Trehir

DEVELOPMENT COMPANY

Closure Report
Trehir Landfill Site

February 2006

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1. Area of closure

1.1. Site location

Trehir Landfill site is centred on National Grid Reference (NGR) ST 155 897. The site is located in South Wales approximately 2.5km north of the centre of Caerphilly. The nearest villages are Bedwas approximately 1.7km east/southeast of the site and Llanbradach approximately 0.9 km to the north west.

The landfill is a former hard-rock quarry located on the west-facing slope of Mynydd Y Dimlaith and has a north to south alignment with highpoints varying between approximately 194mAOD and 224mAOD. The surrounding land is used for grazing. Approximately 0.03km west of the site is an embankment, which marks the line of a disused railway.

The Rhymney River flows southwards at an elevation of 73mAOD approximately 0.3km to the west of the site before turning eastwards to the south of the site. The site location is shown on **appendix 1**.

1.2. The landfill site area

The site occupies approximately 10ha.

The landfill site area is shown on **appendix 2**.

1.3. Area of the site progressing to definitive closure

Phase 1 and 2 areas were covered in 2003 and 2005 respectively.

Drawings indicating the closure areas of the site are shown on **appendix 3**. (Scale 1:500)

1.4. Final Landform

The final landform for Trehir Landfill Site was approved by the Waste Planning Authority, Caerphilly Borough Council in their planning consent 99/0603 at Appendix B.

2. Waste mass stability

2.1. Waste mass stability study (January 2003, Golder associates)

The waste mass stability takes into account a study dated January 2003. This assessment has used the revised profile. This study is enclosed on **appendix 4**.

2.1.1. Principles

Three cross sections have been used to assess the stability of the site. These cross sections are considered to be representative of the conditions at the site.

Four main materials have been modelled in the stability analyses: capping soils, waste, subgrade and geosynthetic interfaces.

In the stability analyses, the maximum recorded leachate levels at the three cross-sections have been used to assess the stability of the final waste profile.

2.1.2. Conclusion

The stability analyses have demonstrated that the leachate levels within the site are critical to the stability of the site. Nevertheless, the factor of safety is in excess of 1.3 and therefore generally considered satisfactory. Moreover, the stability of the site will increase in the long term as the waste settles to its post-settlement profile.

2.2. Leachate head levels development assessment since 2003

It should be noted that the leachate level has not required the use of the front face pumps since 2003. Monitoring of the leachate head levels is continuous.

To put in evidence that the waste mass is stable a leachate head level development assessment has been undertaken. This assessment is shown on **appendix 5** and recorded leachate head levels are presented in **appendix 6**.

It can be seen that the waste mass has remained stable since 2003, this being obtained with a safety factor higher than 1.3.

Moreover, capping the landfill will reduce the infiltration of rainwater into the waste and consequently reduce the volume of leachate generated, thus the possible maximum height of leachate head.

Once the waste mass has settled, the stability over the long term should be higher still.

2.3. Stability monitoring during after care period

The Trehir Landfill Site has 10 monitoring points for leachate levels within the waste mass; these are set out as shown on figure in **appendix 4**. Levels are

recorded from ground level measuring the distance to the leachate below ground level on a monthly basis by Severn Trend Laboratories. A Geotechnical dip meter is used.

These points serve to monitor the level of leachate to ensure that levels of leachate are kept below trigger levels defined by Golder Associates stability study.

These monitoring points are sufficient to allow samples and for monitoring purposes. The six front face pumps have been removed as agreed with Environment Agency.

The monitoring points will be maintained in a serviceable condition for the post closure life of the landfill.

3. Leachate infrastructure and management

3.1. Leachate infrastructure

Drains are located at the base of the quarry face at the northern, eastern and southern sides of the landfill. Irregularly spaced leachate drains are installed on the top of the basal layer of quarry filler dust and connected to a drain that runs southwards along the length of the toe of the western edge of the landfill. The drain turns westwards and follows the site access road beneath the railway embankment then turns northwards to a leachate collection manhole. A network of drainage pipes below the site was installed in order to assist in the collection of landfill leachate. These are formed from half slotted pipes in aggregate fill which drain into the perimeter drain. This is formed 300 mm half slotted HDPE pipes in an aggregate filled trench. The locations of these drains are shown on **appendixes 7.a and 7.b**.

l50 mm leachate collection drains are installed at various layers along the internal face of the Geomembrane to the rear site extension. These links into the existing perimeter leachate collection system are at both sides of phase 1 of the site.

The basal and perimeter leachate drains provide the collection system that is taken away from the perimeter drain through a discharge chamber on the perimeter drain. The drain flows away from the site to a chamber where the groundwater cut-off water is pumped from a sump on the Pandy Lane boundary if needs be. This then crosses Pandy Lane and through a pipe laid across the disused landfill to a discharge chamber as indicated on **appendix 7.c**.

The leachate flow is then split between the sewer and the river through a valve and “V notch”. The drainage system for Trehir runs to the sewer, which has a consented discharge dealing with a flow to up to 3 l/s. The system works on flow impedance allowing a maximum of three litres per second into the sewer, the balance flowing to river discharge. This discharge to river is consented by the Environment Agency and considers that the flows to river will only occur when the river is in spate.

3.2. Leachate monitoring

There are two consented discharges associated with the Trehir Landfill. The sewer and river discharge consents are shown on **appendixes 8** and **9** respectively.

3.2.1. Leachate flow monitoring

Firstly, the discharge to sewer consented by Welsh Water is 3 l/s. Flows into the sewer are controlled by means of a valve and flowmeter arrangement. Leachate flow is measured by means of a GLI Flow Meter WJ460 located within the drainage chamber by means of V notch weirs and a continuous data recorder. The data are down loaded to a portable computer regularly.

The discharge to the river is also measured by a flowmeter. The main objective is to determine the frequency of the discharge to the river for landfill environment effects monitoring.

3.2.2. Leachate head levels monitoring

Leachate levels are maintained to a maximum level of 12.5 metres in the landfill to prevent leachate outbreak risk. The trigger level identified in the waste licence is 12.5m below the ground level however the EA has clarified that this should read 12.5m over the quarry base i.e leachate head.

Leachate head levels are also monitored to control waste mass stability as described above in part 2.

The Trehir Landfill Site has 10 monitoring points for leachate levels within the waste mass; these are set out as shown on figure in **appendix 4**. Levels are recorded from ground level measuring the distance to the leachate below ground level on a monthly basis by Severn Trend Laboratories.

These monitoring points are sufficient to allow samples and for monitoring purposes. They will be maintained in a serviceable condition for the post closure life of the landfill.

3.2.3. Leachate monitoring points

i) <u>Discharge to sewer monitoring point</u>

The quality of the leachate and other waters discharged to sewer is monitored by Welsh Water and the site receives reports recording results of the samples taken.

ii) <u>Leachate monitoring points location</u>

Leachate monitoring points are located within the body of the tipped waste and on the leachate drainage which runs along the toe of the site and down to the sewer/surface water discharge points.

Leachate monitoring points are shown on the leachate monitoring plan on **appendix 10**.

3.2.4. Leachate monitoring procedures

Standards for leachate monitoring and sampling programme are specified in table 1 below:

Determinands	Monitoring frequencies	Units and accuracies	Trigger Levels
Leachate level in front face wells – Critical level for stability are defined in stability study dated of January 2003 by Golder Associates.	Monthly	Metres AOD	12,5 m
pH	Monthly		
Temperature	Monthly		
Electrical conductivity	Monthly		
Ammoniacal nitrogen	Monthly		
Chlorides	Monthly		
BOD	Monthly		
COD	Monthly		
Sulphates	Quarterly		
Total alkalinity (as $CACO_3$ at pH 4,5)	Quarterly		
Total oxidised nitrogen	Quarterly		
Total organic carbon	Quarterly		
Na	Quarterly		
K	Quarterly		
Ca	Quarterly		
Mg	Quarterly		
Fe	Six monthly		
Mn	Six monthly		
Cd	Six monthly		
Cr	Six monthly		
Cu	Six monthly		
Ni	Six monthly		
Pb	Six monthly		
Zn	Six monthly		

Table 1: Standards for leachate monitoring and sampling programme

The monitoring of chemical and biological determinands is conducted under contract and is subject to agreed quality procedures and rigorous sampling methodologies. Monitoring procedures and methods are provided to the Environment Agency. The monitoring is conducted under a contract currently performed by Severn Trent Laboratories who provide a record of the leachate monitoring and sampling results. A copy is sent to the Environment Agency on a monthly basis in accordance with the standards specified in table 2 below.

Leachate Monitoring and Sampling Records	**Specified Standards**
Quality assurance of monitoring and sampling	Monitoring shall include details of: a) Leachate monitoring and sampling quality assurance plan; b) Monitoring and sampling methodologies (including sample chain of custody/audit trail); c) Analytical methodologies and laboratory competence or accreditation including units and accuracies of measurement; d) Training and competence of monitoring/sampling personnel.
Making of records	Details shall include the following: e) Determinands monitored/sampled; f) Specified details of measurements/samples to support analytical and QA requirements; e.g. dates, times, locations, other relevant parameters; g) Results of measurements/sample analyses, with error limits; h) Interpretation and review of results against trigger levels; i) Validation of accuracy and validity of results, by designated quality assurer.
Submission of records	A copy of the quality assured records of each monitoring and sampling result, with an interpretation of the results against background and trigger levels, shall be submitted to the Agency on a monthly basis, within 1 month of its being carried out in an electronic format.

Table 2: Standards for leachate monitoring and sampling records

Heads of leachate identified within the site will be managed in respect of the need to minimise the inflow of groundwater.

3.3. Leachate infrastructure maintenance

The leachate management system will be retained during the aftercare phase to allow for monitoring, collection and drainage of leachate. Currently the system functions by gravity and maintenance requirements will be focussed on ensuring the free flow of leachate.

Drainage and monitoring points are inspected regularly to ensure the free flow of leachate. Frequency of inspection is dependent on weather conditions with a tendency to undertake more regular monitoring in the winter months. Should damage be identified, the necessary corrective works will be undertaken.

In the event that any results exceed the trigger levels specified, the Environment Agency will be notified of the commencement of the action plan.

Suspended solids are controlled by maintenance of the catch-pits along the drainage run up-flow of the discharge points. These are checked for levels of sedimentation regularly by a TCM and/or CCBC member and emptied as necessary. The last clean was undertaken by Egan Waste on 13 December 2005.

These monitoring points or suitable alternatives will be maintained in a serviceable condition for the post closure life of the landfill.

Where monitoring points are repaired or replaced the revised levels will be surveyed and the table of cross-referenced revisions will be copied to the Environment Agency.

4. Groundwater infrastructure and management

4.1. Groundwater infrastructure

A groundwater cut off system is in operation around the western perimeter of the site intended to prevent migration of leachate contaminated groundwater to potential receptors off site. It is understood that the groundwater cut off system is installed to a depth below surrounding ground level of about 4 to 7 m with a level of approximately 107 mAOD and the drain is installed at approximately 75 to 78mAOD. The length of this system south of the access road is designed such that water is pumped from a sump at approximately 75mAOD.

The groundwater sump collects water from the groundwater cut off ditch to the south west of the site. A pump installed in the groundwater sump automatically pumps water from the ditch into the leachate collection system when it reaches a set

level. The normal flow of discharge from the chamber is into the leachate collection system.

In 2001, impacts of another pump, a borehole pump assessed through pumping trials. The aim of this monitoring was to identify whether the continued pumping of ground water for discharge to the sewer is a justified abstraction in preventing pollution. This study is presented in **appendix 11**. In conclusion this study underlines that “The ground water pumping is having some negative effects on the leachate contamination of the ground water”. That’s why we decommissioned the borehole pump located in the ground water sump.

In addition there are three groundwater interceptor pipes situated beneath the lined black slope of the landfill, at three levels, described as Upper, Middle and Lower. The intercepted groundwater is transferred underneath the haul road to join the toe leachate collector drain.

Groundwater monitoring infrastructures are also composed of 10 boreholes located in the vicinity of the waste mass.

Technical specification of construction and installation of groundwater monitoring system are described in the table 3 below:

Groundwater monitoring system	Specified standards
Design of groundwater monitoring systems	The location, spacing and depth of boreholes shall be as specified in approved design report.
Construction and installation of groundwater monitoring systems	Unless otherwise approved in writing by the Agency: a) The installations shall consist of boreholes of a minimum diameter of groundwater l00mm, containing a rigid HDPE casing of minimum internal diameter of 50mm; b) The annulus of the borehole shall be packed with non-calcareous pea gravel and completed at the surface with a gas tight seal; c) The borehole casing shall consist of manufactured slotted pipe within the response zone of the borehole and plain pipe through the gas tight seal; d) The borehole casing shall be completed at the surface with a removable lid, suitable for groundwater sampling, and these headworks shall be protected from damage with a lockable steel cover set in concrete; e) During construction of the boreholes a record shall be made of the subsurface geology encountered during drilling; and f) The geology shall be described by an appropriately qualified geotechnical engineer or similar person, who shall also provide a record of the 'as-built dimensions of the monitoring installation.
Inspection and maintenance of groundwater monitoring systems	g) Monitoring installations shall be inspected for defects and damage during each routine monitoring exercise. h) Defects and damage shall be noted in the site diary, remedial measures shall be undertaken as soon as possible and in any case within 1 month. i) A record shall be kept in the site diary of all remedial actions undertaken.

Table 3: Standards for groundwater monitoring and sampling system

4.2. Groundwater monitoring

4.2.1. Groundwater monitoring points

N2 is located in the field to the rear of the landfill and is considered by the EA to represent background levels. N4 and N5 are located on the land adjacent to the southern/south-western boundary of the site. N8 is located to the south of the access road from Pandy Lane above traffic lights.

Since March 2005, six new boreholes have been installed to monitor groundwater.

W4 (upper, middle, lower) are collection chambers for water issuing through the back wall of the site (east face) behind the lining system. During 2003, 2004 and 2005 there has been little water in these boreholes and in general only the lower point is being measured.

In addition the ground water sump is included on the monitoring schedule.

The groundwater monitoring points location is shown on **appendix 12**.

4.2.2. Groundwater monitoring procedures

The standards for groundwater monitoring and the sampling programme are specified in table 4 below:

Determinands	Monitoring frequencies
Water level	Monthly
pH	Monthly
Temperature	Monthly
Electrical conductivity	Monthly
Dissolved oxygen	Monthly
Ammoniacal nitrogen	Monthly
Chlorides	Monthly
Sulphates	Quarterly
Total alkalinity (as CaCO3 at pH 4.5)	Quarterly
Total oxidised nitrogen	Quarterly
Total organic carbon	Quarterly
Na	Quarterly
K	Quarterly
Ca	Quarterly
Mg	Quarterly
Fe	Quarterly
Mn	Quarterly
Cd	Quarterly
Cr	Quarterly
Cu	Quarterly
Ni	Quarterly
Pb	Quarterly
Zn	Quarterly

Table 4: Standards for groundwater monitoring and sampling programme

In addition to the above, a complete analysis for List I and List II substances will be made where there is an indication from the monitoring regime that such an analysis is required.

A record of the groundwater monitoring and sampling results shall be made and submitted to the Agency in accordance the standards specified in table 5 below.

Groundwater Monitoring and Sampling Records	Specified Standards
Quality assurance of monitoring and sampling	Monitoring shall include details of: Groundwater monitoring and sampling quality assurance plan; a) Monitoring and sampling methodologies (including sample chain of custody/audit trail); b) Analytical methodologies and laboratory competence or accreditation including units and accuracies of measurement; c) Training and competence of monitoring/sampling personnel.
Making of records	Details shall include the following: Determinands monitored/sampled; a) Specified details of measurements/samples to support analytical and QA requirements; e.g. dates, times, locations, other relevant parameters; b) Results of measurements/sample analyses, with error limits; c) Interpretation and review of results against trigger levels; d) Validation of accuracy and validity of results, by designated quality assurer.
Submission of records	A copy of the quality assured records of each monitoring and sampling result, with an interpretation of the results against background and trigger levels, shall be submitted to the Agency on a monthly basis, within 1 month of its being carried out in an electronic format.

Table 5: Standards for groundwater monitoring and sampling records

As there is at present no standard laid down for the levels of chemical contaminants in ground water samples, it has previously been agreed with EA that the Drinking Water Standards (DWS) for the UK be adopted for the monitored parameters as the benchmark for all analyses.

4.3. Groundwater infrastructure maintenance

The pump in the groundwater sump is maintained and serviced twice a year and no pump failures have occurred during 2004-2005. This pump will be monitoring regularly by a TCM and/or CCBC member during the aftercare period.

In the event that any results exceed the trigger levels specified, the Environment Agency will be notified of the commencement of the action plan.

These ground water monitoring points will be maintained in a serviceable condition for the post closure life of the landfill.

On installation of each groundwater level monitoring point, the monitoring point shall be surveyed and its location provided to the Agency.

If the elevation of the monitoring point is changed as a result of damage, alteration, extension or movement, the monitoring point shall be resurveyed. Re-levelling shall take place before the next monitoring round. The Agency should be notified in writing of the new levels.

5. Landfill gas infrastructure and management

5.1. Existing Landfill gas infrastructure

Landfill gas generated on the site is passively vented by means of

- ⇨ Gas well located on the phase 1 area consisting of vent pipes held within an oversized borehole of approximately 700mm diameter filled with 25mm of clean stone. The pipes vary between a diameter of 150mm and 300mm; all being of fully slotted twin-wall HDPE construction
- ⇨ A perimeter vent filled with aggregate to the North, West and South boundaries
- ⇨ A geomembrane barrier to the upper area of the site facilitates the movement of gas to the surface by acting as a gas barrier. The horizontal migration of landfill gas is diverted when it reaches the lining system where it is likely to follow the route of the geomembrane and rise to the surface of the waste.
- ⇨ An engineered cap including a gas drainage layer that consists of a stone gas drainage blanket and drainage pipework connected to gas vents at regular intervals of around 20m

These measures allow landfill gasses to vent freely to atmosphere and prevent pressure build up within the body of the fill under the effect of the capping material contributing to gas migration in the surrounding soil.

5.2. Objective of the Gas Management Plan

The objective is to minimize risk of landfill gas and environmental effects. Two major possible impacts have been identified:

- Gas migration in soil outside of tip area.
- Landfill gas emission with the two possible impacts
  - Risk of explosion
  - Contributing to greenhouse effect.

5.3. Current situation and further requirements

The assessment of current situation regarding these two possible impacts is as follow:

- No gas migration has been observed in the monitoring wells around the tipping area outside the landfill site. Furthermore, no adverse effect on the vegetation have been observed neither on the restored phase 1 area nor in the surrounding land that would have shown possible environmental effect of non detected gas migration in the soil. (Ref 2004-2005 EPR monitoring results)
- Significant gas quantity is produced by the site due to the quantity of waste tipped in the site and large proportion of domestic waste (see "No flare" Gassim model in appendix 1 of the document presented in appendix 17.
  - Given the situation of the site and meteorological conditions, no situation presenting an explosion risk (5-15% methane content) has been observe on site or in the construction that are under permanent gas control.
  - No landfill gas combustion infrastructure exist on site and there is therefore no mitigation of the greenhouse effect of the methane emission

The assessment of the current situation shows that the site infrastructure is effective in avoiding gas migration in soil and the explosion risk, but that the mitigation of the greenhouse effect of landfill gas emissions is not compliant with existing regulations.

To complete the existing infrastructures, a Landfill Gas collection and combustion system is to be implemented at Trehir together with the additional control and contingency plans.

5.4. Trehir Landfill site Working Plan Existing generation project

The gas management plan of the site working plan states that a power generation project is to be implemented. This management option is based on the assumption that the gas yield allows a commercially viable power generation project and is consistent with the large quantities of domestic waste that have been tipped.

Despite the lease agreement signed by TDC with Hyder Industrial Ltd, the infrastructure for gas collection and power generation has not yet been put in place. From recent assessment undertaken with other companies specialized in developing such projects, the possibility of making viable this option is high. Given the existing contractual situation, the change in the near future of the shareholder structure of TDC and required update of the 2001 project, additional technical, commercial and legal assessment is undertaken to define the gas management strategy for the Trehir Landfill Site.

5.5. Gas management at Trehir

For the present Closure Plan, TDC has examined a number of options for the Gas Management. Two of them have been not considered adequate and have therefore been dismissed:

- ⇨ Passive venting as per existing situation, given the non compliance with regulations
- ⇨ Treatment of gas through soil or a bio-filter, given an expected content of methane of the landfill gas above the range in which these solutions are effective (<8%)

Two other options have been considered acceptable to complete the existing infrastructure as they guaranty compliance with existing regulations and minimise the contribution of the landfill gas emissions to the greenhouse effect, which is the major environmental impact of the existing situation identified in the assessment of the current situation. These options are:

- ⇨ Power generation project as per Trehir Landfill Working Plan
- ⇨ Landfill Gas flaring

Considering that the first option is the best environmental option and that it is likely, even if not confirmed yet, to be commercially and technically viable, this option is the basic option submitted for gas management at Trehir.

It is considered that the environmental performance of this scheme is higher than the one of our alternative gas management plan (described hereunder) and that the compliance with the EA requirement is given by the compliance of the alternative plan as described in detail in appendix 17.

The technical specifications need to be updated together for the implementation of this option and an agreement needs to be obtained. TDC expects to get its partner (a company specialized in power generation) responsible for the construction and operation of the full infrastructure including gas collection systems, networks and generation plant. TDC will include in the agreement all requirements related to the EA control and approval in order to make sure that the infrastructure is build and operated in accordance with the regulations and specific conditions at Trehir. The final update of the scheme will therefore only be available when an agreement is obtained.

Nevertheless, it is not expected major changes from the scheme described in the working plan and it will include the following infrastructures:

- ⇨ Additional gas wells on phase 2 and if required on phase 1 area
- ⇨ Collection network and pumping equipment
- ⇨ Power Generation plant

TDC estimates that a 3 months delay is required to confirm this primary option as its gas management plan. Nevertheless, this multistage assessment process will allow TDC to provide the EA with intermediate information and proposes that updated information is provided to the EA on a monthly basis.

When a decision is made and an agreement obtained to develop the project, the delay for the implementation will be from 3 to 6 months, including detail design under CQA protocol submission, planning permission application, construction of the collection systems and pipework, provision and installation of power generation plant.

5.6. Alternative Gas Management Plan

In the case the Power Generation project cannot be implemented, TDC would implement the second option considered effective to tackle with existing environmental impact of the site.

The alternative gas management plan for Trehir is based on active gas extraction system and gas treatment by flaring. The site passive system will be converted into a positive gas extraction system with controlled combustion in a temporary flare.

It has not been considered practical to define this flaring option as TDC basic Gas Management Plan and as a first step towards a future power generation project for the following reasons:

- ⇨ The time available for the implementation of the scheme under current shareholder structure is limited
- ⇨ The basic Gas Management is likely to be implemented and it is not expected to have the alternative plan implementation required
- ⇨ The collection and transport system for the two options are different, consistent with the different objectives, and therefore the infrastructure

for the flaring option would not be adequate for the power generation option

This scheme is presented in **appendix 17** and further details and specification for this alternative flaring option will be provided within one month of the submission of the present closure report.

In order to be in a position to implement in the required time delay this alternative option, if the decision of not proceeding with the gas generation project is made, TDC submits to the EA approval this alternative option.

5.7. Landfill gas monitoring

5.7.1. Migration gas monitoring

Migration boreholes are checked for soundness and monitored in accordance with requirements on a monthly basis. All results from monitoring are passed on to the Environment Agency monthly.

At each visit the Methane, Oxygen and Carbon Dioxide components are measured and recorded. Other readings will be taken as required, these being detailed in table 6 below. The barometric pressure is also read and recorded. All readings are taken by means of an infrared spectrophotometer or equivalent equipment.

To establish whether landfill gas escapes from the site, monitoring wells have been installed outside the landfill site. The head of the well is gas tight and gas connection points / valves are provided to assist in monitoring. Severn Trent Laboratories undertake the gas monitoring at the same time as the water analysis.

Gas external to the landfill waste is monitored at 5 locations, and a further 6 since March 2005.

- ⇨ R2 is located in the field to the rear of the site which is also N2 for purposes of the water analysis. This is considered as a background monitoring point.
- ⇨ R4 is located on the southern edge of the site close to the boundary on neighbouring land which is also N4 for purposes of the water analysis.
- ⇨ R5 is located on the dismantled railway embankment to the southwest corner of the site on neighbouring land which is also N5 for purposes of the water analysis.
- ⇨ R7 is located adjacent to the access road from Pandy Lane which is also N8 for purposes of the water analysis.
- ⇨ R8 is located adjacent to the garage.
- ⇨ The gas migration is also monitored at boreholes NBH1 to NBH6.

Gas monitoring points location is shown on **appendix 13**.

The external landfill gas monitoring and sampling programme is defined in the table 6 below:

Landfill gas monitoring determinands	Monitoring frequencies	Units and accuracies	Trigger levels
Methane	Monthly	% v/v and 0,1%	>1%
Carbon Dioxide	Monthly with methane monitoring	% v/v and 0,1%	>1,5%
Oxygen	Monthly with methane monitoring	% v/v and 0,1%	<18%
Atmospheric pressure	Monthly with methane monitoring	mbar and to 1 mbar	None
Differential pressure	Monthly with methane monitoring	mbar and to 1 mbar	Not applicable
Water level in monitoring well	Monthly with methane monitoring	Metres	Not applicable

Table 6: External landfill gas monitoring and sampling programme

Records of landfill gas monitoring and sampling are made in accordance with the standards specified in table 7 below:

Quality assurance of monitoring and sampling	1 Monitoring will only be carried out by suitably competent / qualified staff. 2 Monitoring equipment shall be calibrated and serviced in accordance with the manufacturers recommendations. 3 A sample of gas shall be collected during routine monitoring from at least one monitoring point annually and subjected to laboratory analysis using gas chromatography to confirm the accuracy of field measurements.
Making of records	Records will include the following: a) Determinands monitored/sampled; b) Specified details of measurements/samples to support analytical and QA requirements; including dates, times, locations, personnel undertaking monitoring; c) Results of measurements/sample analyses, with error limits; d) Interpretation and review of results against trigger levels; e) Validation of accuracy and validity of results, by designated quality assurer.
Submission of records	A copy of the quality assured records of each monitoring and sampling result shall be submitted to the Agency on a monthly basis within 1 month of its being carried out in an electronic format.

Table 7: Standards for external landfill gas monitoring and sampling records

5.7.2. Emission gas monitoring

In waste gas monitoring could be carried out as proposed in the gas management plan section 3.2.

5.7.3. Gas monitoring in buildings

Monitoring of site buildings is undertaken to identify potentially dangerous levels of gas.

Gas monitoring equipment is provided in site buildings by GMI, Gas Measurement Instruments. When the level of methane reaches trigger levels the methane alarm will activate. Twelve monitoring points are located within the site buildings which are numbered GD1 to GD12.

5.8. Landfill gas infrastructure maintenance

In the event of gas monitoring locations being damaged, the necessary corrective works will be completed. Suitable monitoring points will be maintained.

CCBC member and/or COTC will operate a system of undertaking regular checks of the gas collection system. Gas extraction system and flare maintenance (alternative option) is detailed in **appendix 17**. Basic power generation option will include complementary maintenance procedures including constructor recommendation in order to provide adequate performance of the infrastructures.

The most recent maintenance of the gas monitoring equipment in the buildings was 24th January 2006.

6. Surface water infrastructure and management

6.1. Surface water infrastructure

The surface water discharge drain collects run-off from the landfill cap along the access road where connections pick up road drainage, drainage from the Civic Amenity Site and workshop area and then alongside the access road to a new outfall into the River Rhymney.

6.2. Surface water monitoring

6.2.1. Surface water monitoring points

Surface water monitoring is undertaken at points W1, W2, W3, W5 and NSWD. These surface water monitoring points are shown in **appendix 14**.

- ⇨ W1 is located upstream of the outfall.
- ⇨ W2 is located at the outfall.
- ⇨ W3 is located downstream of the outfall
- ⇨ NSWD is the new surface water discharge to the river since the segregation of leachate and surface water run off from site had been implemented.
- ⇨ W5 is a spring issuing to the northern edge of the landfill, to the rear of the old compactor shed.

Severn Trent Laboratories are contracted to undertake surface water monitoring at Trehir on a monthly basis in accordance with the monitoring requirements identified in the waste licence. Parameters monitored include pH, temperature, conductivity, dissolved oxygen, ammoniacal nitrogen, chloride and chemical oxygen demand.

Results are recorded and sent to the Environment Agency on a monthly basis.

6.2.2. Surface water monitoring procedures

There are two surface water discharges to the river associated with the Trehir Landfill: the consented discharge to the river and the new surface water drainage discharge.

i) Consented discharge to river

The existing leachate drainage system for Trehir runs to the sewer, which has a consented discharge dealing with a flow of up to 3 l/s. Quantities exceeding 3 l/s surcharge to the River Rhymney under a consented discharge from the EA. The drainage system collects leachate from the landfill area and other discharges e.g the ground water sump, access road drainage and ground water. This combines with the leachate prior to discharge. During dry periods the bulk of the discharge flows to the sewer however, during heavy rainfall, the drainage flow is likely to exceed 3l/s and discharge to the river outfall.

The river discharge consent is shows on **appendix 9**. Surface water discharge is among others sampled for suspended solids. The surface water interceptor with silt catch pits is cleaned at a frequency determined by periodical inspection and measured with a dipstick. Silt removal will be ordered to ensure the suspended solids do not exceed the discharge consent to river.

ii) New surface water discharge to river

Since 2004, the segregation of leachate and surface water run off from the site has been implemented to prevent surcharge of the river with leachate.

New surface water discharge to the river is sampled monthly as all the others water monitoring points.

It should be noted that the surface water drain collects other discharges e.g Civic Amenity Centre and workshop area drains. These drains will be connected with leachate drainage system if needs be.

Monitoring and sampling of surface water in the vicinity of the site shall be carried out and recorded in accordance with the standards specified in table 8 below:

Determinands	Monitoring frequencies
pH	Monthly
Temperature	Monthly
Electrical conductivity	Monthly
Dissolved oxygen	Monthly
Ammoniacal nitrogen	Monthly
Chlorides	Monthly
Chemical oxygen demand	Monthly
Level of surface water	Monthly

Table 8: Standards for surface water monitoring and sampling programme

A record of the surface water monitoring and sampling results shall be made and submitted to the Agency in accordance with the standards specified in table 9 below:

Surface water monitoring and sampling records	Specified standards
a) Quality assurance of monitoring and sampling	Monitoring shall include details of: a) Surface water monitoring and sampling quality assurance plan; b) Monitoring and sampling methodologies (including sample chain of custody/audit trail; c) Analytical methodologies and laboratory competence or accreditation including units and accuracies of measurement; d) Training and competence of monitoring/sampling personnel.
b) Making of records	Details shall include the following: a) Determinands monitored/sampled; b) Specified details of measurements/samples to support analytical and QA requirement e.g. dates, times, locations, other relevant parameters; c) Results of measurements/sample analyses, with error limits; d) Interpretation and review of results against trigger levels; e) Validation of accuracy and validity of results, by designated quality assurer.
c) Submission of records	A copy of the quality assured records of each monitoring and sampling result, with an interpretation of the results against background and trigger levels, shall be submitted to the Agency on a monthly basis, within 1 month of its being carried out in an electronic format.

Table 9: Standards for surface water monitoring and sampling records

6.3. Surface water infrastructure maintenance

Surface water infrastructure monitoring will be done by a TCM and/or CCBC member during after care period.

The surface water drainage system will be cleaned at a frequency determined by regular inspection during the aftercare period. The surface water toe ditch will be emptied as necessary.

7. Procedure for reporting any significant environmental event during the aftercare phase

7.1. Water monitoring and infrastructures maintenance reporting

7.1.1. Water monitoring reporting

All the monitoring points within the waste mass and outside the site are sampled monthly by Severn Trent Laboratories who are under contract to Trehir. Monitoring and sampling procedures are recorded on **appendix 15**.

The samples are analysed according to the licence and a report is then produced by Severn Trent Laboratories.

The company has an established monthly routine for preparing a report of environmental performance of the site.

7.1.2. Infrastructures maintenance reporting

The site remains regularly inspected by a TCM and/or CCBC member during after care period. He has to monitor infrastructures on site. After each inspection, an internal site inspection report is provided which reports:

- ⇨ Drainage inspection,
- ⇨ General site inspection,
- ⇨ Road, access, gates and barriers inspection.

7.2. Contingency plans

7.2.1. Leachate action plan

Where leachate levels exceed trigger level in the waste mass on site, then the action detailed below will be implemented:

- ⇨ The Agency will be informed and advised in writing;
- ⇨ Levels will be re-tested after 24 hours. A local company (SLD Pumps or another) will be contacted in order to resume pumping as soon as possible if necessary.
- ⇨ If the well is above trigger level for more than 1.5 meters then the factor of safety is greatly decreased. Measures will be implemented immediately for pumping leachate in the monitoring point.
- ⇨ Where the leachate level is exceeded in one of the leachate monitoring points, leachate level monitoring will be increased in that leachate level monitoring point to daily;
- ⇨ Following extraction of leachate from the leachate monitoring well, levels will be re-tested 24 hours after cessation of pumping.
- ⇨ If the leachate level can't be reduced in the leachate monitoring point within 7 days of pumping having commenced from the monitoring well, then discussions will be held with the Agency, and proposals submitted within 14 days for the reduction of leachate in the waste mass to comply with trigger levels, and will be implemented following approval of the Agency.
- ⇨ Results of daily leachate level monitoring will be forwarded to the Agency on day of measurement.

7.2.2. Ground water action plan

In the event that trigger level for any substance is breached, an action plan is proposed in order to ensure steps are taken to determine both the source of that substance and the impact it may have upon the identified sensitive receptor (The River Rhymney). A proposed action plan in the event of a breached trigger concentration in ground water monitoring boreholes is presented below:

- ⇨ The borehole will be re-sampled within two weeks of receipt of the results and the sampling will be repeated. Results of the second analysis will be obtained as soon as possible and in any case within three weeks. The results of the re-sampling will be forwarded to the agency.
- ⇨ If the result of the second analysis also exceeds the trigger concentration, the borehole in which the excess has occurred will be re-sampled monthly for a further three months.

- ⇨ Data from the borehole exceeding the trigger level and adjacent boreholes will be reviewed by use of statistics and graphical presentation to establish the presence of any trends or patterns;
- ⇨ Groundwater levels will be reviewed to establish flow direction in order to determine whether the site is most likely cause of any change in groundwater quality;
- ⇨ An inspection will be carried out to determine whether there has been unusual activity or occurrence on the site that could account for the increase in the parameter exceeding the trigger concentration.
- ⇨ If the laboratory results from the monthly monitoring show no indication of decline over the four month period, and the evidence indicates that the site is the most likely cause of the increase in levels, then discussions will be held with the Agency, and proposals submitted within 14 days for the reduction of ground water concentration, and will be implemented following approval of the Agency.

7.2.3. Gas action plan

Where a level of 20% of the lower explosive limit is detected, a migration well emergency procedure shall be exercised.

The results shall be notified to the Agency immediately; and the action plan shall be implemented immediately, and recorded.

In the event that any results exceed the relevant trigger levels, the following actions will be taken:

- ⇨ Check the correct functioning of the equipment
- ⇨ Draw clean air through the equipment
- ⇨ Re-monitor the gas well to check levels are accurate
- ⇨ Monitor other wells in the area to identify the extent of migration
- ⇨ Identify potential sources of the gas including non-landfill sources e.g. burst gas main, LPC from bird scaring equipment/canisters brought to site, old landfill adjacent to River Rhymney etc
- ⇨ Identify whether atmospheric pressure is rising or falling - if it is falling below 1000mb gas is likely to be drawn out of the landfill. If it is rising there is an increased risk of underground gas migration.
- ⇨ Identify whether the water table is likely to be rising which is likely to increase the risk of gas migrating from the ground along the easiest pathway (possibly underground migration)
- ⇨ Check gas levels within the landfill site buildings

- ⇨ Identify the location of sensitive receptors in the area around the landfill which may be affected for migration, based on knowledge of potential migration pathways.

For ongoing gas migration problems, and where necessary:

- ⇨ Extraction wells will be installed to intercept gas migration and protect sensitive receptors.
- ⇨ Moreover a temporary flare could be put in place.
- ⇨ The monitoring frequency will also be increased.

All underground chambers or poorly ventilated areas in the vicinity of the landfill are to be considered as confined spaces and as such require confined space procedures to be followed prior to entry, including monitoring of gas levels. Entry should be prevented wherever possible. In the event of gas being detected above the trigger level in boreholes or site buildings, all work in confined spaces must be prevented where possible until conditions improve. Where confined space entry is absolutely essential, strict safety procedures must be followed at all times.

In the building, if the methane alarm Al activates, potential sources of ignition are removed and occupied areas in the vicinity are evacuated. The Environment Agency and Health and Safety Executive must be notified without delay. No electrical switches are operated until the situation is made safe. The control equipment is checked to identify which monitoring points have activated the alarm. The relevant areas are ventilated as much as possible and monitoring is continued to ensure that levels are brought within the safety limits set. A record is made of all alarm events and details of action taken recorded.

If the methane alarm A2 is activated persons are evacuated from these areas and the emergency services are notified. The Environment Agency and Health and Safety Executive will be notified as soon as possible.

Gas levels within the migration boreholes will be monitored as above to assist in identifying the source of the gas and the potential migration pathways.

7.2.4. Surface water action plan

The proposed action plan is suitable for both discharges to the river.

i) Emergency action plan procedure

If the trigger level is breached by any of the specified determinands on any occasion, the Agency will be advised of the excess immediately.

The analytical laboratory will also be contacted and requested to confirm or repeat the analysis.

In addition, a visual inspection will be undertaken of the site surface for signs of leachate breakout and appropriate remedial actions implemented and recorded.

Where the analysis is confirmed, the Agency will be advised of the breach in writing and the surface water discharge point will be re-sampled and analysed for the relevant parameter.

The results of the additional analysis will be forwarded to the Agency immediately on receipt.

Where the additional analysis confirms the action level is still being exceeded, appropriated actions and timescales will be agreed with the Agency and implemented.

ii) Actions carried out to improve new surface water discharge quality

New surface water discharge to river monitoring test results show that ammonia trigger level is sometimes breached when it's heavy raining.

TDC has investigated by sampling several manhole points connected to the surface water drain. The test results are presented in **appendix 16**.

The results highlight that the surface water drainage seems to be contaminated in three locations:

- ⇨ The last surface water chamber at the bottom of phase 1 is contaminated by leachate.
- ⇨ Surface water flowing in the surface water ditch at the base of phase 1 is polluted by punctual leachate outbreaks.
- ⇨ At monitoring point n°10, on the access road ammonia level is higher. Civic Amenity centre and workshop area drainages are collected into this chamber.

Whether an elevated ammonia concentration has been detected at the point n°2, this result can be explained by ongoing phase 2 capping works. Nevertheless, since few weeks surface water drainage has been improved on phase 2. Others samples of point n°2 will be taken to check that surface water management measures put in place prevent this temporary contamination.

Proposed actions to improve the quality of surface water discharge to the river, agreed with the environmental Agency, are described below:

- ⇨ The last surface water chamber at the base of phase 1 has been emptied and daily visual inspection is made to know from where the leachate is coming from. Repairing surface water chamber insulation will be carried out if needs be.
- ⇨ To prevent punctual leachate outbreaks into the surface water toe ditch, the phase 1 slope profile has to be modified. In some location at the base of phase 1, phase 1 slope seems to be less steep than it should be and than doesn't prevent leachate outbreaks.

- ⇨ The gulley and oil interceptor located at the workshop area (in front of the garage) have to be emptied and cleaned respectively.

Proposed monitoring actions:

- ⇨ Monthly monitoring of surface water toe ditch to check if changed phase 1 slope profile is suitable.
- ⇨ Sampling Civic Amenity discharge to check if it's responsible for the surface water contamination when it's raining
- ⇨ Sampling Workshop area discharge when it's raining
- ⇨ Monthly monitoring of new surface water discharge to the river to check if environmental protection measures put in place are adapted.

Proposed timescales to put in place the action plan:

	January	February	March	April
Sampling				
Investigation to know from where phase 1 surface water last chamber contamination is comming				
Repairing surface water chamber accordingly				
Empty gulley and clean interceptor oil located in the workshop area				
Modify phase 1 slope profile to prevent leachate outbreaks in surface water toe ditch				
Monitoring to check measures put in place are adapted				

iii) Actions carried out to improve consent discharge to the river

Consented surface water discharge to river (W2) monitoring test results show that ammonia levels exceed permitted levels during high rainfall.

Objective: Prevent consent discharge failure

It seems that leachate flow isn't diluted enough before discharging into the river.

To prevent discharge consent failures, TDC investigates to reduce flow into leachate drainage system. Capping works will reduce the infiltration of rainwater into the waste and consequently reduce volume of generated leachate. Therefore, volume of leachate generated will be less important in the near future. The risk of overflow (>3l/s) from drainage to the sewer to the W2 discharge will reduce in frequency and will be limited to high dilution level rainfall events that should allow lower contamination levels of the discharge.

Proposed action plan:

TDC investigates by sampling several drains entering into the leachate drainage system in order to characterize the contamination content of these contributions to the global flow. If a significant contributions to the leachate drainage system show low level of contamination (similar to surface water values), these drains might be redirected to the surface water drain and then decrease volume to be discharged to the sewer.

Since 23 January 2006, W2 is sampled once a week to test ammonia in order to monitor that trigger levels are not over passed when leachate drainage is not discharging to the river.

When leachate flow exceeds 3 l/s and then leachate drainage discharges to the river, several samplings are carried out:

- ⇨ Access road surface water flow collected at the chamber located at the corner of Pandy Road.
- ⇨ Ground water in Ground Water Sump entering into leachate drainage system
- ⇨ Discharge to river (W2)

If test results show that these two drains have a good quality then, they might be redirected to the surface water drain in order to decrease volume of leachate and therefore prevent discharge to the river.

After redirecting these drains, W2 monitoring will remain on a monthly basis to monitor that consented discharge to river is respected.

In the event of these two drains can't be redirected to the surface water drain or leachate drainage remains higher than 3 l/s when it's raining, the increase in the consented maximum volume of discharge to the sewer could be discussed with Welsh Water.

During two months, leachate flow would be monitored in order to precisely quantify leachate discharge to sewer.

Proposed timescale of action plan:

	January 2006	February 2006	March 2006	April 2006	May 2006	June 2006
Proposed samplings						
Test results assessment						
If tests results are satisfactory						
Redirect drains						
W2 monthly monitoring						
If drains can't be redirected to NSWD or W2 monitoring test results aren't satifactory						
Leachate volume monitoring						
Obtain agreement to increase consented discharge to sewer						
W2 monthly monitoring						

7.3. Periodic reporting of environmental performance

7.3.1. On a monthly basis

The results of the investigations are submitted in a written report to the Environmental Agency. This report reviews the environmental monitoring results recorded for the site.

7.3.2. On an annual basis

The company will provide the Agency on an annual basis or such other time as is agreed in writing with the Agency, a report on the environmental performance of the site, which shall include the following information:

1. An analysis and review of the environmental monitoring results recorded for the site, with an interpretation of the trend of the results against background and trigger levels;
2. A review of the risk assessment for the site

Appendices

Appendix 1: Site location

Appendix 2: Site area

Appendix 3: Closure area

Appendix 4: Stability Study

Appendix 5: Leachate head levels development assessment

Appendix 6: Recorded leachate head levels

Appendixes 7: Leachate drainage system location

7. a: Leachate drainage phase 1

7. b: Leachate drainage phase 2

7. c: Leachate drainage to sewer

Appendix 8: Sewer discharge consent

Appendix 9: River discharge consent

Appendix 10: Leachate monitoring points location

Appendix 11: Report on Groundwater Monitoring

Appendix 12: Groundwater monitoring points location

Appendix 13: Landfill gas monitoring points location

Appendix 14: Surface water monitoring points location

Appendix 15: Monitoring and sampling procedures

Appendix 16: New surface water drainage monitoring test results

Appendix 17: Gas management plan - Trehir gas flaring