CEMEX UK Materials Limited
Whitehall Landfill
Permit number: MP3036SS
Variation number: LP3630MR

Annual environmental monitoring report for 2015

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1 Introduction

The PPC permit, issued 17 March 2006, for Whitehall Landfill, Permit Number MP3036SS, specifies under condition 4.1.3 that:

"*The Operator shall submit to the Agency a report on the performance of the Permitted Installation over the previous year, by 31 January each year*"

The Variation notice, issued 22 June 2007, Variation Number LP3630MR amends this under condition 4.2.1 to:

"A report or reports on the performance of the activities over the previous year shall be submitted to the Agency by 31 January (or other date agreed in writing by the Agency) each year. The report(s) shall include as a minimum:

(a) A review of the results of the monitoring and assessment carried out in accordance with this permit against the relevant assumptions, parameters and results in the risk assessments submitted with the Application;

(b) Where the operator's management system encompasses annual improvement targets a summary report of the previous year's progress against such targets.

(c) The annual production/treatment set out in Schedule 5 table S5.2

(d) Details of any contamination or decontamination of the site which has occurred

(e) The topographical surveys required by condition 3.6.3 other than those submitted as part of a CQA validation report

(f) The volumetric difference (reported in cubic metres) between the most recent topographical survey and the previous annual topographical survey i.e. the additional volume of the landfill void that is occupied by waste;

(g) An assessment of the settlement behaviour of the landfill body based on the difference between the most recent topographical survey and previous annual topographical survey for the areas of the landfill which did not receive waste between the surveys;

(h) A calculation of the remaining capacity (reported in cubic metres) derived from the pre-settlement contours and the most recent topographical survey;

(i) The compliance testing undertaken in the period.

This report is presented in compliance with these conditions.

In April 2008 the Environmental Permitting Regulations 2008 replaced the PPC Regulations in their entirety, and landfill PPC permits became Environmental Permits; from this point on all references to the site permit in this report are therefore to the Environmental Permit (EP).

The site covers an area of 5.2 ha and lies in a closed limestone quarry to the northwest of Wenvoe, approximately six miles southwest of Cardiff City Centre, South Glamorgan, at NGR 311700 173450. It is permitted to accept inert waste.

The site is surrounded by fields and woodland to the north and woodland to the east (Figure 1). To the west of the site are fields crossed by footpaths and containing a small pond. The southern part of the site is mostly bounded by fields and a track, with

woodland towards the eastern part. The south eastern tip of the site is bounded by the houses and gardens along Wallston Road in Wallston which is at the north western edge of Wenvoe.

2 Site History

The landfill occupies a limestone quarry that was operational from around 1930 until 1976. After cessation of operations the site lay dormant for 20 years. In 1984 a planning application for disposal of inert waste was approved. Following this, in 1996, a Waste Management Licence was granted (by the WRA, the Vale of Glamorgan Borough Council at the time) and landfill operations at the site began.

Waste was first accepted at Whitehall Landfill in November 1998. The site formally operated under Waste Management Licence Number WM130189. Under the WML, the site was licensed to accept solid inert wastes including soils (top soil, sub-soil and overburden), brickwork, stone, concrete, sand (excluding foundry sand), cement, plastics, glass and fired pottery/ceramics. Certain other materials could also be accepted into the landfill provided that together they made up no more than 1% by volume of any one load. These included plaster, wood, wood products and cardboard and paper products.

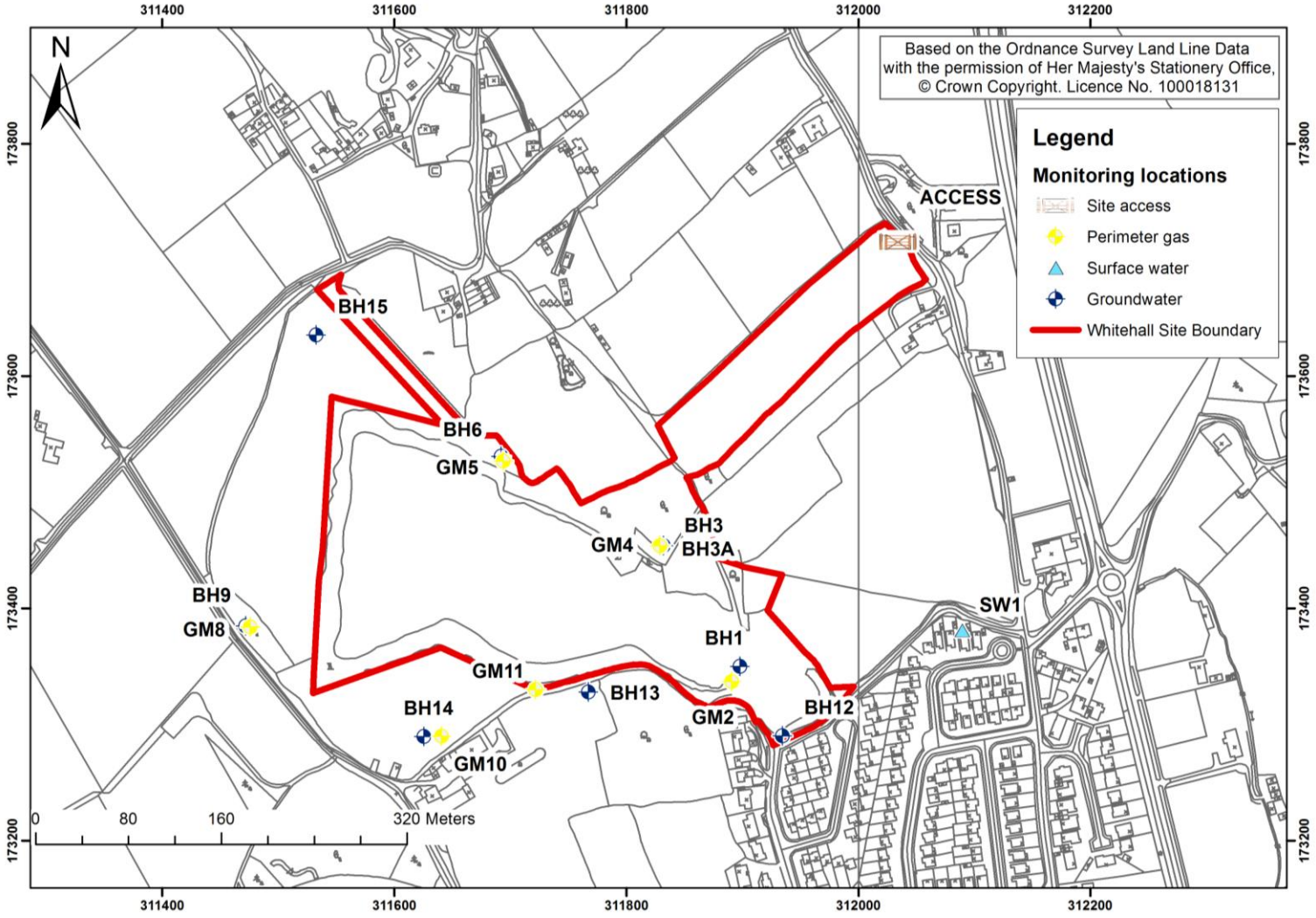
The principal waste streams arriving at Whitehall Quarry are all of construction and demolition waste, originating from various districts within Wales.

There are three closed landfills situated to the north, up gradient of Whitehall Quarry. The most northerly of these, Greenwood Quarry, located approximately 500 m from Whitehall Quarry (Drawing ESID 2, ESI (2005)), was licensed to receive inert and semi-inert material (Wildgust, 1998. Lafferty, 1998). Operations ceased in 1988.

Greenwood Old Quarry lies immediately south of this and was licensed to accept solid non-toxic wastes although Wildgust (1998) and Lafferty (1998) suggest that material outside this classification was also accepted.

The most southerly of these sites, Blue Pool, located approximately 130 m from Whitehall Quarry (Drawing ESID 2, ESI (2005)), accepted solid non-toxic wastes and asbestos. Again Wildgust (1998) and Lafferty (1998) suggest other materials were disposed of at this site.

Figure 1 Site Location Plan



3 Review of Monitoring Data

Schedule 4 of the site Permit specifies that monitoring of landfill gas and groundwater level and quality is required to assess any potential impact of the landfill on the surrounding environment. The following sections review the data collected from January to the end of the calendar year in December 2015. The locations of the monitoring points are shown on Figure 1.

3.1 Landfill Gas Monitoring

Landfill gas has been monitored for selected parameters in seven perimeter gas monitoring boreholes on an approximate monthly frequency, in accordance with the requirements specified in the variation notice. The location of these boreholes is shown on Figure 1. Appendix A presents all gas monitoring data collected at these locations during 2015.

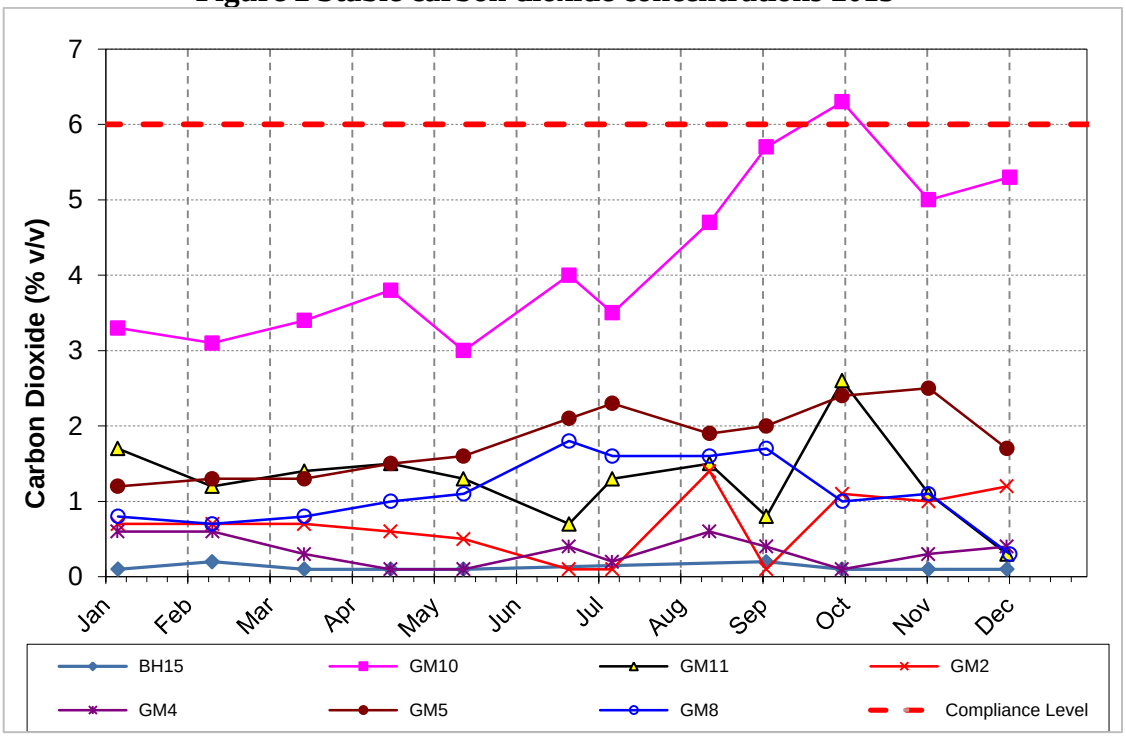
One of the stipulated gas monitoring locations, GM7, was permanently lost in 2007. It has since been replaced by BH15 and gas monitoring has been undertaken at this location (with some interruptions for accessibility issues) since December 2007.

Compliance limits for stable methane and carbon dioxide of 1% v/v and 6% v/v respectively have been derived to provide threshold criteria and allow quantitative assessment of any potential harmful emissions from the landfill.

Methane has not been detected at concentrations above the instrumental detection limit throughout the monitoring period in 2015.

Stable carbon dioxide concentrations between January and December 2015 are compared to the 6% v/v compliance limit at the required gas monitoring locations in Figure 2 below.

Figure 2 Stable carbon dioxide concentrations 2015

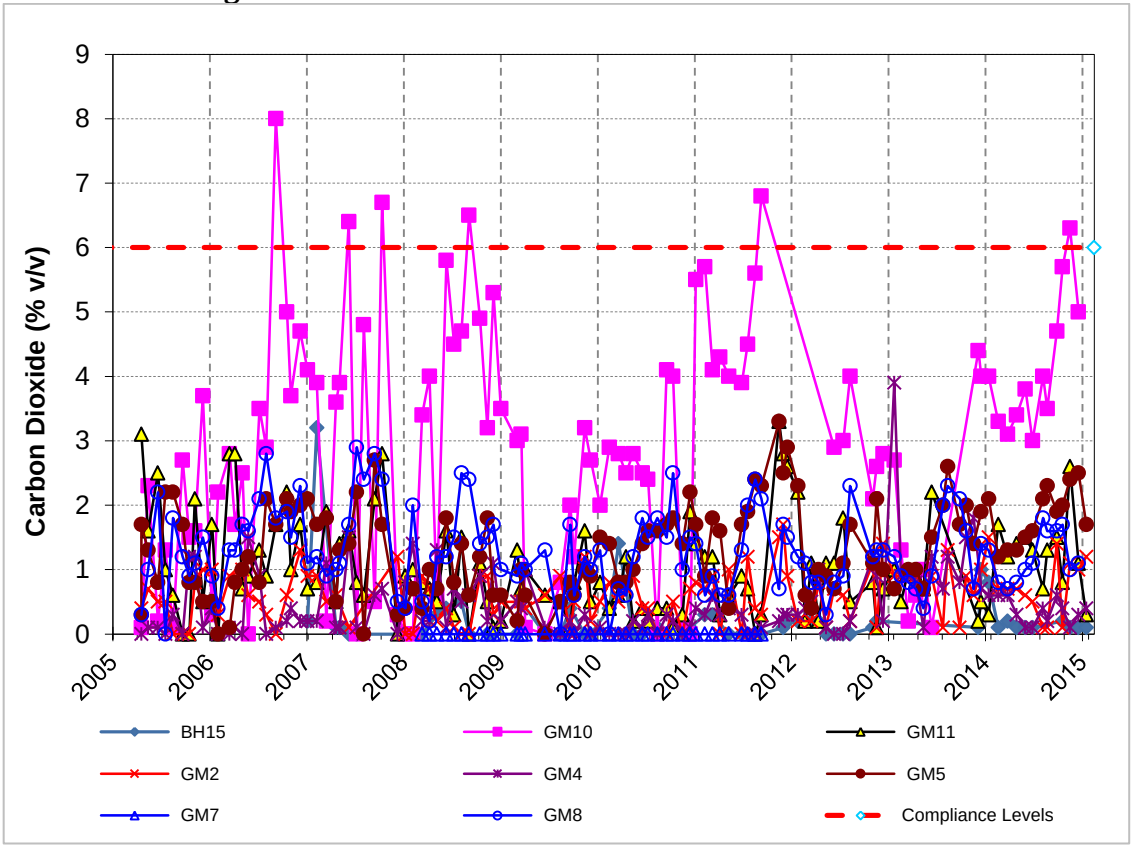


The carbon dioxide compliance limit was exceeded once during 2015 within GM10 in October 2015 with a reading of 6.3%. The majority of monitoring locations showed concentrations below 3% v/v. Historically carbon dioxide concentrations have always been highest in GM10.

As with previous years, there are no apparent short term trends in the data and concentrations are variable over the year at all monitoring points. Variations tend to correlate from one borehole to another, and are presumably related to variations in barometric pressure.

Historical stable carbon dioxide concentrations from early 2006 onwards are presented in Figure 3 below. The data show that concentrations of carbon dioxide were similar in 2015 to those in 2014 and previous years.

Figure 3 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the Permit requires groundwater quality to be monitored at four down-gradient site perimeter boreholes, BH1, BH12, BH13 and BH14, which have compliance limits set, as well as at five up-gradient boreholes BH3, BH3A, BH6, BH9 and BH15, which do not have any compliance limits. These were sampled on an approximate monthly frequency during 2015. The locations of the monitoring boreholes are shown on Figure 1.

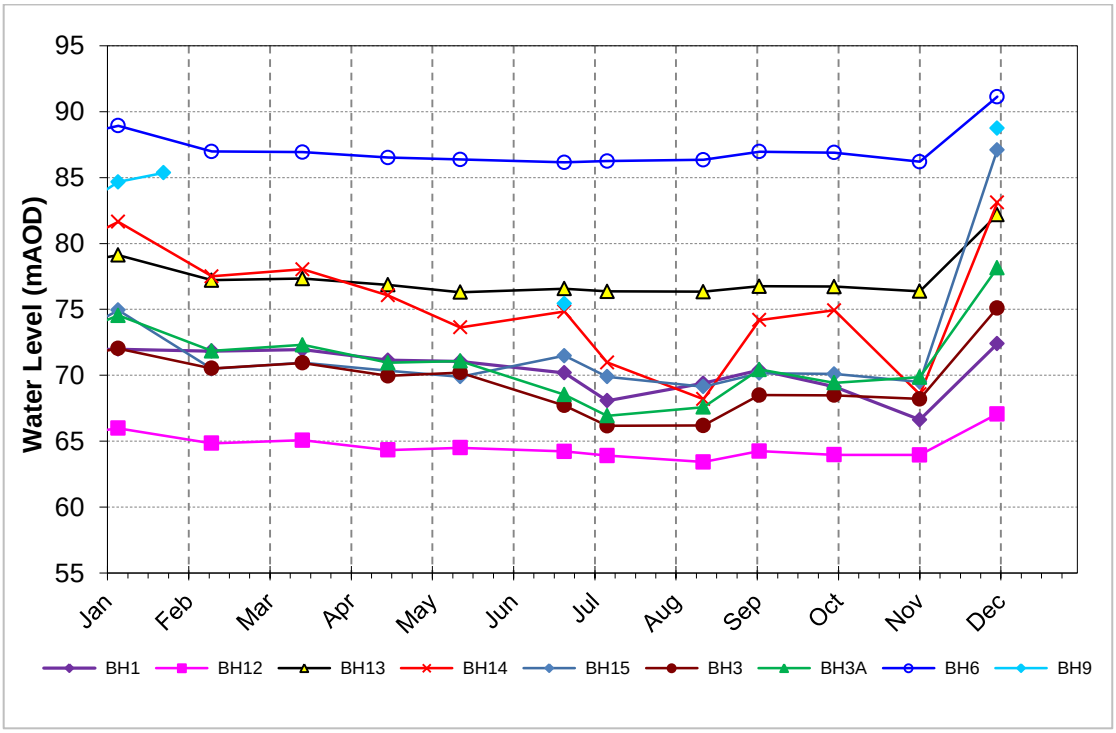
3.2.1 Groundwater Levels

Figure 4 presents the groundwater level data collected during the 2015 monitoring period.

BH9 was only monitored on 4 occasions, twice in January, once in June and once in December. The remaining monitoring visits recorded that the well was dry. BH9 is known to be blocked and the dip probe cannot pass to the full depth of the installed well. This was established following a camera survey carried out in May 2015, at which time a second minor blockage was also removed. Therefore it is only possible to monitor this well under high groundwater level conditions.

The groundwater hydrograph shows moderately increased levels between November and December, reflecting the higher levels of recharge during these months. Generally groundwater levels drop from January to February and remain relative steady prior to the increase in December. After a slight drop in groundwater levels throughout the year from January, groundwater levels are at their lowest in July and August. BH14 fluctuates the greatest throughout the year with lower groundwater levels observed in July, August and November.

Figure 4 2015 Groundwater levels

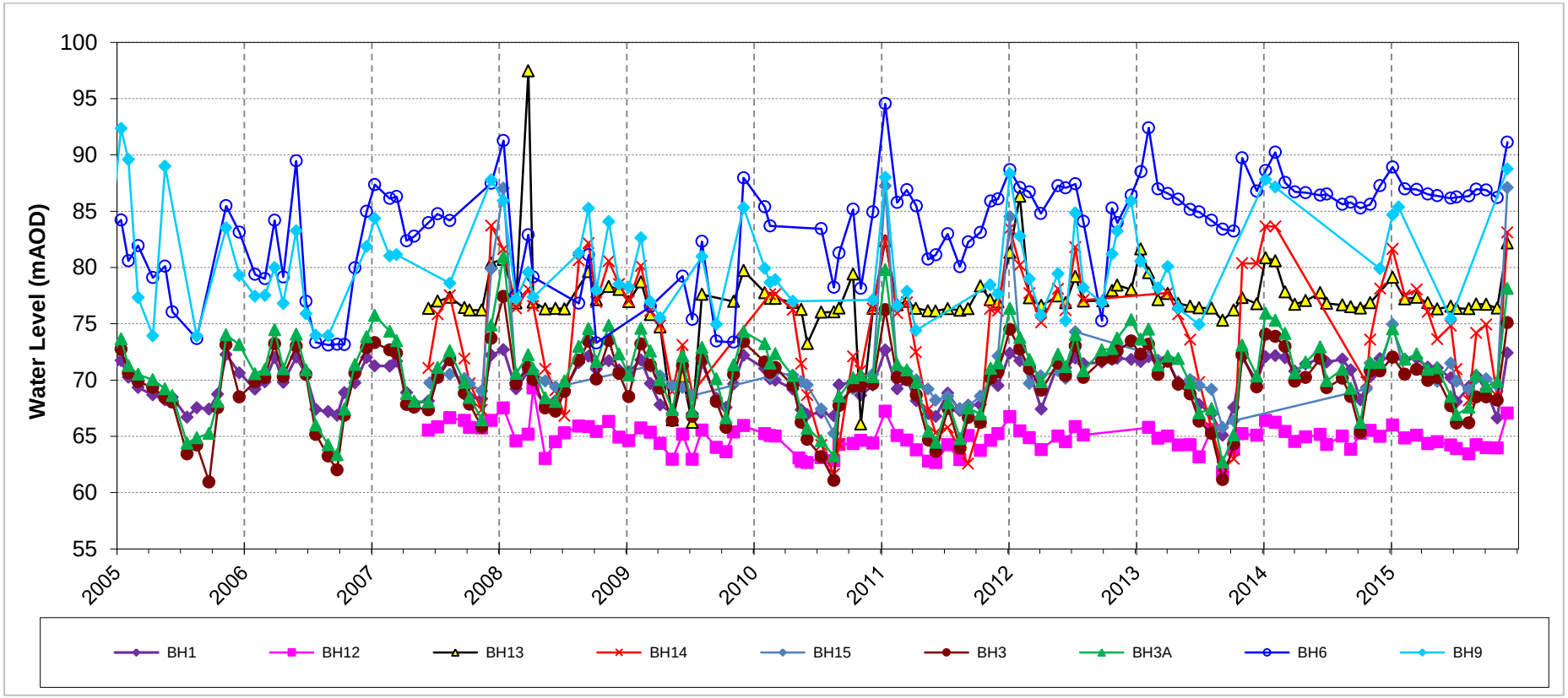


Groundwater levels have been monitored monthly at BH1 to BH3 from mid-1996 to present and at BH3A from mid-2000 to present. Monthly monitoring for BH12 to BH14 has been undertaken since their installation in July 2007.

Historical observed water levels for all monitoring locations are shown in Figure 5. The groundwater levels monitored in BH3 and BH3A exhibit a similar trend to BH1, but with greater variation. The remaining monitoring locations all exhibit similar fluctuation timings, with varying degrees of variation, BH12 / BH13 showing the least variation and BH14 showing the most. Groundwater levels are generally more variable to the south-west where, historically, the variation in groundwater level is markedly greater in BH14. BH9 also showed a large variation in groundwater levels, however, no clear evaluation of 2015 data is possible for BH9 due to the absence of a full data because of the measurement issues noted above.

Groundwater levels for BH12 and BH13 remain consistent throughout the year with the exception of the water level recorded for December. Groundwater levels in BH1, BH3 and BH3A decline between May and July before increasing again in August From January through November, the range of water levels at the monitoring locations is less than 7.0 m, however from November to December an increase in water levels is observed across all monitoring locations varying from 3.1 m in BH12 to 17.59 m in BH15, the mean across all monitoring locations (excluding BH9) was recorded at an increase of 8.36 m. Such variations are common in limestone aquifers that have limited storage.

Figure 5 Historical groundwater levels



3.2.2 Groundwater Quality

Groundwater quality monitoring has been conducted in accordance with conditions specified in Schedule 4 of the PPC Variation Notice (LP3630MR) for stipulated parameters on an approximate monthly frequency and for additional parameters on an annual basis. The entire data set for 2015 is presented in Appendix C.

3.2.2.1 Determinands for which compliance limits have been set

Compliance limits for the groundwater quality parameters have been derived in order to quantitatively assess landfill performance. A review of defined compliance limits was conducted by CEMEX in 2008 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.

Table 1 below details the compliance limits applied to the appropriate groundwater quality determinands at the required locations. There are no compliance limits specified for up-gradient boreholes BH3, BH3A, BH6, BH9 or BH15.

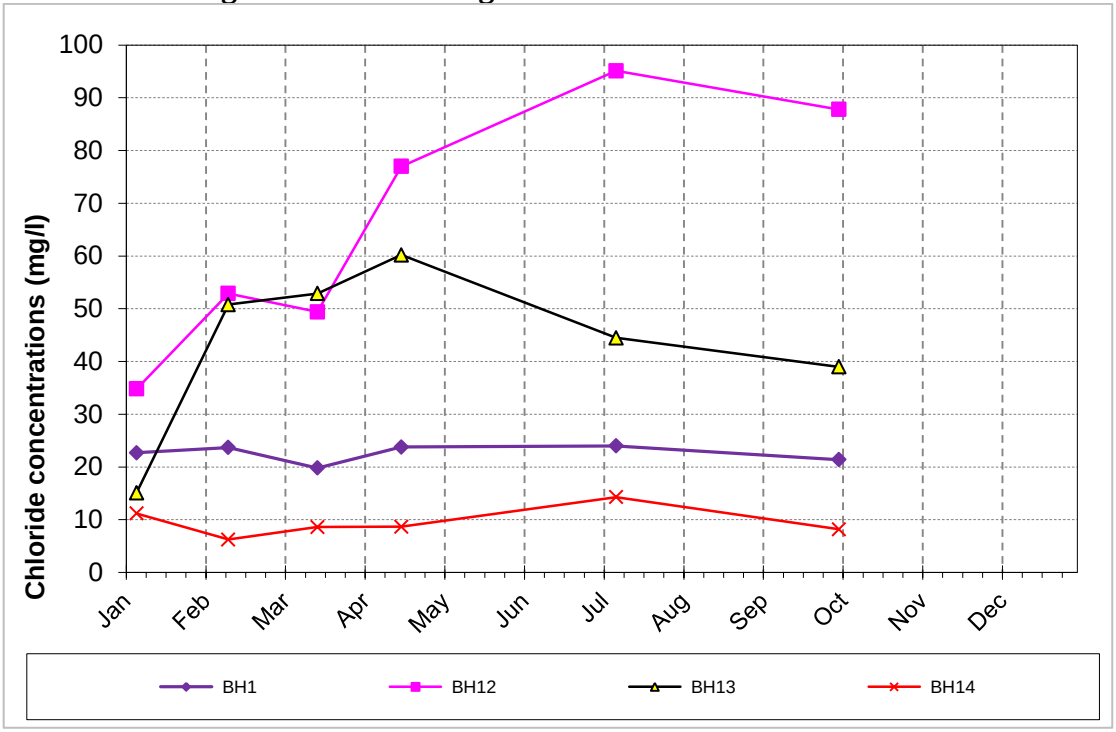
Table 1 Groundwater quality compliance limits

	Compliance Limit				
Monitoring Locations	**Ammoniacal Nitrogen (mg/l)**	**Chloride (mg/l)**	**Iron as Fe (µg/l)**	**Potassium (mg/l)**	**Naphthalene (µg/l)**
BH1	0.39	250	200	12	0.05
BH12				14.73	
BH13				12	
BH14					

Ammoniacal nitrogen results for 2015 showed only three results above the limit of detection (0.06 mg/l) with concentrations of 0.16 mg/l and 0.11 mg/l in BH14 in February and July respectively, and 0.17 mg/l in BH15 in April.

Figure 6 presents observed chloride concentrations in all the down-gradient boreholes for the year. There were no breaches of the chloride compliance limit during 2015, with the maximum observed chloride concentration being 95.1 mg/l (which is over 15 mg/l below the peak recorded chloride concentration in 2014).

Figure 6 2015 Down-gradient chloride concentrations

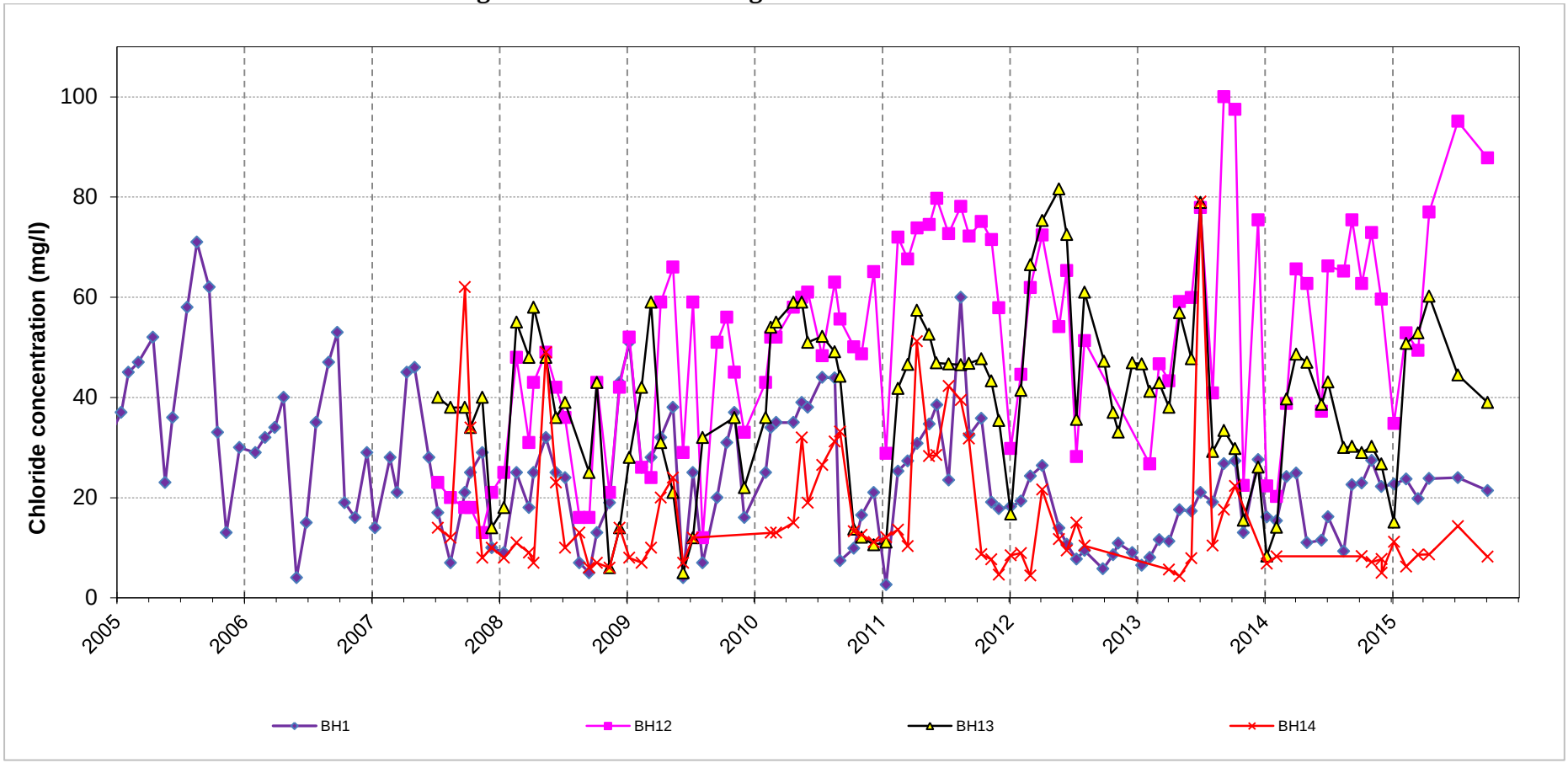


Groundwater at BH12 had the highest recorded chloride concentrations and also the highest baseline concentrations over the year. In two locations, BH12 and BH13, an increase in concentration between January and December of 53.0 mg/l and 23.9 mg/l is recorded, however in BH14 chloride concentrations are shown to decline between January and December by 3 mg/l. Concentrations remained stable in BH1 throughout the year. Chloride concentrations in BH13 show an upward trend during the spring and a downward trend in the autumn, consistent with previous years.

Historical chloride concentration data from 2003 to the present time are displayed in Figure 7.

Data for BH12-BH14 are only available following their installation in July 2007. Chloride concentrations in BH13 have reduced since their peak of 81.6 mg/l in 2012.

Figure 7 Historical down-gradient chloride concentrations



There have been no detections of naphthalene during 2015, with all results below the 0.01 µg/l limit of detection.

There were a total of 12 exceedances of the iron compliance limit (200 µg/l) in 2015 with a reported exceedance at each compliance limit location in January, February and March 2015 of 230 µg/l at the limit of detection. The limit of detection was subsequently lowered to 120 µg/l from April onwards, reducing the chance of any further potentially erroneous exceedances of the compliance limit. There was only one detection of iron, reported at 274 µg/l, in BH3 in January.

Observed potassium concentrations during the monitoring period are compared to the assigned compliance limits in Figure 8 and historical potassium concentrations since 2003 are provided in Figure 9.

Potassium concentrations in BH13 and BH14 are relatively low and stable throughout 2015. As has been observed in previous years, potassium concentrations at BH1 and BH12 are relatively elevated. In 2015 the maximum concentration in BH1 reached or exceeded the compliance limit on three occasions, in January, October and December respectively, with a maximum concentration of 25.9 mg/l in December. Concentrations at BH12 ranged between 5.6 mg/l and 15.9 mg/l, with exceedances of its specific compliance limit in October and November.

Historical potassium concentrations in BH13 and BH14 have remained consistently low with the exception of a couple of anomalous peaks in 2008 and 2013. Historical potassium concentrations for BH1 remained relatively consistent between when data was first recorded in mid-1996 through until mid-2011. Since mid-2011 concentrations have steadily increased with peaks in concentration above the compliance limit in the autumn-winter months of 2011, 2012, 2013, 2014 and 2015. The greatest peak recorded in BH1 was observed in 2014 at 19 mg/l in October. BH12 has seen an increase in concentrations year on year since data was first recorded in 2007 with concentrations above the compliance limit being recorded on numerous occasions each year since 2010. However, the peak concentration recorded during 2015 of 15.9 mg/l is slightly below the concentration observed in 2014 at 16.4 mg/l, suggesting that potassium levels may be levelling off or decreasing overall. Similarly to 2014, the peak potassium concentration in BH12 fell below the peak concentration monitored in BH1 for the second time since monitoring began.

Potassium concentrations in down-gradient wells BH13 and BH14 must be compared to the up-gradient wells (Figure 12). Potassium concentrations are elevated in up-gradient borehole BH9, where they have been recorded at over 25 mg/l in 2003 to 15 mg/l at the start of 2015 and 13.8 mg/l in December 2015. BH3A, which is cross-gradient, also shows elevated potassium with an annual maximum of 6.73 mg/l recorded in October 2016.

The nature of the rises and falls in potassium concentrations at up and down-gradient wells and the absence of other contamination such as chloride or ammoniacal nitrogen indicates an off-site source rather than Whitehall Landfill itself.

The absence of contamination observed at BH1 and BH14 indicates the heterogeneous nature of groundwater flow within the limestone aquifer which occurs predominantly as fissure flow.

Figure 8 Down-gradient potassium concentrations

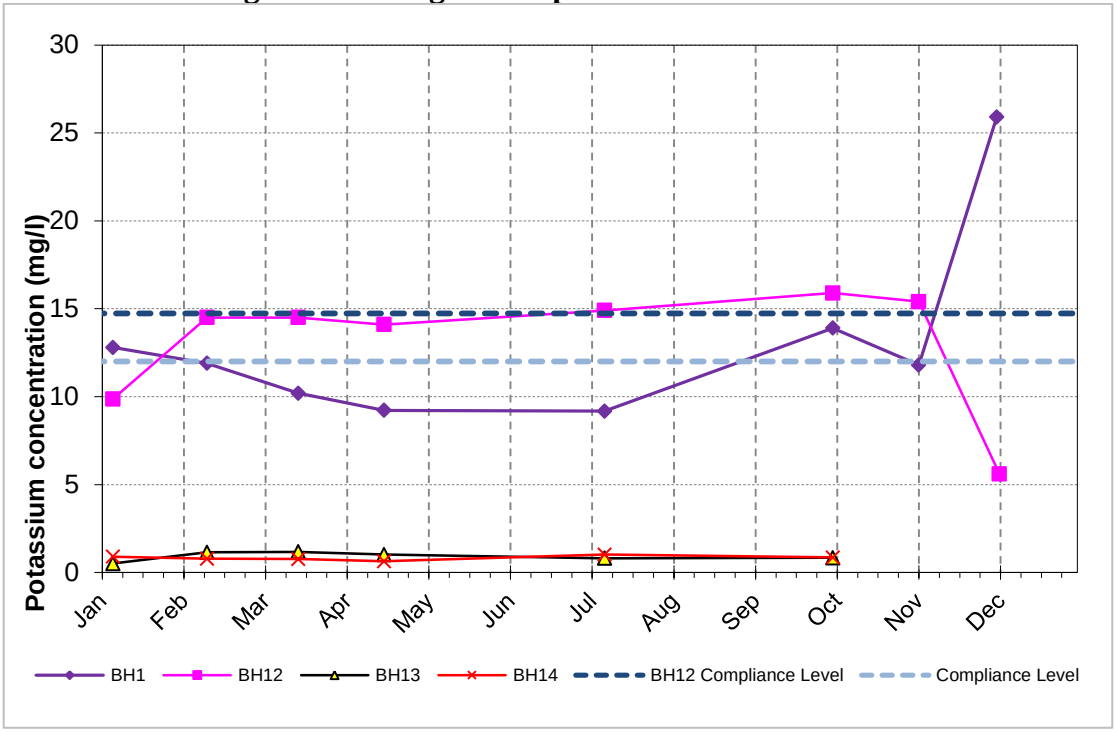
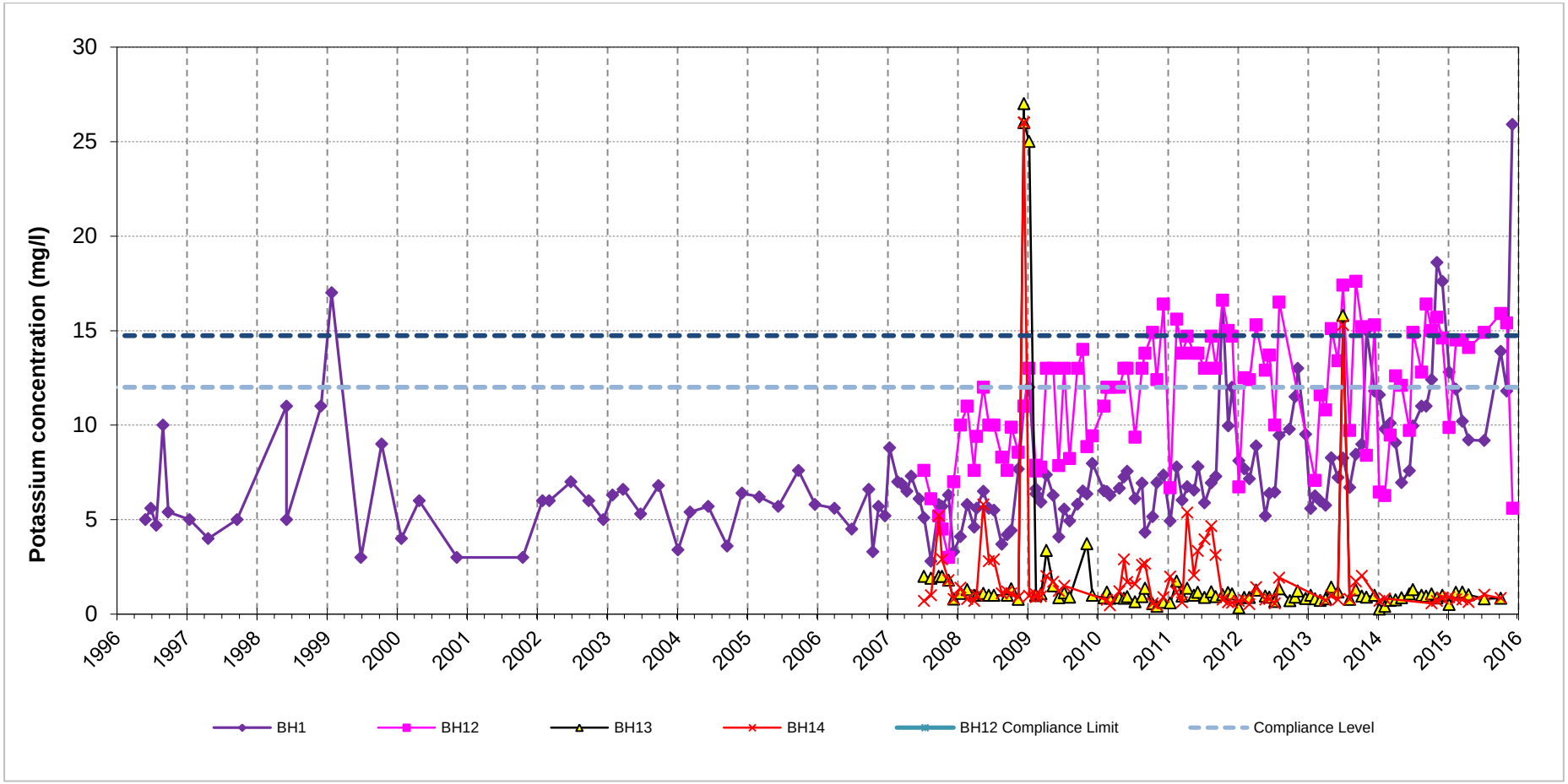


Figure 9 Historical down-gradient potassium concentrations



3.2.2.2 Determinands for which compliance limits have not been set

Table S4.4 of Schedule 4 of the PPC Variation Notice (LP3630MR) provides a list of parameters to be monitored at monthly and annual intervals. Table 2 provides a statistical overview of the results of the monitoring rounds.

The data show groundwater is generally of high quality with only potassium, sulphate and manganese occasionally observed at concentrations above the UK drinking water standard (DWS) concentrations.

Ammoniacal nitrogen concentrations from 2003 to present for all up-gradient boreholes are given in Figure 10 with the UK DWS shown as a red dotted line. The DWS was exceeded on two occasions in 2014 at BH3A with a recorded concentration of 0.89 mg/l in May and 2.45 mg/l in July, however no exceedances were recorded in 2015.

Figure 10 Up-gradient ammoniacal nitrogen concentrations

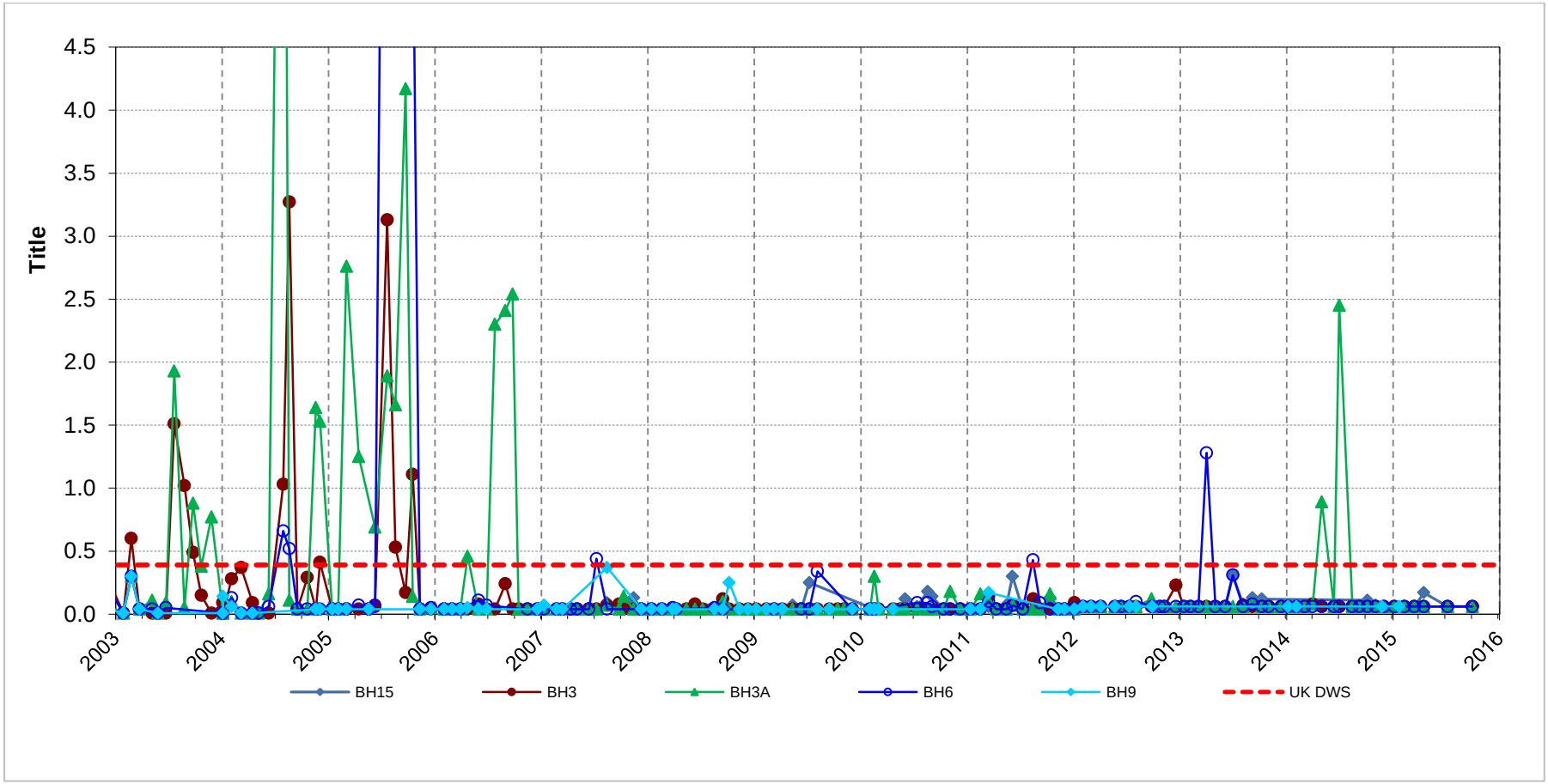


Table 2 Statistical summary of groundwater quality in 2015

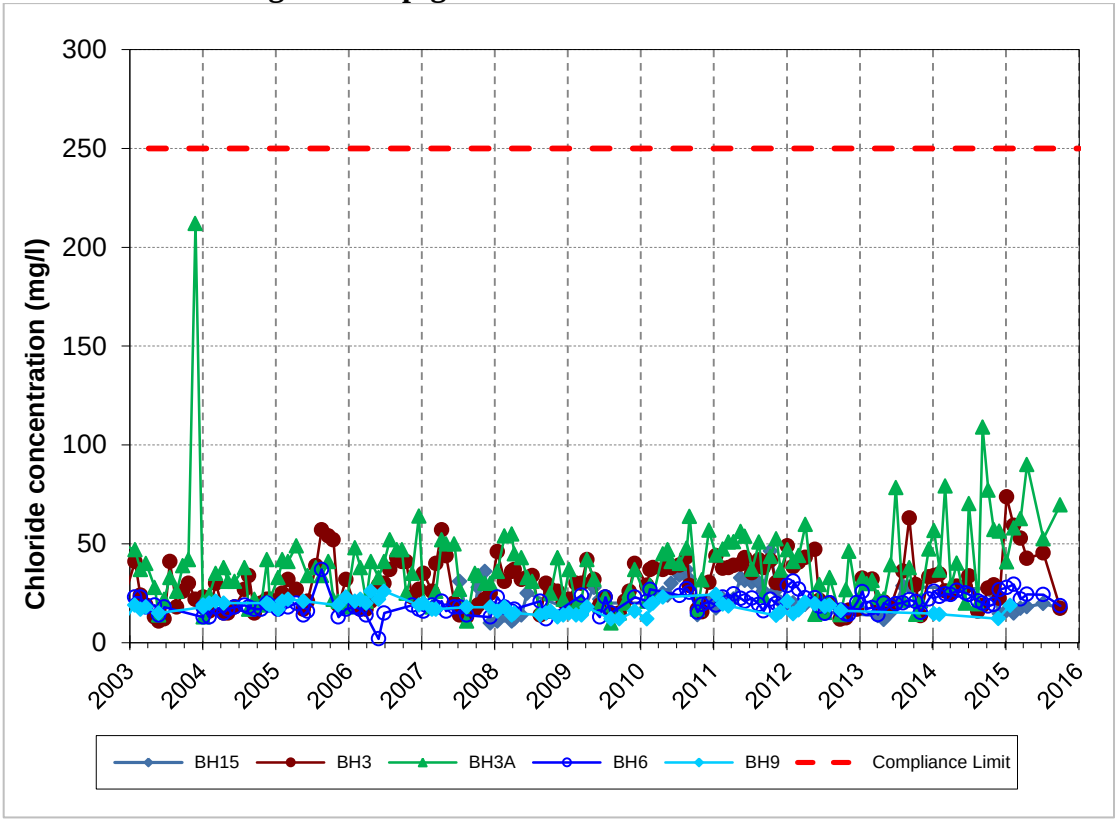
Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS No. Exceeding	UKDWS % Exceeding	UKDWS Action Level
Field and laboratory parameters													
Conductivity- Electrical (Field)	47	µS/cm	507	1467	758	210	576	1255	47	100	-	-	-
Conductivity- Electrical 20deg	49	µS/cm	537	1360	733	208	552	1256	49	100	-	-	-
D.O. concentration	8	mg/l	2.6	9.2	6.21	2.16	3.09	8.75	8	100	-	-	-
pH	49	pH units	7.4	8.4	7.92	0.293	7.5	8.36	49	100	-	-	-
Major ions													
Alkalinity as CaCO3	49	mg/l	144	441	316	69.6	199	428	49	100	-	-	-
Calcium	49	mg/l	73.3	213	114	35.9	83.2	208	49	100	0	0	250
Chloride	49	mg/l	6.25	95.1	36.5	23.6	8.63	83.5	49	100	0	0	250
Magnesium	49	mg/l	16.3	47.7	28	9.01	17.3	41.8	49	100	0	0	50
Nitrate as N	8	mg/l	<0.42	5.93	1.52	1.96	n.d.	4.78	5	62.5	0	0	11
Nitrogen (total oxidised) as N	49	mg/l	<0.42	9.48	1.65	2.25	n.d.	6.4	27	55.1	-	-	-
Potassium	54	mg/l	0.51	25.9	5.62	6.08	0.773	15.3	54	100	11	20.4	12
Sodium	49	mg/l	3.65	58.1	18	13.7	4.22	46.4	49	100	0	0	200
Sulphate as SO4	49	mg/l	<4.4	447	75.6	113	2.1	341	48	98	6	12.2	250
Metals													
Cadmium	8	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.005
Chromium	8	mg/l	<0.002	<0.002	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.05
Copper	8	mg/l	<0.009	<0.009	n.d.	n.d.	n.d.	n.d.	0	0	0	0	2
Iron	25	mg/l	<0.23	0.274	n.d.	n.d.	n.d.	n.d.	1	4	1	4	0.2
Iron	24	mg/l	<0.12	<0.12	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.2
Lead	8	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.025
Manganese	8	mg/l	0.022	0.153	0.0433	0.0449	0.0227	0.115	8	100	1	12.5	0.05

Determinand	No. of Results	Unit	Min	Max	Mean	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS No. Exceeding	UKDWS % Exceeding	UKDWS Action Level
Nickel	8	mg/l	<0.003	<0.003	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.02
Zinc	8	mg/l	<0.018	0.02	n.d.	n.d.	n.d.	0.0162	1	12.5	0	0	5
Nitrogen species													
Ammoniacal Nitrogen as N	49	mg/l	<0.06	0.17	n.d.	n.d.	n.d.	0.078	3	6.12	0	0	0.39
Other parameters													
Bicarbonate Alkalinity	8	mg/l	229	419	317	68.1	239	410	8	100	-	-	-
COD (Total)	8	mg/l	13	25	17.5	3.89	13.4	23.3	8	100	-	-	-
Naphthalene	49	mg/l	<1E-05	<1E-05	n.d.	n.d.	n.d.	n.d.	0	0	-	-	-
TOC (filtered)	49	mg/l	0.8	8.7	3.52	1.96	1.32	7.2	49	100	-	-	-

** Mean statistics for non-detects are calculated at half the limit of detection.*

Chloride concentrations in up-gradient monitoring locations are shown on Figure 11. BH3A, in contrast to the other up-gradient monitoring locations, has shown a generally rising trend in chloride concentrations over 2013, 2014 and 2015.

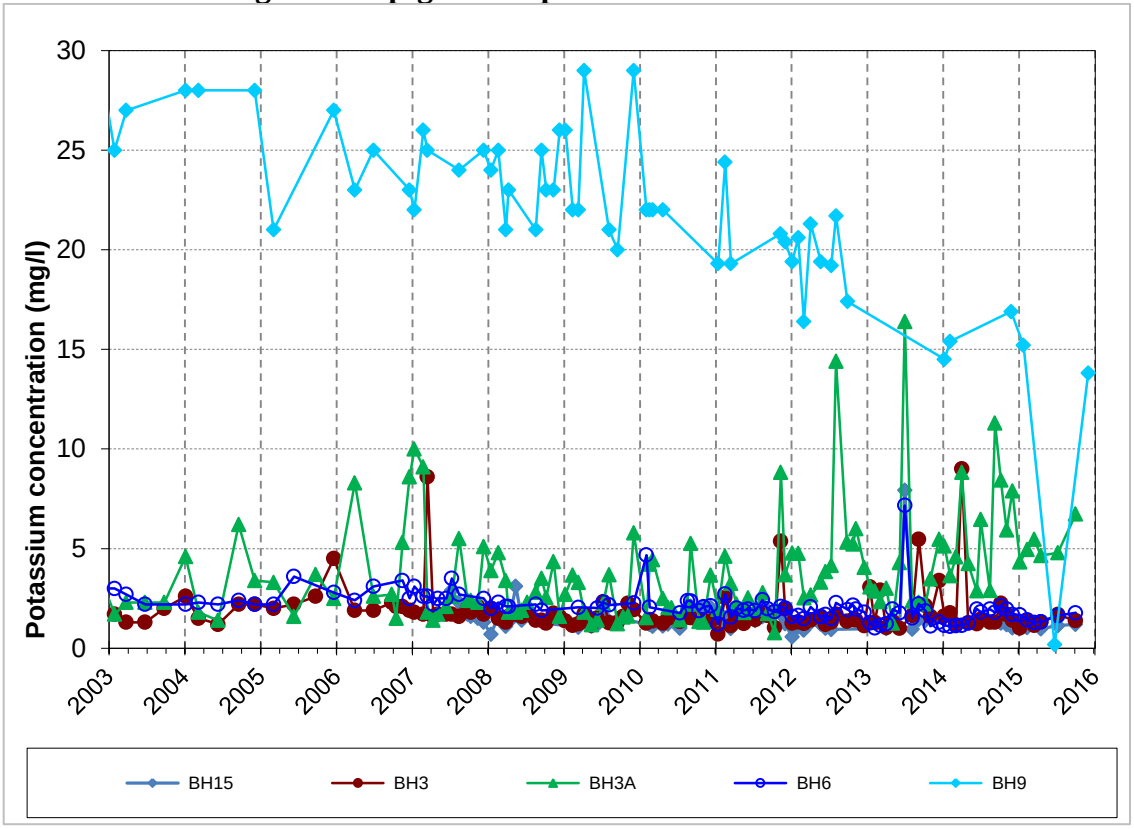
Figure 11 Up-gradient chloride concentrations



Potassium concentrations in most up hydraulic gradient boreholes are relatively stable and retain low concentrations with the exception of BH3A and BH9 (see Figure 12). Potassium concentrations in BH3A historically remained below the compliance limits set for down gradient monitoring locations. However, since late-2011 there has been a slight rising trend with isolated peaks at or above the down-gradient compliance limits in 2012 and 2013.Concentrations observed in 2015 have not followed this and have in fact decreased with an annual peak in 2015 of 6.73 mg/l in October compared to an annual peak in 2014 of 11.3 mg/l in September.

As discussed above, BH9 has historically had higher concentrations compared to the other up-gradient locations, although a general downward trend has been apparent over the entire monitoring period. Data is available for 2015 on only two occasions due to the fact that the well is damaged and can only be sampled when groundwater levels are high. A concentration of 15.2 mg/l was recorded in January and a concentration of 13.8 mg/l was recorded in December. The sample collected in June 2015 (0.18 mg/l) is likely to have been collected from stagnant water since the water level was below the blocked section of well and is therefore not representative of the local groundwater.

Figure 12 Up-gradient potassium concentrations



4 Other Reporting Requirements

4.1 Annual Improvement Targets

Whitehall Landfill is operated in accordance with an externally accredited ISO14001 Management System, and the annual improvement targets are set and reviewed as part of this scheme.

The following targets were agreed for 2015:

- The improvement of welfare facilities at the site, which led to the installation of new toilet block;
- The donation of part of the completed site for use by the local community. An area has now been fenced off and is accessible to the neighbouring orchid field;
- The incorporation of the environmental training elements into the site specific training matrix to improve employee training process. This has been progressed and further opportunities for improvement have been identified;
- An increase in the provision of recycling facilities at the site. Progress against this target is still ongoing and will be reviewed during 2016;
- The management of gas oil at the site was to be reviewed with the potential to reduce deliveries onto the site. The installation of a tank was considered but this was not possible due to a lack of a suitable long-term location. Site are continuing to follow the existing procedure whilst ensuring all environmental protection measures are in place.

4.2 Production and Treatment

Schedule 5 Table S5.2 requires the operator to report the annual production and treatment of surface water and or groundwater that has been disposed of off-site and/or disposed to any effluent treatment plant.

No surface water or groundwater has been taken off site or disposed of to any effluent treatment plant, thus no return is reported for 2015.

4.3 Contamination/Decontamination

There has been no contamination or decontamination of the site within the reporting period.

4.4 Topographical Survey

The most recent topographical survey undertaken in March 2013 is included in Appendix D.

4.5 Compliance Testing and Other Details

In 2015 an estimated 128,101 tonnes of was tipped at the site. The remaining reported capacity is 122,481 m^3.

All waste accepted on the site were from CEMEX Approved List (as detailed in the PPC Application document WHL IPPC Volume 2, Site Operation Plan). Therefore no waste characterisation was required or undertaken.

5 Summary

This annual environmental monitoring report for Whitehall Landfill covers the period from January to December 2015.

The review has shown the following:

- Methane has not been detected at concentrations above the instrumental detection limit in 2015.
- There was one breach of the carbon dioxide compliance limit during 2015 against a compliance limit of 6% observed in October at GM10 with a observed concentration of 6.3%. Carbon dioxide concentrations in 2015 are comparable to those recorded in 2014 especially in relation to GM10, which showed an increase in concentrations from April until October followed by a fall. No significant long term trends in carbon dioxide concentrations are apparent.
- Groundwater levels in 2015 are similar with those recorded in the previous years and variations consistent with seasonal influences. No significant long term trends in groundwater elevations are apparent.
- Ammoniacal nitrogen was detected twice during 2015 in one down-gradient monitoring location (BH14), with a maximum concentration of 0.16 mg/l observed in February. This is significantly below the compliance limit of 0.39 mg/l. No compliance limit exists for any of the up-gradient monitoring locations, however, all up gradient boreholes were below the compliance limits set for the down gradient boreholes. A potential up-gradient source for ammoniacal nitrogen is the historical landfills located to the north of Whitehall.
- Chloride concentrations did not exceed the compliance limit in 2015 for any down-gradient boreholes. A possible increasing trend in chloride concentrations has been identified in BH3A which is an up-gradient monitoring location.
- Following on from CEMEX discussions with Natural Resources Wales in 2014 regarding the suitability of the existing compliance limit for iron, the limit of detection was reduced to 120 µg/l in April, from 230 µg/l previously. Three exceedances of the 200 µg/l compliance limit were observed at each location in January, February and March 2015 prior to this change.
- Potassium concentrations at BH12 exceeded the compliance limit twice in 2015, and the compliance limit was reached or exceeded a further three times in BH1. This is a reduction in exceedances in both BH12 and BH1 in comparison to four exceedances at both locations in 2014. During 2015, potassium concentrations in the up-gradient monitoring location BH9 were similar to those recorded in BH1 and BH12 suggesting that the concentrations reflect background conditions rather than any deterioration in groundwater quality as a result of the landfill. The up-gradient landfills are a possible source of potassium. It is however recommended that potassium concentrations both up and down hydraulic gradient of the landfill are kept under review to confirm this conclusion.

6 References

ESI/Arup, 2005. Whitehall Landfill Conceptual Model, ESID Report.

Lafferty, F. 1998. Landfill Gas Monitoring and Risk Assessment at Whitehall Quarry. M.Sc. Thesis, Applied Environmental Geology, unpublished.

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Appendix A
Landfill Gas Monitoring Data

Appendix A Table Gas monitoring data for 2015

Location	Date	Baro mbar	CH4Stable %	CO2Stable %	FlowrateVol l/h	O2Stable %
BH15	06/01/2015	1021	0	0.1		21.7
BH15	10/02/2015	1020	0	0.2	0.4	21.5
BH15	16/03/2015	1011	0	0.1		21.2
BH15	17/04/2015	1008	0	0.1		19.4
BH15	14/05/2015	996	0	0.1		21
BH15	03/09/2015	1004	0	0.2		20.8
BH15	01/10/2015	1019	0	0.1		20.5
BH15	02/11/2015	1011	0	0.1		21
BH15	01/12/2015	1011	0	0.1		21.2
GM2	10/02/2015	1025	0	0.7	0.5	21
GM2	16/03/2015	1016	0	0.7		21.1
GM2	17/04/2015	1012	0	0.6		20.8
GM2	14/05/2015	1001	0	0.5		21.2
GM2	22/06/2015	1004	0	0.1		21
GM2	08/07/2015	1004	0	0.1		20.8
GM2	13/08/2015	1008	0	1.4		19.1
GM2	03/09/2015	1009	0	0.1		20.9
GM2	01/10/2015	1025	0	1.1		20.7
GM2	02/11/2015	1016	0	1		20.4
GM2	01/12/2015	1016	0	1.2		20.6
GM4	06/01/2015	1017	0	0.6		21
GM4	10/02/2015	1022	0	0.6	0.4	20.8
GM4	16/03/2015	1015	0	0.3		20.8
GM4	17/04/2015	1010	0	0.1		21
GM4	14/05/2015	1001	0	0.1		21.1
GM4	22/06/2015	1002	0	0.4		20.6
GM4	08/07/2015	1002	0	0.2		20.6
GM4	13/08/2015	1007	0	0.6		20.2
GM4	03/09/2015	1008	0	0.4		20.6
GM4	01/10/2015	1024	0	0.1		21.1
GM4	02/11/2015	1017	0	0.3		20.8
GM4	01/12/2015	1014	0	0.4		21
GM5	06/01/2015	1020	0	1.2		19.8
GM5	10/02/2015	1022	0	1.3	0.4	19.3
GM5	16/03/2015	1011	0	1.3		19.1
GM5	17/04/2015	1008	0	1.5		17.2
GM5	14/05/2015	989	0	1.6		18.7
GM5	22/06/2015	998	0	2.1		18.4
GM5	08/07/2015	1000	0	2.3		18.7
GM5	13/08/2015	1003	0	1.9		18.8
GM5	03/09/2015	1005	0	2		18.3
GM5	01/10/2015	1020	0	2.4		17.8
GM5	02/11/2015	1012	0	2.5		18.8
GM5	01/12/2015	1011	0	1.7		19.2
GM8	06/01/2015	1021	0	0.8		21
GM8	10/02/2015	1022	0	0.7	0.1	20.5
GM8	16/03/2015	1011	0	0.8		20.4
GM8	17/04/2015	1010	0	1		20.2
GM8	14/05/2015	999	0	1.1		20

Location	Date	Baro mbar	CH4Stable %	CO2Stable %	FlowrateVol l/h	O2Stable %
GM8	22/06/2015	999	0	1.8		18.8
GM8	08/07/2015	1002	0	1.6		19.4
GM8	13/08/2015	1004	0	1.6		19.9
GM8	03/09/2015	1005	0	1.7		19.5
GM8	01/10/2015	1022	0	1		20.8
GM8	02/11/2015	1012	0	1.1		20.4
GM8	02/12/2015	1006	0	0.3		19.7
GM10	06/01/2015	1021	0	3.3		17.7
GM10	10/02/2015	1023	0	3.1	0.3	18.6
GM10	16/03/2015	1011	0	3.4		16
GM10	17/04/2015	1011	0	3.8		16.8
GM10	14/05/2015	998	0	3		17.9
GM10	22/06/2015	999	0	4		17.1
GM10	08/07/2015	1001	0	3.5		18.2
GM10	13/08/2015	1004	0	4.7		16.2
GM10	03/09/2015	1005	0	5.7		10.5
GM10	01/10/2015	1021	0	6.3		12
GM10	02/11/2015	1012	0	5		14.4
GM10	02/12/2015	1007	0	5.3		13.6
GM11	06/01/2015	1021	0	1.7		19.4
GM11	10/02/2015	1023	0	1.2	0.3	20.9
GM11	16/03/2015	1011	0	1.4		20
GM11	17/04/2015	1011	0	1.5		18.6
GM11	14/05/2015	998	0	1.3		19.7
GM11	22/06/2015	999	0	0.7		20.6
GM11	08/07/2015	1001	0	1.3		19.8
GM11	13/08/2015	1003	0	1.5		19.7
GM11	03/09/2015	1005	0	0.8		20.4
GM11	01/10/2015	1021	0	2.6		19
GM11	02/11/2015	1012	0	1.1		20.4
GM11	01/12/2015	1012	0	0.3		21.1

Appendix B
Groundwater Level Data

Appendix B Table Groundwater elevation (mAOD) during 2015

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
06/01/2015	71.98	65.99	79.12	81.64	74.95	72.03	74.55	88.93	84.67
23/01/2015									85.36
10/02/2015	71.83	64.84	77.21	77.51	70.49	70.52	71.85	86.98	Water below damaged well section
16/03/2015	71.94	65.08	77.34	78.04	70.96	70.94	72.31	86.93	
17/04/2015	71.14	64.33	76.86	76.06	70.35	69.95	70.95	86.51	
14/05/2015	71.05	64.50	76.31	73.63	69.89	70.21	71.08	86.37	
22/06/2015	70.19	64.23	76.57	74.83	71.49	67.71	68.53	86.15	75.43*
08/07/2015	68.07	63.91	76.37	70.97	69.89	66.17	66.93	86.25	Water below damaged well section
13/08/2015	69.39	63.42	76.34	68.19	69.14	66.19	67.59	86.34	
03/09/2015	70.39	64.25	76.75	74.19	70.16	68.50	70.44	86.96	
01/10/2015	69.13	63.97	76.73	74.93	70.10	68.48	69.44	86.89	
02/11/2015	66.63	63.96	76.38	68.56	69.51	68.21	69.86	86.20	
01/12/2015	72.40	67.06	82.18	83.10	87.10	75.10	78.15	91.13	88.74

Note* Level not reliable as water level probably below damaged section of well. Dip probably represents standing water at base of damaged section.

Appendix C
Groundwater Quality Monitoring Data

Appendix C Table 1 Quarterly groundwater quality data for 2015

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity-Electrical (Field) µS/cm	Conductivity-Electrical 20deg µS/cm	Iron µg/l	Magnesium mg/l	Naphthalene µg/l	(total oxidised) as N mg/l	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	Temperature (Field) deg c	TOC (filtered) mg/l
BH1	06/01/2015	260	<0.06	101	22.7	576	622	<230	17.7	<0.04	<0.42	7.6	8.2	12.8	12.8	79.7	10	6.7
BH1	10/02/2015	281	<0.06	113	23.7	701	666	<230	19.1	<0.02	<0.42	7.5	8	11.9	14.5	85.9	9.1	6.7
BH1	16/03/2015	229	<0.06	96.6	19.8	598	553	<230	16.7	<0.01	<0.42	7.9	8.1	10.2	11.8	62.8	8.4	5.7
BH1	17/04/2015	269	<0.06	105	23.8	746	629	<120	18.1	<0.01	<0.42	8.3	7.9	9.22	13.4	75.1	9.8	4.4
BH1	08/07/2015	265	<0.06	104	24	702	631	<120	17.3	<0.01	0.44	7.7	7.7	9.18	12.7	75	11.5	7.2
BH1	01/10/2015	262	<0.06	107	21.4	654	664	<120	17.8	<0.01	0.9	8.2	7.1	13.9	13.1	96.2	11.6	8.7
BH12	06/01/2015	343	<0.06	143	34.8	912	863	<230	27.8	<0.04	2.24	7.7	7.7	9.87	19.9	135	10.2	5.9
BH12	10/02/2015	389	<0.06	205	52.9	1273	1190	<230	38	<0.02	2.36	7.5	7.6	14.5	40.4	291	9.5	6.6
BH12	16/03/2015	394	<0.06	204	49.4	1212	1140	<230	39.4	<0.01	2.64	7.9	8	14.5	37.2	259	8.9	5.5
BH12	17/04/2015	337	<0.06	210	77	1467	1300	<120	38.2	<0.01	1.86	8.2	7.7	14.1	50	374	10.9	4.8
BH12	08/07/2015	343	<0.06	213	95.1	1401	1350	<120	41.4	<0.01	1.1	7.9	7.5	14.9	57.5	447	13.3	7.2
BH12	01/10/2015	293	<0.06	211	87.8		1360	<120	37.9	<0.01	2	8.2	7.1	15.9	58.1	413	11.8	6
BH13	06/01/2015	387	<0.06	90.2	15.1	686	646	<230	37.2	<0.04	<0.42	7.7	7.9	0.51	7.38	3.8	10.1	1.6
BH13	10/02/2015	389	<0.06	97	50.8	748	774	<230	45.3	<0.01	0.63	7.5	7.1	1.15	19.2	22.2	14.3	2.9
BH13	16/03/2015	367	<0.06	102	52.9	797	767	<230	47.7	<0.01	0.67	8	8.4	1.17	20.4	21.9	9.8	3.6
BH13	17/04/2015	368	<0.06	90	60.2	893	774	<120	42.1	<0.01	0.66	8.3	8.1	1.02	20.5	19	11.4	1.6
BH13	08/07/2015	343	<0.06	90.7	44.5	759	701	<120	40.7	<0.01	<0.42	7.9	8.1	0.81	17.5	11.9	12.6	2.9
BH13	01/10/2015	361	<0.06	88.7	39	680	704	<120	39.6	<0.01	<0.7	8.3	7.4	0.84	16	8	12.1	1.2
BH14	06/01/2015	429	<0.06	120	11.2	802	755	<230	35.4	<0.04	8.91	7.6	7.9	0.9	5.53	2.1	8.8	2

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity-Electrical (Field) µS/cm	Conductivity-Electrical 20deg µS/cm	Iron µg/l	Magnesium mg/l	Naphthalene µg/l	(total oxidised) as N mg/l	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	Temperature (Field) deg c	TOC (filtered) mg/l
BH14	10/02/2015	437	0.16	127	6.25	704	701	<230	31.2	<0.01	3.96	7.6	7.6	0.78	3.65	2.1	13	3.6
BH14	16/03/2015	419	<0.06	129	8.61	765	720	<230	34.5	<0.01	5.93	8	8.2	0.76	4.48	1.7	9.8	2.7
BH14	17/04/2015	427	<0.06	123	8.67	826	713	<120	30	<0.01	4.86	8.3	8.2	0.64	3.81	1.8	11.1	1.5
BH14	08/07/2015	408	0.11	134	14.3	818	757	<120	36.7	<0.01	6.71	7.7	7.9	1.02	6.9	11.7	13.4	3
BH14	01/10/2015	441	<0.06	122	8.2	720	748	<120	32.7	<0.01	5.5	8.1	7.5	0.85	4.04	<4.4	12.4	1.5
BH15	06/01/2015	303	<0.06	97.2	16.2	593	554	<230	17.4	<0.04	1.38	7.7	8.3	0.98	7.37	7.8	9.7	2.6
BH15	10/02/2015	303	<0.06	101	15	507	561	<230	17.4	<0.01	1.26	7.6	8.2	1.04	7.71	11.1	16.2	3.2
BH15	16/03/2015	283	<0.06	105	17.4	579	551	<230	18.4	<0.01	1.24	8	8.1	1.25	8.65	11.4	9.4	2.4
BH15	17/04/2015	304	0.17	101	18.2	655	566	<120	18	<0.01	1.39	8.2	8	0.97	9.02	10.9	12.4	1.9
BH15	08/07/2015	302	<0.06	104	19.9	646	585	<120	21.3	<0.01	<0.42	7.8	8	1.13	9.69	14.3	12.6	2.7
BH15	01/10/2015	325	<0.06	98.5	17.4	592	596	<120	20.6	<0.01	<0.7	8.2	7.5	1.2	10.2	8	12.2	1.7
BH3	06/01/2015	309	<0.06	92.9	73.8	743	723	274	28.5	<0.04	<0.42	7.7	8.1	1.02	22.9	19.7	10	2.7
BH3	10/02/2015	307	<0.06	100	59.3	623	698	<230	28.9	<0.01	<0.42	7.5	8.1	1.4	22.8	18	16	3.7
BH3	16/03/2015	295	<0.06	101	52.9	763	679	<230	29.6	<0.01	<0.42	7.9	7.5	1.15	23	19.9	9.4	3.2
BH3	17/04/2015	265	<0.06	82.4	42.6	700	582	<120	21.1	<0.01	<0.42	8.4	7.1	1.32	15.6	15.6	10.5	1.5
BH3	08/07/2015	237	<0.06	91	45.4	597	630	<120	24.2	<0.01	<0.42	7.9	7.3	1.69	18.8	59.8	12.6	3
BH3	01/10/2015	265	<0.06	78.9	17.4	660	538	<120	19.4	<0.01	<0.7	8.3	11	1.38	11.8	24.1	7	2.7
BH3A	06/01/2015	235	<0.06	73.3	40.9	583	537	<230	16.3	<0.1	<0.42	7.8	8.1	4.33	18.7	17.3	9.9	7.3
BH3A	10/02/2015	192	<0.06	91.5	58	598	668	<230	20.4	<0.01	1.04	7.6	7.9	4.95	27.7	97.7	162	3.9
BH3A	16/03/2015	257	<0.06	133	62.8	779	855	<230	31	<0.01	1.08	8	7.7	5.47	31.8	162	9.3	4.1

Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity-Electrical (Field) µS/cm	Conductivity-Electrical 20deg µS/cm	Iron µg/l	Magnesium mg/l	Naphthalene µg/l	(total oxidised) as N mg/l	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	Sulphate as SO4 mg/l	Temperature (Field) deg c	TOC (filtered) mg/l
BH3A	17/04/2015	176	<0.06	100	90.1	938	805	<120	21.6	<0.01	1.84	8.3	7.4	4.65	41	146	10.2	2.3
BH3A	08/07/2015	144	<0.06	95.9	52.6	808	690	<120	19.8	<0.01	2.18	7.9	7.1	4.79	30	166	12.1	3.6
BH3A	01/10/2015	209	<0.06	149	69.7	993	1020	<120	29.2	<0.01	3.3	8.4	7.1	6.73	36	281	11.4	3.1
BH6	06/01/2015	344	<0.06	96.2	27.9	683	640	<230	31.4	<0.1	<0.42	7.7	8.2	1.68	7.87	10.8	9.9	1.6
BH6	10/02/2015	319	<0.06	99.3	29.5	550	613	<230	24	<0.01	<0.42	7.6	8.2	1.42	9.96	10.8	15.5	3
BH6	16/03/2015	292	<0.06	97.9	22.1	577	554	<230	21.3	<0.01	<0.42	8	8.3	1.29	11	9.9	9.9	2.4
BH6	17/04/2015	315	<0.06	89.7	24.5	693	590	<120	25.6	<0.01	<0.42	8.3	7.9	1.32	9.61	12.4	12.6	0.9
BH6	08/07/2015	319	<0.06	88.5	24.3	685	624	<120	32.6	<0.01	<0.42	7.9	8	1.63	8.54	15.3	12.8	2.1
BH6	01/10/2015	346	<0.06	84.4	18.7	621	585	<120	33.8	<0.01	<0.7	8.4	7.4	1.78	7.68	11.6	12.2	0.8
BH9	06/01/2015	Well damaged, no water above damaged section																
BH9	23/01/2015	378	<0.06	124	18.9		754	<230	19.3	<0.01	9.48	7.4		15.2	6.07	43		2.4
BH9	10/02/2015	Well damaged, no water above damaged section																
BH9	16/03/2015	Well damaged, no water above damaged section																
BH9	17/04/2015	Well damaged, no water above damaged section																
BH9	22/06/2015					843							7.7	<0.18			11.7	
BH9	08/07/2015	Well damaged, no water above damaged section																
BH9	01/10/2015	Well damaged, no water above damaged section																

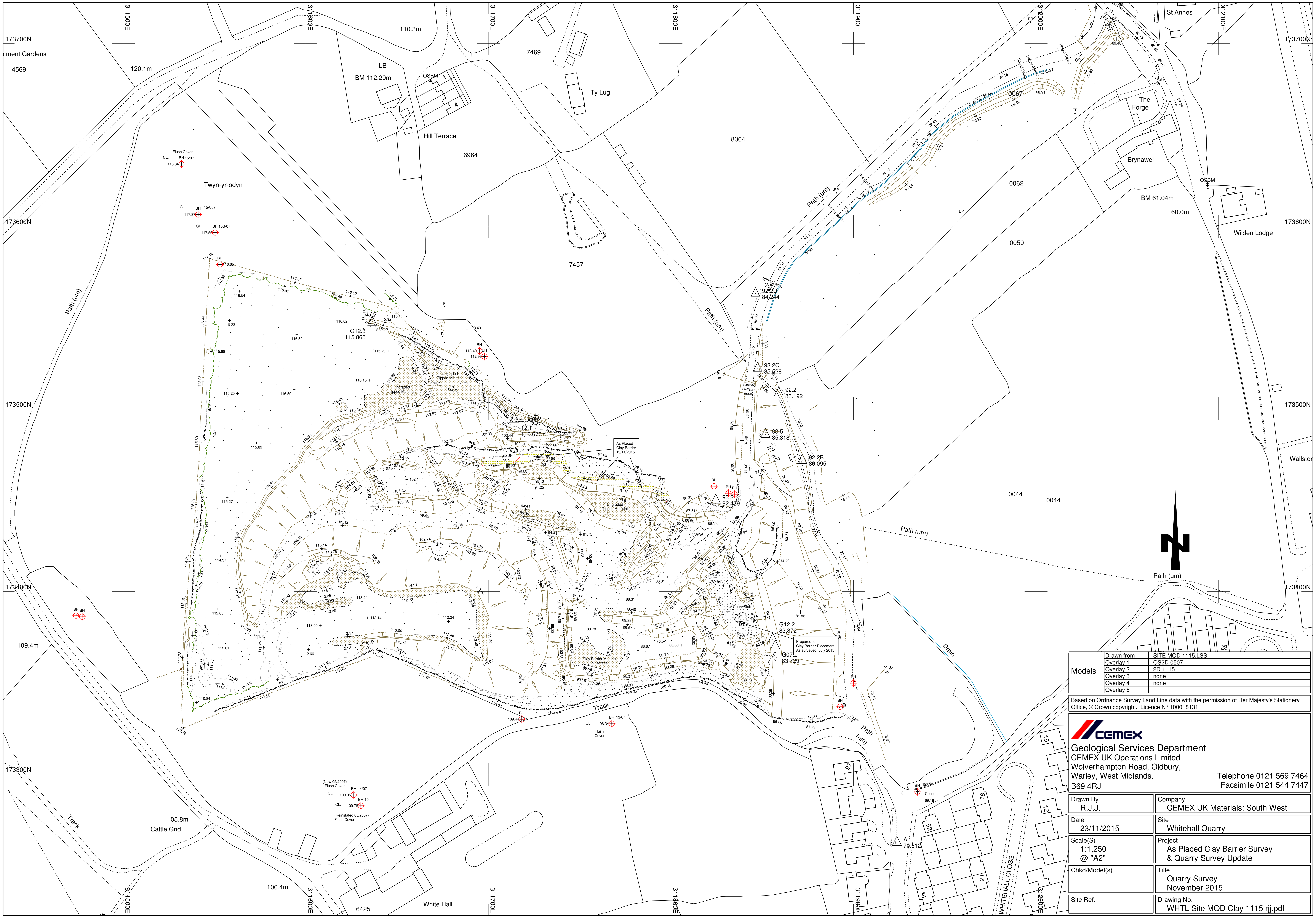
Appendix C Table 2 Annually groundwater quality data for 2015

Determinand	Unit	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6
Cadmium	µg/l	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
Chromium	mg/l	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
COD (Total)	mg/l	25	19	16	18	20	14	13	15
Copper	mg/l	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009	<0.009
Lead	mg/l	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Manganese	mg/l	0.153	0.044	0.024	0.027	0.022	0.024	0.028	0.024
Nickel	mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Zinc	mg/l	<0.018	0.02	<0.018	<0.018	<0.018	0.018	<0.018	<0.018

Appendix C Table 3 Additional potassium analysis in November and December 2015

Location	Date	Potassium mg/l
BH1	02/11/2015	11.8
	01/12/2015	25.9
BH12	02/11/2015	15.4
	02/12/2015	5.6
BH9	01/12/2015	13.8

Appendix D
Topographical Survey



Models		
	Drawn from	SITE MOD 1115.LSS
	Overlay 1	OS2D 0507
	Overlay 2	2D 1115
	Overlay 3	none
	Overlay 4	none
	Overlay 5	

CEMEX
Geological Services Department
CEMEX UK Operations Limited
Wolverhampton Road, Oldbury,
Warley, West Midlands.
B69 4RJ
Telephone 0121 569 7464
Facsimile 0121 544 7447

Drawn By: R.J.J.	Company: CEMEX UK Materials: South West
Date: 23/11/2015	Site: Whitehall Quarry
Scale(S): 1:1,250 @ "A2"	Project: As Placed Clay Barrier Survey & Quarry Survey Update
Chkd/Model(s)	Title: Quarry Survey November 2015
Site Ref.	Drawing No.: WHTL Site MOD Clay 1115 rjj.pdf