

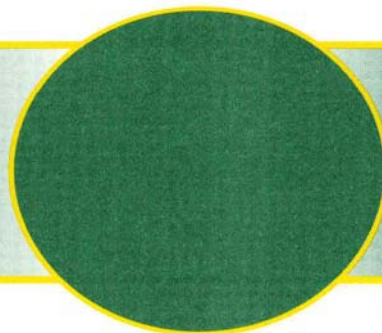
# **Pwllfawatkin Landfill Site**

## **Leachate Management Plan**

**October 2010**

**PPC Permit Ref: BU8819IV**

**Variation Number: YP3333MK**



**October 2010**

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## 1. Introduction

This revised Leachate Management Plan aims to address the following:

- To minimise the risk of leachate migration from the site.
- To promote a strategy of maximising degradation of waste in the site through achieving optimum temperature and moisture content, leading to enhanced stabilisation.
- To monitor the effectiveness of the leachate management infrastructure and procedures.
- To comply with Improvement Conditions 3 ~~and 5~~ of the Permit
- Details the leachate extraction programme required to enable leachate level reduction to be achieved and maintained in line with the consent levels agreed with the Environment Agency (Agency).
- To address queries raised by the Agency in correspondence dated 13<sup>th</sup> October 2008, 15<sup>th</sup> January 2009 and 9<sup>th</sup> October 2009.
- To address queries raised by the Agency in meeting held between the Agency and WRG on 15<sup>th</sup> April 2010.

Extract from Table S1.3 Improvement Programme Requirements:

|   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                            |
|---|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 3 | The Operator shall submit to the Agency for approval further information for a revised leachate management plan, as requested by the Agency on 01 May 2007.<br>The response shall be limited to the outstanding requirements of original IC 1.4.1.11 as detailed in the letter.<br>The Operator shall undertake any measures notified in writing by the Agency by the date indicated in the notification.                                                                                                                                  | Improvement condition revised<br><br>28/09/08                              |
| 5 | The Operator shall submit to the Agency for approval revised leachate compliance levels for Phase 1. These limits shall be based on 0.5m below the minimum groundwater level, expressed as 'mAOD' and/or 'm above base'. Individual limits shall be set for monitoring points 41, 51, 74, 82, 91 and 101 as appropriate.<br>Once approved, table S4.1 shall be read as if it contains the new limits. The monitoring frequency for leachate and groundwater level in tables S4.1, S4.8 and S4.10 shall also change from weekly to monthly. | <del>New improvement condition added, see table S4.1</del><br><br>28/09/08 |

### 1.1 Site Background

Pwllfawatkin Landfill site is located approximately 15km north east of Swansea and 5km north west of Pontardawe at National Grid Reference SN 698 088. The site is located in the valley of the Upper Clydach River. Phase 1, Cell 1 construction commenced in 1995 and Cell 2 construction commenced in 1998. The landfill was engineered as a containment landfill using the native glacial clays on site. Phase 2, also known as Tip 890 is approximately 12 hectares in area; the local geology is made ground consisting of colliery shale. The area was used to store settlement pond fines in lagoons formed by the colliery shale bunds. Landfilling commenced in September 2007. The landfills are essentially a land raise within a constructed base.

Geology at the site consists of drift deposits that comprise boulder clay, peat and alluvium which form the valley floor. The drift deposits are underlain by Coal Measures strata into which the Upper Clydach River is cut. The Coal Measures are classified as a minor aquifer. The boulder clay extends across the valley forming the lower slopes of the hills, and the peat and alluvium are restricted to the course of the Upper Clydach River and its tributaries. It is

likely that the groundwater discharges into the Upper Clydach River which flows adjacent to the site.

## 1.2 Environmental Permit Details

Environmental Permit BU88191V was issued in November 2005; it was subsequently replaced by Variation Notice YP3333MK in March 2008. Table S4.1 makes specific reference to leachate levels limits and monitoring requirements. This report proposes specific interim leachate level triggers for Phase 1, as discussed and agreed with the Agency in April 2010, WRG request that the frequency of leachate level monitoring in Phase 1 is decreased from weekly to monthly, as monitoring data shows stabilisation of leachate levels (please refer to the Leachate Action Plan for further discussion on this). WRG have now agreed with the Agency to fortnightly monitoring (Agreed in email dated 21/09/2010) for three months, this will then be reviewed to ensure that the leachate levels continue on the current downward trend.

**Table S4.1 Leachate level limits and monitoring requirements**

| Monitoring point reference/<br>Description                                                                                   | Limit                                                             | Monitoring<br>frequency | Monitoring method                       |
|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------|-------------------------|-----------------------------------------|
| Phase 1:<br>Leachate monitoring points 41, 51, 74, 82, 91 and 101 (2 per basal cell), or as otherwise agreed with the Agency | 0.5m below the minimum surrounding groundwater level <sup>2</sup> | Weekly <sup>2</sup>     | In accordance with guidance in LFTGN 02 |
| Phase 2:<br>All leachate monitoring points to the western side of the landfill                                               | 1.5m above the base of the cell <sup>1</sup>                      | Monthly                 |                                         |
| Phase 2:<br>All leachate monitoring points to the eastern side of the landfill                                               | 2m above the base of the cell <sup>1</sup>                        | Monthly                 |                                         |

**Note 1** The levels for Phase 2 apply for the operational life of the Installation, unless otherwise agreed in writing with the Agency. Revised limits for Phase 2, will be set when its mode of operation changes to hydraulic containment.

**Note 2** Monitoring frequency reduced to monthly if leachate compliance limits revised and stated in mAOD or m above base in accordance with Improvement Condition 5.

## 2. Current Leachate Management System

### 2.1 Phase 1

A leachate management system has been installed in the landfilled area of Phase 1. The leachate management system includes a series of leachate monitoring and extraction wells (prefix LW and PZ), and side wall risers (SR wells) which are no longer in use because they collapsed in 2005/2006. The retrospectively installed 'PZ' leachate wells in Phase 1 were drilled to 2m above the base of the site (in order to avoid compromising the lining system), at a diameter of 450mm and installed with perforated HDPE casing (first 6m only) with a minimum external diameter of 225mm. Drilling restrictions meant that this depth was not achieved in all wells. The annular space around the perforated casing was filled with fines free, non-calcareous gravel with a minimum diameter of 20mm. All wells have been constructed to facilitate leachate and landfill gas extraction.

Leachate is extracted from the 'LW' wells and 'PZ' wells in Phase 1 using electrically or pneumatically powered submersible pumps. The leachate is pumped to the on-site leachate storage tanks located in the former colliery treatment works to the south-east of the current landfill via 110mm diameter pipework (partly surface laid). The primary leachate storage tank has a capacity of 140m<sup>3</sup>; the secondary tanks have a capacity of 46m<sup>3</sup> each.

The leachate tanks consist of twin walled construction to minimise the risk of contamination associated with spillage or leakage from the tanks. Drainage ditches have been cut around

the outside of the tanks to relieve groundwater pressure. Filler and dispenser points are located inside bunded or contained areas. There is a telemetry system connected to the primary leachate tank that will de-activate all leachate pumps when the tank is full. The secondary leachate containment tanks are connected to the primary tank as an overflow precaution. There is a telemetry system connected to the secondary tanks that will dial out to pre-determined site staff should the level in the tank approach the top.

## 2.2 Phase 2

In Phase 2, the leachate management system consists of leachate monitoring wells (LMW) and leachate extraction sidewall risers (LSW). The leachate monitoring points are installed on concrete pads on the liner, at a minimum diameter of 450mm and installed with 6m perforated HDPE casing followed by plain casing. The annular space around the perforated casing is filled with non calcareous gravel with a minimum diameter of 20mm. The annular space around the plain casing is sealed with bentonite. The side risers are constructed using solid HDPE leachate pipe 450mm. The pipes are installed from the drainage blanket up along the sidewalls during the engineering phase of the cell. Where possible, the pipes are protected by placing a layer of gravel or similar on top of them. Where necessary, gas extraction is also facilitated.

Leachate is extracted from the side wall risers using electrically or pneumatically powered submersible pumps. The leachate is pumped to two 50m<sup>3</sup> bunded on-site leachate holding tanks via 110mm diameter pipework (all surface laid). The tanks are located next to the haul road on the eastern side of the site. Each tank is connected to a telemetry system.

To minimise the risk associated with leachate migration during the period of landfilling in new landfill areas, the leachate level in each cell is maintained below the top of the low permeability internal bund (2m). Waste is covered progressively following the tipping operations to reduce surface water infiltration into the site.

For subsequent cells in Phase 2, the leachate drainage system will consist of pipework that drains towards predetermined collection points or sumps as appropriate, based on risk assessment. The leachate drainage system will be agreed with the Agency before construction, and will comply with Construction Quality Assurance (CQA) procedures. Leachate monitoring and collection wells will progressively be constructed during landfilling to enable level monitoring and leachate removal where necessary.

## 2.3 Other Information for Phases 1 and 2

A cross section of a typical landfill gas/leachate extraction well is shown on drawing reference 900D009 (Appendix A). The layout of the existing gas and leachate management system in the landfilled areas of the site is shown on drawing reference 479M047e (Appendix B). Each leachate well has a unique reference number and the top of the well is surveyed to metres above ordnance datum. The layout of the wells is designed to facilitate collection of data and determination of the distribution of leachate in the site.

Details of the leachate management during the aftercare period will be agreed with the Agency prior to closure of the site.

### 3. Leachate Level Monitoring and Trigger Levels

#### 3.1 Phase 1 Leachate Level Monitoring

In the original permit, Table 2.10.12 detailed leachate wells (side risers) SR1L, SR2L, SR3L, SR1S, SR2S and SR3S to be monitored on a weekly basis for leachate level. However, it was not possible to obtain accurate level data from these wells because the side risers collapsed. Waste Recycling Group (WRG) wanted to ensure that level data was still obtained from Phase 1, so in October 2006, it was agreed with Kevin Bennett of the Agency, that as a temporary measure, wells LW41, 51, 74, 82, 91 and 101 would be monitored for leachate level until the replacement steel piezo wells (PZ) were drilled. Six PZ wells were subsequently drilled in November 2007 (The CQA construction plan for this work is in Appendix D).

In the current Permit, Table S4.1 states for Phase 1 that wells 41, 51, 74, 82, 91 and 101 (2 per basal cell) *or as otherwise agreed with the Agency* should be monitored. WRG request that the clause "*or as otherwise agreed with the Agency*" is now applied and some of the LW wells are replaced by the PZ wells, as shown in Table 3.1 below. The use of the proposed wells was agreed in a meeting with the Agency in April 2010. An assessment into leachate level monitoring on phase 1 (against the requirements of the permit) is currently underway which may (subject to agency approval) result in changes to tables 3.1 and 3.2.

**Table 3.1. Phase 1 Proposed Leachate Well Replacements**

| Cell Reference | Well Description in Permit | Description of Proposed Replacement Well |
|----------------|----------------------------|------------------------------------------|
| 1C             | LW41                       | PZC1C-2                                  |
| 1C             | LW51                       | PZC1C-1                                  |
| 2A             | LW74                       | PZC2A-1                                  |
| 2A             | LW82                       | LW82                                     |
| 3A             | LW91                       | LW91                                     |
| 3A             | LW101                      | LW101                                    |

If any of the leachate level monitoring wells in Phase 1 are pumped, extraction will cease at least 24 hours prior to a dip being taken in order that a representative rest leachate level is recorded. In the event that a leachate well can not be monitored due to health and safety reasons, the well will be re-visited once more during the month. If a level result is still not obtained, the site business manager and technical team will be notified within 24 hours (of the second visit). The Agency will be notified within one month (of second visit) detailing proposals for obtaining a level reading.

#### 3.2 Phase 1 Proposed Trigger Levels

In April 2010, WRG attended a meeting with the Agency, one area for discussion was Improvement Condition 5 and the setting of leachate trigger levels for Phase 1. WRG highlighted that setting a trigger level of 0.5m below minimum groundwater level was unachievable with current infrastructure.

The option to install additional leachate wells was discussed, however this was deemed inappropriate as replacement steel wells (PZ wells) have already been installed in the phase and these were drilled as deep as reasonably practicable.

In the meeting, it was also suggested to re-examine the hydrogeological risk assessment for the site. WRG will carry out a review of the current model and forward a proposal to the Agency by September 2010 on how to progress with setting appropriate triggers for Phase 1.

During the April meeting, WRG agreed with the Agency to set interim trigger levels for Phase 1, for a period of 6 months, based on 2.25 m above the base of the 6 replacement wells listed in Table 3.1. The trigger level of 2.25m above base was used because this is the minimum leachate head in each well that the leachate pumps can reduce levels to.

To accurately set these triggers of 2.25m above base of the compliance wells on Phase 1, an up to date dip to base survey was carried out on 2<sup>nd</sup> July 2010 (top of well survey data from 6<sup>th</sup> May 2010 was used to calculate the base in mAOD). This data is shown in Table 3.2.

For optimum pump performance in any leachate well, there needs to be a depth of at least 2.25m from the base of a well, and this is why this value was used in setting the trigger limit. This amount is required for these reasons:

- between 0.5 to 1m of sludge will remain in the base of the well following de-sludging.
- a distance of at least 0.25m needs to be left between the top of the sludge and the base of the pump for effective pump operation.
- a pump needs to have at least 1m of liquid around it to operate.

Due to the 2.25m above base being the lowest limit that can be practically set for these wells, it is not considered appropriate to set control levels for the phase.

The current silt levels within the 6 wells listed in Table 3.2 ranges from 0m to 0.46m. It is unlikely that this residual silt can be removed as some of the wells are up to 24m deep. WRG will review silt levels on a six monthly basis, and de-silt when practicable and required.

**Table 3.2. Summary of Proposed Monitoring Locations and Interim Trigger Levels for Phase 1**

| Leachate Well | Cell | Base Of Cell mAOD | Top Of Well mAOD | Base Of Well mAOD | Trigger Level mAOD (2.25m above base of well) |
|---------------|------|-------------------|------------------|-------------------|-----------------------------------------------|
| PWPZC1C-1     | 1C   | 155.70            | 182.88           | 158.04            | 160.29                                        |
| PWPZC1C-2     | 1C   | 155.70            | 181.53           | 158.07            | 160.32                                        |
| PWPZC2A-1     | 2A   | 155.00            | 180.08           | 156.16            | 158.41                                        |
| PWLW0082      | 2A   | 155.00            | 179.94           | 157.64            | 159.89                                        |
| PWLW0091      | 3A   | 154.00            | 177.24           | 155.58            | 157.83                                        |
| PWLW0101      | 3A   | 154.00            | 177.73           | 156.12            | 158.37                                        |

*The cell base data was taken from Table 12 of the Hydrological Risk Assessment, 2001, report number 11210.*

### Phase 2 Leachate Level Monitoring

Leachate levels are monitored on a monthly basis from the leachate wells in Phase 2, as per Table S4.1 of the Permit. There are two wells per cell which are monitored for level.

If any of the leachate level monitoring wells in Phase 2 are pumped, extraction will cease at least 24 hours prior to a dip being taken in order that a representative rest leachate level is recorded. In the event that a leachate well can not be monitored due to health and safety reasons, the well will be re-visited once more during the month. If a level result is still not obtained, the Site Business Manager and Regional Technical Manager will be notified within 24 hours (of the second visit). The Agency will be notified within one month (of second visit) detailing proposals for obtaining a level reading.

### Phase 2 Trigger Levels

The trigger levels for Phase 2 are 1.5m above the base of the cell for wells on the western side of the landfill and 2m above base of the cell for wells in the east.

The following table summarises the wells that are monitored plus the corresponding trigger level.

**Table 3.3. Leachate Trigger Levels for Phase 2**

| Cell Reference | Well Description | Top Survey Level (m AOD) | Base Level (m AOD) | Control Level (m AOD) | Trigger Level (m AOD) |
|----------------|------------------|--------------------------|--------------------|-----------------------|-----------------------|
| 1              | LMW1A            | 180.533                  | 158.23             | 159.73                | 160.23                |
| 1              | LMW1B            | 182.491                  | 159.13             | 160.13                | 160.63                |
| 2              | LMW2A            | 181.771                  | 158.19             | 159.69                | 160.19                |
| 2              | LMW2B            | 183.372                  | 158.97             | 159.97                | 160.47                |
| 3              | LMW3B1           | 175.581                  | 158.64             | 160.14                | 160.64                |
| 3              | LMW3B2           | 166.351                  | 159.3              | 160.30                | 160.8                 |

### Contingency Plans for Breach of Leachate Control and Trigger Level

**Table 3.4. Contingency Plan Following Breach of Control Level in Phase 2**

|    | Task                                                                                                                                                                                                                                                                                                                  | Timescale                                | Responsible Person         |
|----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|----------------------------|
| 1. | Leachate level monitoring conducted. Data recorded on excel spreadsheet which automatically highlights any breaches.                                                                                                                                                                                                  | Within 24 hours                          | Site Technical Manager     |
| 2. | If level is greater than control level but less than a trigger this will be highlighted to the Regional Technical Manager (RTM) and Site Business Manager (SBM) by email. Pumping efficiency will be checked in corresponding cell and measures to reduce the leachate levels will be discussed with the SBM and RTM. | Within 24 hours                          | Site Technical Manager     |
| 3. | Data imported into database and control breach report produced which is sent to Regional Technical Manager and Site Business Manager.                                                                                                                                                                                 | Within 48 hours                          | Site Technical Manager     |
| 4. | If the well breaches the control level for three consecutive months, trend graph will be produced and sent to Regional Technical Manager and Site Business Manager.                                                                                                                                                   | Within 1 month of third reading.         | Site Technical Manager     |
| 5. | Regional Technical Manager will discuss control breaches with Site Technical Manager and Site Business Manager to determine if further action is required.                                                                                                                                                            | Within 1 month of receiving trend graph. | Regional Technical Manager |



**Table 3.5. Contingency Plan Following Breach of Trigger Level in Phase 2**

|    | Task                                                                                                                                                                                                                                                                                                                                            | Timescale       | Responsible Person     |
|----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------|
| 1. | Leachate level monitoring conducted. Data recorded on excel spreadsheet which automatically highlights any breaches.                                                                                                                                                                                                                            | Within 24 hours | Site Technical Manager |
| 2. | If there is a leachate level breach a schedule 6 will be submitted to the Environment Agency.                                                                                                                                                                                                                                                   | Within 24 hours | Site Technical Manager |
| 3. | Data imported into database and trigger breach report produced which is sent to Regional Technical Manager and Site Business Manager.                                                                                                                                                                                                           | Within 48 hours | Site Technical Manager |
| 4. | Following a breach of the level (first time that a well has breached). The leachate well will be re-monitored to confirm the result. Result will be imported into database, but the result will only be reported to the Agency if large deviation from original breach.                                                                         | Within 1 week   | Site Technical Manager |
| 5. | WRG Site Business Manager & Regional Technical Manager will be notified of the breach.                                                                                                                                                                                                                                                          | Within 24 hours | Site Technical Manager |
| 6. | Leachate extraction system will be checked and modified where possible. For example, the pumps in LSW wells in Phase 2 will be checked to ensure optimum performance, if it is found that extraction is not affecting leachate level in corresponding compliance well, the option of installing a pump in the compliance well will be reviewed. | Within 1 month  | Site Technical Manager |

WRG will continue to reduce the leachate levels in Phase 1 in line with the revised Leachate Action Plan (July 2010). In Phase 2, the leachate levels are currently compliant, if a leachate level result breaches a trigger actions will be taken as per Table 3.5. Table 3.5 will also apply to Phase 1 once the levels are compliant.

## **4. Leachate Treatment Options**

### **4.1 Disposal Off-Site**

As necessary, leachate from either tank area is removed for off-site treatment and disposal by road tanker to suitably licensed facilities under normal Duty of Care procedures. Tankers can remove leachate from the site only during operational hours. The rate of leachate removal from the site is maintained subject to breakdown and drying up of wells and agreed maximum levels. Where practicable, pumps are repaired or replaced within 48 hours of identification of a problem. The amount of leachate extracted from the site is recorded at the weighbridge, as the tanker vehicles are weighed prior to leaving the site and the information is recorded on the Gladis system. WRG reviewed the system and it is now possible to differentiate the leachate volume data from Phases 1 and 2 at the weighbridge. Records of total volumes of leachate removed from the site are submitted annually to the Agency as required by the Permit.

A factor that must be considered when determining leachate extraction rates, is the finite disposal capacity available at the various disposal points for which a number of WRG landfills and many other liquid waste producers are competing.

### **4.2 On-Site treatment**

There are currently no facilities for on-site treatment at this landfill site. However Waste Recycling Group are actively trialling modular leachate treatment options alongside permanent treatment plants in other areas of the UK. If seen as being successful this technology could be presented for discussion at a future time.

## **5. Method statement for the disposal of leachate specifying the controls in place to avoid odour nuisance as a result of these practices.**

- As mentioned earlier in this plan leachate is currently collected via a network of pumps, through pipes to holding tanks. Each well containing a pump will be sealed to prevent odours and all pipework by their very nature are sealed units.
- The holding tanks have the potential to create odours due to the constant filling and emptying process caused by the actions of extraction to tanker and refilling from site. The process of the tanks refilling from the site leachate system causes the free air within void space of the tanks to be displaced. The displaced air will be odorous due to the nature of the leachate. To control the discharge of potentially odorous emissions all above ground holding tanks will be sealed and displaced air will be forced through an activated carbon filter if odour become a nuisance in these areas. This method is in use at many other WRG landfill sites and has proved to be effective. Strong odours have not been a nuisance from the underground leachate storage tank collecting leachate from phase 1 however if an odour problem does become persistent a review will be carried out for the best option going forward.

## 6. System Maintenance

The leachate management systems are inspected at regular intervals. WRG will endeavour to repair wells that are no longer fit for purpose within one month, if this is not possible an action plan will be submitted to the Agency detailing proposed remediation measures, which may involve rodding, camera surveys or well flushing. The following table details the system checks that are carried out, both during the operational and post-operational phases. Checks are recorded in the site installation log.

**Table 6.1. System Checks**

| Equipment / Location                    | Checking Period                                                      | Comments                                                                          |
|-----------------------------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------|
| Phase 1 Leachate Tank Area              | Weekly                                                               | Visual check of the area looking for leachate staining, leaks etc.                |
| Phase 2 Leachate Tank Area              | Weekly                                                               | Visual check of tank area looking for leaks, surface water build up in bunds etc. |
| Leachate Pump Performance Check         | Monthly                                                              | Pump hours recorded                                                               |
| Leachate Wells                          | Monthly                                                              | Confirmation that leachate compliance well can still be dipped.                   |
| Leachate Collection Pipework            | Monthly                                                              | Walking of leachate lines checking for leaks.                                     |
| Tank inspections                        | Monthly                                                              | Check bunds, valves, switches.                                                    |
| Dip and Rod Survey                      | Six Monthly                                                          | See Leachate Action Plan                                                          |
| Leachate Well Top Survey                | Six monthly                                                          |                                                                                   |
| Phase 1 Concrete Tank and Overflow Tank | Annually                                                             | Visual check of surfaces.                                                         |
| NDT Testing of Steel Leachate Tanks     | Timescale to be confirmed following agreement with tank manufacturer | Nuclear density testing to be carried out.                                        |

A record will be made on the monthly leachate level monitoring results of any well extensions. The wells (top of well) will be re-surveyed at six monthly intervals with the monitoring records updated accordingly. When a leachate well is extended, a note of the extension length will be made in the monitoring results, the level will be confirmed by a surveyor within two months of the well raise.

## 7. Conclusions

- For Phase 1 the following interim leachate level triggers are proposed:

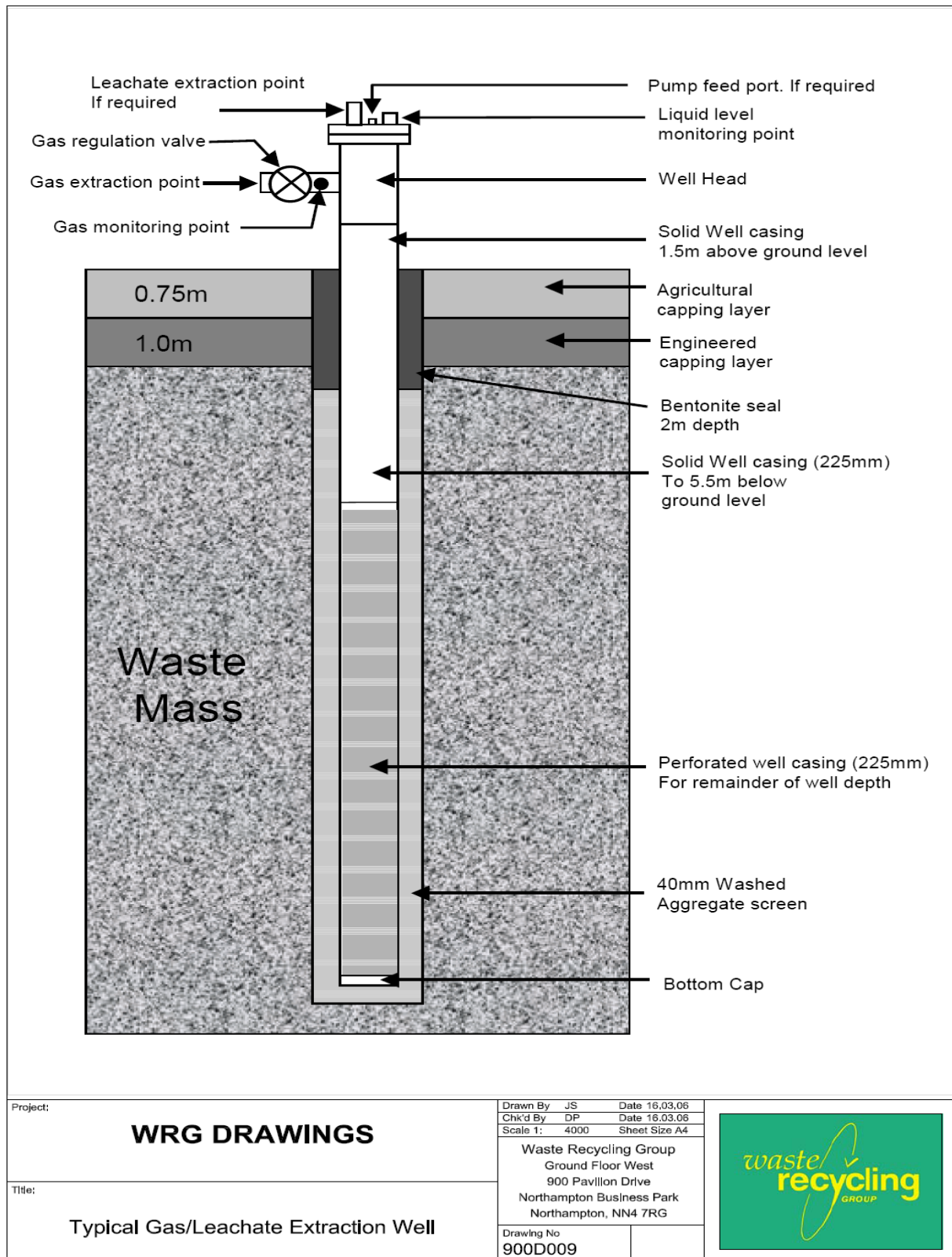
Cell 1C – 160.29m AOD (well PZC1C-1)  
Cell 1C – 160.32m AOD (well PZC1C-2)  
Cell 2A – 158.41m AOD (well PZC2A-1)  
Cell 2A – 159.89m AOD (well LW0082)  
Cell 3A – 157.83m AOD (well LW0091)  
Cell 3A – 158.37m AOD (well LW0101)

An assessment into leachate level monitoring on phase 1 (against the requirements of the permit) is currently underway which may (subject to agency approval) result in changes to these limits.

- For Phase 2, the leachate trigger levels remain the same: 1.5m above the base of the cell for wells on the western side of the landfill and 2m above base of the cell for wells in the east.
- Leachate is currently tankered off site. Future on-site treatment options will be discussed with the Agency.

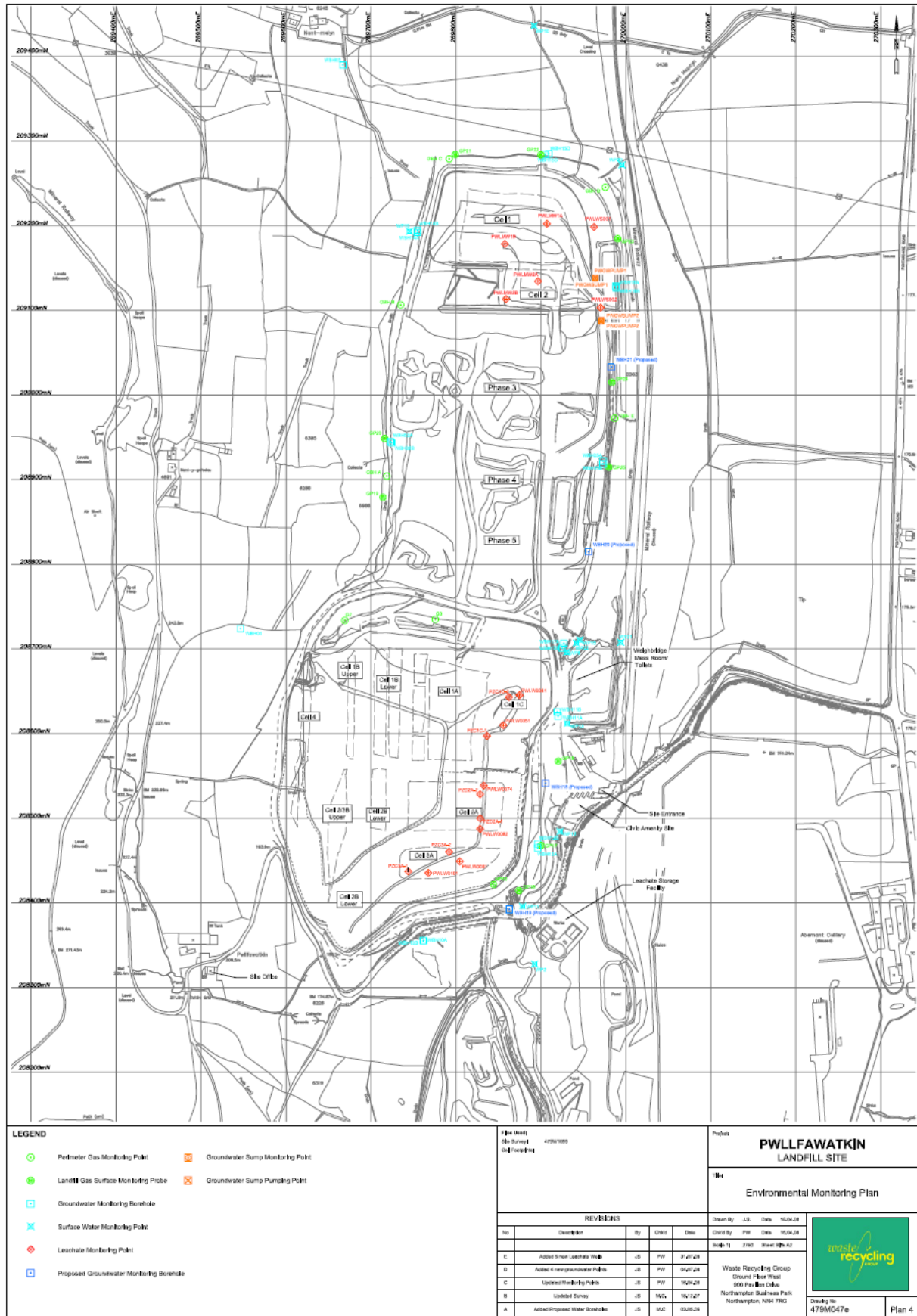
## Appendix A.

### Construction diagram of a typical gas/leachate well.

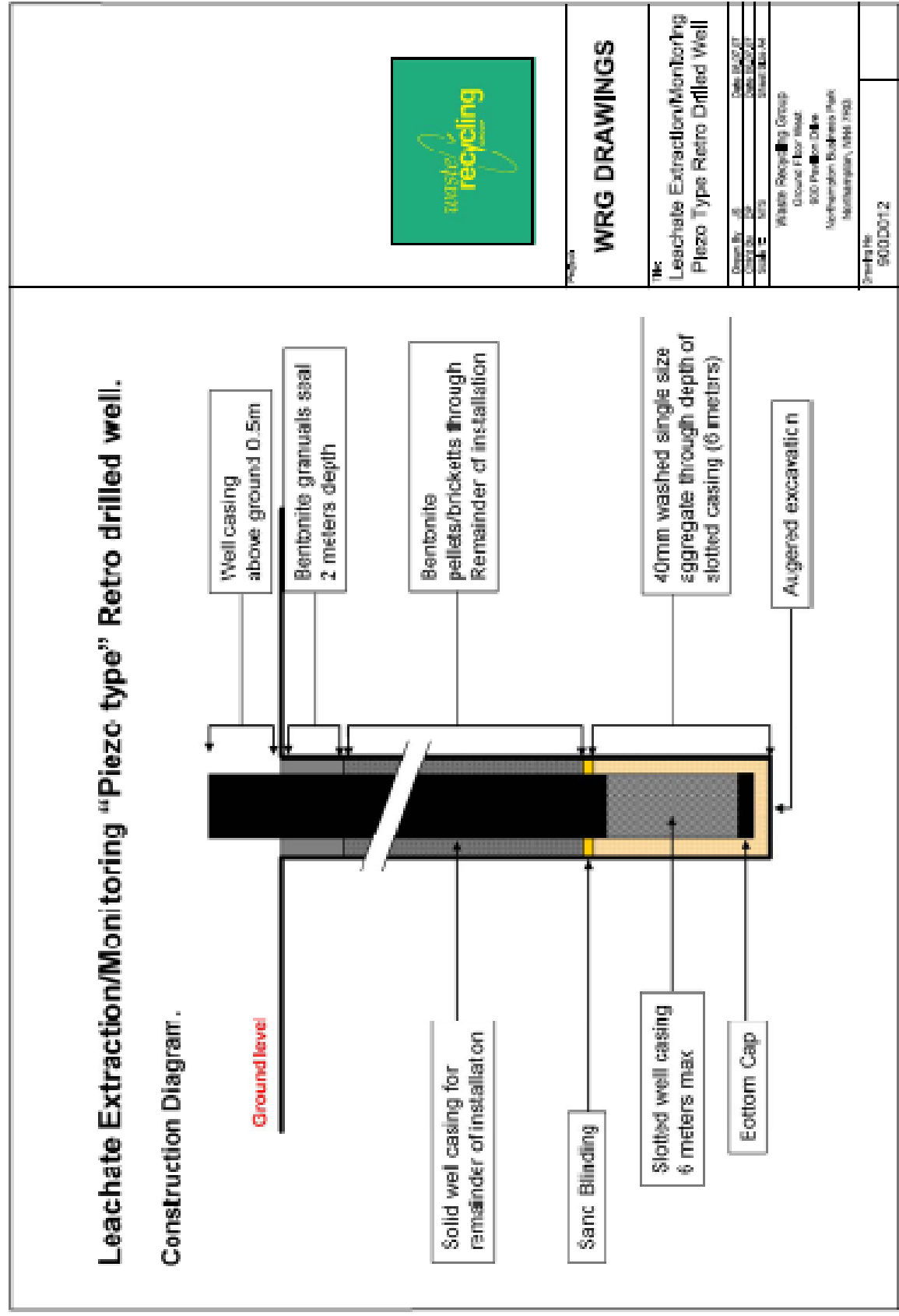


## Appendix B

### Location plan of leachate management infrastructure



**Appendix C.**  
**Typical Construction of a steel type Piezo Well (Phase 1).**





## **Appendix D**

### **Phase 1 – Leachate Well CQA Report**



# **CQA Report for DRILLING OF LEACHATE WELLS At Pwllfawatkin Landfill Site,**

**For**



**November 2007**

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## **1.0 GENERAL**

### **1.1 Introduction**

This CQA report is a document that addresses site responsibilities, authorities and qualifications, inspecting, monitoring and testing activities to ensure that facility construction meets or exceeds design criteria, plans and specifications for Leachate Well installation at Pwllfawatkin Landfill site.

A total of 6 Leachate wells have been drilled.

A surveyor pegged out the well locations and waste depth to basal level was established. Depths were checked by the surveyor and Engineer to ensure the correct stand off from the base. Drilling depths and casing / bentonite installation details were passed on to both the drilling contractor and the CQA Engineer.

The barrel auger contents were also monitored closely, thus ensuring that the strata of the waste could be accurately recorded.

Dated and timed electronic photographs of all parts of the installation are available in JPEG format if required.

## Project Summary Information

|                                       |                                              |
|---------------------------------------|----------------------------------------------|
| WRG Engineer:                         | Dave Parker                                  |
| Surveyor:                             | WRG                                          |
| Drilling Contractor:                  | Magpie Drilling John Clarke lead driller     |
| CQA Engineer:                         | Marcus Holden / Andrew George                |
| Report Author and senior CQA Engineer | Marcus Holden                                |
| Drilling Commencement Date:           | 16.10.07                                     |
| Drilling Completion Date:             | 19.11.07                                     |
| CQA Report Date:                      | Friday, 30 November 2007                     |
| No of wells proposed:                 | 6                                            |
| No of wells installed:                | 6                                            |
| Plant used:                           | Rotary barrel auger 450 mm auger             |
| Rig Manufacturer:                     | Commacio MC3000S                             |
| Other plant:                          | 5 tonne teleporter<br>5 tonne tracked dumper |

# Installation Records

## **2.2 Inspection of materials and competency**

The competencies and qualifications of the drilling contractor were verified together with method statements, risk assessments and equipment testing certificates. The equipment testing certificates for the excavator and dumper were not verified, as it was not deemed critical to the work involved.

The pipe and bentonite were visually inspected. The pipe was confirmed to be 225mm OD SDR 11 DIN specification by the printed marking on the side of the pipe, which was as per specification. Push-fit and screwed caps were to specification.

The gravel annulus was inspected on delivery and found to be to specification.

## **2.3 MC3000S**

The barrel of the unit was 4.8m long including hydraulic ejector . A 5m section of extension pipe was fitted permanently to the ejector, giving a total of 9.8m before extension pipes were required. The extension pipes themselves were 10m sections but were made up on the carousel of the rig at 10m. Therefore, to attain the correct drilling depth the wells were drilled to under the depth by visible means, than a measurement was taken using a tape measure from the relevant marker point to the surface of the waste. The barrel diameter was 450mm.

## **2.4 Sinkage and settlement**

Sinkage can be a problem where the waste is not tightly compacted - drill rigs are often heavy pieces of equipment and the vibrations from the drilling operations can cause the waste to compact, thus altering the depth measurements. Settlement of the waste is also possible, especially with fresh waste mass, and the waste AOD as measured by the surveyor can differ from the actual AOD if a time delay between surveying and drilling is apparent. Both of these phenomena can cause errors in drill depths.

The depths to bottom of well were all witnessed in this drilling operation.

# Drill Log sheets

## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rain                  |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <b>PZC1C-2</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 08-11-07 at 11:00 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 08-11-07 at 13:55 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                       |
| <p>The diagram illustrates the vertical profile of a borehole. At the top, an 'End cap' is shown at an elevation of +0.80 m. A horizontal line indicates the 'Ground level'. The borehole is filled with 'Bentonite' from the ground level down to -14.40 m. Below this, the casing is divided into two sections: a 'Plain' section from -14.40 m to -15.40 m, and a 'Slotted' section from -15.40 m to -21.40 m. The borehole is described as a '450mm borehole with 170mm plain and slotted steel casing'. The bottom of the borehole is sealed with a 'Welded end cap' at an elevation of -21.40 m. The area below the slotted section is labeled 'Gravel'.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Andrew George         |



## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Fine and dry          |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | <b>PZC3A-1</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 31-10-07 at 10:35 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 31-10-07 at 15:10 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |
| <p>The diagram illustrates the vertical profile of borehole PZC3A-1. At the top, an 'End cap' is shown at an elevation of +0.47 m. Below this is the 'Ground level'. The borehole is filled with 'Bentonite' up to a depth of -17.00 m. Below -17.00 m, the casing transitions to 'Plain' (solid) and then 'Slotted' (indicated by horizontal lines) as it descends into a 'Gravel' layer. The casing is described as a '450mm borehole with 170mm plain and slotted steel casing'. The bottom of the borehole is sealed with a 'Welded end cap' at an elevation of -23.99 m. The slotted section of the casing extends from -18.07 m to the bottom at -23.99 m.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Marcus Holden - ECUK  |

## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Fine and dry          |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>PZC3A-2</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 01-11-07 at 11:15 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 01-11-07 at 15:45 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                       |
| <p>The diagram illustrates the vertical profile of a borehole. At the top, an 'End cap' is shown at an elevation of +0.92 m. Below this is the 'Ground level'. The borehole is filled with 'Bentonite' up to a depth of -16.00 m. Below -16.00 m, the casing is divided into 'Plain' and 'Slotted' sections, extending to -17.74 m. The bottom section of the borehole is filled with 'Gravel' and terminates at a 'Welded end cap' at an elevation of -23.68 m. A label on the left indicates a '450mm borehole with 170mm plain and slotted steel casing'.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Marcus Holden - ECUK  |

## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Overcast              |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>PZC2A-1</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 02-11-07 at 09:35 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 02-11-07 at 11:30 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| <p>The diagram illustrates the vertical profile of borehole PZC2A-1. At the surface (+1.00 m), there is an 'End cap'. The ground level is indicated by a horizontal line. Below ground level, the borehole is filled with 'Bentonite' up to a depth of -15.00 m. From -15.00 m to -16.78 m, the casing is 'Plain'. From -16.78 m to the bottom at -22.80 m, the casing is 'Slotted' and surrounded by 'Gravel'. The casing is described as a '450mm borehole with 170mm plain and slotted steel casing'. A 'Welded end cap' is located at the bottom of the borehole at -22.80 m.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Marcus Holden - ECUK  |

## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Fine and dry          |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <b>PZC2A-2</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 06-11-07 at 14:30 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 06-11-07 at 17:00 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |
| <p>The diagram illustrates the vertical profile of the borehole. At the top, an 'End cap' is shown at an elevation of +1.25 m. Below this, the 'Ground level' is indicated by a horizontal line. The borehole is filled with 'Bentonite' from the ground level down to -14.50 m. Below -14.50 m, the casing is divided into two sections: a 'Plain' section from -14.50 m to -15.58 m, and a 'Slotted' section from -15.58 m to the bottom. The casing is labeled as a '450mm borehole with 170mm plain and slotted steel casing'. The bottom of the borehole is marked with a 'Welded end cap' at an elevation of -21.77 m. The area between the slotted casing and the borehole wall is labeled 'Gravel'.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Andrew George         |

## Borehole Construction Record

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Fine and dry          |
| Borehole Reference:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>PZC1C-1</b>        |
| Purpose of Borehole:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Leachate piezometer   |
| Drilling Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MC3000 rig            |
| Date / Time Borehole Installation Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 07-11-07 at 13:05 hrs |
| Date / Time Borehole Installation Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 07-11-07 at 15:45 hrs |
| Borehole Construction Diagram (not to scale)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                       |
| <p>The diagram illustrates the vertical profile of borehole PZC1C-1. At the top, an 'End cap' is shown at an elevation of +0.60 m. Below this, the 'Ground level' is indicated by a horizontal line. The borehole is filled with 'Bentonite' from the ground level down to a depth of -16.50 m. Below -16.50 m, the casing transitions to a 'Plain Slotted' section, which extends to a depth of -17.58 m. Below -17.58 m, the casing is 'Gravel' filled. The borehole terminates at a 'Welded end cap' at a depth of -23.18 m. A label on the left side of the diagram specifies '450mm borehole with 170mm plain and slotted steel casing'.</p> |                       |
| Remarks: See daily records                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Andrew George         |

# Site Diary records

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Gas / leachate wells  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 24-10-07 at 08:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 24-10-07 at 17:10 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>08:30 – 09:20hrs the MC3000-S rig was set up at GW-A, drilling commenced at 09:25hrs.</p> <p>09:25 – 12:20hrs borehole GW-A was advanced to 14.5 mbgl using the 450mm rotary barrel. Waste arisings from GW-A were damp from ground level to 10.0 mbgl. Leachate was observed from 10.0 to 11.0 mbgl, perched on 0.5 m clay. Ground conditions were damp from 11.5 to 14.5 mbgl.</p> <p>12:20hrs installation began at GW-A using 225mm plain and perforated well casings, including the following sections:</p> <ul style="list-style-type: none"> <li>1 x 5.82m (perforated)</li> <li>1 x 2.86m (perforated)</li> <li>1 x 5.84m (plain)</li> <li>1 x 180mm end cap</li> </ul> <p>The total length of well casing was 14.70m, including the end cap addition of 180mm. The length of casing above ground after installation was 0.70m; therefore the depth of GW-A was calculated as 14.00 mbgl.</p> <p>13:00 – 14:00hrs a gravel response zone was installed at GW-A from 14.00 – 4.00 mbgl. A hydrated bentonite seal was added from 4.00 mbgl to ground level. The 225mm borehole casing was sealed above ground using a rubber push-on cap.</p> <p>13:30 – 15:50hrs the MC3000-S rig was tracked to leachate piezometer borehole PZ3A-1.</p> <p>16:05hrs drilling commenced at PZ3A-1 using the 450mm rotary barrel and the following capping sequence was observed:</p> <ul style="list-style-type: none"> <li>G.L. to -0.5m: Clay / topsoil (haul road)</li> <li>-0.5m: Bituminous membrane with geotextile</li> <li>-0.5m to 2.0m: Clay / soil (re-worked boulder clay)</li> <li>-2.0m: Landfill waste</li> </ul> <p>17:00hrs drilling at PZ3A-1 was halted at 9.0 mbgl. The 450mm barrel was left in the borehole, which was sealed around ground level with hydrated bentonite.</p> <p>17:10hrs work was halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Andrew George         |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 25-10-07 at 08:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 25-10-07 at 15:00 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>09:25 – 10:10hrs borehole PZ3A-1 was advanced to 16.0 mbgl using the 450mm rotary barrel. The following borehole observations were recorded, based on visual inspection of waste arisings:</p> <p>G.L. to 9.0 mbgl: damp waste.<br/> 9.0 to 10.0 mbgl: perched leachate on 0.5 m clay / colliery spoil mix.<br/> 10.5 to 13.0 mbgl: damp waste with clay layers.<br/> 13.0 to 14.0 mbgl: perched leachate on 0.5 m clay / colliery spoil mix.<br/> 14.5 to 16.0 mbgl: damp waste with clay layers.</p> <p>10:10 – 12:25hrs 170mm steel casing sections were selected, measured, and brought to the drilling area ready for installation.</p> <p>12:25 – 13:45hrs borehole PZ3A-1 was advanced to 22.0 mbgl using the 450mm rotary core barrel. The following borehole observations were recorded:</p> <p>16.0 to 19.0 mbgl: damp waste.<br/> 19.0 to 19.5 mbgl: perched leachate on clay mixed with damp waste.<br/> 19.5 to 21.0 mbgl: clay mixed with damp waste.<br/> 21.0 to 22.0 mbgl: damp waste.</p> <p>13:45hrs drilling was halted at 22.0 mbgl. The lead driller (John Clarke) advised that the steel pin securing the drill rod to the 450mm barrel mechanism had sheared and the rig would not be operational until a replacement was found. He advised that drilling would resume on Monday 29-10-07.</p> <p>14:00 – 15:00 borehole PZ3A-1 was sealed at ground level.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Andrew George         |



## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Overcast              |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 29-10-07 at 13:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 29-10-07 at 17:00 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>CQA engineer present on site at 13:30hrs. Drillers not on site as they were picking up a replacement barrel from Derby. Drillers arrived 16:45hrs, no work done on site.</p> <p>A note was made of all equipment being used, comprising:<br/>Commacio MC3000S drill rig.<br/>3 tonne wheeled dumper and 5 tonne tracked dumper.<br/>450 rotary barrel used for leachate wells. 1st section including barrel and ejector 9.8m, 5 off rods on the carousel at 10m each.</p> <p>Borehole steel casing diameters were measured at OD = 177mm, ID = 156mm with threaded male and female. Slots burnt in to casing 500mm long x approx 9mm wide, 12 off to each slotted section.</p> <p>Left site 17:00.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Marcus Holden – ECUK  |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 30-10-07 at 08:00 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 30-10-07 at 16:00 hrs |
| Work Supervised and Progress on Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |
| <p>CQA engineer present on site at 8:00am.</p> <p>08:00 – 12:30hrs drillers carried out repairs to the 450mm barrel.</p> <p>12:30 – 13:30hrs the MC3000 rig was tracked to borehole location LPZ3A-1, which had been drilled to 22.0 mbgl on 25-10-07. Relocating the drill rig took considerable time as part of the access haul road had collapsed. 13:30 – 16:00hrs the drillers continued with repairs to the 450mm barrel once the rig was set up at LPZ3A-1.</p> <p>No drilling was performed during the remainder of the afternoon.</p> <p>Left site 16:00.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Marcus Holden – ECUK  |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 31-10-07 at 08:00 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 31-10-07 at 16:00 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>CQA engineer present on site at 08:00hrs.</p> <p>09:00 – 09:50hrs drilling resumed at borehole LPZ3A-1, which had already been drilled to 22.0 mbgl on 25-10-07. By 09:50hrs the borehole was advanced to 24.0 mbgl and considerable amounts of leachate were pulled out of the top of the barrel.</p> <p>10:35hrs installation began at LPZ3A-1 using 170mm threaded steel plain and perforated well casings, including the following sections:</p> <ul style="list-style-type: none"> <li>1 x 2.90m (perforated with welded end cap)</li> <li>1 x 3.02m (perforated)</li> <li>1 x 2.53m (plain)</li> <li>1 x 2.93m (plain)</li> <li>1 x 2.47m (plain)</li> <li>1 x 2.86m (plain)</li> <li>1 x 2.40m (plain)</li> <li>1 x 2.45m (plain)</li> <li>1 x 2.90m (plain)</li> </ul> <p>The total length of well casing was 24.46m, including the flush welded end cap. The length of casing above ground after installation was 0.47m; therefore the depth of LPZ3A-1 was calculated as 23.99 mbgl. 12:00hrs completed installing casing, drillers went for lunch.</p> <p>13:00 – 15:10hrs a gravel response zone was installed at LPZ3A-1 from 23.99 – 17.00 mbgl. A hydrated bentonite seal was added from 17.00 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>15:15hrs the MC3000 rig was moved to well PZC3A-2. Drilling commenced at 15:30hrs using the 450mm rotary barrel. The following visual observations were made during drilling:</p> <ul style="list-style-type: none"> <li>G.L. to 0.5mbgl: clay.</li> <li>0.5m: HDPE cap.</li> <li>0.5 to 12.0m: dry waste.</li> </ul> <p>17:00hrs work was halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Marcus Holden – ECUK  |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 01-11-07 at 08:00 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 01-11-07 at 17:00 hrs |
| <p>Work Supervised and Progress on Site:<br/> CQA engineer present on site at 08:00hrs.</p> <p>08:30hrs drilling resumed at borehole PZC3A-2. 11:00hrs borehole PZC3A-2 was advanced to 23.70 mbgl using the 450mm rotary barrel. The following visual observations were made:<br/> 12.0 to 15.0 mbgl: dry waste.<br/> 15.0 to 15.5 mbgl: wet waste.<br/> 15.5 to 19.0 mbgl: dry waste, with leachate running into the borehole from 15.0m.<br/> 19.0 to 23.6 mbgl: damp waste, with leachate running into the borehole from above.</p> <p>11:15hrs installation began at PZC3A-2 using 170mm threaded steel plain and perforated well casings, including the following sections:<br/> 1 x 2.94m (perforated with welded end cap)<br/> 1 x 3.00m (perforated)<br/> 1 x 2.92m (plain)<br/> 1 x 2.93m (plain)<br/> 1 x 2.32m (plain)<br/> 1 x 2.88m (plain)<br/> 1 x 2.94m (plain)<br/> 1 x 2.83m (plain)<br/> 1 x 0.95m (plain)<br/> 1 x 0.89m (plain)</p> <p>The total length of well casing was 24.60m, including the flush welded end cap. The length of casing above ground after installation was 0.92m; therefore the depth of PZC3A-2 was calculated as 23.68 mbgl. 12:00hrs completed installing casing, the rig was tracked to PZC2A-1 and re-fuelled.</p> <p>12:30 – 15:45hrs a gravel response zone was installed at PZC3A-2 from 23.68 – 16.00 mbgl. A hydrated bentonite seal was added from 16.00 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>15:15 – 16:45hrs borehole PZC2A-1 was advanced to 19.0 mbgl using the 450mm rotary barrel. The following visual observations were made during drilling:<br/> G.L. to 0.5mbgl: clay, HDPE cap at 0.5m.<br/> 0.5 to 19.0m: dry waste, with a minor perched leachate level at 15.0m running in.<br/> 17:00hrs work halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Marcus Holden – ECUK  |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Overcast              |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 02-11-07 at 08:00 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 02-11-07 at 12:00 hrs |
| <p>Work Supervised and Progress on Site:<br/> CQA engineer present on site at 08:00hrs.</p> <p>08:30hrs drilling resumed at borehole PZC2A-1. 09:25hrs borehole PZC3A-2 was advanced to 22.80 mbgl using the 450mm rotary barrel. The following visual observations were made:<br/> 19.0 to 20.0 mbgl: damp waste with leachate running into the borehole from above.<br/> 20.0 to 22.8 mbgl: wet waste to final depth.</p> <p>09:35hrs installation began at PZC2A-1 using 170mm threaded steel plain and perforated well casings, including the following sections:<br/> 1 x 2.82m (perforated with welded end cap)<br/> 1 x 3.20m (perforated)<br/> 1 x 2.39m (plain)<br/> 1 x 2.41m (plain)<br/> 1 x 2.36m (plain)<br/> 1 x 2.89m (plain)<br/> 1 x 2.93m (plain)<br/> 1 x 2.96m (plain)<br/> 1 x 0.92m (plain)<br/> 1 x 0.92m (plain)</p> <p>The total length of well casing was 23.80m, including the flush welded end cap. The length of casing above ground after installation was 1.00m; therefore the depth of PZC2A-1 was calculated as 22.80 mbgl. 12:00hrs completed installing casing, the rig was tracked to PZC2A-1 and re-fuelled.</p> <p>10:20 – 11:30hrs a gravel response zone was installed at PZC2A-1 from 23.80 – 15.00 mbgl. A hydrated bentonite seal was added from 15.00 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>12:00hrs work halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Marcus Holden – ECUK  |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                            |                       |
| Client / Site:                                                                                                                                                                                                                     | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                | Fine a.m. rain p.m.   |
| Purpose of Work:                                                                                                                                                                                                                   | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                    | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                   | 05-11-07 at 09:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                 | 05-11-07 at 16:30 hrs |
| Work Supervised and Progress on Site:                                                                                                                                                                                              |                       |
| <p>14:45hrs drillers arrived on site. The MC3000 rig was tracked to borehole location PZC2A-A and set up at the marker peg; however heavy rain prevented drilling operations from commencing.</p> <p>16:30hrs work was halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                          | Andrew George         |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 06-11-07 at 08:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 06-11-07 at 17:15 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>09:15 – 14:25hrs borehole PZC2A-2 was advanced to 21.80 mbgl using the 450mm rotary barrel. The following borehole observations were recorded, based on visual inspection of waste arisings:</p> <p>G.L. to 0.5 mbgl: clay/topsoil.<br/> 0.5 mbgl: geotextile layer and plastic capping membrane.<br/> 0.5 to 1.0 mbgl: clay.<br/> 1.0 to 15.0 mbgl: damp waste.<br/> 15.0 to 16.0 mbgl: perched leachate on 0.5m firm clay and waste.<br/> 17.5 to 18.5 mbgl: perched leachate on 1.0m firm clay and waste.<br/> 19.5 to 21.80 mbgl: saturated waste.</p> <p>14:30hrs installation began at PZC2A-2 using 170mm threaded steel plain and perforated well casings, including the following sections:<br/> 1 x 2.97m (perforated with welded end cap)<br/> 1 x 3.22m (perforated)<br/> 1 x 2.58m (plain)<br/> 1 x 2.94m (plain)<br/> 1 x 2.99m (plain)<br/> 1 x 3.00m (plain)<br/> 1 x 2.32m (plain)<br/> 1 x 3.00m (plain)</p> <p>The total length of well casing was 23.02m, including the flush welded end cap. The length of casing above ground after installation was 1.25m; therefore the depth of PZC2A-2 was calculated as 21.77 mbgl.</p> <p>15:35hrs the MC3000 rig was relocated to borehole location PZC1C-1 and set up at the marker peg.</p> <p>16:10 – 17:00hrs a gravel response zone was installed at PZC2A-2 from 21.77 – 14.50 mbgl. A hydrated bentonite seal was added from 14.50 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>17:15hrs work was halted</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Andrew George         |

## Daily Site Record Journal

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| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Fine and dry          |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 07-11-07 at 08:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 07-11-07 at 16:45 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>08:35 – 12:55hrs borehole PZC1C-1 was advanced to 23.20 mbgl using the 450mm rotary barrel. The following borehole observations were recorded, based on visual inspection of waste arisings:</p> <p>G.L. to 1.0 mbgl: clay/topsoil.<br/> 1.0 mbgl: geotextile layer and plastic capping membrane.<br/> 1.0 to 20.0 mbgl: dry waste.<br/> 20.0 to 23.20 mbgl: damp waste with firm clay.</p> <p>No leachate was observed during drilling.</p> <p>13:05hrs installation began at PZC1C-1 using 170mm threaded steel plain and perforated well casings, including the following sections:<br/> 1 x 2.78m (perforated with welded end cap)<br/> 1 x 2.82m (perforated)<br/> 1 x 3.10m (plain)<br/> 1 x 3.00m (plain)<br/> 1 x 3.10m (plain)<br/> 1 x 3.10m (plain)<br/> 1 x 2.97m (plain)<br/> 1 x 2.91m (plain)</p> <p>The total length of well casing was 23.78m, including the flush welded end cap. The length of casing above ground after installation was 0.60m; therefore the depth of PZC1C-1 was calculated as 23.18 mbgl.</p> <p>13:05 – 15:45hrs a gravel response zone was installed at PZC1C-1 from 23.18 – 16.50 mbgl. A hydrated bentonite seal was added from 16.00 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>13:45hrs the MC3000 rig was relocated to borehole location PZC1C-2 and set up at the marker peg. 13:50 – 16:30hrs borehole PZC1C-2 was advanced to 10.0 mbgl using the 450mm rotary barrel. A geotextile membrane and plastic capping layer was noted at 0.5 mbgl beneath a temporary clay cover. Waste was dry to 10.0 mbgl.</p> <p>16:45hrs work was halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Andrew George         |



## Daily Site Record Journal

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| Project / CQA Plan Ref:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                       |
| Client / Site:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Pwllfawatkin Landfill |
| Weather Conditions:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Rain                  |
| Purpose of Work:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Leachate piezometers  |
| Equipment Used:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MC3000 rig            |
| Date / Time Supervision Started:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 08-11-07 at 08:30 hrs |
| Date / Time Supervision Completed:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 08-11-07 at 16:00 hrs |
| <p>Work Supervised and Progress on Site:</p> <p>09:00 – 10:30hrs borehole PZC1C-2 was advanced to 21.40 mbgl using the 450mm rotary barrel. The following borehole observations were recorded, based on visual inspection of waste arisings:</p> <p>G.L. to 16.0 mbgl: damp waste.<br/> 16.0 to 17.0 mbgl: perched leachate on 1.0m firm clay and waste.<br/> 18.0 to 19.0 mbgl: perched leachate on 1.0m firm clay and waste.<br/> 20.0 to 21.40 mbgl: damp waste (not saturated) with firm clay.</p> <p>11:00hrs installation began at PZC1C-2 using 170mm threaded steel plain and perforated well casings, including the following sections:<br/> 1 x 3.00m (perforated with welded end cap)<br/> 1 x 3.00m (perforated)<br/> 1 x 2.98m (plain)<br/> 1 x 2.95m (plain)<br/> 1 x 2.47m (plain)<br/> 1 x 3.00m (plain)<br/> 1 x 2.89m (plain)<br/> 1 x 1.91m (plain)</p> <p>The total length of well casing was 22.20m, including the flush welded end cap. The length of casing above ground after installation was 0.80m; therefore the depth of PZC1C-2 was calculated as 21.40 mbgl.</p> <p>12:30 – 13:55hrs a gravel response zone was installed at PZC1C-2 from 21.40 – 14.40 mbgl. A hydrated bentonite seal was added from 14.40 – 2.00 mbgl using bentonite pellets. A hydrated bentonite seal was added from 2.00 mbgl to ground level using bentonite granules. The 170mm steel borehole casing was sealed above ground using a plastic push-on cap.</p> <p>14:00 – 14:30hrs the MC3000 rig was relocated to gas borehole location GW-G and set up at the marker peg. 14:45 – 15:45hrs borehole GW-G was advanced to 10.0 mbgl using the 450mm rotary barrel. A geotextile membrane and plastic capping layer was noted at 0.5 mbgl beneath a temporary clay cover. Waste was dry to 5.0 mbgl.</p> <p>16:00hrs work was halted.</p> |                       |
| CQA Supervising Engineer:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Andrew George         |



# General and technical Specification Used

## **Construction Quality Assurance (CQA) Plan**



### **1. Introduction**

### **2. Detail of the Proposed Gas/Leachate Extraction Wells**

### **3. Supervision and Record Keeping**

### **4. Reporting**

#### **Appendix A**

**Proposed Drilling Data.**

#### **Appendix B**

**Well Construction Diagram.  
Drawing No 900D012**

#### **Appendix C**

**Well Construction Diagram.  
Drawing No 900D015**

#### **Appendix D**

**Well location Drawing.  
Drawing No 479A214**

**A Construction Quality Assurance (CQA) Plan for the Installation of additional Leachate extraction/monitoring points at Pwllfawatkin Landfill Site beginning in October 2006.**

**1. Introduction**

- 1.1 Pwllfawatkin landfill site has a number of Leachate level monitoring wells in accordance with Permit No. BU88191V, a number of these wells have become un-monitorable due to collapse and it is proposed that these wells are re-drilled to enable Leachate monitoring.
- 1.2 It is proposed that 6 vertical leachate extraction/monitoring wells are to be installed at the Site in accordance with Permit No. BU88191V. It is necessary to submit to the Environment Agency a Construction Quality Assurance Plan (CQA) for the installation of the wells to comply with the PPC Permit.
- 1.3 This document presents details of the proposed leachate extraction/monitoring wells including the method of installation of the wells, the measures for the control of nuisance during installation, proposals for the supervision of the installation, record keeping and reporting.

**2. Detail of the Proposed Gas/Leachate Extraction Wells**

- 2.1 6 leachate extraction/monitoring wells will be installed at the site at the approximate locations shown in appendix C drawing reference 479A214. This is to comply with Permit No BU88191V.
- 2.2 All wells will be drilled to within 1 metre of the pit base to comply with PPC Permit No BU88191V.
- 2.3 Prior to the commencement of drilling the location of each of well will be surveyed in and the ground level will be recorded relative to meters Above Ordnance Datum (mAOD). The location of each well will be identified with a wooden peg following surveying. The level of the base of the site below each proposed well location will be estimated from historic records and the maximum drilling depth of each well will be calculated. A record of the drilling depth will be maintained during drilling and the maximum drilling depth will not be exceeded.  
Due to the locations of the drilling operation at Pwllfawatkin, the exact location can only be identified when the drillers are on site for reasons of access and rig suitability.
- 2.4 The wells will be drilled using a rotary barrel auger to a calculated depth 2m above the pit base. To achieve the additional depth of 1m to comply with the requirement to achieve a depth of 1 metre above pit base, a probe drill head will be used to advance the additional meter in small increments to avoid damage to the pit base liner. Once the required depth has been achieved the barrel auger will once again be used to remove the waste.

- 2.5 The drilling technique will be dependant on the waste and the behaviour of the stability of the excavated well hole.

**Scenario 1.** The waste is stable and does not collapse within the well.

All of the wells will be drilled to a minimum diameter of 350mm and cased with 219mm diameter perforated steel pipe through the first 6 meters from the bottom of the well. The upper part of the casing will be plain 219mm steel pipe for a minimum of 5.5m. The annular space round the perforated casing will be filled with minimum diameter 20mm fines free, non-calcareous gravel. The annular space round the plain casing will be sealed with bentonite.

See Appendix B. Well Construction Diagram. Drawing No 900D012

**Scenario 2.** The waste is unstable and collapse within the well is evident.

All of the wells will be drilled to a minimum diameter of 450mm and cased with 406mm steel casing through 80% of the excavation this is to prevent waste collapse. The 350mm auger will then be used inside the outer casing to excavate the remainder of the well. 219mm diameter perforated steel pipe through the first 6 meters from the bottom of the well. The upper part of the casing will be plain 219mm steel pipe for a minimum of 5.5m. The annular space round the perforated casing will be filled with minimum diameter 20mm fines free, non-calcareous gravel. The annular space round the plain casing will be sealed with bentonite.

See Appendix C. Well Construction Diagram. Drawing No 900D015

- 2.6 The plain MDPE or steel pipe in each well will extend approximately 0.5m above ground level and will be completed with a gas/leachate extraction well head which will facilitate connection of the well to the gas/leachate extraction system at the site if required. The wellhead will incorporate monitoring ports, which will facilitate gas and leachate monitoring. Valves to control the flow of gas from the well will be provided. The monitoring ports will be located on the well side of the control valves.

See Appendix B. Well Construction Diagram. Drawing No 900D012

And/or

See Appendix C. Well Construction Diagram. Drawing No 900D015

- 2.7 Due to the waste types deposited previously at the site there is a risk of odour nuisance during the installation of the wells. Measures will be taken during the installation of the wells to ensure that the risk of odour nuisance is minimised. Only one well will be drilled at any one time. All wells are completed and sealed by the end of the working day. During drilling waste recovered from the well will be removed as soon as possible for disposal. No waste will be stored adjacent to a well overnight. Crowcon Triple Plus or similar instruments will be in constant use monitoring  $\text{H}_2\text{S}$ ,  $\text{CH}_4$ ,  $\text{CO}_2$  and  $\text{O}_2$ .

- 2.8 Following the completion of the installation of the wells the location of each well will be surveyed at ground level and the level of the top of the wellhead relative to mAOD. The location of the wells will be shown on a scale drawing.

**3. Supervision and Record Keeping**

- 3.1 The installation of the wells will be supervised on a full time basis by a nominated third party supervisor who will keep a detailed record of all site works.
- 3.2 A detailed drilling record will be kept during the installation of the wells.

**4. Reporting**

- 4.1 Following the completion of the installation of the wells a Validation Report summarising the installation of the wells will be prepared and submitted to the Environment Agency. The report will be submitted within 1 month of the completion of the works.
- 4.2 The Validation Report will include a drilling record for each of the wells showing the results of the drilling, the installed casing detail and the depth of each well relative to ground level at mAOD. A scale drawing showing the location of each of the wells. Photographs will be included where appropriate.

**Appendix A****Proposed Drilling Data.****PWLLFAWATKIN PROPOSED GAS WELL LOCATIONS**

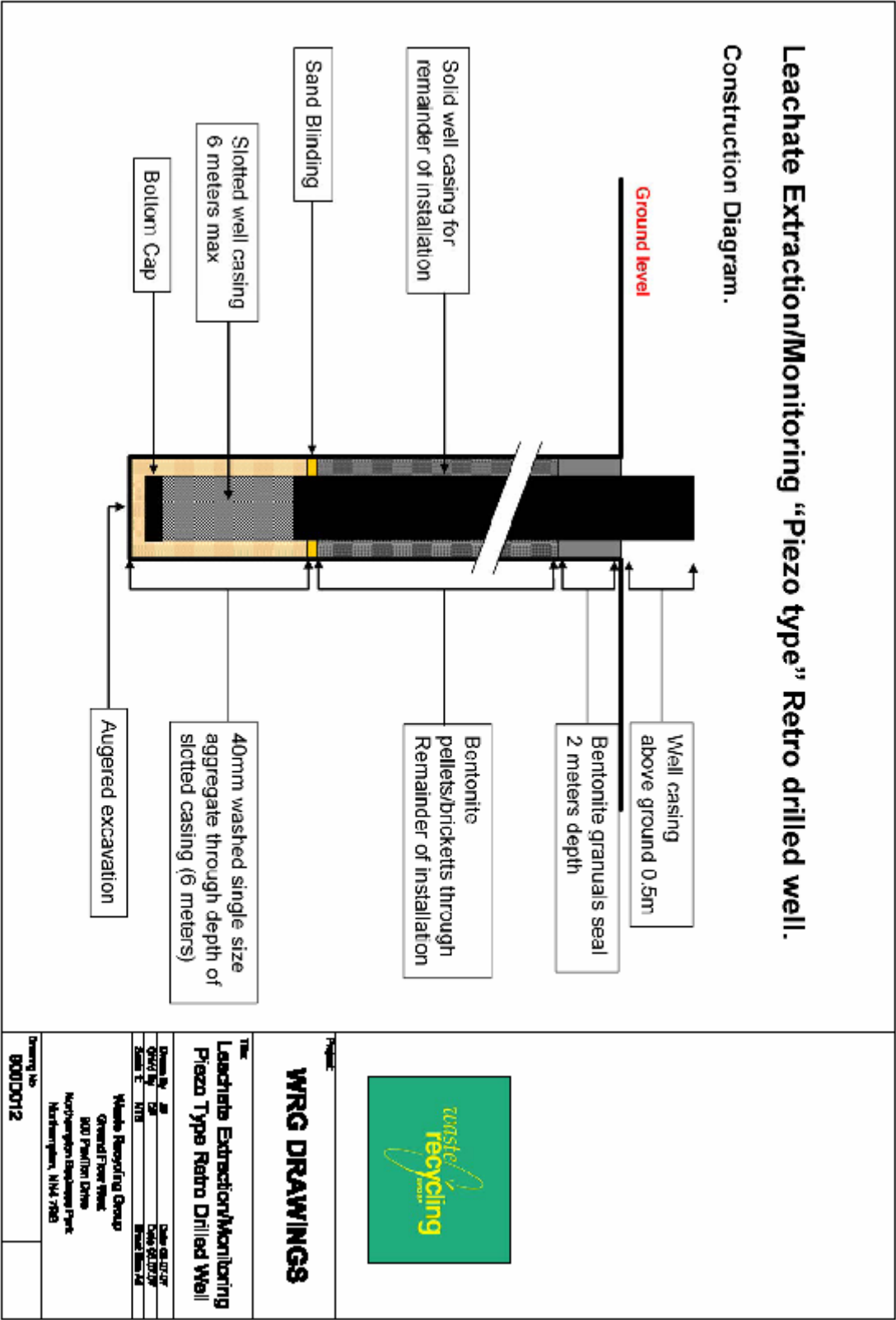
| <b>I.D.</b>    | <b>EASTING</b> | <b>NORTHING</b> | <b>Ground<br/>Level</b> | <b>Base<br/>Level</b> | <b>PIT<br/>BASE</b> | <b>Drill<br/>Depths<br/>to Probe</b> | <b>Drill<br/>Depths</b> |
|----------------|----------------|-----------------|-------------------------|-----------------------|---------------------|--------------------------------------|-------------------------|
| <b>PZ1C-2</b>  | 269860.382     | 208645.053      | 180.000                 | 157.315               | 22.685              | 20.685                               | 21.685                  |
| <b>PZC1C-1</b> | 269836.892     | 208596.891      | 180.000                 | 156.997               | 23.003              | 21.003                               | 22.003                  |
| <b>PZC2A-2</b> | 269828.516     | 208533.212      | 180.000                 | 157.553               | 22.447              | 20.447                               | 21.447                  |
| <b>PZC2A-1</b> | 269827.955     | 208495.046      | 180.000                 | 155.495               | 24.505              | 22.505                               | 23.505                  |
| <b>PZC3A-2</b> | 269797.635     | 298459.686      | 180.000                 | 155.483               | 24.517              | 22.517                               | 23.517                  |
| <b>PZC3A-1</b> | 269744.576     | 208431.623      | 180.000                 | 155.589               | 24.411              | 22.411                               | 23.411                  |



Appendix B

Well Construction Diagram.

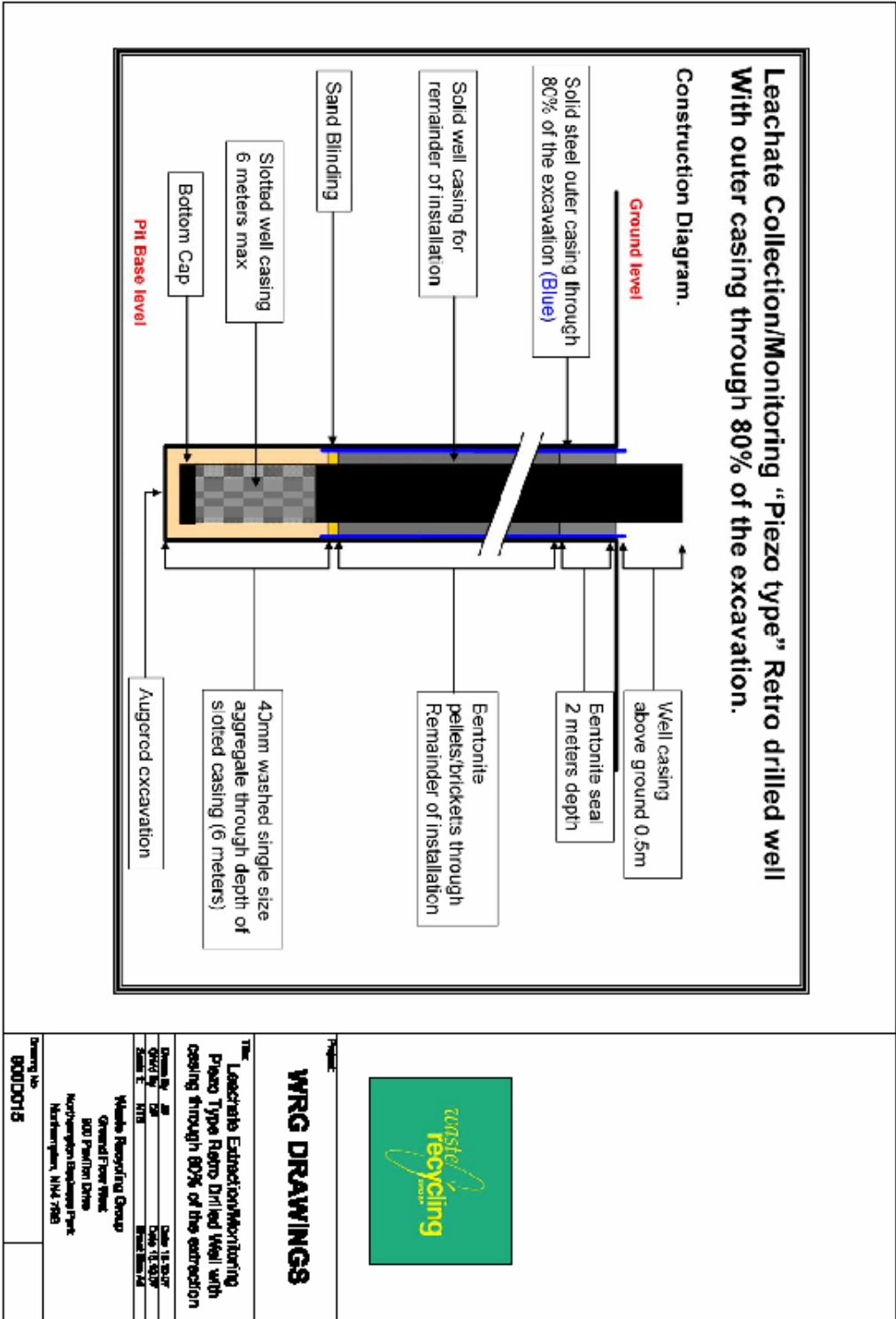
Drawing No 900D012



Appendix C

Well Construction Diagram.

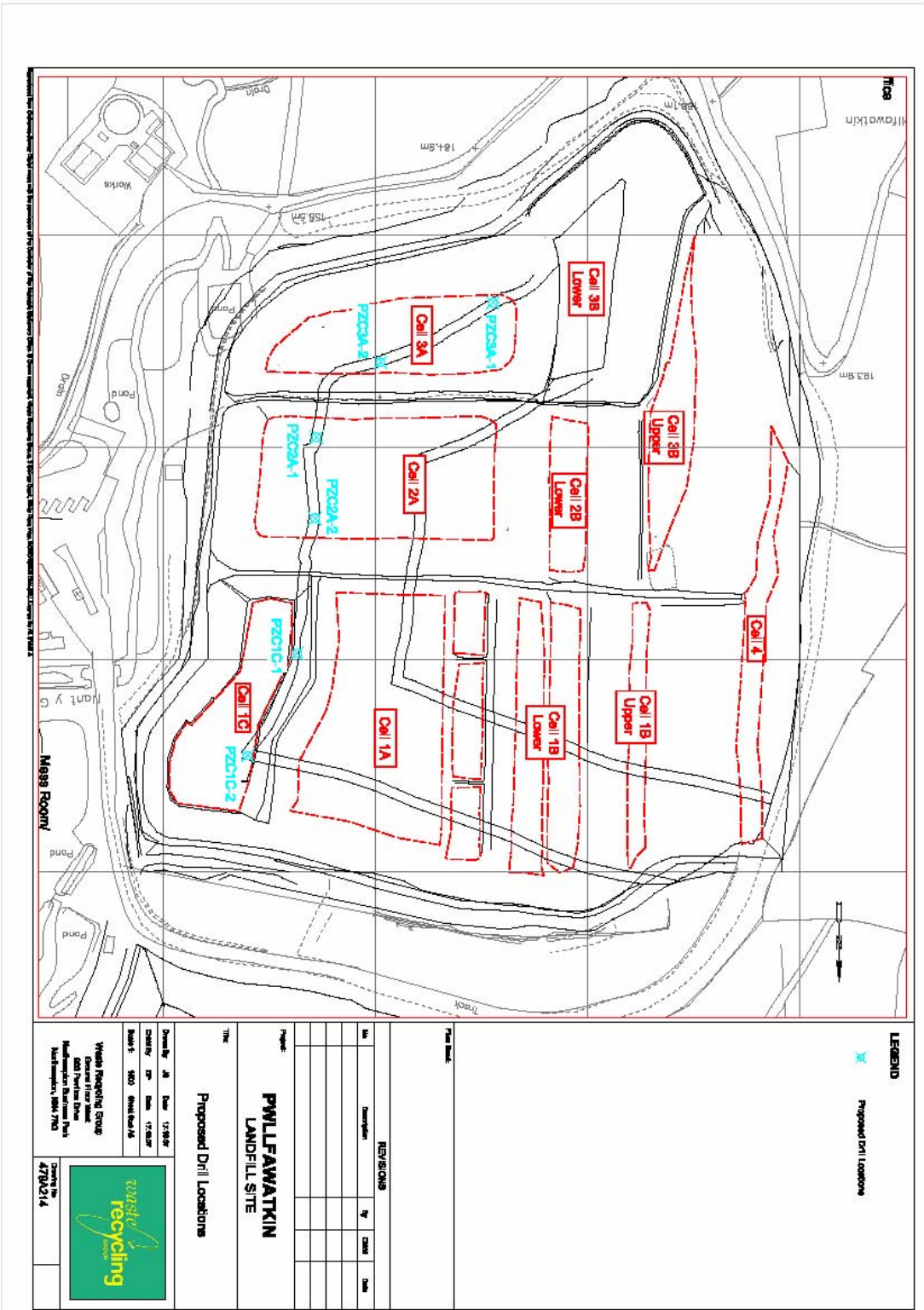
Drawing No 900D015



Appendix D

Well location Drawing.

Drawing No 479A214



# Selection of photographs taken

Note – a full list of dated and timed JPEG photographs has been supplied to WRG with this report, all photographs have not been included as it would make the report unnecessarily large

## General photos







## PZC1C-2













## PZC2A1



















## PZC3A1











## PZC3A2











