaline; and Electrical Conductivity was recorded between 3,500µs/cm and 17,000µs/cm.

7.2.6 The latest monitoring results are comparative with and slightly lower than those detected in 2021. Leachate monitoring data is presented in Appendix 5.

8.0 GROUNDWATER

8.0.1 Groundwater monitoring requirements are stated in EP Schedule 3:

- Table S3.5 Groundwater – Trigger levels for emissions into groundwater and monitoring requirements
- Table S3.10 Groundwater – other monitoring requirements.

8.0.2 Groundwater monitoring points are shown on drawing fc37224.

8.1 Groundwater Quality

8.1.1 Groundwater monitoring requirements are listed in Tables 6a and 6b below.

Table 6a: Groundwater – other monitoring requirements (Table S3.10)

Monitoring Point ID	Frequency	Parameter
BH1-BH31, BH50-BH54 BH1/88, BH2/88, BH96B	Annually	Water Level

Table 6b: Groundwater – other monitoring requirements (Table S3.10)

Monitoring Point ID	Frequency	Parameters	Limit, mg/l
BH1/88 BH2/88 BH19 BH96B	Annually	pH Electrical conductivity Chloride Ammoniacal nitrogen COD BOD Dissolved Oxygen	none
BH2/88 BH8/88* BH22 BH96B	6-monthly	Sulphates Alkalinity TON TOC Nitrates Sodium Potassium Calcium Magnesium Iron Manganese Chromium Copper Nickel Lead Zinc	none
BH2/88 BH8/88* BH22 BH96B	Annually	List 1 substances found in Leachate	None

*BH8/88 is lost and will not be reinstated as agreed with NRW

8.1.2 Compliance limits are set up to regulate groundwater quality downgradient from the site. For this purpose, two representative monitoring points (BH2/88 and BH96B) are used. The relevant compliance limits are listed in Table 7.

Table 7: Compliance limits for emissions into groundwater (Table S3.5)

Monitoring Point ID	Parameters	Limit, mg/l	Frequency
BH2/88	Chloride	75	Annually
	Ammoniacal Nitrogen	0.56	
BH96B	Chloride	34	
	Ammoniacal Nitrogen	3.0	

8.1.3 Ammoniacal nitrogen was tested in all groundwater monitoring points and detected in variable low concentrations 0.05mg/l (BH1/88), 0.38mg/l (BH2/88), 1.60mg/l (BH19), 0.04mg/l (BH96B). Compliance limit for NH_3-N was not exceeded in two regulated monitoring points BH2/88 and BH96B.

8.1.4 Chloride was detected in concentrations 10mg/l (BH1/88), 41mg/l (BH2/88), 26mg/l (BH19), 36mg/l (BH22) 38mg/l (BH96B). Compliance limit for Cl was marginally exceeded in borehole BH96B.

8.1.5 Inorganic parameters (calcium, potassium, sodium, sulphate) were detected in variable but low concentrations. Heavy metals and non-hazardous substances (cadmium, chromium, copper, iron, magnesium, manganese, nickel, lead, zinc) were similarly low. If assessed against the EQSs for freshwater the detected concentrations were below the relevant standards. Hazardous substances (mecoprop, tributyltin) were not tested during this review period; these were either not detected or were present in negligible concentrations in 2021.

8.1.6 Other tested parameters were detected as follows:

- pH levels of groundwater were slightly alkaline at between 7.4 and 7.8.
- Electrical Conductivity levels varied between 220 µs/cm and 730 µs/cm.
- BOD ranged from<1.0 mgO_2/l (BH2/88) to 7.5 mgO_2/l (BH96B).
- COD ranged between 19 mgO_2/l (BH2/88) and 160 mgO_2/l (BH96B).

8.1.7 The latest groundwater monitoring results are consistent with those in 2021. Groundwater monitoring data is presented in Appendix 6.

9.0 SURFACE WATER

9.0.1 The monitoring requirements of surface water quality are outlined in the Schedule 3 of the permit, as follows:

- Table S3.3 Point source emissions to water.
- Table S3.9 Surface water – other monitoring requirements.

9.0.2 Surface water monitoring was carried out at 10 monitoring points:

- SW1 Drain and tributary of Afon Braint, upstream of the site;
- SW2 Water entering Afon Braint from the drain (SW1);
- SW3 Afon Braint to the west and upstream of the site;
- SW4 Drain from wetland to Afon Braint, downgradient of the site;
- SW5 A wetland area downstream from the site (Area 2);
- SW6 A drain entering the site from east; an upstream monitoring point;
- SW7 A stream entering the site from drain SW6; an upstream monitoring point (sampled in the sump before entering the culvert beneath Area 2);
- SW8 At the culvert exit, downstream of the site (Area 2);
- SW9 A drainage ditch draining from wetland towards Afon Braint;
- SW10 Afon Braint at the point of entry from drainage ditch (SW9).

9.0.3 Surface water monitoring locations are shown on drawing fc37224.

9.1 Point source emissions to water

9.1.1 Surface water monitoring requirements are listed in Table 8 below.

Table 8: Surface water – other monitoring requirements (Table S3.9)

Monitoring Point ID	Frequency	Parameters	Limit, mg/l
SW1 SW2 SW3 SW4 SW5 SW6 SW7 SW8 SW9 SW10	Annually	pH Electrical conductivity Chloride Ammoniacal nitrogen COD BOD Dissolved oxygen	none

9.1.2 Compliance limits are set up to regulate concentrations of NH_3-N and Cl in surface water downstream from the site. For this purpose, two representative monitoring points (SW9 and SW10) are used. The compliance limits are listed in Table 9.

Table 9: Point source emissions to water (Table S3.3)

Monitoring Point ID	Frequency	Parameters	Limit, mg/l
SW9	6-monthly	Chloride	64
		Ammoniacal Nitrogen	1.3
SW10		Chloride	61
		Ammoniacal Nitrogen	0.53

9.1.3 The SW9 ammoniacal nitrogen was detected in concentrations 8.5mg/l (26 June) and 0.2mg/l (11 November). Chloride was detected in concentrations 78mg/l (26 June) and 23 mg/l (11 November). The water sample collected on 26 June showed elevated concentrations of both regulated parameters.

9.1.4 The SW10 ammoniacal nitrogen was detected in concentrations 0.09mg/l (26 June) and 0.2mg/l (11 November). Chloride was detected in concentration of 23mg/l on both occasions. Both sets of results from this monitoring point were compliant with the limits set in Table S3.3.

9.1.5 Surface water quality in other downstream monitoring points SW4, SW5 and SW8 was as follows:

- pH levels of groundwater were near neutral at 7.3 and 7.5.
- Electrical Conductivity levels varied between 260 µs/cm and 590 µs/cm. EC indicates a presence of dissolved salts and other inorganic chemicals. These levels of EC in surface water are considered insignificant.
- Ammoniacal nitrogen was detected in concentrations between 0.13mg/l and 1.0mg/l (SW8). Concentrations of Ammon-N in surface water below 0.5mg/l are considered to be low and insignificant.
- Chloride was detected in concentrations between 21mg/l and 36mg/l.
- BOD ranged from <0.1 mgO_2/l to up to 3.5 mgO_2/l (SW5). BOD levels in water of 3-5mg/l is considered moderately clean. BOD levels of 6-9mg/l and above indicate a presence of organic matter.
- COD ranged between 70mgO_2/l and 94 mgO_2/l (SW8). COD is an 'umbrella' indicator of organic pollution in water.

9.1.6 Surface water quality in upstream monitoring points SW1, SW2, SW3, SW6 and SW7 was as follows:

- pH levels of groundwater were near neutral at 7.3 and 7.6.
- Electrical Conductivity levels varied between 240 µs/cm and 1100 µs/cm (SW7) which indicates a presence of dissolved salts and other inorganic chemicals. These levels are considered insignificant.
- Ammoniacal nitrogen was detected in concentrations between 0.08mg/l and 0.23mg/l. These concentrations of Ammon-N in surface water are considered to be insignificant.
- Chloride was detected in concentrations between 21mg/l and 45mg/l.
- BOD ranged from 2.3 mgO_2/l to up to 3.9 mgO_2/l (SW6). BOD levels in water of 3-5mg/l is considered moderately clean. BOD levels of 6-9mg/l and above indicate a presence of organic matter.
- COD ranged between 62mgO_2/l and 130 mgO_2/l (SW7). COD is an 'umbrella' indicator of organic pollution in water. The latest monitoring results showed indicates that local agricultural activities are likely to contribute to pollution of surface water with organic matter.

9.1.7 Surface water monitoring data is presented in Appendix 7.

10.0 ANNUAL PRODUCTION/TREATMENT

10.0.1 Details of the annual production/treatment at Penhesgyn Gors Landfill during the review period are stated in the EP Schedule 4, Table S4.2, and summarised below.

Table 10: Annual Production, 2022

Leachate	**Volume, m^3/year**
Tankered off site for disposal	0
Treated at the on-site effluent treatment plant	0
Recirculated into the waste mass	170
Landfill Gas	**Nm^3/year**
Combustion in flare	770
Combustion in gas engines	493480
Other methods of gas utilisation	n/a

11.0 TOPOGRAPHIC SURVEY

11.0.1 Condition 3.5.3 of the site permit requires that *"A topographical survey of the site referenced to ordnance datum shall be carried out:*

(a) annually, and

(b) following closure of the landfill or part of the landfill.

The topographical survey shall be used to produce a plan of a scale adequate to show the Survey."

11.0.2 A topographic survey of the site was carried out in January 2023. The resultant survey drawing is enclosed in Appendix 8.

11.0.3 The topographic survey completed has been compared to the 2019 survey data. Cross sections have been produced to compare the levels to allow an assessment of any changes. The survey comparison indicates some slight change in levels, however, the changes are not considered to be significant. It is considered likely due to the more precises in accuracies of survey equipment, and the different methods used (land surveying equipment compared to the Drone survey completed more recently), that the level changes observed in the cross sections is not representative of settlement at the site. The drone survey is within tolerances of +/- 50mm.

12.0 SUMMARY

12.0.1 This annual monitoring report was prepared in accordance with the requirements of the varied and consolidated environmental permit EPR/KP3994F/V007. During the 2022 review period the Site Operator continued to collect monitoring data as per Schedule 3 – Emissions and monitoring, of the Permit. Interim monitoring data was reported to NRW as per Schedule 4 - Reporting. The Site Operator also notified NRW of the incidents of breaching the emissions limits, as per Schedule 5 – Notifications.

12.0.2 Penhesgyn Gors non-hazardous landfill site is in the 15th year of post closure management. The site is fully capped and restored. The environmental monitoring infrastructure on site comprises a large number of in-waste gas and leachate extraction wells, gas manifolds and other elements of the extraction systems, as well as external monitoring points. During the review period, landfill gas (presence and concentrations) was monitored in both in-waste monitoring points and in perimeter boreholes as per the permit conditions.

12.0.3 Stack gas emissions to air of total VOCs, NO_X and CO from the gas engine were monitored. All monitoring results showed that the Gas Utilisation Compound was operating within tolerance margins of the emission standards. Point source emissions to air from the gas flare were not tested, because the gas plant was utilised during less than 10% of the time, during 2022.

12.0.4 Methane concentrations in perimeter monitoring boreholes remained low and below the compliance limit in all perimeter monitoring points. Carbon dioxide was detected in generally low concentrations in all boreholes. Borehole specific Action Levels of CO_2 were exceeded in PENBH06, PENBH11, PENBH14, PENBH17, and PENBH18. These exceedances were random and insignificant.

12.0.5 The quantity and quality of the generated landfill gas remained sufficient to support active gas management at this site. The current capacity of the GUP is adequate to utilise volumes of the recovered landfill gas. The quality of the gas remained relatively stable across the site with average concentrations of methane of 42.4%, carbon dioxide 20.1%, oxygen 1.4% and the remainder being balance gas and trace gases. Oxygen concentrations exceedances (>5%v/v) were recorded on occasions in a small number of in-waste monitoring points. On detecting such exceedances YLEM engineers isolate the affected well(s) and/or sections of the gas system for further investigation in line with the company's gas monitoring action procedures.

12.0.6 Concentrations of carbon monoxide in the gas collection system remained very low throughout the review period, with average concentrations of 0.8ppm. Hydrogen Sulphide levels in the gas collection system were similarly low across the site, with average concentration 1.0ppm.

12.0.7 Landfill gas quality in the inlet to the GUC was tested at the time of the gas balancing throughout the review period. Concentrations of methane, carbon dioxide, oxygen, balance gas, gas flow rate and suction pressure were recorded. The quality of raw gas on the input to the GUC was 36.4-52.6% CH_4, 20.7-24.6% CO_2. Oxygen concentrations did not exceed 5% v/v and the balance gas did not exceed 20% v/v. The gas quality data collected during 2022 was consistent with the data from 2021.

12.0.8 Leachate levels in Area 3 varied between cells. In the known 'dry' Cell 1 and the Valley Cell the levels were low and below the compliance limit. In other cells (Cell 2, Cell 3A and Cell 3B), leachate levels were higher and in excess of the compliance level of 2m above cell base. The average levels in Cell 2 and Cell 3 were 2.8m and 2.1m, respectively. In Valley Cell the leachate levels remained low and compliant with the limit throughout the review period. The levels of leachate recorded during 2022 were generally consistent with those recorded in 2021.

12.0.9 Leachate levels measured in Area 2 were generally consistent and corresponded with the groundwater table downgradient of the site.

12.0.10 The quality of raw leachate in Area 2 was tested for pH, Electrical Conductivity, Ammoniacal Nitrogen, Chloride, BOD, COD, Dissolved Oxygen. The monitoring results are indictive of weak/diluted leachate in Area 2. The detected levels of these parameters were similar or lower than those observed in 2021.

12.0.11 A more extensive leachate testing was carried out in landfill Area 3. There, leachate samples were taken every 6 months and analysed for a wider range of parameters. Ammoniacal nitrogen was detected in variable concentrations across this landfill area. Leachate in Cells 1 and 2 continued to show higher concentrations of ammoniacal-N compared to those in Cell 3 and the Valley Cell. Similarly, chloride was detected in higher concentrations in Cells 1 and 2 compared to those observed in Cell 3 and the Valley cell.

12.0.12 Other tested inorganic parameters (calcium, potassium, sodium, sulphate) were present in leachate in concentrations which are similar or lower than those observed in 2021. Levels of BOD and COD varied significantly across the site and over time. Both parameters were overall highest in Cell 2. pH levels were slightly alkaline.

12.0.13 Groundwater quality was tested in all regulated monitoring points. Ammoniacal nitrogen was tested in all groundwater monitoring points and detected in variable low concentrations. Compliance limit for NH_3-N was not exceeded in two regulated monitoring points BH2/88 and BH96B. Chloride was detected in variable low concentrations; a compliance limit for Cl was marginally exceeded in borehole BH96B. Inorganic parameters (calcium, potassium, sodium, sulphate) were detected in variable but low concentrations. Heavy metals and non-hazardous substances (cadmium, chromium, copper, iron, magnesium, manganese, nickel, lead, zinc) were similarly low. Overall, the quality of the local groundwater was similar to the quality seen during 2021.

12.0.14 Local surface water quality was monitored in ten reference monitoring points which are representative of the water quality upstream and downstream from the site. Concentrations of ammoniacal-N and chloride are regulated in two downstream water monitoring points SW9 and SW10 which are sampled 6-monthly. These samples showed that in SW9 the water sample collected on 26th June contained elevated concentrations of both regulated parameters, whereas the sample collected on 11th November was compliant with the permit on both regulated parameters. In SW10 both sets of data were compliant with the limits set in the permit.

12.0.15 Other surface water samples contained variable but overall low concentrations of NH_3-N and Cl. BOD were similarly variable. The higher level of BOD was recorded in the upstream point SW7 which is indicative of the presence of organic matter. COD levels were highly variable (<2-130 mgO_2/l). This indicates that local agricultural activities are likely to be contributing to pollution of surface water with organic matter. pH levels of groundwater were between 7.3 and 7.8, i.e. the water was slightly alkaline. Electrical Conductivity levels varied from 240 µs/cm to up to 1100 µs/cm (SW7). These levels are considered insignificant and within the freshwater margin of 1500 µs/cm. Overall, the surface water quality during the 2022 review period was similar to the quality seen during 2021.

12.0.16 During 2022 the monitoring works encountered the following constraints and limitations:

- Landfill gas monitoring boreholes BH06 and BH22 were reinstated or repaired to enable collection of the monitoring data. They were available for monitoring in the latter part of the year.

- Borehole BH13 was silted up and not available for monitoring on one occasion.

Cyngor Sir Ynys Môn

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Appendix 1

Point source emissions to air – survey report

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Appendix 2

Landfill Gas in Perimeter Monitoring Points

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Appendix 3

Landfill Gas in Collection System

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Appendix 4

Leachate Levels

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Appendix 5

Leachate Quality

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Appendix 6

Groundwater Quality

Cyngor Sir Ynys Môn

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Appendix 7

Surface Water Quality

Cyngor Sir Ynys Môn

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Appendix 8

Topographic Survey of Penhesgyn Gors Landfill Site