

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

Annual environmental monitoring report for 2020

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1 Introduction

The Environmental Permit for Whitehall Landfill (the Site), no. MP3036SS, issued by the Environment Agency on 17 March 2006, specifies under condition 4.2.1 that:

“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 in relation to this installation and any agreed amendments thereto;*
- (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 you 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) a summary of the WAC compliance testing undertaken in the period.”*

This report is presented in compliance with this condition.

The installation is a landfill site and associated infrastructure, for disposal of inert waste. 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.

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 Walston Road in Walston, which is at the north western edge of Wenvoe.

2 Site Description and History

The Site covers an area of 5.2 ha and lies to the northwest of Wenvoe, approximately six miles southwest of Cardiff City Centre, South Glamorgan, at NGR 311700 173450. It is currently permitted to accept inert waste, however it stopped accepting waste at the end of October 2018 as filling is complete. In-waste gas monitoring wells are scheduled to be installed in spring 2021.

The landfill occupies a former 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 Waste Regulatory Authority, 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 this WML, the site was licensed to accept solid inert wastes including soils (topsoil, 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 in total they made up no more than 1% by volume of any one load. These included plaster, wood, wood products, cardboard and paper products. Following transition to an Environmental Permit in 2006 the range of wastes that could be accepted was restricted to inert waste as defined by the Landfill Regulations.

The principal waste streams that arrived at Whitehall Quarry were all of construction and demolition waste, originating from various districts within Wales. The Site is certified to the environmental management standard ISO 14001:2015.

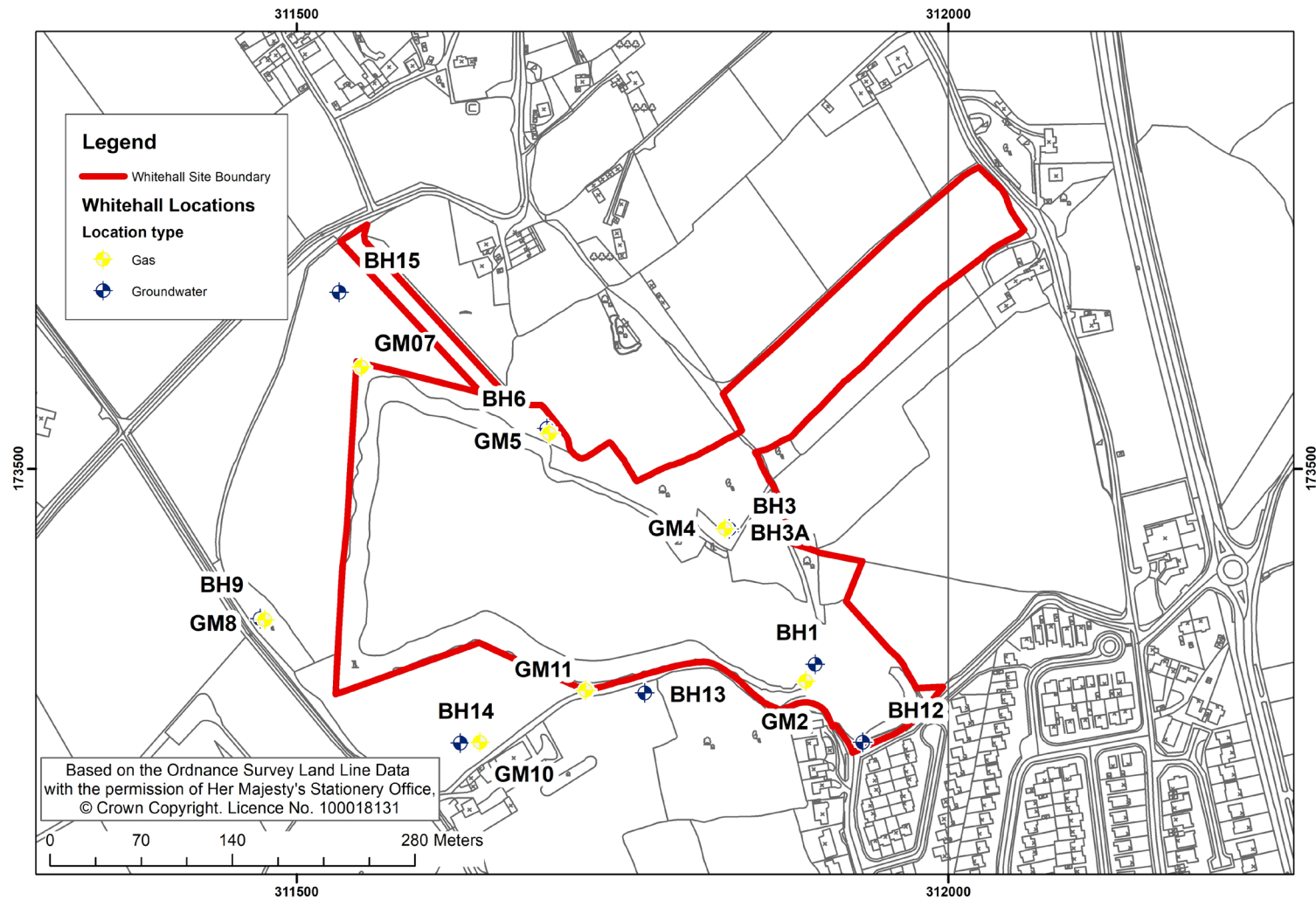
There are three closed landfills situated to the north, up-gradient of Whitehall Quarry. The most northerly of these, Greenwood Quarry, located approximately 500 m from Whitehall Quarry (Drawing ESID 2, ESI/Arup (2005)), was licensed to receive inert and semi-inert material (Wildgust, 1998. Lafferty, 1998). Operations at Greenwood Quarry ceased in 1988. Greenwood Old Quarry lies immediately south of Greenwood Quarry 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/Arup (2005)), accepted solid non-toxic wastes and asbestos. Again, Wildgust (1998) and Lafferty (1998) suggest other materials were accepted at this site.

Whitehall Landfill

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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 2020. The locations of the monitoring points are shown on Figure 1.

3.1 Landfill Gas Monitoring

Landfill gas has been monitored in seven perimeter gas monitoring boreholes on a monthly frequency in accordance with the requirements specified in the permit. The monitoring requirements and compliance limits are given in Table 1. The location of these boreholes is shown on Figure 1.

Appendix A presents all gas monitoring data collected at these locations during 2020. No monitoring data is available for November 2020 due to technician error.

One of the stipulated gas monitoring locations, GM7, was lost in 2007. It was replaced by BH15 and gas monitoring had been undertaken at this location (with some interruptions for accessibility issues) since December 2007 until March 2017 when GM7 was located again and monitoring resumed.

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.

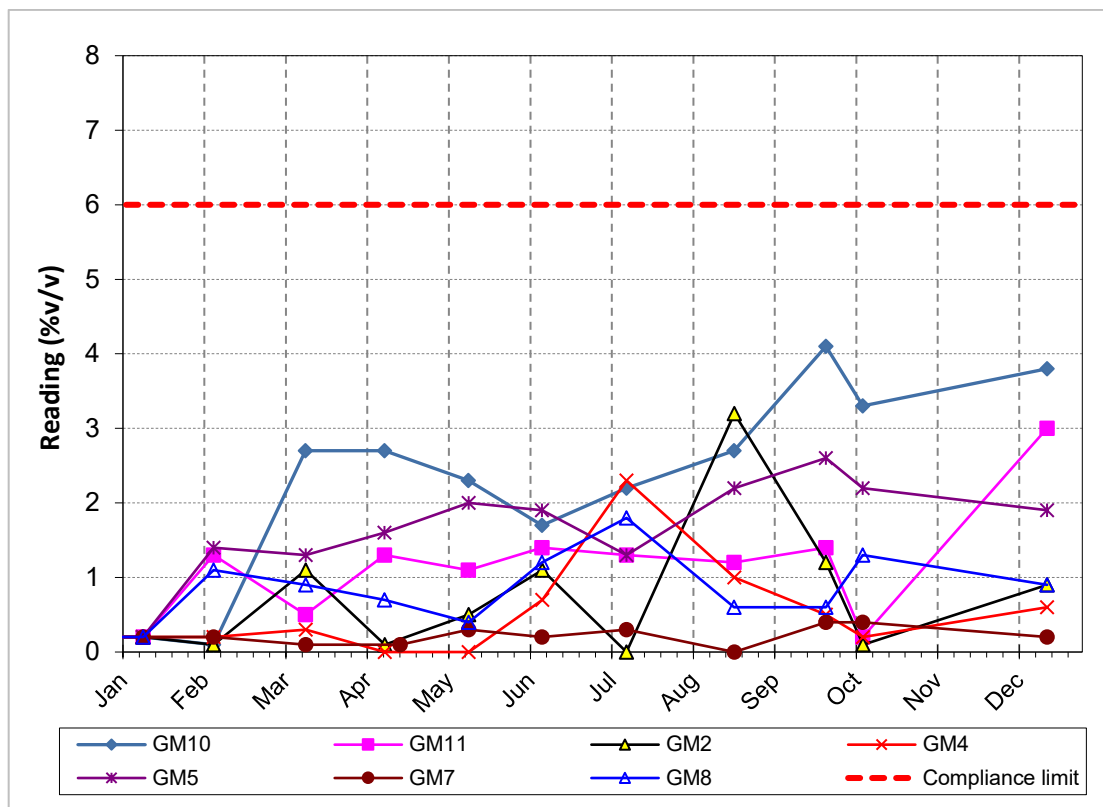
Methane has not been detected throughout the monitoring period in 2020, except on fourteen occasions at 0.1 %v/v in April, May or December. These detections occurred at all of the locations over the course of the year. There have been no exceedances of the compliance limit.

Table 1 Monitoring requirements and compliance limits for landfill gas monitoring in perimeter boreholes

Monitoring Locations	Parameter	Frequency	Compliance limit (% v/v)
GM2, GM4, GM5, GM7, GM8, GM10, GM11	Methane	Monthly	1
	Carbon dioxide		6

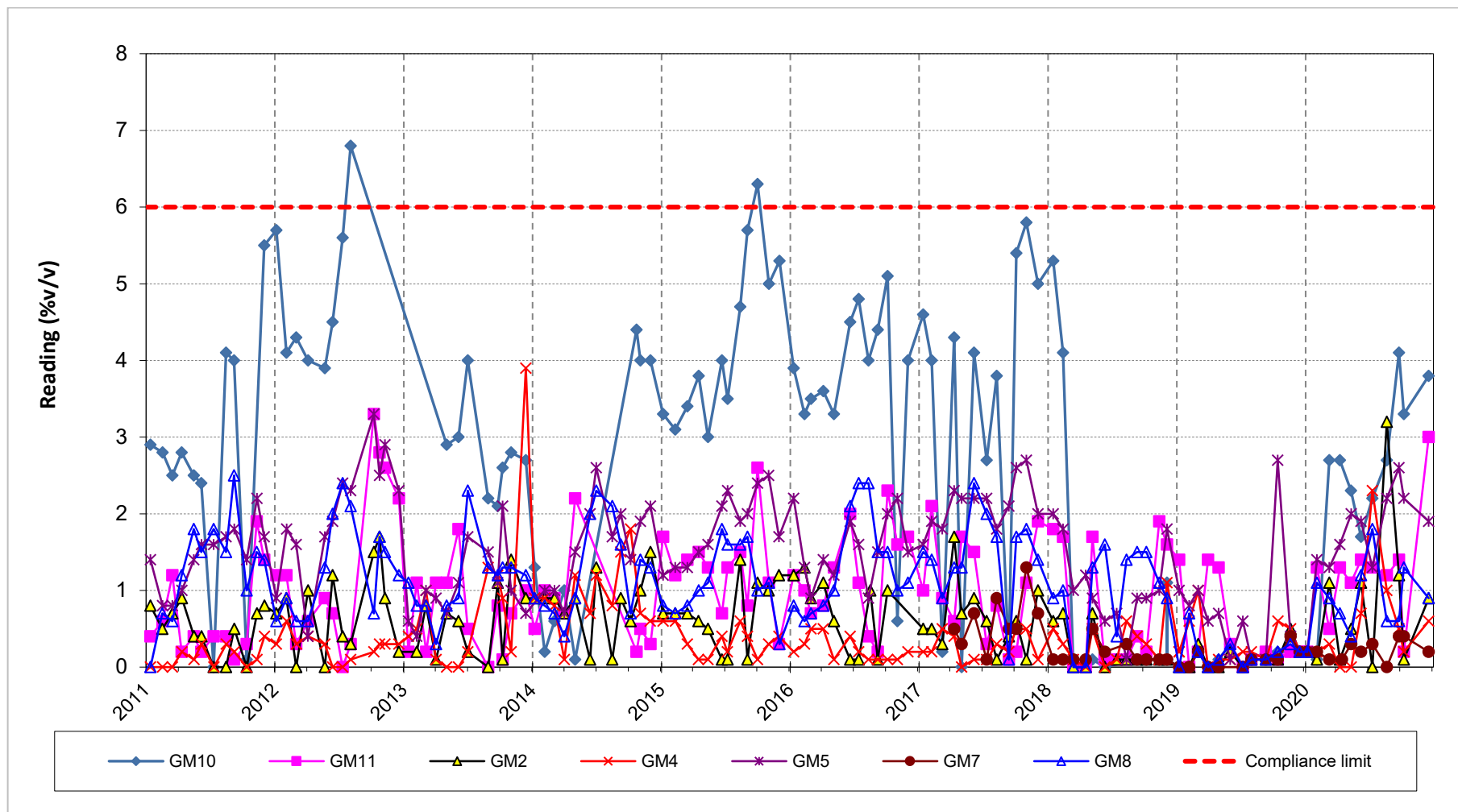
Stable carbon dioxide concentrations between January and December 2020 are compared to the 6 %v/v compliance limit at the required gas monitoring locations in Figure 2 below.

Figure 2 Stable carbon dioxide concentrations in 2020



The carbon dioxide compliance limit was not exceeded on any occasion during 2020. The majority of monitoring locations showed concentrations below 4 %v/v, except for one reading of 4.1 %v/v at GM10 in September. There is a slight increasing trend at some locations during 2020. In January carbon dioxide concentrations were 0.2 %v/v at all locations and were higher in subsequent months. Concentrations in 2019 were lower than previous years, but concentrations in 2020 returned to a more typical range. Historical carbon dioxide concentrations are presented in Figure 3. The data is consistent with previous years.

Figure 3 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the Permit requires monitoring of groundwater quality at four down-gradient site perimeter boreholes, BH1, BH12, BH13 and BH14, which have compliance limits set, and at five up-gradient boreholes BH3, BH3A, BH6, BH9 and BH15, which do not have any compliance limits. The required parameters are listed in Table S4.4 of the permit and summarised in Table 2. These locations were sampled on a quarterly and annual frequency for relevant determinands during 2020. The locations of the monitoring boreholes are shown on Figure 1.

Table 2 Groundwater monitoring requirements

Borehole	Parameter	Frequency
BH1, BH3, BH3A, BH6, BH9, BH12, BH13, BH14, BH15	Water level, pH, Electrical conductivity, Ammoniacal Nitrogen as N, Chloride, Sulphate as SO ₄ , Alkalinity, TON, TOC, Sodium, Potassium, Calcium, Magnesium, Iron	Quarterly ¹
	Manganese, Cadmium, Chromium, Copper, Nickel, Lead, Zinc, Naphthalene	Annually

¹ Frequency reduced from monthly to quarterly in mid-2015.

Control levels and compliance limits were updated for selected locations following the 2016 HRA review (ESI, 2016). These changes were agreed with NRW via letter and email dated 15 July 2016. The control level and compliance limit for BH12 was updated in 2020 via a revised 2019 Annual Report (Cemex, 2020). This change was also agreed with NRW via email on 30th September 2020. The current compliance limits are given in Table 3.

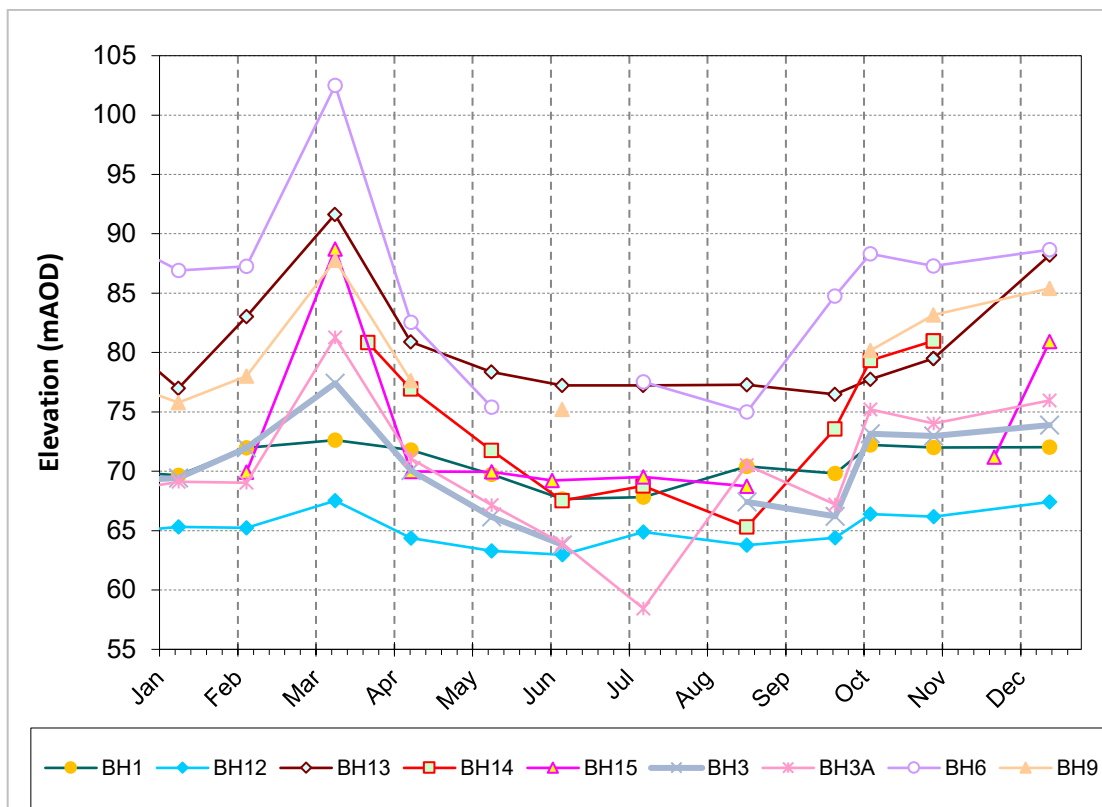
3.2.1 Groundwater Levels

Monthly groundwater level data collected during 2020 are presented in Figure 4.

BH14 could not be found from January to March and BH15 could not be found in January and from September to November due to long grass, however it has since been relocated.

In 2020, groundwater levels reached their maximum in March, which is likely due to the prolonged high rainfall across the UK at the end of 2019 and start of 2020. Groundwater elevation fell to more typical levels in April until the end of the year. There was a rise in levels at most locations from October to December. The highest levels are typically at BH06 and BH13 which are located in the north and south of the centre of the Site respectively.

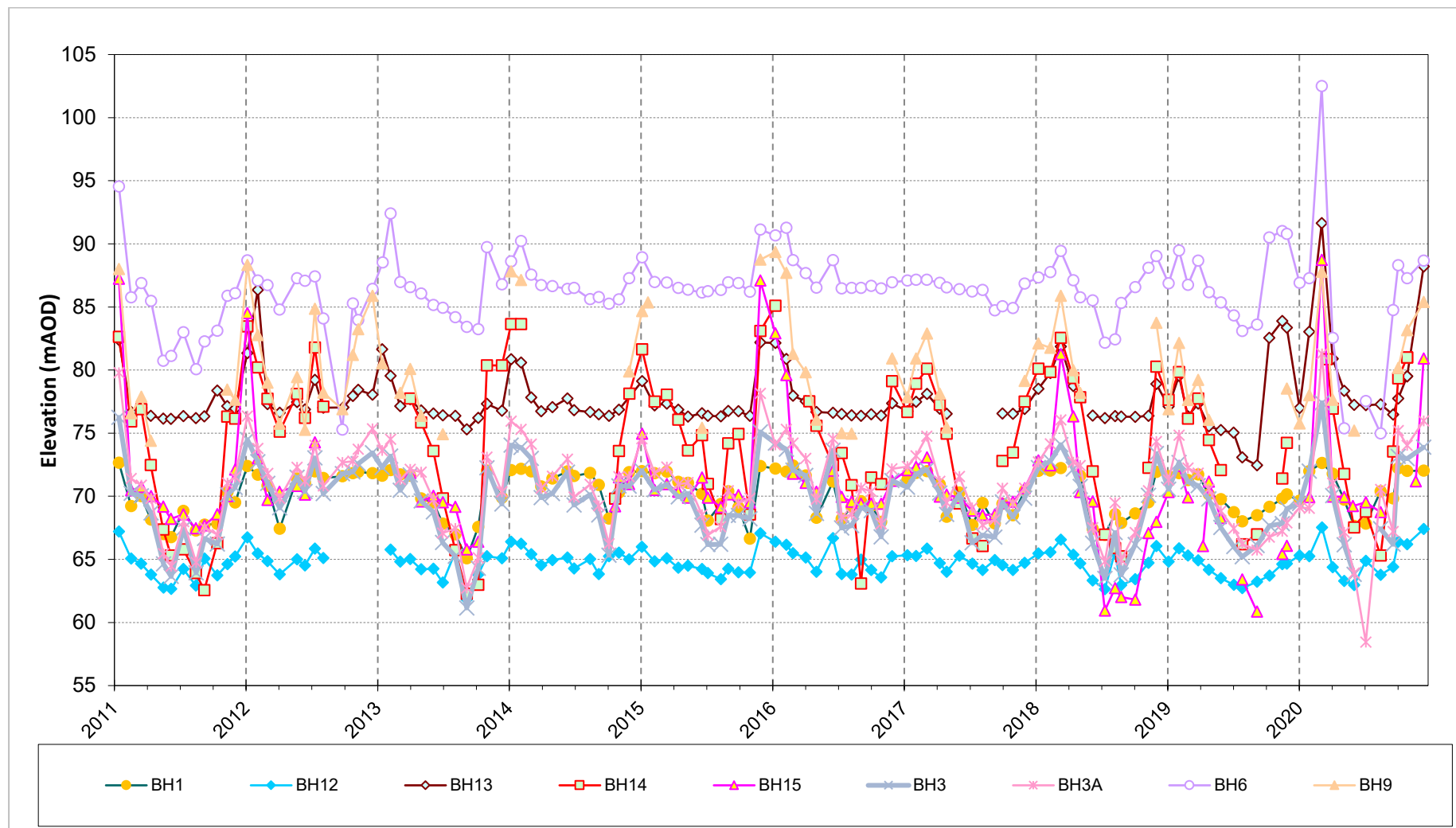
Figure 4 Groundwater elevation during 2020



Historical observed groundwater levels for the past decade for all monitoring locations are shown in Figure 5. Overall, the groundwater levels match with the historical trends, although levels in March 2020 were the highest in the last decade at most locations. The groundwater elevation at all monitoring locations exhibit similar fluctuation timings, with differing degrees of variation. BH12 shows smaller amplitudes than the other wells. In 2020 BH06 has lower levels during the middle of the year at around 75-77 mAOD. Levels at BH06 have not been lower than 80 mAOD since 2012 when levels were 75.3 mAOD in September.

Groundwater levels are generally more variable to the south-west where, historically, the variation in groundwater level is markedly greater in BH14, which has continued to be the case during 2020 although matched by some other locations.

Figure 5 Historical groundwater elevation (2011-2020)



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) as outlined in Table 2.

The quarterly data set for 2020 is presented in Appendix C.

Compliance limits for selected 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.

Compliance limits were subsequently revised as part of the 2016 HRA review (ESI, 2016) and these were agreed with NRW in July 2016. Table 3 below details the compliance limits applied to the appropriate groundwater quality determinands at the required locations.

The compliance limit for potassium BH12 was updated in the revised 2019 annual report (Cemex, 2020) to reflect the increase in concentrations due to a potassium-rich plume originating upgradient of the landfill (Cemex, 2016). A new compliance limit of 24.7 mg/l was calculated (included in Table 3) as well as a control limit of 19.7 mg/l. There are no compliance limits specified for up-gradient boreholes BH3, BH3A, BH6, BH9 or BH15.

Table 3 Groundwater quality compliance limits

Location	Determinand				
	Ammoniacal Nitrogen (mg/l)	Chloride (mg/l)	Iron as Fe (µg/l)	Potassium (mg/l)	Napthalene (µg/l)
BH1	0.39	250	200	27	0.05
BH12	0.39	250	200	24.7	0.05
BH13, BH14	0.39	250	200	12	0.05

A statistical summary of groundwater quality compliance parameters is presented in Table 4. The data for potassium has been split over three rows, as there are separate compliance limits.

There were no exceedances of the compliance limits during 2020. There was no exceedance of the control limit of 19.7 mg/l at BH12 during 2020, as the maximum potassium concentration was 17.1 mg/l

Table 4 Statistical summary of groundwater compliance parameters in 2020

Determinand	No. of Results	Unit	Min	Max	Mean	Median	95th Percentile	# > LOD	% > LOD	Limits		
										No. Exceeding	% Exceeding	Action Level
Ammoniacal Nitrogen as N	15	mg/l	<0.06	0.23	0.051	n.d.	0.167	2	13.3	0	0	0.39
Chloride	15	mg/l	6.6	53.5	26.04	19.4	48.74	15	100.0	0	0	250
Iron	15	mg/l	<0.025	0.046	0.022	n.d.	0.044	5	33.3	0	0	0.2
Napthalene	15	µg/l	<0.01	0.011	n.d.	n.d.	0.02	1	6.7	0	0	0.05
Potassium (BH1)	3	mg/l	8.2	11.9	10.1	10.2	11.7	3	100	0	0	27
Potassium (BH12)	4	mg/l	7.18	17.1	13	13.9	16.7	4	100	0	0	24.7
Potassium (BH13, BH14)	8	mg/l	0.79	10	3.485	2.215	8.9535	15	100	0	0	12

Groundwater ammoniacal nitrogen concentrations for the last decade are presented in Figure 6. This shows that in the last ten years, the majority of samples at down-gradient boreholes are at or below the detection limit. There are a number of peaks in concentration up to a maximum of 0.92 mg/l at BH1 in 2016, although this was an isolated peak. Ammoniacal concentrations appear to be lower in 2020.

Potassium concentrations in groundwater during the last decade are presented in Figure 7 and Figure 8. Potassium concentrations have been slightly elevated at BH1, BH12 and BH13 since 2016. CEMEX (2016) suggested that a plume containing potassium had originated from up-hydraulic-gradient of the Site and is currently passing through it. Historical potassium concentrations in BH9 (up-hydraulic-gradient) were higher (Figure 8) but stabilised around 15 mg/l from 2013 and in 2020 have dropped to around 9 mg/l. There was no monitoring of BH9 during 2019 as it was dry or there was insufficient water to obtain a sample. This issue was discussed previously in CEMEX (2016). Potassium concentrations at BH3A (up-gradient) were higher in 2019 than in the last 5 years, however they have returned to more typical concentrations in 2020.

In the HRA Review (ESI, 2016) it was noted that the compliance limits were to be reviewed annually at BH1 and BH12. On the basis of the current data, it is recommended that the compliance limits at BH1 and BH12 are maintained at their current levels for 2020 and reviewed again in the next annual report.

Historical iron concentrations are plotted on Figure 9. Iron concentrations are consistent with previous years.

There were no naphthalene exceedances during 2020 (see Table 4). A statistical summary of general groundwater quality at the site is presented in Table 5. Determinands have been compared to the UK Drinking Water Standards (UK DWS) for reference.

Groundwater quality at the Site is generally good, with concentrations above the UK DWS only recorded during 2020 for sulphate. There was only one sample above the sulphate UKDWS of 250 mg/l at BH12 in July with a concentration of 255 mg/l. Data for 2020 is in line with the historical dataset.

Figure 6 Ammoniacal nitrogen in groundwater at boreholes with compliance limits

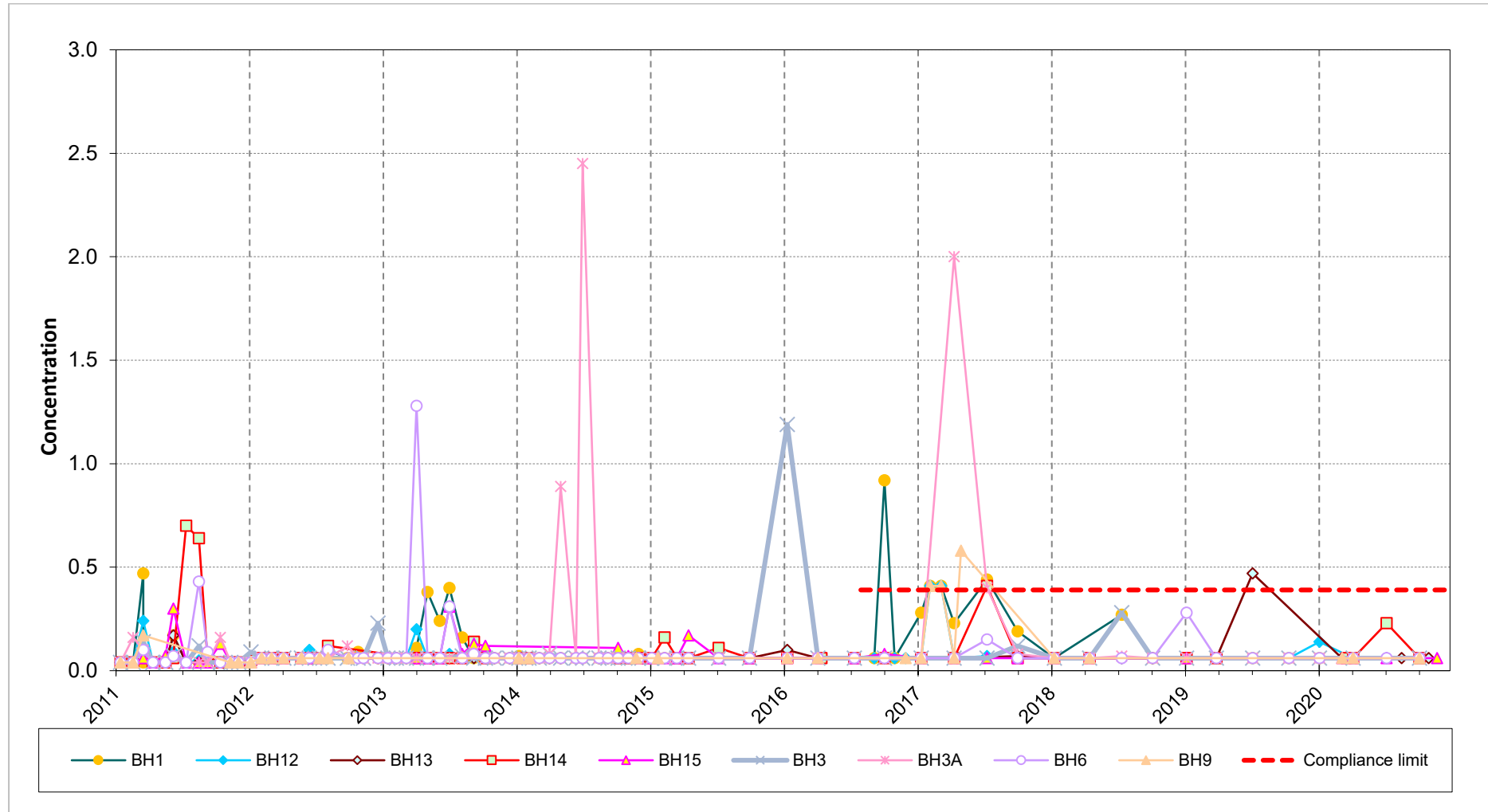


Figure 7 Potassium concentrations in groundwater at boreholes with compliance limits (downgradient)

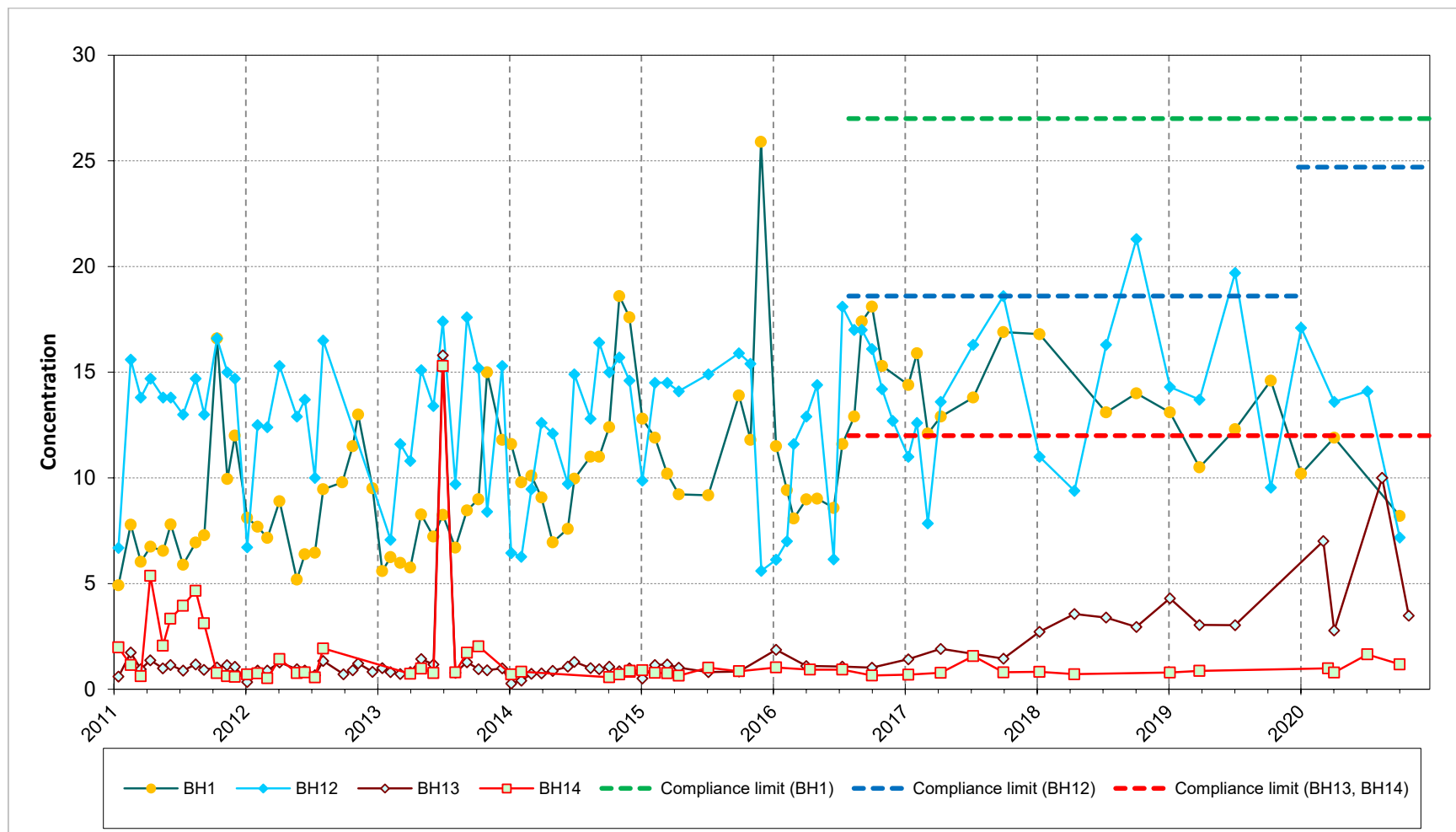


Figure 8 Potassium concentrations in groundwater at boreholes without compliance limits (upgradient)

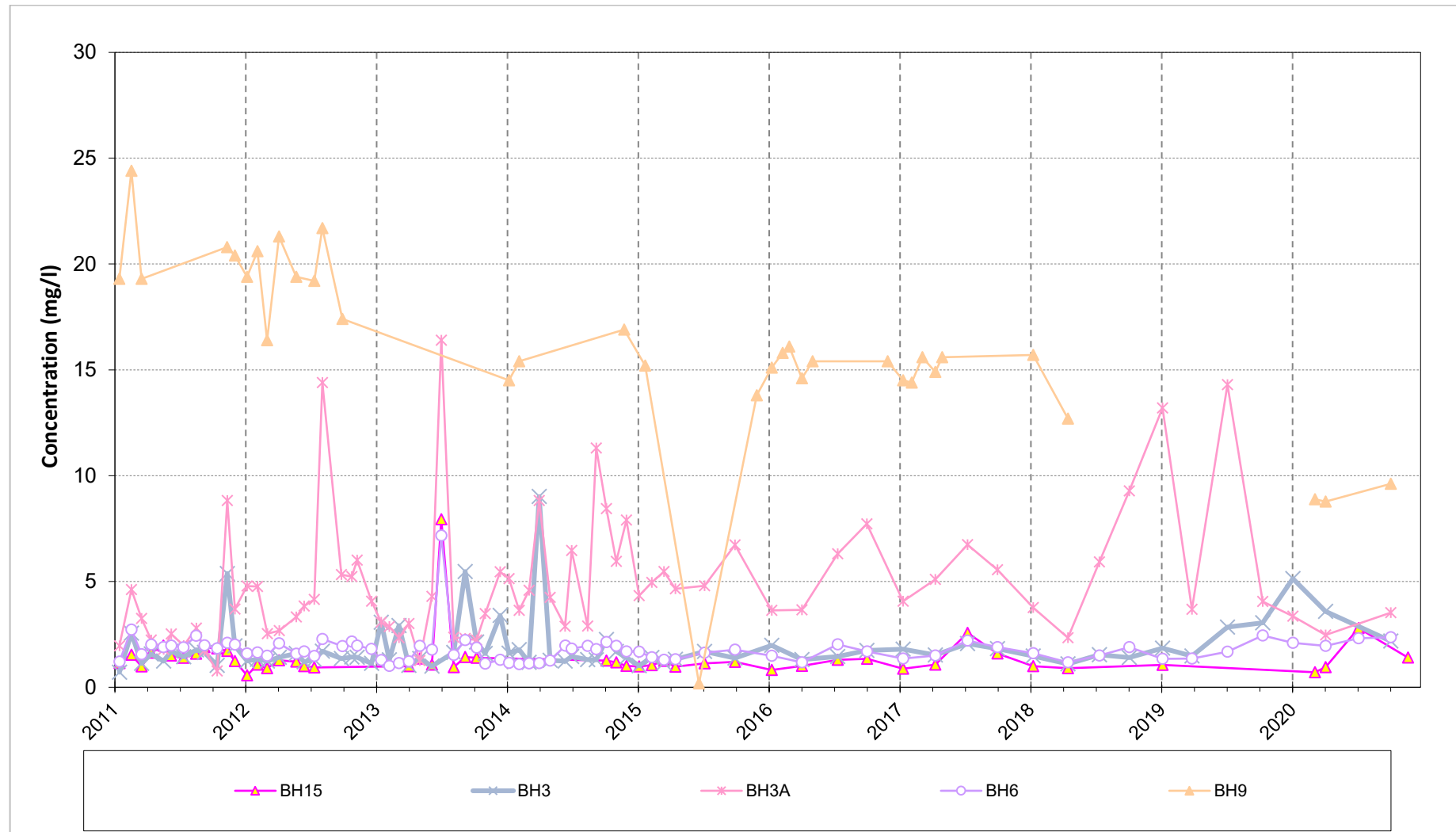
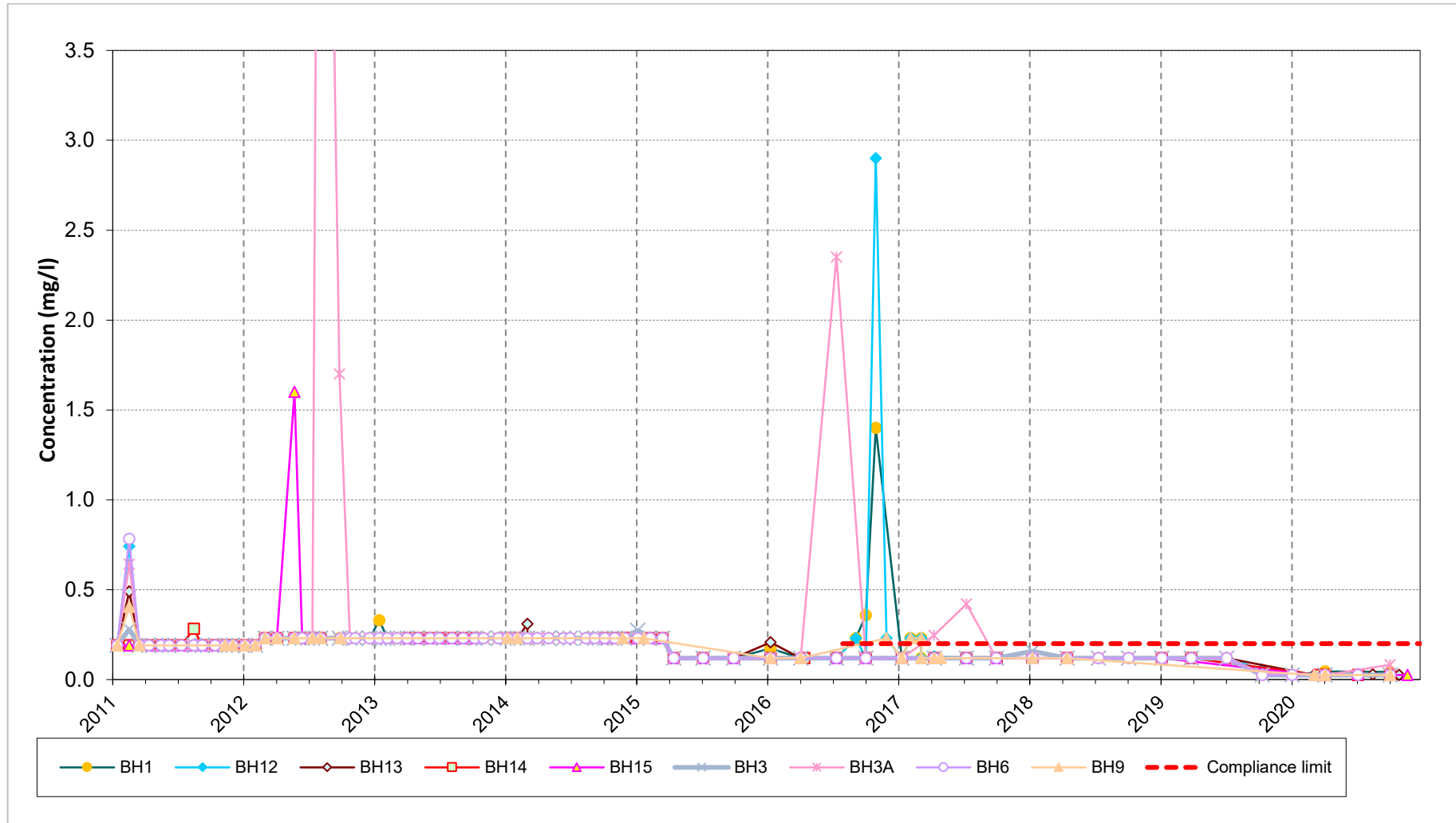


Figure 9 Iron concentrations at all groundwater locations



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Table 5 Statistical summary of groundwater quality in 2020

UKDWS														
Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	No. Exceeding	% Exceeding	Action Level
Field / lab parameters														
Conductivity- Electrical (Field)	32	µS/cm	581	3400	1371.5	1148.5	715.5	737.3	3143	32	100	0	0	
Conductivity- Electrical 20deg	32	µS/cm	175	1050	627.6	621	209.0	295.5	1008	32	100	0	0	
pH	32	pH units	7	8.4	7.7	7.75	0.291	7.26	8.19	32	100	0	0	
pH (Field)	32	pH units	6	8.1	7.2	7.2	0.381	6.48	7.60	32	100	0	0	
Major ions														
Alkalinity as CaCO3	18	mg/l	60.8	451	304.6	313	93.0	134.1	420.3	32	100	0	0	
Calcium	32	mg/l	19.4	206	100.6	96.35	37.0	49.0	172.1	32	100	0	0	
Chloride	32	mg/l	6.6	53.5	24.7	19.5	13.6	9.8	48.9	32	100	0	0	250
Magnesium	32	mg/l	2.2	48.8	23.6	21.95	11.6	5.61	42.6	32	100	0	0	
Potassium	32	mg/l	0.71	17.1	5.4	3.42	4.5	0.878	13.8	32	100	0	0	
Sodium	32	mg/l	3.95	38.9	15.3	10.75	10.3	5.00	35.3	32	100	0	0	200
Sulphate as SO4 (numeric)	32	mg/l	<4.4	255	37.1	14.1	62.8	n.d.	203.8	32	100	1	3.13	250
Minor ions														
Cadmium	9	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.005
Chromium	9	mg/l	<0.002	<0.002	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.05
Copper	9	mg/l	<0.009	0.015	n.d.	n.d.	n.d.	n.d.	0.011	1	11.1	0	0	2
Iron	32	µg/l	<25	82	20.4	n.d.	15.4	n.d.	44.6	9	28.1	0	0	
Lead	9	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.01
Manganese	9	mg/l	<0.007	0.032	0.008	n.d.	0.00922	n.d.	0.0236	3	33.3	0	0	0.05

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Determinand	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
												No. Exceeding	% Exceeding	Action Level
Nickel	9	mg/l	<0.003	0.005	0.003	0.003	0.0013	n.d.	0.005	5	55.6	0	0	0.02
Zinc	9	mg/l	<0.018	<0.018	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	-
Nitrogen species														
Ammoniacal Nitrogen as N	32	mg/l	<0.06	0.23	n.d.	n.d.	n.d.	n.d.	0.079	2	6.25	0	0	0.39
Nitrogen (total oxidised) as N	32	mg/l	<0.7	19.1	2.80	0.575	4.37	0.35	11.31	16	50	0	0	
Landfill parameters														
TOC (filtered)	32	mg/l	1.4	23.2	5.35	3.9	4.77	1.7	15.26	32	100	0	0	
PAH														
Napthalene	32	µg/l	<0.01	0.011	n.d.	n.d.	n.d.	n.d.	0.015	1	3.13	0	0	

Note: if significant number of results exceed action limit row is coloured as follows: 10 – 25% pale red, 25 – 50% darker red, >50% dark red. n.d. statistic not determinable. Mean statistics for non-detects are calculated at half the limit of detection.

4 Other Reporting Requirements

4.1 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 2020.

4.2 Contamination/Decontamination

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

4.3 Topographical Survey

An up to date topographical survey is included in Appendix D.

4.4 Compliance Testing and Other Details

No waste has been accepted in 2020 since filling ceased in October 2018.

5 Summary

The review covers the period between January and December 2020 and reviews the landfill gas, groundwater level and groundwater quality dataset at the Site.

The review has shown the following:

- Landfill gas has been monitored on an approximately monthly basis in seven perimeter gas boreholes in accordance with the requirements specified in the variation notice.
- There have been no exceedances of the compliance limit for methane, which was only detected fourteen times out of 77 in 2020, all at 0.1 %v/v.
- Carbon dioxide concentrations did not exceed the 6% v/v compliance limit during the year. The majority of monitoring locations recorded concentrations below 4% v/v. The maximum carbon dioxide concentration was at GM10 in September at 4.1%v/v. Carbon dioxide returned to more typical concentrations in 2020 after relatively low concentrations in 2019.
- Groundwater levels peaked in March 2020 reaching new maximums at many locations. This likely due to prolonged heavy rain and levels returned to more typical values in the rest of 2020. Groundwater levels generally increased from October to December.
- There were no exceedances of the compliance limits for ammoniacal nitrogen, iron, chloride or potassium concentrations in groundwater during the quarterly monitoring rounds. Concentrations of both are in line with previous years. There were no significant changes in the data set from that of previous years. There is a continuation of the rising trend in potassium concentrations at BH13 and potassium concentrations at other locations are consistent with previous years.
- Groundwater quality is generally good, with only sulphate concentrations slightly above the UKDWS at BH12 in July.

6 References

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- Lafferty, F. 1998.** Landfill Gas Monitoring and Risk Assessment at Whitehall Quarry. M.Sc. Thesis, Applied Environmental Geology, unpublished.
- Natural Resources Wales [NRW], 2016.** Letter from Gwyn Jones to Gillian Ratcliffe, Re: Whitehall Quarry Hydrogeological Risk Assessment, dated 10 June 2016.
- Wildgust, N.A., 1998.** Hydrogeological Risk Assessment, Whitehall Quarry Landfill, Wenvoe, South Wales. M.Sc. Thesis, Applied Environmental Geology, Dept. of Earth Sciences, University of Cardiff (Unpublished).

Appendix A

Landfill Gas Monitoring Data

Appendix A Table 1 Gas monitoring data for 2020

Location Date		Baro mb	CH4Stable %	CO2Stable %	DiffPress mb	O2Stable %	Ground conditions
GM10	08/01/2020	1017	0	0.2	0.14	21.2	Damp
GM10	04/02/2020	1014	0	0.1	-0.26	22.4	Damp
GM10	10/03/2020	990	0	2.7	2.61	18.4	Damp
GM10	09/04/2020	1011	0	2.7	-0.01	18.7	Dry
GM10	11/05/2020	1007	0	2.3	0.93	19.8	
GM10	08/06/2020	1008	0	1.7	-0.04	19.7	Damp
GM10	10/07/2020	1009	0	2.2	-0.04	18.7	Damp
GM10	20/08/2020	989	0	2.7	-0.17	17.8	Dry
GM10	24/09/2020	980	0	4.1	3.89	18.7	Damp
GM10	08/10/2020	997	0	3.3	-0.2	16.6	Damp
GM10	Nov 2020	No data available					Damp
GM10	17/12/2020	999	0.1	3.8	1	16.1	
GM11	08/01/2020	1017	0	0.2	0.07	21.2	Damp
GM11	04/02/2020	1015	0	1.3	-0.19	21.2	Damp
GM11	10/03/2020	990	0	0.5	8.13	20.7	Damp
GM11	09/04/2020	1011	0	1.3	-0.06	19.3	Dry
GM11	11/05/2020	1007	0	1.1	0.43	20.1	Damp
GM11	08/06/2020	1008	0	1.4	-0.05	19.7	Damp
GM11	10/07/2020	1009	0	1.3	4.88	19.7	Damp
GM11	20/08/2020	989	0	1.2	0.53	19.7	Damp
GM11	24/09/2020	980	0	1.4	1.35	20.4	Damp
GM11	08/10/2020	997	0	0.2	-0.37	20.9	Damp
GM11	Nov 2020	No data available					Damp
GM11	17/12/2020	998	0.1	3	0.14	17.7	
GM2	08/01/2020	1017	0	0.2	-0.36	21.2	Damp
GM2	04/02/2020	1018	0	0.1	-0.4	22.5	Damp
GM2	10/03/2020	995	0	1.1	11.36	20.6	Damp
GM2	09/04/2020	1015	0.1	0.1	1.82	20.6	Dry
GM2	11/05/2020	1012	0.1	0.5	-0.01	20.9	
GM2	08/06/2020	1012	0	1.1	6.92	19.9	Damp
GM2	10/07/2020	1013	0	0	-0.1	21.3	Dry
GM2	20/08/2020	993	0	3.2	-0.29	18.4	Dry
GM2	24/09/2020	984	0	1.2	15.64	20.5	Damp
GM2	08/10/2020	1003	0	0.1	-22.75	21.1	Damp
GM2	Nov 2020	No data available					Damp
GM2	17/12/2020	1000	0.1	0.9	9.97	20.9	
GM4	08/01/2020	1017	0	0.2	-0.17	21	Damp
GM4	04/02/2020	1017	0	0.2	-0.22	22.5	Damp
GM4	10/03/2020	993	0	0.3	5.26	20.9	Damp
GM4	09/04/2020	1013	0.1	0	-0.26	20.8	Dry
GM4	11/05/2020	1010	0.1	0	0.47	21.2	
GM4	08/06/2020	1009	0	0.7	-0.05	20.5	Damp
GM4	10/07/2020	1009	0	2.3	4.68	19.7	Damp
GM4	20/08/2020	991	0	1	7.97	19.8	Damp
GM4	24/09/2020	982	0	0.5	0.16	21.1	Damp
GM4	08/10/2020	1002	0	0.2	1.83	21	Damp
GM4	Nov 2020	No data available					Damp

		Baro	CH4Stable	CO2Stable	DiffPress	O2Stable	Ground conditions
Location	Date	mb	%	%	mb	%	
GM4	17/12/2020	1000	0.1	0.6	0.21	20.8	
GM5	08/01/2020	1017	0	0.2	-0.1	21	Damp
GM5	04/02/2020	1013	0	1.4	-0.1	20.9	Damp
GM5	10/03/2020	990	0	1.3	-1.93	19.2	Damp
GM5	09/04/2020	1011	0.1	1.6	-0.15	17.3	Dry
GM5	11/05/2020	1007	0	2	-12.69	18.6	
GM5	08/06/2020	1008	0	1.9	-0.12	19.4	Damp
GM5	10/07/2020	1008	0	1.3	-0.03	19	Damp
GM5	20/08/2020	989	0	2.2	-0.65	17.7	Damp
GM5	24/09/2020	980	0	2.6	0.15	17.6	Damp
GM5	08/10/2020	998	0	2.2	-0.07	18.2	Damp
GM5	Nov 2020	No data available					Damp
GM5	17/12/2020	998	0.1	1.9	0.22	17.7	
GM7	08/01/2020	1017	0	0.2	-0.09	21	Damp
GM7	04/02/2020	1013	0	0.2		22.5	Damp
GM7	10/03/2020	990	0	0.1	0.18	21.1	Damp
GM7	15/04/2020	1007	0	0.1	-0.19	20.7	Dry
GM7	11/05/2020	1006	0.1	0.3	0.08	20.8	
GM7	08/06/2020	1008	0	0.2	-0.07	20.7	Damp
GM7	10/07/2020	1008	0	0.3	-0.05	20.8	Dry
GM7	20/08/2020	989	0	0	-2.29	20.6	Damp
GM7	24/09/2020	980	0	0.4	0.13	20.9	Damp
GM7	08/10/2020	998	0	0.4	14.76	20.6	Damp
GM7	Nov 2020	No data available					Damp
GM7	17/12/2020	998	0.1	0.2	3.28	21.2	
GM8	08/01/2020	1017	0	0.2	0	21	Damp
GM8	04/02/2020	1014	0	1.1	-0.31	21.8	Damp
GM8	10/03/2020	991	0	0.9	1.4	20.1	Damp
GM8	09/04/2020	1011	0.1	0.7	3.54	19.7	Dry
GM8	11/05/2020	1007	0	0.4	-12.6	20.9	
GM8	08/06/2020	1008	0	1.2	-0.12	19.9	Damp
GM8	10/07/2020	1009	0	1.8	-0.06	19.2	Damp
GM8	20/08/2020	989	0	0.6	10.54	20.2	Damp
GM8	24/09/2020	980	0	0.6	5.62	20.8	Damp
GM8	08/10/2020	997	0	1.3	7.37	19.6	Damp
GM8	Nov 2020	No data available					Damp
GM8	17/12/2020	998	0.1	0.9	6.01	20.5	

Appendix B

Groundwater Level Monitoring Data

Appendix B Table 1 Groundwater level data (mAOD) for 2020

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
08/01/2020	69.65	65.31	77.00	a	a	69.43	69.11	86.91	75.77
04/02/2020	71.98	65.24	83.04	a	69.93	71.98	69.05	87.27	78.00
10/03/2020	72.63	67.52	91.63	a	88.72	77.41	81.27	102.49	87.78
23/03/2020				80.85					
09/04/2020	71.78	64.37	80.89	76.93	69.97	70.05	71.05	82.55	77.64
11/05/2020	69.73	63.28	78.36	71.76	69.95	66.15	67.15	75.39	
04/06/2020					69.23				
08/06/2020	67.65	62.96	77.24	67.53		63.81	63.91		75.20
10/07/2020	67.83	64.89	77.22	68.77	69.53	Blocked	58.44	77.54	
20/08/2020	70.40	63.77	77.29	65.31	68.73	67.43	70.53	74.98	
24/09/2020	69.82	64.40	76.48	73.55	a	66.20	67.20	84.76	
08/10/2020	72.22	66.40	77.75	79.34	a	73.15	75.21	88.30	80.16
02/11/2020	72.01	66.19	79.51	80.99	a	72.97	74.03	87.28	83.16
26/11/2020					71.19				
18/12/2020	72.02	67.41	88.21	Blocked	80.92	73.88	75.96	88.67	85.39

a - Location could not be found (due to long grass etc)

Appendix C

Groundwater Quality Monitoring Data

Appendix C Table 1 Quarterly groundwater quality data for 2020

Location	Date	Alkalinity as CaCO ₃ mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity- Electrical (Field) µS/cm	Conductivity- Electrical 20deg µS/cm	Ionic balance %	Iron µg/l	Magnesium mg/l	Napthalene µg/l	Nitrogen (total oxidised) as N mg/l	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	TOC (filtered) mg/l
BH1	08/01/2020	139	<0.06	51.8	10.9	1537	318	4	26	6.6	0.011	0.8	7.7	7.3	10.2	6.23	6.8
BH1	09/04/2020	239	<0.06	96.5	19.4	1136	487	6.2	46	14.3	<0.02	<0.7	7.9	7.1	11.9	11.5	6.1
BH1	10/07/2020	Dry															
BH1	08/10/2020	128	<0.06	46.4	6.6	1017	268	3	42	4.4	<0.01	<0.7	7.6	7.3	8.2	3.95	6.7
BH12	08/01/2020	371	0.14	206	45	1154	1030	10	<25	41.3	<0.01	2.2	7.6	7.6	17.1	38.9	12.2
BH12	09/04/2020	391	<0.06	188	46.7	1203	1050	2.8	<25	37.5	<0.02	<0.7	8.1	7.4	13.6	35	8
BH12	10/07/2020	297	<0.06	159	45.7	1243	990	-2.8	<25	29.3	<0.01	2.8	7.7	7.4	14.1	30.8	7
BH12	08/10/2020	307	<0.06	111	18.3	1249	668	-0.8	<25	20.7	<0.01	6.9	7.7	7.4	7.18	11.7	4.8
BH13	08/01/2020	Borehole blocked															
BH13	10/03/2020	428	<0.06	121	33.6	1046	901	-0.2	<25	44.1	<0.01	19.1	7.2	7.2	7.01	35.6	6.7
BH13	09/04/2020	398	<0.06	99.5	53.5	964	805	-2.7	27	39.8	<0.01	4	7.8	6.2	2.78	28.8	4
BH13	20/08/2020	60.8	<0.06	19.4	14.3	1266	175	2.4	29	2.2	<0.04	<0.7	7	7.4	10	6.7	19
BH13	02/11/2020	451	<0.06	121	41.7	1175	970	-2.4	<25	48.8	<0.01	16.7	7.3	7.3	3.48	29.6	4.2
BH14	08/01/2020	Borehole not located															
BH14	23/03/2020	348	<0.06	95.9	14.7	1143	574	-4.3	<25	25.1	<0.04	3.8	8.4	7.6	0.99	7.03	1.4
BH14	09/04/2020	411	<0.06	116	11.2	749	694	-1	<25	31.9	<0.01	4.4	7.8	6.7	0.79	5.22	2.3
BH14	10/07/2020	409	0.23	124	20.2	2250	764	-1.3	<25	34.5	<0.01	3.5	7.7	7	1.65	11.3	4.5
BH14	08/10/2020	414	<0.06	116	8.8	1962	711	0.1	<25	34	<0.01	4.3	7.7	7.1	1.18	5.15	2
BH15	08/01/2020	Borehole not located															
BH15	10/03/2020	295	<0.06	102	16.6	581	508	3	<25	16.2	<0.01	<0.7	7.9	8.1	0.71	9.79	3.4
BH15	09/04/2020	307	<0.06	96.6	16	943	530	-1.7	<25	17.2	<0.01	1	8.1	7.1	0.95	8.14	2.4

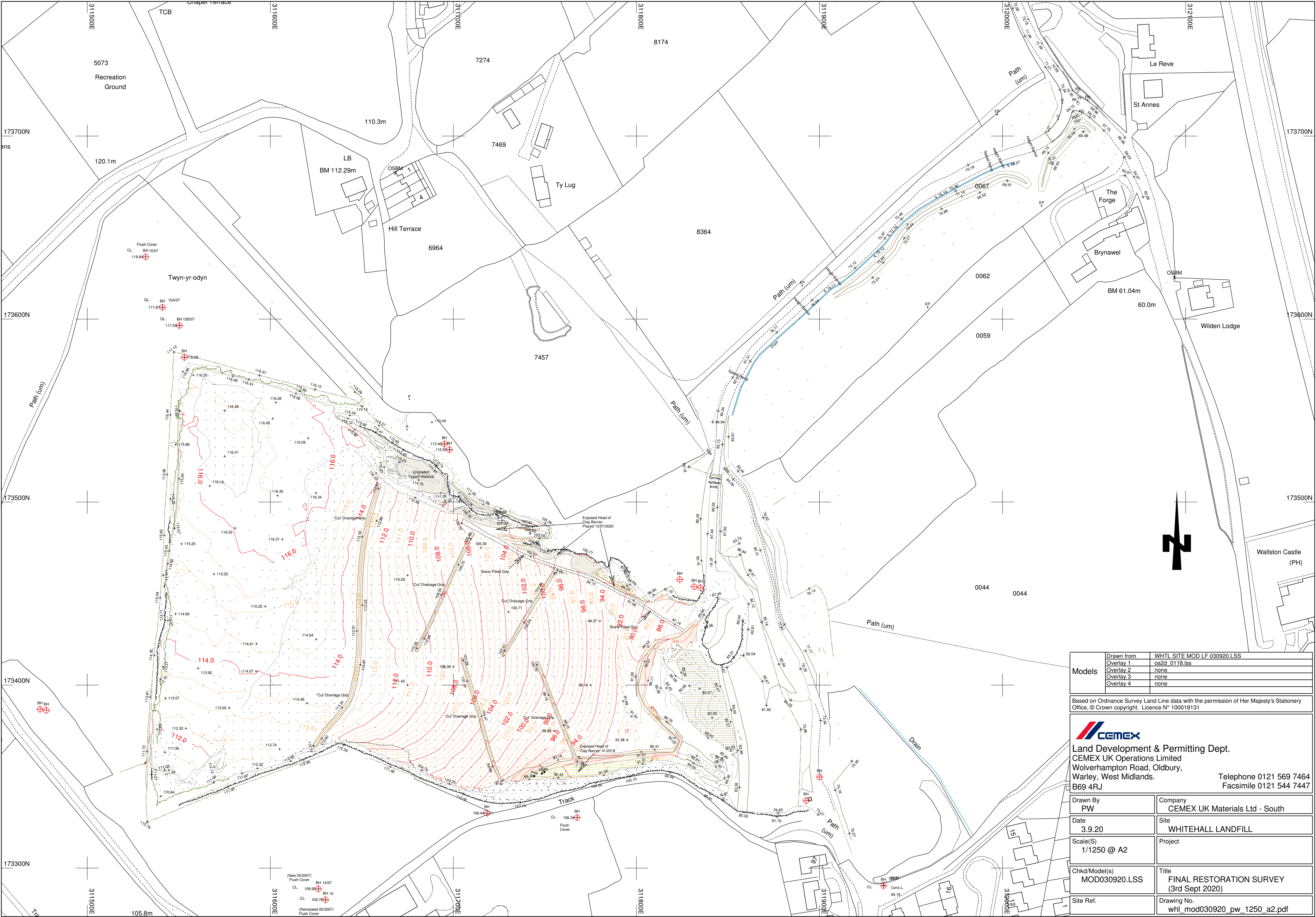
Location	Date	Alkalinity as CaCO3 mg/l	Ammoniacal Nitrogen as N mg/l	Calcium mg/l	Chloride mg/l	Conductivity- Electrical (Field) µS/cm	Conductivity- Electrical 20deg µS/cm	Ionic balance %	Iron µg/l	Magnesium mg/l	Napthalene µg/l	Nitrogen (total oxidised) as N mg/l	pH pH units	pH (Field) pH units	Potassium mg/l	Sodium mg/l	TOC (filtered) mg/l
BH15	10/07/2020	246	<0.06	86.8	19.6	2035	517	-1.6	30	11.7	<0.01	4.6	7.8	7.3	2.79	14.3	4.3
BH15	08/10/2020	Borehole not located															
BH15	25/11/2020	319	<0.06	95.3	15.7	1182	579	-2.6	<25	18.6	<0.01	<0.7	7.5	7.2	1.4	8.91	5.1
BH3	08/01/2020	251	<0.06	96.2	30.8	783	624	1.6	<25	22.7	<0.01	<0.7	7.8	7.1	5.13	18.8	2.8
BH3	09/04/2020	261	<0.06	84	35.4	1028	578	-2.9	<25	21.7	<0.01	<0.7	8.3	6.7	3.58	20.3	2.9
BH3	10/07/2020	Borehole blocked															
BH3	08/10/2020	187	<0.06	61.3	18.7	3040	398	0.8	<25	14.5	<0.01	<0.7	7.9	7.2	2.18	10.2	3.3
BH3A	08/01/2020	291	<0.06	88.7	51.6	3270	660	-0.2	27	22.2	<0.01	<0.7	7.3	7.2	3.36	25.1	6.9
BH3A	09/04/2020	303	<0.06	82.2	44.6	1003	634	-2.6	<25	23.3	<0.01	<0.7	7.9	6.9	2.47	26.7	3.7
BH3A	10/07/2020	Insufficient liquid to obtain a sample															
BH3A	08/10/2020	159	<0.06	51.2	25.2	3400	361	3.2	82	10	<0.01	<0.7	7.8	7.3	3.52	15.6	23.2
BH6	08/01/2020	300	<0.06	95.4	16.8	827	567	0.5	<25	17.8	<0.01	<0.7	7.7	7.4	2.1	9.81	1.9
BH6	09/04/2020	319	<0.06	85	20.2	1009	563	-2.9	<25	25.7	<0.01	<0.7	8	7.1	1.96	9.75	1.7
BH6	10/07/2020	334	<0.06	85.6	24.3	1003	618	-1.2	<25	34.2	<0.01	<0.7	7.8	7.1	2.31	10.1	2.7
BH6	08/10/2020	330	<0.06	92.1	21.1	1009	617	0.7	<25	30.3	<0.01	<0.7	7.6	7.2	2.36	9.44	1.7
BH9	08/01/2020	Dry															
BH9	10/03/2020	356	<0.06	120	17.1	723	630	1.9	<25	19	<0.01	2.6	7.5	7.3	8.88	10	3.8
BH9	09/04/2020	335	<0.06	107	16.2	1208	643	-1.5	26	18.1	<0.01	4	7.8	6	8.78	11.9	3.1
BH9	10/07/2020	Dry															
BH9	08/10/2020	363	<0.06	118	10.7	1750	652	0	<25	18.8	<0.01	3.4	7.6	7.1	9.61	4.81	2.6

Appendix C Table 2 Annual groundwater quality data 2020

Location	Date	Cadmium µg/l	Chromium mg/l	Copper mg/l	Lead mg/l	Manganese mg/l	Nickel mg/l	Zinc mg/l
BH1	09/04/2020	<0.6	<0.002	<0.009	<0.006	0.032	<0.003	<0.018
BH12	09/04/2020	<0.6	<0.002	0.015	<0.006	0.009	0.005	<0.018
BH13	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH14	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	<0.003	<0.018
BH15	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	0.005	<0.018
BH3	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH3A	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	<0.003	<0.018
BH6	09/04/2020	<0.6	<0.002	<0.009	<0.006	<0.007	<0.003	<0.018
BH9	09/04/2020	<0.6	<0.002	<0.009	<0.006	0.011	0.003	<0.018

Appendix D

Topographic Survey



Models	Drawn from	WHTL SITE MOD LF 030920.LSS
	Overlay 1	0523_0118.lss
	Overlay 2	none
	Overlay 3	none
	Overlay 4	none

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 Land Development & Permitting Dept. CEMEX UK Operations Limited Wolverhampton Road, Oldbury, Warley, West Midlands. B69 4RJ		Telephone 0121 569 7464 Facsimile 0121 544 7447
Drawn By PW	Company CEMEX UK Materials Ltd - South	
Date 3.9.20	Site WHITEHALL LANDFILL	
Scale(S) 1/1250 @ A2	Project	
Chkd/Model(s) MOD030920.LSS	Title FINAL RESTORATION SURVEY (3rd Sept 2020)	
Site Ref.	Drawing No. whl_mod030920_pw_1250_a2.pdf	