

2. SITE ENGINEERING FOR POLLUTION PREVENTION AND CONTROL

2.1 Engineering Surveys

At present survey stations are referenced to a (local site grid). However, levels are referenced to Newlyn datum level. Plans are produced by the survey contractor and contain a scheduled list of the co-ordinates, levels and descriptions for all major features within the licensed area.

Topographical surveys will be carried out as detailed in the site licence. In general topographic surveys are undertaken on a quarterly basis and when otherwise required. The survey data produced is nominally at a 1:1250 scale and the plans are two fold in nature.

- Site Layout and general arrangement – this drawing is produced to reflect and adequately show- Site roads, monitoring points, gas extraction systems, structures, boundaries etc.
- Site Survey and contour plan – this drawing is generated with the intention of providing contours of the site profile, embankments, slopes, and stockpiles. Accurate information is also produced from this drawing to enable the calculation of void-space and cut volumes.

2.2 Engineered Landfill Containment System for Solid and Liquid Wastes (Leachate and Gas Generating).

2.2.1 Conceptual Engineering Design

The site has been designed as a contained landfill. The containment system is divided into two cells, Cell 1 and Cell 2, to enable the effective management of leachate and raw landfill gas (RLFG), to allow progressive infilling and

restoration. The majority of the basal engineering has been undertaken and the restoration engineering has been started in Cell 1.

The containment system consists of a fully welded 2.5mm basal geomembrane liner overlaying a layer of compacted colliery spoil, with a further layer of colliery spoil acting as a protection layer. The underlying layer of colliery spoil has a nominal thickness of 1 metre, with the protective layer having a nominal thickness of 450mm. Both layers have a particle size of sub. 20mm. A drainage system has been installed beneath the geomembrane to control groundwater flow and above the geomembrane to collect leachate. Each cell contains leachate collection and discharge wells to control leachate heads above the liner.

During restoration an engineered cap will be constructed of low permeability geosynthetic liner or suitable alternative with a 1m thickness of cover soils, designed to minimise infiltration and control surface water run off. The engineered cap will minimise the infiltration of rainwater and prevent the uncontrolled escape of landfill gases.

Up to June 2001 the following engineering work has been undertaken:

- Basal liner for Cell 1 (constructed in 1987) and Cell 2 (constructed in 1990).
- Inert bund constructed at the eastern perimeter of Cell 1 (constructed in 1987 and raised to its current height around 1992).
- Leachate collection system in Cell 1 (constructed in 1987) and Cell 2 (constructed in 1990).
- Under drainage collection system installed beneath Cell 1 (constructed in 1987) and Cell 2 (constructed in 1990).
- Installation of gas extraction system in Cell 1 (passive venting system installed in 1987 for cell 1 and 1990 for cell 2). Active gas extraction to flare started in 1997.
- Installation of eductor -system for leachate and condensate abstraction system for Cell 1 (commissioned in 1998).

- Installation and construction of flare compound (commissioned in 1997 – open type Hofstetter flare, replaced later that year by a Hi-Lo high temperature flare stack, capacity 1200m³. In September 1998, this was replaced by 2 No. Organics high temperature flare stacks, each with a capacity of 1000m³. In June 2001 one of the Organics flares was replaced by a Hofstetter LCM3C/1500 flare stack), capacity 1500m³.
- Construction of perimeter surface water collection system (1987) and surface water collection system and settlement lagoons (constructed 1998).
- Construction of leachate collection system, leachate holding pond and discharge system to sewer (constructed 1987).
- Construction of geomembrane cap and placement of cover soils over 40% of Cell 1 (constructed 2000)

2.2.2 Detailed Engineering Design

2.2.2.1 Basal Engineering

The basal engineering for both cells was constructed and consists of the following:

The containment system used was a synthetic liner of 2.5mm high density polyethylene (HDPE). Cell 1 of the site was laid onto a prepared sub-base and then protected by a minimum 450mm layer of compacted colliery shale. In Cell II the liner was sandwiched between compacted layers of screened colliery shale 300mm thick. Before this system was installed the site was prepared by the removal of up to 1 metre of natural ground in order to remove unsuitable material and sealing fissures in the underlying bedrock. Groundwater drainage was installed at this stage in the sub-base. Long sheets of HDPE were then laid and welded together followed by a protective layer of screened colliery shale, which was then compacted to achieve a permeability of 10⁻⁷ ms⁻¹. This not only provided protection against damage to the HDPE liner but also acted as an additional barrier to leachate escape.

2.2.3 Basal Drainage

The basal engineering of Cell 1 and Cell 2 consists of a drainage layer below the geomembrane liner (sub-liner drainage layer) and a drainage layer above the geomembrane (leachate collection system)

Sub-Liner Drainage Layer - Existing

The sub-liner drainage system was designed to collect groundwater from beneath the geomembrane and transfer it away from the site to reduce the potential build up of hydrostatic head beneath the liner.

The sub-liner drainage system is monitored from a number of vertical monitoring chambers that pass through the geomembrane and have been raised with the placement of waste. The sub-liner drainage system, has been designed and constructed to allow for the removal of surface water from within the lined cells, prior to the placement of the waste. The surface water would have been collected from the top of the geomembrane and discharged through into the sub-liner drainage system. This pathway, from above the liner to beneath the liner was sealed prior to placement of waste to prevent leachate escape.

The sub-liner drainage system is constructed from 300mm of graded colliery spoil with no fines gravel collection drains with geotextile filter warp. Two sub-liner drainage systems have been installed beneath the site, the Lower System and the Upper System.

The Lower System takes water from wells S1 and S2 in Cell 1, to the discharge point on the Nant y Gwyddon stream.

The Upper System takes water, from Cells 1 and 2, via chambers L21, L16, S9 and S7 (within the landfill), via S6 to S1 (located outside of the landfill) to the

discharge point on the Nant y Gwyddon stream. Inspection access to the underdrainage system is via wells S2, S7 and S9.

In Cell 1, the sub liner drainage system was sealed from the above liner system prior to placement of waste.

In Cell 2 the sub liner drainage system is used to remove surface water collecting on the lined area and transfer it, under gravity, to the discharge point, S1, on the Nant y Gwyddon stream. Prior to placement of waste in Cell 2 the connection between the drainage system above and below the liner, at well S21, will be sealed using a plug (CQA procedure required and approval from the Agency sought). Alternatively the well will be sealed by removal of the well above the geomembrane level and the area repaired with welded geomembrane.

Drainage System - Future

If repairs or additions are required to the basal drainage system the following procedures will apply:

- Pipework will be constructed from HDPE or MDPE pipe or suitable alternative (as agreed with the Agency prior to construction).
- Drainage pipework will have slots sized to allow unhindered flow of leachate or groundwater and prevent the migration of the surrounding drainage medium into the pipe (as agreed with the Agency prior to construction). The slots shall typically have a minimum open area of 10%, and a minimum slot width of 5mm, subject to detailed engineering design.
- Drainage pipes to be surrounded by a minimum of 100mm of drainage material, specification non-calcareous stone 10 – 14mm diameter no fines (as agreed with the Agency prior to construction).
- Drainage pipes to be joined by push fit couplings, butt jointed or fusion welded couplings, or alternative depending on location (as agreed with the Agency prior to construction).

- The pipe work shall be delivered, handled and stored in accordance with the manufacturer's recommendations and in such a way that damage will not occur to any material. The pipes will be stored on an area flat enough to accommodate the entire length of the pipes and in such a way so that they are not deformed or damaged. The pipes shall not be stacked higher than 1 m.
- Confirmation of the quality control procedures taken by the pipe manufacturer and copies of quality control certificates shall be supplied. A record of the materials used in construction of the drainage system, manufacturer's quality control certificates and as built drawings shall be submitted as part of the CQA reporting on the cell construction.

2.2.4 Geomembrane Liner Specification and Construction Quality Assurance

Geomembrane used in the construction of the base liner consists of 2.5mm-textured HDPE. It is not envisaged that any further basal liner will be required, however in the event that it is the following procedures will apply to the materials used:

- Geomembrane to be 2.5 mm textured HDPE.
- Geomembrane to be securely anchored at the margins in an anchor trench at the top and bottom of side slopes.
- The geomembrane material shall consist of high density polyethylene (HDPE) produced from new resins; it shall contain no fillers, plasticisers or additives of any kind with the exception of carbon black.
- Quality control records shall be issued by the geomembrane manufacturer to demonstrate that the material delivered to site meets the required design specifications. This shall be checked by undertaking conformance testing on any new material delivered to site.

2.3 Leachate Management Systems

2.3.1 Maximum Permitted Leachate Level

The maximum permitted leachate level for the site in Cell 1 is 1m above the base of the cells as measured at the leachate monitoring wells. Leachate heads within the cell will be established using existing S and L series wells (see Section 5 for detail). Prior to monitoring this will be agreed with the agency. The methods and frequency under which these wells are monitored will be governed by health and safety issues.

The maximum permitted leachate level for the site in Cell 2 is 1m above the base of the cell as measured at the leachate extraction well.

2.3.2 Basal Drainage

The basal leachate collection system for Cells 1 and 2 have been constructed, as shown on Drawing 4.

Leachate collection is undertaken from two separate systems, an upper and a lower system. The lower system has been constructed in Cell 1 only and collects leachate via a series of HDPE drains installed above the 300mm graded colliery protection layer. These drains collect and transport leachate from the eastern section of Cell 1, via well L6. From here the leachate flows under gravity through twin pipes to wells L3 and L4, located outside of the landfill area.

An additional leachate collection system has been installed against the inert bund along the eastern boundary of Cell 1. This consists of a vertical stone column, extending between L7 and L8, and connecting to the lower leachate system at L5. The stone column has been designed to intercept leachate from the waste before it comes into contact with the inert bund.

Leachate from the lower system is collected at wells L3 and L4 from where it is piped to the existing leachate lagoon to the north east of the site. Leachate from the collection lagoon is discharged directly to the foul sewer system.

The upper leachate collection system consists of 15, as-constructed leachate wells, L8 to L21. The leachate collection system consists of 200mm diameter HDPE drainage pipe with gravel surround installed on the 300mm graded colliery spoil protection layer. The drainage pipes encourage leachate to flow from the highest point of the base of the landfill at L22 to the low point at L8.

From manhole L8 the leachate is piped, under gravity, via manholes L7 to L1 and from here to the leachate collection lagoon at the north east corner of the site. From the collection lagoon leachate is discharged directly to the foul sewer system. The upper leachate collection system in Cell 1 is operative. In Cell 2 wells L20, L21 and L22 are currently used for surface water collection and will not be connected to the leachate system until waste placement is undertaken in Cell 2.

The basal leachate collection system for Cell 1 and Cell 2 has been completed. An inspection of the condition of the Cell 2 leachate collection system will be undertaken prior to placement of waste (the proposed method and timescale of the condition survey will be through consultation and agreement with the Agency) in this cell. If the condition of the leachate collection system is not found to be satisfactory then amendments to the current system will be proposed and forwarded to the Agency for approval. Further details and the timescale of this exercise will be agreed with the agency prior to commissioning.

Due to blockages in the gravity leachate collection system in Cell 1, an additional leachate abstraction system has been installed in Cell 1. This consists of:

- Leachate eductors installed in the gas extraction wells of Cell 1

- Leachate is abstracted and pumped to the leachate/condensate collection tanks, located to the north of Cell 1, see Drawing 4.
- The leachate and condensate is pumped from the collector tank to the leachate lagoon, located at the northeast corner of the site and from here to the public sewer.

Leachate from Cell 1 is prevented from entering Cell 2 by a north south orientated bund. The bund is approximately 1m high, located on the cell base, at the eastern end of Cell 2. The bund is referred to as the 'Jones's Bund', see Drawing 3.

Leachate from Cell 2 will be controlled by installation of a leachate collection sump at the low point of the cell.

This topic is covered in greater detail in Arup contract documentation, which has been supplied to the Environment Agency.

2.3.3 Leachate Monitoring and Extraction Wells

It is intended that leachate monitoring and extraction will take place from the S and L series wells situated in Cell 1 of the landfill refer to Section 5 for detail.

2.3.4 Leachate System Maintenance Program

A leachate system maintenance program is in operation at the site and included in Appendix 10 of this Working Plan.

2.3.5 Construction Quality Assurance for Installation of Additional Leachate Management System

Proposed amendments or additions to the existing leachate management system and the proposed Construction Quality Assurance to be employed during the works shall be forwarded to the Environment Agency for approval, prior to installation.

2.3.6 Specification for Leachate Holding Tank

A lined leachate holding tank is located on site, as shown on Drawing 4. The tank consists of a reinforced concrete construction (approx. 20m x 10m x 5m in volume) with a theoretical leachate capacity of 1250 m³.

Leachate generated on site gathers at chamber L2a and via a DI DN150mm pipe flows into the leachate holding tank. The effluent is then discharged in a controlled and recorded manner via a 50mm orifice pipe which is controlled by a penstock valve (within the parameters of Amgen Rhondda's Welsh Water discharge trade effluent consent) via an OD 315 HDPE leachate pipeline to foul sewer.

2.3.7 Specification for Leachate Drainage Materials and Pipework

2.3.7.1. Leachate Drainage Materials

The leachate collection system has been installed at the site. However, should additional leachate collection pipework and associated drainage materials be required they shall comply with the following specification and Section 2.3.7.2.

- Leachate drainage pipes shall be manufactured from HDPE with two thirds of its circumference slotted and non-calcareous aggregate surround i.e. 10-14mm minimum particle size, no fines or suitable alternative.
- The size, spacing and orientation of slots made in the pipe work will allow unhindered flow of leachate and prevent migration of drainage media into the pipe whilst maintaining pipe strength. The slots shall have a typical

open area of 10%, a minimum slot width of 5mm. The slots shall be located around the pipe circumference.

- The pipe extensions above or beyond the lined landfill shall be in plain pipe with end caps to prevent the ingress of debris.
- The pipe work shall be delivered, handled and stored in accordance with the manufacturer's recommendations and in such a way that damage will not occur to any material. The pipes will be stored on an area flat enough to accommodate the entire length of the pipes and in such a way so that they are not deformed or damaged. The pipes shall not be stacked higher than 1 m.

Confirmation of the quality control procedures taken by the pipe manufacturer and copies of quality control certificates shall be supplied. A record of the materials used in construction of the leachate collection system, manufacturer's quality control certificates and as built drawings shall be submitted as part of the CQA reporting on the cell construction.

2.3.7.2 Specification for Leachate Drainage Materials

The leachate collection system has been installed at the site. However, should additional leachate collection pipework and associated drainage materials be required they shall comply with the following:

- The drainage material will consist of clean gravel having a calculated permeability no less than 1×10^{-4} m/s and a carbonate content of less than 10%. The material supplied shall be graded to ensure adequate flow of liquid into the drainage pipe, whilst preventing the clogging or silting up of the pipework i.e. 10-14mm minimum particle size, no fines or suitable alternative.
- Conformance testing for each source of drainage material will be undertaken in accordance with the CQA Plan for the works to ensure compliance and consistency of the material.

- Drainage material will be placed in a systematic manner so that shovels or excavator blades do not damage the underlying liner.
- Amgen Rhondda shall investigate the use of alternative drainage media. This may include the use of recycled aggregates or geocomposite materials. Prior to the use of alternative materials, a full specification and description of the proposed material shall be submitted to the Agency for written approval. Submissions to the Agency will include, where necessary, supporting information such as the results of laboratory tests to demonstrate the suitability of the proposals. Supporting information will typically include consideration of permeability, transmissivity, crush strength, shear strength, methods of installation and longevity.

2.3.8 Installation, Inspection, Maintenance and repair of Leachate Monitoring Points.

A reputable, competent specialist contractor will only install these aforementioned monitoring points. The points will be inspected on a daily basis by the site supervisor or in his absence a duly appointed alternative officer of the company. In the case that the need for maintenance or repair is required the leachate monitoring points will be repaired within 1 week.

2.4 Construction Quality Assurance

All future significant engineering works will be undertaken in accordance with Construction Quality Assurance (CQA) requirements. A description of the CQA procedures to be followed will be detailed in the Construction Quality Assurance Plan, to be forwarded to the Agency for approval, prior to commencement of engineering works.

A suitably experienced CQA Engineer will be present during the construction works managed by a suitably experienced Chartered Engineer or Chartered

Geologist to ensure compliance with the CQA requirements. The curriculum vitae of the Engineer shall be submitted to the Agency prior to the works.

The construction works shall be carried out using Construction Quality Assurance (CQA) procedures developed for the works and which will form part of this Working Plan. The CQA procedures include for checking of various parts of the Works in a systematic way and include, but are not limited to, consideration of the elements described.

On completion of engineering works a report summarising the construction activity carried out during the works, details of all inspections and testing carried out as part of the CQA programme and as-built drawings will be forwarded to the Agency.

2.5 Landfill Gas Management Systems

An active gas extraction system has been installed at the site in Cell 1.

The extraction system will be continued into Cell 2 along the same design principles.

The active gas extraction system for Cell 2 will be progressively installed within 12 months of completion of the restoration of the cell.

2.5.1 Conceptual Design

The landfill gas extraction wells will be spaced to optimise gas extraction and to ensure that the landfill gas is drawn back towards the centre of the site and away from the lined sideslopes and capping.

The conceptual design of the gas extraction system is based on the existing gas extraction system installed for Cell 1 and is summarised below:

The gas extraction system will include the following principal elements:

- Vertical gas wells
- Wellhead on each well to provide monitoring facilities
- Connecting pipe linking each gas well individually to a manifold
- Manifolds to connect the gas wells to the gas main and provide monitoring and control facilities
- The installation of gas mains to connect the manifolds to the gas compound
- Condensate knockout pots to remove condensate from the mains
- Connection to the existing gas extraction system.

2.5.1.1 Well Design

Each new gas extraction well will be drilled at an approximate diameter of 250 to 350mm and will be completed with a slotted well liner installed in the borehole, the annulus being filled with no fines granular material.

A typical well detail is given in Drawing 11.

The gas wells will be drilled to 80% of the depth of the waste to ensure no interference with the basal liner. The wells will typically be constructed from 125mm to 160mm plain and slotted well screen manufactured from suitable pressure rated MDPE or HDPE, or as otherwise agreed in writing with the Agency. The wellhead shall fit the well casings and a flex-seal coupling and supporting ring shall be fitted externally to provide a gas tight seal and prevent the ingress of debris. Well heads will be manufactured with a control valve, gas monitoring point.

The wellhead shall allow for the movement of the gas well in relation to the waste in both the horizontal and vertical directions with a flexible hose connection to the outgoing connecting pipework.

2.5.1.2 Carrier Pipework and Fittings

Pipework and fittings will be of varying sizes fabricated from suitable pressure rated HDPE or MDPE pipe, or suitable alternative (To be agreed with Agency). Condensate traps (pots) will be installed in the system at appropriate intervals to prevent the build up of condensate inside of the pipework. Condensate pots may be either sealed and pumped to a collection/discharge chamber or installed within the waste to allow condensate to soak back into the landfill.

In Cell 1 condensate and leachate is removed using eductor pumps installed into each well head, see Drawing 11. The leachate is pumped from the well to a collection tank at the northern end of the site see Drawing 4.

The leachate is then pumped to the leachate collection lagoon for discharge to sewer.

In Cell 1, carrier pipework will be installed to gradients sufficient to allow condensate to flow, under gravity, to in waste dewatering locations. Ideally carrier mains should be laid to minimum gradients of 1 vertical to 25 horizontal. If sufficient quantity of condensate is produced or leachate levels are high, consideration will be given to the installation of an active condensate de-watering system in accordance with Cell 1.

2.5.1.3 Operation, maintenance and review of landfill gas management system

The operation of the gas management system, is constantly ongoing, the infrastructure is inspected on a daily basis and all necessary readings are recorded, along with any manual dewatering. All faults found are noted and carried out during Amgen Rhondda Ltd's rolling programme of gas management maintenance.

The gas management system is reviewed by Amgen Rhondda Ltd's technical staff on a fortnightly basis whilst the gas field is being balanced. Changes to the

system are made in line with the current tipping operation in order to facilitate maximum gas flaring.

2.5.1.4 Action plan for failure of, or damage to components of landfill gas flare

The flare stacks at Nant-y-Gwyddon have a flashing red beacon light that illuminates during the operation of the respective flare stack. The stacks are also constantly observed from the weighbridge by the site manager and are inspected daily by the site supervisor.

In the event that a flare stack fails or receives component damage, then with immediate effect the Agency will be notified and the event will be recorded in the site diary.

In such circumstances the reserve flare will be commissioned and the flaring of landfill gas will continue, the appropriate flare company will be contacted and the damaged flare stack will be repaired within 24 hours or as soon as practically possible.

2.5.1.5 Power Generation and Flare Stack

The site operates one 1000 m³/hr and one 1500 m³/hr flare to extract gas from Cell 1 which are located as shown on Drawing 7. At present ARL employs;

- 1 No. Organics SC 1000 range; high temperature enclosed flare stack.
- 1 No Hofstetter LCM 3c/1500 high temperature enclosed flare stack.

Amgen Rhondda Ltd. proposes to utilise a power generation scheme at the landfill in the near future.

Flare specifications are attached as Appendix 16.

2.6 Drilling Logs

Drilling logs will be provided for each new well detailing the nature of the waste/material drilled through, the presence of any leachate levels (perched or otherwise), the depth to base and top of the stone annulus and top of the slotted well casing. The location of each well will be signed and related to National Ordnance Survey grid references once installed permanently (Appendix 10 contains a copy of existing monitoring borehole logs).

2.7 Pipe Jointing

All new pipes shall be joined using electrofusion, butt - welding or similar techniques and equipment, except where specified otherwise as agreed and approved by the agency. These will be subjected to CQA techniques and inspections as agreed in CQA plan to be submitted under Section 2.4 of this working plan.

2.8 Pressure Testing

All fabricated MDPE components to be factory tested to 1 bar gauge and supplied to Site with a pressure certificate and subject to CQA techniques and inspections as agreed and approved by the agency.

2.9 Commissioning

Commissioning shall be detailed in the CQA Plan for the Works and shall include pressure testing on the gas main from the gas extraction plant to the inlet valves from each well at the manifolds and shall include any pumped knockout pots. If an eductor system is installed the pipework shall be pressure tested in accordance with the expected working pressures.

2.10 Engineered Surface Water Management Systems

2.10.1 Operational Surface Water System

A surface water collection system has been constructed around the perimeter of the site. Along the southern, western and northern boundaries the surface water system collects run off from outside of the landfill and from Cell 1 and transfers it to the Fire Water Lagoon. From here surface water is directed to three surface water settlement lagoons, before discharging to the Nant-y-Gwyddon stream.

Around the boundary of Cell 2 the surface water system collects water from beyond the cell. Surface water collecting within Cell 2 does not flow over the Cell boundary, but is diverted into the sub liner drainage system at well L21. From here the surface water collecting within the cell flows under gravity, via buried drainage pipework to manhole S1, where it discharges to the Nant y Gwyddon stream, see Section 2.10.5

Surface water collecting in Cell 2 is kept separate from leachate from Cell1 by the lined inter cell bund (Jones Bund).

During the operation of Cell 1 and Cell 2 water collecting in the cell will be treated as leachate and discharged in accordance with Section 2.10.5 Leachate will be prevented from entering the perimeter surface water system by the lined perimeter seal. Waste placement against the perimeter will be maintained at least 1m below the top of the lined cell wall.

Should surface water become contaminated by leachate the following actions will be taken:

- The contaminated surface water to be treated as leachate unless analysis shows otherwise.
- The contaminated surface water to be pumped immediately from unlined areas to the nearest available leachate collection point.
- The contaminated surface water should be isolated by construction of a temporary bund around the localised area to keep the contaminated volume to a minimum.

- Where the surface water channel or areas outside of the landfill have been in contact with the leachate then the soil to be removed for a minimum depth of 100mm and transferred to the landfill. The excavated materials to be replaced with similar clean material and placed to achieve the same properties as the original material, prior to contamination.
- If the contamination of surface water is located within the settlement lagoons all of the water to be treated as leachate and pumped to the leachate collection lagoon, unless analysis proves the material to be uncontaminated.
- A copy of all chemical analysis to be forwarded to the Agency with a detailed breakdown of the reason for the contamination, the remedial measures undertaken and the additional measures to be installed to prevent a similar occurrence in the future.

2.10.2 Restored Surface Water Management System

The majority of Cell 1 has been restored. Surface water run off is collected in the perimeter surface water system and channelled to the surface water settlement lagoons and then to discharge to the Nant-y-Gwyddon stream.

Surface water run off from the capped Areas A, B and D, of Cell 1, is channelled through the capping materials by nine herringbone drainage systems. These are designed to prevent surface water erosion of the capped soils. Surface water from this area is channelled to the surface water settlement lagoons before being discharged to the Nant y Gwyddon stream.

2.10.3 Modifications to the Surface Water management System

If modifications to the existing surface water monitoring system or if additional surface water systems are required detailed drawings and construction procedures will be forwarded to the Agency for approval prior to construction. All future significant surface water engineering works shall be recorded in a Construction

Quality Assurance report to confirm that the engineering has been undertaken in accordance with the approved Specification.

2.10.4 Inspection of Surface Water Management System

The surface water management scheme shall be inspected each month by the Site Manager who shall record the inspection in the site diary. All remedial works required shall be undertaken within 14 days of the inspection. If considered urgent, the repairs will be undertaken immediately.

In addition, an annual inspection of the surface water collection ponds and lagoons will be undertaken so that maintenance can be carried out in the summer when access is possible.

2.10.5 Discharge to Nant-y-Gwyddon Stream

Surface water runoff from the site is occasionally treated with a flocculant (as approved by the Agency) and directed to three surface water settlement lagoons where the settlement process is maximised. This surface water is then discharged to the head of the Nant-y-Gwyddon stream subject to the interim guidance standards detailed in section 5 of this working plan.

Surface water runoff from the vicinity of Gell Tip No. 322 is also discharged (after treatment) via its own settlement lagoon to the head of the Nant-y-Gwyddon.

These form consented discharges, Gelli Tip No. AN030820101. Settlement-Lagoon No. AN030830101 and Storm Overflow discharge AN030830102. The Environment Agency regulates all of which.

The underdrainage system described in 2.2.3 is also discharged (untreated) to the Nant-y-Gwyddon stream. These discharges are identified on Drawing No. 12

2.10.6 Record Keeping

Inspection of surface water management system, and remedial actions undertaken i.e. routine dredging and maintenance of surface water lagoons. Removal of leachate contaminated surface waters to leachate management system will be recorded in the site diary.

2.11 Installation, Maintenance and Protection of Final Capping

2.11.1 Settlement

Degradation of wastes deposited within the landfill will result in the settlement of the final landfill surface. Therefore, to achieve the post-settlement levels set out in the planning permission, surcharging of the wastes will be required. The pre-settlement restoration profile is shown on Drawing No. 9 and the post settlement contours given in Drawing 10. The site is currently surveyed every 3 months to identify current contours. Should differential settlement be noted following a routine landform survey, then further action will be discussed with the Agency in order to remedy the problem of differential settlement.

2.11.2 Capping

To reduce the amount of precipitation that can infiltrate the waste, a low permeability cap, with a maximum permeability of 1×10^{-9} m/s will be constructed on completion of filling to the final pre-settlement levels.

The cap will be constructed in accordance with the following parameters:

- A low permeability liner with a maximum permeability of 1×10^{-9} m/s.
- A minimum pre-settlement cap gradient of 1 in 20 to encourage run off of surface water.
- A minimum of 1m of cover soils..

- A perimeter surface water collection ditch around the capped area to transfer run off to the silt trap and Nant y Gwyddon stream, see section 2.10.5
- The cap will extend beyond the existing waste boundary to provide an overlap between the sideslope liner and the low permeability cap of 2m.
- Existing and future monitoring wells, gas wells and leachate extraction wells will be taken through, and sealed into, the low permeability cap. The headworks will be protected within the restoration profile by a suitable chamber secured by a cover at ground level or protruding by a maximum of 300mm.

Construction of the capping for Cell 1 has been undertaken and the construction details for the Cell 1 cap is summarised below:

- 800mm of Class B subsoil, maximum grain size 125mm, over
- 200mm of sand protection layer with a maximum grain size of 20mm, over
- 1mm Low density polyethylene (LDPE) geomembrane, over
- 300mm blinding sand protection layer with maximum grain size of 20mm
- Surface water collection drains have been installed into the cap to reduce the effects of erosion by surface water.

Construction details, including the proposed materials and the Construction Quality Assurance Plan to be implemented during the future capping works will be forwarded to the Environment Agency for approval prior to works commencing.

The engineered capping shall be subject to Construction Quality Assurance by an approved party who, on completion, shall submit a Construction Quality Assurance report to the Agency for approval.

2.12 Inert Bund.

An inert bund has been constructed along the eastern boundary of Cell 1. The methodology for constructing the bund is summarised below:

The bund was constructed from inert material only, with no organic or biodegradable material used in its construction.

- The bund was designed with a minimum factor of safety of 1.5. (See Annual Engineers report on bund stability by Arup)
- Compaction trials were undertaken to determine the minimum number of passes required for the material to be used. Alternatively compaction was achieved using a minimum of 4 No. Passes with a towed vibrating roller with a minimum weight of not less than 20 tonnes, over a width of 1m.
- The material was compacted in less than 500mm thick layers.
- The bund is monitored via piezometers.
- The bund is constructed with a maximum sideslope of 1 in 2.5.
- Two leachate interceptor drains were constructed from free draining materials, in trenches, between the bund and the waste.

The bund has been constructed to full height along the eastern boundary of Cell 1.

Long term monitoring of the bund is required to ensure its long term stability, at the frequencies given in Table 5 overleaf:-

Table 5: Monitoring Schedule for Inert Bund.

Monitoring	Frequency	Reporting to the Agency
Visual, survey and sampling if required	Annually	Within 2 months
Full independent site investigation and stability analysis	Every two years	Within 2 months
Visual, survey and sampling if required	After a evidence of instability of any description	Within 2 months

Should any water quantities be found within the piezometers, then such liquid will be collected and be subject to a basic analysis suite to determine if such water is contaminated with leachate.

The basic suite will consist of the following determinants:

- Ammoniacal Nitrogen.
- Chloride.
- Total C.O.D.
- Temperature.
- P.H.
- Electrical Conductivity.

Note:

Any irregularities in the readings or observations to be reported to the Agency within 24 hours.

Annual and bi-annual inspections of the bund to be undertaken by suitable experienced chartered civil engineer, as approved by the Agency.