

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

Annual environmental monitoring report for 2021

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1 Introduction

The Environmental Permit (EP) 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 2.1). 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 (GF01-GF11) were installed from May-June 2021. The Site is now fully restored, and a Closure Plan was submitted to Natural Resources Wales (NRW) for review (Stantec, 2021a) in September 2021. Once this has been approved an application will be made to put the Site into formal aftercare. CEMEX intend to follow this Closure Plan in 2022.

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.

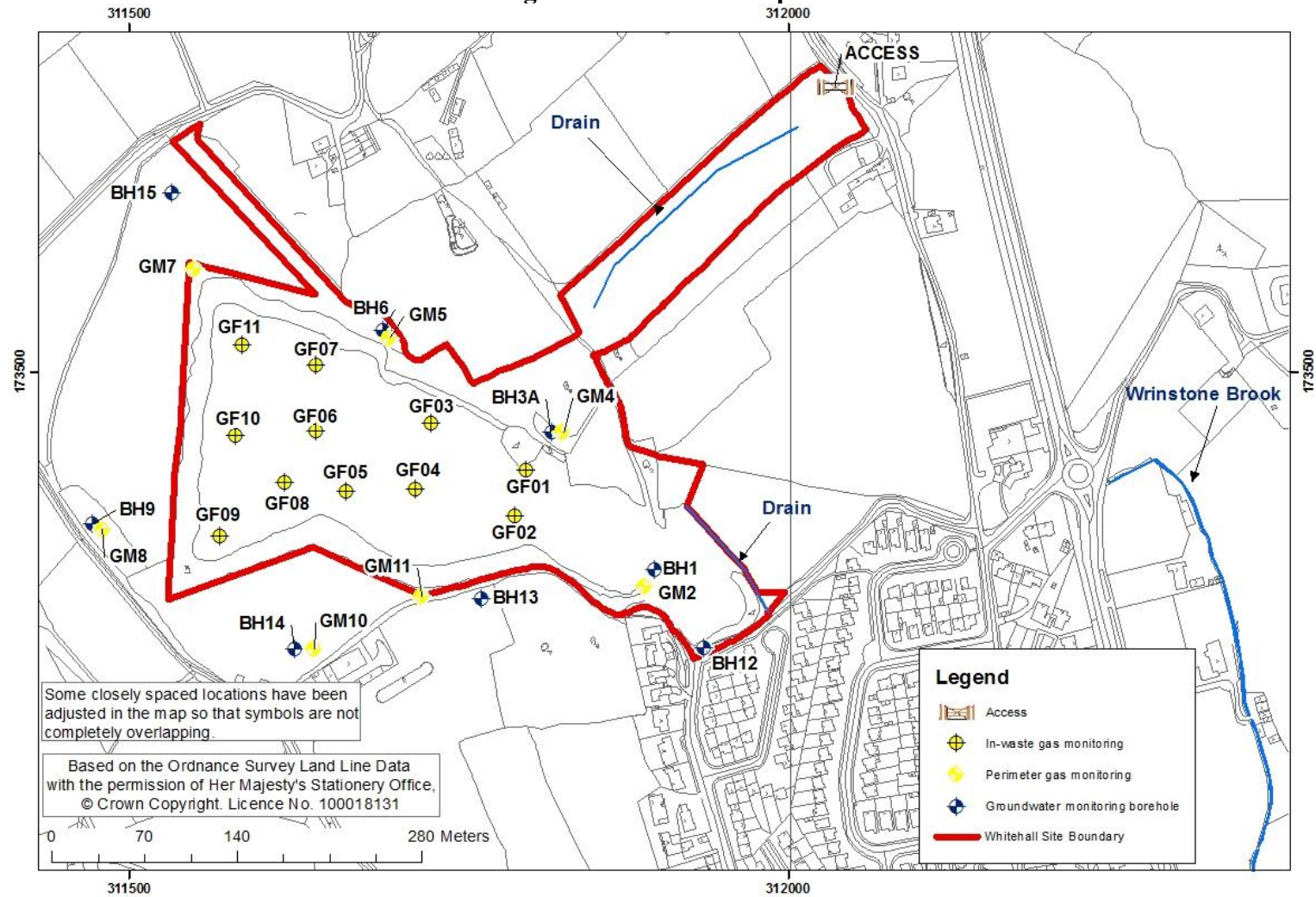
There are three closed landfills situated to the north, up-gradient of Whitehall Quarry. The most northerly of these, Greenwood Quarry, located approximately 500 m from Whitehall Quarry (Drawing ESID 2, ESI/Arup (2005)), was licensed to receive inert and semi-inert material (Wildgust, 1998. Lafferty, 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 2.1 Site location plan



3 Review of Monitoring Data

Schedule 4 of the EP 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 2021. The locations of the monitoring points are shown on Figure 2.1.

3.1 Gas Monitoring

3.1.1 In-waste Gas Monitoring

From May to June 2021, eleven in-waste boreholes were drilled and monitoring commenced in July 2021. These have been monitored monthly as specified in the EP and detailed in Table 3.1.

Monitoring requirements for the in-waste gas wells are detailed in the Closure Plan (Stantec, 2021a). Whilst not formally adopted to the permit, the data obtained from these wells is presented in this section for information.

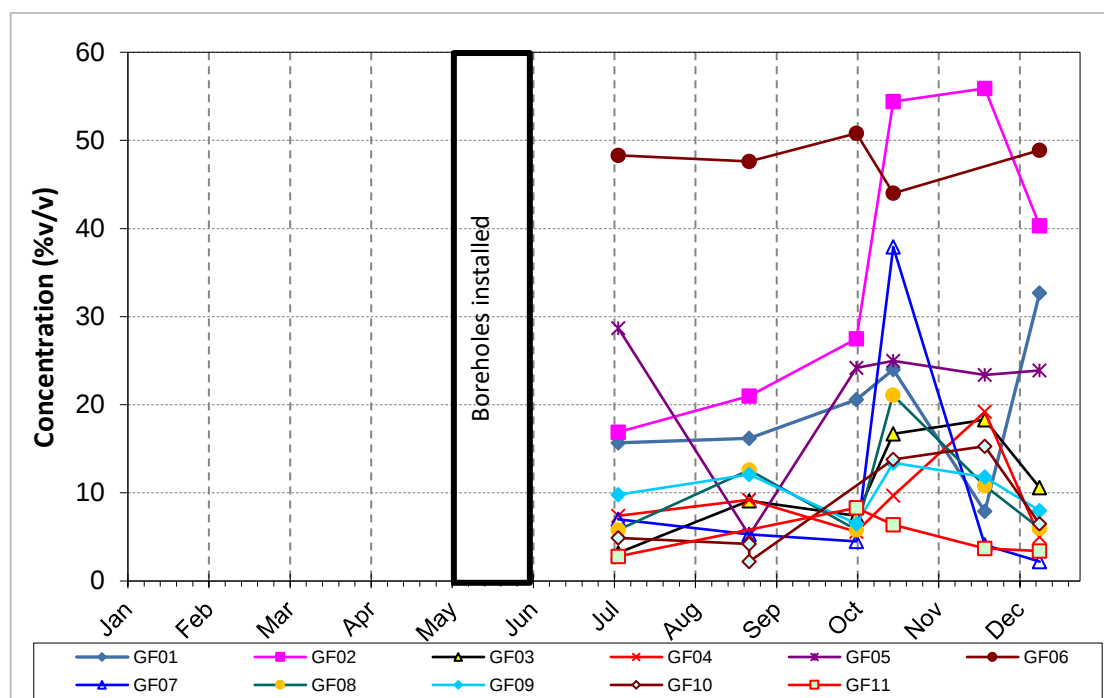
Appendix A presents all in-waste gas concentrations collected during 2021. During this period, flow rate has not been measured. This parameter will be added from 2022 onwards in order to build the necessary dataset to inform the permit surrender application in due course.

Table 3.1 Monitoring requirements at in waste boreholes.

Monitoring Locations	Parameter	Frequency
GF1-GF11	Methane	Monthly
	Carbon dioxide	
	Oxygen	
	Atmospheric Pressure	
	Differential Pressure	
	Flow Rate	

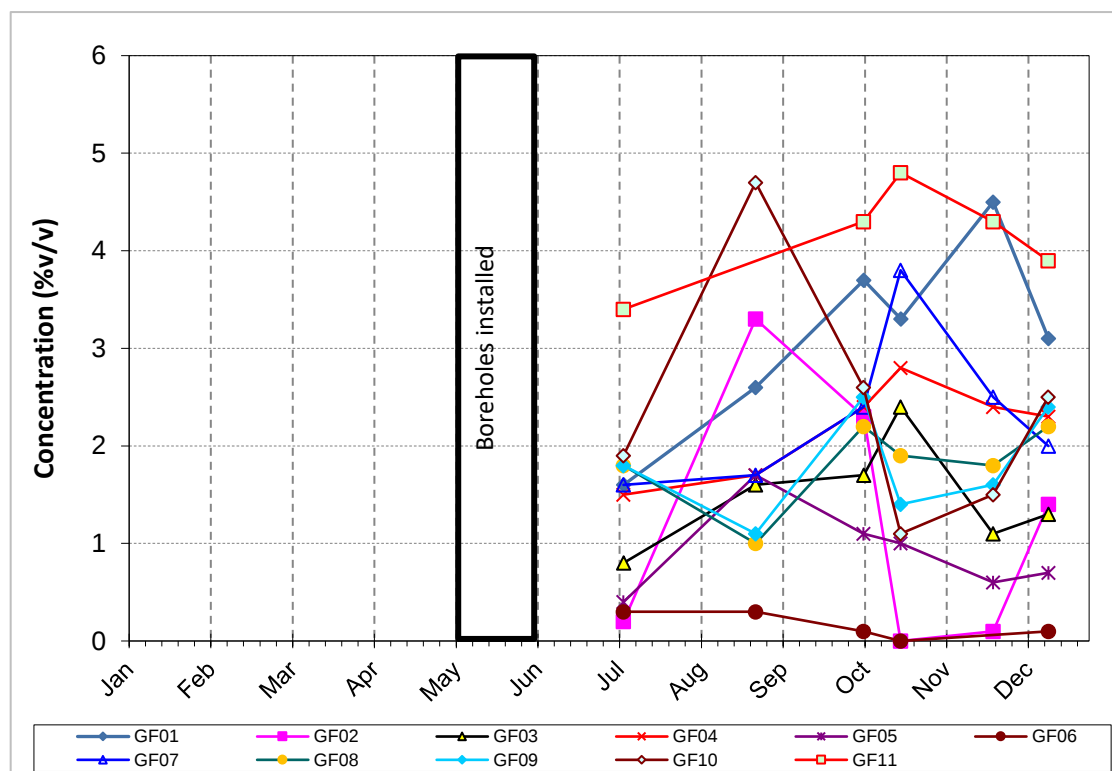
Methane varies between 2.8 %v/v in GF11 and 55.9 %v/v in GF02 (Figure 3.1). However, most concentrations remain below 30 %v/v, except at GF06 where all results are around 50 %v/v. The locations with the highest carbon dioxide concentrations have the lowest methane concentrations and vice versa. No discernible trends can be gathered as the time period of data collection is too short.

Figure 3.1 In-waste stable methane concentrations in 2021



Carbon dioxide concentrations in 2021 are presented in Figure 3.2. Carbon dioxide appears to be highest in GF11, with concentrations reaching 4.8 %v/v. Carbon dioxide is lowest in GF06 with all results less than 0.3 %v/v. Similarly, no obvious trends can be observed due to the short time period of data collection.

Figure 3.2 In waste carbon dioxide concentrations in 2021



3.1.2 Perimeter 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 EP. The monitoring requirements and compliance limits are given in Table 3.2

Appendix B presents all gas monitoring data collected at these locations during 2021.

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 due to 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. These are presented in Table 3.2

Table 3.2 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

Methane has been detected at 23 of the 86 occasions at very low levels of between 0.1 %v/v and 0.3 %v/v in February, May, July and October, as presented in Table 3.3. These detections occurred at all the locations over the course of the year. There have been no exceedances of the compliance limit.

Table 3.3 Location of methane detections

Location	Date of detection	Reading (%v/v)
GM10	24/02/21	0.1
	11/05/21	0.1
	07/07/21	0.3
	06/10/21	0.1
GM11	24/02/21	0.1
	11/05/21	0.1
	07/07/21	0.3
	06/10/21	0.1
GM2	24/02/21	0.1
	07/07/21	0.3
GM4	24/02/21	0.1
	11/05/21	0.1
	07/07/21	0.3
	06/10/21	0.1
GM5	24/02/21	0.1

Location	Date of detection	Reading (%v/v)
GM7	11/05/21	0.1
	07/07/21	0.3
	24/02/21	0.1
	11/05/21	0.1
	07/07/21	0.3
	06/10/21	0.1
GM8	24/02/21	0.1
	11/05/21	0.1
	07/07/21	0.3

The carbon dioxide compliance limit was exceeded once during the reporting period with a result of 6.5 %v/v at GM4 in October 2021 (Figure 3.3). This value appears to be a one-off exceedance with the following month measurement decreasing to 2.5 %v/v. The remaining concentrations are largely below 5 %v/v, except for two readings including the compliance limit exceedance and a measurement of 5.2 %v/v at GM4 in June. Both of these readings are new maximums at GM4. There is a slight increasing trend at GM4 and GM11 where carbon dioxide concentrations increased at the end of 2020 and have remained elevated, increasing from 1.4 %v/v in May to 2.7 %v/v in December (Figure 3.4). Concentrations have increased steadily since 2019 when very low concentrations were recorded. Carbon dioxide concentrations are higher in 2021 than previous years in GM4 which has recorded the two highest data points compared to the historical data.

Figure 3.3 Stable carbon dioxide concentrations in 2021

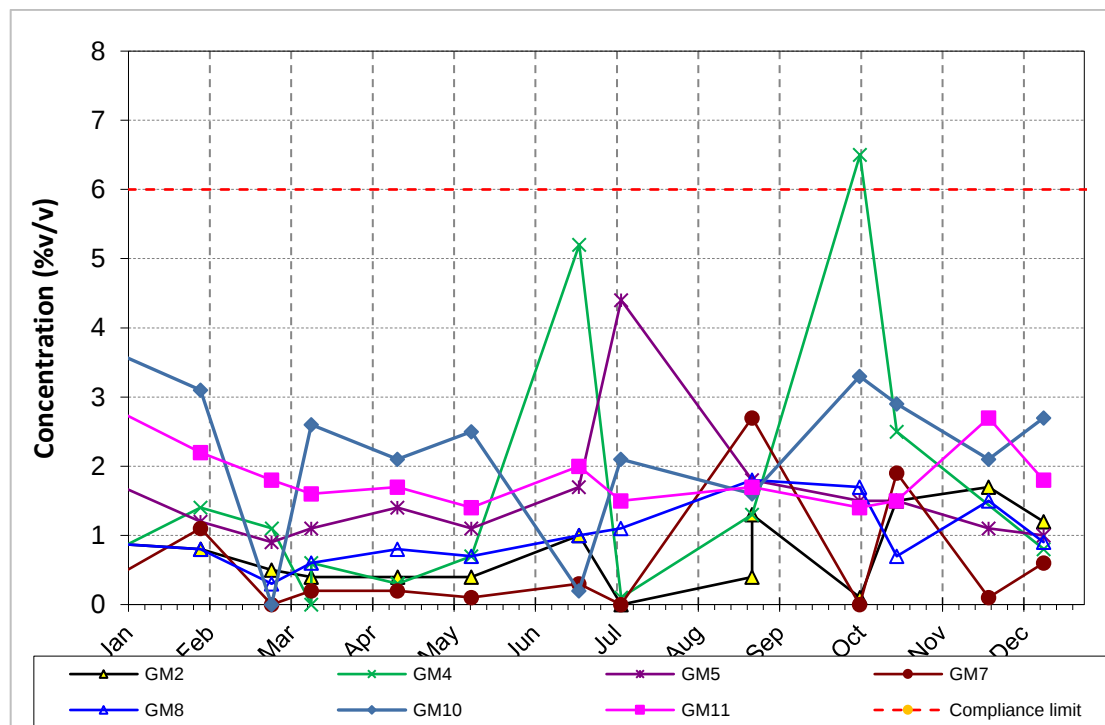
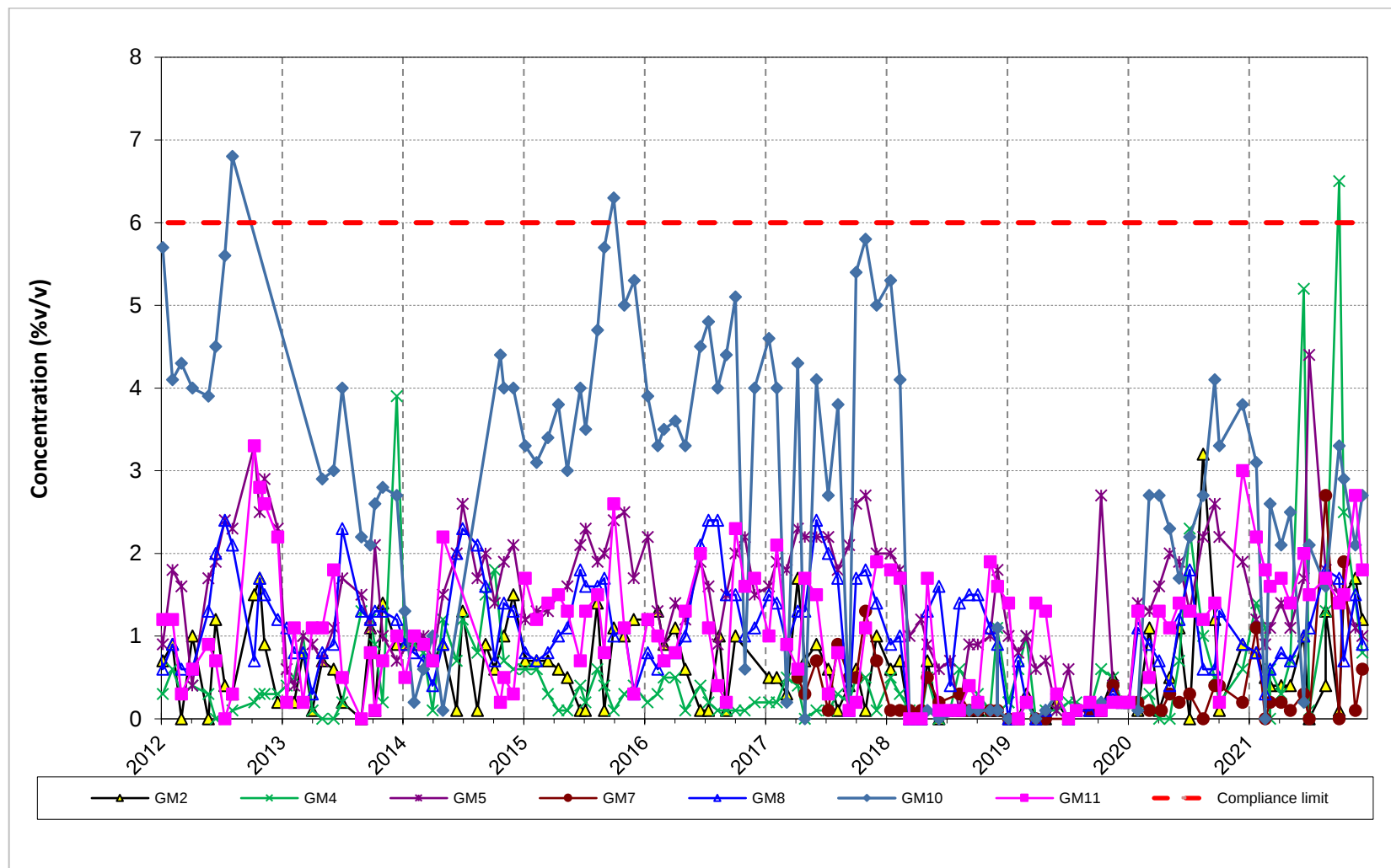


Figure 3.4 Historical stable carbon dioxide concentrations



3.2 Groundwater Monitoring

Schedule 4 of the EP requires monitoring of groundwater quality at four down-gradient 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 EP and are summarised in Table 3.4. These locations were sampled on a quarterly and annual frequency for relevant determinands during 2021. The locations of the monitoring boreholes are shown on Figure 2.1.

We note that BH3 and BH3A are located very close to each other. The Closure Plan (Stantec, 2021a) recommends that BH3 is removed from the monitoring network.

Table 3.4 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.

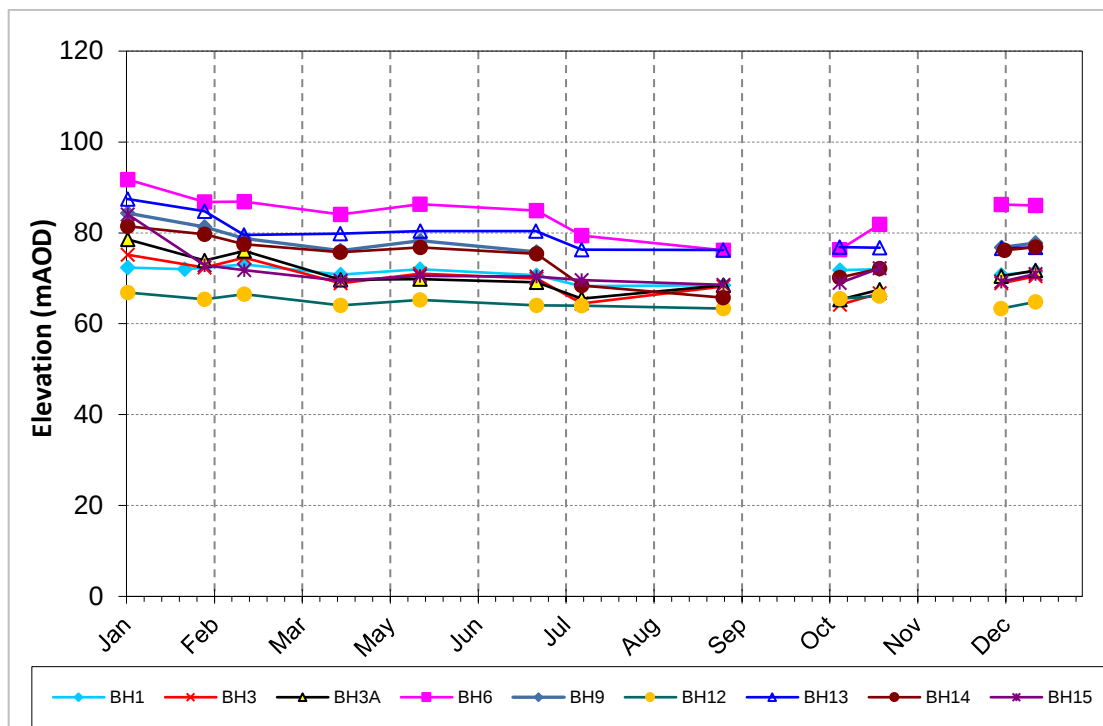
3.2.1 Groundwater Levels

Monthly groundwater level data collected during 2021 are presented in Figure 3.5. A full dataset for 2021 is presented in Appendix C

BH09 was dry from July to October so no groundwater levels were recorded.

In 2021, groundwater levels reached their maximum in January, before decreasing at all locations until July. 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 Site respectively. The data remains fairly consistent with the historical trends

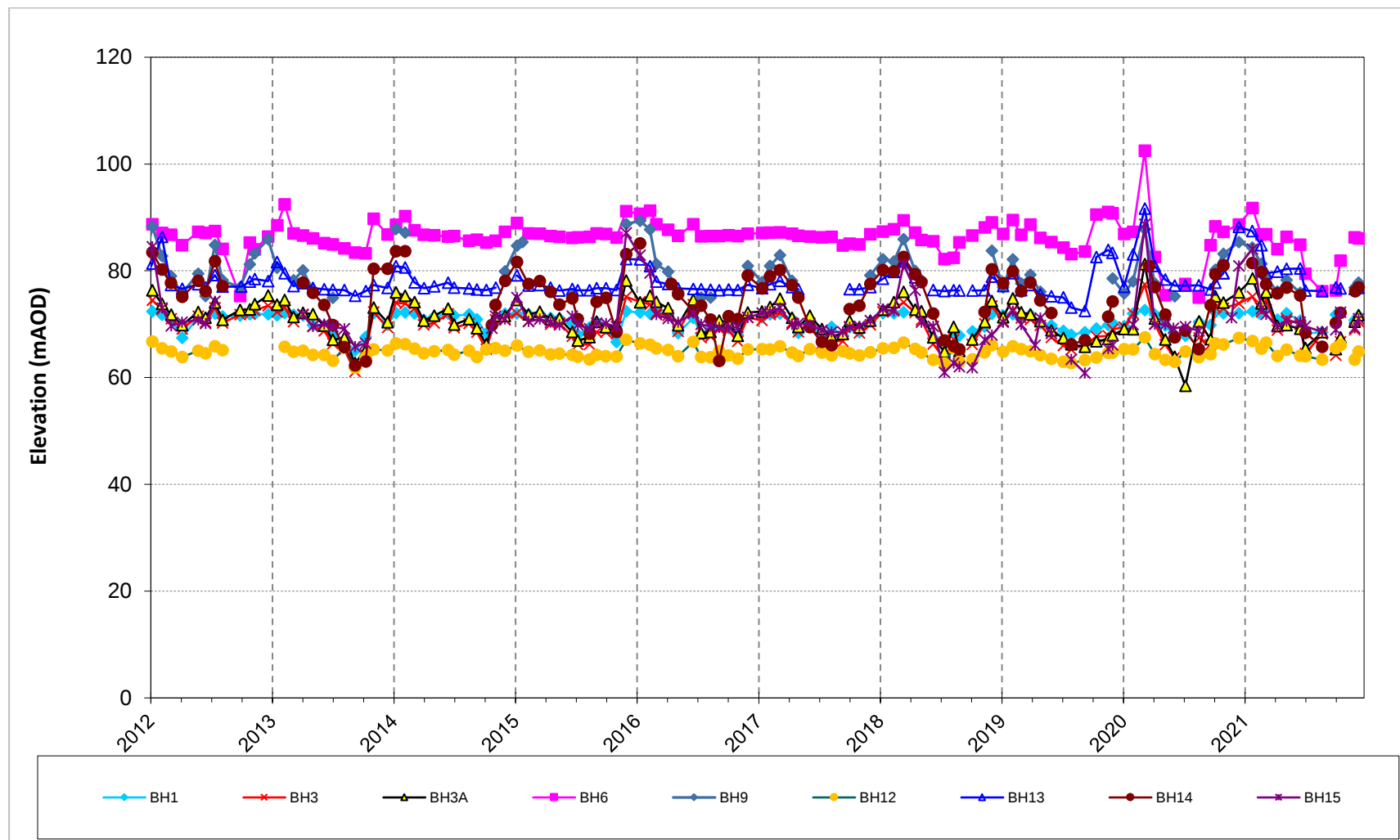
Figure 3.5 Groundwater elevation during 2021



Historical observed groundwater levels for the past decade for all monitoring locations are shown in Figure 3.6. Overall, the groundwater levels are consistent with historical trends. The groundwater elevation at all monitoring locations exhibit similar fluctuation timings, with differing degrees of variation. BH12 shows smaller amplitudes than the other wells. There were lower groundwater levels at BH06 in 2020 and 2021 compared to the period 2012 to 2019. There were six readings below 80 mAOD in 2020 and 2021 (altogether) and there were no readings below 82 mAOD since 2012.

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 2021 although matched by some other locations (BH06, BH03A).

Figure 3.6 Historical groundwater elevation (2012-2021)



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 3.4.

The quarterly dataset for 2021 is presented in Appendix D.

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 3.5 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 3.5 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 3.6. The data for potassium has been split over three rows, as there are separate compliance limits.

There was one exceedance of the compliance limits during 2021. This was naphthalene in January at BH1.

Table 3.6 Statistical summary of groundwater compliance parameters in 2021

Determinand	No. of Results	Unit	Min	Max	Mean	Median	# > LOD	% > LOD	Compliance limit		
									No. Exceeding	% Exceeding	Action Level
Ammoniacal Nitrogen as N	16	mg/l	<0.06	<0.06	n.d.	n.d.	0	0	0	0	0.39
Chloride	16	mg/l	5.8	71.3	30	18.5	16	100	0	0	250
Iron	16	mg/l	<0.025	0.166	0.032	n.d.	6	37.5	0	0	0.2
Naphthalene	16	mg/l	<0.01	0.06	n.d.	n.d.	4	28.6	1	6.25	0.05
Potassium (BH1)	4	mg/l	6.39	8.63	7.89	8.27	4	100	0	0	27
Potassium (BH12)	4	mg/l	4.64	16.9	12.76	14.8	4	100	0	0	24.7
Potassium (BH13, BH14)	8	mg/l	0.78	7.33	2.93	2.08	8	100	0	0	12

Groundwater ammoniacal nitrogen concentrations for the last decade are presented in Figure 3.7 and Figure 3.8. This shows that in the last ten years, the majority of samples at down-gradient boreholes are at or below the detection limit with limited detections recorded. Ammoniacal nitrogen is detected four times during the reporting period. This includes an isolated peak concentration of 4.38 mg/l at BH3 in April. There are no compliance limits for BH3 as it is an upgradient well. As a result, the recent data maintains the same trends as the historical data with most results below the detection limit with occasional isolated peaks.

Potassium concentrations in groundwater during the last decade are presented in and Figure 3.10. 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 3.10) but stabilised around 15 mg/l from 2013 and in 2020 dropped to around 9 mg/l continuing into 2021. 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). Most potassium results show decreases through 2019-2020 with recent 2021 data showing a slight concentration increase in BH1, BH12, BH13, and BH3A, however the results remain consistent with previous historical data.

In the HRA Review (Stantec, 2021) it was recommended that the compliance limits were 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 2022 and reviewed again in the next annual report.

Historical iron concentrations are plotted on Figure 3.11. Iron concentrations are consistent with previous years with only 29.4% of samples above the detection limit at a maximum of 0.166 mg/l.

There was one naphthalene exceedance during 2021 (see Table 3.6) with a result of 0.06 mg/l recorded at BH1 in January. Results return below the detection limit in the following sample.

A statistical summary of general groundwater quality for all determinands that are monitored at the Site is presented in Table 3.7. 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 2021 for sulphate, manganese, and ammoniacal nitrogen. There was only one result above the sulphate UKDWS of 250 mg/l at BH12 in December with a concentration of 269 mg/l. Three manganese results are above the UKDWS (0.05 mg/l) equating to 33.3 % of the samples. Similarly, two ammoniacal nitrogen results exceed the UKDWS (0.39 mg/l) however these are just 5.8 % of the results.

Figure 3.7 Historical ammoniacal nitrogen in groundwater at boreholes with compliance limits (downgradient)

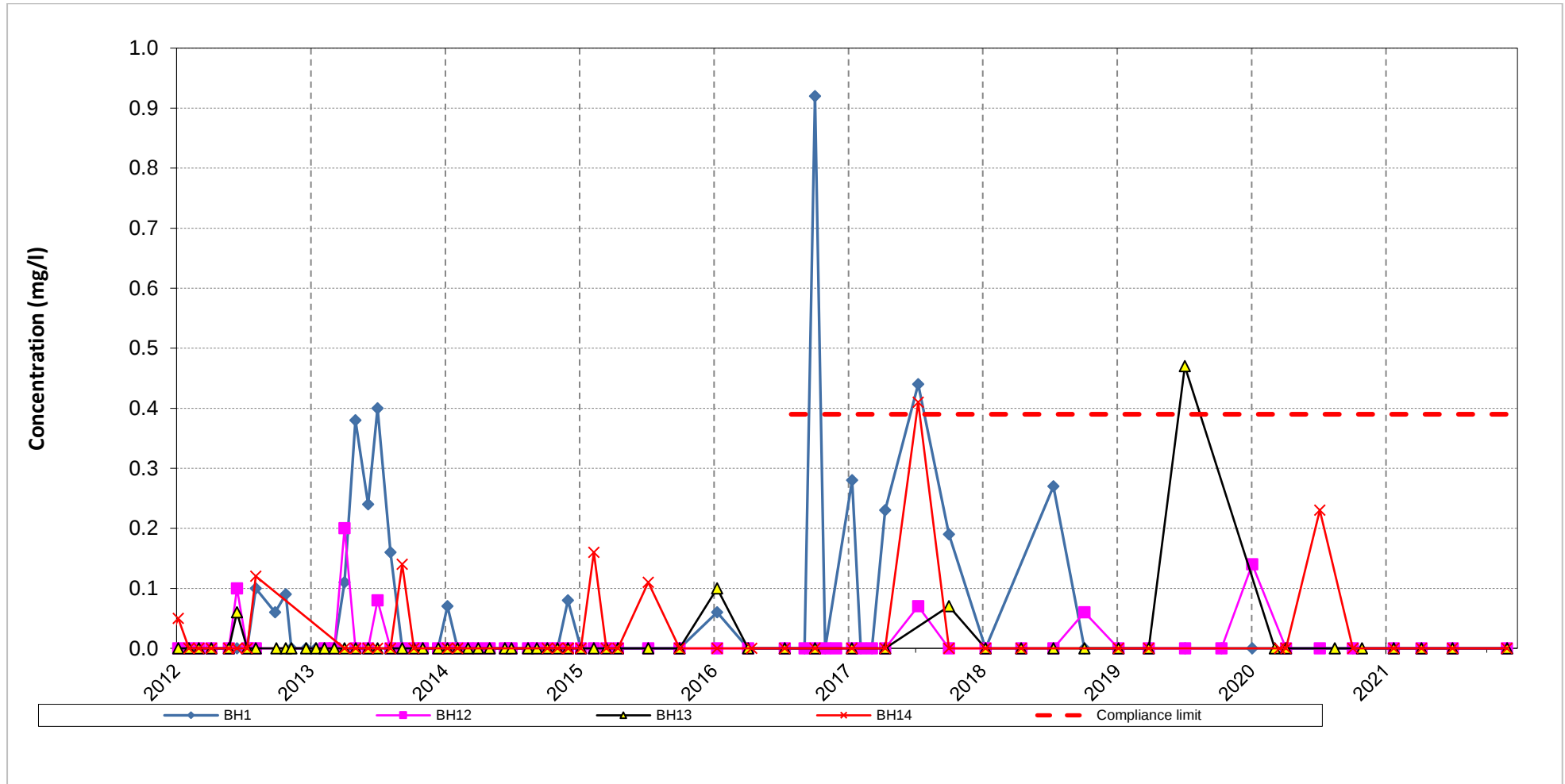


Figure 3.8 Historical ammoniacal nitrogen concentrations in groundwater at boreholes without compliance limits (upgradient)

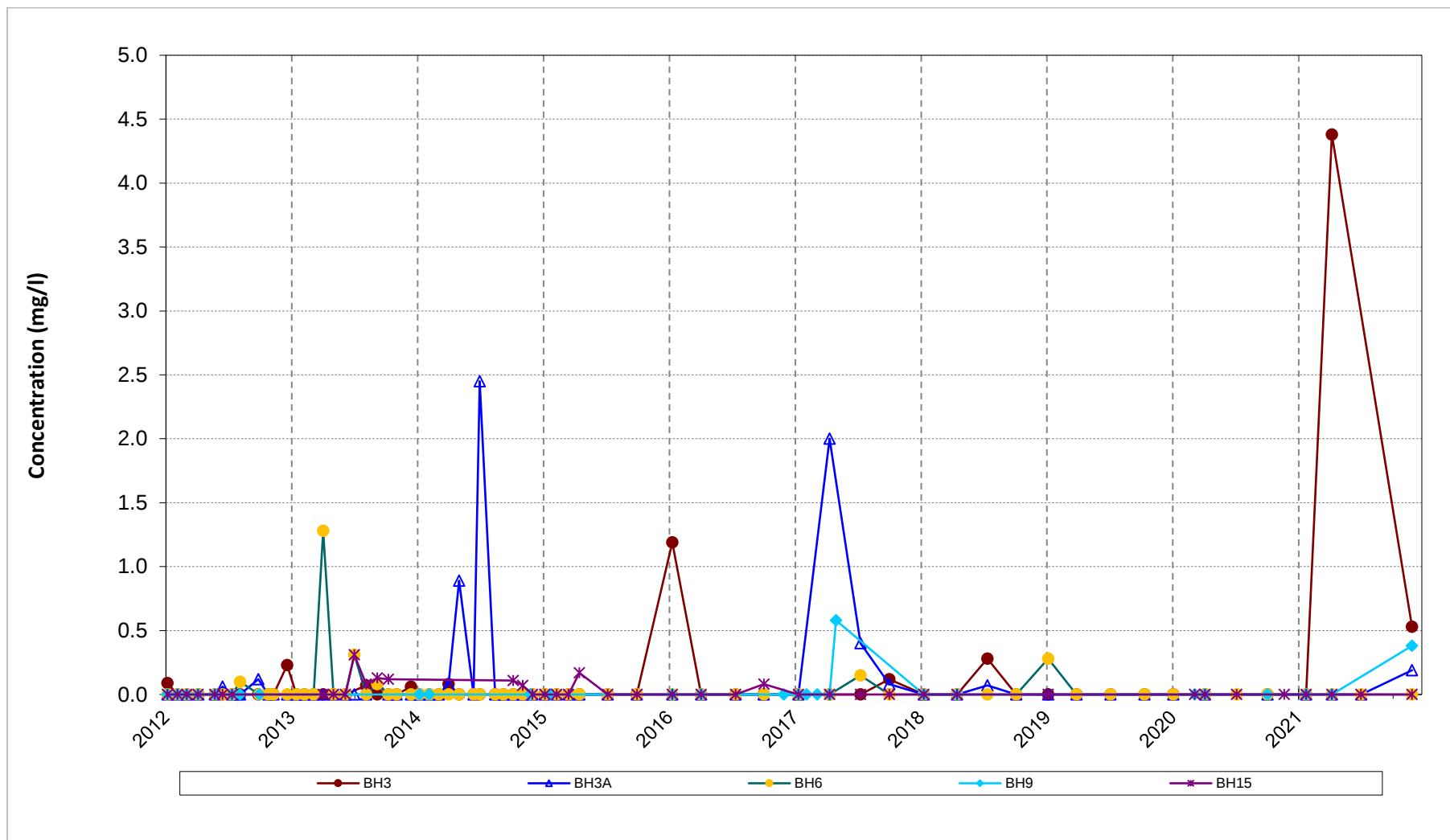


Figure 3.9 Historical potassium concentrations in groundwater at boreholes with compliance limits (downgradient)

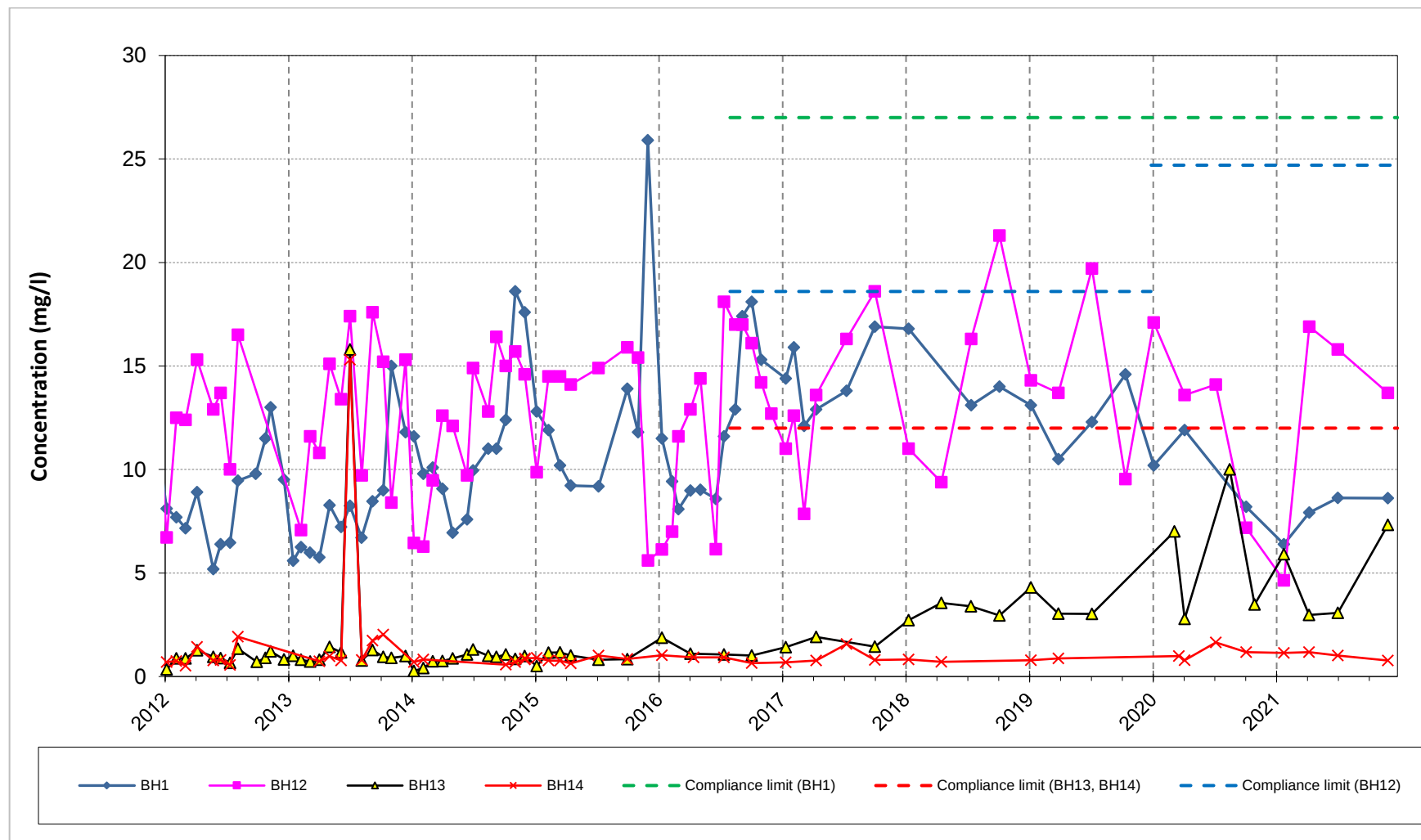


Figure 3.10 Historical potassium concentrations in groundwater at boreholes without compliance limits (upgradient)

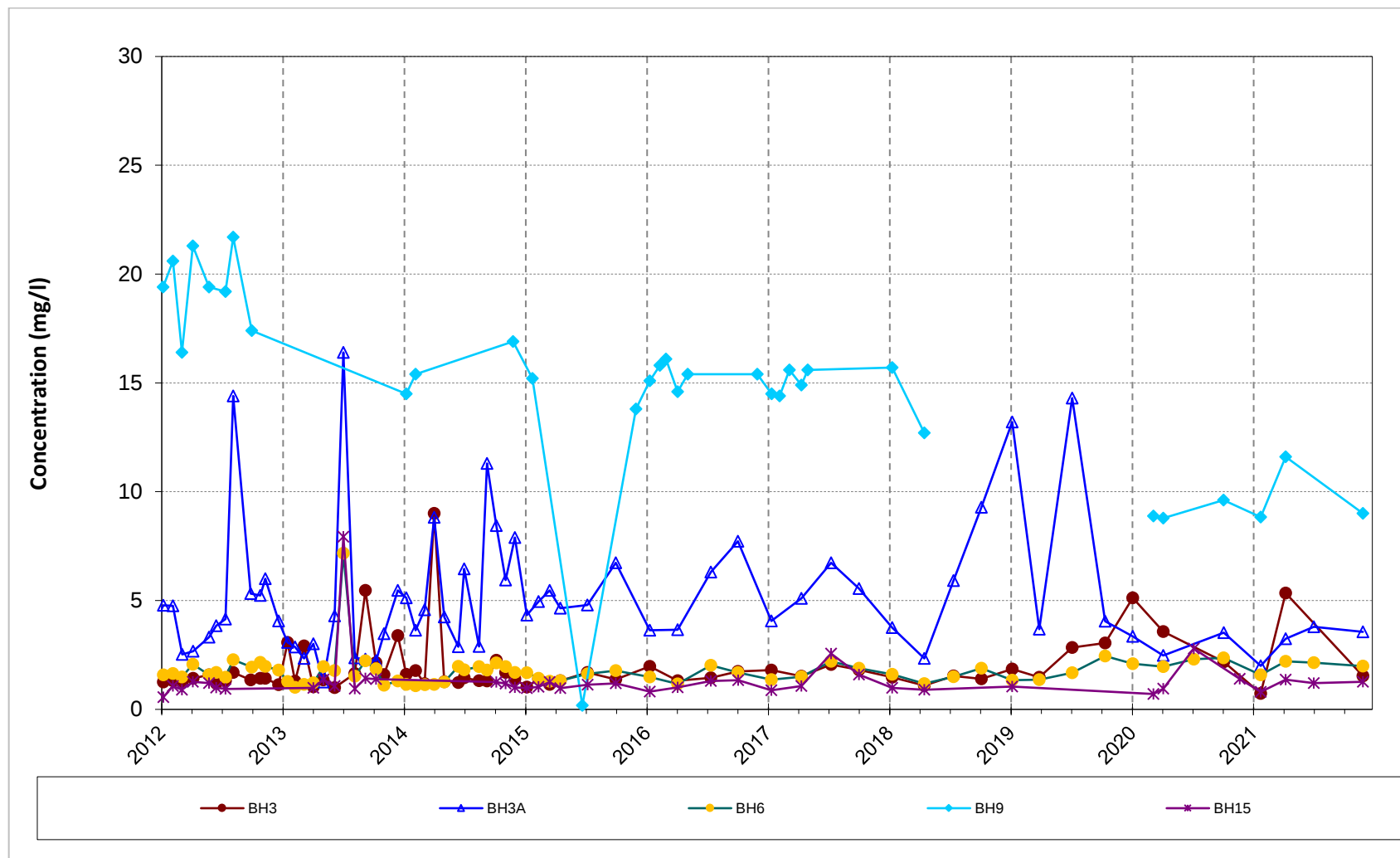
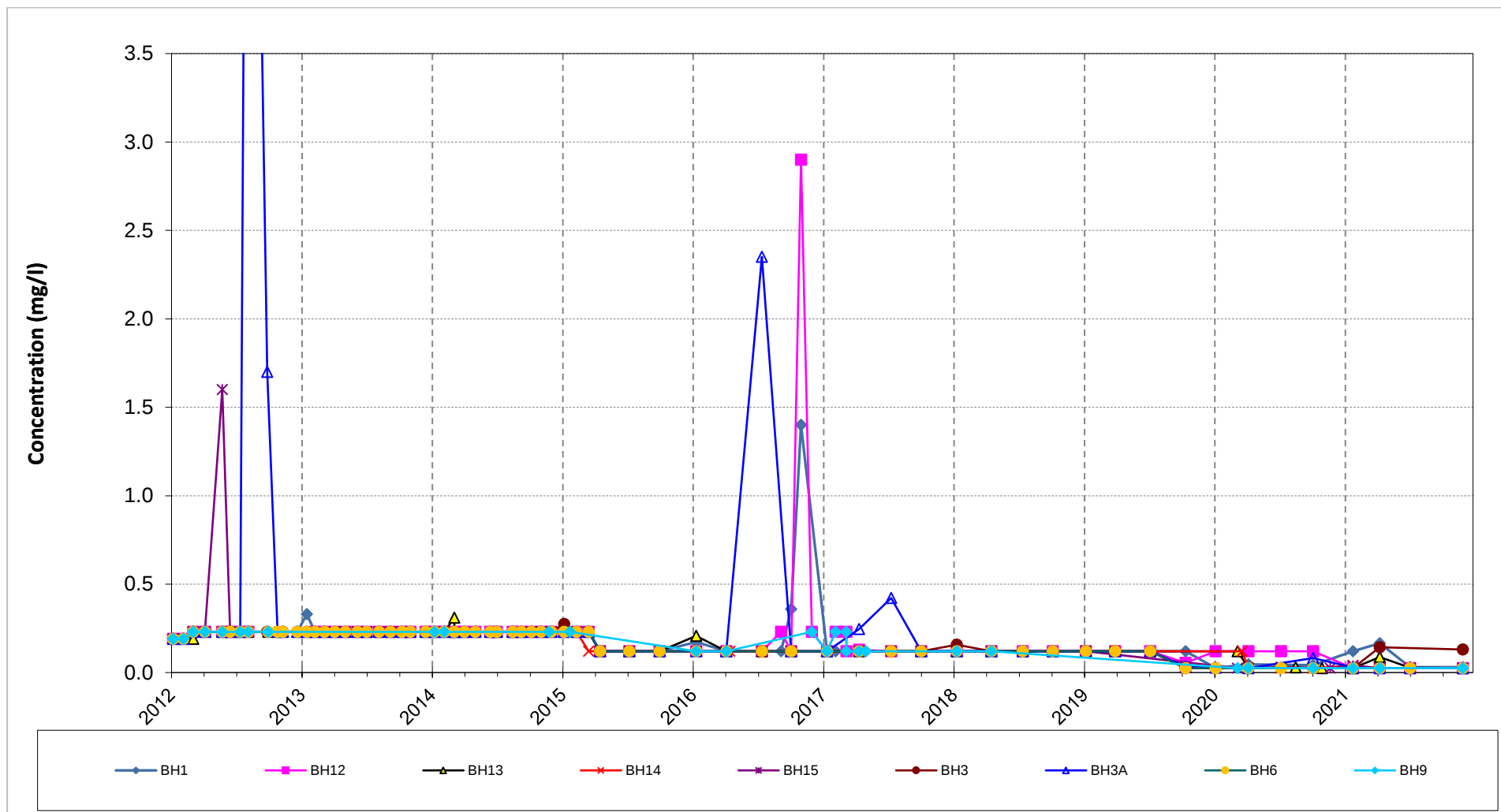


Figure 3.11 Historical iron concentrations at all groundwater locations



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Table 3.7 Statistical summary of groundwater quality in 2021

Determinand	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
														No. Exceeding	% Exceeding	Action Level
Field / lab parameters																
pH	WG	All	34	pH units	7	7.9	7.50	7.5	0.26	7.08	7.90	34	100			
pH (field)	WG	All	31	pH units	6.9	9.1	7.70	7.4	0.61	6.96	8.98	31	100			
Conductivity- Electrical (Field)	WG	All	31	uS/cm	641	3250	1597	1117	831.35	684.2	3184	31	100			
Conductivity- Electrical 20deg	WG	All	34	uS/cm	347	1220	653	618	191.01	359	1175	34	100			
Major ions																
Alkalinity as CaCO3	WG	All	34	mg/l	165	429	308	305	69.39	165.75	422.3	34	100	0	0	-
Calcium	WG	All	34	mg/l	45.1	199	102	98.05	31.69	55.825	192.3	34	100	0	0	-
Chloride	WG	All	34	mg/l	5.8	71.3	24.84	18.9	16.40	6.025	62.08	34	100	0	0	250
Magnesium	WG	All	34	mg/l	8.1	47.2	24.86	22.65	9.96	9.6	41.5	34	100	0	0	-
Potassium	WG	All	34	mg/l	0.73	16.9	4.95	3.16	4.42	0.7675	16.08	34	100	0	0	-
Sodium	WG	All	34	mg/l	5.09	46	15.18	9.975	10.74	5.18	42.1	34	100	0	0	200
Sulphate	WG	All	34	mg/l	2.20	269	44.19	13.55	70.08	2.20	253.3	32	94.12	1	2.94	250
Minor ions																
Cadmium	WG	All	9	mg/l	<0.0006	<0.0006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.005
Chromium	WG	All	9	mg/l	<0.002	0.002	n.d.	n.d.	n.d.	n.d.	n.d.	1	11.11	0	0	0.05
Copper	WG	All	9	mg/l	<0.009	0.018	0.01	n.d.	n.d.	n.d.	n.d.	4	44.44	0	0	2
Iron	WG	All	34	mg/l	<0.025	0.166	0.03	n.d.	n.d.	n.d.	n.d.	10	29.41	0	0	0.2
Lead	WG	All	9	mg/l	<0.006	<0.006	n.d.	n.d.	n.d.	n.d.	n.d.	0	0	0	0	0.01
Manganese	WG	All	9	mg/l	<0.007	0.152	0.05	0.01	0.057	n.d.	n.d.	7	77.78	3	33.33	0.05

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Determinand	Matrix	Fraction	No. of Results	Unit	Min	Max	Mean	Median	Standard Deviation	5th Percentile	95th Percentile	# > LOD	% > LOD	UKDWS		
														No. Exceeding	% Exceeding	Action Level
Nickel	WG	All	9	mg/l	<0.003	0.009	0.005	0.004	0.003	n.d.	n.d.	7	77.78	0	0	0.02
Zinc	WG	All	9	mg/l	<0.018	0.02	n.d.	n.d.	n.d.	n.d.	n.d.	1	11.11	0	0	-
Nitrogen species																
Ammoniacal Nitrogen as N	WG	All	34	mg/l	<0.06	4.38	n.d.	n.d.	n.d.	n.d.	n.d.	4	11.76	2	5.88	0.39
Nitrogen (total oxidised) as N	WG	All	34	mg/l	<0.7	6.1	1.51	0.575	1.58	n.d.	n.d.	17	50.00	0	0	-
Landfill parameters																
TOC (filtered)	WG	All	34	mg/l	2	22.2	5.54	4.8	3.72	2	13.65	34	100	0	0	-
PAHs																
Napthalene	WG	All	34	mg/l	<0.01	0.1	0.01	n.d.	n.d.	n.d.	n.d.	7	20.59	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 2021.

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 E.

4.4 Compliance Testing and Other Details

No waste has been accepted in 2021 since filling ceased in October 2018.

5 Summary

This review covers the period between January and December 2021 and reviews the landfill gas, groundwater level and groundwater quality dataset at the Site.

The review has shown the following:

- Eleven in waste gas wells were installed in May and June 2021 with data first recorded in July. Flow data will start being collected during 2022 in order to build the dataset to support the permit surrender.
- 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 in perimeter boreholes. Methane was only detected 23 times out of 86 in 2021, all between 0.1 and 0.3 %v/v.
- Carbon dioxide concentrations in perimeter boreholes exceeded the 6% v/v compliance limit once during the year at a value of 6.5 %v/v in October at GM4.
- Groundwater levels are consistent with previous years following high rainfall in 2020. Groundwater levels generally decreased from January to July and subsequently increased from August 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.
- There was one exceedance of the naphthalene compliance limit at BH1 in January 2021.
- Groundwater quality is generally good, with limited sulphate, manganese, and ammoniacal nitrogen concentrations above the UKDWS.

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.
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Appendix A

In-waste Gas Monitoring Data

Appendix A Table 1 In-waste gas monitoring data for 2021

		Baro	CH4Stable	CO2Stable	DiffPress	O2Stable	FlowrateVol	Ground conditions
Location	Date	mb	%	%	mb	%	l/h	
GF01	07/07/2021	999	15.7	1.6	2.38	8.7	Not collected	
GF01	26/08/2021	1011	16.2	2.6	-0.27	8.1		Damp
GF01	06/10/2021	1008	20.6	3.7	3.26	6.3		Waterlogged
GF01	20/10/2021	986	24	3.3	1.96	5		Waterlogged
GF01	24/11/2021	1007	7.9	4.5	-10.95	5.2		Damp
GF01	15/12/2021	1022	32.7	3.1	-0.15	3.9	0.3	Damp
GF02	07/07/2021	998	16.9	0.2	0.97	12.4	Not collected	
GF02	26/08/2021	1011	21	3.3	1.21	9.3		Damp
GF02	06/10/2021	1006	27.5	2.3	-0.45	3.8		Waterlogged
GF02	20/10/2021	987	54.4	0	2.76	0.1		Waterlogged
GF02	24/11/2021	1006	55.9	0.1	-8.72	0.1		
GF02	15/12/2021	1019	40.3	1.4	-0.12	0.6	0.3	Damp
GF03	07/07/2021	999	3.2	0.8	0.25	0.8	Not collected	
GF03	26/08/2021	1010	9.1	1.6	-0.26	1.1		Damp
GF03	06/10/2021	1006	7.4	1.7	-0.05	7.8		Damp
GF03	20/10/2021	985	16.7	2.4	0.42	0.8		Damp
GF03	24/11/2021	1005	18.3	1.1	-5.61	0.7		Damp
GF03	15/12/2021	1019	10.6	1.3	-0.15	0.7	0.3	Damp
GF04	07/07/2021	997	7.4	1.5	1.64	0.3	Not collected	
GF04	26/08/2021	1010	9.2	1.7	-0.13	7.4		Damp
GF04	06/10/2021	1006	5.6	2.4	-8.43	1.2		Damp
GF04	20/10/2021	986	9.7	2.8	5.2	0.1		Damp
GF04	24/11/2021	1005	19.2	2.4	-5.27	2.8		Damp
GF04	15/12/2021	1019	5	2.3	-0.15	1.3	0.3	Damp
GF05	07/07/2021	997	28.7	0.4	-8.06	0.2	Not collected	
GF05	26/08/2021	1010	5.2	1.7	-0.23	0.1		Damp
GF05	06/10/2021	1003	24.2	1.1	0.79	0.5		Damp
GF05	20/10/2021	983	25	1	0.09	0.2		Damp
GF05	24/11/2021	1004	23.4	0.6	-12.29	1.1		Damp
GF05	15/12/2021	1019	23.9	0.7	-0.07	0.7	0.3	Damp
GF06	07/07/2021	997	48.3	0.3	-0.12	0.3	Not collected	
GF06	26/08/2021	1010	47.6	0.3	-0.38	0.4		Damp
GF06	06/10/2021	1003	50.8	0.1	-0.96	0.5		Damp
GF06	20/10/2021	983	44	0	-33.75	0.4		Damp
GF06	15/12/2021	1019	48.9	0.1	0	0.7	0.4	Damp
GF07	07/07/2021	997	7	1.6	-0.31	0.7	Not collected	
GF07	26/08/2021	1010	5.3	1.7	-10.09	0.2		Damp
GF07	06/10/2021	1003	4.5	2.4	-0.1	0.6		Damp
GF07	20/10/2021	983	37.9	3.8	-0.33	0.4		Damp
GF07	24/11/2021	1004	4.1	2.5	-12.76	0.1	0.3	Damp
GF07	15/12/2021	1019	2.2	2	-0.05	0.5		Damp

		Baro	CH4Stable	CO2Stable	DiffPress	O2Stable	FlowrateVol	Ground conditions
Location	Date	mb	%	%	mb	%	l/h	
GF08	07/07/2021	998	5.8	1.8	-5.13	0.9	Not collected	
GF08	26/08/2021	1010	12.6	1	-0.1	0.2		Damp
GF08	06/10/2021	1004	5.8	2.2	-0.66	1		Damp
GF08	20/10/2021	983	21.1	1.9	-0.14	0.7		Damp
GF08	24/11/2021	1004	10.8	1.8	-0.3	1.3		Damp
GF08	15/12/2021	1019	6	2.2	0.03	0.6	0.3	Damp
GF09	07/07/2021	998	9.8	1.8	0	0.3	Not collected	
GF09	26/08/2021	1010	12.1	1.1	-0.21	0.3		Damp
GF09	06/10/2021	1004	6.5	2.5	-0.03	0.5		Damp
GF09	20/10/2021	984	13.4	1.4	1.35	0.4		Damp
GF09	24/11/2021	1004	11.8	1.6	-0.57	0.8		Damp
GF09	15/12/2021	1019	8	2.4	-0.02	0.7	0.3	Damp
GF10	07/07/2021	998	4.9	1.9	-0.51	0.4	Not collected	
GF10	26/08/2021	1010	2.2	4.7	0.47	0.5		Damp
GF10	06/10/2021	1003	4.3	2.6	0	1.1		Damp
GF10	20/10/2021	983	13.8	1.1	-0.21	0.5		Damp
GF10	24/11/2021	1004	15.3	1.5	-0.24	0.3		Damp
GF10	15/12/2021	1018	6.5	2.5	0.08	0.7	0.3	Damp
GF11	07/07/2021	998	2.8	3.4	0	0.1	Not collected	
GF11	06/10/2021	1003	8.3	4.3	0.79	0.2		Damp
GF11	20/10/2021	983	6.4	4.8	-52.93	0.3		Damp
GF11	24/11/2021	1004	3.7	4.3	-0.59	0.6		Damp
GF11	15/12/2021	1018	3.4	3.9	0.05	0.4	0.2	Damp

Appendix B

Perimeter Gas Monitoring Data

Appendix B Table 1 Perimeter gas monitoring data for 2021

Location	Date	Baro mb	CH4 Stable %	CO2 Stable %	Differential pressure mb	O2 Stable %	Ground conditions -
GM10	28/01/2021	993	0	3.1	0.28	16.8	Damp
GM10	24/02/2021	1008	0.1	0	-0.17	21	--
GM10	11/03/2021	987	0	2.6	-0.69	17.1	
GM10	13/04/2021	1021	0	2.1	0.21	18.6	Damp
GM10	11/05/2021	992	0.1	2.5	-39.93	17.8	Damp
GM10	21/06/2021	1002	0	0.2	-0.49	20.8	Damp
GM10	07/07/2021	998	0.3	2.1	-60.69	18.7	-
GM10	26/08/2021	1010	0	1.6	1.15	20.4	Damp
GM10	06/10/2021	1003	0	3.3	-1.29	18.5	Damp
GM10	20/10/2021	984	0	2.9	-0.36	17.9	Damp
GM10	24/11/2021	1007	0	2.1	-4	18.9	Damp
GM10	15/12/2021	1018	0	2.7	-0.27	18.4	Damp
GM11	28/01/2021	993	0	2.2	1.77	18.2	Damp
GM11	24/02/2021	1008	0.1	1.8	0.26	19.2	-
GM11	11/03/2021	988	0	1.6	-0.69	20	
GM11	13/04/2021	1021	0	1.7	2.51	19.4	Damp
GM11	11/05/2021	992	0.1	1.4	7.68	19.1	Damp
GM11	21/06/2021	1002	0	2	2.74	18.7	Damp
GM11	07/07/2021	998	0.3	1.5	3.14	19.4	-
GM11	26/08/2021	1010	0	1.7	0	20.1	Damp
GM11	06/10/2021	1003	0.1	1.4	-1.3	19.7	Damp
GM11	20/10/2021	984	0	1.5	-0.44	19.5	Damp
GM11	24/11/2021	1007	0	2.7	-4.04	18.6	Damp
GM11	15/12/2021	1017	0	1.8		19.8	Damp
GM2	28/01/2021	996	0	0.8	1.26	20.2	Damp
GM2	24/02/2021	1012	0.1	0.5	-0.17	20.7	-
GM2	11/03/2021	990	0	0.4	-0.44	20.9	
GM2	13/04/2021	1025	0	0.4	4.75	21	Damp
GM2	11/05/2021	998	0	0.4	7.75	20.3	Damp
GM2	21/06/2021	1006	0	1	3.94	20	Dry
GM2	07/07/2021	1003	0.3	0	0.7	20.4	-
GM2	26/08/2021	1015	0	0.4	2.12	20.2	Damp
GM2	26/08/2021	1012	0	1.3	4.07	20.9	Damp
GM2	06/10/2021	1009	0	0.1	-0.77	20.6	Damp
GM2	20/10/2021	988	0	1.5	-0.52	18.7	Damp
GM2	24/11/2021	1009	0	1.7	-3.06	20.7	Damp
GM2	15/12/2021	1018	0	1.2	-0.25	20.6	Damp
GM4	28/01/2021	998	0	1.4	9.52	20.2	Damp
GM4	24/02/2021	1009	0.1	1.1	6.36	19.9	-
GM4	11/03/2021	986	0	0	-0.73	21.2	
GM4	11/03/2021	986	0	0.6	-0.7	20.9	
GM4	13/04/2021	1025	0	0.3	4.95	21	Damp
GM4	13/04/2021	1025	0	0.3	-0.39	21	
GM4	11/05/2021	995	0.1	0.7	2.86	20	Damp
GM4	21/06/2021	1004	0	5.2	-0.28	17.9	Damp
GM4	07/07/2021	1003	0.3	0.1	2.77	20.4	-
GM4	26/08/2021	1012	0	1.3	-22	20.9	
GM4	06/10/2021	1009	0.1	6.5	-0.34	17.6	Damp

		Baro mb	CH4 Stable %	CO2 Stable %	Differential pressure mb	O2 Stable %	Ground conditions -
Location	Date						
GM4	20/10/2021	986	0	2.5	-0.21	17.6	Damp
GM4	15/12/2021	1022	0	0.8	-0.12	21	Damp
GM5	28/01/2021	994	0	1.2	-0.35	19.6	Damp
GM5	24/02/2021	1007	0.1	0.9	-11.98	19.5	-
GM5	11/03/2021	988	0	1.1	5.62	18.8	
GM5	13/04/2021	1020	0	1.4	-0.35	18.7	Damp
GM5	11/05/2021	992	0.1	1.1	-16.1	18.5	Damp
GM5	21/06/2021	1001	0	1.7	-0.5	18.8	Damp
GM5	07/07/2021	997	0.3	4.4	-0.19	18	-
GM5	26/08/2021	1010	0	1.8	-6.36	20.1	Damp
GM5	06/10/2021	1004	0	1.5	0.92	19	Damp
GM5	20/10/2021	984	0	1.5	-9.76	18.1	Damp
GM5	24/11/2021	1005	0	1.1	-6.14	20.2	
GM5	15/12/2021	1018	0	1	-0.24	20.2	Damp
GM7	28/01/2021	994	0	1.1	6.85	18.1	Damp
GM7	24/02/2021	1007	0.1	0	4.61	21	-
GM7	11/03/2021	987	0	0.2	-0.73	21.3	
GM7	13/04/2021	1020	0	0.2	0.3	20.8	Damp
GM7	11/05/2021	992	0.1	0.1	-16.33	20.5	Damp
GM7	21/06/2021	1001	0	0.3	-0.54	20.6	Damp
GM7	07/07/2021	996	0.3	0	4.17	20.3	-
GM7	26/08/2021	1010	0	2.7	-0.19	20	Damp
GM7	06/10/2021	1003	0	0	-0.91	20.6	Damp
GM7	20/10/2021	983	0.1	1.9	-0.44	19.7	Damp
GM7	24/11/2021	1004	0	0.1	-5.05	6	
GM7	15/12/2021	1017	0	0.6	0	20.9	Damp
GM8	28/01/2021	994	0	0.8	9.15	19.9	Damp
GM8	24/02/2021	1007	0.1	0.3	4.02	20.7	-
GM8	11/03/2021	988	0	0.6	0.55	20.8	
GM8	13/04/2021	1021	0	0.8	3.72	20.4	Damp
GM8	11/05/2021	991	0.1	0.7	1.81	19.6	Damp
GM8	21/06/2021	1001	0	1	-0.35	20.3	Damp
GM8	07/07/2021	998	0.3	1.1	15.04	19.7	-
GM8	26/08/2021	1010	0	1.8	3.56	15.9	Damp
GM8	06/10/2021	1004	0	1.7	-5.17	19.3	Damp
GM8	20/10/2021	984	0	0.7	-37.96	20	Damp
GM8	24/11/2021	1007	0	1.5	-10.76	20.1	Damp
GM8	15/12/2021	1018	0	0.9	-0.25	20.5	Damp

Appendix C

Groundwater Level Monitoring Data

Appendix C Table 1 Groundwater level data (mAOD) for 2021

Date	BH1	BH12	BH13	BH14	BH15	BH3	BH3A	BH6	BH9
28/01/2021	72.36	66.85	87.45	81.43	84.04	75.18	78.528	91.76	84.34
17/02/2021	72.03								
24/02/2021		65.4	84.76	79.72	72.89	72.34	73.88	86.8	81.3
10/03/2021	73.05	66.55	79.54	77.47	71.82	74.53	76.01	86.84	78.78
13/04/2021	70.83	64.05	79.84	75.74	69.49	68.88	69.7	84.04	76.12
11/05/2021	72.03	65.22	80.38	76.81	70.54	70.99	69.81	86.34	78.27
21/06/2021	70.66	64.07	80.41	75.38	70.38	69.94	69.12	84.87	75.84
07/07/2021	68.26	64	76.28	68.41	69.62	64.5	65.53	79.42	Dry
26/08/2021	68.49	63.33	76.22	65.74	68.54	68.17	68.51	76.17	
06/10/2021	71.8	65.51	76.86	70.2	68.96	64.16	65.32	76.31	
20/10/2021	72.03	66.11	76.71	72.15	72.21	66.7	67.51	81.87	
02/12/2021	70.77	63.37	76.61		69.23	68.94	70.46	86.24	76.83
03/12/2021				76.15					
14/12/2021	71.53	64.85	76.77	76.9	70.98	70.48	71.7	86.05	77.76

Shaded cells indicate where data was taken on a different day during the month

Appendix D

Groundwater Quality Monitoring Data

Appendix D Table 1 Quarterly groundwater quality data for 2021

		Alkalinity as CaCO ₃	Ammoniacal Nitrogen as N	Calcium	Chloride	Conductivity- Electrical 20deg	Ionic balance	Iron	Magnesium	Naphthalene	Nitrogen (total oxidised) as N	pH	Potassium	Sodium	Sulphate as SO ₄	TOC (filtered)
Location	Date	mg/l	mg/l	mg/l	mg/l	µS/cm	%	µg/l	mg/l	µg/l	mg/l	pH units	mg/l	mg/l	mg/l	mg/l
BH1	28/01/2021	166	<0.06	59.4	12.8	363	-0.6	<25	8.1	0.06	<0.7	7.7	6.39	7.03	22.5	7.1
BH1	13/04/2021	204	<0.06	73	12.8	427	1.1	166	10.1	0.05	<0.7	7.2	7.92	7.05	21.2	5.3
BH1	07/07/2021	261	<0.06	83.2	13.7	515	-3.5	31	12.2	0.024	<0.7	7.4	8.63	8.22	26.6	7.1
BH1	02/12/2021	280	<0.06	107	16.3	575	1.7	30	15.1	0.035	<0.7	7.2	8.62	9.46	44.3	6.1
BH12	28/01/2021	300	<0.06	99.7	20.7	615	-0.5	<25	18.3	<0.01	2.1	7.5	4.64	14	26.7	9.6
BH12	13/04/2021	365	<0.06	199	49.5	1070	8.3	<25	39.2	<0.01	0.8	7.2	16.9	40.3	204	8.3
BH12	07/07/2021	363	<0.06	173	71.3	1160	-2.4	<25	33.1	<0.01	<0.7	7.7	15.8	46	248	10.8
BH12	02/12/2021	418	<0.06	190	59	1220	-3.0	<25	37.6	<0.01	<0.7	7.3	13.7	40.8	269	7.7
BH13	28/01/2021	371	<0.06	102	53.8	790	-0.3	<25	36.6	<0.01	2.6	7.5	5.91	21.8	7.1	6.9
BH13	13/04/2021	319	<0.06	93.1	48.7	731	5.3	87	39.6	<0.01	1.7	7.1	2.98	29.2	21.8	3.8
BH13	07/07/2021	369	<0.06	94.3	42.8	742	-0.7	27	39.6	<0.01	3.2	7.5	3.08	26.8	25.5	4.1
BH13	02/12/2021	393	<0.06	110	43	860	0.0	<25	47.2	<0.01	6.1	7.1	7.33	24.7	54.6	3
BH14	28/01/2021	386	<0.06	111	12.7	680	-0.4	41	32	<0.01	5.3	7.5	1.14	6.87	5.8	4.1
BH14	13/04/2021	414	<0.06	125	7.4	725	3.0	<25	36.2	<0.01	4.3	7.0	1.18	5.09	6.5	2.7
BH14	07/07/2021	429	<0.06	122	9.7	728	-0.9	<25	34.2	<0.01	4.3	7.4	1.02	5.61	9	2.3
BH14	02/12/2021	420	<0.06	118	5.8	705	0.6	<25	32.9	<0.01	2.6	7.3	0.78	5.21	<4.4	2.1

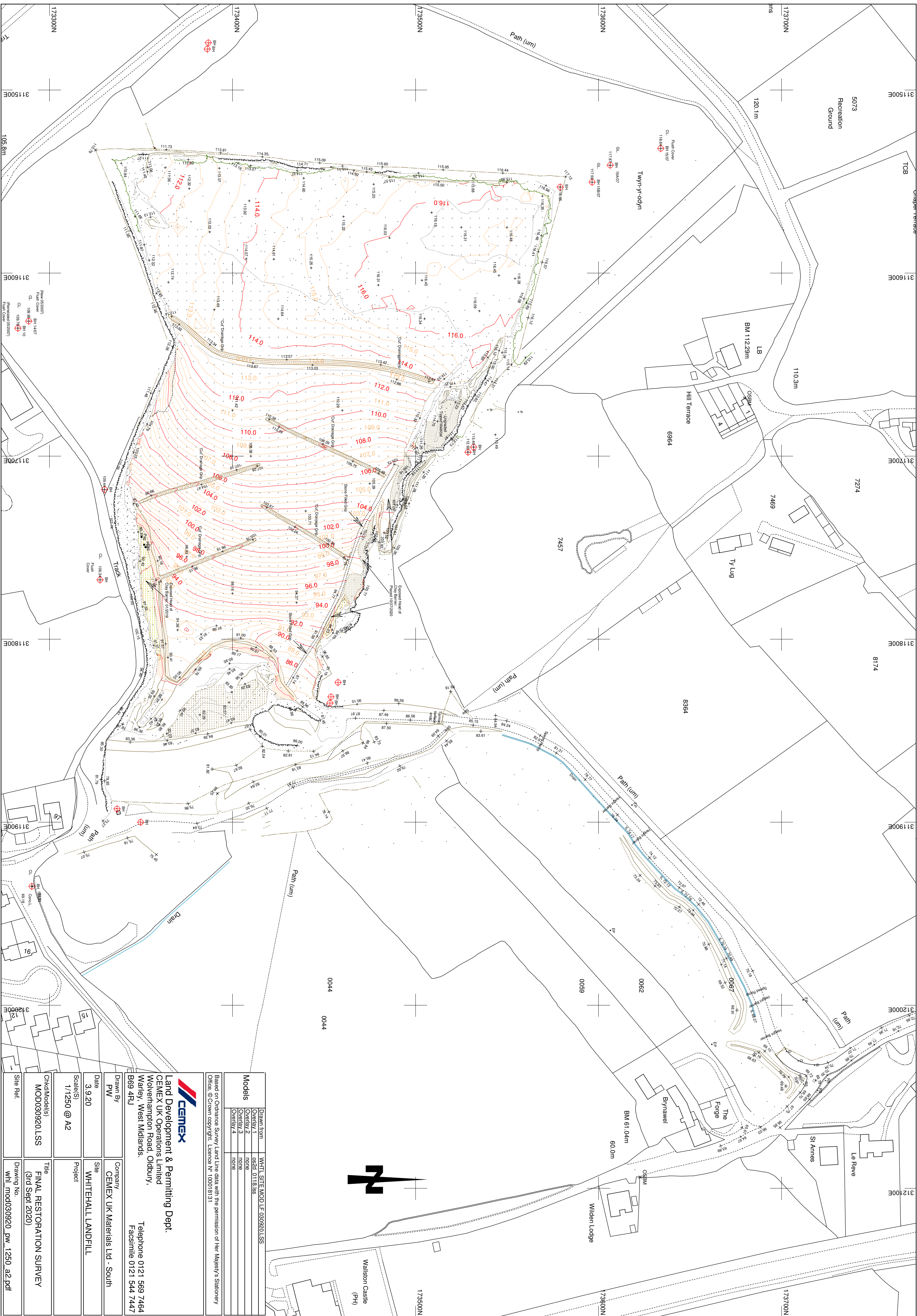
		Alkalinity as CaCO3	Ammoniacal Nitrogen as N	Calcium	Chloride	Conductivity- Electrical 20deg	Ionic balance	Iron	Magnesium	Naphthalene	Nitrogen (total oxidised) as N	pH	Potassium	Sodium	Sulphate as SO4	TOC (filtered)
Location	Date	mg/l	mg/l	mg/l	mg/l	µS/cm	%	µg/l	mg/l	µg/l	mg/l	pH units	mg/l	mg/l	mg/l	mg/l
BH15	28/01/2021	293	<0.06	90.8	16.6	541	-0.5	37	17.7	<0.01	<0.7	7.6	0.8	9.46	7.8	4.7
BH15	13/04/2021	306	<0.06	105	12.6	564	3.8	<25	19.4	<0.01	<0.7	7.1	1.37	8.39	11.1	2.5
BH15	07/07/2021	316	<0.06	102	12.1	565	-0.1	<25	18.8	<0.01	1	7.6	1.21	7.79	13.8	2.3
BH15	02/12/2021	301	<0.06	94.7	10.6	556	-1.1	<25	17.3	<0.01	0.9	7.9	1.27	7.29	12.6	2.5
BH3	28/01/2021	266	<0.06	71	38.5	555	-2.6	<25	22.1	<0.01	<0.7	7.9	0.73	22.5	14.2	4.3
BH3	13/04/2021	256	4.38	76.7	25.2	530	5.6	143	19	<0.01	<0.7	7.1	5.34	15.5	<4.4	22.2
BH3	02/12/2021	248	0.53	79.7	18.2	493	2.5	130	16.3	<0.01	<0.7	7.6	1.54	10.4	4.7	7
BH3A	28/01/2021	165	<0.06	45.1	23.6	347	-0.8	29	12.3	0.10	<0.7	7.8	2	15.6	4.5	9.2
BH3A	13/04/2021	244	<0.06	91.1	35.8	647	-1.5	<25	24.4	0.010	2.1	7.8	3.24	22.7	87.3	5.8
BH3A	07/07/2021	199	<0.06	96.4	27	683	-3.6	<25	23.2	0.025	0.9	7.5	3.79	17.7	161	5.4
BH3A	02/12/2021	263	0.19	107	29.5	728	-2.0	<25	24.2	<0.01	<0.7	7.7	3.56	18.1	119	4.1
BH6	28/01/2021	261	<0.06	78.7	15.9	480	-0.2	<25	15.9	<0.01	<0.7	7.7	1.59	11.6	7	4.9
BH6	13/04/2021	289	<0.06	81.5	19.3	562	1.9	<25	28.1	<0.01	<0.7	7.8	2.21	9.55	13.3	3.7
BH6	07/07/2021	336	<0.06	81	20.2	621	-4.1	<25	31.3	<0.01	<0.7	7.6	2.14	7.63	15	2
BH6	02/12/2021	307	<0.06	88.2	18.5	594	1.8	<25	28.6	<0.01	<0.7	7.8	1.99	8.16	11.8	2
BH9	28/01/2021	304	<0.06	100	19.5	591	0.7	<25	16.4	<0.01	2	7.5	8.84	11	8.3	6.7
BH9	13/04/2021	325	<0.06	112	15.4	626	3.7	<25	20	<0.01	3.1	7.7	11.6	8.42	9	5.2
BH9	07/07/2021	Dry														
BH9	02/12/2021	343	0.38	109	6.1	621	1.1	<25	18.3	<0.01	2.4	7.8	9.01	6.05	5	3

Appendix D Table 2 Annual groundwater quality data 2021

Location	Date	Cadmium	Chromium	Copper	Lead	Manganese	Nickel	Zinc
		µg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
BH1	13/04/2021	<0.6	<0.002	<0.009	<0.006	0.129	0.003	<0.018
BH12	13/04/2021	<0.6	<0.002	0.012	<0.006	0.008	0.007	0.02
BH13	13/04/2021	<0.6	0.002	<0.009	<0.006	0.008	0.006	<0.018
BH14	13/04/2021	<0.6	<0.002	<0.009	<0.006	<0.007	0.003	<0.018
BH15	13/04/2021	<0.6	<0.002	<0.009	<0.006	<0.007	0.004	<0.018
BH3	13/04/2021	<0.6	<0.002	<0.009	<0.006	0.152	0.007	<0.018
BH3A	13/04/2021	<0.6	<0.002	0.016	<0.006	0.011	<0.003	<0.018
BH6	13/04/2021	<0.6	<0.002	0.012	<0.006	0.010	<0.003	<0.018
BH9	13/04/2021	<0.6	<0.002	0.018	<0.006	0.089	0.009	<0.018

Appendix E

Topographic Survey



Models	
Drawn from	WHTL SITE MOD LE 030920.LSS
Overlay 1	052d 0118.LSS
Overlay 2	none
Overlay 3	none
Overlay 4	none

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Wolverhampton Road, Oldbury

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Drawn By	Company
PW	CEMEX UK Materials Ltd - South
Date	Site
3.9.20	WHITEHALL LANDFILL
Scale(S)	Project
1/1250 @ A2	
Chkd(Model/s)	Title
MOD0030920.LSS	FINAL RESTORATION SURVEY (3rd Sept 2020)
Site Ref	Drawing No.
	w/1/mod0030920 pw_1250_a2.pdf