CEMEX UK Materials Ltd

Whitehall Landfill

Site Monitoring Plan

WHL EP VOLUME 3

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Ove Arup & Partners Ltd
Admiral House Rose Wharf
78 East Street
Leeds LS9 8EE
United Kingdom
www.arup.com

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1 Introduction

1.1 Overview

Whitehall Landfill is owned and operated by CEMEX UK Materials Ltd (formerly RMC).

This report is produced for CEMEX by Ove Arup & Partners, and has been updated since the original environmental permit application to reflect current monitoring and reporting procedures.

The document provides details of the procedures for monitoring:

- Landfill gas generation
- Groundwater and surface water quality
- Dust
- Noise and vibration
- Weather conditions
- The waste body.

1.2 Associated Documents

This report should be read in conjunction with the following documents:

- PPC Permit Application Form
- Volume 1 ESID — ESI/Arup, 2005
- Volume 2 Site Operating Plan — Arup, 2005
- Volume 4 Supporting Information — Arup, 2005
- Volume 5 Hydrogeological Risk Assessment — ESI, 2016

2 Landfill Gas Monitoring & Reporting

2.1 Landfill Gas Monitoring Installations

2.1.1 Locations Within the Waste Body

Landfill gas monitoring points within the waste body will be provided in the locations shown on Drawing ESID 8. The gas monitoring installations will be constructed once landfilling is complete.

2.1.2 Locations Outside the Waste Body

A landfill gas monitoring system has been provided to enable monitoring for migration of landfill gas outside the waste body. The existing gas monitoring points comprise boreholes located as shown on Drawing ESID 8. Summary logs are included in Volume 1, the ESID Report, Appendix C.

Table 1 summarises the existing landfill gas monitoring installations as shown on Drawing ESID 8.

Table 1 Existing Landfill Gas Monitoring Installations

Borehole	NGR Co-ordinates	Ground Level (mAOD)	Overall Depth (mbgl)	Sampler No.	Sampler Depth (m)
GM2	311891, 173337	73.96	14.00	S1	
GM4	311829, 173454	90.62	24.00	SI	1.0 – 24.0
GM5	311694, 173527	112.26	41.00	S1	1.0 – 41.0
GM7	311550, 173578	116.99	47.00	S1	1.0 – 41.0
GM8	311476, 173384	110.23	39.00	S1	1.0 – 39.0
GM10	311641, 173290	111.00	35.00	SI	1.0 – 35.0
GM11	311722, 173330	110.95	35.00	SI	1.0 – 35.0

2.1.3 Design

New gas monitoring installations will comprise a 50 mm diameter HDPE pipe installed in a 150mm diameter borehole. The installations will extend through the full depth of the waste.

The base of the pipe will be plugged and with the exception of the upper 1.0 m, the sampling pipe will be perforated by holes not greater than 5 mm diameter at intervals of approximately 75 mm. or equivalent area of slots.

The perforated/slotted pipe will be surrounded by clean gravel within the grading 10 – 20 mm.

The upper 1.0 m of the sampling pipe will comprise plain HDPE pipe surrounded by bentonite grout.

Each sampling pipe will be finished with a screwed plastic cap or similar fitted with a gas sampling valve, and will be protected at the ground surface by a lockable steel cover set in concrete.

The final depth and installation details are determined by suitably qualified and experienced personnel (eg. Chartered Geologist or Chartered Engineer) with previous experience of installing environmental monitoring boreholes, having regard to the actual geology encountered.

2.1.4 Construction

Boring of gas monitoring wells will be carried out using suitable drilling equipment operated by a suitably experienced driller. Boreholes will be drilled vertically.

The pipe, with centralising devices attached at intervals, will be lowered carefully down the borehole, and the borehole backfilled with gravel (see Section **Error! Reference source not found.**) to within 0.9 m of ground level.

The upper 0.9 m of the borehole will be sealed with bentonite grout. The grout will be prepared by mixing bentonite powder with just sufficient water to form a stiff, cohesive paste. The paste will be formed into balls, placed into the borehole and punned to form a homogeneous mix. Alternatively, compressed bentonite pellets may be used, in which case the pellets will be partially hydrated before being added to the borehole.

2.1.5 Quality Assurance

Construction of gas monitoring installations will be carried out under the supervision of the Installation Supervisor (e.g. Chartered Geologist or Chartered Engineer) with previous experience of installing environmental monitoring boreholes.

Installation records will be prepared for each monitoring installation showing:

- Site name;
- Drilling contractors and operators name;
- Borehole number;
- Date of drilling;
- Equipment and technique used;
- Diameter and depth of borehole and any casing used;
- Depth of each change of stratum;
- Description of each stratum;
- Depth of groundwater strikes and flow rates;
- Depth and length of gas sampler, lengths of gravel filters and bentonite seals;

- All above information to be presented on a geological log compatible with AGS transfer;
- Details of manufacturer and supplier of each component with respective reference numbers.

The Installation Supervisor will verify that the details included on each monitoring borehole installation record are accurate.

A validation report containing the installation records will be prepared by the Installation Supervisor and submitted to the Agency within two calendar months of completion of the work.

2.1.6 Maintenance

Inspections will be carried out during each routine monitoring visit to ensure that the installations are undamaged and functioning correctly. If any damage or defect is found the details will be recorded in the site diary and remedial measures implemented as soon as practicable.

Usually this will be within one month unless re-drilling is required, in which case a new borehole will be installed as soon as ground conditions permit. A record of the remedial measures will also be made in the site diary. Once completed the installations will be given permanent marker posts that will be located to Ordnance Survey National Grid and levelled to Ordnance Datum.

2.2 Landfill Gas Monitoring and Sampling Programme

2.2.1 Within Waste Body

Monitoring and sampling of landfill gas within the waste body will be carried out and recorded in accordance with Table 2 and the procedures specified in Appendix A.

Table 2 Gas Monitoring Programme within Waste Body

Phase	Frequency	Determinants	Units	Accuracy
Site Post Closure	Monthly for 1 year, then quarterly until surrender of the permit	Methane (CH4)	% v/v &	±0.3 - 3% v/v
		Carbon Dioxide (CO2)	% v/v	±1% v/v
		Oxygen (O2)	% v/v	±1% v/v
		Atmospheric Pressure	Mb	±1mb
		Differential Pressure	Mb	0.1mb
		Flow Rate*	l/s	±0.1l/s

*Only if methane concentration exceeds Control Level.

Note. Accuracy of methane and carbon dioxide monitoring equipment varies depending on the concentration of gas being measured. The greater accuracy is achieved at lower gas concentrations.

Monitoring of surface emissions will not be undertaken as the gas risk assessment has identified that the risk of landfill gas generation is very low, consequently the likelihood of measurable surface emissions is very low. However, if gas concentrations and flow rates in the in-waste monitoring points exceed the designated trigger levels, the need for surface emission monitoring will be reviewed.

2.2.2 External to Waste Body

Monitoring and sampling of landfill gas external to the waste body will be carried out and recorded in accordance with Table 3 and the procedures specified in Appendix A.

Table 3 Gas Monitoring Programme External to Waste Body

Phase	Frequency	Determinants	Units	Accuracy
Site Operation	Monthly	Methane (CH4)	% v/v &	±0.3 - 3% v/v
		Carbon Dioxide (CO2)	% v/v	±1% v/v
		Oxygen (O2)	% v/v	±1% v/v
		Atmospheric Pressure	Mb	±1mb
		Differential Pressure	Mb	0.1mb
		Flow Rate*	l/s	±0.1l/s
Site Post Closure	Monthly for 1 year, then quarterly until surrender of the permit	Methane (CH4)	% v/v &	±0.3 - 3% v/v
		Carbon Dioxide (CO2)	% v/v	±1% v/v
		Oxygen (O2)	% v/v	±1% v/v
		Atmospheric Pressure	Mb	±1mb
		Differential Pressure	Mb	0.1mb
		Flow Rate*	l/s	±0.1l/s
*Only if methane concentration exceeds Control Level. Note. Accuracy of methane and carbon dioxide monitoring equipment varies depending on the concentration of gas being measured. The greater accuracy is achieved at lower gas concentrations.				

2.2.3 Monitoring and Sampling Records

A record of the landfill gas monitoring and sampling results will be made in accordance with the format specified in Appendix A.

The following information is to be collected and recorded:

- Site code;
- Monitoring point reference code;
- Field equipment reference code;
- Name of sampling personnel;

- Date of monitoring event;
- Time of monitoring event;
- Parameter measured;
- Value;
- Measured value unit;
- Atmospheric pressure;
- Comments on sampling.

A permanent record of all gas monitoring is maintained at the Company's Head Office. A copy of the results will be submitted to the Environment Agency within one month of sampling.

2.2.4 Quality Assurance of Monitoring and Sampling

The monitoring and sampling will be quality assured in accordance with the landfill gas monitoring procedures specified in Appendix A.

2.2.5 Submission of Records

A copy of the latest assured records of each monitoring or sampling result will be submitted to the Environment Agency in accordance with permit of its being carried out. The format of the records will be agreed with the Environment Agency.

2.3 Baseline Monitoring Results

The baseline monitoring results are presented in Volume 1, ESID Appendix B.

2.4 Landfill Gas Monitoring Action Plan

2.4.1 Control and Trigger Levels

2.4.1.1 Methane

The results from the background monitoring of gas concentrations in the existing monitoring installations have been reviewed and used as the basis to derive control and trigger levels for the external monitoring installations listed in **Error! Reference source not found.**:

1. A Control Level at 0.5% v/v methane (or 10%LEL) which gives a warning of a potential rise in flammable gas concentrations.
2. A Trigger Level at 1% v/v methane (or 20% LEL) which represents a level considered to represent a potential hazard if it were to persist for an extended period.

The Control Level is designed to provide an early warning of potential gas migration. The Trigger Level represents a level considered to be a potential hazard if it were to persist.

The Control and Trigger Levels only apply to the monitoring installations outside the waste body and not to the in-waste installations.

In the event that concentrations of landfill gas in any of the external monitoring installations exceed the trigger levels given above, the Company will initiate the investigation procedure set out in Section 2.5.2 below.

2.4.1.2 Carbon Dioxide

The results from the background monitoring of gas concentrations in the existing monitoring installations have been reviewed and used as the basis to derive control and trigger levels for carbon dioxide generation, based on the following principles:

1. Control Level = $x'+2\sigma_n$ + 1% (1 % above 95th percentile background level)
2. Trigger Level = x' +$2\sigma_n$ + 1.5% (1.5% above 95th percentile background level)

where x' = mean value from background data

and σ_n = standard deviation

Based on the background data, between October 2001 and August 2004 the following levels have been established:

1. A Control Level at 5% v/v carbon dioxide.
2. A Trigger Level at 6% v/v carbon dioxide.

In the event that concentrations of landfill gas in any of the external monitoring installations exceed the trigger levels given above, the Company will initiate the investigation procedure set out in Section 2.5.2 below.

2.4.1.3 Oxygen

Control and trigger levels have not been set for oxygen as there is generally an inverse relationship between oxygen and carbon dioxide concentrations. Consequently conditions of low oxygen concentration will be identified any way due to elevated carbon dioxide concentrations.

2.4.2 Investigation Procedure

The procedures for the assessment of gas monitoring results in relation to trigger limits are as follows:

1. For methane and carbon dioxide concentrations below the Control Level - allow as normal variability.

2. If methane or carbon dioxide concentrations exceed the Control Level then check previous two readings from the gas database and:
    a. If the previous readings do not exceed the Control Level then no further action is required other than to note that a breach has occurred.
    b. If the previous two readings do exceed the Control Level, then increase monitoring frequency to fortnightly in affected and adjacent boreholes; and assess the possible cause of the increase in concentrations by problem solving described in Section 2.4.3.
3. If methane or carbon dioxide concentrations exceed the Trigger Level then check the previous reading from the gas database and:
    a. If the previous reading in the affected borehole was below the Control Level then take no further action except to note that the trigger level has been breached.
    b. If the previous reading was above Control Level, then increase monitoring frequency to weekly in affected boreholes until concentrations reduce below Trigger Level %.
    c. Assess the possible cause of the increase in concentrations by problem solving described in Section 2.4.3, and review previous monitoring results to see if there is any indication of a trend.
    d. Monitor borehole pressure to determine likelihood of significant gas flow rates.

The procedures for the assessment of gas flow monitoring results in relation to trigger limits are as follows:

If significant flow rates are absent then continue monitoring weekly until gas concentrations reduce below Trigger Level.

If significant flow rates are absent but gas concentrations do not reduce below the Trigger Level within three months and the source of the gas has been identified as the licensed landfill, then consider the initiation of appropriate gas control measures in association with the Environment Agency (see Section 2.4.4).

If significant flow rates are present and readings persist above the Trigger Level % for more than 6 weeks with no signs of decreasing levels then carry out a gas survey of street services (for methane and carbon dioxide). Dependent on the results of the street survey, consider carrying out a gas survey of potentially affected properties after discussion with the Environment Agency.

The Company will make immediate arrangements to install gas control measures after consultation with the Environment Agency.

2.4.3 Problem Solving

In the preceding section, the first course of action proposed following any breach of trigger limits is to “assess the possible cause of the increase in gas concentrations”. The routine to be followed to perform this instruction is set out below:

1. Check whether the barometric pressure was rising, falling or steady on the day and in the day(s) preceding the date of monitoring.
2. Check the results against those of other site monitoring boreholes to determine if the result is part of a general deterioration in the gas levels in the area, or a localised occurrence.
3. Check oxygen and carbon dioxide concentrations to determine if these correlate to a deterioration in methane concentrations.
4. Ensure that monitoring equipment is functioning effectively and in any case take a confirmatory sample for gas-chromatographic analysis.
5. Attempt to identify the most likely source of methane, in relationship to the history of landfill at the site, and previous monitoring results.
6. Investigate the surrounding area for signs of gas or leachate escape.
7. When measured gas concentrations fall below control level, resume normal monitoring frequency.

If a problem is identified, it will be rectified as soon as possible. The Landfill Manager or his nominee will be informed immediately, and he will co-ordinate any action required.

Record all actions in the Site Diary.

2.4.4 Gas Control Procedure

Gas control measures may include one or more of the following:

- Cut-off barrier;
- Passive vent trench;
- Pumped wells.

The selection of the appropriate control measures will be discussed with the Environment Agency prior to installation, and will take into account the nature and depth of the waste deposited. As this site contains only inert waste, it is highly unlikely that gas control procedures will be required, however if they were a passive vent trench or passive venting boreholes would probably be the most effective remedy.

Increased gas monitoring in the affected boreholes will continue throughout and after installation of the control measures and until values drop below the Control Level. Monthly monitoring will then resume unless the Control Level is exceeded again.

2.5 Landfill Completion Criteria

Monitoring of landfill gas will continue until the maximum concentration of methane and carbon dioxide in in-waste and external monitoring installations is similar to background concentrations.

Monitoring will be carried out over a 24 month period on at least 4 occasions, including 2 occasions when the atmospheric pressure is falling and is less than 1000 mb.

3 Leachate Monitoring & Reporting

As the site will accept only inert waste, no leachate storage, collection or treatment systems will be adopted at this site. Therefore, no leachate monitoring is required.

4 Groundwater Monitoring & Reporting

4.1 Risk Assessment & Management

Details of the groundwater risk assessment are contained in the Volume 5, Hydrogeological Risk Assessment (ESI, 2000).

4.2 Design, Construction and Construction Quality Assurance

4.2.1 Existing Groundwater Monitoring Boreholes

Groundwater monitoring boreholes have already been installed around the site. Detailed logs of the installations are included on the borehole logs in Volume 1, ESID, Appendix C. The locations of the monitoring points are shown on Drawing ESID 11.Table 4 summarises the existing groundwater monitoring installations.

Table 4 Groundwater Monitoring Borehole Details

Borehole	NGR Co-ordinates	Ground Level (mAOD)	Overall Depth (mbgl)	Response Zone Depth (m)	Response Zone Unit
BH 1	311898, 173350	73.83	30.0	2.0 – 30.0	Limestone
BH 3	311832, 173454	89.88	39.0	2.0 – 39.0	Limestone
BH3A	311829, 173454	90.00	43.0	8.5 – 42.5	Limestone
BH 6	311692, 173531	112.67	55.0	2.0 – 51.0	Limestone
BH 9	311472, 173385	110.29	53.5	2.0 – 55.0	Limestone
BH12	311934, 173290	69.52	25.0	3.0 – 25.0	Limestone
BH13	311767, 173328	106.34	60.4	3.0 – 60.4	Limestone
BH14	311626, 173290	109.95	51.2	3.0 – 51.2	Limestone
BH15	311533, 173635	118.84	83.5	3.0 – 83.5	Limestone

4.2.2 Design

New groundwater installations required will comprise a 50mm diameter HDPE (or other approved) perforated well screen and plain access pipe installed in 150mm diameter borehole.

The well screen will be surrounded by a filter to a depth of 0.3 metre above the top of the screen.

The remainder of the annulus will be surrounded by a bentonite cement grout to ground surface.

Each sampling pipe will be finished with a screwed plastic cap or similar and will be protected at the ground surface by a lockable cover set in concrete.

The final depth and installation details are determined by suitably qualified and experienced personnel (e.g. experienced Geologist or Engineer) with previous

experience of installing environmental monitoring boreholes, having regard to the actual geology encountered.

4.2.3 Construction

Drilling of groundwater monitoring wells will be carried out using cable percussion or rotary open hole drilling equipment operated by a suitably experienced driller. Boreholes will be drilled vertically.

The well screen and access pipe, will be lowered carefully down the borehole. The primary sand filter will be placed to the required level. Where the sand is placed into water, sufficient time will be allowed for all sand to settle. The level of the top of the sand filter will be measured and the level and volume of sand placed recorded.

A bentonite plug not less than 0.5m thick will be placed at the top of the sand filter. The plug will be prepared by mixing bentonite powder with just sufficient water to form a stiff, cohesive paste. The paste will be formed into balls, placed into the borehole and punned to form a homogeneous mix. Alternatively, compressed bentonite pellets may be used, in which case the pellets will be partially hydrated before being added to the borehole. The remainder of the borehole will then be filled with cement bentonite grout.

4.2.4 Quality Assurance

Construction of groundwater monitoring installations will be carried out under the supervision of the Installation Supervisor (e.g. Chartered Geologist or Chartered Engineer) with previous experience of installing environmental monitoring boreholes.

Installation records will be prepared for each monitoring installation showing:

- Site name;
- Drilling contractors and operators name;
- Borehole number;
- Date of drilling;
- Equipment and technique used;
- Diameter and depth of borehole and any casing used;
- Depth of each change of stratum;
- Description of each stratum;
- Depth of groundwater strikes and flow rates;
- Depth and length of gas sampler, lengths of gravel filters and bentonite seals;
- All above information to be presented on a geological log compatible with AGS transfer;

- Details of manufacturer and supplier of each component with respective reference numbers.

The Installation Supervisor will verify that the details included on each monitoring borehole installation record are accurate.

A validation report containing the installation records will be prepared by the Installation Supervisor and submitted to the Agency within two calendar month of completion of the work.

4.3 Maintenance

Inspections will be carried out during each routine monitoring visit to ensure that the installations are undamaged and functioning correctly. If any damage or defect is found the details will be recorded in the site diary and remedial measures implemented as soon as practicable.

Usually this will be within one month unless re-drilling is required, in which case a new borehole will be installed as soon as ground conditions permit. A record of the remedial measures will also be made in the site diary. Once completed the installations will be given permanent marker posts that will be located to Ordnance Survey National Grid and levelled to Ordnance Datum.

4.4 Groundwater Monitoring and Sampling Programme

Procedures for groundwater monitoring and sampling are described in Appendix B.

Sampling frequency and determinands will be as summarised in Table 5.

Table 5 Groundwater Monitoring Programme

Phase	Sampling Frequency	Determinands
Site Operation	Quarterly	Water Level, pH, EC, NH_4-N, Cl, SO_4, Alk, TON, TOC, Na, K, Ca, Mg, Fe
	Annually as quarterly plus:	Mn, Cd, Cr, Cu, Ni, Pb, Zn, Naphthalene
Site Post-closure (for minimum 2 years and until surrender of the permit)	Quarterly	Water Level, pH, EC, NH_4-N, Cl, SO_4, Alk, TON, TOC, Na, K, Ca, Mg, Fe, Naphthalene
	Six-monthly	Water Level, pH, EC, NH_4-N, Cl, SO_4, Alk, TON, TOC, Na, K, Ca, Mg, Fe, Mn, Cd, Cr, Cu, Ni, Pb, Zn, Naphthalene

Any new boreholes will be monitored monthly for a period of six months after installation, then in accordance with Table 5 above.

The minimum reporting values (MRVs) for the determinands to be assessed are presented in Table 6.

Table 6 Minimum Reporting Values for groundwater analysis

Determinand	MRV	Units	Determinand	MRV	Units
Water Level	NA	mAOD	Calcium	1	mg/l
pH (field and lab)	NA	pH units	Magnesium	1	mg/l
EC (field and lab)	10	µS/cm	Iron	0.05	mg/l
NH_4-N	0.3	mg/l	Manganese	0.04	mg/l
Chloride	2	mg/l	Cadmium	1	µg/l
Sulphate	5	mg/l	Chromium	5	µg/l
Alkalinity (as $CaCO_3$)	5	mg/l	Copper	0.02	mg/l
TON	0.3	mg/l	Nickel	7	µg/l
TOC	0.3	mg/l	Lead	0.01	mg/l
Sodium	1	mg/l	Zinc	0.03	mg/l
Potassium	1	mg/l	Naphthalene	2	µg/l

4.5 Groundwater Monitoring and Sampling Records

4.5.1 Groundwater Levels

Records of groundwater level monitoring will be entered into the Company's environmental database.

The following information is to be collected:

- Site code;
- Monitoring point reference code;
- Date of monitoring event;
- Time of monitoring event;
- Parameter measured;
- Value;
- Measured value unit.

4.5.2 Groundwater Sampling and Analysis

The following information will be collected in relation to each monitoring event:

4.5.3 Field Sample Level Information

- Site Code;
- Location code;

- Unique sample code;
- Date of sampling;
- Time of sampling;
- Any quality control duplicate information;
- Sample matrix code;
- Sample type;
- Date sent to laboratory;
- Name of sampling personnel;
- Reason for sampling;
- Sampling technique;
- Whether the sample is a composite or not;
- Composite description if appropriate;
- Colour;
- Odour;
- Description of weather;
- Comments on sampling.

4.5.4 Additional Field Test Level Information

- Date of test;
- Time of test;
- Field test name;
- Field test result;
- Field test result unit;

4.5.5 Additional Laboratory Test Level Information

- Name of analytical method for each test used by the laboratory;
- Date of analysis;
- Time of analysis;
- Type of test (i.e. initial, re-extract or re-analysis);
- Name of laboratory;
- Laboratory sample reference;
- Comment on laboratory test.

4.5.6 Additional Laboratory Result Level Information

- CAS number or alternative unique identifier for each element or compound;

- Chemical name;
- Result value;
- Result unit;
- Detect flag;
- Method detection limit;
- Reporting limit
- Comment on result.

4.5.7 Quality Assurance of Monitoring and Sampling

The records will be quality assured in accordance with the groundwater monitoring procedures specified in Appendix B1.

4.5.8 Submission of Records

A copy of the latest quality assured records of each monitoring or sampling result will be submitted to the Environment Agency in accordance with the sampling frequency indicated in Table 5 in accordance with the Permit. The format of the data to be submitted will be agreed with the Environment Agency.

4.6 Groundwater Action Plan

4.6.1 Groundwater Trigger Concentrations

In order to provide an initial assessment as to whether leachate may be being generated, the concentrations of selected determinands will be monitored against Control and Trigger Levels which are based on the Hydrogeological Risk Assessment. Full details of the methodology for derivation of the trigger levels are presented in the Hydrogeological Risk Assessment, Volume 5 (ESI, 2000). A review of defined compliance limits was conducted by CEMEX in 2008 (ESI, 2008[1]) and submitted to the Environment Agency, as the regulating authority at the time, which approved the revised levels. These came into effect in October 2008. Compliance limits were subsequently revised as part of the 2016 HRA review (ESI, 2016)[2] and these were agreed with NRW in July 2016.

The current determinands, control and trigger levels are listed in Table 7 and Table 8 respectively.

Table 7 Groundwater Control Concentrations

Location	Trigger Level				
	Ammoniacal Nitrogen (mg/l)	Chloride (mg/l)	Iron as Fe (µg/l)	Potassium (mg/l)	Naphthalene (µg/l)
BH1	0.32	100	125	19	-
BH12	0.29			14.6	
BH13	0.25			5	
BH14	0.3			6	

Note: naphthalene is hazardous substance. Trigger level is minimum reporting value so no lower control level can be set.

Table 8 Groundwater Trigger Concentrations

Location	Trigger Level				
	Ammoniacal Nitrogen (mg/l)	Chloride (mg/l)	Iron as Fe (µg/l)	Potassium (mg/l)	Naphthalene (µg/l)
BH1	0.39	250	200	27	0.05
BH12				18.6	
BH13				12	
BH14					

4.6.2 Investigation Procedure and Follow-up Action

In the event that any Control Level is exceeded in one sampling point on one occasion, the following action will be taken:

1. The Company database will be queried to identify the past 12 months results from the affected location. If less than two of the last four results have breached the Control Level, no further action will be taken, other than to note that a breach has occurred. However if two or more of the last four sampling results have breached the Control Level at this location, then the borehole will be re-sampled as soon as possible after receipt of the results.

If the repeat sample also exceeds the Control Level the following course of action will be taken: -

2. Data from the monitoring point exceeding the Control Level and adjacent monitoring points will be reviewed by use of statistics and graphical presentation to establish the presence of any trends or patterns.
3. Groundwater levels will be reviewed to establish flow direction in order to determine whether the landfill is the most likely cause of any change in groundwater quality.
4. A preliminary inspection will be carried out to determine whether there has been:

a) Any unusual activity or occurrence on or around the site that could account for the increase in the parameter exceeding the trigger concentration.

b) Any spillage of contaminants at the surface in the vicinity of the affected boreholes.

5. The Company will assess the results of all of the above information and specify its course of action on future monitoring.

Note that for potassium at BH12, it is expected that the control level may be exceeded whilst a plume from up hydraulic gradient passes through the Site. In the event that the control level is exceeded at BH12 no re-sampling will be undertaken.

In the event that any Trigger Level is exceeded in one sampling point on one occasion, the following action will be taken:

1. The monitoring point will be re-sampled as soon as possible after receipt of the results; whether the elevated determinand was derived from field or laboratory analysis the re-analysis will be carried out in the laboratory. This initial procedure will be used to eliminate errors that might be introduced during sampling, field analysis or laboratory analysis, before continuing. If this second sample does not exceed the Trigger Level then no further action will be taken unless it exceeds the Control Level in which case the procedures set out above will be followed.

If the additional repeat sample also exceeds the Trigger Level then:

2. The actions described in 2 to 4 above will be carried out; and

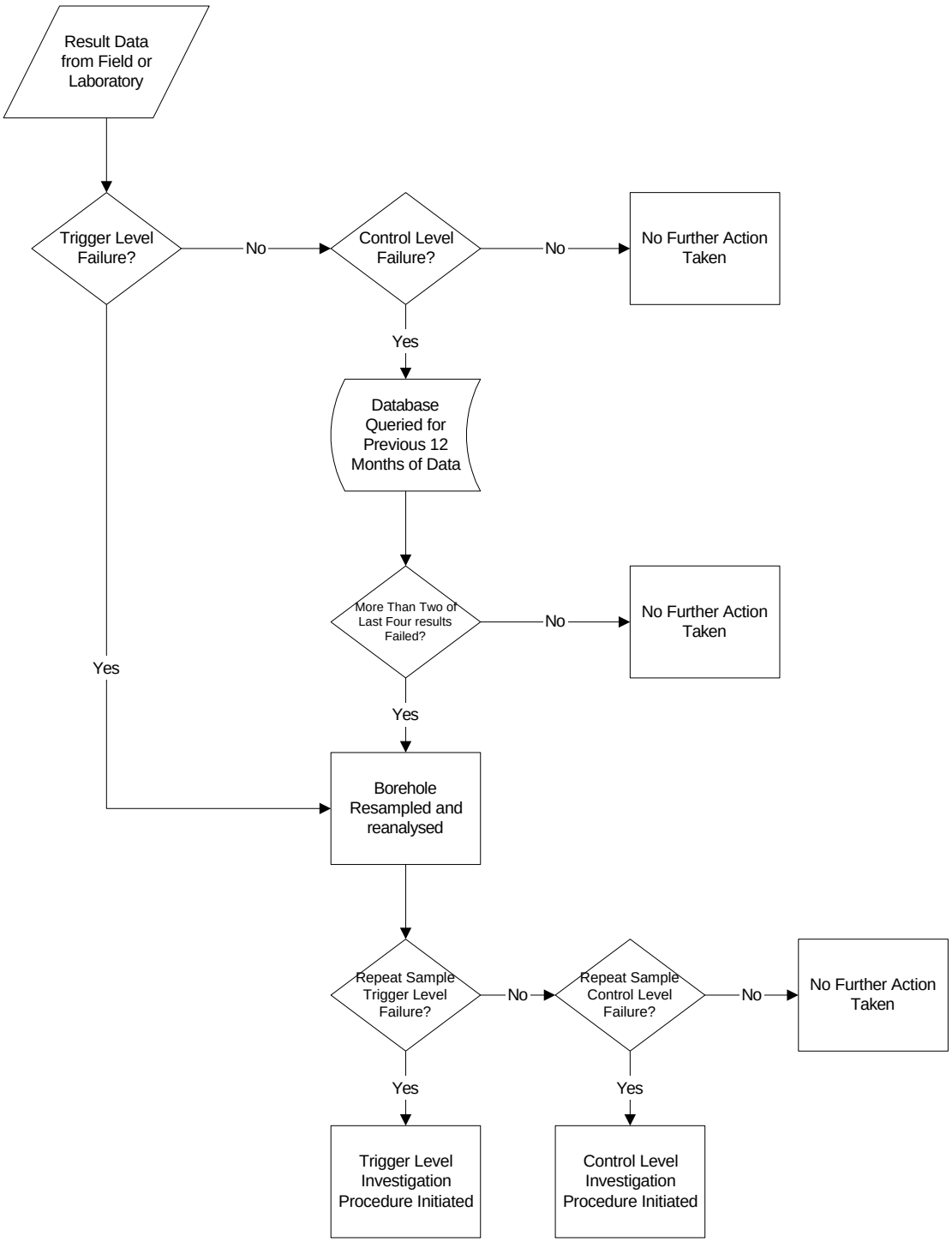
3. The monitoring frequency will be increased to monthly for an agreed set of monitoring determinands by laboratory analysis in the affected borehole and adjacent boreholes on a monthly frequency until the determinand concentration falls below the Trigger Level.

4. If the laboratory results from the monthly monitoring show no indication of decline over a four month period (or other period assessed appropriate with respect to the rate of flow of groundwater at the site), and the evidence indicates that the landfill is the most likely cause of the increase in concentrations, then a hydrological risk assessment will be carried out (see below).

5. The Company will conclude the risk assessment with an explanation of the effect of the groundwater quality changes on the groundwater and surface water resource with recommendations for any remedial action if it is considered necessary. A course of action will be agreed with the Environment Agency.

The control and trigger level procedure is summarised on the flow chart overleaf.

Control and Trigger Level Procedure



4.6.3 Hydrological Risk Assessment and Hydrogeological Review

Where a hydrogeological risk assessment is required it will have particular regard to those substances that have exceeded the trigger level. The assessment will determine the likely effects of the wastes deposited within the licensed area on surrounding groundwater quality and will be presented in the form of a written report that will include:

1. A summary of all groundwater monitoring carried out to date, including graphical representations of time series data for water levels and the concentrations of determinands measured in the existing observation boreholes around the permitted area.
2. An assessment of the expected dilution and attenuation of contaminants migrating from the permitted area.
3. Consideration of the need for the construction and siting of additional groundwater monitoring boreholes both upstream and downstream of the permitted area together with a timetable for their installation.
4. Recommendations for water quality objectives at downstream groundwater monitoring boreholes.
5. An assessment of possible remedial options which could be taken in the event that adverse changes are detected in the quality of ground and/or surface waters in the vicinity of the site.

5 Surface Water quality Monitoring and Reporting

No surface water receptors have been identified during the hydrogeological risk assessment. Therefore, no surface water monitoring is proposed.

6 Dust Monitoring and Reporting

The site, including both the waste disposal area and access roads, will be inspected at least twice daily for dust. The findings of each inspection will be recorded in the Environmental Dust Log. Dust suppression measures will be undertaken as necessary. Full details of the dust mitigation procedure is given in Volume 2, the Site Operating Plan.

No additional dust monitoring is proposed. The dust monitoring procedure will be reviewed by the Landfill Manager if complaints are received from the general public.

7 Noise monitoring and Reporting

A subjective noise assessment will be carried out by the landfill manager daily.

Should any complaints be received a noise survey will be carried out at the receptor, or at the receptor's boundary closest to the site, and at the site boundary closest to the receptor in accordance with procedures in Appendix C.

Noise assessments and any change to mitigating measures will be recorded in the Site Diary.

Should any complaints be received, the requirement for formal noise monitoring will be reviewed.

8 Meteorological Monitoring

8.1 Location and Design

Meteorological conditions monitoring will be carried out at the main site office complex shown on drawing ESID 6.

The following parameters will be recorded in the site diary:

- Wind strength and direction
- The occurrence of rainfall

Wind strength and rainfall will be recorded qualitatively.

8.2 Meteorological Conditions Monitoring Programme

Each parameter will be observed at the start of each day and recorded in the site diary. Any significant changes during the day will be recorded in the site diary.

8.3 Meteorological Monitoring Records

Meteorological monitoring data will be recorded in the site diary.

8.4 Meteorological Conditions Action Plan

The Landfill Manager will assess if additional dust control measures are required to be put into place. Consideration will be given to temporarily stopping deposition of any particularly dusty wastes during periods of high winds.

The Landfill Manager will assess if additional road cleaning measures are required to be put into place as a result of wet weather conditions.

9 Waste Body Monitoring

Permanent survey markers have been established on the site, co-ordinated to the Ordnance Survey National Grid and levelled to Ordnance Datum before the site development commences.

Further topographic surveys will be carried out:

- At annual intervals whilst the site is operational;
- On completion of landfilling;
- once after completion of restoration followed by annual level surveys on a number of known fixed points;
- prior to surrender of the permit.

Plan positions of ground features will be determined to within 1m and spot levels to 0.01m will be taken at a density to allow adequate representation of the true landform. Survey drawings will be produced at a scale of not less than 1:1250 and will include all ground features, roads, structures, boundaries, monitoring points and an indication of the surrounding landform.

A calculation of void space in cubic metres will be carried out following each survey during the operation period.

10 Reporting Environmental Performance

The Company will prepare a review of environmental monitoring data every year during the operational life of the site and during the post closure phase, and will undertake a review of the Hydrogeological Risk Assessment as directed by the Environment Agency. The reports will be submitted to the Agency at the frequency required by the permit, or as otherwise agreed with the Environment Agency. A completion report will be prepared at the end of the site completion phase.

The report will include the following information:

- An analysis and review of the environmental monitoring results recorded for the site, with an interpretation of the results against background and trigger levels;
- a review of the risk management systems provided for the site.

References

[1] ESI, 2008. Whitehall control and trigger level review. Report reference: 6496h. May 2008.

[2] ESI, 2016. Whitehall Landfill: Six-year Hydrogeological Risk Assessment Review. Report reference: 60080ADR1.

Appendix A

Landfill Gas Monitoring

A1 Gas Monitoring Procedures

A1.1 General

Landfill gas monitoring will be undertaken by personnel trained in the use of the monitoring equipment and familiar with the monitoring procedures set out below.

All equipment will be maintained and calibrated inline with manufacturers' recommendations.

A1.2 Pre-Sampling Procedures

1. Check the landfill gas monitoring instrument(s) to ensure that it is in within its calibration date.
2. Check the battery life of each instrument is sufficient for the sampling round. If fitted, check that the equipment filter is clean, - if not then replace it.
3. Take a dip meter for checking the depth of water in boreholes.
4. Take a notebook or data recording device.
5. Ensure that the sampler has the means to gain access to the monitoring points that require sampling (e.g. keys, spanners, screwdrivers etc.).
6. If a sample(s) of gas is to be taken ensure that the appropriate sample container(s) is carried and that it is clearly labelled.

A1.3 Monitoring Equipment

The company has, or has access to, several gas measuring devices including:

- Analox 1200 IR Gas Analyser or equivalent;
- Research Engineers Gas Tec;
- GA94
- GA2000
- GEM2000
- Differential 3 Scale Pressure Gauge;
- Flow Meter.

The equipment will conform to BS 6020 or certified to BASEEFA certification standard SFA 3007/1981.

A1.4 Monitoring and Sampling Procedure for Boreholes

A1.4.1 General

Ensure that any sample taken from a gas monitoring borehole is representative of the gases in the ground. Gases present in the well may not be representative of the ground atmosphere on the day of sampling since they may have become stratified or "stagnant".

Ensure that sufficient time is allowed for sampling each well to enable fresh gases to be drawn into the well. The period of pumping will vary from well depending on its size and depth.

Ensure that air is not drawn into the well during the sampling process. The well should be fitted with a removable but airtight cap that contains an integral gas-sampling tap.

A safe system of work should be observed; personnel must wear protective clothing and not smoke in the vicinity of the monitoring point.

A1.4.2 Monitoring Procedure

1. At each well check the appearance and condition of the cover and note any damage or unusual occurrence. Damage must be reported to the Landfill Manager or his nominee as soon as possible and arrangements for repair or replacement actioned.
2. Switch on the gas meter(s) and take a sample of air to "zero" the meter. Ensure that the reading is zero for methane (CH_4) and carbon dioxide (CO_2) and is approximately 21% for oxygen (O_2).
3. If appropriate measure the gas pressure within the well first by connecting the pressure meter to the sampling tap by means of a piece of (rubber) tubing and note the reading obtained.
4. Connect the gas analyser to the sampling tap and pump a sample of gas from the well through the analyser.
5. Note the gas level indicator continuously for changes and pump from the well for at least 2 minutes, or longer until a stable reading is obtained.
6. It is preferable for gas measurements to be taken simultaneously, as there may be limited quantities of sample in the well. With multi-gas analysis this situation is catered for by the instrument but if separate gas monitors are used a compromise can be established by connecting them in series. If this is done then the carbon dioxide (CO_2) meter should be the first instrument in the gas pathway as methane (CH_4) could be oxidised during its passage through a catalytic oxidation detector giving rise to an enhanced carbon dioxide (CO_2) reading.

7. Note the peak readings of methane (CH_4) and carbon dioxide and also note the lowest reading of oxygen (O_2) and whether the readings stabilise after the peak reading have been obtained or whether they fluctuate.
8. Disconnect the analyser and pump air through the machine to return it to "zero".
9. Note the atmospheric pressure.
10. Remove the well cap and dip the well to determine the water level to the marked datum point. Record the water depth and replace the well cap tightly.
11. Proceed to the next well and repeat the procedure.
12. Before leaving site, ask site manager make a note in the site diary to record the date of the monitoring round.

A1.5 Monitoring Records

A permanent record of all gas monitoring is maintained at the Company's Head Office, a copy of which will be kept in the site office during the operational phase. A copy of the results will be submitted to the Environment Agency in accordance with the Permit.

The following information is to be collected and recorded:

- Site code;
- Monitoring point reference code;
- Field equipment reference code;
- Name of sampling personnel;
- Date of monitoring event;
- Time of monitoring event;
- Parameter measured;
- Value;
- Measured value unit;
- Atmospheric pressure;
- Comments on sampling.

A1.6 Limitations of Monitoring Equipment

Catalytic Oxidation detectors (LEL Range of GMI Landsurveyor) require a minimum percentage of oxygen to be present in the sample. Thus in an oxygas instrument such as the Landsurveyor LEL readings must be treated with suspicion at oxygen concentrations of less than 12%. The 100% gas range of the instrument is unaffected by the presence of oxygen but is inaccurate at the low end of the scale.

Flame Ionisation Detectors such as the Gas Tec are very sensitive but are not intrinsically safe. They must not be taken into buildings unless the internal atmosphere has been checked with an instrument such as the Landsurveyor.

The pellisters used in flammable gas detectors are prone to poisoning by a wide range of chemicals many of which may be present in trace amounts in landfill gas. It is for this reason that gas instruments should be regularly recalibrated.

Some gases interfere with the performances of the gas detectors. Hydrogen can significantly increase the response of catalytic oxidation and thermal conductivity meters to methane. Carbon dioxide, on the other hand can depress the response of the meter to methane.

Where the concentrations of gases present in a sample appear strange (e.g. low oxygen, low methane, low carbon dioxide) it may be appropriate to take a gas sample for confirmatory analysis in the laboratory.

Appendix B

Groundwater Monitoring

B1 Groundwater Monitoring Procedures

B1.1 Monitoring Equipment

- Dipmeter;
- Appropriate sample bottles with any necessary preservatives;
- Labels and waterproof markers;
- Flexible hose;
- Graduated bucket;
- Notebook or data recording device;
- Equipment for accessing boreholes (e.g. keys, spanners, screwdrivers, etc);
- Gloves and other relevant PPE;
- Spare waterproof plasters.

B1.2 Pre-Sampling Procedures

Two weeks (or more) prior to sampling:

1. Check with the laboratory in advance to ensure it will be able to cope with the number of samples and the determinands required on the appointed day. Commercial laboratories may require less notice than in-house facilities; but it is recommended that the laboratory is contacted at least two weeks before the sampling round is due.

   NOTE: Analysis must be carried out by laboratories holding NAMAS accreditation for the procedures that are to be employed. Proof of NAMAS accreditation together with details of the analytical techniques must be obtained for each laboratory.

2. Check the amount of sample required, whether any special fixatives are necessary and what type of sampling container(s) should be used and that suitable sampling containers are available or there is still time for the laboratory to supply them.

3. Check that required bottles have been ordered and delivered to agreed location. Allow for QA samples if required (see B1.3.4 below).

The day before or immediately prior to sampling:

Before proceeding on a monitoring round a number of preliminary checks should be made by monitoring personnel to ensure that they:

1. Have all their necessary protective equipment (including gloves).

2. Have any cuts on the hands or forearms covered with waterproof plasters and the equipment should include a spare pack of waterproof plasters.

3. Have all the necessary sampling equipment and that it is clean and in good working order (bailer, dipper, portable Waterra pump, graduated bucket, cool box etc.).
4. Have their notebook or data recording device.
5. Have at least 2 waterproof marker pens (i.e. 1 plus a spare).
6. Have the means to gain access to the monitoring points that require sampling (e.g. keys, spanners, screwdrivers etc).
7. Have a sufficient number of clean sample containers (with any necessary preservatives) and labels available (N.B. allow for at least one spare container).
8. Have a measuring container for gauging the volume of groundwater removed during purging of the boreholes if required.
9. Have details of the depths and diameters of the monitoring wells so that purging volumes can be calculated.

B1.3 Groundwater Monitoring and Sampling Procedure

B1.3.1 General

Ensure that any sample taken is representative of the groundwater in the ground.

Ensure that sufficient time is allowed for sampling each monitoring point to enable fresh groundwater to be taken.

Ensure that the sample is not contaminated by the sampling procedure.

A safe system of work should be observed; personnel must wear protective clothing and not smoke in the vicinity of the monitoring point.

B1.3.2 Groundwater Level Monitoring Procedure

1. Check the monitoring location and reference number and write this in the notebook (or data recorder).
2. Note anything unusual about the monitoring location e.g. damage.
3. Lower the dip-meter probe until the buzzer sounds.
4. Raise the probe slowly until the buzzer stops.
5. Lower the probe slightly until the buzzer just begins to sound.
6. Read the level of groundwater below the datum point from the tape and note the depth.

B1.3.3 Groundwater Sampling Procedure

1. Check the monitoring location and reference number and write this in the notebook (or data recorder).
2. Note anything unusual about the monitoring location, e.g. damage.
3. Measure the level of groundwater in the monitoring well using dip meter.
4. Note depth in notebook and calculate approximate depth of water column within the well.
5. Calculate the volume of groundwater within the well.
6. Pump out three times the standing volume of groundwater and discard.
7. Provided that the sample bottle does not contain fixative chemicals, rinse sample bottle twice with groundwater form latter part of purging operation and rinse outer part of sampling tube. Discard groundwater. If the sample bottle contains fixative do not rinse.
8. Re-insert the rinsed tube to the base of the bottle and fill bottle with the water sample. Continue to pump water into the bottle once full so that excess sample overflows from the bottle. Ensure that the equivalent of several bottle-volumes of water are passed through the bottle, unless the bottle contains fixative chemicals in which case ensure that none of the fixative is lost.
9. Carefully withdraw the sample tube whilst still pumping so that the bottle is completely full.
10. Seal so that it is airtight (i.e. there is no airspace). This procedure ensures that the minimum amount of air is allowed in contact with the sample.
11. Label the sample bottle with the following information, Date, Time, Site, Contents, Location and/or Sampling Point Number.
12. Note anything unusual about the sample e.g. its odour, colour, presence of foreign bodies etc.

B1.3.4 Sample Storage and Delivery

Complete, sign and date a chain of custody record to accompany the sample to the laboratory.

Provide the analyst with a written order that details which determinands are to be tested for and any pre-analysis preparation that is required (e.g. filtering of the sample), ensuring that it is clear that the standard procedures for the CEMEX contract are to be followed.

Before leaving site, make a note in the Site diary to record the date of the sampling round and the date the samples were delivered to the laboratory.

On handing over samples ensure that the person receiving completes the chain of custody record and retain a signed copy.

B1.3.5 Analysis Results

The analysis results will be entered onto the Company environmental database. The original certificates of analysis will be placed on file at The Company's head office.

Appendix C

Noise Monitoring

C1 Noise & Vibration Monitoring Procedures

C1.1 General

CEMEX do not propose to carry out routine monitoring. Should any complaints be received, the following procedures will apply.

All noise monitoring should be undertaken in accordance with BS 4142.1997 – Rating industrial noise affecting mixed residential and industrial areas.

C1.2 Measuring Equipment

C1.2.1 Equivalent continuous noise level

Equivalent continuous noise levels shall be measured using an integrating-averaging sound level meter or equivalent system conforming to type 2 or better of BS EN 60804 and reported in terms of $L_{A90,\,T}$ and $L_{Aeq\,T}$.

NOTE. If the noise is steady, an approximation to $L_{Aeq,T}$ can be obtained by visually averaging the indication of a sound level meter set to frequency weighting `A' and the use of this method should be reported.

C1.3 Measurement practice

C1.3.1 Operational tests

Apply an acoustic calibrator or pistonphone conforming to BS 7189 to the microphone to check

C1.3.2 Measurement Positions

Choose measurement positions that are outside buildings and that will give results that are representative of the specific noise level and background noise level at the buildings where people are likely to be affected.

The measurement position should be

- At least 3.5m from any reflecting surface other than the ground;
- Between 1.2 and 1.5m above the ground.

Report the measurement position, height and the distance from any reflecting structure other than the ground.

Where possible, adopt the same monitoring position for each survey to ensure consistency between the results.

C1.3.3 Precautions Against Interference

Take precautions to minimize the influence on the readings from sources of interference such as the following (and from any other sources):

- wind, passing over the diaphragm of the microphone of a sound level meter which can generate noise interference;
- heavy rain, falling on the microphone windshield or nearby surfaces which can cause noise interference;
- electrical interference, which can be caused in the sound level meter by, for example, nearby power cables or radio transmitters.

Use an effective windshield to minimize turbulence at the microphone.

NOTE. For the purposes of this standard, windshields are generally effective up to windspeeds of 5 m/s.

Record the weather conditions prevailing during all measurements.

Measured levels shall be considered valid only if they exceed readings on the measuring instrument owing to the above influences by at least 10 dB.

Postpone monitoring if:

- Average wind speed is greater than 5 m/s;
- Temperature is less than 3°C.

C1.4 Measurement Period

The specific noise level at the assessment locations will be determined as a discrete entity, distinct and free of influence from other noises contributing to the ambient noise.

C1.4.1 Survey Frequency

The noise level surveys will be undertaken in the event of noise complaints during the operation of the site.

C1.4.2 Time of Survey

The noise monitoring must:

- Be undertaken during typical working hours;
- Should avoid meal breaks;
- Should avoid period of plant breakdown.

C1.4.3 Reference time interval

Two 15 minute samples should be made at each location within the normal working day.

If it appears that the site noise at any dwelling is within 1 dB(A) of, or may be exceeding the relevant day to day limit, or temporary operation noise limit if appropriate, site noise shall be monitored for a full 1 hour and a report made of the site noise sources which are considered to be the cause of the excess.

Where practicable, extraneous noise should be paused out of the survey but where this proves impossible a note shall be made of the best estimate of noise from the site. Where extraneous noise dominates the overall noise level, a clear statement to that effect shall be included in the report. Where extraneous noise is below the site noise contribution, a correction shall be made to the site noise to allow for the extraneous portion in accordance with the provisions of BS 4142:1997.

C1.5 Rating Level

Certain acoustic features can increase the likelihood of complaint over that expected from a simple comparison between the specific noise level and the background noise level. Where present at the assessment location, such features are taken into account by adding 5 dB to the specific noise level to obtain the rating level.

Apply a 5 dB correction if one or more of the following features occur, or are expected to be present for new or modified noise sources:

- the noise contains a distinguishable, discrete, continuous note (whine, hiss, screech, hum, etc.);
- the noise contains distinct impulses (bangs, clicks, clatters, or thumps);
- the noise is irregular enough to attract attention.

NOTE. The rating level is equal to the specific noise level if there are no such features present or expected to be present.

C1.6 Reporting

The following information shall be reported:

a) source under investigation as follows:

1) description of source and of specific noise;

2) hours of operation;

3) mode of operation (e.g. continuous, twice a day, only in hot weather);

4) description of premises in which source is situated (if applicable).

b) subjective impressions including:

1) dominance or audibility of specific noise;

c) location of measurement positions, their distance from the specific noise source and the topography of the intervening ground, distance from specific

noise source and any reflecting surface other than the ground including a dimensioned sketch with a north marker;

d) noise measuring instruments including calibrator or pistonphone used:

1) type;

2) manufacturer;

3) serial number;

4) details of the latest verification test including dates.

e) operational test:

1) reference level of calibrator or pistonphone;

2) meter reading before and after measurements with calibrator or pistonphone applied.

f) weather conditions, including:

1) wind speed and direction;

2) presence of conditions likely to lead to temperature inversion (e.g. calm nights with little cloud cover);

3) precipitation;

4) fog.

g) date and time of measurements;

h) specific noise level;

1) measured noise level(s);

2) residual noise level and method of determination;

3) specific noise level and method of determination;

4) justification of methods;

5) details of any corrections applied.

i) measurement time intervals;

j) reference time interval(s);

k) rating level;

1) specific noise level;

2) any acoustic features of the specific noise;

3) rating level.

l) background noise level and measurement time interval and in the case of measurements taken at an equivalent location, the reasons for presuming it to be equivalent;

m) excess of the rating level over the measured background noise level and the assessment.

If site noise level appears to be exceeding the relevant noise limit, the operating company shall be informed within 1 working day and advised of the preliminary findings.

Copies of the noise monitoring reports shall be kept on site for five years from the monitoring date. Noise monitoring reports shall be submitted to the Environment Agency in accordance with the permit.