Providing Ground Solutions

Waverley Borough Council

Weydon Lane Landfill, Farnham

Updated site maintenance and management plan

August, 2014

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EXECUTIVE SUMMARY

Card Geotechnics Limited) was commissioned by Waverley Borough Council to complete an assessment of the former landfill located off Weydon Lane in Farnham. The assessment included reviewing the feasibility and development potential for the site for a number of possible development options and producing a maintenance and management plan to allow the site to remain as informal, or become formal, public open space.

This report forms the maintenance and management plan for the site. The plan has been divided into the requirements recommended in the short, medium and long term and details are summarised in the table presented in Appendix A.

In summary the requirements include:

1. Additional gas and groundwater monitoring;
2. Surface emission monitoring;
3. Inspections, re-levelling and augmentation of the clay cap, as required;
4. Managing and maintenance of the vegetation to ensure that the vent trench is not further covered/blocked;
5. Ecology surveys;
6. Drainage/control of surface run-off;
7. Producing a DSEAR (Dangerous Substance and Explosive Atmospheres Regulations) assessment.

1. INTRODUCTION

Card Geotechnics Limited (CGL) was commissioned by Waverley Borough Council (WBC) to complete an assessment of the former landfill located off Weydon Lane in Farnham. The scope of works included assessment of the feasibility and development potential for the site for a number of possible development options. In addition, a maintenance and management plan is also to be produced to allow for the site remain as informal public open space. CGL has also produced an updated summary and data review report[1] for the site, which included a review of the various investigations and reports that have been completed previously for the site.

This report provides an assessment of the site and provides long term maintenance and management requirements, including an indication of timescales, for on-going use as public open space. The report includes:

- Feasibility for use of the site as an informal public open space;
- Assessment of settlement impact on the clay cap and implications;
- Assessment of risks associated with ponded standing water;
- Assessment of the need for near surface gas monitoring;
- Long term maintenance requirements for the existing vent trench and ecological implications;
- Recommendations for additional investigation/survey work; and
- A formal gas management plan.

[1] Card Geotechnics Limited (2014). *Updated summary of data review and site walkover, Weydon Lane Landfill, Farnham*. CG5934. July 2014.

2. SITE CONTEXT

2.1 General

Various investigations and reports have previously been completed for the site including the following:

- Card Geotechnics Limited, 2013 Ground Gas Monitoring Report, Weydon Lane Landfill, Farnham. CG/5934A. July 2013
- Card Geotechnics Limited, Land development feasibility report, Weydon Land Landfill, Farnham. CG/5934. April 2012[2]
- Card Geotechnics Limited, Preliminary summary report on report review and site walkover, Weydon Land Landfill, Farnham. CG/5934. March 2012
- Card Geotechnics Limited, Site maintenance and management plan, Weydon Land Landfill, Farnham. CG/5934. March 2012
- Ground-Gas Solutions Ltd, GGS DataPack, Weydon Lane Landfill, Farnham. GGS187/DP. October 2011
- Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Further Gas Monitoring. 0001-UA003194-GDR-01. March 2011
- Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Further Gas Monitoring. 0110-GD00720-GDR-AO. May 2009
- Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Further Gas Monitoring. 0106-GD00720-GDR-AO-2. February 2009
- Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Groundwater and Human Health Assessment, Ground Investigation and Interpretation. 0001-GD00720-GDR-02. August 2008.

[2] Card Geotechnics Limited (2012). *Land development feasibility report, Weydon Lane Landfill, Farnham*. CG5934. March 2012.

- Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Landfill Gas Assessment of Adjacent Residential Properties, Landfill Gas Assessment Report. 0001-GD00720-GDR-02. March 2007
- Hyder Consulting (UK) Ltd. RPS Report Non-Technical Summary, October 2006
- RPS Planning Transport and Environment. Final Environmental Site and Risk Assessment Report at Weydon Lane, Farnham, Surrey. JER2963. August 2006
- Card Geotechnics Ltd. Weydon Lane, Review of construction options for recreational facilities. CG/4053. May 2005.
- RPS Planning Transport and Environment. Environmental Site Report, Weydon Lane, Farnham, Surrey. Revision 1. JER 2963. February 2005[3].
- Environmental Safety Group. An investigation of methane concentrations in and around a landfill site at Weydon Lane, Farnham, Surrey. May 1982.[4]

The full reports should be reviewed for detailed information; however, a summary of the reports is provided in the CGL preliminary summary report[1] and pertinent information is provided below.

2.2 Site location and description

A site walkover was conducted by CGL on 25 June 2014. At that time, the site was used as an informal public open space, which the surrounding residents used primarily for dog walking and jogging. The site was generally overgrown with tall grass and a variety of trees/shrubs, with a footpath around the perimeter of the site.

The ground level at the site dropped from south to north and the surface of the site was undulating. In some areas, generally within the centre and south of the site several depressions were noted, which have previously been observed to contain ponded water. It is understood from WBC that during wetter weather conditions a large area of surface ponding occurs. Reeds were noted within these areas indicating that wetter ground conditions have occurred previously and over an extended period of time.

A gravel trench approximately 1m wide was located along the boundaries of the site. The

[3] A copy of the RPS 2005 report was not available for review, however it is understood that information from this report has been incorporated into the 2006 RPS report.
[4] Text unclear.

majority of the trench was covered at the surface by overgrown vegetation including brambles and nettles. The trench was only visible where footpaths crossed it along the eastern and south western boundaries.

The site appeared to be generally free of fly tipping; however, grass cuttings (likely to be from the adjacent residential properties) were noted along the eastern boundary.

The site was bounded by Weydon Lane to the north, residential properties to the west and east and Upper Way to the south. Residential properties were located beyond the roads to the north and south of the site.

The site location plan and site layout plan are presented in Figures 1 and 2, respectively. Photographs taken at the time of the walkover survey are provided within the July 2014 summary report[1].

2.3 Ground conditions – Geology, hydrogeology and hydrology

The previous investigations within the site boundary identified the following ground conditions:

- Topsoil/capping – 0.8m to 3m thick (mix of granular and cohesive soils)
- Landfill material – Proven to between 7.2mbgl and 14.7mbgl
- Folkestone Formation – Thickness not proven (silty slightly gravelly sand/sandstone; occasional pockets of silt and clay)
- Groundwater – level at approximately 16mbgl within the Folkestone Formation. Leachate and perched groundwater was also encountered within the landfill material.

The Folkestone Formation is classified as a Principal Aquifer; however, the site is not located within a groundwater source protection zone. The closest groundwater abstraction point is at the Bourne Pumping Station approximately 1km to the south east of the southern site boundary. The closest surface water receptor is the River Wey, which is located approximately 200m to the north of the site.

2.4 Historical development

The site lies in an area where historically gravel pits have been worked. Gravel extraction at the site started in the mid-1930s. It is understood that landfilling commenced at the site in 1972 and was completed in 1981. A mixture of waste was landfilled including commercial, inert and domestic waste; including putrescible waste. The site was restored to grass land in about 1986 and has been under the management of Waverley Borough Council since then.

2.5 Previous investigations and reports

2.5.1 RPS, Hyder Consulting and GGS reports

Various phases of ground investigations have been completed at the site and in the surrounding area since the landfill was closed in the 1980s.

In the early 1980s investigations and monitoring identified elevated gas concentrations in the back gardens of residential properties at Pilgrim Close (western boundary). A trial venting trench was installed along the western boundary, which appeared to be successful in reducing gas concentrations. As a result, in 1984 a venting trench was installed around the entire site perimeter. Construction details are unclear for the full trench but they are likely to have been similar to the details for the trial trench, which included a 1m wide trench 5m in depth filled with uniformly graded stone with a perforated pipe in the base.

The investigations and assessments completed by RPS and Hyder Consulting (Hyder) indicated that soil, leachate and groundwater concentrations pose a low risk to human health (based on the end use as open space) and a low risk to controlled waters. A hotspot of lead was recorded in shallow soils (<0.2m bgl) in one location. It is understood from the Hyder 2008 report that some large assumptions were used in the detailed quantitative risk assessment for controlled waters, particularly the groundwater flow direction. However, according to the report (and supported by discussions with WBC), the Environment Agency considered further investigations to reduce the uncertainties would be desirable but not essential.

Elevated methane and carbon dioxide concentrations were encountered within the landfill. Monitoring undertaken by Hyder in March 2011 indicated: maximum carbon dioxide = 17.9%, maximum methane = 38.5%, maximum flow = 0.1l/hr. Monitoring of boreholes within the gardens of the residential properties in November 2008 recorded lower soil gas

concentrations and flow rates (maximum carbon dioxide = 4.8%, maximum methane = 0.2%, maximum flow = 1.3 l/hr). Based on the off-site monitoring at the adjacent residential properties, the risk to residents from soil gas migrating from the landfill was considered to be low and no retrospective gas protection measures are considered necessary.

Figures 3a and 3b present the exploratory hole locations from the RPS and Hyder investigations, respectively.

In addition to works within the site, monitoring was completed by Hyder at 29 standpipes within the gardens of the adjacent residential properties at weekly basis, for 6 weeks, between November 2006 and January 2007. Further monitoring rounds were undertaken in August 2007 and November 2008. These monitoring rounds indicated that generally near normal oxygen concentrations were detected off-site, with low carbon dioxide (<5%) and methane concentrations (<1%), and the risk to occupants was considered to be low. Therefore, it was agreed with WBC at the time that no further monitoring would be required as sufficient data was available from boreholes outside the gas venting trench.

2.5.2 CGL reports

Monitoring by CGL at selected boreholes at the site in March 2012, July 2013 and June 2014 recorded generally similar elevated soil gas concentrations within the landfill (maximum methane: 71.1%; maximum carbon dioxide: 26.6%) and relatively low flow rates (maximum 4 l/hr). It was noted during the June 2014 monitoring visit that only two of the monitoring wells outside of the vent trench could be found due to overgrown vegetation.

CGL has previously undertaken feasibility assessments for potential development options for the site in 2005 and 2012. The reports concluded that the two options considered (tennis courts, bowling greens and pavilion buildings in 2005 and sports pitches with pavilion in 2012) were feasible and provided recommendations to address potential risks associated with settlement, soil gas and to protection human health and controlled waters. It was also recommended that the existing cap be augmented to a depth of 1m with suitable cohesive material and a growth medium.

3. ASSESSMENT

3.1 Feasibility for use as informal public open space

Based on the information obtained from the previous investigations at the site it is considered feasible for the continued use of the site as an informal/formal public open space.

Human heath assessments of soil contaminants have been completed by RPS and Hyder. The assessments reported that, although an isolated elevated concentration of lead was recorded within the shallow soils, this was not considered to be representative of the shallow soils beneath the site and was potentially an isolated occurrence. It was concluded that the risk to human health and controlled waters is low. It has been assumed that these assessments, including the generic assessment criteria and site specific criteria derived, have been approved by WBC.

Over a 10 year period (although not at regular intervals and not consistently at the same locations) 19 rounds of gas monitoring have been conducted at boreholes across the site. Recent monitoring has shown that although soil gas concentrations are still relatively high (maximum carbon dioxide at approximately 20% and maximum methane between approximately 30-70%), flow rates are generally low (typically <0.1 / 0 l/hr; maximum of 4 l/hr recorded in 2012). On this basis the soil gas regime has been classified as Characteristic Situation 3[5]. This classification system is not specifically applicable to public open space and is generally applied for the selection of appropriate gas protection measures when considering the presence of buildings where soil gases can accumulate beneath a structure. With the open space end use the risk of accumulation of soil gases is considered to be low given the open nature and ventilation available. The soil gas concentrations above also relate to monitoring points that have been installed into the landfill material and not surface emissions. Very limited monitoring by CGL in 2012 indicated that no significant soil gas concentrations have been detected at the surface through the landfill cap (carbon dioxide concentration of 0.2%, volatile organic compound concentrations between 0ppm and 3ppm, no methane detected).

For the continued use as open space the following is required and these are discussed in further detail below and the proposed strategy is presented in Section 4:

[5] CIRIA. *Assessing risks posed by hazardous ground gases to buildings*. C665. 2006

1. Gas and groundwater monitoring;
2. Monitoring and augmenting of the clay cap;
3. Assessment of ecological issues;
4. Maintenance of ventilation trench;
5. Near surface gas monitoring;
6. Control of surface run-off;
7. Implementation of a gas management plan.

The proposed strategy assumes that on-going soil gas and groundwater monitoring indicates that conditions remain similar to those previously recorded.

3.2 Gas and groundwater monitoring

Ongoing soil gas monitoring is required to check that the venting trench continues to be effective. During the 2014 monitoring visit, only two of the monitoring wells outside of the vent trench could be found due to overgrown vegetation. Therefore, it is recommended that limited vegetation clearance is undertaken to locate these boreholes so that the monitoring network can be re-established.

The risk assessment undertaken by Hyder in 2008 indicated that the potential risk to controlled waters was low. That assessment was based on groundwater conditions at the time, including a groundwater flow direction to the south. It is recommended that additional monitoring is undertaken to provide up to date information of groundwater quality and the groundwater flow direction to confirm that conditions have not adversely changed. In addition, the results of the monitoring should be provided to the Environment Agency to confirm that conclusions of the previous assessment still meet their requirements.

3.3 Clay cap

The cap currently present across the site is inconsistent in thickness and composition (granular and cohesive). Monitoring has also shown that to some degree the cap is limiting infiltration as significant leachate/perched water has not been encountered within the landfill material. In addition, the risk assessments undertaken to date indicate that, based

on current conditions, the risk to controlled waters is low and the potential risk presented to human health from contaminants in shallow soils is low, with the exception of an isolated elevated lead concentration.

In the event that long term use of the site continues to be open space, consideration should be given to upgrading the cap to allow continued protection to site users by providing a consistent cohesive layer above the landfill material. This could be combined with re-levelling works likely to be required if the site is converted into a managed open space.

It may not be cost effective to complete this work should the plans to redevelop the site for other purposes be imminent as previous assessments indicate that the augmentation of the cap is unlikely to be required in the short term.

A localised hotspot of lead has been identified in shallow soils, which presents a potential risk to human health. Further assessment and/or remedial works should be undertaken to address this potential risk.

Typically, for landfills, most settlement takes place over 30 years with the majority occurring in the initial 5 year period[6]. Therefore, self-settlement of this landfill should generally be completed (approximately 28 years since closure). However, it is recommended that the cap is inspected regularly, including after re-levelling and augmentation, should this be undertaken, to confirm if settlement is still occurring and if differential settlement has resulted in cracks/undulations. Such cracks/undulations could provide a pathway for soil gases to migrate to the surface, allow infiltration of water or permit ponding of water at the surface.

Should works be undertaken on the cap, gas monitoring should subsequently be completed at the boreholes on the periphery of the site (and off-site if possible) to confirm that the works have not changed the off-site migration of soil gases (a clay cap on an unlined landfill may encourage lateral migration[7]). The requirements for this monitoring are further discussed in Section 4.

[6] Environment Agency (2007). *Guidance for the Landfill Sector. Technical Requirements of the Landfill Directive and Integrated Pollution Prevention Control (IPPC S5.02).* April 2007.
[7] Environment Agency (2004). *Guidance on the management of landfill gas*. Landfill directive. LFTGN 03. September 2004.

3.4 Control of surface water run-off

Ephemeral areas of standing water are present in the centre and south of the site. Although investigations have shown that the risk to controlled waters is low, this surface water could slowly migrate through the capping and into the landfill material and be a continued source resulting in the generation of leachate, which could increase the potential risk to controlled waters. Therefore, should the long term development plan for the site be an open space, some form of surface water drainage is recommended.

3.5 Surface emission monitoring

To demonstrate compliance with the Landfill Directive monitoring of methane emissions through the cap of a landfill should be undertaken to identify faults in the gas management system and quantify the total emissions of this important greenhouse gas. The Environment Agency does not regulate closed historical landfill sites that no longer have a permit. However, they maintain an interest in these sites because of their potential to release greenhouse gases.

Very limited and preliminary surface monitoring completed by CGL in 2012 with a Photo Ionisation Detector (PID) indicated very low surface emissions. However, this could be confirmed by monitoring as recommended by the Environment Agency[8]. There are two stages involved with assessing surface emissions:

1. First stage – This comprises a walkover survey to identify emissions at the surface with a Flame Ionisation Detector (FID). This hand held equipment is used to scan the air close to the surface of the cap and therefore detect significant concentrations of methane.

2. Second stage – This involves a flux box survey, which is used to more accurately determine the rate of surface emission and compliance with the emission standard (<0.001 mg/m^2/second). However, given the low flow rates encountered, it is unlikely that significant surface emissions will occur at the site. Therefore, it is recommended that a flux survey is only required should significant flow rates be encountered during gas monitoring or should significant concentrations be encountered (i.e. >100ppm above the surface of the site or >1000ppm over features such as monitoring wells and the venting trench) with the FID. If

[8] Environment Agency (2010). *Guidance on monitoring landfill gas surface emissions*. LFTGN07 v2 2010.

completed, another flux survey would not be required provided there have been no significant changes to the site conditions.

3.6 Venting trench

It is understood that Hyder previously suggested that the overgrown vegetation along the venting trench may potentially adversely affect the performance of the venting trench. Although the density of the vegetation in the past is unknown, the brambles across the venting trench have been present since the 2004 walkover by RPS and subsequent gas monitoring has shown that soil gas concentrations beyond the trench and within the nearby private gardens have been low. Therefore, it appears that the vegetation across the trench is not currently significantly impacting its performance.

Removal of this vegetation may have ecological implications that need to be considered before vegetation is cleared. The vegetation also provides a barrier that stops the public from coming into contact and interfering with this gas venting feature. Therefore, unless continued monitoring shows that the performance of the venting trench is being impeded by vegetation (see Section 4); it is considered that the vegetation provides a benefit, both ecologically and as a barrier mechanism, to the site. Further details regarding ecological issues are discussed below.

3.7 Ecological issues

There are currently trees and vegetation present along the boundaries of the site and it is assumed if the site is converted into a managed open space area, some landscaping or vegetation clearance may be completed. However, such clearance may result in an ecological impact. In addition, it is anticipated that some vegetation removal would be required to locate missing boreholes and to clear the vent trench.

An ecological appraisal was completed by RPS in 2004, which stated that the site was likely to be of local ecological significance and the ecological value of the site was largely restricted to the periphery.

CGL previously obtained a preliminary ecological assessment (by Remenham Associates) based on the photographs taken during the site walkover in March 2012. A summary of this assessment is provided below:

The site generally - and in particular the gas trench and its vegetation - present suitable habitat for nesting birds around the edge of the site and in the vegetation, amphibians and reptiles (although only the common species and at relatively low density). There is some standing water on the site shown in the photographs, but this looks as though it may be seasonal and so the potential for Great Crested Newts is limited from the site itself.

However, the risk of Great Crested Newts living in ponds around the site's perimeter can't be ruled out and the vegetation does provide suitable terrestrial habitat for them. There MAY be bats in the trees which are shown the photographs - an inspection would be needed to confirm presence / absence as the quality of the trees as suitable habitat is unclear.

The additional survey works required to address these issues are further discussed in Section 4.

4. SITE MAINTENANCE AND MANAGEMENT PLAN

4.1 General

The maintenance and management requirements for the short, medium and long term are outlined below. A summary of the maintenance and management plan for the site (including the Gas Management Plan) is presented in Appendix A. Should the end use of the site change, this plan will need to be amended and possibly replaced with a remedial/verification plan.

4.2 Short term

4.2.1 Gas and groundwater monitoring

4.2.1.1 Soil gas

With the continued use of the site as open space, the main receptors at risk from landfill gases are the occupants of the adjacent residential properties. Previous monitoring has indicated that the venting trench is effective. However, vegetation is present within the trench and due to overgrowth vegetation only two monitoring wells outside the trench could be located during the recent monitoring visit. Therefore, on-going monitoring is required to confirm that the venting trench remains effective. In addition, re-levelling and augmenting of the landfill cap may adversely affect the soil gas regime.

4.2.1.2 Groundwater

Further groundwater monitoring and sampling is recommended to confirm the current groundwater regime for comparison against the findings of the previous risk assessment undertaken by Hyder in 2008.

4.2.1.3 Gas and groundwater monitoring programme

Based on the findings of previous assessment and observations during the recent site walkover, the monitoring programme is focussed on:

- re-establishing the monitoring network;
- confirming whether vegetation is adversely affecting the performance of the

venting trench;

- confirming the off-site gas regime is not adversely changed by works to repair/augment the capping layer (if undertaken); and
- Confirming the current groundwater regime beneath the site.

Initially, limited vegetation clearance should be undertaken to locate the missing boreholes outside of the vent trench. Gas monitoring should then be completed twice a month for three months. Unless monitoring shows significant adverse changes in the soil gas regime outside the landfill (methane >1%, carbon dioxide >5%, Characteristic Situation > 1) it is considered that no further gas monitoring is required unless development occurs at the site that may affect the soil gas regime, or if during inspection visits the vegetation along the trench has significantly overgrown and blocked the trench. It may, however, be prudent to continue to undertake gas monitoring on an annual basis, unless vegetation along the trench is cleared/maintained regularly.

Figure 4 shows the locations of the proposed gas monitoring boreholes and these are also highlighted below in Table 1. Monitoring should be completed during various conditions, which include both low (including falling) and high atmospheric pressure conditions and should include determination of carbon dioxide, methane and oxygen concentrations, volatile organic compound levels (PID) and flow rates.

Table 1. Boreholes for short term monitoring

Borehole	**Location**
HS304, BH01	Northern boundary; outside venting trench
BH03, BH107	Eastern boundary; outside and inside venting trench
BH101, BH102	Eastern boundary; outside and inside venting trench
HS301, BH103	Southern boundary; outside and inside venting trench
BH02	Southern boundary; outside venting trench
BH114, BH105	Western boundary; outside and inside venting trench
HS302, BH104	Western boundary; outside and inside venting trench

Note:

1. Access should be maintained to all existing monitoring points on site
2. Where access is possible boreholes within the private gardens of surrounding residential properties should also be monitored.

It is recommended that groundwater levels are recorded during each monitoring visit to enable an assessment of the current groundwater flow direction. Groundwater samples should be obtained from the deep monitoring wells (BH401, BH402 and BH03) and selected shallow monitoring wells including BH501) on two occasions during the three month period to establish the current groundwater quality beneath the site. The results should be compared against the findings of the risk assessment undertaken by Hyder in 2008. It is recommended that the Environment Agency be consulted to confirm their current requirements.

4.2.1.4 Surface emission monitoring

During monitoring of the boreholes (six visits over three months) surface emissions (<5cm from surface) should be monitored with a hand held FID (more sensitive to flammable gases) at approximate 75m spacing across the site. A flux survey would only be required if significant concentrations (i.e. >100ppm above the surface of the site or >1000ppm over features such as monitoring wells and the venting trench) have been encountered. Prior to undertaking the flux survey an assessment should be undertaken to determine the likely cause for the increase in surface emissions and remedial measures put in place (if required). The surface emission should then the re-checked with the FID to ensure concentrations are below the values above before proceeding with the secondary flux survey. Further assessment of the site conditions may be required if the emission standard (<0.001 mg/m^2/second) has not been met. If completed, another flux survey would not be required provided there have been no significant changes to the site conditions.

In addition, it is recommended that additional monitoring visits be undertaken in the event that works are undertaken to augment/improve the clay cap.

4.2.2 Clay cap

As discussed in Section 3, the risk assessments undertaken to date indicate that, based on current conditions, the risk to controlled waters is low and across the majority of the site the potential risk presented to human health from contaminants in shallow soils is low. Therefore, the proposed strategy for management of the cap in the short term comprises:

- Visual inspection of cap to check for cracks/depressions and undertake remedial works if identified.
- Further assessment and/or mitigation of hotspot of lead identified in shallow soils.

During the gas monitoring visits (6 visits in 3 months) the ground level should be visually inspected and the capping inspected for differential settlement, cracking or surface water ponding at the surface. This could include a topographical survey to enable future settlement monitoring to be undertaken. Once the gas monitoring is completed it is recommended that the ground level and clay cap is inspected twice a year to confirm no significant changes have occurred. Depending on the observations made during inspection visits surface maintenance of the capping may be required.

Should it be necessary to import material to site to repair the cap, it should be sourced from a reputable source and be chemically and geotechnically suitable for use at the site. The imported material should meet the specification provided in Appendix A.

Prior to import onto site laboratory test data should be provided by the supplier to show that the soil meets the required specification and verification testing would be required once on site.

4.2.3 Venting trench

The three months of gas monitoring (see above) will allow the functioning of the venting trench to be assessed. Depending on the findings of the assessment, and the associated ecological constraints (see below), it may be necessary to undertake some vegetation clearance within the trench. As a minimum, the vegetation along the trench should be managed and maintained to ensure that the trench is not further covered/blocked as this may affect its function.

4.2.4 Ecological surveys

For continued use as open space, the initial recommendation is to carry out a Constraints Survey (factual report and recommendations for further works, if necessary) for the site prior to clearing vegetation. In addition to the site survey, a data search is recommended to confirm if a Great Crested Newt survey is required. These surveys would be required to identify the potential constraints associated with clearing vegetation within the vent trench and to locate the missing boreholes, and enable mitigation measures to be defined. Additional surveys would be required should additional vegetation clearance be required (for example to enable remedial works to the clay cap).

Should development plans change to include sports pitches with a pavilion, prior to the development of the site it is recommended that an Extended Phase 1 Habitat Survey is

completed to confirm the ecological issues, if any, at the site and the mitigation measures required prior to development and clearance of vegetation. The Extended Phase 1 Habitat Survey will include identifying the potential for relevant protected species (including bats) and set out recommendations for the procedures to follow during site clearance. This survey should be suitable for submission as part of a planning application for near future development, if required. However, it should be noted that there is a 'shelf-life' attached to these surveys as site circumstances change.

4.3 Medium term

4.3.1 Clay cap

Should the use of the site remain as informal open space in the medium term, then it is recommended that the ephemeral areas of standing water are re-levelled to reduce the standing water on site. This will also assist with controlling surface water run-off (see below). Should material be imported to site this should meet the requirements presented in Section 4.2.2.

4.3.2 Controlling surface water run-off

It is likely that the surface water is ponding within the undulations at the site. Therefore, re-levelling of the standing water areas, along with the use of the natural topography (dropping from south to north) would allow the surface water to drain and prevent significant ponding.

4.3.3 Venting Trench

Vegetation along the trench should be managed and maintained to ensure that the trench is not further covered/blocked, which may affect its function.

4.4 Long term

4.4.1 Clay cap

Should the long term use for the site remain as public open space, a consistent clay cap (minimum of 1m thick[9]) should be present across the site (the location and extent would

[9] Environment Agency. *LFE4 – Earthworks in landfill engineering. Design, construction and quality assurance of earthworks in landfill engineering.*

be informed by the information from the existing exploratory holes). Where possible, the capping (and topsoil) at the site should be reused to create the cap and a growth medium. This could be accomplished through waste exemptions, environmental permits or through the Development Industry Code of Practice[10]. The latter has been developed to enable earthworks on site using site won material.

Should material be imported to site this should meet the requirements presented in Section 4.2.2.

After re-levelling and upgrading of the clay cap a topographical survey should be completed at the site to enable future settlement monitoring to be undertaken.

4.4.2 Drainage

It is recommended that the works undertaken to provide a consistent clay cap should include re-levelling of the site. This, combined with the use of the natural topography (dropping from south to north) would allow the surface water to drain and prevent significant ponding. Alternatively, more formal drainage options could be considered.

4.4.3 Venting Trench

Vegetation along the trench should be managed and maintained to ensure that the trench is not further covered/blocked, which may affect its function.

4.4.4 DSEAR assessment

In the long term condition, the site should be classified in line with the Dangerous Substance and Explosive Atmospheres Regulations 2002 (DSEAR), for a more robust appraisal of the site. DSEAR require employers to control the risks to safety from fire and explosions. Under DSEAR employers are required to:

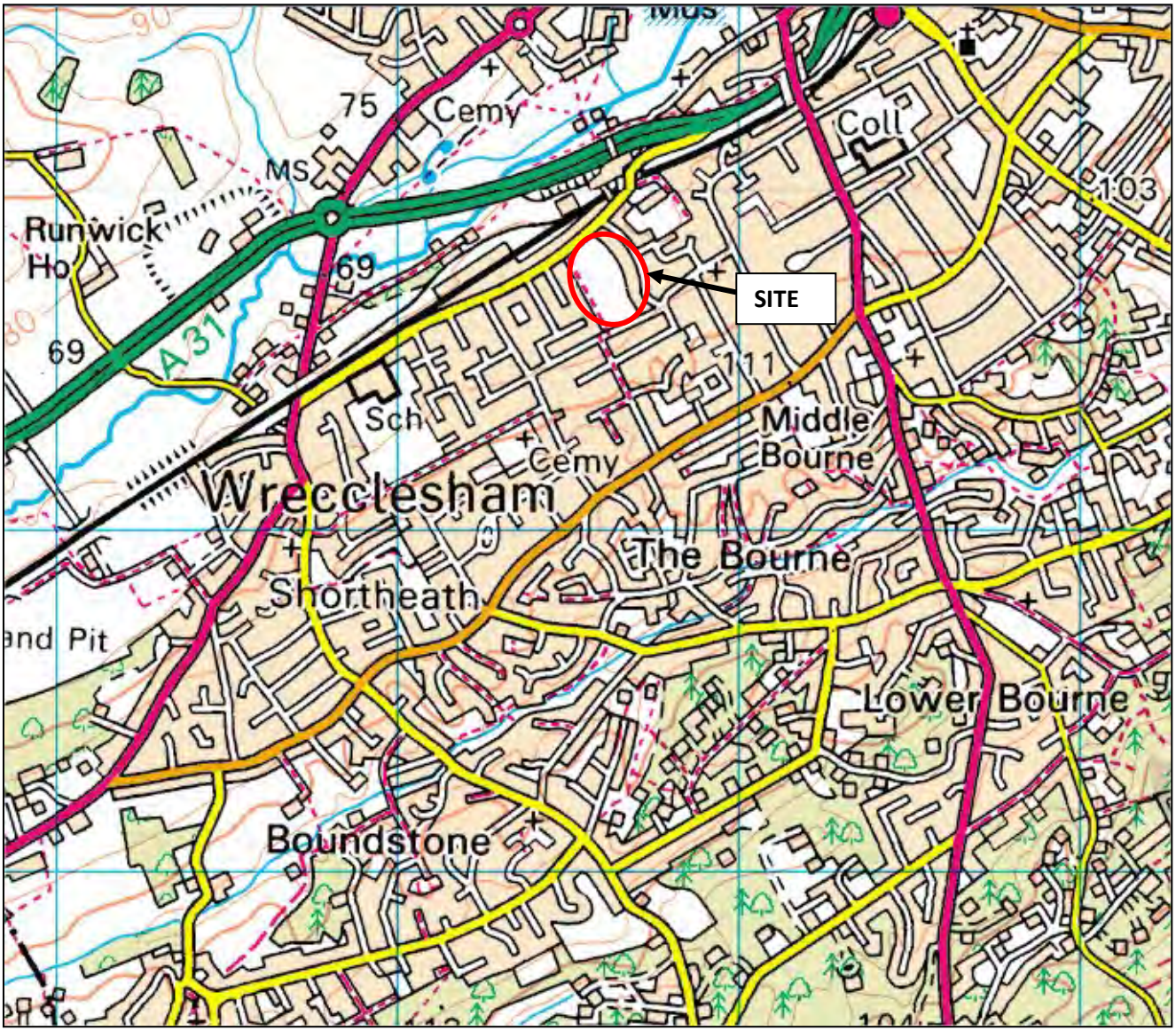
- Find out what dangerous substances are in their workplace and what the fire and explosion risks are;
- Put control measures in place to either remove those risks or, where this is not possible, control them;

[10] CL:AIRE. *The Definition of Waste: Development Industry Code of Practice*. Contaminated Land: Application in Real Environments. Version 2. March 2011.

- Put controls in place to reduce the effects of any incidents involving dangerous substances;
- Prepare plans and procedures to deal with accidents, incidents and emergencies involving dangerous substances;
- Make sure employees are properly informed about and trained to control or deal with the risks from the dangerous substances;
- Identify and classify areas of the workplace where explosive atmospheres may occur and avoid ignition sources (from unprotected equipment, for example) in those areas.

CGL has had experience where a DSEAR assessment was required as part of the planning conditions prior to development on a former landfill.

FIGURES



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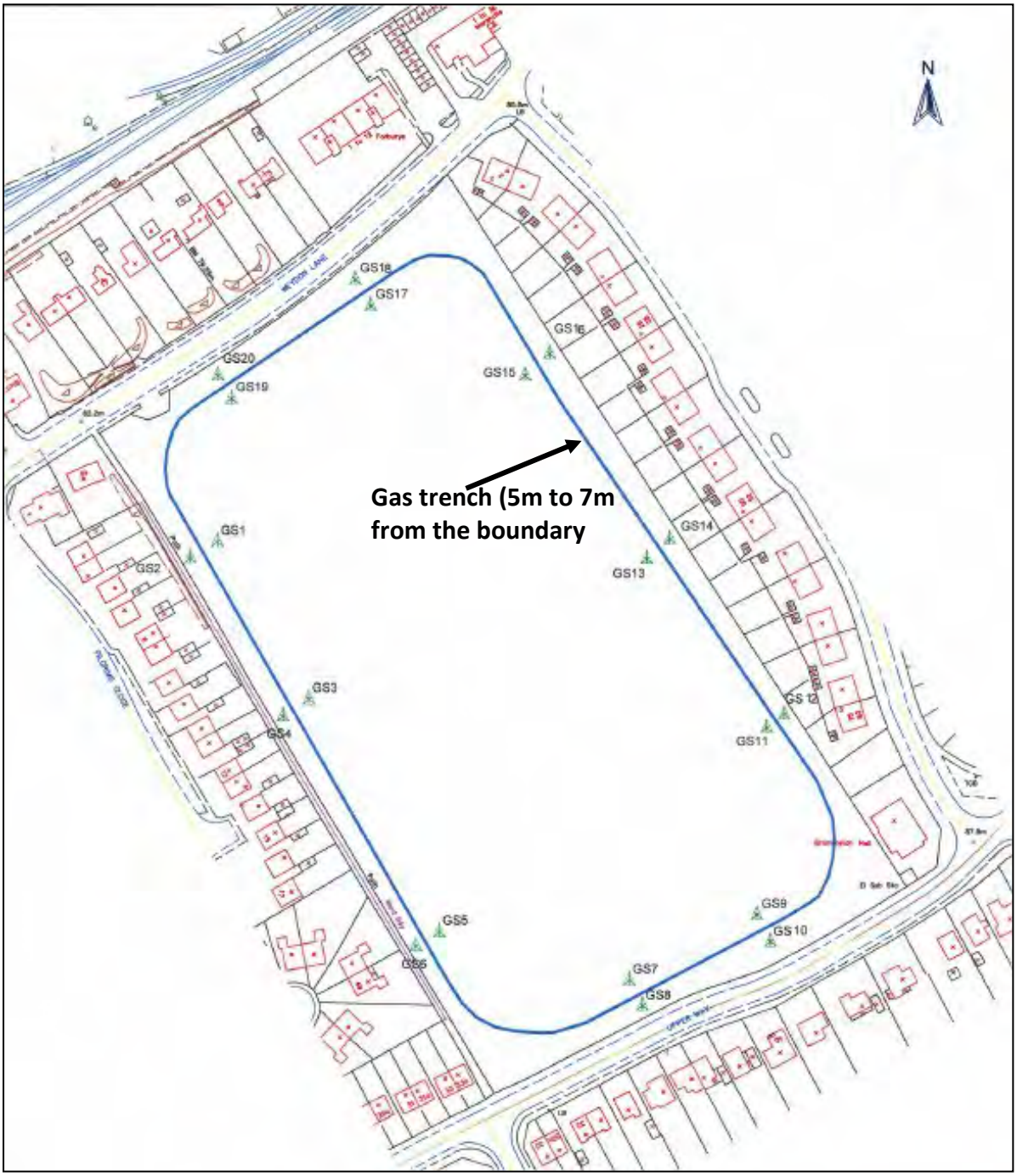
Client	Project	Job No
Waverley Borough Council	**Weydon Lane Landfill, Farnham**	**CG/5934C**
CGL	Title: **Site location plan**	**Figure 1**

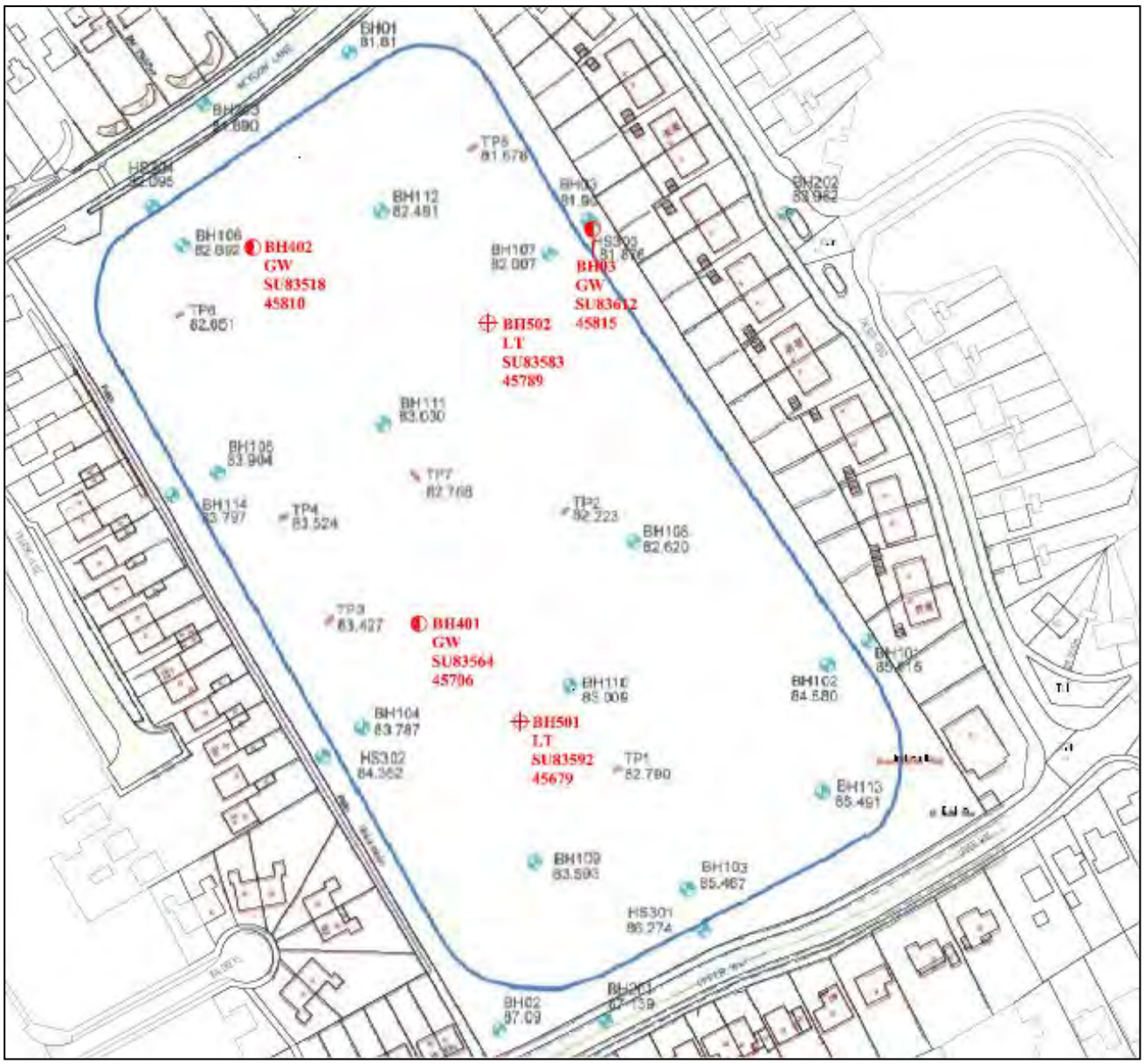


Reference: RPS Planning Transport and Environment. Final Environmental Site and Risk Assessment Report at Weydon Lane, Farnham, Surrey. JER2963. August 2006

Client	Project	Job No
Waverley Borough Council	**Weydon Lane Landfill, Farnham**	**CG/5934C**
CGL	Title: **Site layout plan**	**Figure 2**

Reference: RPS Planning Transport and Environment. Final Environmental Site and Risk Assessment Report at Weydon Lane, Farnham, Surrey. JER2963. August 2006

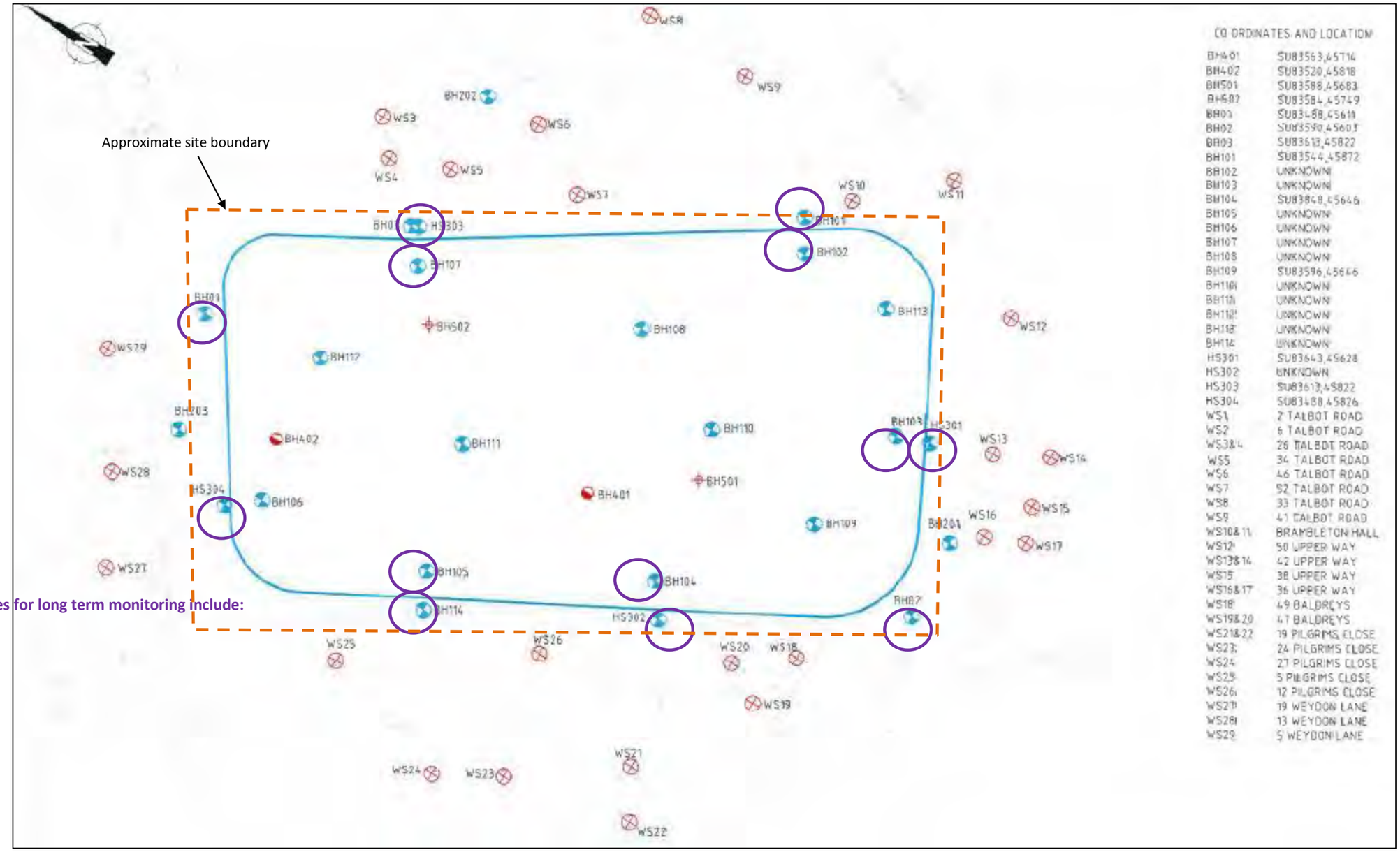
Client	Project	Job No
Waverley Borough Council	**Weydon Lane Landfill, Farnham**	**CG/5934C**
CGL	Title **Exploratory hole location plan - RPS**	**Figure 3a**



Reference: Hyder Consulting (UK) Ltd. Weydon Lane Landfill. Groundwater and Human Health Assessment, Ground Investigation and Interpretation. 0001-GD00720-GDR-02. August 2008.

(75 hand dug trial pits also excavated across the site based on a herringbone pattern and a grid size of 16.6m by 16,6m)

Client	Project	Job No
Waverley Borough Council	**Weydon Lane Landfill, Farnham**	**CG/5934C**
CGL	Title **Exploratory hole location plan – Hyder Consulting**	**Figure 3b**



CO ORDINATES	AND LOCATION
BH401	SU83563,45714
BH402	SU83520,45818
BH501	SU83588,45683
BH502	SU83584,45749
BH03	SU83488,45618
BH02	SU83590,45603
BH03	SU83613,45822
BH101	SU83544,45872
BH102	UNKNOWN
BH103	UNKNOWN
BH104	SU83848,45646
BH105	UNKNOWN
BH106	UNKNOWN
BH107	UNKNOWN
BH108	UNKNOWN
BH109	SU83596,45646
BH110	UNKNOWN
BH111	UNKNOWN
BH112	UNKNOWN
BH113	UNKNOWN
BH114	UNKNOWN
HS301	SU83643,45628
HS302	UNKNOWN
HS303	SU83613,45822
HS304	SU83488,45826
WS1	2 TALBOT ROAD
WS2	6 TALBOT ROAD
WS3&4	26 TALBOT ROAD
WS5	34 TALBOT ROAD
WS6	46 TALBOT ROAD
WS7	52 TALBOT ROAD
WS8	33 TALBOT ROAD
WS9	41 TALBOT ROAD
WS10&11	BRAMBLETON HALL
WS12	50 UPPER WAY
WS13&14	42 UPPER WAY
WS15	38 UPPER WAY
WS16&17	36 UPPER WAY
WS18	49 BALDREYS
WS19&20	47 BALDREYS
WS21&22	19 PILGRIMS CLOSE
WS23	24 PILGRIMS CLOSE
WS24	27 PILGRIMS CLOSE
WS25	5 PILGRIMS CLOSE
WS26	12 PILGRIMS CLOSE
WS27	19 WEYDON LANE
WS28	13 WEYDON LANE
WS29	5 WEYDON LANE

NOTE:

Proposed boreholes for long term monitoring include:

- **HS304**
- **BH01**
- **BH03**
- **BH107**
- **BH101**
- **BH102**
- **HS301**
- **BH103**
- **BH02**
- **BH114**
- **BH105**
- **HS302**
- **BH104**

If access is available installations within the private gardens of surrounding properties should also be monitored.

Client	Project	Job No
Waverley Borough Council	**Weydon Lane Landfill, Farnham**	**CG/5934C**
CGL	Title: **Long term monitoring points**	**Figure 4**

APPENDIX A

Summary of long term maintenance and management plan

Reference	Principal requirements	Site visit required	Supporting documentation
1.0 General principles	The following provides a summary of the maintenance and management plan for the former landfill off Weydon Lane in Farnham. The following is based on the continued use of the site as open space for the community. Should the development plans for the site change the following will need to be amended and possibly replaced with a remedial/verification plan.	**YES** As detailed below	As detailed below
2.0 Compliance with legislation	The activities on the site should be undertaken in accordance with all current health and safety and environmental legislation.	-	-
SHORT TERM			
3.0 Monitoring of installations – Gas monitoring	Gas monitoring should be completed twice a month for 3 months (i.e. 6 in total). Unless monitoring shows significant adverse changes in the soil gas regime outside the landfill (methane >1%, carbon dioxide >5%, Characteristic Situation > 1) no further gas monitoring is required unless development occurs at the site that may adversely affect the soil gas regime or during inspection visits the vegetation along the trench has significantly overgrown and blocked the trench. It may, however, be prudent to continue to undertake gas monitoring on an annual basis, unless vegetation along the trench is cleared/maintained regularly. Figure 4 shows the locations of the boreholes proposed for monitoring. These are also highlighted below in Table A4. Monitoring should be completed during various conditions which include both low (including falling) and high atmospheric pressure conditions and should include determination of carbon dioxide, methane and oxygen concentrations, volatile organic compound levels (PID) and flow rates.	**YES** Gas monitoring visits	Gas monitoring records
4.0 Monitoring of installations – Groundwater monitoring	During each gas monitoring visits the groundwater levels should be recorded. In addition, groundwater samples should be obtained from the deep monitoring wells (BH401, BH402 and BH03) and selected shallow monitoring wells including BH501 on two occasions during the three month period.	**YES** Groundwater sampling visits	Groundwater monitoring records Laboratory test certificates

Reference	Principal requirements	Site visit required	Supporting documentation
	In-situ groundwater parameters should also be recorded including: dissolved oxygen, redox potential, pH, temperature, total dissolved solids, and electrical conductivity. Samples should be sent for chemical analysis at a UKAS and MCERTS accredited laboratory and should be analysed for a similar suite of contaminants as completed during previous investigations. The results should be compared to the findings of the risk assessment undertaken by Hyder in 2008 to confirm if the conditions have changed and the Environment Agency should be consulted to confirm their current requirements.		
5.0 Surface emission	To be completed generally in accordance with Environment Agency Guidance *(Guidance on monitoring landfill gas surface emissions. LFTGN07 v2 2010.)* First stage – Site visits to confirm emissions at the surface with a Flame ionisation detector (FID) which is more sensitive to flammable gases. This will be completed during the monitoring of the boreholes (6 visits in 3 months) and subsequently twice a year during capping inspection visits. Second stage – A flux survey would only be required if significant FID concentrations (i.e. >100ppm above the surface of the site or >1000ppm over features such as monitoring wells and the venting trench) have been encountered. Prior to undertaking the flux survey an assessment should be completed to determine the likely cause for the increase in surface emissions and remedial measures put in place (if required). The surface emission should then the re-checked with the FID to ensure concentrations are below the values above before proceeding with the secondary flux survey. The flux box survey would determine the rate of surface emission to confirm compliance with the emission standard (<0.001 mg/m^2/second). Further assessment of the site conditions may be required if the emission standard has not been met.	**YES** Walkover survey (and if required a flux box survey).	Site inspection records. Flux survey report (if required)

Reference	Principal requirements	Site visit required	Supporting documentation
	Once completed another flux survey would not be required provided there have been no significant changes to the site conditions.		
6.0 Clay cap	During the gas monitoring visits, the cap should be visually inspected to check for cracks/depressions or surface water ponding at the surface and remedial measures undertaken if necessary. A topographical survey could be completed to enable future settlement monitoring to be undertaken. Upon completion of the gas monitoring visits, the cap should be inspected twice a year to confirm no significant changes have occurred. In addition further assessment and/or mitigation of the hotspot of lead identified in shallow soils should be undertaken. Should it be necessary to import material onto site to repair the cap, is should be sourced from a reputable source and be chemically and geotechnical suitable for use at the site.	**YES** Capping inspection visits Validation of capping should repair works be undertaken	Site visit/inspection records. Topographical survey plan (if required) Pre-import source data for the imported capping material, if required. Verification chemical and geotechnical testing to confirm suitability for use at the site, if required. (see import specification tables A1, A2 and A3 below).
7.0 Venting trench	Depending on the findings of the gas monitoring it may be necessary to undertake some vegetation clearance within the trench. As a minimum, the vegetation should be managed and maintained to ensure that the trench is not further covered/blocked.	**YES** Inspection visits undertaken as part of gas monitoring and capping inspection visits.	See above
8.0 Ecological survey	Prior to clearing vegetation, a Constraints Survey (factual report and recommendations for further works, if necessary) should be completed. A data search should also be completed to confirm if a Great Crested Newt survey is required.	**YES** Survey by a qualified ecologist Site inspections	Survey report
MEDIUM TERM – Informal open space			
9.0 Clay cap	The ephemeral areas of standing water should be re-levelled to reduce standing water on site. Should it be necessary to import material onto site to repair the cap, is should be sourced from a reputable source and be chemically and		Site visit/inspection records. Pre-import source data for the imported capping material, if required.

Reference	Principal requirements	Site visit required	Supporting documentation
	geotechnical suitable for use at the site.		Verification chemical and geotechnical testing to confirm suitability for use at the site, if required. (see import specification tables A1, A2 and A3 below).
10.0 Drainage	Re-levelling of the site and use of the natural topography (dropping from south to north) would allow the surface water to drain and prevent significant ponding within undulations.	**YES** Site inspection	Site visit/inspection records
11.0 Venting trench	Vegetation should be managed and maintained to ensure that the trench is not further covered/blocked.	**YES** Site inspections	Site inspection records
LONG TERM – Formal public open space			
12.0 Clay cap	A consistent clay cap (minimum of 1m thick) should be present across the site. The location and extent of upgrading works would be informed by the existing exploratory holes. Where possible the existing capping and topsoil should be reused. Should it be necessary to import material onto site to repair the cap, is should be sourced from a reputable source and be chemically and geotechnical suitable for use at the site. After re-levelling and upgrading the clay cap a topographical survey should be completed to enable future settlement monitoring to be undertaken. Upgrading of the cap may adversely affect the soil gas regime at the site and additional monitoring is recommended (see Item 3.0)	**YES** Site inspections to validate replacement of cap, where necessary	Site visit/inspection records. Pre-import source data for the imported capping material, if required. Verification chemical and geotechnical testing to confirm suitability for use at the site, if required. (see import specification tables A1, A2 and A3 below).
13.0 Drainage	Re-levelling of the site and use of the natural topography (dropping from south to north) would allow the surface water to drain and prevent significant ponding within undulations.	**YES** Site inspection	Site visit/inspection records
14.0 Venting trench	Vegetation should be managed and maintained to ensure that the trench is not further covered/blocked.	**YES** Site inspections	Site inspection records
15.0 DSEAR	Assessment and classification in line with the Dangerous Substance and	**YES**	Site inspection records

Reference	Principal requirements	Site visit required	Supporting documentation
	Explosive Atmospheres Regulations 2002 (DSEAR).	Site inspection	DSEAR assessment report

IMPORT SPECIFICATION

Chemical specification

Soil Guideline Values (SGVs) have not been issued by the Environment Agency for the "*Residential (without home-grown produce)*" land-use category (considered a conservative assessment for this site). The soil should therefore be compared to *Generic Assessment Criteria* (GACs) that have been derived in-house by CGL using the *Contaminated Land Exposure Assessment (CLEA)* model[1] and version 1.06 of the CLEA software to assess the risk to human health from chemical contamination in the soils.

The GACs represent conservative screening criteria and have been calculated using the default parameters for the standard land use scenario set out in the CLEA technical report and toxicological inputs in line with the requirements of *Science Report SC050021/SR2*[2] and, in the case of petroleum hydrocarbons, Science *Report P5-080/TR3*[3]. In the case of selenium, mercury, arsenic, nickel and the BTEX compounds, SGVs have been issued by the Environment Agency for other land-use categories and the physical-chemical and toxicological inputs have been taken from the published SGV reports.

The GACs have been generated assuming a sandy loam soil type and a Soil Organic Matter of 1%, 2.5% and 6%. More detailed information on the derivation of the CGL GACs can be provided upon request.

These maximum permissible concentrations (MPCs) are import criteria only and are not necessarily appropriate for human health risk assessment.

Upon receipt of the chemical test data the results will be compared to the appropriate table based on the SOM.

[1] Environment Agency. (January 2009). *Updated technical background to the CLEA model*. Science Report SC050021/SR3.
[2] Environment Agency. (January 2009). *Human health toxicological assessment of contaminants in soil*. Science Report SC050021/SR2.
[3] Environment Agency. (February 2005). *The UK Approach for Evaluating Human Health Risks from Petroleum Hydrocarbons in Soils*. Science Report P5-080/TR3.

Table A1 Chemical import criteria

Contaminant	MPC @ 1% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 2.5% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 6% SOM for Residential (no private gardens) land-use (mg/kg)
SOM (%)	*[1]	*	*
Arsenic	35[2]	35[2]	35[2]
Cadmium	85[2]	85[2]	85[2]
Chromium (total)	38	38	38
Chromium (III)	1,100	1,100	1,100
Chromium (VI)	4.2	4.2	4.2
Lead	310[11]	310[11]	310[11]
Mercury (inorganic)	240[2]	240[2]	240[2]
Selenium	600[2]	600[2]	600[2]
Boron	5[9]	5[9]	5[9]
Copper[7]	135[6] (6,700)	135[6] (6,700)	135[6] (6,700)
Nickel	130[2]	130[2]	130[2]
Zinc[7]	300[6] (20,000)	300[6] (20,000)	300[6] (20,000)
Barium	300	300	300
Beryllium	26	26	26
Vanadium	210	210	210

Contaminant	MPC @ 1% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 2.5% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 6% SOM for Residential (no private gardens) land-use (mg/kg)
Phenols[3]	310[2]	420[2]	520[2]
Cyanide	17[8]	17[8]	17[8]
Asbestos	No visible fibres[10]		
BTEX compounds			
Benzene	0.27[4]	0.50[4]	1.00[2]
Toluene	610[4]	1,300[4]	2,700[2]
Ethyl benzene	170[4]	380[4]	840[2]
m-xylene[6]	55[4]	130[4]	300[2]
o-xylene[6]	60[4]	140[4]	320[2]
p-xylene[6]	53[4]	130[4]	290[2]

Notes:

1. * = no value currently defined
2. Based on the published Soil Guideline Value (Environment Agency, 2009), adjusted for no plant uptake and 1%, 2.5% SOM and 6%
3. GAC relates to Phenol (C_6H_5OH) only.
4. Based on the published SGVs for BTEX at 6% SOM (Environment Agency, 2009), adjusted for 1% SOM and no plant uptake
5. Concentrations for total xylenes should be compared to the value for m-xylene for fresh spills and to o-xylene for all other cases.
6. Schedule 2, Sludge (Use in Agriculture) Regulations 1989. Values taken for pH 6-7
7. Import criteria limited by waste assessment thresholds - if failure occurs further assessment can be made– copper and zinc concentrations may individually exceed MPC, subject to the assessment of the cumulative effect of copper and zinc, but may not exceed bracketed human health GAC values.
8. Generic Assessment Criteria generated 'in-house' based on CLEA model.
9. Limit for phytotoxic effect (Nable, Banuelos and Paul. (1997). *Boron Toxicity*. Plant and Soil, **Vol. 193**, pp1 81-198).
10. Laboratory screen by microscopy may be required subject to source of material.
11. Published C4SL for lead (DEFRA, 2014)

Table A2 Chemical import criteria cont.

Contaminant	MPC @ 1% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 2.5% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 6% SOM for Residential (no private gardens) land-use (mg/kg)
Total Petroleum Hydrocarbons (TPH)			
TPH aliphatic EC5-6	24	41	79
TPH aliphatic EC>6-8	49	100	230
TPH aliphatic EC>8-10	10	25	59
TPH aliphatic EC>10-12	540	540	540
TPH aliphatic EC>12-16	1,000[1]	1,000[1]	1,000[1]
TPH aliphatic EC>16-35	1,000[1]	1,000[1]	1,000[1]
TPH aromatic EC5-7	0.27	0.50	1.0
TPH aromatic EC>7-8	610	1,000[1]	1,000[1]
TPH aromatic EC>8-10	17	41	96
TPH aromatic EC>10-12	88	210	480
TPH aromatic EC>12-16	1,000[1]	1,000	1,000
TPH aromatic EC>16-21	1,000[1]	1,000[1]	1,000[1]
TPH aromatic EC>21-35	1,000[1]	1,000[1]	1,000[1]
Sum of TPH aliphatic & aromatic C5-C10	<1000[2]	<1000[2]	<1000[2]
Sum of TPH aliphatic & aromatic C10+	<1000[2]	<1000[2]	<1000[2]

Contaminant	MPC @ 1% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 2.5% SOM for Residential (no private gardens) land-use (mg/kg)	MPC @ 6% SOM for Residential (no private gardens) land-use (mg/kg)
Polycyclic Aromatic Hydrocarbons (PAH)			
Benzo(a)anthracene	7.7	13	18
Benzo(a)pyrene	2.3	2.4	2.5
Benzo(b)fluoranthene	22	24	24
Benzo(k)fluoranthene	23	24	25
Chrysene	170	210	230
Dibenzo(a,h)anthracene	2.1	2.3	2.4
Indeno(1,2,3-cd)pyrene	21	23	24
Naphthalene	1.6	3.9	9.2

Notes:
1. GAC derived MPC for TPH fraction limited to 1,000mg/kg based on 'waste thresholds'.
2. Hazardous waste thresholds (C10+ MPC based on threshold for C25+). Environment Agency. (2007). *A Guide to Hazardous Waste Regulations: How to find out if waste oil and waste that contain oil are hazardous*. HWR08.

Geotechnical specification

The following is based on the recommendations provided in the Environment Agency guidance for earthworks in landfill engineering[4].

Table A3 Geotechnical import criteria

Property	**Minimum requirement**
Permeability	<1 x 10^{-9} m/s
Remoulded undrained shear strength	>/= 50kN/m^2
Plasticity Index	>/= 10% and </= 6%
Liquid Limit	</=90%
Percentage fines <0.063mm	</=30%
Maximum particle (stone) size	2/3rd compacted layer thickness. Typically 125mm but must not prejudice the cap (i.e. larger particles sticking together to form larger lumps).
Compaction testing	To determine the optimum moisture content and dry density for placement and compaction.

[4] Environment Agency. *LFE4 – Earthworks in landfill engineering. Design, construction and quality assurance of earthworks in landfill engineering*.

LONG TERM MONITORING POINTS

Table A4. Boreholes for long term monitoring

Borehole	Location
HS304, BH01	Northern boundary; outside venting trench
BH03, BH107	Eastern boundary; outside and inside venting trench
BH101, BH102	Eastern boundary; outside and inside venting trench
HS301, BH103	Southern boundary; outside and inside venting trench
BH02	Southern boundary; outside venting trench
BH114, BH105	Western boundary; outside and inside venting trench
HS302, BH104	Western boundary; outside and inside venting trench

Note:

1. Access should be maintained to all existing monitoring points on site
2. Where access is possible boreholes within the private gardens of surrounding residential properties should also be monitored.