

Report: *WR7350/CP*

Date: *April 2018*

CLOSURE PLAN

PEN-Y-BONT LANDFILL SITE,
PENTRE, CHIRK, WREXHAM,
LL14 5AR

Prepared for
FCC Waste Services (UK) Limited



Prepared by



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**Project Quality Assurance
Information Sheet**

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1.0 INTRODUCTION

1.1 Scope and background

- 1.1.1 Sirius Environmental Limited (Sirius) has been commissioned by FCC Waste Services (UK) Limited to prepare a Closure Plan to enable the 'definitive closure' of Pen-y-bont Landfill Site, Chirk, Wrexham.
- 1.1.2 Planning permission was granted by Wrexham County Borough Council for the landfilling of Controlled Wastes at Pen-y-bont Landfill in 1993. A Waste Management Licence (EAWML/37123) was subsequently granted to Shanks & McEwan (Northern) Limited on 4th of December 1994. The Waste Management Licence EAWML/37123 was transferred to Shanks & McEwan (Midlands) Limited on 8th September 1997. Landfilling operations commenced at the site on November 16th, 1997.
- 1.1.3 An application for a Pollution Prevention Control (PPC) Permit was made in October 2004 and was subsequently issued in November 2005. As a result of this, the Waste Management Licence was re-referenced and updated to PPC Permit Number GP3830BG. At this time, the WML was transferred to the Waste Recycling Group (now FCC Waste Services UK Limited) who took over the management of the site in 2004.
- 1.1.4 The PPC Permit (Permit Number GP3830BG), dated 9th November 2005 the receipt, handling and storage of 270,000 tonnes per annum of non-hazardous wastes and up to 30,000 tonnes per annum of inert wastes for deposit into the landfill void.
- 1.1.5 An Environment Agency (now Natural Resources Wales) led variation to the PPC Permit (Environmental Permit Number GP3830BG) was issued in June 2007. The result of this variation was to update the Environmental Permit in line with the (then) new PPC template permit for landfill. There were no substantial changes to the Installation as a result of this variation.
- 1.1.6 There have been several variations to the Environmental Permit since 2007, which have predominantly been associated with variations to specified conditions, the implementation of the Industrial Emissions Directive (IED), as well as an administrative variation in December 2012 to account for a change in operator name from WRG to FCC Waste Services (UK) Limited. The latest variation to the Environmental Permit (EPR/GP3830BG/V007) was issued in November 2014 and related to a change in requirements for emissions monitoring, for both leachate and landfill gas.
- 1.1.7 The site comprises three fully engineered cells (Cell 1, Cell 2 and Cell 3) as shown on **Drawing Reference Number WR7350/5/02**. Each individual cell is hydraulically contained.
- 1.1.8 Since completion to the approved levels, all phases are considered stable with appropriate leachate, groundwater, surface water and landfill gas monitoring and management infrastructure in place to enable ongoing, effective

management during the aftercare phase. The operator therefore considers the site to be at the appropriate stage for definitive closure.

1.1.9 The following key guidance documents have been consulted during the preparation of this Closure Report:–

- Regulatory Guidance Series, No LFD 1 – Understanding the Landfill Directive (Version 4, October 2014)
- How to comply with your Environmental Permit – Additional guidance for Landfill – EPR 5.02 (October 2014)
- Environmental Permitting Guidance – The Landfill Directive, for the Environmental Permitting (England and Wales) Regulations 2010 (v. 3.1 updated March 2010).

1.1.10 Other guidance documents are referenced where appropriate within this report.

1.1.11 In lieu of the above guidance, this report has been prepared to demonstrate the site meets the requirements for ‘definitive closure’ under the Landfill Directive. The following key information is therefore included:–

- Area of Closure;
- Compliance with Environmental Permit Conditions;
- Site Stability and Final Landform;
- Management and Monitoring; and
- Environmental Reporting Procedures

1.2 Site Setting

1.2.1 Pen-y-bont Landfill Site is located c. 500m North of the village of Pentre, c. 525m to the west of the village of Newbridge and c. 8.8km to the south west of the town of Wrexham at National Grid Reference 329254, 341680. The landfill is located within a former mineral (clay) extraction quarry, which was historically excavated into reddish brown mudstone/marl strata (Ruabon Marl) of the Upper Carboniferous Coal Measures. The landfill extends over an area of approximately 18ha and is situated within a meander of the west to easterly flowing River Dee.

1.2.2 Pen-y-bont Landfill comprises 3 landfill cells, which are situated in a roughly west to east alignment. The boundary to which the Environmental Permit for the site applies as well as the corresponding landfill cell boundaries are presented on **Drawing Reference Number WR7350/5/01** and **Drawing Reference Number WR7350/5/02** accordingly.

1.2.3 The landfill is located within a relatively rural setting, interspersed with small villages situated in all directions. It is bounded to the east and south by agricultural land, while to the west is a narrow band of woodland area which lies adjacent to the B5605 road. A number of residential dwellings (situated near the landfill entrance), as well as woodland, a field and Pen-y-bont Farm are also located along this boundary and to the North/North West. As previously mentioned, the site is situated within a meander of the River Dee and is

- therefore encompassed by the River Dee to the North, East and West, at a minimum distance of c. 40m from the Environmental Permit boundary.
- 1.2.4 As indicated above, the nearest residential receptors (a series of houses, including Pen-y-bont Cottage) are situated adjacent to the sites entrance alongside the site boundary to the south west. To the North West, between c. 95m and 120m from the site boundary lies Pen-y-bont Farm, Waterside Barn and Hayside.
- 1.2.5 In terms of statutory designations, the River Dee and Bala Lakes Special Area of Conservation (SAC) and the River Dee Site of Special Scientific Interest (SSSI) is situated, at its closest point c. 40m to the North of the site. The River Dee is notified for its nationally important transition through a range of river types from mesotrophic to eutrophic. It is also notified for Atlantic salmon, otter, club-tailed dragonfly and fluvial geomorphology. In addition to this, the Nant-y Belan and Prynela Woods SSSI is situated c. 600m to the south/south east of the site. The area is of special interest botanically, representing a significant area of largely semi-natural woodland, which has not been affected by large scale replanting by conifers and non-native hardwoods.
- 1.2.6 The River Dee is the main surface water feature present in the vicinity of the site which passes within a minimum distance of 40m of the Northern permit boundary as well as within close proximity of the Western and Southern site boundary. There are also a number of small tributaries of the River Dee situated within the large woodland area beyond the northern banks of the river to the north of the site as well as to the east. A larger tributary, the Afon Eitha is situated to c. 700m to the east of the site.
- 1.2.7 There are no Public Rights of Way (PRoW) within the immediate vicinity of the site.
- 1.2.8 The site itself is not located within a Flood Zone where the risk of flooding is less than 0.1%. Notwithstanding this, the banks of the River Dee are attributed with a high risk of flooding, with an area of "low risk" of flooding situated to the North East of the site, beyond the site boundary.
- 1.2.9 The site is not located within a Nitrate Vulnerable Zone (NVZ) for either surface water or groundwater.
- 1.2.10 The boundary of the landfill site is securely fenced with a 2.0m and 1.2m wire and barbed wire stock-proof fence around the whole perimeter of the landfill (including non-landfill areas). There are also 2.0m high steel gates at the entrance to the site.
- 1.2.11 The superficial geology at Pen-y-bont landfill comprises deposits of alluvium (with sands and gravels) or made ground due to the various historical industrial activities which have taken place in the area. The made ground varies in thickness between 1m to 5m but is known to be as great as 15m in places on the floodplain to the East. It is known that colliery waste was tipped towards the south and east of the site between 1977 and 1988 which may have

contributed to the presence of the made ground. The alluvial deposits are generally between 2m and 10m thick with some localised glacial till.

- 1.2.12 The underlying bedrock geology at the site comprises mudstones of the Etruria Formation (also known as Ruabon Marl) which is between 2m and 50m thick. It is a sedimentary bedrock which formed approximately 308 to 319 million years ago in the Carboniferous Period, where the local environment was previously dominated by rivers.
- 1.2.13 According to the Groundwater Vulnerability Map for the area, (Sheet 16 1:100,00 Scale 'West Cheshire'), the installation is located on strata classified by the Natural Resources Wales (NRW) as a Secondary A aquifer of variable permeability. The classification of 'Secondary A aquifer' refers to the whole of the Upper (and Middle) Carboniferous Group from which large abstractions of water can be locally abstracted from sandstone horizons, but yields can be variable both spatially and temporally. At the site, Ruabon Marl (mudstone) predominate within which permeability would be low and intergranular/fracture flow would be expected to be modest. Accordingly, the Ruabon Marl strata themselves could be classified as unproductive strata.
- 1.2.14 Pen-y-bont Landfill is not situated within a Groundwater Source Protection Zone.
- 1.2.15 It is proposed that the site will be restored to a mixture of woodland, hedges, pasture areas and grassland. The restoration details for the facility are illustrated upon **Drawing Reference Number WR7350/5/05**. Please note, the restoration details for the site have recently been amended slightly (in order to allow for the 3 surface water ponds to the north east of the site to be retained as opposed to a reduction to one pond as well as to lower the final contours of the site) therefore, the restoration plans are currently pending approval with the Local Planning Authority.

1.3 Area of Closure

- 1.3.1 This Closure Plan seeks definite closure for the landfill facility as a whole, as identified by the Environmental Permit Boundary presented on **Drawing Reference Number WR7350/5/01**.

2.0 WASTE STABILITY

2.1 General

2.1.1 The documents examined to provide additional information for this chapter are as follows:

- Stability Risk Assessment (SRA) for Pen-Y-Bont Landfill Site, Report No. WR4446/SRA
- Drawing No. 466A263, Annual Site Plan 2017.
- Drawing 466D-NW-2014-34, Approximate Extent of Capping Works 2015 and Construction Details.
- Slope Stability Monitoring Plan 2006. Document Reference: AS5916/rac/01.

2.1.2 The general nature and history of the site has been described in Section 1. The geology at Pen-Y-Bont Landfill consists of alluvial deposits, generally between 2 and 10m thick with some localised glacial till. These superficial layers are underlain by Ruabon Marl which is between 2m and 50m thick. The marl in turn overlies Carboniferous Middle Coal Measures Sands and silts which contain local organic layers.

2.2 Risk Models and Screening

2.2.1 **Basal Sub grade** – The basal subgrade in each cell comprises un weathered Ruabon Marl.

All cells have been constructed in accordance with the relevant site permits and CQA Plans. Filling with waste, capping and restoration has now been completed at the site. No issues regarding subgrade instability, or heave, were reported during the construction of the cells. There is not considered to be any change from the 2004 PPC Permit SRA. Therefore, there are no remaining stability issues for the basal sub grade.

2.2.2 **Side Slope Sub-Grade** – The side-slope subgrade was created by re-grading the excavated quarry face.

All cells have been constructed in accordance with the relevant site permits and CQA Plans. Filling with waste, capping and restoration has now been completed at the site. The 2004 PPC Permit SRA considered a worst-case analysis of the side slope comprising a 10m vertical height slope with a 1 in 2 side-slope gradient. No stability issues have been reported for the side slope subgrade. There is no change from the 2004 PPC Permit SRA. Therefore, there are no remaining stability issues for the side-slope sub grade.

2.2.3 **Basal Lining System** – The basal lining system for the cells (from the base upwards) comprised:

Cell 1

- 1m thick, engineered clay liner with maximum permeability of $5.5 \times 10^{-10} \text{ ms}^{-1}$ and;
- Herringbone Piped leachate drainage blanket.

Cell 2

- 1m thick, engineered clay liner with maximum permeability of $5.5 \times 10^{-10} \text{ ms}^{-1}$ and;
- 300mm thick granular leachate drainage blanket (extending 2m vertically up the side slopes).

Cell 3

- 1m thick, engineered clay liner with maximum permeability of $5.5 \times 10^{-10} \text{ ms}^{-1}$;
- 2mm HDPE geomembrane liner;
- geotextile protection separator; and
- 300mm thick granular leachate drainage blanket (extending 2m vertically up the side slopes).

2.2.4 All cells have been constructed in accordance with the relevant site permit and CQA Plans. Filling with waste, capping and restoration has now been completed at the site. The basal lining has been constructed in accordance with the modelled system, and there is not considered to be any change from the 2004 PPC Permit SRA. Therefore, there are no remaining stability issues for the basal lining system.

2.2.5 **Side-Slope Lining System** – The side slope lining system construction for each of the cells comprised of the following (from base upwards):

- 1m thick, engineered clay liner with maximum permeability of $1 \times 10^{-9} \text{ m/s}$;
- 2mm HDPE geomembrane liner; and
- geotextile protection separator.

2.2.6 All cells have been constructed in accordance with the relevant site permit and CQA Plans. Filling with waste, capping and restoration has now been completed at the site. The 2004 PPC Permit SRA considered a worst-case analysis of the side slope liner, installed at a gradient of 1 in 2.5. No instability has been reported during the construction of the cells. There is not considered to be any change from the 2004 PPC Permit SRA. Therefore, there are no remaining stability issues for the side-slope subgrade.

2.2.7 **Waste Mass** – The landfill accepted Household, Commercial and Industrial (HCI) waste until its closure. Tipping was completed on 28th October 2016, and the site has since been subject to capping and restoration.

The worst-case temporary waste slope analysed was with a gradient of 1 in 2.5. All the waste has been in-filled, and no slope stability problems of the

temporary waste slopes was reported. There is not considered to be any change from the 2004 PPC Permit SRA. Therefore, there are not considered to be any remaining stability issues relating to the final waste slopes at the site.

2.2.8 Capping System – The landfill was capped by the following system:

- 0.3m thick waste regulation layer;
- Lower protector geotextile (if required);
- 1mm thick double textured LLDPE geomembrane liner;
- Geocomposite drainage layer; and
- 1000mm restoration soils.

2.2.9 The 2004 SRA considered two separate capping slopes, 45m at a gradient of 1 in 2.8, and 105m at a gradient of 1 in 5.4. The SRA concluded that suitable factors of safety were achieved for the slopes analysed so long as textured geomembrane was used for slopes greater than 1 in 6, and so long as extreme plant movements were prevented from occurring on the cap.

2.2.10 **Drawing 466AQ263**, Annual Site Plan 2017, shows the complete capping works on the site. The slopes shown on the drawing are in line with those assessed in the 2004 SRA. There is not considered to be any change from the 2004 PPC Permit SRA. The capping slopes will reduce in gradient as settlement of the waste mass occurs, therefore the stability of the capping system will only increase with time. Therefore, there are not considered to be any remaining stability issues relating to the final capped slopes at the site.

2.3 Waste Settlement

2.3.1 Based on the CQA Plans for the capping works, final capping at the site occurred in November 2016, with final waste placement occurring during October 2016. Settlement of the waste mass is anticipated over the coming years and is likely to be in the order of 25% of the total waste mass. This will be monitored by annual settlement surveys of the site. The stability of the waste slopes and capping system should increase with additional settlement of the site, as the slope gradients gradually decrease. Therefore, there are not considered to be any remaining stability issues relating to the settlement of the waste mass at the site.

2.4 Perimeter Slopes

2.4.1 Concerns over the stability of perimeter slopes to the landfill in 1999 resulted in investigation by consultants Sir Frederick Snow & Partners, with consequential reprofiling to three slopes at the site. A ground movement occurred on Slope 2 (which is located on the northern boundary overlooking the River Dee, as discussed in the SRA included in Appendix 4) towards the end of 2000, necessitating significant investigation and remedial works in 2001, undertaken under the direction of consultants Entec UK. Following completion of these remedial works, a two-year monitoring survey programme was agreed between regulatory agencies and the site's operator.

- 2.4.2 Following the recommendations outlined in the PPC SRA, we understand that this particular slope was monitored for movement until 2006, to verify that the slope remediation measures implemented had been successful. After this time, monitoring ceased when no further movement was detected, and the remedial measures were considered to have achieved their stated aims.

2.5 Conclusions

- 2.5.1 After a review of the 2004 PPC Stability Risk Assessment (SRA), construction details (CQA Plans), as-built surveys, and the CQA Validation Reports for the site, there are considered to be no significant issues with regard to the stability of the site at present and in future years.

3.0 SITE INFRASTRUCTURE

3.1 Leachate Management Infrastructure

- 3.1.1 The management of leachate at the site is facilitated by engineered capping of the site surface, lining systems and active extraction from in-waste leachate extraction wells.
- 3.1.2 The leachate collection and extraction system in Cell 1 consists of a herringbone drainage pattern of leachate collection pipes falling at a gradient of no less than 1:50 to individual vertically extended leachate collection sumps/extraction chambers.
- 3.1.3 Within Cell 2, leachate collection/drainage system comprises a continuous 300mm blanket of 20mm clean-graded non-calcareous drainage stone within which are lain 160mm diameter drainage pipes falling at a gradient of no less than 1:50 to vertically extended individual leachate collection sumps/extraction chambers.
- 3.1.4 Within Cell 3, the leachate collection system comprises a 300mm thick continuous drainage blanket constructed out of 20mm clean-graded non-calcareous drainage stone within which 160mm diameter leachate collection pipes have been lain falling at a gradient of 1:50 to 2 individual sidewall riser leachate extraction points. These structures are made of 450mm non-perforated HDPE pipe, rising at an angle of 26 degrees from the cell base, again against the cell side wall. The risers are protected by surrounding leachate drainage stone lain up to a height to 1500mm above the cell base and are for leachate abstraction only.
- 3.1.5 The site is provided with leachate pumping, storage and disposal infrastructure. Leachate is removed from the cells by pumping, utilising electric submersible pumps installed within the leachate collection/extraction wells, side slope risers and if necessary, the leachate monitoring points. This is then discharged to the 2 tanks (with a capacity of 80m³ each), situated near the gas compound, prior to transfer to 2 additional tanks (150m³ capacity) situated at the site entrance. The leachate storage capacity is sufficiently sized to maximise the continual removal of leachate from the site. Please note, at the current time there are no plans to change the location or the capacity of the leachate storage tanks at the site. However, if receipt of planning permission pertaining to the future development of the site necessitates an alteration in capacity and location of said tanks, this will be fully discussed with NRW and relevant CQA details will be provided as appropriate. All leachate is then tankered offsite for disposal at a suitably licenced treatment facility. The Leachate Management Plan for the site is included within **Appendix 1**.

Basal Lining and Capping Systems

- 3.1.6 The landfill has been operated as a fully engineered containment site since its initial development. Each landfill cell is comprised of individual hydraulically

isolated containment cells utilising a 1m thick engineered basal clay liner possessing a specified permeability of $< 5.5 \times 10^{-10}$ m/s. The engineered clay liner has been constructed out of reworked Ruabon Marl which was previously excavated from the quarry. There is also a 2mm HDPE artificial sealing liner installed within Cell 3.

- 3.1.7 The capping has been completed at the site on a phased basis, utilising (working from waste side up) a 0.3m thick waste regulation layer, lower protector geotextile (if required), a geomembrane liner of minimum 1mm thickness, a geocomposite drainage layer and 1000mm of restoration soils.

3.2 Leachate Infrastructure Maintenance

- 3.2.1 The leachate pumping and extraction system is regularly inspected by suitably trained personnel. In the event of a failure etc arrangements will be made immediately to have the system repaired and Natural Resources Wales will be informed within 24 hours, unless already rectified. The replacement of collapsed/blocked wells will be undertaken as and when necessary to ensure a requisite number of extraction and monitoring points are present.
- 3.2.2 The leachate management system will be regularly cleaned, descaled and if necessary unblocked to ensure collection effectiveness.
- 3.2.3 Walkover surveys will allow identification of visible damage to surface collection wells.

3.3 Landfill Gas Infrastructure

- 3.3.1 Gas management and control is achieved by:
- The operation of an internal gas monitoring system
 - The operation of an external gas monitoring system
 - A permanent active gas extraction system and;
 - The low permeability lining system installed across the base, perimeter side-slopes and final capping of the site surface.
- 3.3.2 The landfill gas extraction system comprises a combination of horizontal, vertically extended and retro-drilled wells. All types of extraction well are connected to a gas extraction gas main. Optimal well spacing has been defined through site-based knowledge and in line with NRW/EA guidance, Industry Codes of Practice and operational experience. Vertical bores have been drilled into the waste and lined with flush threaded or butt-fused sections of polyethylene pipework. The vertical wells that have been retro drilled into the waste are no more than 80% of the depth of the waste or a minimum of a 3-metre stand-off from the base to ensure that there is no interference with the basal lining system.
- 3.3.3 Gas extraction pipework consist of various sizes, typically ranging from 63mm outside diameter to 355mm. The site ring main comprises 355mm diameter gas collection mains along the boundary of the site connecting to gas

compound. In addition to this, condensate management within the gas system comprises a series of pumped knock-out pots.

3.3.4 The active gas extraction system also incorporates a Gas Utilisation Plant. The Landfill Gas Utilisation Plant comprises two Caterpillar engines, each capable of generating 1,150kW. In addition to this, there is also a 2,500m³ capacity high temperature flare situated on site, capable of sufficient gas control in the event of gas engines being unavailable. The system was initially installed and commissioned in 2003. The gas utilisation plant will be kept under review during the closure phase to ensure that it remains appropriate for the volume of gas being produced.

3.3.5 Landfill gas is routinely monitored in 30 perimeter gas boreholes installed at the locations illustrated on **Drawing Reference Number WR7350/5/03**. The Gas Management Plan for Pen-y-bont Landfill Site is contained within **Appendix 2**.

3.4 Landfill Gas Infrastructure Maintenance

3.4.1 The gas control systems will be kept in good working order at all times by regular inspection, maintenance and repair and shall be retained on site until such a time that it can be demonstrated that the potential for the migration of landfill gas no longer remains. Any failures in the landfill gas control systems are reported to the Site Manager and reported to Natural Resources Wales as soon as is practicable, in accordance with the Permit notification requirements.

3.4.2 Olfactory monitoring will be carried out by FCC personnel during site visits which will identify potential gas infrastructure failure.

3.4.3 Landfill gas extraction wells are inspected during each monitoring round and are also visually inspected to ensure their integrity. The landfill has inspection, maintenance and servicing regime, as well as the general procedures for the management of gas are described in the Gas Management Plan which has been produced for the site, which is contained within **Appendix 2**.

3.4.4 The gas management infrastructure and revised monitoring schedule are compliant with the minimum requirements specified in Annex III of the Landfill Directive and LFTGN 03 (September 2004).

3.5 Groundwater

Groundwater Infrastructure

3.5.1 There is a total of 27 groundwater boreholes (some of which are combined groundwater and gas monitoring boreholes) situated around the periphery of the permit boundary. Please note, it is now proposed to reduce the number of groundwater monitoring boreholes from 27 to 13, as discussed in **Section 4.3**. Given the sites locality, within a meander of the River Dee, it can be considered that groundwater flow is towards the River in a north, east and west direction.

- 3.5.2 The site is considered to be in hydraulic containment, with groundwater flow in the immediate proximity to the landfill flowing towards the site. It is also assumed that a groundwater divide encircles the site, beyond which groundwater flow is away from the site towards the River Dee as stated above.
- 3.5.3 There is no pumped groundwater management system. However, groundwater flows into the installation are minimised by the presence of a 1m thick mineral basal and side slope liner constructed to a permeability of $<5.5 \times 10^{-10}$ m/s in addition to a composite 2mm HDPE membrane liner across the basal and side slope area in Cell 3 (and side slope area in Cell 2 and most of Cell 1).

Groundwater Infrastructure Maintenance

- 3.5.4 Groundwater infrastructure will be kept in good working order at all times by regular inspection, maintenance and repair. In the event of failure etc, arrangements will be made immediately to have the infrastructure repaired and Natural Resources Wales will be informed within 24 hours unless already rectified.

3.6 Surface Water Infrastructure

- 3.6.1 Surface water runoff from the closed landfill will discharge via perimeter surface drains and be directed towards the north east of the site. To the northeast of the landfill is the surface water treatment area in the form of three settling lagoons. Each settling lagoon is unlined and is connected by a 1m wide channel. Each settling lagoon is surrounded by a 0.5m high bund which is suitable for ensuring the necessary water retention. The connecting pipes are fitted with valves which allow lagoons to be isolated in emergency situations. Surface water from the landfill site is directed to the first settling lagoon within which suspended solids are settled out before being directed to the second settling lagoon for further settling of suspended solids. Final suspended solid settlement is achieved within a third lagoon.
- 3.6.2 The outlet system for the site (from the settling lagoons) discharges to 3 filtration/infiltration basins (comprising reed beds), situated to the north of the surface water lagoons. The discharge is fed via overland pipework and can be controlled by the use of an isolation gate valve. Surface water from the settling lagoon (when discharged) naturally infiltrate and soak away through the reed bed plots into natural soils and drift strata to enter the local groundwater systems. An appropriate discharge consent (ref CGG0385601) is held for this activity. The final basin is fitted with 200mm overflow to provide a method of controlled discharge to the River Dee in the event of an emergency, in which the surface water volume exceeds the capacity of the basins. This discharge is also permitted via an appropriate consent (CM0094101).
- 3.6.3 Please note, the discussion of soil depths is included within **Appendix 6**.

3.7 Surface Water Infrastructure Maintenance

- 3.7.1 In the event of silting or blockages of the scheme, arrangements will be made to have the system remediated if required and Natural Resources Wales will be informed.
- 3.7.2 Vegetation will be controlled to ensure accessibility to surface water monitoring points.

4.0 MONITORING

4.1 Leachate Monitoring

- 4.1.1 A summary of the current leachate monitoring points and their associated landfill cells is presented in **Table 1**. The locations of all leachate monitoring points are illustrated on **Drawing Reference Number WR7350/5/03**. Please note, sample points LC06 and LC07 are utilised for abstraction purposes only and are not included within the leachate monitoring schedule.

Table 1 – Summary of Existing Leachate Monitoring & Abstraction Points

Location ID	Cell Number	Designation
LC01B	1	Monitoring & Abstraction
LC03	1	Monitoring & Abstraction
LM05B	2	Monitoring & Abstraction
LC05B	2	Monitoring & Abstraction
LC04B	2	Monitoring & Abstraction
LM04B	2	Monitoring & Abstraction
LC06	3	Abstraction Only
LC07	3	Abstraction Only
LM06B	3	Monitoring & Abstraction
LM07B	3	Monitoring & Abstraction
LT1	Leachate Tank	–

- 4.1.2 The proposed leachate monitoring and testing schedule to be implemented during the aftercare phase of the landfill is presented in **Table 2**. Table S4.8 of current Environmental Permit (EPR/GP3830BG/V007) stipulates that leachate sampling should be conducted at a quarterly frequency. However, Table 6.9 of the Environment Agency's Technical Guidance Note 02 (which is utilised by NRW) – "*Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water*" recommends that once initial characterisation of leachate quality is complete, the frequency of monitoring can be reduced for routine indicators, with annual monitoring allowing for ongoing characterisation. The leachate composition is well established at Pen-y-bont and the final engineered cap has been installed, therefore it is appropriate to reduce the sampling frequency (to 6 monthly) and to reduce the number of parameters to a more basic suite of 'indicator' substances, as is detailed in **Table 2**. The annual analytical suite remains in line with those detailed in Table S4.8 of the Environmental Permit.

This approach has been previously outlined in correspondence between the operator and Natural Resources Wales, dated 23rd January 2017.

Table 2 – Aftercare phase leachate monitoring schedule

Monitoring Point	Parameter	Frequency
LC03, LC01B, LC04B, LC05B, LM04B, LM05B, LM06B & LM07B	Leachate Level	Monthly
LC01B, LC04B, LC05B, LM07B	pH, EC, Ammoniacal Nitrogen, Chloride, COD and BOD.	6-monthly
LC01B, LC04B, LC05B, LM07B	pH, Electrical Conductivity, Ammoniacal Nitrogen, Temperature, Chloride, Sulphate, BOD, Total Alkalinity (CaCO ₃) (tot alk), Total Phenols, COD, TOC, TON, Sodium, Potassium, Calcium, Chromium, Copper, Iron, Lead, Magnesium, Manganese, Cadmium, Mecoprop, Napthalene, Nickel, Zinc, Mercury, Total Cyanide, Hazardous Substances (List I) screen	Annual

4.1.3 Table 6.2 of the Environment Agency's Technical Guidance Note 02 (which is utilised by NRW) – "*Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water*" recommends that in terms of number of monitoring points, one appropriate quality point per 5ha cell is appropriate. Given this, in terms of leachate quality, the number of monitoring points has been reduced to those listed in **Table 2** above, compared to what is listed in the Environmental Permit. Please note, the reduction in monitoring points (in terms of assessing for leachate quality) in **Table 2** complies with the guidance, in that at least one installation will be monitored per cell. All leachate monitoring points will be checked for leachate level at the appropriate frequency.

4.1.4 Details of the leachate head compliance levels are presented in **Table 3**. The current Environmental Permit (Table S4.1) sets the leachate level limit at 1m above the base of the cell. Leachate level compliance was maintained at 100% compliance within the specified trigger limit of 1m above the cell base in 2016, according to the 2016 annual report. However, in line with the Natural Resources Wales approved HRAR (dated February 2016, V3, contained within **Appendix 5**), it is now considered appropriate (given long periods of leachate head compliance) to vary the leachate head compliance limit at the site to allow for additional operational flexibility going forward.

4.1.5 Pen-y-bont Landfill site is operated under the principal of hydraulic containment and therefore leachate levels are maintained below surrounding groundwater levels. Based on modelling conducted as part of the 2009 and 2016 HRAR (contained in **Appendix 5**), it is proposed that a compliance limit of 43mAOD is to be adopted going forward (which can be considered to be a conservative approach). This represents a c. 3m head difference between leachate level and groundwater level (assuming minimum groundwater level of

46mAOD). Given that the site has ceased operation (waste acceptance ceased on 28th October 2016) and site capping was completed on 16th November 2016, (which provides further precaution should leachate control be lost for a short period of time), it is considered that the variation to the leachate head limits is now appropriate. This has been discussed and approved via previous correspondence between the operator and the regulator.

- 4.1.6 In addition to the above, it is also considered appropriate (in line with the HRAR dated February 2016, V3, contained within **Appendix 5**) to remove the compliance limit for LC03 as it is located on a bench close to the sidewall and as such does not monitor leachate levels acting on the base of the site, as referenced in **red** in **Table 3** below.

Table 3: Leachate head trigger levels

Reference Point	Cell Number	Basal Level (mAOD)	Compliance Level (mAOD)
LC01B	1	40.64	43
LC03	1	64.01	–
LM05B	2	40.58	43
LC05B	2	41.23	43
LC04B	2	40.82	43
LM04B	2	40.63	43
LM06B	3	40.47	43
LM07B	3	39.60	43

4.2 Landfill Gas Monitoring

Source Emissions

- 4.2.1 The monitoring schedule for the landfill gas extraction system at Pen-y-bont is presented in **Table 4**. All landfill gas management at the site is undertaken by an external company (Infinis) with cognisance to the specified Gas Management Plan, included in **Appendix 2**. In addition to this, the Perimeter Borehole Gas Review (dated March 2014) is contained within **Appendix 3**.

Table 4 – In-waste Landfill Gas Monitoring Frequencies

Determinand	Monitoring Frequency	Typical Accuracies
Methane (CH ₄) (%)	Monthly	% v/v ±3
Carbon Dioxide (CO ₂) (%)	Monthly	% v/v ±3
Oxygen (O ₂) (%)	Monthly	% v/v ±1
Atmospheric Pressure	Monthly	±5mb

- 4.2.2 Emissions monitoring for the gas flare and engines will be reported to NRW on an annual basis.
- 4.2.3 Monitoring will be undertaken by personnel who are familiar with the equipment and its limitations, as per Technical Guidance Note M2. The results will be reported to Natural Resources Wales within 28 days of the end of the monitoring period.

- 4.2.4 Emissions from the landfill gas flare and engines will be subject to the emission limits presented in **Table 5**. As stated previously, the landfill gas management at the site is undertaken by an outsourced gas operator, Infinis PLC.

Table 5: Emissions Limit Values for landfill gas utilisation and flare systems

System	Parameter	Emission Limit (mg/m ³)	Monitoring Frequency
A1 – Flare Stack ¹	Nitrogen Oxides (NOx)	150 mg/m ³	Annually
	Carbon Monoxide (CO)	50 mg/m ³	
	Total VOCs	10 mg/m ³	
A2 – Engine Exhausts (2 x Caterpillar engines) ²	Nitrogen Oxides (NOx)	650 mg/m ³	
	Carbon Monoxide (CO)	1500 mg/m ³	
	Total Volatile Organic Compounds (VOC's)	1750 mg/m ³	
A2 – Engine Exhausts ³	Nitrogen Oxides (NOx)	500 mg/m ³	
	Carbon Monoxide (CO)	1400 mg/m ³	
	Total Volatile Organic Compounds (VOC's)	1000 mg/m ³	

¹ – Annual monitoring is only required when flares operate in excess of 10% of the time, taken on an annual assessment period

² – For engines commissioned before 31st December 2005

³ – For engines commissioned after 31st December 2005

- 4.2.5 Measurements of landfill gas will be carried out utilising appropriately calibrated equipment. The results will be made available for inspection by Natural Resources Wales.

Lateral Emissions

- 4.2.6 To date, a total of 30 perimeter gas monitoring boreholes have been installed at the site. Notwithstanding this, although T11 is routinely monitored, there is not an action limit applied to it. The monitoring results for landfill gas at T11 (which is installed into colliery shale) consistently showed high levels of methane which were proved to have been present prior to waste management tipping operations at the site. That is, when the gas from borehole T11 was sampled it indicated a chemical signature pointing to a source other than landfill in origin. Given this, it can be considered that there are 29 perimeter gas monitoring boreholes which have been installed around the perimeter of the landfill to monitor the lateral migration of landfill gases, that are attributed with relevant action limits. The locations of all existing monitoring boreholes are summarised as follows:

- Borehole numbers: T1, T2, T3, T4, T5, T6, T7, T8 and T9 have been installed along the northern boundary of the site.
- Borehole numbers: T10, T11 (no longer attributed with a trigger limit), T12 and T13 have been installed along the eastern boundary of the site.

- Boreholes numbers: G8, G9, G10, G11, G12, G13, G14, G15, G16 and G17 have been installed along the southern boundary of the site.
- A further 7 boreholes have been installed along the western boundary of the site, these include borehole numbers G1, G2, G3, G4, G5, G6 and G7.

4.2.7 Monitoring within each perimeter borehole will include the parameters detailed in **Table 6**. Please note, based upon the annual reports for the site for 2015 and 2016, as well as the proximity of receptors to the site, it is considered appropriate to continue with monthly gas monitoring along the southern and western boundaries of the site (which is in line with the Environmental Permit). However, during the closure of the site, based on the proximity of receptors, it is considered acceptable to reduce the frequency of gas monitoring at the boreholes situated along the eastern and northern boundaries to quarterly (please note that this is seen to be a conservative approach as the Landfill Directive suggests that the frequency of monitoring can be reduced to 6 monthly during the aftercare phase).

Table 6 – Perimeter Borehole Monitoring Requirements

Monitoring Point Reference	Frequency	Parameter	Limit (%v/v)	Action Limit (%v/v)
G1, G2, G3, G4, G5, G6, G7, G8, G9, G10, G11, G12, G13, G14, G15, G16, G17,	Monthly	Oxygen	N/A	
		Atmospheric Pressure & Meteorological Conditions	N/A	
		Methane	1% v/v	
T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T12, T13	Quarterly	Oxygen	N/A	
		Atmospheric Pressure & Meteorological Conditions	N/A	
		Methane	1% v/v	
G1	Monthly	Carbon Dioxide		3.22
G2	Monthly	Carbon Dioxide		3.21
G3	Monthly	Carbon Dioxide		2.91
G4	Monthly	Carbon Dioxide		2.57
G5	Monthly	Carbon Dioxide		2.53
G6	Monthly	Carbon Dioxide		2.77
G7	Monthly	Carbon Dioxide		3.36
G8	Monthly	Carbon Dioxide		3.62
G9	Monthly	Carbon Dioxide		3.48
G10	Monthly	Carbon Dioxide		2.76
G11	Monthly	Carbon Dioxide		2.72
G12	Monthly	Carbon Dioxide		3.33
G13	Monthly	Carbon Dioxide		2.28
G14	Monthly	Carbon Dioxide		2.82
G15	Monthly	Carbon Dioxide		2.27
G16	Monthly	Carbon Dioxide		2.18
G17	Monthly	Carbon Dioxide		3.19
T1	Quarterly	Carbon Dioxide		2.86
T2	Quarterly	Carbon Dioxide		2.90
T3	Quarterly	Carbon Dioxide		3.49
T4	Quarterly	Carbon Dioxide		4.99
T5	Quarterly	Carbon Dioxide		3.85
T6	Quarterly	Carbon Dioxide		3.69
T7	Quarterly	Carbon Dioxide		2.91
T8	Quarterly	Carbon Dioxide		3.50
T9	Quarterly	Carbon Dioxide		3.90
T10	Quarterly	Carbon Dioxide		2.40
T11	Quarterly	Carbon Dioxide		–
T12	Quarterly	Carbon Dioxide		2.71
T13	Quarterly	Carbon Dioxide		2.96

4.2.8 Monitoring will be conducted utilising a suitably ATEX approved gas analyser. Calibration and serving of portable instruments will be carried out in accordance with the manufacturers recommendations and records of calibration certificates will be provided upon request.

- 4.2.9 Monitoring will be undertaken by personnel (either from FCC or suitably trained contractor) who are familiar with the equipment and its limitations. The operator warrants that the personnel engaged in monitoring activities are trained to undertake the task. Monitoring personnel will be able to correctly use gas analysers and interpret landfill monitoring data. Training records and calibration certificates will be maintained. When required, and in accordance with the landfill gas action plan, samples will be taken for subsequent laboratory analysis using an appropriately approved technology and relevant sampling methodology e.g Tedlar gas bags.
- 4.2.10 The monitoring results will be reported to the Agency within 28 days of the end of each reporting period.

Surface Emissions

- 4.2.11 The capping systems placed over all cells have been constructed under strict CQA standards with appropriate leak testing along welded joints of the geomembrane liner.
- 4.2.12 In accordance with LFTGN03 and LFTGN07, a flux box monitoring survey to determine surface emissions through capped areas will be undertaken on an annual basis. However, if the cap has previously been shown to be compliant, a detailed walkover survey will be undertaken which is considered to be acceptable.
- 4.2.13 In summary, the aftercare monitoring strategy will comprise a walkover survey of capped areas using portable equipment (such as a Flame Ionisation Detector or similar) carried out at regular lines and transects at a minimum spacing of 50m. Particular attention will be given to:
- Surface cracking or fissures;
 - Stressed vegetation;
 - Interfaces between capped zones;
 - Landfill edges and side slopes;
 - Gas and leachate wells
- 4.2.14 Where the survey identifies a cap location with particularly high emissions the location will be recorded and described in relation to a fixed point on the cap together with a GPS reference to allow identification for subsequent remedial work. Discrete features such as gas or leachate wells emitting substantial amounts of gas will be recorded and reported.
- 4.2.15 The monitoring protocols for surface emissions are listed within **Table 7** below. A flux box survey shall be conducted if results of a walkover survey indicate that this is required. The site walkover survey will be conducted with cognisance to the techniques and control concentrations specified in the Gas Management Plan for the site, contained within **Appendix 2**. In order to monitor methane emissions through the cap and demonstrate compliance with the Landfill Directive, monitoring will be carried out in accordance with methods described in LFTGN07 (v2, 2010).

Table 7– Monitoring Protocols for Surface Emissions

Monitoring Point	Parameter	Frequency	Other specifications
Permanently capped zone ¹	Average Methane Flux	Annually	When a rate of 0.001 mg/m ² /second is exceeded, appropriate measures must be taken to reduce the rate

¹ If a cap has previously been shown compliance and there have been no physical changes in the gas management during the year, a detailed walkover survey can be used to demonstrate that the surface emissions are under control. If this survey shows no change in the pattern of methane emissions, it may be used as the annual survey. The values for flux and total methane emissions measured in the previous year 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 further quantitative flux box survey is required.

4.3 Groundwater Monitoring

- 4.3.1 A network of 27 boreholes currently monitor groundwater around the periphery of the Pen-y-bont Landfill Site. However, the Environment Agency's Technical Guidance Note 02 (which is utilised by NRW) – “*Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water*” stipulates that groundwater monitoring boreholes are required to be spaced at a maximum of 100m apart on the down gradient site boundary of a landfill. As a response to an improvement condition imposed by the Environment Agency Wales (now NRW), dated 9th February 2006, the operator was required to design install and monitor additional groundwater monitoring boreholes which should be at a “minimum of 100m spacing around the perimeter of the installation”. The spacing of the additional groundwater monitoring boreholes was agreed with Environment Agency Wales (now NRW). Currently, in terms of compliance with the guidance, there is an excess of groundwater monitoring boreholes at the site, particularly along the northern, eastern and the large majority of the western boundary of the site. The number of groundwater monitoring points which are therefore monitored and sampled at the site has been reduced to 13, which is seen to be appropriate. Their locations are shown on **Drawing Reference Number WR7350/5/03**.
- 4.3.2 The monitoring results are reported to Natural Resources Wales within 28 days of the end of reporting period as appropriate.
- 4.3.3 A summary of the groundwater monitoring schedule is presented in **Table 8**. Table S4.10 in the Environmental Permit stipulates that a number of parameters (groundwater level, temperature, pH, Chloride, Electrical Conductivity, Ammoniacal Nitrogen, Dissolved Oxygen, COD, BOD and Suspended Solids) are monitored on a monthly basis. However, Table 6.9 in LFTGN 02 indicates that, in the case of groundwater level, monitoring frequency can be reduced to quarterly or six-monthly if normal seasonal fluctuations have been established. From analysis of results presented in the HRAR (contained within **Appendix 5**) it can be considered that the groundwater level has been stable in the large

majority of boreholes analysed during the assessment period (2009–2014). Given this, it has been considered appropriate to amend the monitoring frequency of groundwater level to quarterly.

- 4.3.4 With regards to the monthly monitoring of groundwater composition (listed in Table S4.10 of the Environmental Permit), Table 6.9 in LFTGN 02 indicates that, in terms of monitoring of routine indicators, this can be reduced to 6 monthly or annually (from quarterly) if stable conditions are proved. It also stipulates that frequencies should be increased where groundwater flow velocities are high. In addition to this, with regards to routine ongoing characterisation (which should initially be monitored on a 6-monthly basis), monitoring can be reduced to annually if stable conditions are proven. It also states that there should be an increased frequency where groundwater flow velocities are high. Given that the composition of the surrounding groundwater has been well characterised at Pen-y-bont through monthly monitoring since the site opened, it is considered that all parameters which were previously monitored on a monthly basis can be monitored on a quarterly basis going forward, those which were monitored quarterly can now be monitored 6 monthly and those previously monitored 6 monthly can be added to the annual analytical suite. As well as this, it is considered appropriate to amend the frequency of monitoring for hazardous substances to every 2 years, which is considered standard practice for closed landfill sites.

Table 8 – Aftercare Phase Monitoring Schedule

Locations	Frequency	Measurement and Analytical Suite
BH4, BH7, BH8, BH9, BH10, BH12, BH13, BH14, T2, T4, T6, T12, & T13.	Quarterly	Groundwater Level
	Quarterly	Temperature, pH, Chloride, Electrical Conductivity, Ammoniacal Nitrogen, Dissolved Oxygen, COD, BOD, Suspended Solids
	6 monthly	Calcium, Magnesium, Potassium, Alkalinity, TOC, TON, Sulphate, Chromium, Lead
	Annually	Copper, Iron, Manganese, Zinc, Toluene, Orthophosphate, Nickel, Mecoprop, Cadmium, Naphthalene, TPH, Total Phenols, Mercury
	Every 2 years	Hazardous substances in leachate

Groundwater Compliance Levels

- 4.3.5 Groundwater compliance limits are contained within **Table 9** below. The 2016 annual review of groundwater quality indicates that there were no breaches of any substances (listed within the Environmental Permit) tested during that year. The trigger levels for emissions to groundwater for a number of boreholes

pertaining to Ammoniacal Nitrogen, Cadmium and Mecoprop levels have been amended in accordance with the findings of the recent HRAR (v3 2016), which have been discussed previously with NRW. With regards to Ammoniacal Nitrogen, in light of the analysis conducted as part of the HRAR (v3 2016) it is suggested that the compliance limits of boreholes BH10 and BH13 are amended on a mean plus 2 standard deviations basis from that listed in Table S4.4 of the Environmental Permit.

4.3.6 In addition to this, in light of the complex geological matrix for groundwater at Pen-y-bont, it is suggested that the groundwater Mecoprop and Cadmium concentration limits should be amended from those listed in Table S4.4 of the Environmental Permit in line with the Environment Agency's fact sheet on Minimum Reporting Values (MRV's). The proposed amendments to the compliance limits are further discussed in the HRAR (v3, 2016) which is included in **Appendix 5** and have been updated as such in **Table 9** below.

Table 9 – Aftercare phase trigger levels for emissions into groundwater

Locations	Frequency	Parameter	Compliance Limit
BH4, T2, T4, T6 and T13	Quarterly	Chloride	250 mg/l
	6 monthly	Chromium	0.05 mg/l
	Annually	Nickel	0.02 mg/l
	6 monthly	Lead	0.025 mg/l
	Annually	Cadmium	0.001 mg/l
	Annually	Mecoprop	0.1 µg/l
	Annually	Napthalene	1 µg/l
BH4	Quarterly	Ammoniacal Nitrogen	3.0 mg/l
	Annually	Manganese	7.7mg/l
	Annually	Zinc	0.014 mg/l
BH7, BH8, BH9, BH10, BH12, BH13 and BH14	6 monthly	Chromium	0.05 mg/l
	6 monthly	Lead	0.025 mg/l
	Annually	Napthalene	0.001 mg/l
	Annually	Mecoprop	0.0001 mg/l
	Annually	Cadmium	0.001 mg/l
BH7	Quarterly	Ammoniacal Nitrogen	1.3 mg/l
	Quarterly	Chloride	250 mg/l
	Annually	Zinc	0.02 mg/l
	Annually	Manganese	0.05 mg/l
	Annually	Nickel	0.02 mg/l
BH8	Quarterly	Ammoniacal Nitrogen	1.2 mg/l
	Quarterly	Chloride	250 mg/l
	Annually	Zinc	0.25 mg/l
	Annually	Manganese	0.30 mg/l
	Annually	Nickel	0.05 mg/l
BH9	Quarterly	Ammoniacal Nitrogen	0.5 mg/l
	Quarterly	Chloride	250 mg/l
	Annually	Zinc	0.02 mg/l
	Annually	Manganese	0.20 mg/l
	Annually	Nickel	0.02 mg/l
BH10	Quarterly	Ammoniacal Nitrogen	1.0 mg/l
	Quarterly	Chloride	250 mg/l
	Annually	Zinc	0.02 mg/l
	Annually	Manganese	0.7 mg/l
	Annually	Nickel	0.02 mg/l

BH12	Quarterly	Ammoniacal Nitrogen	3.5 mg/l
	Quarterly	Chloride	460 mg/l
	Annually	Zinc	0.02mg/l
	Annually	Manganese	10.2 mg/l
	Annually	Nickel	0.04mg/l
BH13	Quarterly	Ammoniacal Nitrogen	0.92mg/l
	Quarterly	Chloride	320 mg/l
	Annually	Zinc	0.02 mg/l
	Annually	Manganese	3.3 mg/l
	Annually	Nickel	0.02 mg/l
BH14	Quarterly	Ammoniacal Nitrogen	1.9mg/l
	Quarterly	Chloride	340 mg/l
	Annually	Zinc	0.02 mg/l
	Annually	Manganese	2.6 mg/l
	Annually	Nickel	0.02 mg/l
T12	Quarterly	Ammoniacal Nitrogen	0.5 mg/l
	Annually	Manganese	12.0 mg/l
	Annually	Zinc	0.251 mg/l
	Quarterly	Chloride	250mg/l
	6 monthly	Chromium	0.05mg/l
	Annually	Nickel	1.4mg/l
	Annually	Lead	0.025mg/l
	Annually	Cadmium	0.006mg/l
	Annually	Mecoprop	0.04µg/l
	Annually	Napthalene	1 µg/l
T13	Quarterly	Ammoniacal Nitrogen	2.5mg/l
	Annually	Manganese	2.1 mg/l
	Annually	Zinc	0.031 mg/l

4.4 Surface Water Monitoring

4.4.1 FCC conduct surface water sampling at 3 points, WP1, WP2, and WP3 (upstream, downstream and adjacent to the site), as shown on **Drawing Reference Number WR3750/5/03**. In addition to this, there is a surface water sampling point (WP4) situated, after the settlement lagoons but before the infiltration reed beds to the north east of the site. In the event that a surface water discharge is made from the site to the River Dee, sampling is also conducted at an additional monitoring point, WP5. The surface water monitoring schedule for during the aftercare phase of the site is presented in **Table 10**.

4.4.2 The monitoring results will be reported to the Agency within 28 days of the end of each six-monthly reporting period.

Table 10 – Surface Water Monitoring

Monitoring Point Reference	Frequency	Parameter
WP1, WP2, WP3 and WP4, WP5 (if surface water is discharged from the site)	Quarterly	Ammoniacal Nitrogen, Chloride, Suspended Solids, pH, Electrical Conductivity
WP1, WP2, WP3 and WP4, WP5 (if surface water is discharged from the site)	Six -Monthly	COD, Dissolved Oxygen, Sulphate, Alkalinity, Total Oxidised Nitrogen, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Cadmium, Chromium, Copper, Nickel, Lead, Zinc, Phosphate

- 4.4.3 The above monitoring frequencies are at least in line with the minimum monitoring requirements of the LFD. Monitoring will be carried out by a suitably trained person.
- 4.4.4 Monitoring will be carried out in accordance with guidance as stipulate in LFTGN02. When collecting a surface water sample the following procedure will be adhered to as necessary:
- Samples from the water surface will be avoided wherever possible. Sample containers or transfer containers will be submerged below the water surface to avoid collecting floating debris or other products. If this is not possible, solid materials will be removed from the transfer vessels before pouring into a sample container.
 - During sampling, the suitably trained person will stand downstream of the sample point and collect water into sample containers in the flow of water to avoid disturbing water upstream of the sample location. It is preferable to sample direct into sample bottles to avoid cross contamination from sampling containers.

Trigger Levels

- 4.4.5 **Table 11** contains trigger levels associated with discharge points WP4 and WP5. Please note, the discharge of surface water from the site WP4 and WP5 is a rare occurrence and therefore monitoring will be conducted on a 6-monthly basis, as necessary.

Table 11 – Surface Water Trigger Levels

Surface water	Frequency	Parameter				
		Suspended Solids	Oil & Grease	Ammoniacal Nitrogen	Chloride	Volume
WP4 (to the grass plots to the North East of the site)	If utilised, Six-monthly	100 mg/l	No visible oil or grease	3 mg/l	250 mg/l	5616 m ³
WP5 (to the River Dee)	If utilised, six monthly	100 mg/l	No visible oil or grease	3 mg/l	250 mg/l	5616 m ³

4.5 Cap Maintenance/Restored Surface Monitoring

- 4.5.1 Surface monitoring will comprise the methods detailed in Section 4.2.11 and proceeding sections. A walkover survey will also include visual inspection of the landfill surface to identify potential areas of localised settlement and damage.

- 4.5.2 Any damage to the cap will be reported to Natural Resources Wales with 24 hours of discovery. The source and extent of any damage to the landfill cap will be fully investigation and remedial action agreed with Natural Resources Wales. Repairs to the engineered containment and additional soils will be placed to rectify any identified areas of localised settlement as may be necessary.

4.6 Particulate Matter

- 4.6.1 The site is capped and is undergoing restoration. The risk from particulates mater release during the aftercare phase is low. Any works required to repair/maintain any management systems will be appropriately risk assessed and mitigation measures implemented accordingly.

4.7 Odours

- 4.7.1 During the aftercare phase the potential for odours are likely to be as a consequent of a failure in the landfill cap, gas management infrastructure, or leachate management infrastructure, and during the installation of replacement in-waste monitoring and management infrastructure. Olfactory monitoring will be carried out by FCC personnel during site visits to identify any potential significant emissions.

5.0 REPORTING SIGNIFICANT ENVIRONMENTAL EFFECTS**5.1 Malfunctions, Breakdowns or Failures**

- 5.1.1 Any malfunction, breakdown or failure of the infrastructure which has caused, is causing or may cause significant pollution will be notified to Natural Resources Wales within 24 hours of detection.

5.2 Trigger/ Compliance Level Breach

- 5.2.1 Any breach of the trigger levels described in Section 4.0 will be notified to Natural Resources Wales within 24 hours of detection. The source will be investigated (with repeat monitoring as necessary) within a timescale agreed with Natural Resources Wales and contingency actions will be implemented.

5.3 Annual Report

- 5.3.1 The results of all monitoring undertaken will be stored on the FCC environmental database system. All results will be submitted to the Natural Resources Wales in support of an Annual Report that will discuss the performance of the landfill and its Directly Associated Activities over the previous year, to be submitted.