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Review of data relevant to the characterisation of leachate from Burgess Field waste dump, Oxford

Groundwater Programme

Internal Report IR/15/037

BRITISH GEOLOGICAL SURVEY

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INTERNAL REPORT IR/15/037

Review of data relevant to the characterisation of leachate from Burgess Field waste dump, Oxford

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Aerial view of Burgess Field waste dump during flooding in January 2007.

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Summary

This report provides a summary of data available for the Burgess Field waste dump, Oxford. These include historical data records held by the Oxford City Council for free gas concentrations, selected inorganic chemistry and groundwater levels (between 1989 and 1996). They also include inorganic chemistry and groundwater levels collected from selected piezometers by the British Geological Survey at the site since 2011. These data are used to characterise the leachate in groundwaters within and below the dump, addressing spatial variability and long term changes.

Burgess field is an unlined historical waste dump located on the floodplain of the River Thames on the eastern side of Port Meadow, in the vicinity of the city of Oxford. The waste dump was closed in 1980 and the area is now a mixed grassland and woodland nature reserve. Subsequent monitoring of the site included a network of seven boreholes installed into the waste dump in 1991; of the seven original sites, only three could be located for the field campaign from 2011 onwards.

Groundwater levels at Burgess field exhibit spatial and temporal variability and have been found to rise above the base of the dump at some borehole locations, producing a saturated zone within the waste material. There is potential interaction of leachate with groundwater under all of the waste material as the dump is unlined.

Uneven settling and the heterogeneous composition of waste is highlighted by spatial and temporal variation in the dissolved gas, groundwater level data and the inorganic chemistry.

Free gas concentrations between 1989 and 1996 show the following:

- CO_2 and O_2 are highly variable and mirror each other at all sites; where one increases in concentration the other is seen to decrease in concentration
- Methane concentrations are variable: there was no methane detected in the southern sites; methane was detected in the northern sites, indicating the occurrence of methanogenisis, apart from the most northerly site where is has not been detected.

Long term trends in inorganic chemistry for the three sites that were sampled during both the 1990s and the 2010s show:

- Spatial variation in the concentrations of Fe, Mn and B is maintained across the two sampling periods;
- Conductivity is generally higher in the current period than during the 1990s, reflecting higher SO_4 and HCO_3 concentrations;
- Dissolved N concentrations vary spatially and temporally but the reduced form of nitrogen (NH_4) is dominant. Concentrations of NH_4 were high during the two periods of study showing a large plume of NH_4 below/within the landfill.

In summary, this points to a heterogeneous waste dump where fill is spatially variable in composition, and breakdown of the material is at different stages. This reflects the long period during which waste was dumped in the area (1930s-1980) and the potentially varied nature of this material, for which there is very limited information. The data collected on Burgess Field shows: it is a source of pollution in the form of NH_4, SO_4, Fe, and Mn; that conditions are anaerobic; and HCO_3 concentrations are buffering the pH so acidic conditions are not occurring.

1 Introduction

Burgess Field is an unlined waste dump located on the floodplain of the River Thames in the city of Oxford (Figure 1). It is situated on the eastern side of Port Meadow, a component of the Oxford Meadows Special Area of Conservation. The site was operational from 1937 to 1980 during which time it accepted all categories of waste (Gooddy et al 2014). The site has been restored to mixed grassland and woodland and is now a nature reserve. Although the dump was capped in 1980, rubbish is visible along the western margin of the waste dump which suggests it is not well sealed.

The waste dump is underlain by a silty clay alluvium, less than 1 m thick and 4 to 5 m of river terrace gravels. As the landfill is unlined, groundwater can flow laterally through the saturated part of the landfill. Precipitation flows through the unsaturated zone of the landfill mixing with leachate before infiltrating the underlying shallow aquifer. Ongoing studies by the British Geological Survey (BGS) are investigating the influence of Burgess Field waste dump on the down-gradient groundwater quality (Macdonald et al 2012; Gooddy et al 2014). In this report, recent data collected from boreholes within the boundary of the waste dump are combined with those collected as part of previous studies, to better characterise the contamination being input to the shallow aquifer from the dump.

The results from the analyses of BGS samples are combined with the historical data to help better understand, within the boundary of the waste dump, the following:

1. Spatial variation in water quality;
2. Seasonal variation in water quality;
3. Long term changes in water quality.

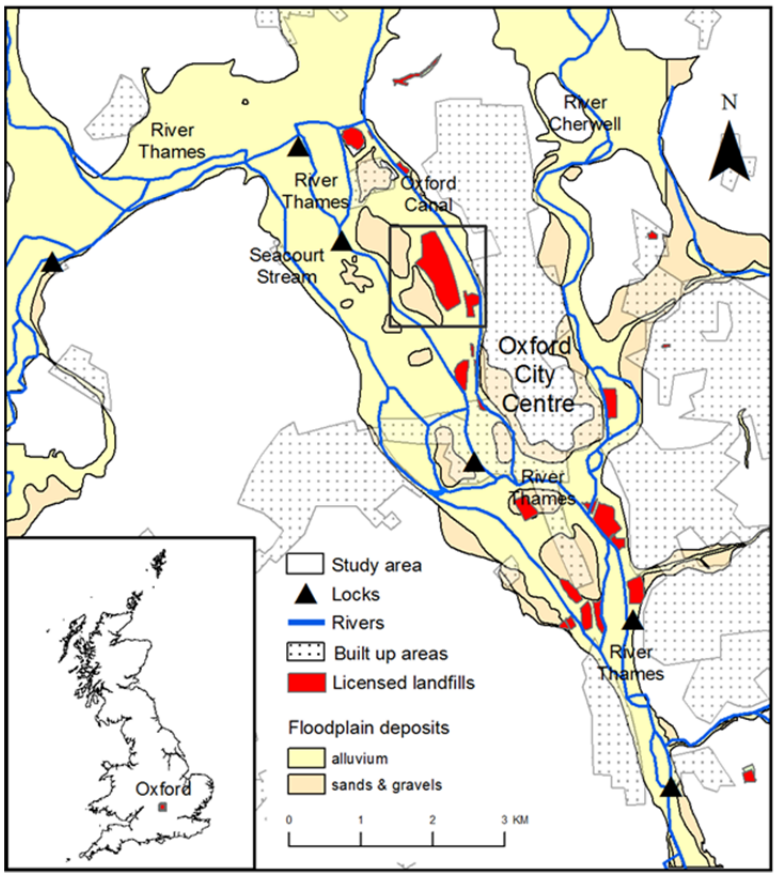

Figure 1 Burgess Field study area

2 Methodology

After the closure and landscaping of Burgess Field, gas and groundwater monitoring boreholes were installed along the boundaries of the waste dump. Records obtained on the waste dump suggest the monitoring network was put in place by Oxfordshire County Council and that subsequent sampling was undertaken by the Environment Agency. Seven gas and groundwater and six groundwater-only monitoring boreholes were completed. The logs of the boreholes are presented in Appendix A. All the holes were drilled through the waste, and into the underlying superficial geology deposits; all but one (G13) were finished within the gravels. It is not known where these boreholes were screened. The original drilling dates and depths are shown in Table 1 and the locations are shown in Figure 2.

Table 1 Burgess Field monitoring network.

Borehole	Grid references	Date of drilling	Depth	Type
GBH1	449968 207974	21 Nov 1991	4.40 m	Gas &Water
GBH3	449801 208349	13 Nov 1991	5.50 m	Gas &Water
GBH5	449545 208649	14 Nov 1991	5.60 m	Gas &Water
GBH7	449643 208964	18 Nov 1991	5.80 m	Gas &Water
GBH9	449920 208838	19 Nov 1991	5.50 m	Gas &Water
GBH11	450072 208469	20 Nov 1991	5.55 m	Gas &Water
G2	449852 208160	12 Nov 1991	5.30 m	Gas
G4	449682 208514	12 Nov 1991	3.70 m	Gas
G6	449656 208787	13 Nov 1991	3.10 m	Gas
G8	449844 208995	13 Nov 1991	4.80 m	Gas
GI0	450003 208656	14 Nov 1991	5.60 m	Gas
G12	450110 208271	14 Nov 1991	4.70 m	Gas
G13	450152 208074	15 Nov 1991	2.70 m	Gas

Historical data obtained for the Burgess Field are summarised in Table 2. The method of collection and analysis was not documented in records received by BGS. It has not been possible to confirm if the data obtained for the sites include all those available. All those data sheets obtained by BGS have been replicated in Appendix B.

BGS staff attempted to find all the monitoring boreholes listed in Table 1, however, only boreholes GBH3, GBH5 and GBH9 were found. Sampling rounds undertaken that included these boreholes are listed in Table 2. Hydrochemical and water level sampling has been carried out at GBH3, GBH5 and GBH9 (seasonally) by BGS since 2011. Groundwater levels were determined prior to sampling using a calibrated waterlevel dip meter.

A Whale™ Gulper 320 high capacity pump was used to purge the boreholes before sampling with a Solinst™ model 410 peristaltic pump with Pt cured silicon pump tubing and PE downhole tubing where waterlevels allowed. Where waterlevels were beyond the capacity of the peristaltic pump, samples were taken using the Gulper. Inorganic samples were collected in a rinsed plastic beaker and filtered through 0.45 µm cellulose nitrate filters into clean Nalgene LDPE or HDPE bottles. DOC/Fluorescence samples were collected into a stainless steel cup and filtered through a 0.45 µm silver filter using a stainless steel filter holder and a glass syringe. A HACH alkalinity titration was performed (using 1.6 N or 0.16 N sulphuric acid cartridges and a bromocresol green indicator) at site where the colour of the sample allowed otherwise HCO_3 was determined at the BGS Keyworth laboratories along with other inorganic parameters.

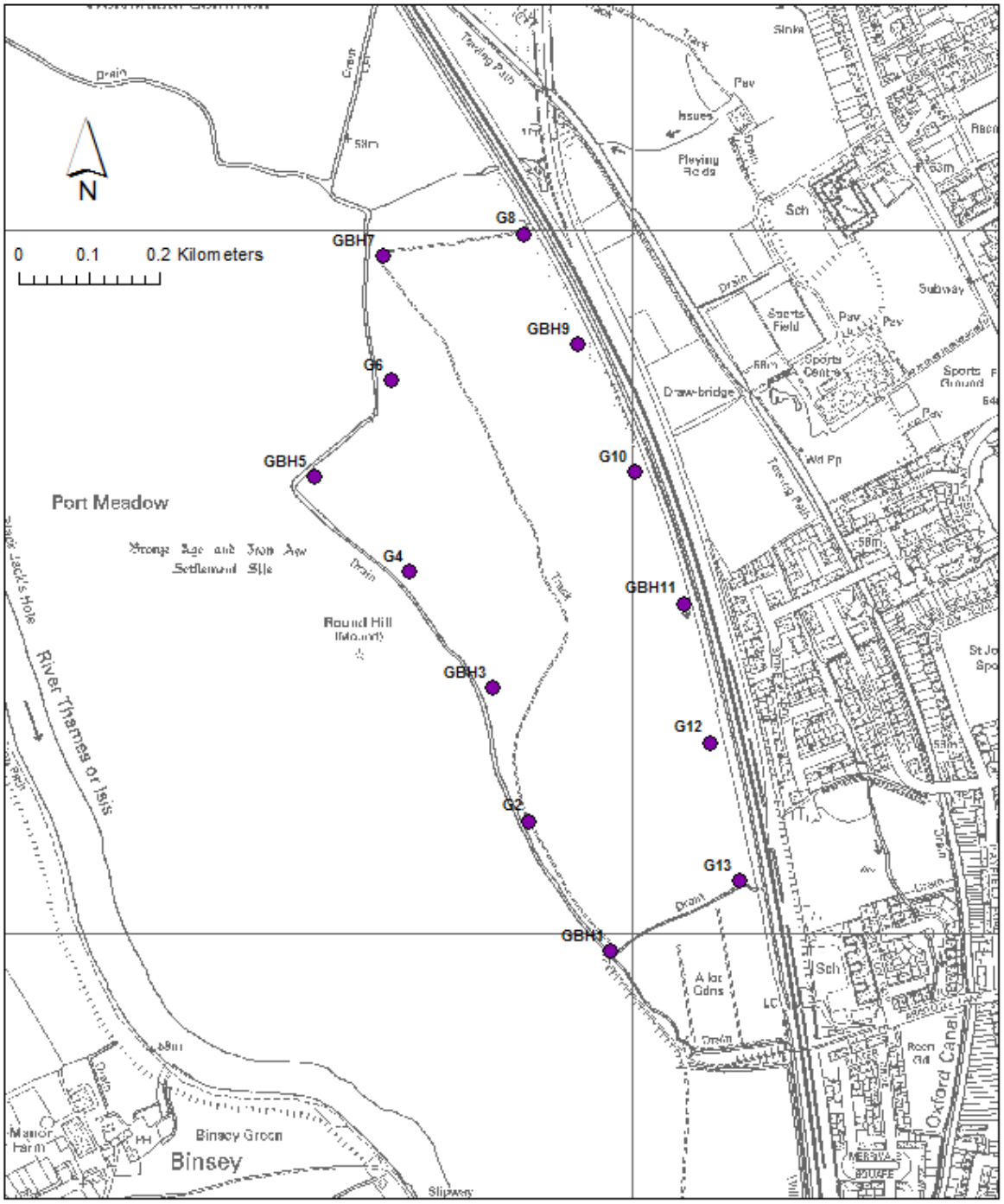

Figure 2 Burgess Field monitoring network.

3 Results and interpretation

3.1 LANDFILL GAS

The landfill gas survey undertaken in 1989 sampled the subsoil every 15 m along the eastern boundary of Burgess Field and no methane was detected.

From 1991 to 1996 gas samples were taken from the Burgess Field borehole network by contractors on behalf of Oxfordshire County Council. Free gas was sampled from above the groundwater in the boreholes. The following is a summary of the measured methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) concentrations reported.

During sampling, groundwater level was not always measured and therefore it has not been possible to contrast gas concentrations with groundwater levels within the waste dump. Table 2 summarizes the available free gas data (number of samples, min, max and average concentration) and Figure 3 spatially summarizes the average concentrations of CH_4, CO_2 and O_2 per site. Averages were calculated as the arithmetic mean, any sample below the detection limit (<DL) were treated as zero but left in the calculation.

Table 2 Maximum, minimum and average values of CH_4, CO_2 and O_2 (ppm). Sample concentrations below detection limit are represented by '<DL', 'n' denotes number of samples.

Site	n	CH_4			CO_2			O_2		
		min	*max*	*mean*	*min*	*max*	*mean*	*min*	*max*	*mean*
GBH1	11	<DL	<DL	<DL	2000	89000	26000	103000	210000	176000
G2	11	<DL	<DL	<DL	25000	146000	95000	12000	191000	97000
GBH3	10	<DL	36000	8000	5000	186000	51000	<DL	199000	146000
G4	11	21000	228000	161000	72000	243000	199000	<DL	142000	24000
GBH5	10	<DL	2000	200	9000	43000	21000	159000	199000	186000
G6	11	<DL	112000	30000	6000	211000	98000	<DL	203000	111000
GBH7	11	2000	331000	143000	9000	304000	199000	<DL	204000	44000
G8	8	<DL	<DL	<DL	16000	97000	55000	108000	203000	149000
GBH9	11	<DL	408000	78000	<DL	346000	125000	3000	209000	87000
G10	11	29000	356000	202000	59000	289000	201000	<DL	163000	42000
GBH11	11	<DL	66000	11000	<DL	204000	63000	5000	207000	139000
G12	6	<DL	<DL	<DL	37000	95000	59000	50000	163000	123000
G13	5	<DL	<DL	<DL	30000	127000	72000	91000	187000	137000

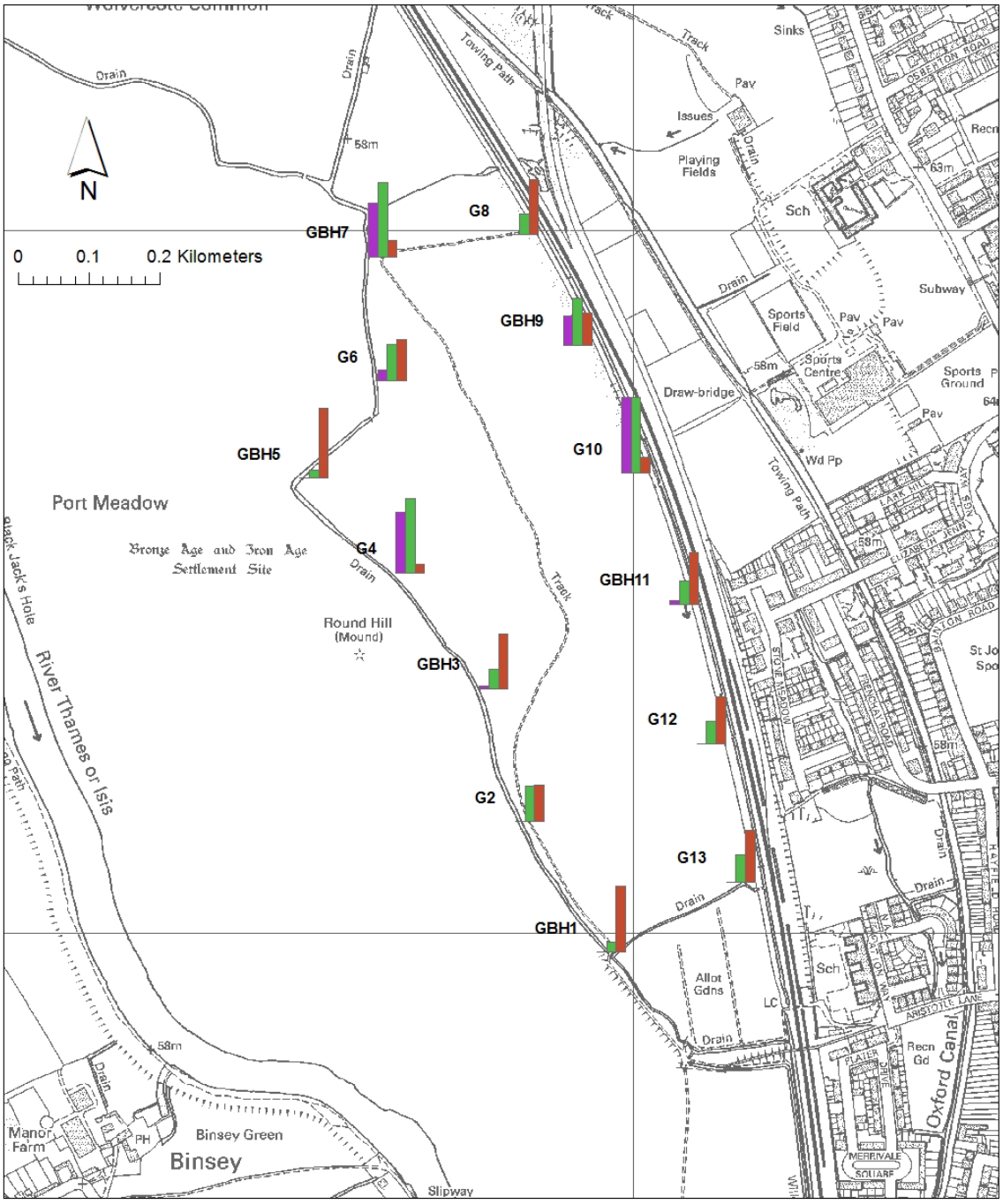

Figure 3 Summary of arithmetic mean of gas concentrations (ppm) found at each site. CH_4 (purple bar), CO_2 (green bar) and O_2 (brown bar). Refer to Table 2 for relative scale of gas concentrations.

Appendix D shows the temporal variation of all three free gases by site. A summary of observations made on data for each gas type is given in the following sub sections; CO_2 and O_2 have been summarized together as they react in parallel. No annual or seasonal cycle was seen, possibly due to the scarcity of the data. The dominant gas varies with site.

3.1.1 Methane

Concentrations of methane were consistently below the detection limit at GBH1, G2, G8, G12 and G13. While the highest level of methane measured at the site was at GBH9 (408,000 ppm, Nov 1991). Below is a summary per site:

GBH1	concentrations below detection limits
G2	concentrations below detection limits
GBH3	below detection limits during most sampling events. only rising in concentration intermittently. The highest concentration measured was 36,000 ppm in Dec 1993.
G4	elevated concentrations, never falling below 21,000 ppm, with an average of approx. 160,000 ppm
GBH5	only goes above detection limits once, during the study rising to 2000 ppm in June 1993
G6	concentrations often elevated with an average of 30,000 ppm and a maximum concentration of 112,000 ppm - concentrations were also measured below detection limits on 3 occasions
GBH7	overall reduction in concentrations over time but remained high at the end of the study (150,000 ppm 12/1996)
G8	concentrations below detection limits.
GBH9	initially high concentration (408,000 ppm) with an overall trend of decreasing concentrations
G10	average concentrations higher than CO_2 and O_2 for most of the study. From June 1995 concentrations drop significantly although never go below 29,000 ppm
GBH11	on average low, with highest concentration in August 1992 (66,000 ppm) - the only time methane is higher than either of the other gases
G12	concentrations below detection limits.
G13	concentrations below detection limits.

3.1.2 Carbon dioxide and oxygen

Carbon dioxide was detected at every site although concentrations were highly variable; some concentrations were below detection at GBH9 and GBH11 on at least one occasion. The highest detected concentration was 346000 ppm at GBH9.

Oxygen was detected at all of the sites, however, concentrations were below the level of detection on at least one occasion at GBH3, G4, G6, GBH7 and G10. The highest concentration was detected at GBH9. CO_2 and O_2 are seen to mirror each other at all sites; where one increases in concentration the other is seen to decrease in concentration. Below is a summary of CO_2 and O_2 per site:

GBH1	O_2 concentrations are always consistently the highest. There appears to be no annual cycle.
G2	CO_2 and O_2 concentration reverse in dominance over time with both fluctuating about the approximate same mean (95000 ppm)
GBH3	CO_2 and O_2 concentrations again mirror each other around a similar mean however, oxygen is on average higher although it does go below detection on one occasion.
G4	O_2 is lower on average dipping below detection limits on one occasion.
GBH5	O_2 is substantially higher that CO_2 (as can be seen from table 1).
G6	Average concentrations of CO_2 and O_2 are within the same order of magnitude and maximum concentrations are similar at 21100 ppm and 203000 ppm for CO_2 and O_2 respectively but they are seen to cross over in dominance regularly.

GBH7	CO_2 concentrations are overall higher than O_2 concentrations and there are some changes in dominance during the study period.
G8	O_2 is higher in concentration throughout the study.
GBH9	CO_2 concentrations are overall higher than O_2 concentrations but CO_2 and O_2 change dominance regularly.
G10	CO_2 concentrations are on average higher than O_2 concentrations during most of the study but from June 1995 this changes coinciding with the reduction in methane concentration (average CO_2 and O_2 201273 ppm, 41636 ppm respectively)
GBH11	O_2 is on average higher than CO_2 but this is reversed during the two 1992 samples.
G12	Gas concentrations were only measured on 6 occasions between November 1991 and December 1996. Over all O_2 is higher than CO_2 but this is reversed on 2 occasions in 1992.
G13	Similarly, gas concentrations were only measured on 5 occasions between Nov 1991 and June 1993. Concentrations of O_2 are again higher than CO_2 reversing in dominance only once during the study.

3.1.3 Interpretation of gas results

Concentrations of CH_4, CO_2, and O_2 vary significantly spatially and temporally, with no one gas consistently the highest across Burgess Field. Methane was not detected at five of the sites, including the four sites in the south (GBH1, G2, G12 and G13) and G8 in the far north. CH_4 was only measured above detection limit once at GBH5. Methane concentrations are seen to be elevated at G4, GBH7, GBH9 and G10. Where methane has been detected methanogenesis is occurring in the vicinity of the gas sampling port or upflow of the port.

Oxygen and CO_2 are seen to mirror each other but the concentrations can be seen to change in dominance during the study but always as one increases in concentration the other decreases. Oxygen is on average higher than CO_2 at GBH1, GBH3, GBH5, G8, GBH 11, G12 and G13 and CO_2 is on average higher than O_2 at G4, GBH 7, GBH9 and G10. Oxygen and CO_2 have similar means at G2 and G6.

Overall the gas concentrations point to the conclusion that waste is not in a homogenous layer across the site and/or is decomposing at differing rates in different areas.

No conclusions could be drawn between groundwater level and the concentration of free gas due to the small amount of landfill gas and groundwater level data.

3.2 HYDROCHEMISTRY

Below is a summary of the Burgess Field groundwater hydrochemistry and groundwater levels. Local council data from 1991 to 1994 (GBH1, 3, 5, 9 and G11) is presented along with more modern BGS data from 2011 to February 2015 (GBH3, 5, and 9 only). Availability of data is sparse and variable per site. Appendix E provides plots of all anions, cations and N species per site while selected single ion plots for all sites are presented below.

3.2.1 Burgess Field groundwater levels

Groundwater level data are available both from the 1990s and recent monitoring campaigns. However, resurveying of the datums for boreholes used within the recent sampling campaign indicates that the ground level has fallen, most likely due to settlement of the waste dump contents. Groundwater levels from the 1990s campaign are measured relative to the earlier

datums; groundwater levels from the recent campaign are measured relative to the newly surveyed datums. Sites at which there are a substantial number of measurements during both periods are shown in Figures 4 to 6; the Figures include the base of waste, base of alluvium (where it exists), and the base of the borehole (other groundwater level plots are provided in Appendix C). The figures show a general decrease in groundwater levels in recent years. There is some uncertainty over the measured datums of the 1990s datums which needs to be taken into account when interpreting these results. Groundwater sampled from horizons within the waste dump could potentially have a stronger leachate component than groundwater solely from the gravel aquifer. In some boreholes (e.g.GBH3 and GBH9), the groundwater level rises above the base of the waste dump seasonally. This can cause enhanced decomposition and transport of emissions during periods of very high groundwater levels (Neuhold 2013)

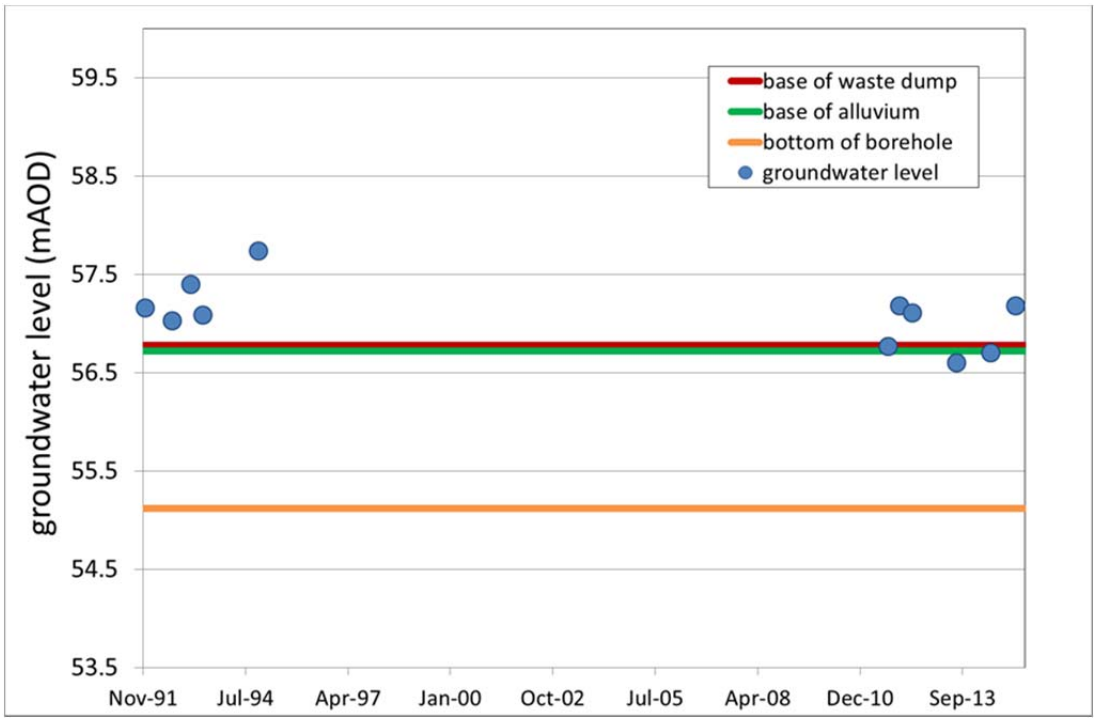

Figure 4 Groundwater levels in monitoring borehole GBH3 in Burgess Field waste dump

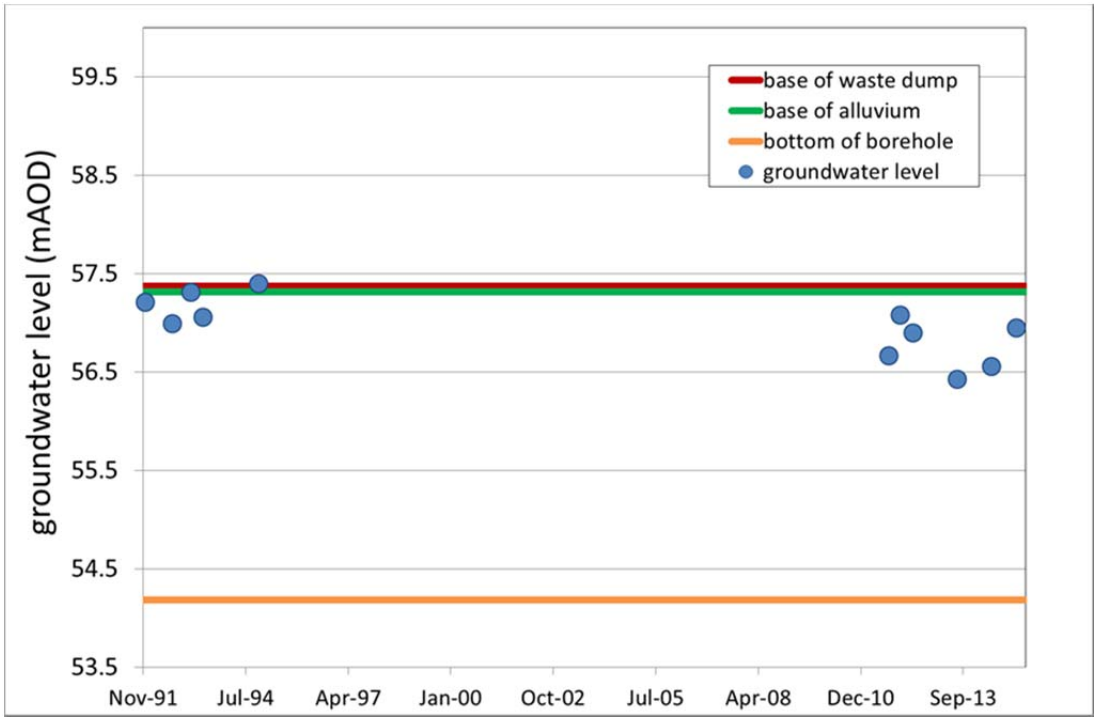

Figure 5 Groundwater levels in monitoring borehole GBH5 in Burgess Field waste dump

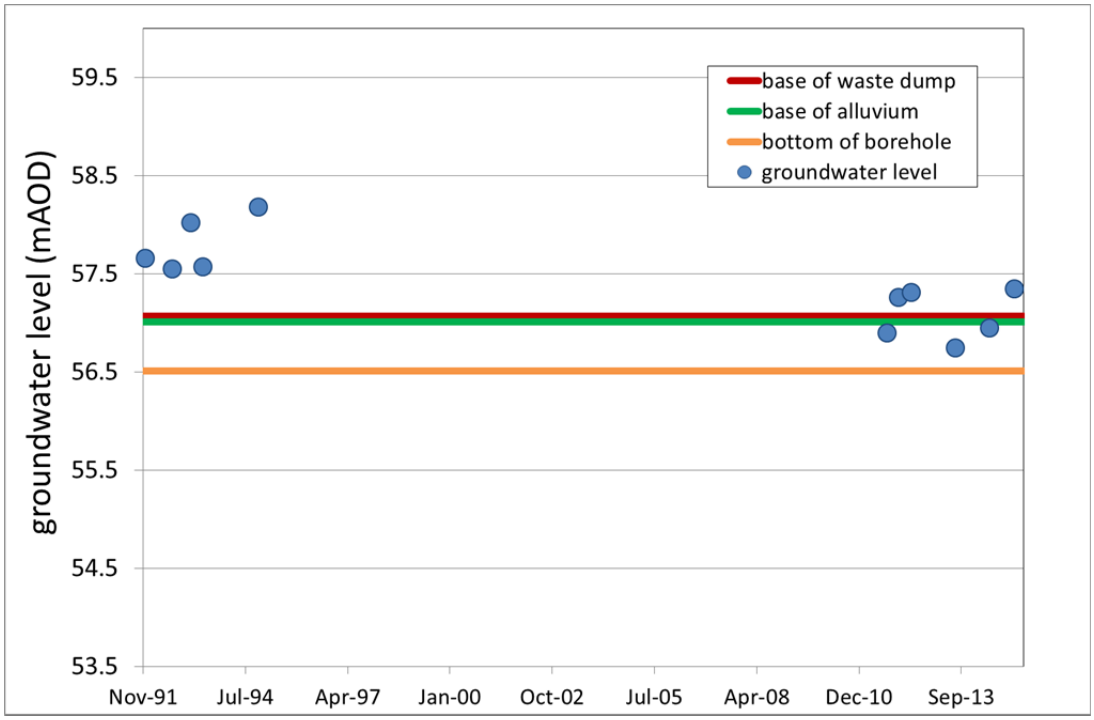

Figure 6 Groundwater levels in monitoring borehole GBH9 in Burgess Field waste dump

The groundwater flow gradient within/beneath the waste dump is difficult to assess given the limited number of data points, however, those levels available indicate that the flow directions implied by the groundwater contours produced by Macdonald et al (2012) for 2011 (Figure 7) are generally consistent.

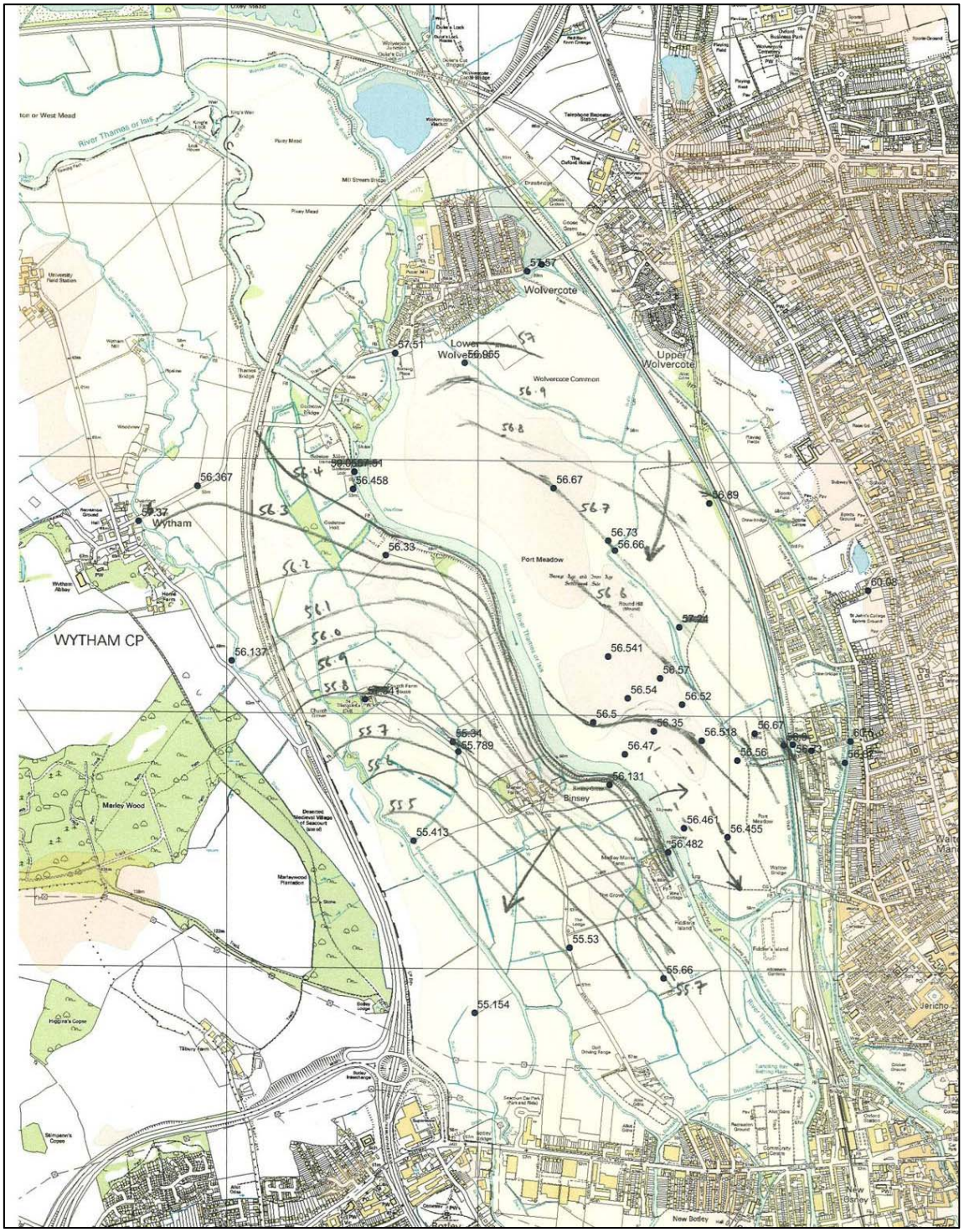

Figure 7 Hand-drawn groundwater contours from levels measured 3-7 October 2011 (from Macdonald et al 2012)

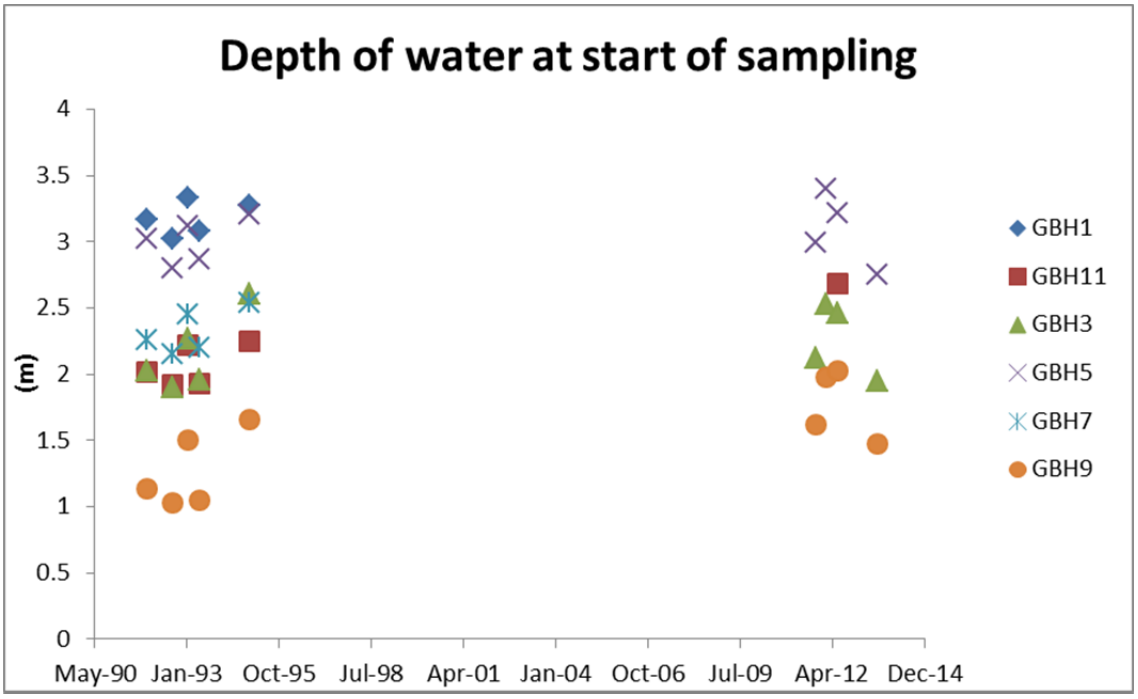

Figure 8 Graph showing the depth of groundwater in the piezometer immediately prior to sampling.

3.2.2 Conductivity and Major Ions

Conductivity is a good indicator of total dissolved ions. Conductivity measurements (Figure 9) are included from field measurements on unfiltered samples and laboratory measurements on filtered samples. This may cause some variability within the data as after sampling some dissolved ions will drop out of solution and be filtered out or sit on the bottom of the sample. No seasonal trend can be seen to indicate the influence of recharge diluting the leachate but, as samples are taken from depth within the landfill, mixing will occur to mask this. With the spread and paucity of data, no reliable pattern can be seen between the two sampling campaigns but on average the conductivity at GBH 3 is higher in the recent sampling campaign compared to that undertaken in the 1990s. In February 1993 and December 1994 conductivity dropped at GBH3 which coincided with lower than normal concentrations of Ca, Cl, K, Mg, SO_4, and NH_4. This points to dilution of the leachate at this time.

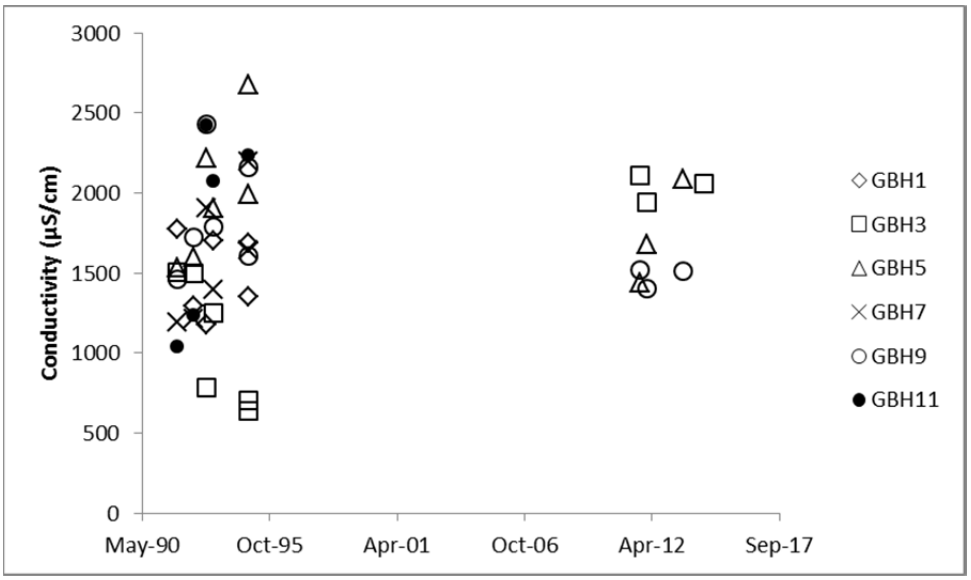

Figure 9 Conductivity (µS/cm) in boreholes within Burgess Field waste dump

A marked reduction in Cl concentration can be seen in GBH9 and GBH5 between the 1990s data and the more recent data, whereas at GBH3 it appears similar but less varied (figure 10). Chloride concentrations from piezometers within/below the landfill are not particularly high for landfill leachates, and are comparable to the spread of data presented for piezometers in Port Meadow (Stuart 2010) and the more modern Port Meadow data presented in Gooddy et al (2014). This may be due to a lack of initial soluble Cl in the landfill or because it has already dissipated.

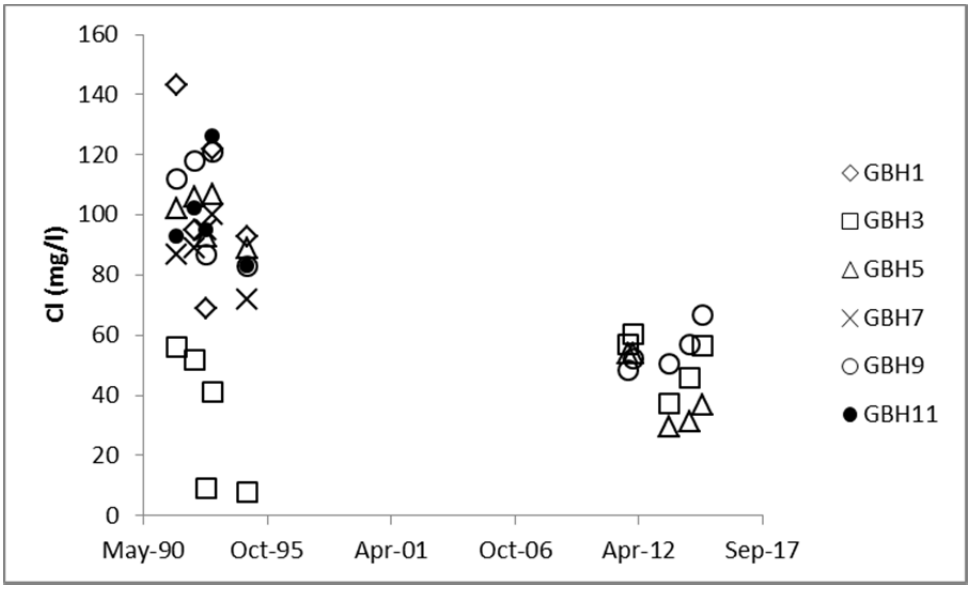

Figure 10 Concentration of Cl (mg/l) in boreholes within Burgess Field waste dump.

Concentrations of HCO_3 are high compared with the concentrations at piezometers at Port Meadow not impacted by leachate across the landfill but vary with site and time. Figure 11 highlights the variation of concentrations measured at each site over time and Figure 12 shows the site average concentration to highlight the spatial variation.

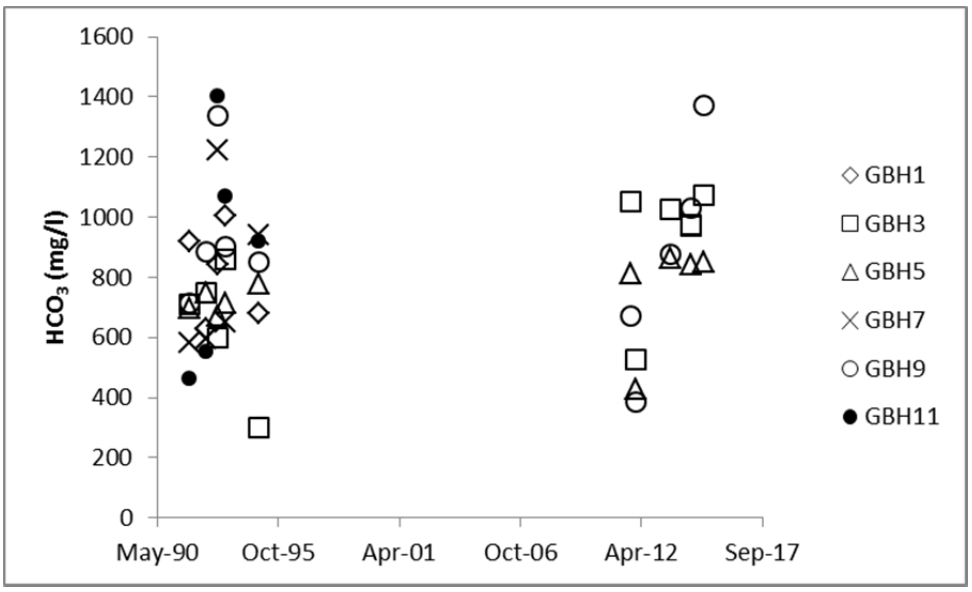

Figure 11 Concentration of HCO_3 (mg/l) in boreholes within Burgess Field waste dump.

As it can be seen, HCO_3 values are elevated above background concentrations and, at times, above those in Port Meadow as reported by Stuart (2010). High HCO_3 produced from the breakdown of organic waste will act to buffer the pH to stop the site becoming acidic.

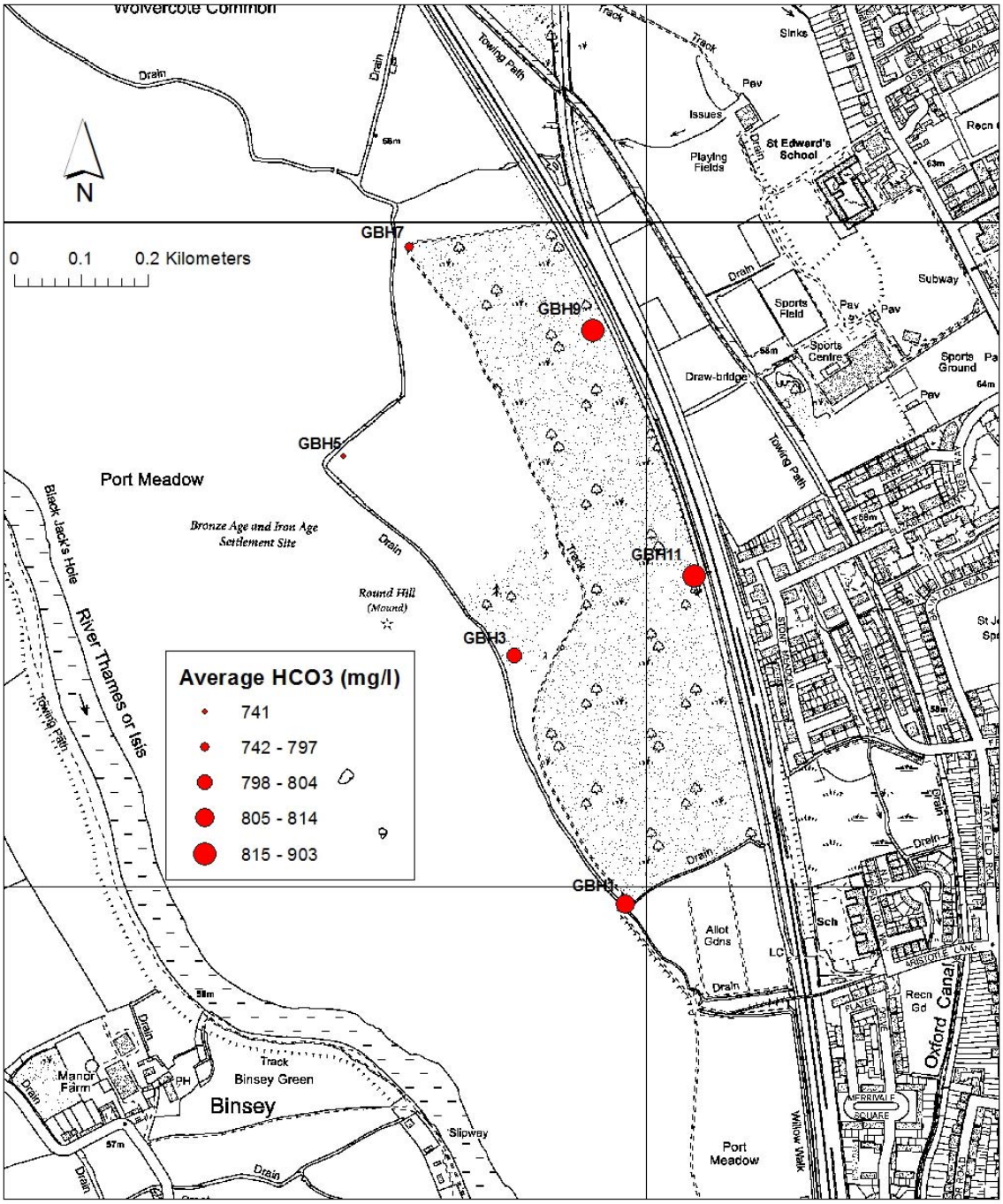

Figure 12 Average concentrations of HCO_3 (mg/l) per site.

Concentrations of SO_4 in the area of the waste dump are high across the site. The high temporal variability within boreholes (especially GBH 3 and 5) is highlighted in Figure 13. The arithmetic average per site has been used to look for spatial variability across Burgess Field (Figure 14). GBH3 and GBH 5 in the east of the area have the highest average SO_4 concentrations but also the greatest variability with time. Sulphate concentrations are in part controlled by the redox couple $SO_4^{2-}/S^{2-;}$ in the reduced state there is an absence/low concentrations of SO_4 (Stuart and Lapworth 2011). This redox pair has been used by Janowski and Acworth (1997) to define the anaerobic central zone of a landfill leachate plume where S, N, Fe and Mn are seen in their reduced form. We do not have data for S but the concentrations of SO_4 are still elevated at Burgess Field.

Concentrations in GBH9 and 11 are closer to the concentrations reported in Port Meadow by Macdonald et al 2012 while elevated concentrations are seen elsewhere in Burgess Field. This

points to low/incomplete SO_4 reduction in the area. It is possible that the system is not yet in equilibrium due to high SO4 load.

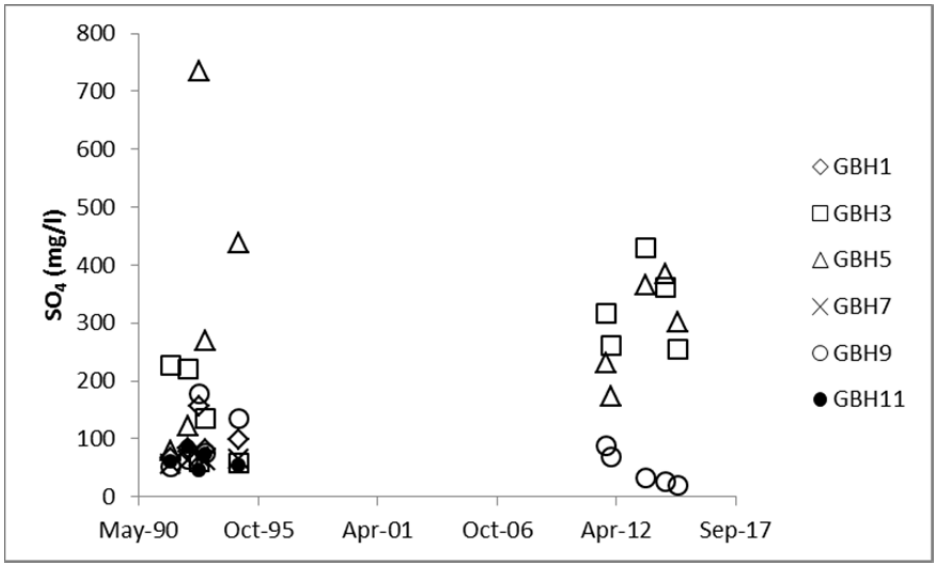

Figure 13 Concentration of SO_4 (mg/l) in boreholes within Burgess Field waste dump.

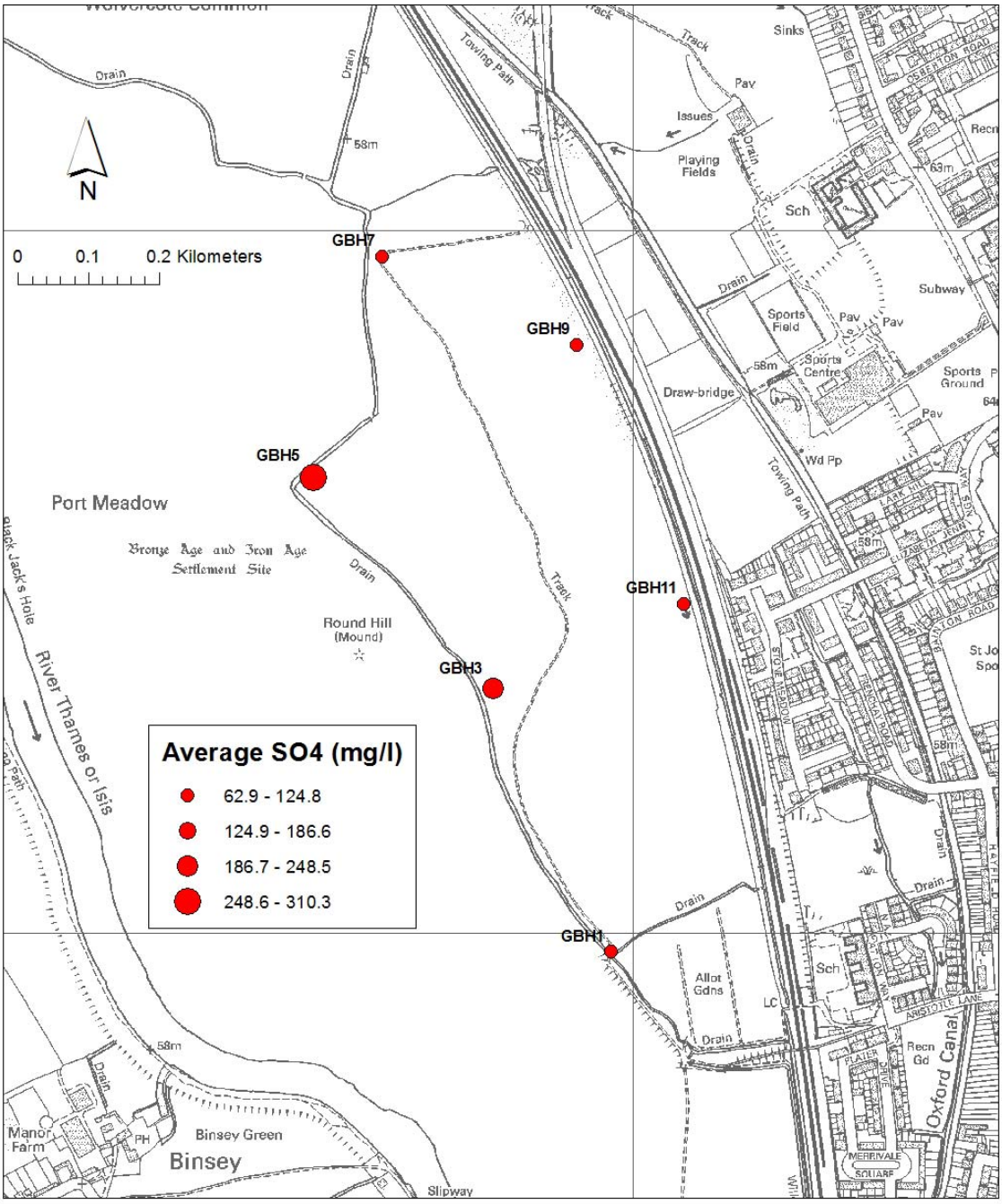

Figure 14 Average SO_4 concentration per site.

The groundwaters across the site are mostly HCO_3 – Ca (GBH3, GBH7, GBH 9 and GBH 11) to HCO_3 - Ca/Mg (GBH1) dominated waters. GBH5 shows variable dominance during the 1990s and in Feb 1993 SO_4 became the dominant anion.

Due to the paucity of data it is difficult to pick out seasonal or temporal trends within and between the two sampling campaigns in Burgess Field but the trilinear plot for GBH11 (Figure E17) seems to show increasing HCO_3 and Ca dominance with time. GBH1 (Figure E12) and GBH 7 (Figure E15) plots show little variation with time. There is slight variation within GBH3 (Figure E13) but all are Ca- HCO_3 dominated water with the more recent monitoring producing slightly higher SO_4 dominance and concentrations than the samples in the 1990's. Since 2011 GBH 5 (Figure E14) has been Ca-HCO_3 dominant.

3.2.3 Boron

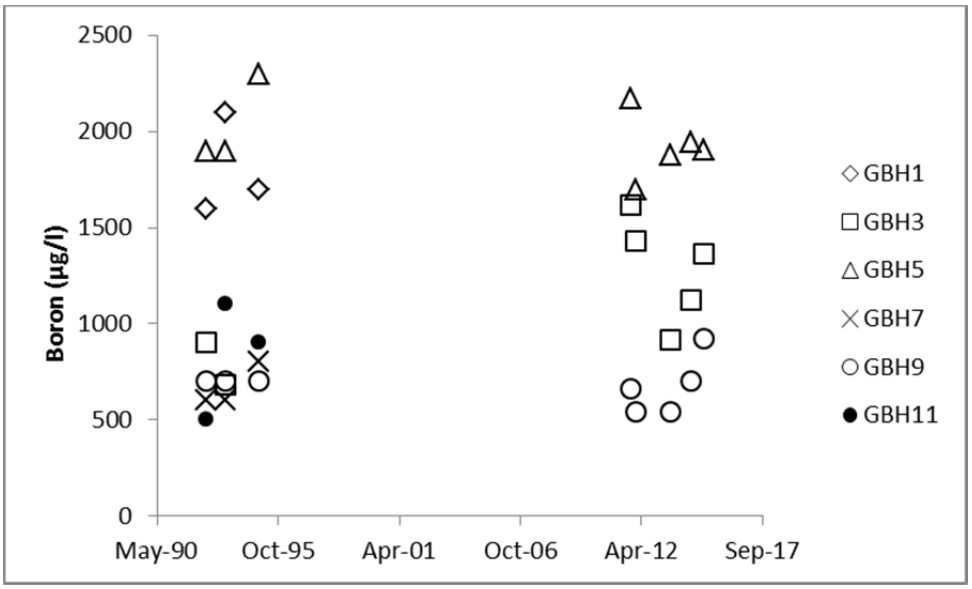

Figure 15 Concentration of Boron (µg/l) in boreholes within Burgess Field waste dump.

Boron (B) concentrations (Figure 15) are variable across the landfill being higher at the western edge than the eastern edge (GBH 9) but again only a few sites were sampled. Overall, B concentrations appear to be stable over the monitoring period at each location. The highest concentrations are seen in GBH5 and GBH1. Boron has been used as a tracer for sewage discharge and landfill leachate in the past, as B concentrations are elevated above the natural background concentrations within the landfill it could be used to trace the leachate plume in Port Meadow.

3.2.4 Redox sensitive ions.

Concentrations of NH_4 and TON (concentrations of NO_3-N + NO_2-N) were measured in the 1990s; since 2011 NH_4, NO_3 and NO_2 concentrations have been measured. The concentrations per site for these ions can be found in graphical form in Appendix E. Gooddy et al (2014) reports the findings of a study to look at N dynamics in the peri-urban environment, conducted in the Port Meadow area (including Burgess Field and the River Thames). They concluded, from N isotopes, N speciation and dissolved nitrous oxide gas, that the dominant source of nitrogen in the floodplain is NH_4 originating from the landfill. Their results show that some nitrification of the NH_4 has occurred along with some denitrification of the resultant nitrate. This is seen in the results presented here as NO_3 concentrations are detectable and occasionally increase over time (eg GBH9, where in Oct 2011 NO_3 was 47.7 mg/l). Concentrations of NH_4 remained high during the two periods of study showing a large plume of NH_4 below/within the landfill.

Concentration of NH_4 are higher than concentrations of TON (NO_3 and NO_2 in the more modern data) at all sites except GBH9 where in Oct 2011 NO_3 (at 47.7 mg/l) is elevated and higher than NH_4. It returned to its normal low levels during the next sampling round. The increased NO_3 levels within GBH9 during Oct 2011 cannot be explained by being unusually low or high groundwater levels during sampling as the groundwater levels were lower during other summers and are higher most winters; sampling is at the beginning of the recharge period. This may be due to aggressive pumping in GBH9 at this time as there is usually little water in this piezometer. This was, however, the first round of sampling since 1994 so may indicate stagnant water in the locality of the borehole that has allowed nitrification to occur.

Concentrations of NH_4 within the landfill are between 1.1 and 186 mg/l (Figure 16). Average concentrations per site are plotted in Figure 17. The highest average concentrations are seen in the east of the landfill. GBH3s average concentration is a quarter of the average concentration seen at GBH11 but GBH11 shows the greatest variability in concentration over time. The NO_3/

NH_4 redox pair has also been used in literature to define zones within landfill leachate. The data indicates that the reduced form of N is dominant in the vicinity of the landfill.

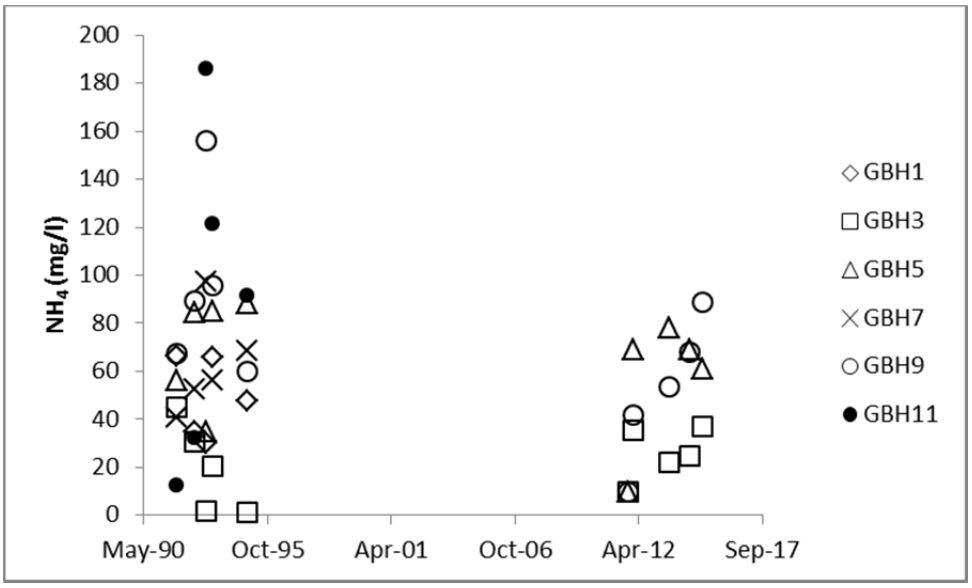

Figure 16 Concentrations of NH_4 (mg/l) in boreholes within Burgess Field waste dump.

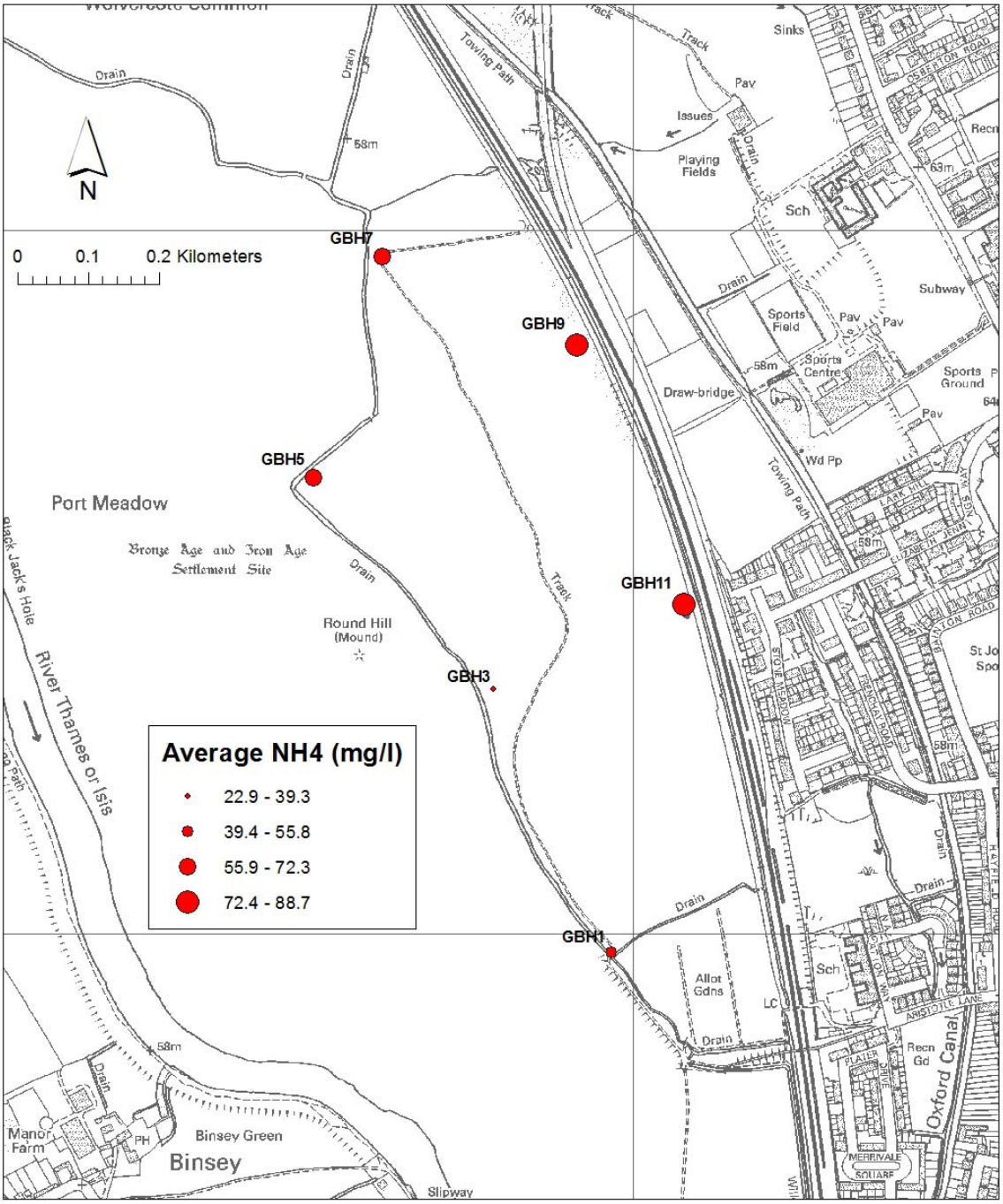

Figure 17 Average NH_4 (mg/l) concentration per site.

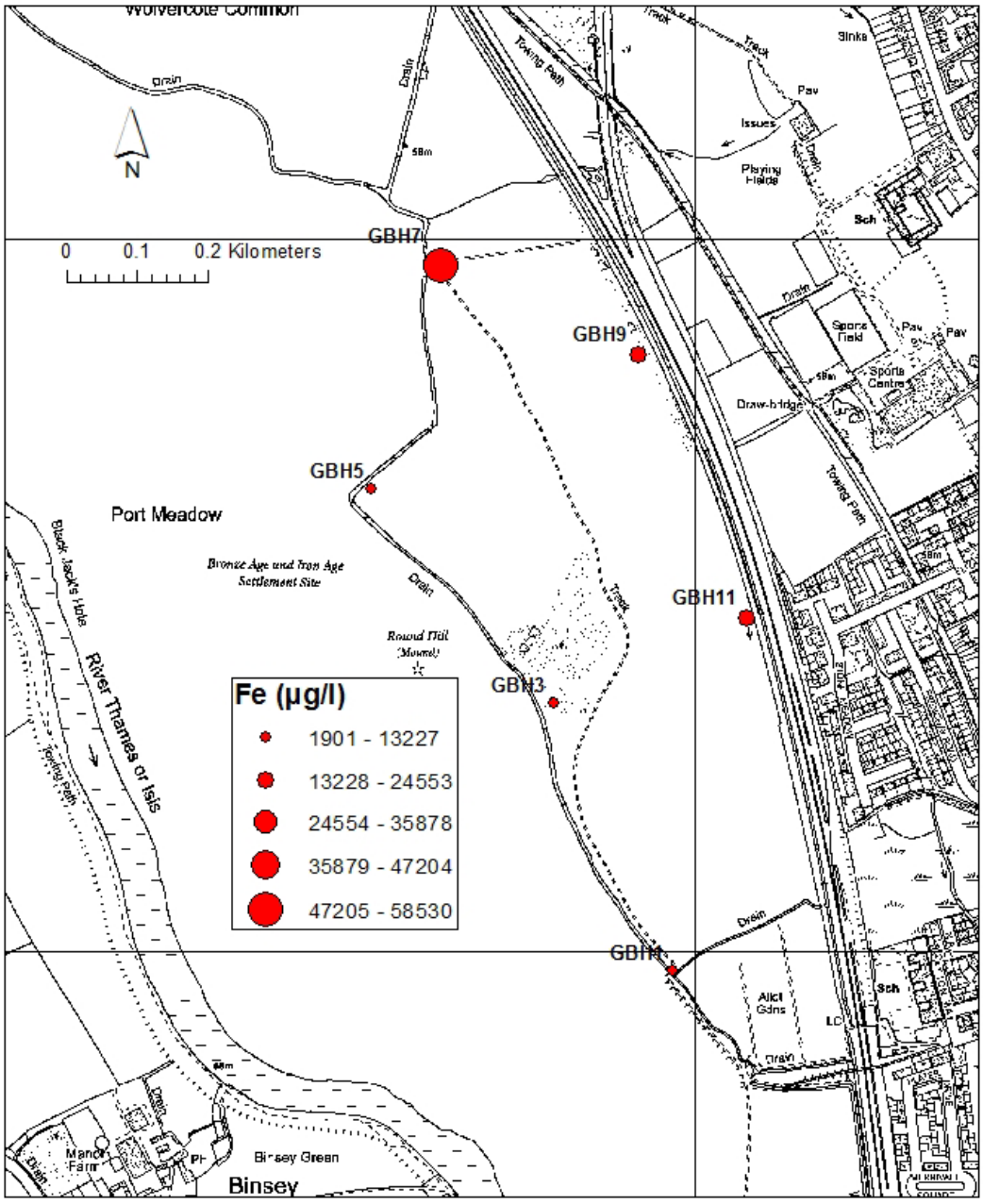

Figure 18 Average Fe (µg/l) concentration per site.

Iron (Fe) is another redox-sensitive ion and dissolved Fe concentrations are very high across the site (Figure 18), as expected of an anaerobic domestic landfill. Dissolved Fe at near neutral pH (pH's about 6.4 to 7.2 across site) can indicate Fe reduction (Christensen et al 2000).

GBH7s average concentration of 58,520 µg/l is skewed by one concentration of 139,882 µg/l. As can be seen from Figure 19, this concentration is abnormally high. The lowest average Fe concentrations are seen at the front of the landfill.

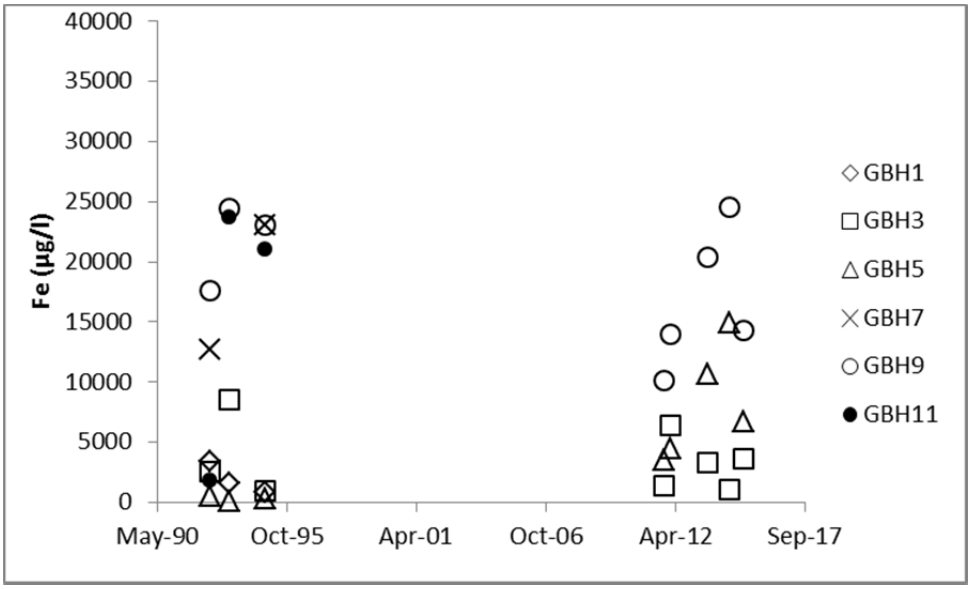

Figure 19 Concentration of Fe (µg/l) in boreholes within Burgess Field waste dump.

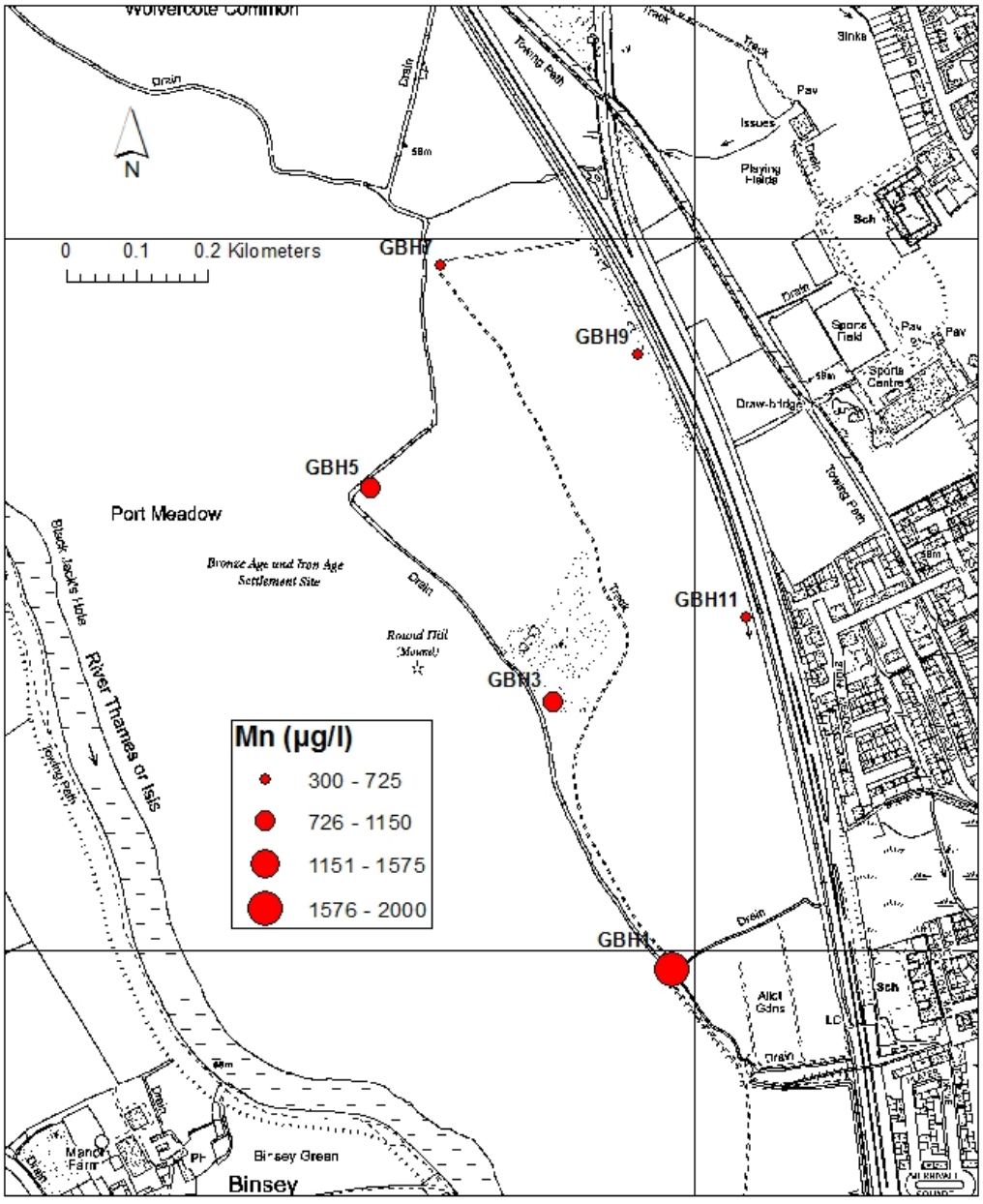

Figure 20 Average Mn (µg/l) concentration per site.

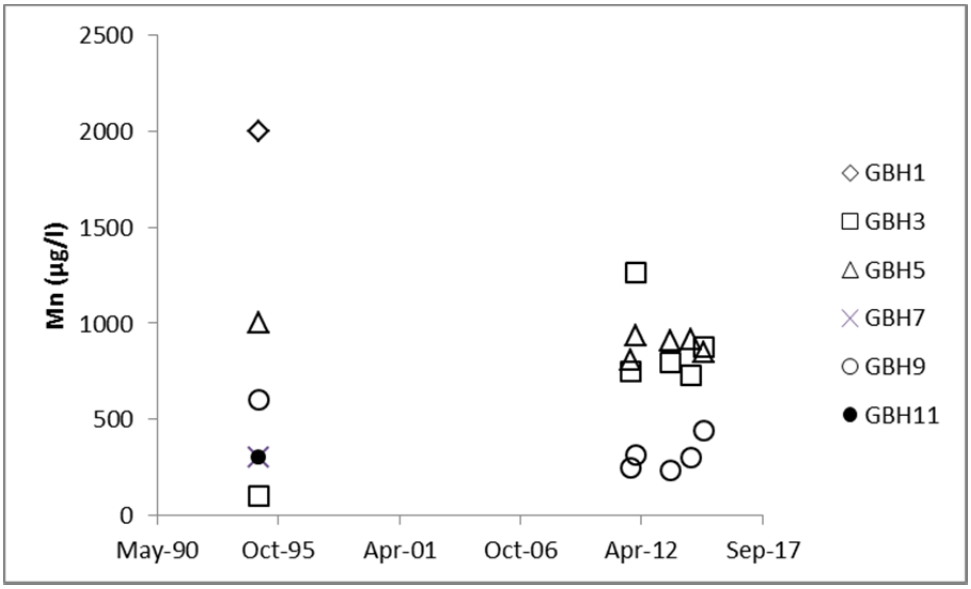

Figure 21 Concentration of Mn (µg/l) in boreholes within Burgess Field waste dump.

Manganese (Mn) can be found in the dissolved form in anaerobic waters as the reduced form is more soluble; the oxidized form is solid and has a low solubility in groundwaters with near neutral pH. In all piezometers, Mn is to be found in the dissolved (reduced) form. As can be seen in Figure 21, concentrations of Mn are stable and high in GBH5, have increased in GBH 3 and look to have decreased in GBH 9 over time. Higher average concentrations are found at the front of the landfill (Figure 20).

3.2.5 Lithium

Concentrations of lithium (Li) within Burgess Field are elevated above the expected background concentrations when compared with the median Li concentrations in UK aquifers, for example median concentrations of 0.8 to 34 µg/l in the Chalk (Shand et al 2007), especially in the east of the area. Li can be found naturally in clay minerals, pegmatites and silicate minerals but may also have an anthropogenic source within the landfill. Once in solution Li is much less easily sorbed than other cations and tends to increase in concentration with residence time. The different sampling points within the landfill appear to have distinct Li concentrations and may represent different sources within the landfill.

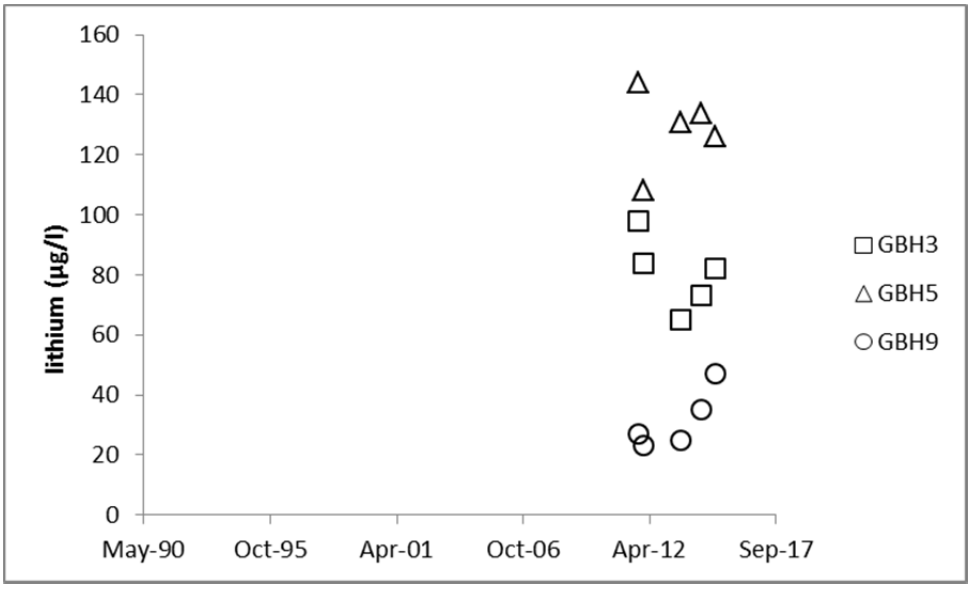

Figure 22 Concentration of Li (µg/l) in boreholes within Burgess Field waste dump.

3.2.6 Phosphate chemistry

During the more recent sampling events, samples from GBH3, 5 and 9 were analysed for total dissolved phosphate (TDP), total phosphate (TP), and soluble reactive phosphate along with the more usual HPO_4. Concentrations are shown graphically in Figures 18 to 20 in Appendix E. Concentrations of phosphate are not seen to be high in any of these forms but the particulate form (TP) of the nutrient is dominant. The general trends in the phosphate chemistry within the 3 boreholes are summarized below:

- GBH3 shows a general reduction in TDP and TP concentration over time showing a general reduction of mobile phosphate in the source with time.
- At GBH 5 a general downward trend in TP is marred by the low concentrations seen during August 2013 when water levels in this piezometer were the lowest ever seen. This could also be showing a general decrease in mobile particulate phosphate with time.
- Phosphate chemistry is variable at GBH9 with no obvious driver.

3.3 INTERPRETATION OF HYDROCHEMISTRY

Variability of groundwater levels prior to sampling and the variability of depth of water within each piezometer over time shows seasonal variation and again hints at uneven settling within the site or a change in drainage pattern over time. Unfortunately the site has only been surveyed once so we are not able to verify this.

The pH is variable spatially and temporally.

Landfill zonation can be defined by redox sensitive ion (Christensen et al 2001) including the NO_3/NH_4 redox pair and Stuart (2010) defines the NO_3 reducing zone at Port Meadow. High concentrations of NH_4 and low TON/NO_3 are indicative of reduction of NO_3 as well as microbial degradation of organic nitrogen (Stuart and Lapworth 2011). A spike in concentration of NO_3 at GBH 9 and reduction in concentration of NH_4 in Oct 2011, as discussed above, is unusual but could indicate a local change in this redox pair as could the variation of NH_4 over time within each piezometer.

Jankowski and Acworth (1997) defines the central zone as an anaerobic zone which has the highest concentrations of S, NH_4, Fe, Mn, HCO_3 and TIC with the pH occurring in a narrow range indicative of pH buffering. However they continue by defining the zone as having an absence of SO_4 and NO_3. Transition zone 1 is defined as being anaerobic with traces of sulphate and NH_4, Fe, Mn, HCO_3, with TIC still elevated above the background but lower than in the Central Zone. An anaerobic central zone within the leachate has been seen at many sites (Christensen et al 2001)

In Burgess Field we have reduced Mn, Fe, N (NH_4), but SO_4 is still elevated in this area as the redox pair hasn't had time to reach an equilibrium due to a high amount of SO_4 in the original material. Or the high concentrations of SO_4 are due to microbial oxidation of iron sulphides in response to water level fluctuations as oxidised water enters the landfill during times of heavy rain. (Jorstad et al 2004). Christensen et al (2000) note that the contaminant plume from a landfill is unlikely to be in internal equilibrium especially as several of the redox processes have very slow kinetics.

4 Conclusions

This report has brought together data on free gases, groundwater chemistry and groundwater levels from the Burgess Field waste dump, Oxford, to assess the nature of leachate in groundwaters that are in the gravel aquifer below the dump and that temporarily saturate waste material within the dump; addressing spatial variability and long term changes. Sampling was

undertaken in the 1990s by environmental consultants and in the 2010s by the British Geological Survey.

Modern lined landfills are designed to prevent groundwater entering the landfill to reduce the risk of associated instability or reduction in effectiveness of engineering controls or environmental protection measures, and manage the risk to the environment. The geological barrier of a modern landfill must also provide sufficient attenuation to prevent a potential risk to soil and groundwater during the life-cycle of the site. This is not the case with Burgess Field; due to the lack of any capping or lining of the base, rainfall is able to infiltrate into the dump, with the resulting leachate free to enter the underlying aquifer. In addition, groundwater levels measured in Burgess field in recent years show that in some locations there is seasonal saturation of the base of the dump, enhancing movement of leachate into the underlying gravel aquifer.

Of the seven groundwater monitoring sites originally constructed within the Burgess Field waste dump in 1991, only three could be located in the 2010s field campaign; these are widely spaced and interpolation/extrapolation from these is not advisable. Therefore it is not possible to identify if saturation of the waste dump due to rising groundwater is focussed in specific areas of the dump. Datums for measuring groundwater levels have changed during the past two decades due to subsidence of the surface of the dump and therefore recent measurements of groundwater levels cannot be compared with those from the 1990s. As a result it is not possible to say if there have been long-term changes in groundwater levels within the dump.

Spatial variation in free gas and water chemistry is seen within the sampled groundwater during each sampling round undertaken. Patterns of spatial and temporal variability are difficult to unravel. Average gas concentrations across the waste dump in the 1990s vary spatially; methane concentrations are low or undetectable in the sample sites in the south and generally higher in the north indicating methanogenisis occurring upflow of, or in the vicinity of the gas sampling ports. There are no free or dissolved gas data for the 2010s making it difficult to assess if these patterns of methanogenisis persist.

Spatial variation is also seen within the dissolved N species, with no consistent pattern although the reduced form of N, NH_4, is dominant across the site.

When looking for long term trends only GBH3, 5 and 9 can be used as no other sites were sampled after the 1990s. Spatial variation can be seen in the concentrations of Fe, Mn and B at these 3 sites. Looking at all of the data, Fe exhibit consistent spatial variation always higher at GBH9 lower at GBH3 in both sets of data. B is always higher at GBH5, intermediate at GBH3 (where data exist) and lower at GBH9. There are no data for Mn for the 1990s but the data since 2011 show concentrations always less than 500µg/l at GBH9 and greater than 500 µg/l at GBH3 and GBH5.

There is limited evidence of seasonal variation, however; in the 1990s at GBH3 and GBH5, conductivity, Ca, Cl, K, Mg, SO_4, and NH_4 were lower during two successive winter sampling events in comparison to the summer events, suggesting dilution.

A long term change has been seen in conductivity at GBH3 as, on average, conductivity is higher in the later sampling campaign than the 1990s, reflecting a higher concentration of ions such as SO_4 and HCO_3 at these points. These are both products of breakdown, and increasing conductivity may indicate less dilution or higher concentrations of these ions in this area.

In summary, this points to a heterogeneous waste dump where fill is spatially variable in composition, and breakdown of the material is at different stages. This reflects the long period during which waste was dumped in the area (1930s-1980), and potentially varied material, on which there is very limited information. The data collected on Burgess Field shows: it is a source of pollution in the form of NH_4, SO_4, Fe, and Mn; that conditions are anaerobic; and HCO_3 concentrations are buffering the pH so acidic conditions are not occurring.

References

British Geological Survey holds most of the references listed below, and copies may be obtained via the library service subject to copyright legislation (contact libuser@bgs.ac.uk for details). The library catalogue is available at: http://geolib.bgs.ac.uk.

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Appendix A Logs of gas and water monitoring boreholes within Burgess Field waste dump

To follow are pages copied from the original report on monitoring boreholes within the Burgess Field waste dump, prepared for Oxfordshire County Council by Soiltec Soils and Gas in November 1991

Soiltec
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OXFORDSHIRE COUNTY COUNCIL

PORT MEADOW LANDFILL SITE

MONITORING BOREHOLES SUMMARY

NOVEMBER, 1991

Soiltec
SOILS AND GAS

DRILLING SUMMARY

LANDFILL MONITORING BOREHOLES - PORT MEADOW

Borehole No	Date of Installation	Depth of Installation	Gas/Gas & Water
GBH1	21 11 91	4.40 m	Gas & Water
GBH3	13 11 91	5.50 m	Gas & Water
GBH5	14 11 91	5.60 m	Gas & Water
GBH7	18 11 91	5.80 m	Gas & Water
GBH9	19 11 91	5.50 m	Gas & Water
GBH11	20 11 91	5.55 m	Gas & Water
G2	12 11 91	5.30 m	Gas
G4	12 11 91	3.70 m	Gas
G6	13 11 91	3.10 m	Gas
G8	13 11 91	4.80 m	Gas
G10	14 11 91	5.60 m	Gas
G12	14 11 91	4.70 m	Gas
G13	15 11 91	2.70 m	Gas

* G = Gas
GBH = Gas & Water

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Ledian Farm Ind. Estate, Upper Street, Leeds, Nr. Maidstone, Kent ME17 1RZ.
Telephone: (0622) 861350 Fax: (0622) 862752

Soft Ground Daily Record

Town OXFORD.
Site Name PORT MEADOW.
Borehole No. GBH1.
Equipment in Use DANDO 150.
Vehicle No. F 201 SKM.
Date + Time of Start/Finish 20-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L
TARMAC CONCRETE AND HARD CORE					0.50.
CLAY					2.00
RIVER GRAVEL					2.20
End of days drilling					2.20

SAMPLES												REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450		

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
8 INCH.		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE			1.20.		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / ~~Drizzling / Raining / Stormy / Snow / Freezing~~

SIGNATURES
DRILLER ..... CLIENT .....

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Telephone: (0622) 861350 Fax: (0622) 862752

Soft Ground Daily Record

Town OXFORD.
Site Name POINT MEADOW.
Borehole No. BH1.
Equipment in Use DANDO 150.
Vehicle No. E201 SKM.
Date + Time of Start/Finish 21-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine · Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands · Cobbles etc.	
Start of days drilling					2.20
RIVER GRAVEL					4.40

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS : End of days drilling

U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
8 INCH.		

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE.			4.40.		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

SIGNATURES
DRILLER .....
CLIENT .....

WEATHER : Fine / ~~Drizzling / Raining / Stormy / Snow / Freezing~~

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Soft Ground Daily Record

Town OXFORD
Site Name PORT MEADOW
Borehole No. 6BH.3
Equipment in Use DANDO 150
Vehicle No. F201 SKM.
Date + Time of Start/Finish 13-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L.
TOP SOIL.					0.30
Dark brown clay and brick					0.90
TIP Rubbish					3.90
River Gravel.					5.50
End of days drilling					5.50

SHOW SAMPLES THUS :

SAMPLES												
No	Type	Penetration m From	Penetration m To	U blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	REMARKS

U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
200 MM	G.L	5.50

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
Hit Water Table.			4.70		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : ~~Fine~~ / ~~Drizzling~~ / Raining / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

SIGNATURES
DRILLER
CLIENT

Soft Ground Daily Record

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SOILTEC SOILS AND GAS LIMITED
Ledian Farm Ind. Estate, Upper Street, Leeds, Nr. Maidstone, Kent ME17 1RZ.
Telephone: (0622) 861350 Fax: (0622) 862752

Town OXFORD
Site Name PORT MEADOW
Borehole No. GBHS
Equipment in Use DANDO 150
Vehicle No. E201 SKM

Date + Time of Start/Finish 14-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/Stiff / Loose/Dense	Colour / Fine · Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L.
TOP SOIL.					0.40
BRICK RUBBLE and concrete					1.00
TIP RUBBISH					2.50
River Gravel					5.60

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS : End of days drilling

U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
8 inch.		

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
Hit water table			2.80		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / ~~Drizzling~~ / ~~Raining~~ / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

SIGNATURES
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Soft Ground Daily Record

Town OXFORD
Site Name POINT MEADOW
Borehole No. GBH 7
Equipment in Use DANDO 150
Vehicle No. E201 SKM

Date + Time of Start/Finish 15-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L.
TOP SOIL AND BRICK AND CONCRETE					1.50
TIP RUBBISH					3.50
RIVER GRAVEL					4.00
End of days drilling					4.00

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T. mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING

SIZE (mm)	FROM (m)	TO (m)
8 INCH		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE.			3.50		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / ~~Drizzling~~ / ~~Raining~~ / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

SIGNATURES
DRILLER
CLIENT

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Telephone: (0622) 861350 Fax: (0622) 862752

Soft Ground Daily Record

Town OXFORD
Site Name POINT MEADOW
Borehole No. GBH7
Equipment in Use DANDO 150.
Vehicle No. F 201 SKM.
Date + Time of Start/Finish 19-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					4.00
RIVER GRAVEL.					5.80
End of days drilling					

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
8 INCH.		

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE.			3.50.		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

SIGNATURES
DRILLER ..... CLIENT .....

WEATHER : ~~Fine~~ / Drizzling / ~~Raining~~ / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

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Soft Ground Daily Record

Town OXFORD
Site Name PORT MEADOW.
Borehole No. GBH 9.
Equipment in Use DANDO 150.
Vehicle No. F 201 SKM.
Date + Time of Start/Finish 18-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L.
TOP SOIL					0.30.
TIP RUBBISH.					3.20
End of days drilling					3.20

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
8 INCH.		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / ~~Drizzling~~ / ~~Raining~~ / ~~Stormy~~ / ~~Snow~~ / Freezing

SIGNATURES
DRILLER ..... CLIENT .....

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Soft Ground Daily Record

Town OXFORD
Site Name PORT MEADOW
Borehole No. GBH 9.
Equipment in Use DANDO 150
Vehicle No. E201 SKM.
Date + Time of Start/Finish 18-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					3.20
TIP RUBBISH					5.00
RIVER GRAVEL.					5.50
End of days drilling					5.50

SAMPLES												REMARKS
No	Type	Penetration m From	Penetration m To	U blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450		

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING

SIZE (mm)	FROM (m)	TO (m)
8 INCH		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE			4.50		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER ~~Fine~~ / ~~Drizzling~~ / Raining / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

SIGNATURES
DRILLER
CLIENT

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Soft Ground Daily Record

Town OXFORD
Site Name PORT MEADOW.
Borehole No. GEH 11.
Equipment in Use DANDO 150
Vehicle No. E201 SHCM

Date + Time of Start/Finish 20-11-91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy, etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					G.L.
TOP SOIL					0.40
TIP RUBBISH					4.20
BIVER GRAVEL					5.55
End of days drilling					5.55

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS : U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
6 INCH.		

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HIT WATER TABLE.			3.60		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

SIGNATURES
DRILLER ..... CLIENT .....

WEATHER : Fine / ~~Drizzling~~ / ~~Raining~~ / ~~Stormy~~ / ~~Snow~~ / ~~Freezing~~

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Soft Ground Daily Record

Town PORT MEADOW. OXFORD.
Site Name PORT MEADOW.
Borehole No. GL2.
Equipment in Use JANDO 150.
Vehicle No. J379 LKN.
Date + Time of Start/Finish 12/11/91

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					GL.
BRICK, ASH, CONCRETE PATH.					0.80
ASH FILL, BRICK, CLAY					2.40
SOFT BROWN SANDY CLAY					3.00.
COARSE SANDY + GRAVELS.					
End of days drilling					5.30.

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	blows	S.P.T./C.P.T. mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

CASING		
SIZE (mm)	FROM (m)	TO (m)
250	GL.	5.30

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HR/O			3.00.		
END OF T/H			2.80.		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE		5.30.			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / (Drizzling) / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER
CLIENT

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Soft Ground Daily Record

Town OXFORD.
Site Name PORT MEADOW.
Borehole No. G4
Equipment in Use DANDO 150.
Vehicle No. J379 LKN.
Date + Time of Start/Finish 12/11/91

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					GL
TOPSOILS					0.10
WASTE PLUS CLAY FILL					3.40
COARSE SANDS + GRAVELS					
End of days drilling					3.70

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	U blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS : U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING

SIZE (mm)	FROM (m)	TO (m)
250	GL	3.50

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
HOLE			3.50		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE		3.30			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER ~~Fine~~ / Drizzling / ~~Raining / Stormy / Snow / Freezing~~

SIGNATURES
DRILLER R. Elliott
CLIENT

Soft Ground Daily Record

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Town OXFORD
Site Name PORT MEADOW
Borehole No. CG
Equipment in Use DANDO 150
Vehicle No. J378 LKN
Date + Time of Start/Finish 12/11/91

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/Stiff : Loose/Dense	Colour : Fine - Coarse Medium	Clayey Silty - Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					GL
TOPSOILS					0.10
WASTE / CLAY FILL					3.00
COARSE SANDS + GRAVELS					
End of days drilling					3.10

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
850	GL	3.00

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
12/0			3.05		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE		3.10			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level; Dry

WEATHER : Fine / (Drizzling) / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER C. Philpott
CLIENT

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Soft Ground Daily Record

Town OXFORD.
Site Name PORTMEADOW.
Borehole No. G8.
Equipment in Use DANDO 150.
Vehicle No. J378LKN.
Date + Time of Start/Finish 13/11/91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					GL.
TOPSOILS.					0.10.
CLAY FILL. ASH, BRICK.					4.60.
COARSE SANDS + GRAVELS.					
End of days drilling					4.80.

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	U blows	S.P.T./C.P.T = mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS : U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING		
SIZE (mm)	FROM (m)	TO (m)
250.	GL.	4.60.

WATER					
OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
H2O.			4.65.		

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.			
Cause	From (m)	To (m)	Time (hr)

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE.		4.80.			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER : Fine / (Drizzling) / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER R. Pinkard
CLIENT

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Soft Ground Daily Record

Town OXFORD.
Site Name PORT MEADOW.
Borehole No. G10.
Equipment in Use DANDO 150.
Vehicle No. J 379L KW.
Date + Time of Start/Finish 14/11/91

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling.					GL.
TOPSOILS.					0.10
WASTE, ASH, CLAY.					3.50
COARSE SANDS + GRAVELS.					
End of days drilling					5.40

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	U blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING

SIZE (mm)	FROM (m)	TO (m)

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
14/11/91			5.60		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63 mm PIPE.		5.40			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER (Fine) / Drizzling / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER R. Pinfold
CLIENT

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Soft Ground Daily Record

Town OXFORD
Site Name PORT MEADOW
Borehole No. G1R
Equipment in Use DANDO 150
Vehicle No. J 378 LKN
Date + Time of Start/Finish 14/11/91

DESCRIPTION OF STRATA

Soft/Firm/Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	DEPTH to base of STRATA m
			Start of days drilling		GL
			TOPSOILS		0.10
			WASTE, CLAY FILL, BRICK, CONCRETE		4.30
			SOFT GREY/GREEN SANDY CLAY		4.60
			COARSE SANDS + GRAVELS		
			End of days drilling		4.70

SAMPLES

No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T. mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	REMARKS

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test

CASING

SIZE (mm)	FROM (m)	TO (m)
250	GL	4.60

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
NIL			4.60		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE		4.70			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER (Fine) / Drizzling / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER C. Philpott
CLIENT

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Soft Ground Daily Record

Town OXFORD.
Site Name PORT MEADOW.
Borehole No. C13.
Equipment in Use DANDO 150.
Vehicle No. J379 LKO.
Date + Time of Start/Finish 15/11/91.

DESCRIPTION OF STRATA					DEPTH to base of STRATA m
Soft/Firm/ Stiff / Loose/Dense	Colour / Fine - Coarse Medium	Clayey Silty - Sandy etc.	SOIL TYPE	Sand bands Cobbles etc.	
Start of days drilling					GL.
CLAYFILL, WASTE.					2.00
SOFT GREY SILTY CLAY.					
End of days drilling					2.70

SAMPLES											REMARKS
No	Type	Penetration m From	Penetration m To	u blows	S.P.T./C.P.T mms. 0 to 75	75 to 150	150 to 225	225 to 300	300 to 375	375 to 450	

SHOW SAMPLES THUS :
U Undisturbed; D Disturbed; B Bulk; W Water; S Standard Penetration Test; C Cone Penetration Test.

CASING

SIZE (mm)	FROM (m)	TO (m)

DELAYS/BAD ACCESS/PITS/HARD STRATA etc.

Cause	From (m)	To (m)	Time (hr)

WATER

OBSERVATION	DATE	TIME	DEPTH	INFLOW	CASING
24/0			2.60		

STANDPIPE/PIEZOMETER	Time Taken (hr)	Depth	Depth of Seals (m) Top	Depth of Seals (m) Bottom	Reading
63mm PIPE		2.70			

OBSERVATIONS : e.g. Struck, Rate of flow, Sealed, Final standing level, Dry

WEATHER (Fine) / Drizzling / Raining / Stormy / Snow / Freezing

SIGNATURES
DRILLER ..... CLIENT .....

Appendix B Original gas and groundwater analysis result sheets from Burgess Field waste dump monitoring

To follow are pages from a series of reports prepared up to December 1996 that were prepared for Oxfordshire County Council and obtained from the Environment Agency.

ENVIRONMENT AGENCY

Site: Port Meadow

Monitoring Data up to 16th December 1996 on CD in Tactical Planning

GAS CHEMISTRY DATA

OXFORDSHIRE COUNTY COUNCIL
IN SITU MONITORING RESULTS
FOR LANDFILL GAS

SITE NAME	Port Meadow			
DATE SAMPLED	26/11/91	SAMPLED BY :D.Hawley		
BOREHOLE REF	DEPTH	% CH4	% CO2	% O2	COMMENTS
GBH1		00.00	01.20	17.10	Atmospheric Pressure - 1017/8 mb.
G2		00.00	10.70	03.80	
GBH3		00.60	04.90	12.50	
G4		12.10	19.30	01.90	Some of these boreholes have been drilled through waste & so it is not surprising that this quality of gas is being produced.GBH1 on the other hand most probably represents virgin ground. There is no site lining or cap & so gas can vent freely All housing etc. is east of the site with a railway line & waterway separating the two.To the north & west of the site is the meadow with allotments to the south.
GBH5		00.00	01.40	18.10	
G6		00.00	00.60	19.10	
GBH7		33.10	30.40	00.00	
G8		00.00	03.90	16.80	
GBH9		40.80	34.60	00.40	
G10		19.40	20.00	02.30	
GBH11		02.80	07.60	13.00	
G12		00.00	05.60	13.90	
G13		00.00	04.20	16.30	

Oxfordshire County Council
in situ monitoring results
for Landfill Gas

Site name	Port Meadow			
Date sampled	22/05/92	Sampled by:	D.Hawley	
Borehole Ref	Depth (m)	% CH4	% CO2	% O2	Comments
G1		00.00	08.00	11.40	
G2		00.00	12.80	04.00	
GBH3		00.10	02.00	18.40	
G4		20.30	19.40	00.80	
GBH5		00.00	00.90	19.80	
G6		00.90	07.20	13.70	
GBH7		01.80	08.20	12.10	
G8		00.00	09.40	13.20	
GBH9		14.80	19.00	03.00	
G10		31.50	25.30	01.10	
GBH11		00.50	13.70	07.20	
G12		00.00	07.60	12.50	
G13		00.00	12.70	09.10	
Atmospheric pressure - 1010 -1013 mb.					

Oxfordshire County Council
in situ monitoring results
for Landfill Gas

Site name	Port Meadow			
Date sampled	20/08/92	Sampled by: D.Hawley		
Borehole Ref	Depth (m)	% CH4	% CO2	% O2	
GBH1		00.00	08.90	10.30	G8 could not be found.
G2		00.00	14.60	02.50	
GBH3		00.00	00.60	18.80	
G4		02.10	07.20	14.20	
GBH5		00.00	04.30	18.60	
G6		00.70	09.50	11.60	
GBH7		24.90	27.50	00.40	
GBH9		29.70	27.40	02.80	
G10		32.90	28.70	00.80	
GBH11		06.60	20.40	00.50	
G12		00.00	09.50	07.70	
G13		00.00	08.60	11.30	

Site name	Port Meadow			
Date sampled	15/12/92 Sampled by:D.Hawley			
Borehole Ref	Depth(m)	% CH4	% CO2	% O2
GBH1		00.00	00.30	21.00
G2		00.00	09.60	08.70
GBH3		00.00	01.60	18.90
G4		21.70	22.30	02.00
GBH5		00.00	01.30	19.90
G6		00.00	01.10	20.30
GBH7		30.00	23.80	00.60
G8		00.00	03.90	16.40
GBH9		00.00	00.60	19.80
G10		35.60	25.10	01.50
GBH11		00.00	00.00	20.70
G12		00.00	03.70	16.30
G13		00.00	03.00	18.70

Atmospheric pressure - 1005 - 1007 mb.

"Infra-red Gas Analyser Data"

"Code","Time","Date","CH4","CO2","O2","MILLIBAR"

"PORT0001","09:15","25/06/93",000.0,001.3,018.9,1022
"PORT0002","09:21","25/06/93",000.0,005.2,012.8,1021
"PORT0003","09:25","25/06/93",000.0,000.5,019.9,1021
"PORT0004","09:31","25/06/93",022.8,022.4,000.2,1021
"PORT0005","09:36","25/06/93",000.2,004.3,015.9,1020
"PORT0006","09:44","25/06/93",005.8,018.5,001.8,1020
"PORT0007","09:50","25/06/93",022.3,027.8,000.1,1021
"PORT0008","09:54","25/06/93",000.0,009.7,010.8,1020
"PORT0009","10:00","25/06/93",018.6,023.1,001.0,1019
"PORT0010","10:04","25/06/93",034.0,028.9,000.3,1019
"PORT0011","10:09","25/06/93",000.6,004.5,010.8,1019
"PORT0013","10:16","25/06/93",000.0,007.6,013.1,1019

"Infra-red Gas Analyser Data"

"Code","Time","Date","CH4","CO2","O2","MILLIBAR"

"PORT0001","10:57","03/12/93",000.0,000.2,020.4,1013
"PORT0002","11:01","03/12/93",000.0,013.4,007.8,1013
"PORT0003","11:06","03/12/93",003.6,018.6,000.0,1013
"PORT0004","11:11","03/12/93",009.4,020.0,001.0,1013
"PORT0005","11:16","03/12/93",000.0,001.8,018.7,1013
"PORT0006","11:21","03/12/93",011.2,018.6,000.0,1013
"PORT0007","11:25","03/12/93",022.2,022.1,000.0,1012
"PORT0008","11:29","03/12/93",000.0,003.6,018.0,1012
"PORT0009","11:34","03/12/93",000.0,000.0,020.2,1013
"PORT0010","11:39","03/12/93",030.3,022.0,000.0,1012
"PORT0011","11:43","03/12/93",000.0,000.0,020.1,1013

Port Meadow

Borehole	Max CH4	Min CH4	Avg CH4	Max CO2	Min CO2	Avg CO2
G10	35.6	19.4	29.9	28.7	20	24.2
G12	0	0	0.0	9.5	3.7	6.6
G2	0	0	0.0	14.6	9.6	12.2
G4	21.7	2.1	13.1	22.3	7.2	17.6
G6	11.2	0	2.6	18.6	0.6	7.4
G8	0	0	0.0	9.4	3.6	5.2
GBH1	0	0	0.0	8.9	0.3	4.6
GBH11	6.6	0	2.0	20.4	0	8.3
GBH3	3.6	0	0.9	18.6	0.6	5.5
GBH5	0	0	0.0	4.3	0.9	1.9
GBH7	33.1	1.8	22.4	30.4	8.2	22.4
GBH9	40.8	0	17.1	34.6	0	16.3

*** These figures are calculated from the data on computer where borehole type = gas / dual purpose. Data will be missing where the borehole type has not been added to the database.**

Infra-red Gas Analyser Data

Code	Date	CH4	CO2	O2	MILLIBAR
PORT0001	24/06/94	0	1.2	19.7	1006
PORT0002	24/06/94	0	2.5	19.1	1005
PORT0004	24/06/94	20.1	20.1	2.2	1004
PORT0006	24/06/94	0	2.8	19.4	1004
PORT0007	24/06/94	0.2	0.9	20.4	1004
PORT0009	24/06/94	1.8	12.2	0.3	1003
PORT0010	24/06/94	27.7	26	0.2	1002
PORT0011	24/06/94	0.1	2.6	16.8	1002

Gas Analyser Data: Mk1 Gas Analyser								
Code	Date	CH4	CO2	O2	Atmospheric Pressure			
PORT0001	15/12/94	0	2.9	18.2	1025			
PORT0002	15/12/94	0	6.4	15.1	1024			
PORT0003	15/12/94	0	1.7	18.9	1023			
PORT0004	15/12/94	18.9	24.3	0	1024			
PORT0005	15/12/94	0	2.7	17.9	1024			
PORT0006	15/12/94	4.7	15.6	5.5	1024			
PORT0007	15/12/94	0.9	7.5	11.9	1024			
PORT0009	15/12/94	0	0.6	19.8	1022			
PORT0010	15/12/94	28.2	24.2	0.1	1023			
PORT0011	15/12/94	0.2	3.8	15.8	1023			

Gas Analyser Data: Mk2c V2.05 31/03/95						
Code	Date	CH4	CO2	O2	Atmospheric Pressure	
		%	%	%	mBar	
PORT0001	16/06/95	0	1.1	19.1	1004	W
PORT0002	16/06/95	0	14.4	1.2	1003	W
PORT0003	16/06/95	3.4	18.1	0.8	1004	W
PORT0004	16/06/95	18.3	21.6	0.6	1003	W
PORT0005	16/06/95	0	1.3	19.7	1003	W
PORT0006	16/06/95	9.1	21.1	0.7	1003	W
PORT0007	16/06/95	10.5	23.4	0.6	1004	W
PORT0008	16/06/95	0	1.6	20.3	1003	W
PORT0009	16/06/95	0	0.1	20.9	1003	W
PORT0010	16/06/95	3.4	5.9	16.3	1002	W
PORT0011	16/06/95	0.9	6.8	13.9	1002	W

Port Meadow							
Code	Date	CH4	CO2	O2	Atmospheric Pressure		
		%	%	%	mBar		
PORT0001	13/06/96	0	1.8	18.5	1029		W
PORT0002	13/06/96	0	7.6	16.1	1029		W
PORT0004	13/06/96	15.8	21	1.5	1028		W
PORT0003	13/06/96	0	1.3	18.8	1028		W
PORT0005	13/06/96	0	1.5	18.8	1027		W
PORT0006	13/06/96	0.2	6.3	15	1028		W
PORT0007	13/06/96	15.5	23.4	1	1027		W
PORT0008	13/06/96	0	5.8	11.7	1026		W
PORT0009	13/06/96	0	10.1	3.6	1027		W
PORT0010	13/06/96	4.5	7.3	11.6	1027		W
PORT0011	13/06/96	0	4.5	14.8	1026		W
PORT0012	13/06/96	0	4.6	15.5	1027		W

SC 5/7/96

PORT MEADOW

Code	Date	CH4	CO2	O2	Atmospheric Pressure		
		%	%	%	mBar		
PORT0001	16/12/96	0	1.9	18.7	1004		W
PORT0002	16/12/96	0	7.7	16.1	1004		W
PORT0004	16/12/96	15.9	21.1	1.5	1003		W
PORT0003	16/12/96	0	1.4	18.8	1003		W
PORT0005	16/12/96	0	1.6	18.8	1002		W
PORT0006	16/12/96	0.2	6.3	15	1003		W
PORT0007	16/12/96	15.5	23.4	1	1002		W
PORT0008	16/12/96	0	6.3	11.7	1001		W
PORT0009	16/12/96	0	10.2	3.6	1002		W
PORT0010	16/12/96	4.8	8	11.6	1002		W
PORT0011	16/12/96	0	4.9	14.9	1001		W
PORT0012	16/12/96	0	4.6	15.6	1002		W

SC 21/1/97

GROUNDWATER CHEMISTRY DATA

OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING RECORD SHEET

SITE :Port Meadow | DATE RECORDED:26/11/91 | RECORDED BY:D.Hawley

BOREHOLE			GROUNDWATER			MISCELLANEOUS
REF	TOTAL DEPTH M	HEAD OF GROUNDWATER (M)	METRES B.C.L.*	DEPTH(M)	SAMPLE	
GBH1		03.07	01.23	04.30	OCC2	Each groundwater
G2		-	02.44	-	-	monitoring well
GBH3		01.68	03.47	05.15	OCC2	was pumped until
G4		-	03.37	-	-	the sample taken
G5		03.02	02.58	05.60	OCC2	was representative
G6		-	-	-	-	of the groundwater
GBH7		02.26	03.54	05.80	OCC2	in that locality.
G8		-	-	-	-	The samples were
GBH9		01.14	04.36	05.50	OCC2	dispatched to
G10		-	04.76	-	-	Spencer House the
GBH11		01.87	03.53	05.40	OCC2	same day.
G12		-	03.24	-	-	This site is
G13			01.58			located on the
						Thames floodplain
						with the samples
						drawn from the
						river gravels.No
						cap or lining was
						incorporated so
						any leachate
						generated is free
						to disperse.The
						dilution afforded
						by the groundwater
						is probably quite
						substantial
						judging by the
						flow attained when
						pumping.The
						groundwater most
						probably flows
						towards the Thames,
						but borehole
						levels will need
						to be obtained to
						confirm this.some
						boreholes were
						drilled through
						refuse but more
						will be known on
						receipt of the
						drilling logs.
						Contamination of
						groundwater would
						not be unexpected.

* - BELOW COVER LEVEL
OCC1 - LIMITED ANALYSIS ,OCC2 - FULL ANALYSIS,
OCC3 - SELECTED METALS,OCC4 - TRI - HALO METHANES.

THE WATER QUALITY CENTRE

Spencer House, c/o Gainsborough House,
Manor Farm Road, Reading, Berks., RG2 0JN.
Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003057
Tag Number : 00094194

Sample Description : BH1 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20C	1777	uSM/c
COD	62	mg/l
AMMONIACAL NITROGEN	51.400	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.900	mg/l
CHLORIDE AS CL	143	mg/l
SULPHATE AS SO4	66	mg/l
ALKALINITY AS CACO3	752	mg/l
CALCIUM, TOTAL	166	mg/l
SODIUM	106.0	mg/l
POTASSIUM	43.4	mg/l
MAGNESIUM	34.5	mg/l

for The Water Quality Centre
Date of Issue: 16 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003058
Tag Number :00094195

Sample Description : BH3 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.5	NIL U
CONDUCTIVITY AT 20C	1506	uSM/c
COD	64	mg/l
AMMONIACAL NITROGEN	34.900	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.200	mg/l
CHLORIDE AS CL	56	mg/l
SULPHATE AS SO4	227	mg/l
ALKALINITY AS CACO3	581	mg/l
CALCIUM, TOTAL	220	mg/l
SODIUM	46.6	mg/l
POTASSIUM	48.5	mg/l
MAGNESIUM	28.4	mg/l

for The Water Quality Centre
Date of Issue: 13 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003059
Tag Number : 00094196

Sample Description : BH5 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.8	NIL U
CONDUCTIVITY AT 20C	1531	uSM/c
COD	65	mg/l
AMMONIACAL NITROGEN	43.400	mg/l
NITROGEN, TOTAL OXIDISED AS N	1.300	mg/l
CHLORIDE AS CL	102	mg/l
SULPHATE AS SO4	80	mg/l
ALKALINITY AS CACO3	572	mg/l
CALCIUM, TOTAL	162	mg/l
SODIUM	85.7	mg/l
POTASSIUM	49.5	mg/l
MAGNESIUM	30.3	mg/l

for The Water Quality Centre
Date of Issue: 9 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

THE WATER QUALITY CENTRE
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Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003060
Tag Number :00094197

Sample Description : BH7 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.8	NIL U
CONDUCTIVITY AT 20C	1189	uSM/c
COD	71	mg/l
AMMONIACAL NITROGEN	31.700	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.900	mg/l
CHLORIDE AS CL	87	mg/l
SULPHATE AS SO4	56	mg/l
ALKALINITY AS CACO3	476	mg/l
CALCIUM, TOTAL	136	mg/l
SODIUM	61.2	mg/l
POTASSIUM	30.3	mg/l
MAGNESIUM	21.6	mg/l

for The Water Quality Centre
Date of Issue: 10 December 1991

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THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003061
Tag Number : 00094198

Sample Description : BH9 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.6	NIL U
CONDUCTIVITY AT 20C	1461	uSM/c
COD	91	mg/l
AMMONIACAL NITROGEN	52.200	mg/l
NITROGEN, TOTAL OXIDISED AS N	1.000	mg/l
CHLORIDE AS CL	112	mg/l
SULPHATE AS SO4	52	mg/l
ALKALINITY AS CACO3	586	mg/l
CALCIUM, TOTAL	177	mg/l
SODIUM	64.3	mg/l
POTASSIUM	37.1	mg/l
MAGNESIUM	19.3	mg/l

for The Water Quality Centre
Date of Issue: 9 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr D Hawley
Oxfordshire County Council
Waste Disposal Section
Speedwell Street
Oxford
OX1 1NE

Reference :P26019/C003062
Tag Number :00094199

Sample Description : BH11 Suite OCC 2
Sample Site : Port Meadow
Date Received : 27.11.91
Date of Sample : 26.11.91
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20C	1042	uSM/c
COD	33	mg/l
AMMONIACAL NITROGEN	9.800	mg/l
NITROGEN, TOTAL OXIDISED AS N	1.000	mg/l
CHLORIDE AS CL	93	mg/l
SULPHATE AS SO4	61	mg/l
ALKALINITY AS CACO3	379	mg/l
CALCIUM, TOTAL	125	mg/l
SODIUM	50.8	mg/l
POTASSIUM	10.6	mg/l
MAGNESIUM	6.7	mg/l

for The Water Quality Centre
Date of Issue: 9 December 1991

The analytical results given in this report were obtained in the laboratories of Thames Water Utilities Limited.

OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING RECORD SHEET

SITE NAME: Port Meadow | SAMPLED BY: D. Hawley
DATE SAMPLED: 20/08/92

BOREHOLE			GROUNDWATER			MISCELLANEOUS
REF	DEPTH M A.O.D	COVER LEVEL M A.O.D.	METRES B.C.L.	LEVEL - M A.O.D.	SAMPLE	
GBH1			01.38	56.99	OCC2/3/4	All boreholes were
GBH3			03.60	57.02	OCC2/3/4	pumped for 20 mins
GBH5			02.80	56.90	OCC2/3/4	before the samples
GBH7			03.65	57.10	OCC2/3/4	were taken.
GBH9			04.47	57.54	OCC2/3/4	All samples except
GBH11			03.63	57.13	OCC2/3/4	GBH5 were foul
						smelling.
						Borehole covers
						require levels.

* - BELOW COVER LEVEL
OCC1 - LIMITED ANALYSIS , OCC2 - FULL ANALYSIS,
OCC3 - SELECTED METALS, OCC4 - TRI - HALO METHANES.

PROJECT :PORT MEADOW (K3) PORT MEADOW (K3)

DATE :22/ 1/1993

---------- ACSiS Version 1.4i ----------

STRING CODING FILE.

CODE.	RECORD.	Pt.No.	EASTING.	NORTHING.	LEVEL.
PBH		GBH			
	2	1 ~~18~~	449968.409	207974.013	58.373
	3	3 ~~2~~	449801.256	208349.349	60.620
	4	5 ~~4~~	449544.692	208648.678	59.782
	5	7 ~~15~~	449643.410	208964.235	60.751
	6	9 ~~13~~	449920.336	208837.846	62.011
	7	11 ~~7~~	450060.461	208465.200	60.755
CODE.	RECORD.	Pt.No.	EASTING.	NORTHING.	LEVEL.
PG		9			
	8	2 ~~1~~	449851.752	208160.155	59.576
	9	4 ~~7~~	449681.879	208514.458	60.838
	10	6 ~~9~~	449656.240	208786.550	60.280
	11	8 ~~14~~	449843.764	208994.967	61.865
	12	10 ~~4~~	450002.834	208655.887	62.225
	13	12 ~~9~~	450109.767	208271.489	60.490

SUPPLIER : MICHAEL A JENNINGS ASSOCIATES -

THE WATER QUALITY CENTRE
(Part of Thames Water Laboratories)

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100340/C007785
Tag Number : 00202666

Sample Description : BH1 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	1291	µSM/cm
COD	43.0	mg/l
AMMONIACAL NITROGEN	26.90	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.6	mg/l
CHLORIDE AS Cl	95	mg/l
SULPHATE AS SO_4	84.4	mg/l
ALKALINITY AS $CaCO_3$	515	mg/l
CALCIUM, TOTAL	154	mg/l
SODIUM, TOTAL	86.8	mg/l
POTASSIUM, TOTAL	28.7	mg/l
MAGNESIUM, TOTAL	19.9	mg/l
COPPER	<10	µg/l
NICKEL	<10	µg/l
CHROMIUM	<10	µg/l
ZINC	<10	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	3363	µg/l
BORON, TOTAL	1.674	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	4	µg/l
T.H.M, TOTAL	<4.0	µg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

J S Ryan

for The Water Quality Centre
Date of Issue: 4 September 1992

Tests marked "*" are *not* included in the NAMAS Accreditation of our laboratories.
The analytical results given in this report were obtained in the laboratories of
Thames Water Utilities Limited.

NAMAS TESTING

THE WATER QUALITY CENTRE
(Part of Thames Water Laboratories)

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100340/C007783
Tag Number : 00202667

Sample Description : BH3 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.4	NIL U
CONDUCTIVITY AT 20°C	1496	µSM/cm
COD	62.0	mg/l
AMMONIACAL NITROGEN	23.90	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.1	mg/l
CHLORIDE AS Cl	52	mg/l
SULPHATE AS SO_4	219.7	mg/l
ALKALINITY AS $CaCO_3$	612	mg/l
CALCIUM, TOTAL	236	mg/l
SODIUM, TOTAL	41.2	mg/l
POTASSIUM, TOTAL	27.7	mg/l
MAGNESIUM, TOTAL	17.7	mg/l
COPPER	<10	µg/l
NICKEL	<10	µg/l
CHROMIUM	11	µg/l
ZINC	<10	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	2521	µg/l
BORON, TOTAL	0.940	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	<1	µg/l
T.H.M, TOTAL	<4.0	µg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

for The Water Quality Centre
Date of Issue: 4 September 1992

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Thames Water Utilities Limited.

NAMAS TESTING

THE WATER QUALITY CENTRE
(Part of Thames Water Laboratories)

Spencer House, c/o Gainsborough House,
Manor Farm Road, Reading, Berks., RG2 0JN.
Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100340/C007786
Tag Number : 00202668

Sample Description : BH5 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	1601	µSM/cm
COD	81.0	mg/l
AMMONIACAL NITROGEN	65.70	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.4	mg/l
CHLORIDE AS Cl	106	mg/l
SULPHATE AS SO_4	123.1	mg/l
ALKALINITY AS $CaCO_3$	615	mg/l
CALCIUM, TOTAL	126	mg/l
SODIUM, TOTAL	103.2	mg/l
POTASSIUM, TOTAL	57.7	mg/l
MAGNESIUM, TOTAL	30.2	mg/l
COPPER	<10	µg/l
NICKEL	14	µg/l
CHROMIUM	<10	µg/l
ZINC	12	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	491	µg/l
BORON, TOTAL	1.941	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	<1	µg/l
T.H.M, TOTAL	<4.0	µg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100340/C007784
Tag Number : 00202669

Sample Description : BH7 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.8	NIL U
CONDUCTIVITY AT 20°C	1217	µSM/cm
COD	76.0	mg/l
AMMONIACAL NITROGEN	40.80	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.2	mg/l
CHLORIDE AS Cl	89	mg/l
SULPHATE AS SO_4	62.1	mg/l
ALKALINITY AS $CaCO_3$	486	mg/l
CALCIUM, TOTAL	127	mg/l
SODIUM, TOTAL	57.0	mg/l
POTASSIUM, TOTAL	34.8	mg/l
MAGNESIUM, TOTAL	19.1	mg/l
COPPER	<10	µg/l
NICKEL	<10	µg/l
CHROMIUM	<10	µg/l
ZINC	<10	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	12707	µg/l
BORON, TOTAL	0.606	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	<1	µg/l
T.H.M, TOTAL	<4.0	µg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

for The Water Quality Centre
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Certificate of Analysis.

Mr David Hawley
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Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100340/C007781
Tag Number : 00202670

Sample Description : BH9 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.6	NIL U
CONDUCTIVITY AT 20°C	1727	µSM/cm
COD	184.0	mg/l
AMMONIACAL NITROGEN	69.20	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.1	mg/l
CHLORIDE AS Cl	118	mg/l
SULPHATE AS SO_4	65.6	mg/l
ALKALINITY AS $CaCO_3$	724	mg/l
CALCIUM, TOTAL	187	mg/l
SODIUM, TOTAL	71.7	mg/l
POTASSIUM, TOTAL	40.1	mg/l
MAGNESIUM, TOTAL	18.6	mg/l
COPPER	<10	µg/l
NICKEL	<10	µg/l
CHROMIUM	10	µg/l
ZINC	<10	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	17599	µg/l
BORON, TOTAL	0.760	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	2	µg/l
T.H.M, TOTAL	<4.0	µg/l

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for The Water Quality Centre
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Certificate of Analysis.

Mr David Hawley
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Waste Management Section
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Oxon, OX1 1NE

Reference:A100340/C007782
Tag Number : 00202671

Sample Description : BH11 Suite OCC2/3/4
Sample Site : Port Meadow
Date Received : 20.08.92
Date of Sample : not specified
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	1235	µSM/cm
COD	44.0	mg/l
AMMONIACAL NITROGEN	24.90	mg/l
NITROGEN, TOTAL OXIDISED AS N	0.2	mg/l
CHLORIDE AS Cl	102	mg/l
SULPHATE AS SO_4	85.7	mg/l
ALKALINITY AS $CaCO_3$	452	mg/l
CALCIUM, TOTAL	159	mg/l
SODIUM, TOTAL	73.0	mg/l
POTASSIUM, TOTAL	25.6	mg/l
MAGNESIUM, TOTAL	12.2	mg/l
COPPER	<10	µg/l
NICKEL	<10	µg/l
CHROMIUM	<10	µg/l
ZINC	<10	µg/l
CADMIUM	<0.5	µg/l
MERCURY	<0.10	µg/l
IRON	1758	µg/l
BORON, TOTAL	0.570	mg/l
LEAD	<5	µg/l
CHLOROFORM	<1	µg/l
BROMOFORM	<1	µg/l
BROMODICHLOROMETHANE	<1	µg/l
DIBROMOCHLOROMETHANE	<1	µg/l
TRICHLOROETHANE (1,1,1)	<1	µg/l
CARBON TETRACHLORIDE	<0.3	µg/l
TETRACHLOROETHENE (ALIAS 7792)	<1	µg/l
TRICHLOROETHENE	2	µg/l
T.H.M, TOTAL	<4.0	µg/l

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for The Water Quality Centre
Date of Issue: 4 September 1992

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NAMAS TESTING

OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING REPORT SHEET

Site name: Port Meadow
Date sampled: 12/02/93 **Sampled by:** David Hawley
Date of results: 24/02/93

Bailed groundwater samples were taken from all boreholes and analysed for the full suite of inorganic determinands.
Groundwater levels relative to ordnance datum were also recorded.
In all boreholes Ammonia levels are significantly elevated above assumed natural background concentrations and guidelines contained in the Water Quality Regs. 1989, ranging from 1.3 mg/l at BH3 to 144.3 mg/l at BH11. Levels for Chemical Oxygen Demand are also high ranging from 169 - 190 mg/l at BH's 7,9 & 11.

This site is located on the Thames floodplain and was designed on the dilute and disperse principle, therefore it is not unexpected that there is contamination immediately surrounding the landfill.
The principle is that the small volume of leachate produced by the landfill will be afforded adequate dilution by the much larger volume of water present in the aquifer.
Leachate will continue to be generated until there is no more biodegradable waste left.
Groundwater levels have increase by a maximum of 0.5m since the the previous visit made in August 1992.
There is virtually no groundwater gradient but what there is would indicate a flow direction toward the Thames.

THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012145
Tag Number :00294016

Sample Description : BH1 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	7.0	NIL U
CONDUCTIVITY AT 20°C	1178	µSM/cm
COD	39.0	mg/l
AMMONIACAL NITROGEN	18.200	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	69	mg/l
SULPHATE AS SO_4	157.2	mg/l
ALKALINITY AS $CaCO_3$	692	mg/l
CALCIUM	107	mg/l
SODIUM	68.8	mg/l
POTASSIUM	13.8	mg/l
MAGNESIUM	14.7	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

for The Water Quality Centre
Date of Issue: 24 February 1993

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NAMAS TESTING

THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012141
Tag Number :00294018

Sample Description : BH3 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.7	NIL U
CONDUCTIVITY AT 20°C	783	µSM/cm
COD	21.0	mg/l
AMMONIACAL NITROGEN	1.300	mg/l
NITROGEN, TOTAL OXIDISED AS N	1.1	mg/l
CHLORIDE AS CL	9	mg/l
SULPHATE AS SO_4	60.0	mg/l
ALKALINITY AS $CaCO_3$	490	mg/l
CALCIUM	147	mg/l
SODIUM	7.8	mg/l
POTASSIUM	5.6	mg/l
MAGNESIUM	6.3	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

for The Water Quality Centre
Date of Issue: 24 February 1993

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NAMAS
TESTING
No. 0677

THE WATER QUALITY CENTRE

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Tel : 0734 236222. Fax : 0734 756573.

Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012142
Tag Number :00294019

Sample Description : BH5 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	2220	µSM/cm
COD	60.0	mg/l
AMMONIACAL NITROGEN	37.000	mg/l
NITROGEN, TOTAL OXIDISED AS N	31.2	mg/l
CHLORIDE AS CL	93	mg/l
SULPHATE AS SO_4	735.5	mg/l
ALKALINITY AS $CaCO_3$	552	mg/l
CALCIUM	318	mg/l
SODIUM	65.5	mg/l
POTASSIUM	43.2	mg/l
MAGNESIUM	35.1	mg/l

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for The Water Quality Centre
Date of Issue: 24 February 1993

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NAMAS
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THE WATER QUALITY CENTRE

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012144
Tag Number :00294020

Sample Description : BH7 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.9	NIL U
CONDUCTIVITY AT 20°C	1907	µSM/cm
COD	190.0	mg/l
AMMONIACAL NITROGEN	75.500	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	95	mg/l
SULPHATE AS SO_4	70.0	mg/l
ALKALINITY AS $CaCO_3$	1001	mg/l
CALCIUM	136	mg/l
SODIUM	56.3	mg/l
POTASSIUM	35.9	mg/l
MAGNESIUM	26.9	mg/l

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No. 0677

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Certificate of Analysis.

Mr David Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012143
Tag Number :00294021

Sample Description : BH9 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	7.2	NIL U
CONDUCTIVITY AT 20°C	2430	µSM/cm
COD	169.0	mg/l
AMMONIACAL NITROGEN	121.000	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	87	mg/l
SULPHATE AS SO_4	178.9	mg/l
ALKALINITY AS $CaCO_3$	1095	mg/l
CALCIUM	173	mg/l
SODIUM	49.4	mg/l
POTASSIUM	38.9	mg/l
MAGNESIUM	28.3	mg/l

Note - details of the individual methods of analysis and performance characteristics are available upon request from our laboratories.

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Date of Issue: 24 February 1993

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Certificate of Analysis.

Mr David Hawley
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Waste Management Section
Speedwell House
Oxon, OX1 1NE

Reference:A100638/C012146
Tag Number :00294022

Sample Description : BH11 Suite OCC2
Sample Site : Port Meadow
Date Received : 12.02.93
Date of Sample : 12.02.93
Time of Sample : not specified
Sampled By : Client

RESULTS.

Determinand	Result	Units
pH VALUE	6.8	NIL U
CONDUCTIVITY AT 20°C	2420	µSM/cm
COD	185.0	mg/l
AMMONIACAL NITROGEN	144.300	mg/l
NITROGEN, TOTAL OXIDISED AS N	<1.0	mg/l
CHLORIDE AS CL	95	mg/l
SULPHATE AS SO_4	45.3	mg/l
ALKALINITY AS $CaCO_3$	1150	mg/l
CALCIUM	168	mg/l
SODIUM	64.2	mg/l
POTASSIUM	56.4	mg/l
MAGNESIUM	23.1	mg/l

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Date of Issue: 24 February 1993

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NAMAS
TESTING
No. 0677

OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING RECORD SHEET

SITE NAME: Port Meadow				SAMPLED BY: D.HAWLEY	
DATE SAMPLED: 12/02/93					
MONITORING POINT		*GROUNDWATER/LEACHATE*			
REF No.	COVER LEVEL m.A.O.D.	DEPTH B.C.L.	LEVEL m.A.O.D.	ANALYSIS SUITE	OBSERVATIONS
B[redacted]	58.37	01.07	57.30	OCC2	
BH3	60.62	03.23	57.39	OCC2	
BH5	59.78	02.48	57.30	OCC2	
BH7	60.75	03.35	57.40	OCC2	
BH9	62.01	04.00	58.01	OCC2	
BH11	60.76	03.33	57.43	OCC2	

KEY
OCC1 - BASIC INORGANIC SUITE, OCC2 - FULL INORGANIC SUITE
OCC3 - SELECTED METALS, OCC4 - VOLATILE ORGANICS
B.C.L.- BELOW COVER LEVEL
A.O.D. - ABOVE ORDNANCE DATUM

OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING RECORD SHEET

SITE NAME: Port Meadow	**SAMPLED BY:** D.HAWLEY
DATE SAMPLED: 11/06/93	

MONITORING POINT		GROUNDWATER/LEACHATE			
REF No.	COVER LEVEL m.A.O.D.	DEPTH B.C.L.	LEVEL m.A.O.D.	ANALYSIS SUITE	OBSERVATIONS
BH1	58.37	01.32	57.05	OCC2/3/4	All boreholes pumped
BH3	60.62	03.54	57.08	OCC2/3/4	for 10 mins. and then
BH5	59.78	02.73	57.05	OCC2/3/4	sampled.
BH7	60.75	03.60	57.15	OCC2/3/4	All samples taken
BH9	62.01	04.45	57.56	OCC2/3/4	clearly contaminated.
BH11	60.76	03.62	57.14	OCC2/3/4	

KEY
OCC1 - BASIC INORGANIC SUITE, OCC2 - FULL INORGANIC SUITE
OCC3 - SELECTED METALS, OCC4 - VOLATILE ORGANICS
B.C.L.- BELOW COVER LEVEL
A.O.D. - ABOVE ORDNANCE DATUM

THE WATER QUALITY CENTRE | *analysis*
[part of Thames Water Laboratories]

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Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015626
Tag No : 00334359
Date Received : 11.06.93

Sample Description : BH1, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

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pH Value, NIL/U	6.9
Conductivity at 20°C, µS/cm	1702
COD, mg/l	58.0
Ammoniacal Nitrogen, mg/l	50.900
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as Cl, mg/l	122
Sulphate as SO_4, mg/l	81.6
Alkalinity as $CaCO_3$, mg/l	822
Calcium, mg/l	128
Sodium, mg/l	93.8
Potassium, mg/l	38.6
Magnesium, mg/l	29.9
Copper, µg/l	<10
Nickel, µg/l	7
Chromium, µg/l	<5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	1541
Boron, mg/l	2.196
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	5.0
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

NOTES :
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3. The analytical results given in this report were obtained in the Spencer House, Reading Laboratories of Thames Water Utilities Limited.

THE WATER QUALITY CENTRE | *analysis*
[part of Thames Water Laboratories]

Spencer House
Manor Farm Road
Reading
Berks RG2 0JN
Tel 0734 236222
Fax 0734 756573

Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015627
Tag No : 00334360
Date Received : 11.06.93

Sample Description : BH3, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

---

pH Value, NIL/U	6.6
Conductivity at 20°C, µS/cm	1252
COD, mg/l	69.1
Ammoniacal Nitrogen, mg/l	16.000
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as Cl, mg/l	41
Sulphate as SO_4, mg/l	134.2
Alkalinity as $CaCO_3$, mg/l	706
Calcium, mg/l	188
Sodium, mg/l	33.2
Potassium, mg/l	16.8
Magnesium, mg/l	14.0
Copper, µg/l	<10
Nickel, µg/l	5
Chromium, µg/l	<5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	8567
Boron, mg/l	0.688
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

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Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015624
Tag No : 00334361
Date Received : 11.06.93

Sample Description : BH5, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

pH Value, NIL/U	7.0
Conductivity at 20°C, µS/cm	1902
COD, mg/l	77.0
Ammoniacal Nitrogen, mg/l	66.100
Nitrogen, Total Oxidised as N, mg/l	7.2
Chloride as Cl, mg/l	107
Sulphate as SO_4, mg/l	269.3
Alkalinity as $CaCO_3$, mg/l	586
Calcium, mg/l	143
Sodium, mg/l	97.5
Potassium, mg/l	50.7
Magnesium, mg/l	36.8
Copper, µg/l	<10
Nickel, µg/l	10
Chromium, µg/l	<5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	145
Boron, mg/l	1.969
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

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THE WATER QUALITY CENTRE | analysis
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Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015623
Tag No : 00334362
Date Received : 11.06.93

Sample Description : BH7, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

pH Value, NIL/U	6.9
Conductivity at 20°C, µS/cm	1399
COD, mg/l	96.0
Ammoniacal Nitrogen, mg/l	43.500
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as Cl, mg/l	100
Sulphate as SO_4, mg/l	62.6
Alkalinity as $CaCO_3$, mg/l	534
Calcium, mg/l	136
Sodium, mg/l	65.0
Potassium, mg/l	30.7
Magnesium, mg/l	24.1
Copper, µg/l	<10
Nickel, µg/l	<5
Chromium, µg/l	<5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	13982
Boron, mg/l	0.679
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

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THE WATER QUALITY CENTRE | *analysis*
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Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015622
Tag No : 00334363
Date Received : 11.06.93

Sample Description : BH9, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

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pH Value, NIL/U	6.8
Conductivity at 20°C, µS/cm	1791
COD, mg/l	144.0
Ammoniacal Nitrogen, mg/l	74.300
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as Cl, mg/l	121
Sulphate as SO_4, mg/l	75.5
Alkalinity as $CaCO_3$, mg/l	741
Calcium, mg/l	164
Sodium, mg/l	65.6
Potassium, mg/l	35.0
Magnesium, mg/l	21.9
Copper, µg/l	<10
Nickel, µg/l	5
Chromium, µg/l	<5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	24460
Boron, mg/l	0.745
Lead, µg/l	7
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

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Certificate of analysis

Mr D Hawley
Oxfordshire County Council
Waste Management Section
Speedwell House
Speedwell Street
Oxford OX1 1NE

Reference : A100947/C015625
Tag No : 00334364
Date Received : 11.06.93

Sample Description : BH11, Suite OCC2/3/4
Sample Site : Port Meadow
Sampled By : Client

Date of Sample : 11.06.93
Time of Sample : not specified

---

pH Value, NIL/U	6.8
Conductivity at 20°C, µS/cm	2070
COD, mg/l	115.0
Ammoniacal Nitrogen, mg/l	94.100
Nitrogen, Total Oxidised as N, mg/l	<1.0
Chloride as Cl, mg/l	126
Sulphate as SO_4, mg/l	73.5
Alkalinity as $CaCO_3$, mg/l	876
Calcium, mg/l	166
Sodium, mg/l	80.6
Potassium, mg/l	45.2
Magnesium, mg/l	21.0
Copper, µg/l	<10
Nickel, µg/l	<5
Chromium, µg/l	5
Zinc, µg/l	<30
Cadmium, µg/l	<0.5
Mercury, µg/l	<0.05
Iron, µg/l	23700
Boron, mg/l	1.169
Lead, µg/l	<5
Chloroform, µg/l	<2.5
Bromoform, µg/l	<2.5
Bromodichloromethane, µg/l	<2.5
Dibromochloromethane, µg/l	<2.5
Trichloroethane (1,1,1), µg/l	<1
Carbon Tetrachloride, µg/l	<0.3
Tetrachloroethene, µg/l	<1.0
Trichloroethene, µg/l	<2.5
T.H.M Total, µg/l	0

for The Water Quality Centre
Date of Issue: 23 June 1993

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OXFORDSHIRE COUNTY COUNCIL
WATER MONITORING REPORT SHEET

Site Name:Port Meadow
Date sampled:11/06/93 **Sampled by:D.Hawley**
Date of results:28/06/93

All boreholes were pumped for 10 mins. prior to sampling.

INORGANICS (OCC2)
All samples taken show contamination by landfill leachate.
The greatest contamination is evident in boreholes 9 & 11 located on the eastern boundary of the site.

		BH9	BH11	Estimated background conc.
Conductivity	us/cm	1791	2070	<1000
Chemical Oxygen Demand	mg/l	144	115	<50
Ammonia	mg/l	74.3	94.1	<1
Chloride	mg/l	121	126	<50
Sodium	mg/l	65.6	80.6	<20
Potassium	mg/l	35	45.2	<10
Magnesium	mg/l	21.9	21	<10

SELECTED METALS (OCC3)
Only Iron is present at levels exceeding guidelines (Water Quality Regs. 1989).
Level of Iron in BH9 (mg/l) : 24.460
Guideline level : 00.300

ORGANICS (OCC4)
Only in the sample taken from borehole 1 , was a parameter included in the OCC4 analytical suite , to be found.
This reproduces the result obtained from the previous visit for which organics were sampled.

BH1	20/08/92	11/06/93	Guideline Level 1989 Water Quality Regs
Trichloroethene (ug/l)	2	5	30

Recommendations
A second line of boreholes (west of the established boreholes) to be located on the Thames floodplain to ascertain the level of dilution afforded by the gravel aquifer.

INORGANICS (OCC2)	ORGANICS (OCC4)	METALS (OCC3)
pH	T.H.M (TOTAL)	COPPER
CONDUCTIVITY	CHLOROFORM	NICKEL
CHEMICAL OXYGEN DEMAND	BROMOFORM	CHROMIUM
AMMONIA	BROMODICHLOROMETHANE	ZINC
CHLORIDE	DIBROMOCHLOROMETHANE	CADMIUM
NITRATE	TRICHLOROETHANE	MERCURY
SULPHATE	CARBON TETRACHLORIDE	IRON
ALKALINITY	TETRACHLOROETHENE	BORON
CALCIUM	TRICHLOROETHENE	LEAD
SODIUM		
POTASSIUM		
MAGNESIUM		

Oxfordshire County Council

Memorandum *From:* P. PEARCE *To:* FILE

My Reference	Your Reference	Internal Tel:	Date
			30/4/1993

NOTE FOR FILE

UNABLE TO LOCATE G12 OR G13

ON 26/11/1993.

Test report

TEST REPORT NUMBER TH/000422/94

PAGE 1 OF 1

LAB. SAMPLE NUMBER 102308/ 3

NAMAS TESTING No. 1314

Severn Trent Laboratories
COVENTRY LABORATORY
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS LANDFILL MONITORING LTD
Vulcan House
Vulcan Road
Solihull
B91 2JY

Sample date : 17/06/94 Sample received : 20/06/94 Page : 4
Description : PORT MEADOW BH11

Analytical Results

Determinand	Result	Units
pH	6.7	
D.O. concentration	1.9	mg/l
Conductivity- Electrical 25deg	2630	uS/cm
C.O.D. (Total)	111	mg/l
Ammoniacal Nitrogen as N	114	mg/l
Nitrogen, Total Oxidised as N	Less than 0.3	mg/l
Chloride as Cl	121	mg/l
Sulphate as SO4	13	mg/l
Alkalinity as CaCO3	1230	mg/l
Potassium as K	75.0	mg/l
Magnesium as Mg	34	mg/l
Calcium as Ca	209	mg/l
Copper, Total as Cu	30	ug/l
Nickel, Total as Ni	17	ug/l
Chromium, Total as Cr	9	ug/l
Zinc, Total as Zn	50	ug/l
Cadmium, Total as Cd	Less than 1.0	ug/l
Manganese as Mn	340	ug/l
Iron as Fe	27400	ug/l
Lead, Total as Pb	Less than 10	ug/l
Boron as B	1470	ug/l

Analyst Comments :

INORGANIC ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED B.J.Gale NAME BEVERLEY GALE DATE 30/06/94

Test report

TEST REPORT NUMBER TH/000422/94

PAGE 1 OF 1

LAB. SAMPLE NUMBER 102307/ 2

NAMAS TESTING No. 1314

Severn Trent Laboratories
COVENTRY LABORATORY
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS LANDFILL MONITORING LTD
Vulcan House
Vulcan Road
Solihull
B91 2JY

Sample date : 17/06/94 Sample received : 20/06/94 Page : 3
Description : PORT MEADOW BH7

Analytical Results

Determinand	Result	Units
pH	6.9	
D.O. concentration	1.4	mg/l
Conductivity- Electrical 25deg	1770	uS/cm
C.O.D. (Total)	67	mg/l
Ammoniacal Nitrogen as N	53.5	mg/l
Nitrogen, Total Oxidised as N	Less than 0.3	mg/l
Chloride as Cl	92	mg/l
Sulphate as SO4	47	mg/l
Alkalinity as CaCO3	866	mg/l
Potassium as K	42.3	mg/l
Magnesium as Mg	33	mg/l
Calcium as Ca	177	mg/l
Copper, Total as Cu	30	ug/l
Nickel, Total as Ni	13	ug/l
Chromium, Total as Cr	9	ug/l
Zinc, Total as Zn	80	ug/l
Cadmium, Total as Cd	Less than 1.0	ug/l
Manganese as Mn	200	ug/l
Iron as Fe	18900	ug/l
Lead, Total as Pb	50	ug/l
Boron as B	800	ug/l

Analyst Comments :

ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED B. J. Gale NAME BEVERLEY GALE DATE 30/06/94

Test report

TEST REPORT NUMBER TH/000422/94

PAGE 1 OF 1

LAB. SAMPLE NUMBER 102306/ 1

NAMAS TESTING No. 1314

Severn Trent Laboratories
COVENTRY LABORATORY
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS LANDFILL MONITORING LTD
Vulcan House
Vulcan Road
Solihull
B91 2JY

Sample date : 17/06/94 Sample received : 20/06/94 Page : 2
Description : PORT MEADOW BH1

Analytical Results

Determinand	Result	Units
pH	6.7	
D.O. concentration	1.7	mg/l
Conductivity- Electrical 25deg	1890	uS/cm
C.O.D. (Total)	34	mg/l
Ammoniacal Nitrogen as N	53.6	mg/l
Nitrogen, Total Oxidised as N	Less than 0.3	mg/l
Chloride as Cl	143	mg/l
Sulphate as SO4	85	mg/l
Alkalinity as CaCO3	886	mg/l
Potassium as K	50.3	mg/l
Magnesium as Mg	39	mg/l
Calcium as Ca	173	mg/l
Copper, Total as Cu	40	ug/l
Nickel, Total as Ni	22	ug/l
Chromium, Total as Cr	6	ug/l
Zinc, Total as Zn	130	ug/l
Cadmium, Total as Cd	Less than 1.0	ug/l
Manganese as Mn	3200	ug/l
Iron as Fe	2400	ug/l
Lead, Total as Pb	Less than 10	ug/l
Boron as B	2490	ug/l

Analyst Comments :

ANALYSIS CARRIED OUT AT BIRMINGHAM LABORATORY.

SIGNED B.J. Cole NAME BEVERLEY GALE DATE 30/06/94

Ground Water Monitoring

Site: ~~Eyres Lane~~ Port Meadow

Operatives: Graham White and Carl Branch

Number of well volumes to purge: 2

Sample Route: R13

Borehole ref	Date (dd:mm:yy)	Borehole Depth (m)	Liquid Depth (m)	Electrical Cond (µS/cm)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	pH	Temp (^{0}C)	Smell	Comments
GBH 1	17/06/94	4.32	1.54	1592		1.1	7.1	12.6		Murky Brown
JF GBH 3	17/06/94	6.1	3.7	1494		1.2	6.95	12.9	Yes	Cloudy grey Leachate odour
GBH 5	17/06/94	5.4	2.7	2060		1.6	6.83	13.9	Yes	Cloudy grey Leachate odour

Compiled By: Carl Branch

Checked by:

December 1994

Ground Water Monitoring

Site: Port Meadow

Operatives: C. Branch and G. White

Number of well volumes to purge: 2

Sample Route: R13

Borehole ref	Date (dd:mm:yy)	Borehole Depth (m)	Liquid Depth (m)	Liquid Depth AOD (m)	Electrical Cond (µS/cm)	Dissolved Oxygen (%)	Dissolved Oxygen (mg/l)	pH	Temp (^{0}C)	Smell	Comments
GBH 1	09/12/94	4.35	1.13	57.24	1350		3.2	7.58	11.5	No	Clear
GBH 3	09/12/94	5.09	2.89	57.43	640		2.1	8.12	10.5	Yes	Clear, slight leachate odour
GBH 5	09/12/94	5.60	2.39	57.39	1990		1.5	7.29	13.6	No	Clear
GBH 7	09/12/94	5.80	3.26	57.49	1640		1.4	7.24	13.1	Yes	Clear, leachate odour
GBH 9	09/12/94	5.24	3.84	58.17	1610		1.2	7.14	12.9	Yes	Cloudy, leachate odour
GBH 11	09/12/94	5.35	3.30	57.46	1730		1.2	7.25	12.7	Yes	Cloudy, leachate odour. Loose cover

Compiled By: Carl Branch

Checked by:

Test report

TEST REPORT NUMBER TH/ 5802/94

PAGE 2 OF 20

LAB. SAMPLE NUMBER 132250

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 1

Lab	Determinand name	Result	Units
B	pH	6.7	
W	D.O. concentration	1.5	mg/l
B	Conductivity- Electrical 25deg	1690	uS/cm
W	C.O.D. (Total)	40	mg/l
B	Ammoniacal Nitrogen as N	37.0	mg/l
B	Nitrogen, Total Oxidised as N	5.8	mg/l
B	Chloride as Cl	93	mg/l
B	Sulphate as SO4	98	mg/l
B	Alkalinity as CaCO3	557	mg/l
B	Potassium as K	38.9	mg/l
B	Magnesium as Mg	32	mg/l
B	Calcium as Ca	163	mg/l
B	Copper, Total as Cu	20	ug/l
B	Nickel, Total as Ni	10	ug/l
B	Chromium, Total as Cr	<5	ug/l
B	Zinc, Total as Zn	40	ug/l
B	Cadmium, Total as Cd	<1.0	ug/l
B	Manganese as Mn	2000	ug/l
B	Iron as Fe	800	ug/l
B	Lead, Total as Pb	<10	ug/l
B	Boron as B	1700	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132250 complete

Test report

TEST REPORT NUMBER TH/ 5802/94

PAGE 3 OF 20

LAB. SAMPLE NUMBER 132251

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 3

Lab	Determinand name	Result	Units
B	pH	6.4	
W	D.O. concentration	1.3	mg/l
B	Conductivity- Electrical 25deg	708	uS/cm
W	C.O.D. (Total)	31	mg/l
B	Ammoniacal Nitrogen as N	0.9	mg/l
B	Nitrogen, Total Oxidised as N	<0.3	mg/l
B	Chloride as Cl	8	mg/l
B	Sulphate as SO4	59	mg/l
B	Alkalinity as CaCO3	246	mg/l
B	Potassium as K	6.3	mg/l
B	Magnesium as Mg	6	mg/l
B	Calcium as Ca	132	mg/l
B	Copper, Total as Cu	<20	ug/l
B	Nickel, Total as Ni	<7	ug/l
B	Chromium, Total as Cr	<5	ug/l
B	Zinc, Total as Zn	40	ug/l
B	Cadmium, Total as Cd	<1.0	ug/l
B	Manganese as Mn	100	ug/l
B	Iron as Fe	1000	ug/l
B	Lead, Total as Pb	<10	ug/l
B	Boron as B	<100	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132251 complete

Test report

TEST REPORT NUMBER TH/ 5802/94

PAGE 4 OF 20

LAB. SAMPLE NUMBER 132252

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 5

Lab	Determinand name	Result	Units
B	pH	6.7	
W	D.O. concentration	0.7	mg/l
B	Conductivity- Electrical 25deg	2680	uS/cm
W	C.O.D. (Total)	48	mg/l
B	Ammoniacal Nitrogen as N	68.6	mg/l
B	Nitrogen, Total Oxidised as N	3.2	mg/l
B	Chloride as Cl	89	mg/l
B	Sulphate as SO4	439	mg/l
B	Alkalinity as CaCO3	638	mg/l
B	Potassium as K	64.8	mg/l
B	Magnesium as Mg	56	mg/l
B	Calcium as Ca	215	mg/l
B	Copper, Total as Cu	20	ug/l
B	Nickel, Total as Ni	21	ug/l
B	Chromium, Total as Cr	<5	ug/l
B	Zinc, Total as Zn	30	ug/l
B	Cadmium, Total as Cd	4.3	ug/l
B	Manganese as Mn	1000	ug/l
B	Iron as Fe	300	ug/l
B	Lead, Total as Pb	<10	ug/l
B	Boron as B	2300	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132252 complete

Test report

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

TEST REPORT NUMBER TH/ 5802/94

PAGE 5 OF 20

LAB. SAMPLE NUMBER 132253

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 7

Lab	Determinand name	Result	Units
B	pH	6.5	
W	D.O. concentration	<0.5	mg/l
B	Conductivity- Electrical 25deg	2200	uS/cm
W	C.O.D. (Total)	78	mg/l
B	Ammoniacal Nitrogen as N	53.2	mg/l
B	Nitrogen, Total Oxidised as N	<0.3	mg/l
B	Chloride as Cl	72	mg/l
B	Sulphate as SO4	64	mg/l
B	Alkalinity as CaCO3	770	mg/l
B	Potassium as K	35.5	mg/l
B	Magnesium as Mg	31	mg/l
B	Calcium as Ca	230	mg/l
B	Copper, Total as Cu	30	ug/l
B	Nickel, Total as Ni	10	ug/l
B	Chromium, Total as Cr	<5	ug/l
B	Zinc, Total as Zn	50	ug/l
B	Cadmium, Total as Cd	<1.0	ug/l
B	Manganese as Mn	300	ug/l
B	Iron as Fe	23000	ug/l
B	Lead, Total as Pb	12	ug/l
B	Boron as B	800	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132253 complete

Test report

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

TEST REPORT NUMBER TH/ 5802/94

PAGE 6 OF 20

LAB. SAMPLE NUMBER 132254

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 9

Lab	Determinand name	Result	Units
B	pH	6.6	
W	D.O. concentration	<0.5	mg/l
B	Conductivity- Electrical 25deg	2160	uS/cm
W	C.O.D. (Total)	87	mg/l
B	Ammoniacal Nitrogen as N	46.5	mg/l
B	Nitrogen, Total Oxidised as N	<0.3	mg/l
B	Chloride as Cl	83	mg/l
B	Sulphate as SO4	135	mg/l
B	Alkalinity as CaCO3	698	mg/l
B	Potassium as K	33.6	mg/l
B	Magnesium as Mg	28	mg/l
B	Calcium as Ca	250	mg/l
B	Copper, Total as Cu	30	ug/l
B	Nickel, Total as Ni	40	ug/l
B	Chromium, Total as Cr	40	ug/l
B	Zinc, Total as Zn	90	ug/l
B	Cadmium, Total as Cd	<1.0	ug/l
B	Manganese as Mn	600	ug/l
B	Iron as Fe	23000	ug/l
B	Lead, Total as Pb	13	ug/l
B	Boron as B	700	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132254 complete

Test report

TEST REPORT NUMBER TH/ 5802/94

PAGE 7 OF 20

LAB. SAMPLE NUMBER 132255

NAMAS TESTING No. 0691 No. 0861 No. 1314

Severn Trent Laboratories
TORRINGTON AVENUE
COVENTRY
CV4 9GU
TELEPHONE: 0203 692692
TELEFAX: 0203 421423

ARGUS Landfill Monitoring Ltd

Sample Dated : 08-Dec-1994
Sample Received : 09-Dec-1994
Analysis Commenced: 09-Dec-1994

Sample Description :
PORT MEADOW GBH 11

Lab	Determinand name	Result	Units
B	pH	6.5	
W	D.O. concentration	<0.5	mg/l
B	Conductivity- Electrical 25deg	2230	uS/cm
W	C.O.D. (Total)	101	mg/l
B	Ammoniacal Nitrogen as N	70.8	mg/l
B	Nitrogen, Total Oxidised as N	<0.3	mg/l
B	Chloride as Cl	83	mg/l
B	Sulphate as SO4	54	mg/l
B	Alkalinity as CaCO3	755	mg/l
B	Potassium as K	42.6	mg/l
B	Magnesium as Mg	21	mg/l
B	Calcium as Ca	210	mg/l
B	Copper, Total as Cu	<20	ug/l
B	Nickel, Total as Ni	22	ug/l
B	Chromium, Total as Cr	<5	ug/l
B	Zinc, Total as Zn	40	ug/l
B	Cadmium, Total as Cd	<1.0	ug/l
B	Manganese as Mn	300	ug/l
B	Iron as Fe	21000	ug/l
B	Lead, Total as Pb	<10	ug/l
B	Boron as B	900	ug/l

Lab C = Finham; Lab W = Birmingham

sample 132255 complete

Appendix C Plots of groundwater levels in monitoring boreholes in Burgess Field waste dump

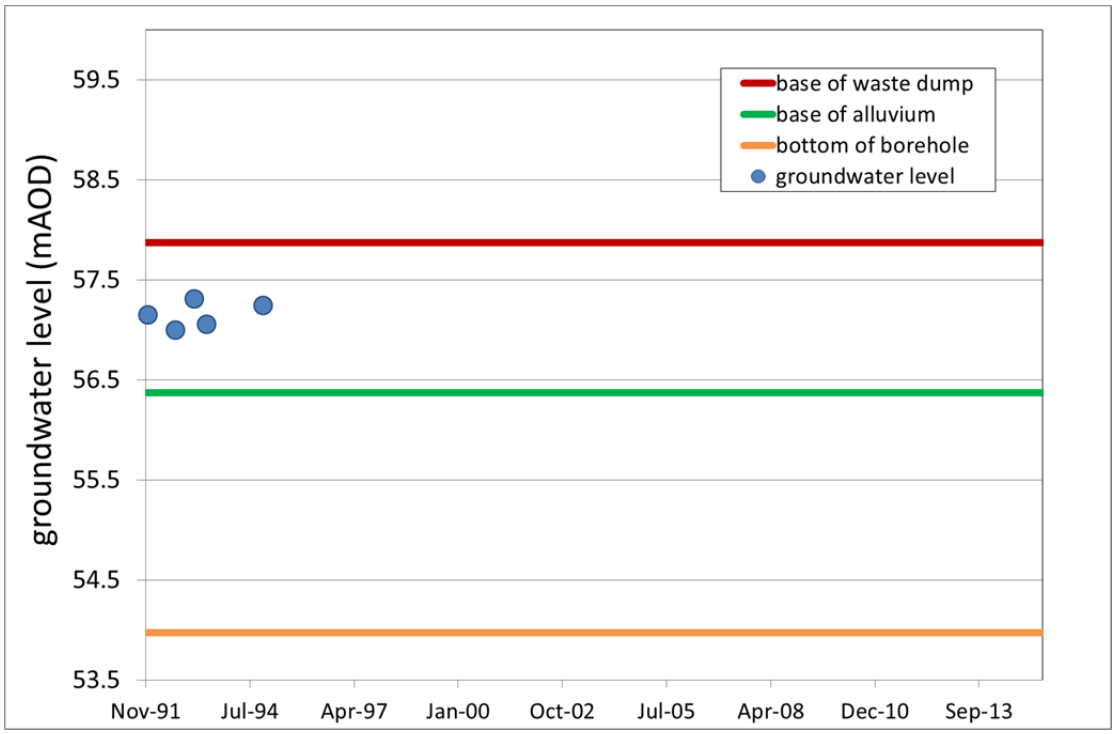

Figure C1 Groundwater levels in monitoring borehole GBH1 in Burgess Field waste dump

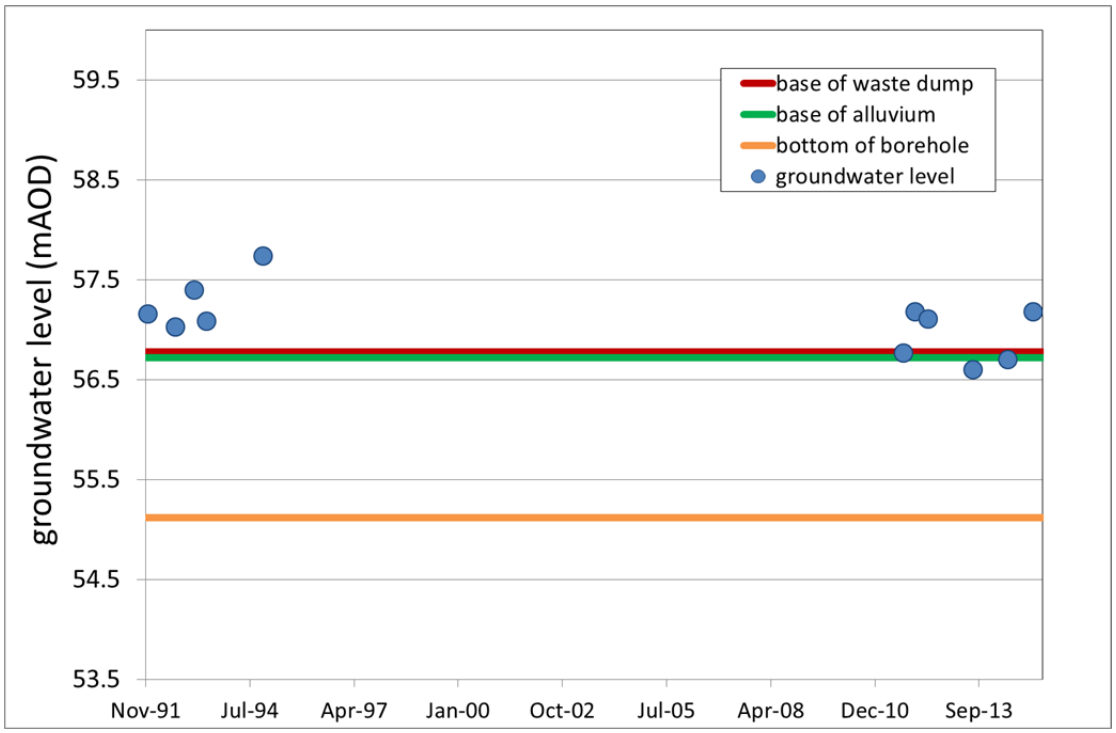

Figure C2 Groundwater levels in monitoring borehole GBH3 in Burgess Field waste dump

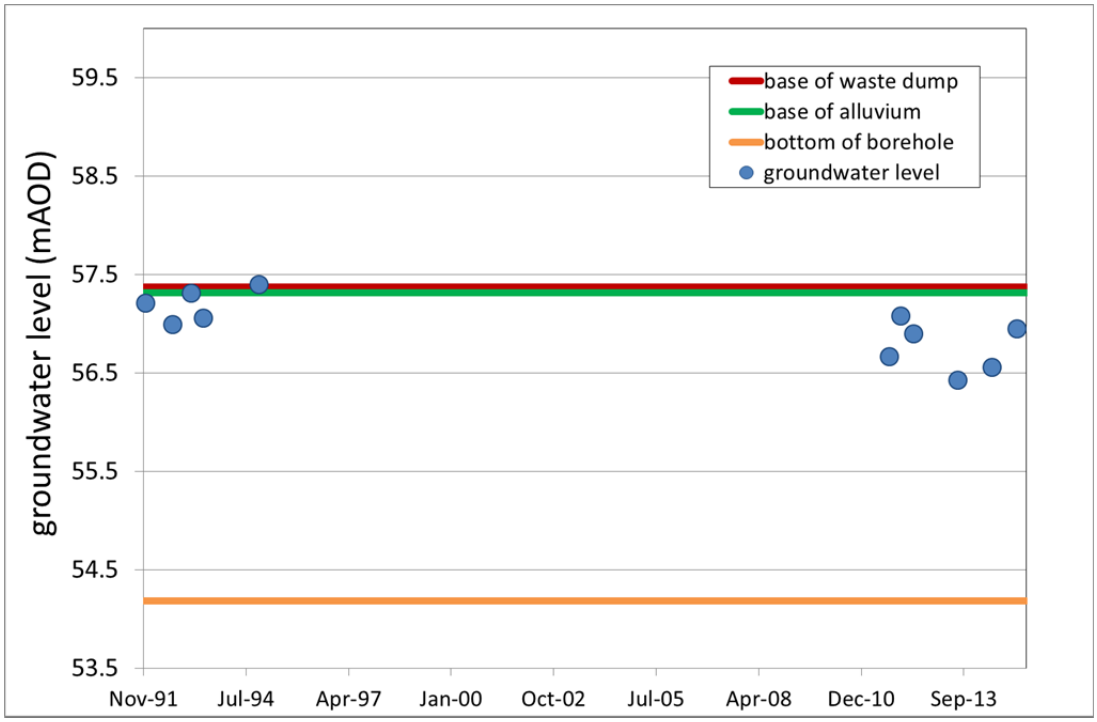

Figure C3 Groundwater levels in monitoring borehole GBH5 in Burgess Field waste dump

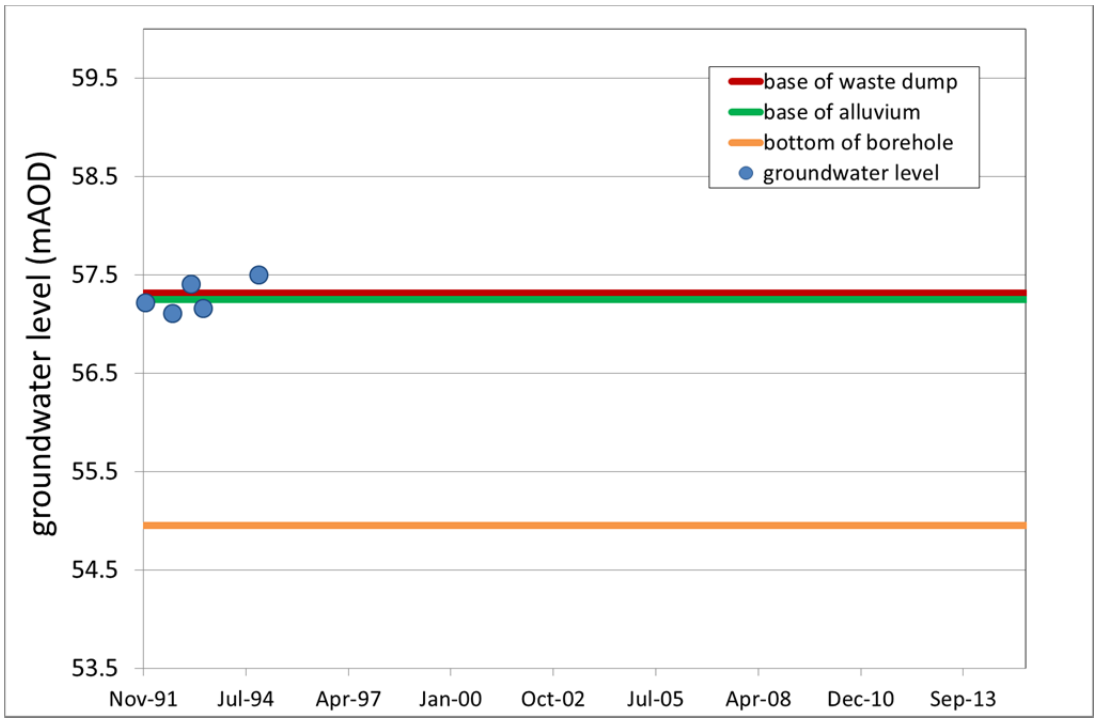

Figure C4 Groundwater levels in monitoring borehole GBH7 in Burgess Field waste dump

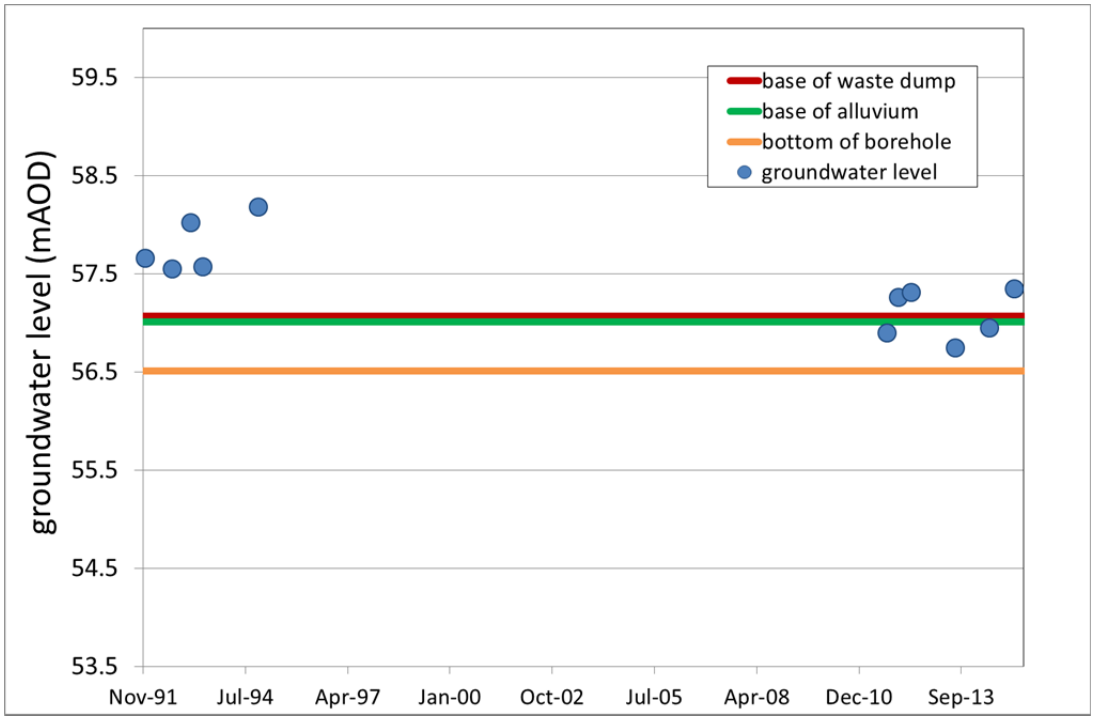

Figure C5 Groundwater levels in monitoring borehole GBH9 in Burgess Field waste dump

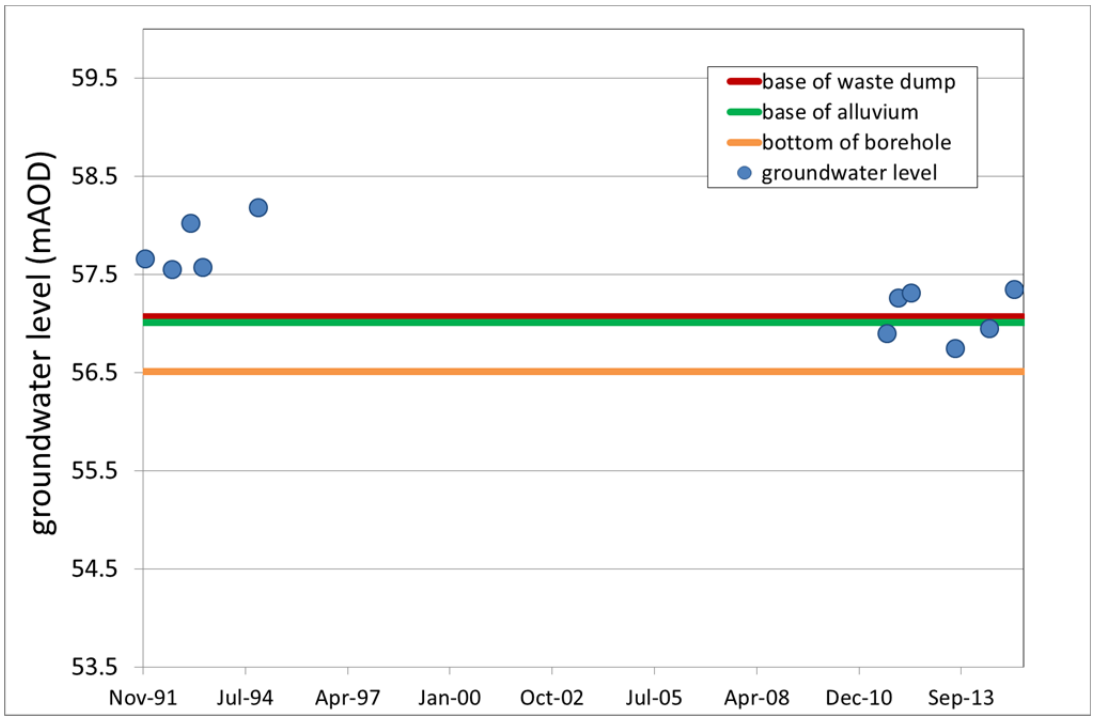

Figure C6 Groundwater levels in monitoring borehole GBH11 in Burgess Field waste dump

Appendix D Burgess field Landfill Gas concentration with time graphs

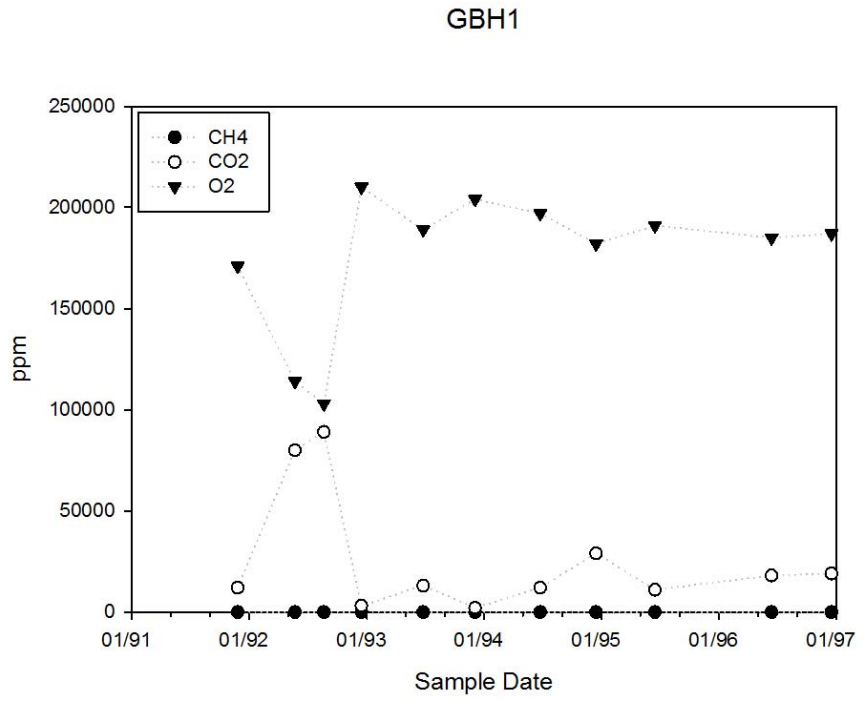

Figure D1 GBH1 landfill gas concentrations time series.

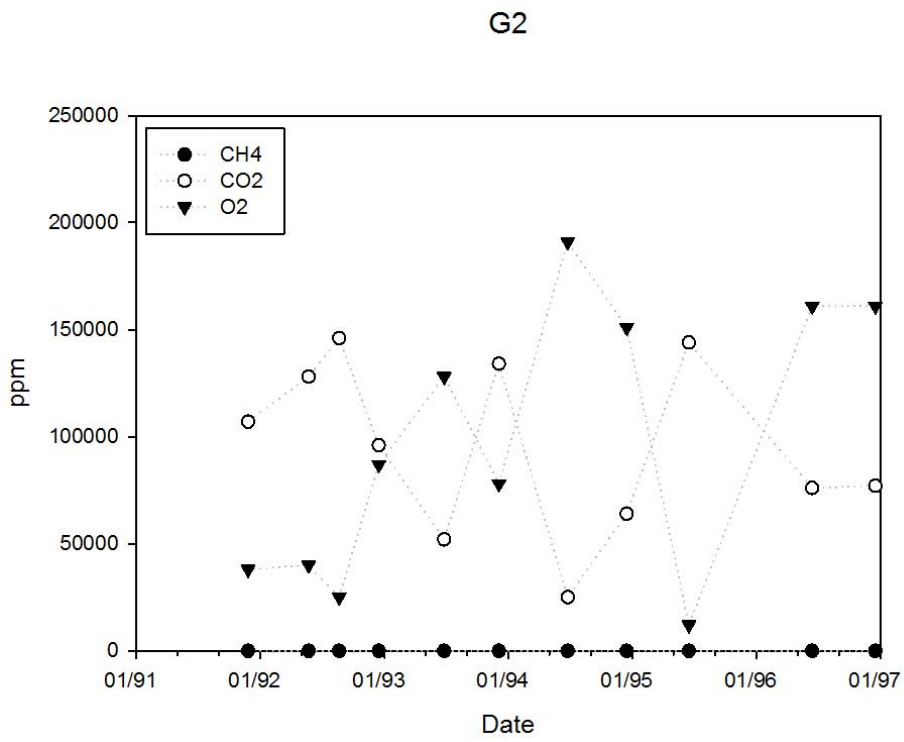

Figure D2 G2 landfill gas concentrations time series.

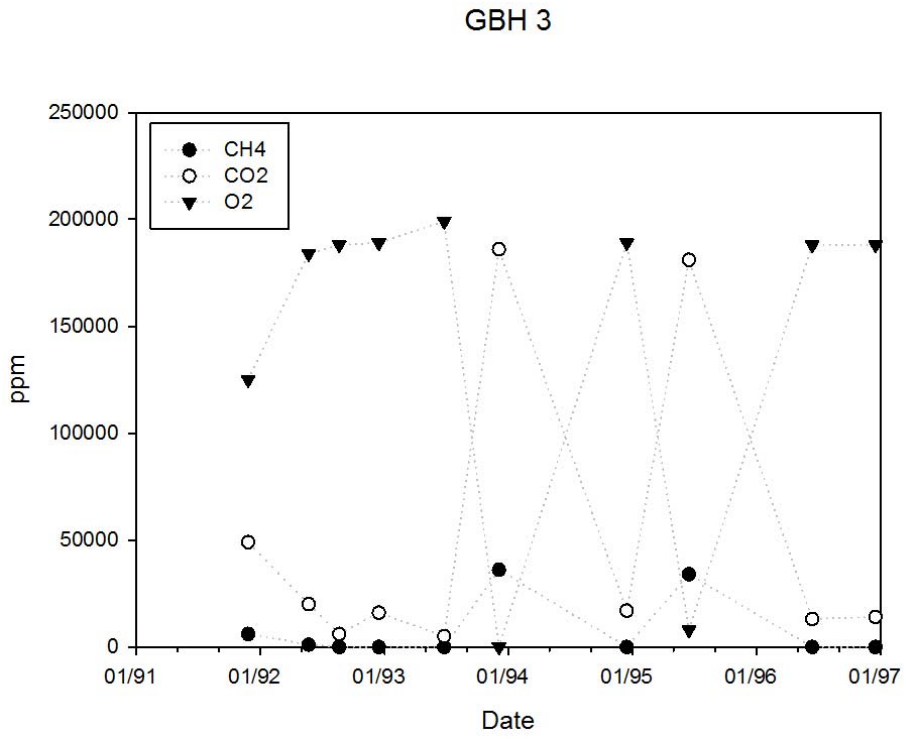

Figure D3 GBH3 landfill gas concentrations time series.

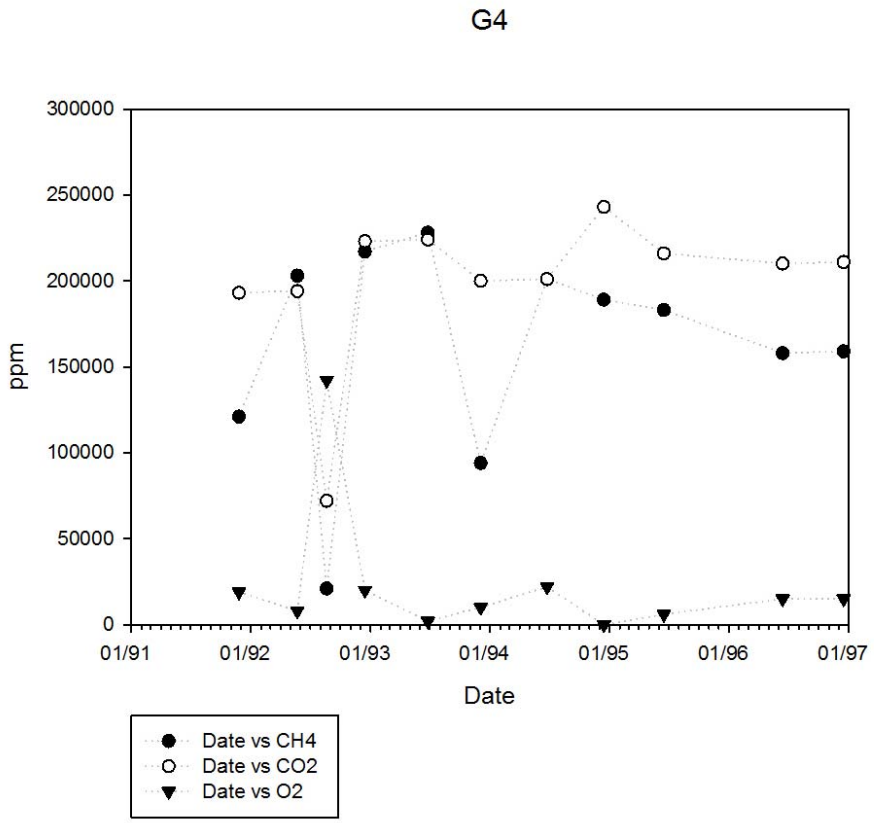

Figure D4 G4 landfill gas concentrations time series.

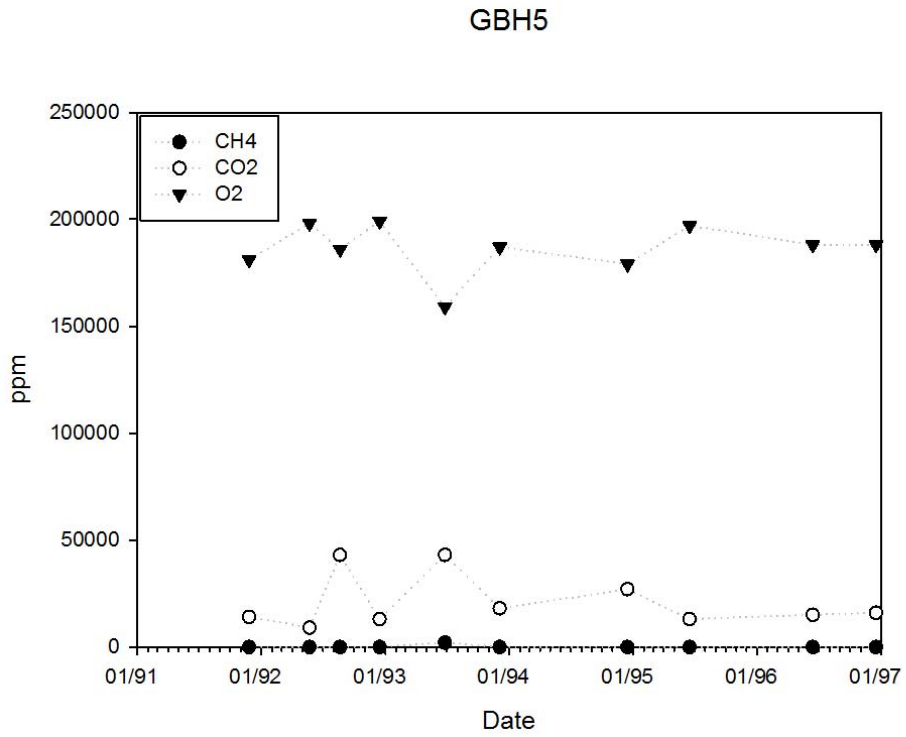

Figure D5 GBH5 landfill gas concentrations time series.

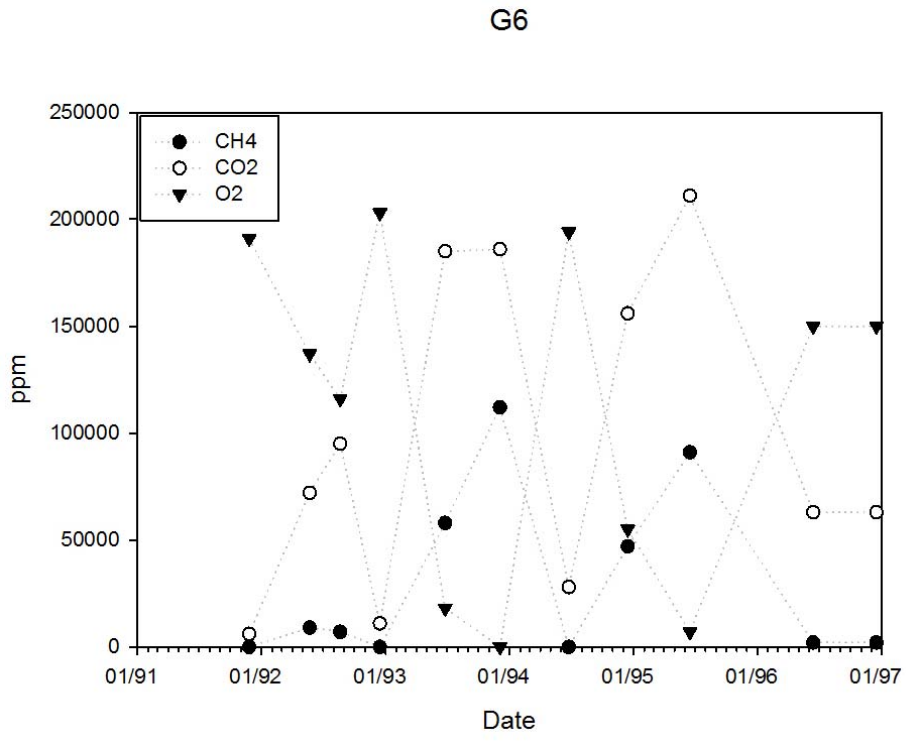

Figure D6 G6 landfill gas concentrations time series.

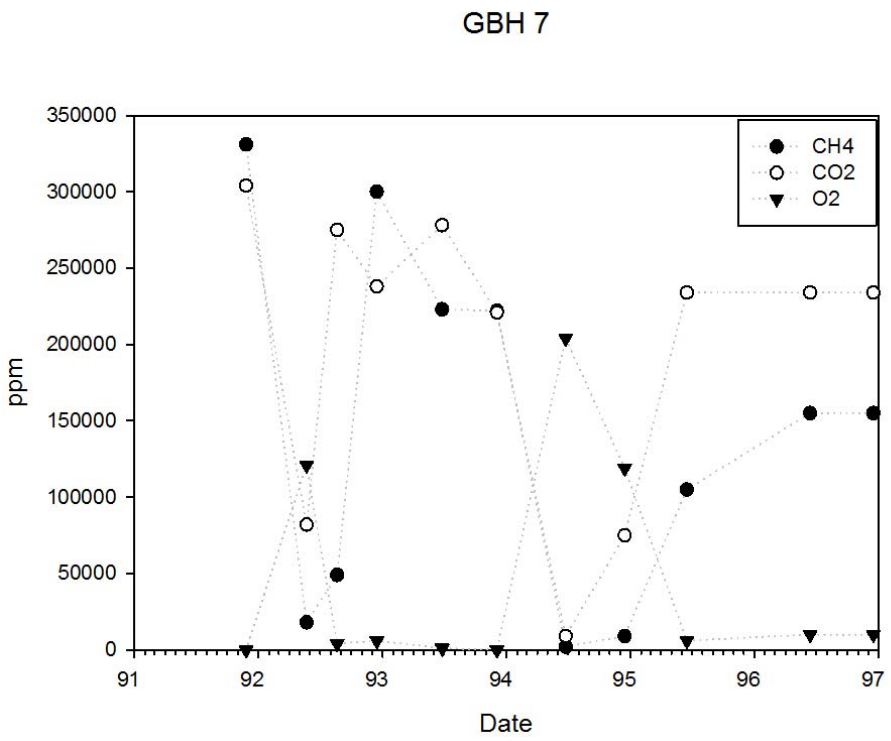

Figure D7 GBH7 landfill gas concentrations time series.

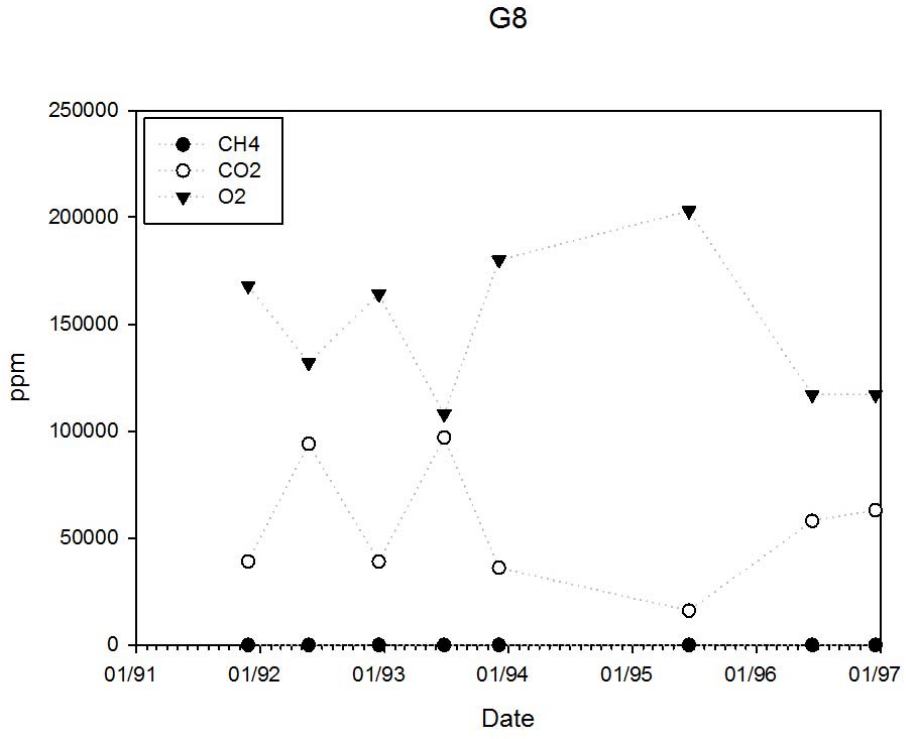

Figure D8 G8 landfill gas concentrations time series.

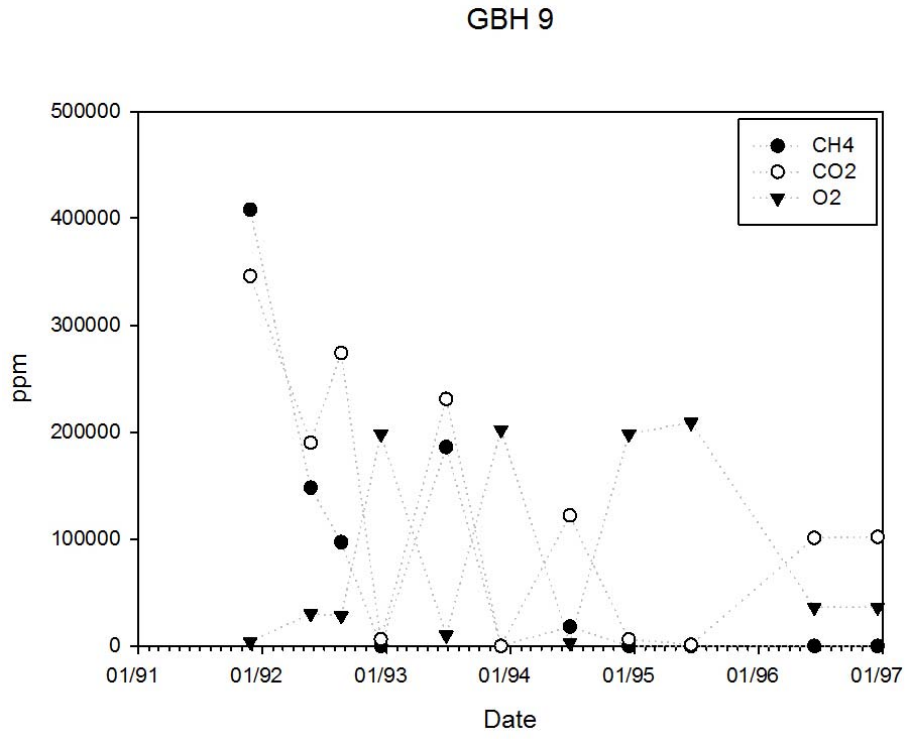

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Figure D9 GBH9 landfill gas concentrations time series.

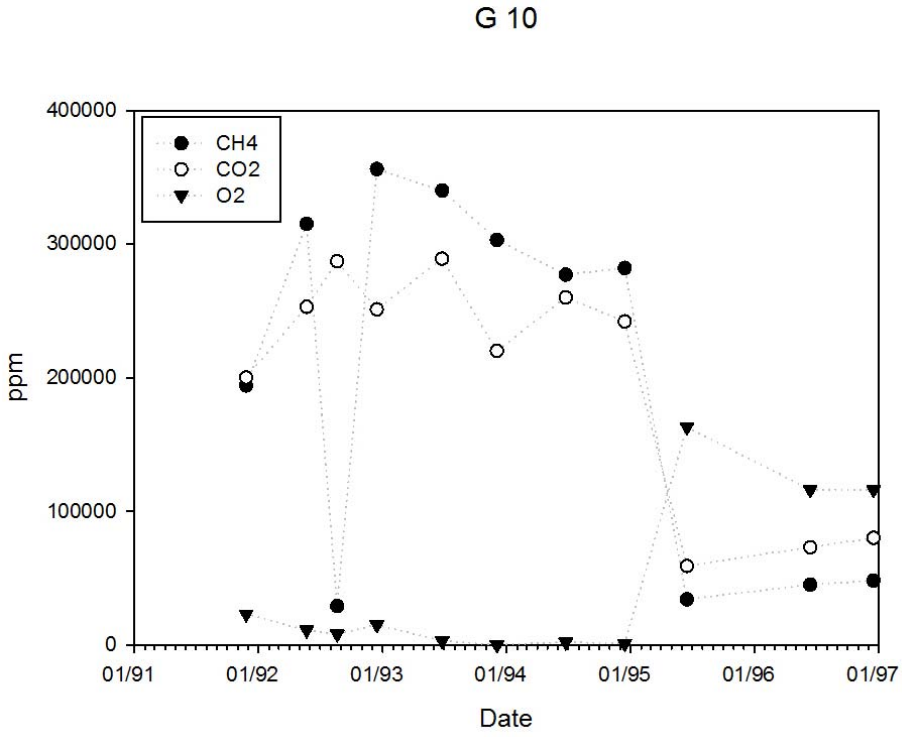

Figure D10 G10 landfill gas concentrations time series.

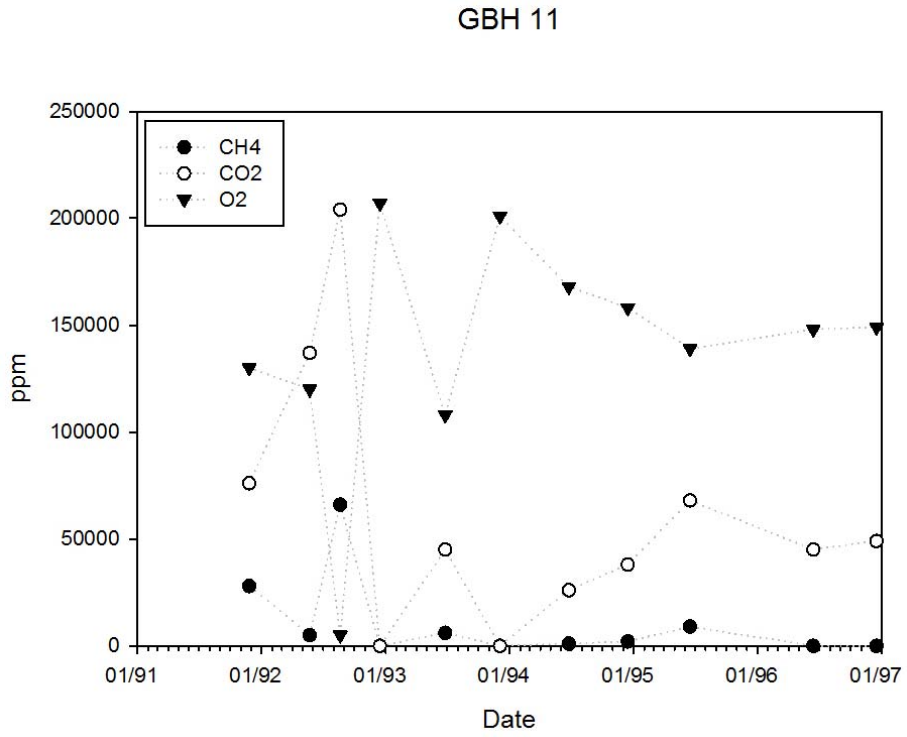

Figure D11 GBH11 landfill gas concentrations time series.

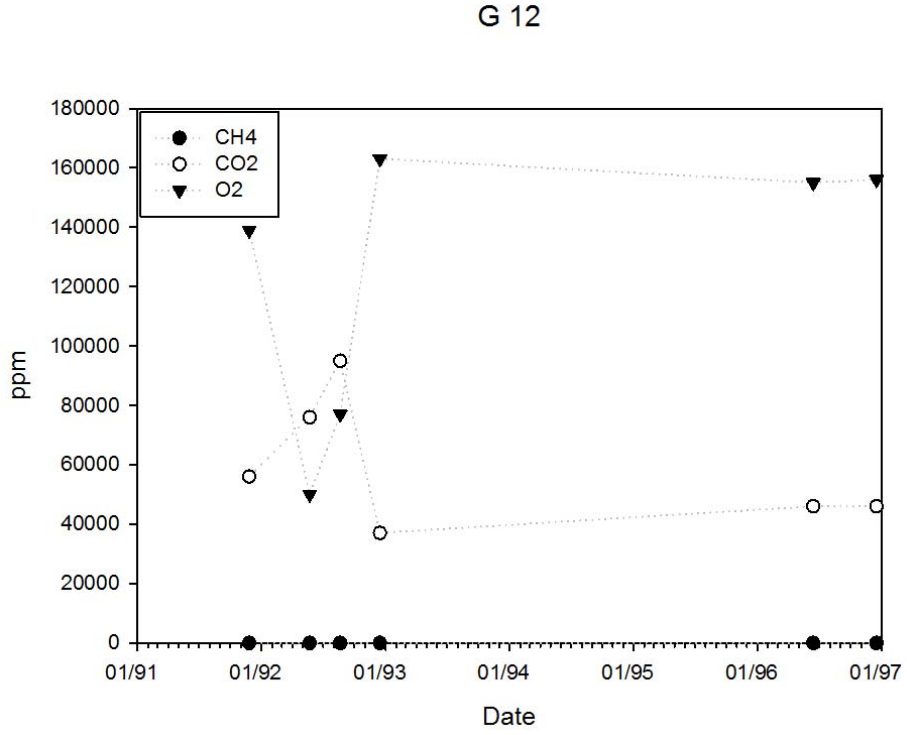

Figure D12 G12 landfill gas concentrations time series.

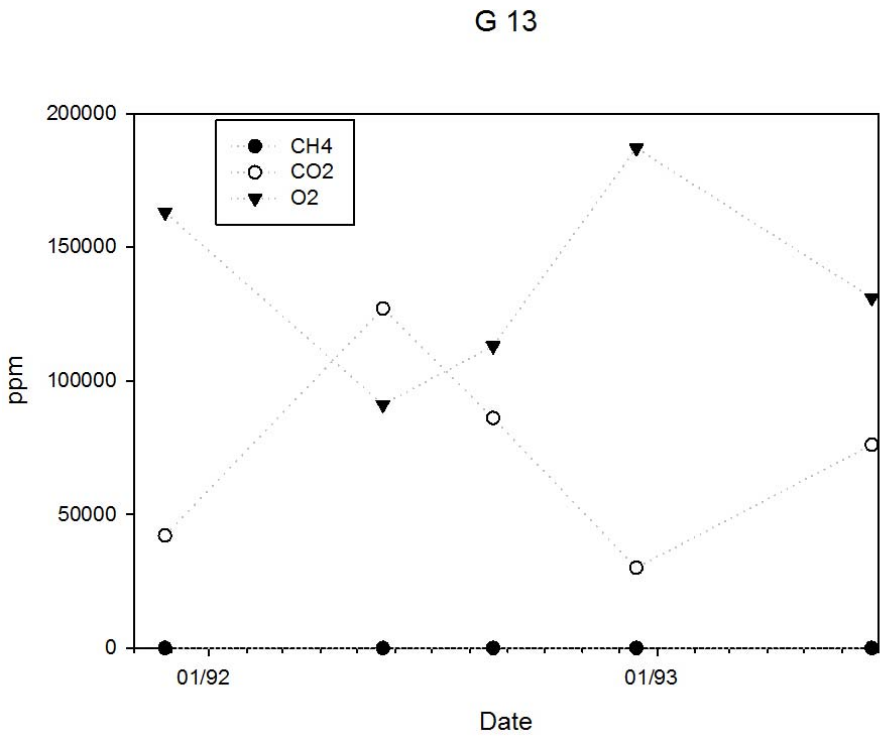

Figure D13 G13 landfill gas concentrations time series.

Appendix E Hydrochemistry with time for Burgess field

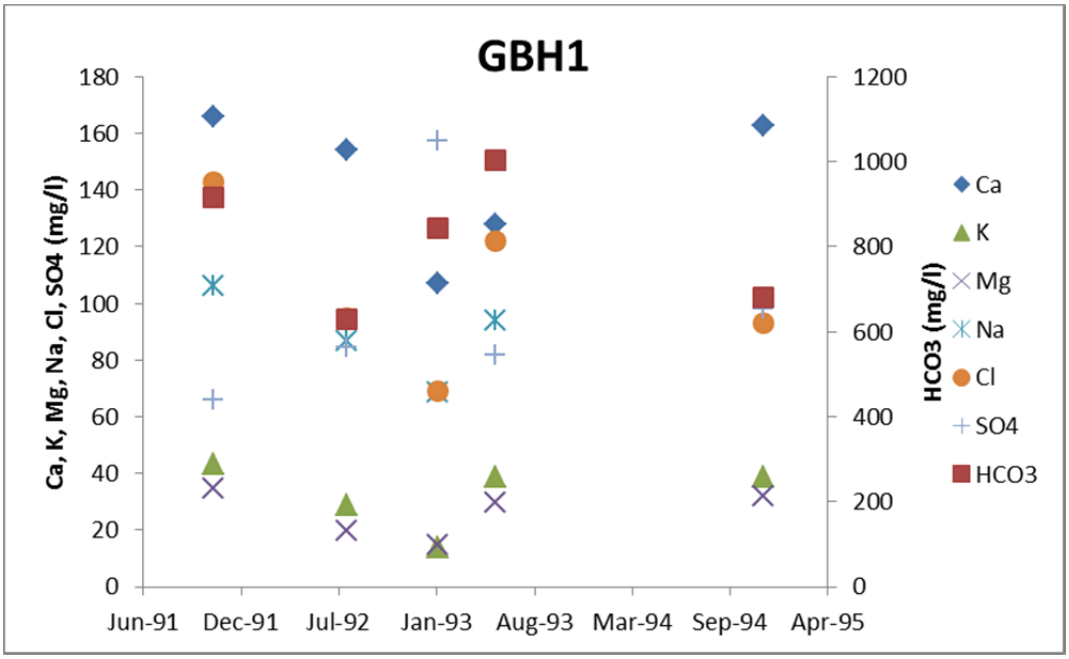

Figure E1 GBH1Major elements time series.

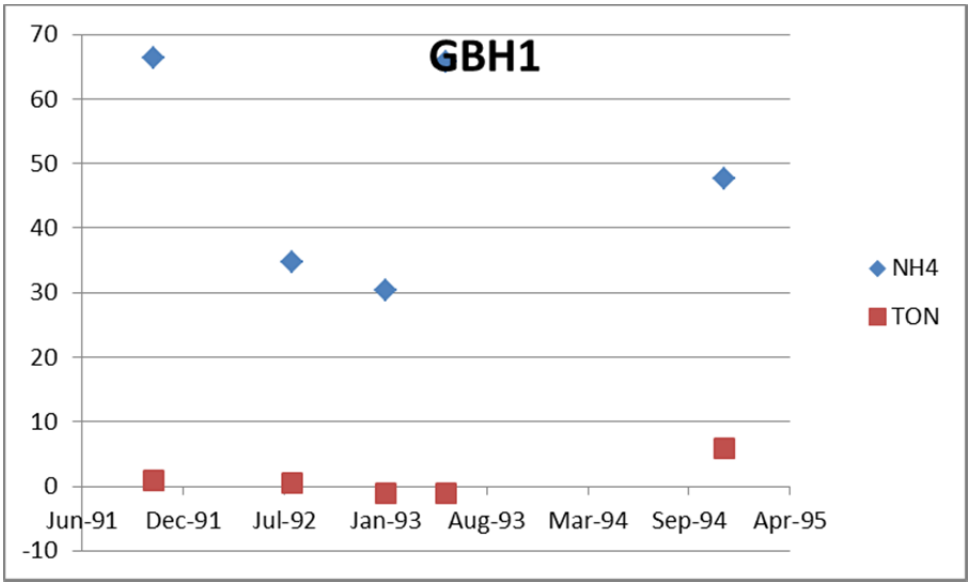

Figure E2 GBH1 Dissolved N time series.

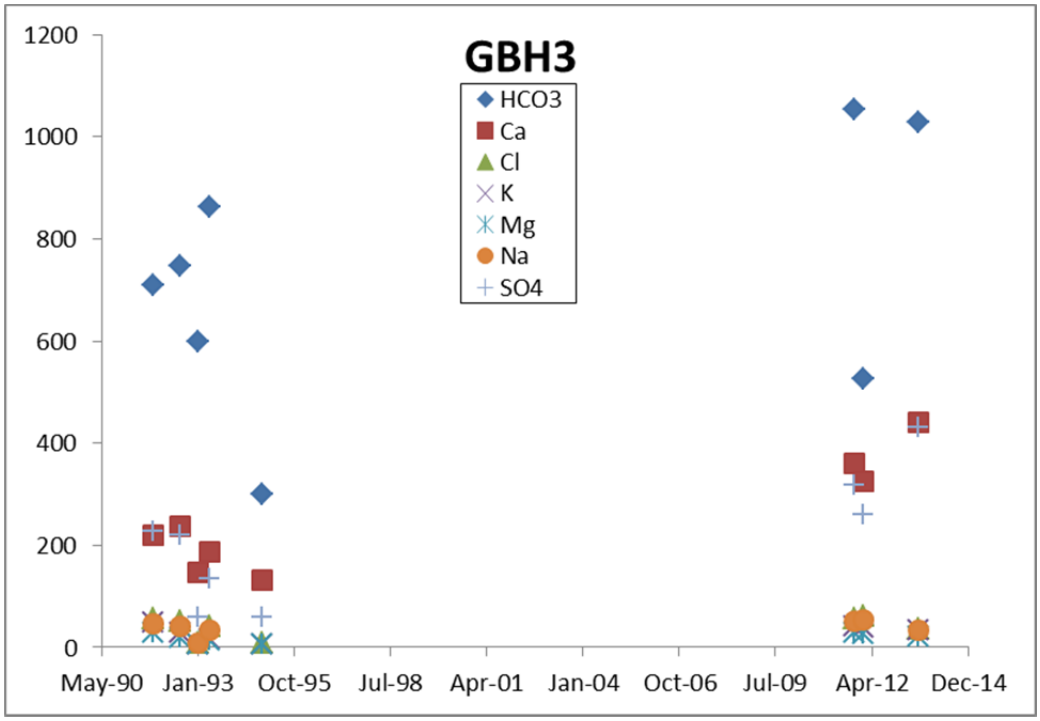

Figure E3 GBH3 major elements time series

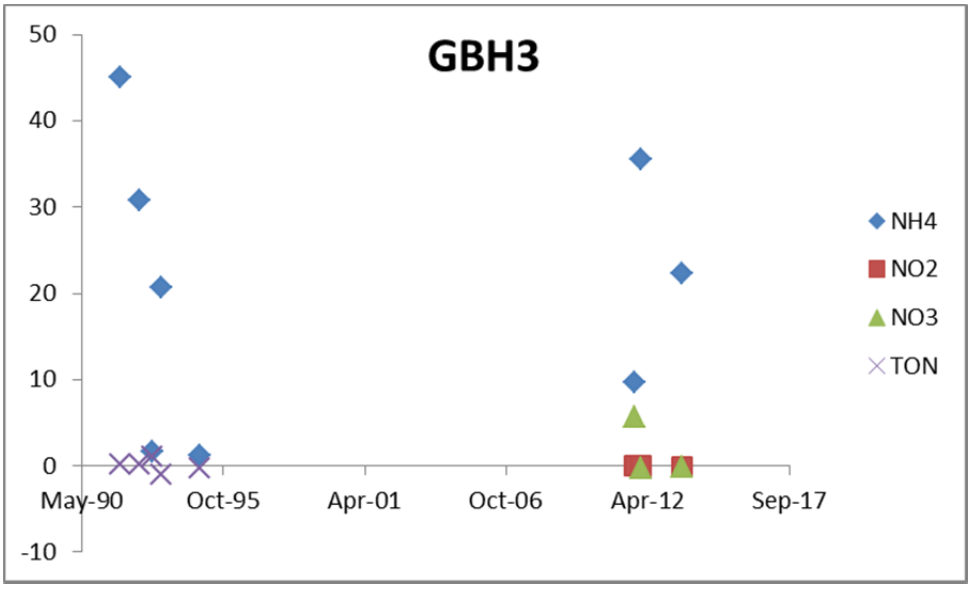

Figure E4 GBH3 Dissolved N time series

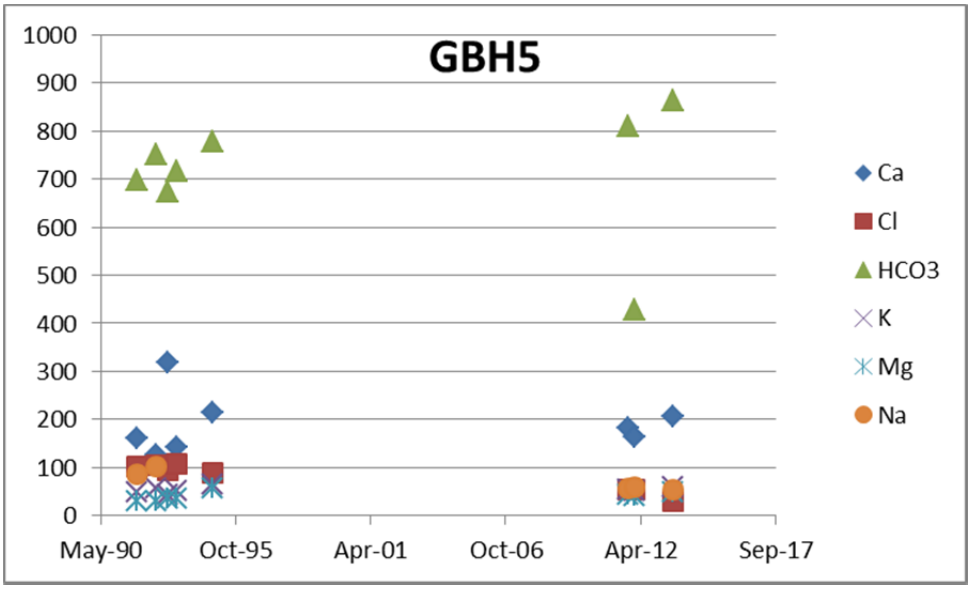

Figure E5 GBH5 major elements time series

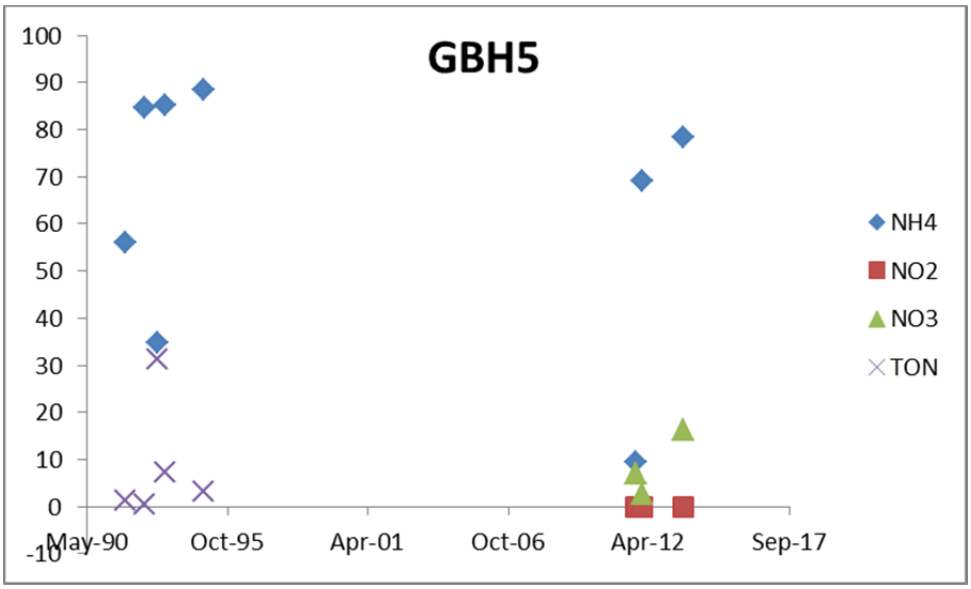

Figure E6 GBH5 dissolved N time series

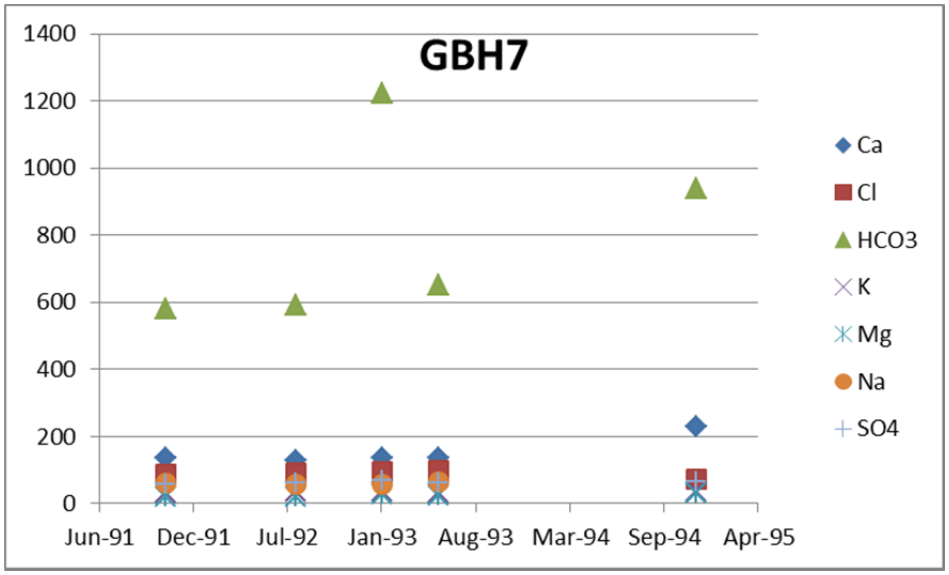

Figure E7 GBH7 major elements time series

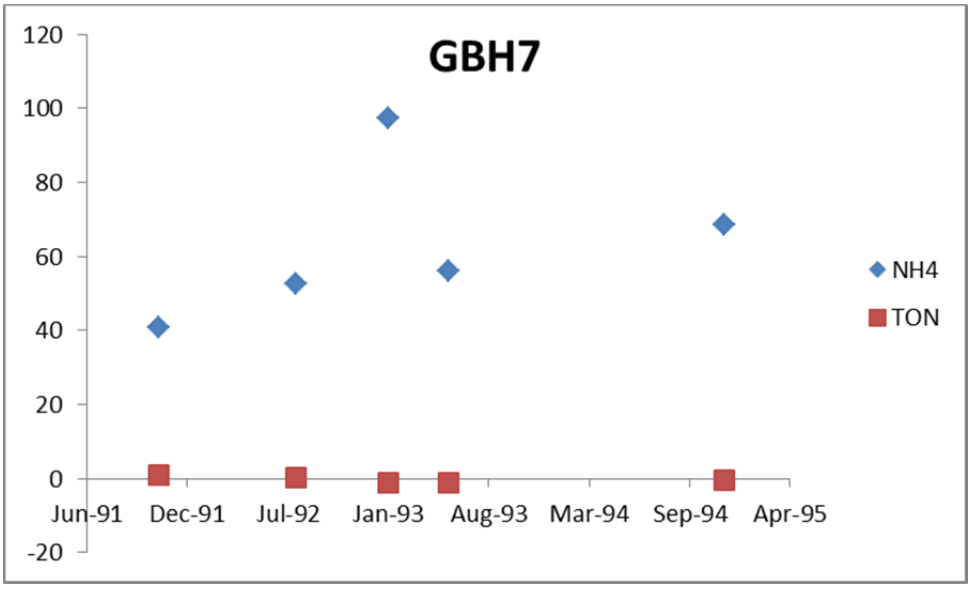

Figure E8 GBH7 dissolved N time series

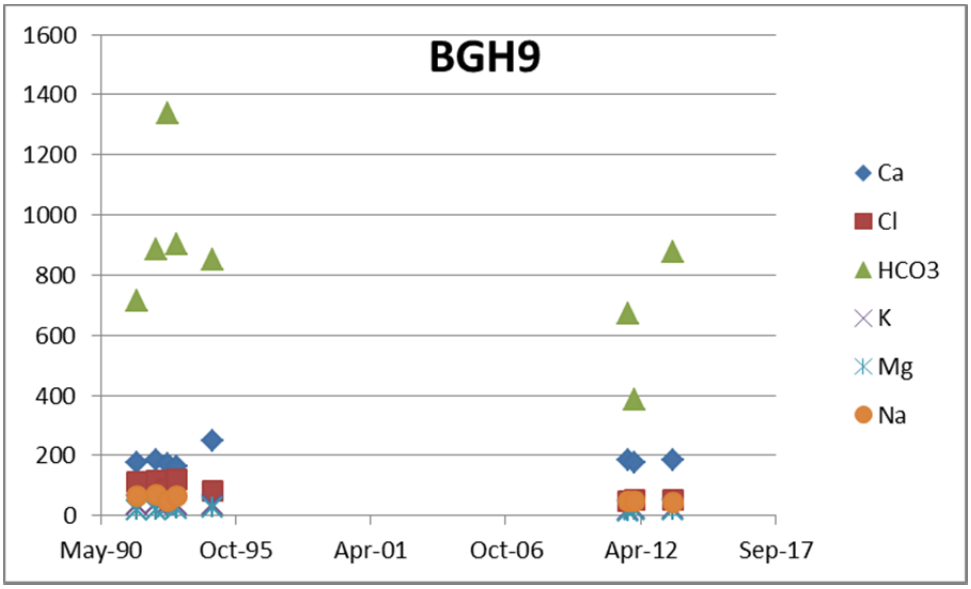

Figure E9 GBH9 major elements time series

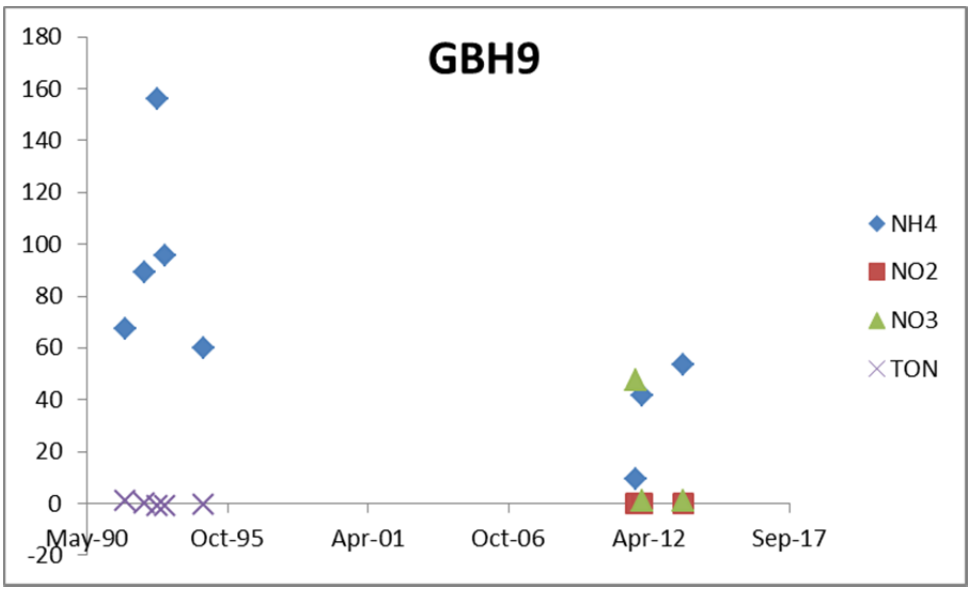

Figure E10 GBH9 dissolved N time series

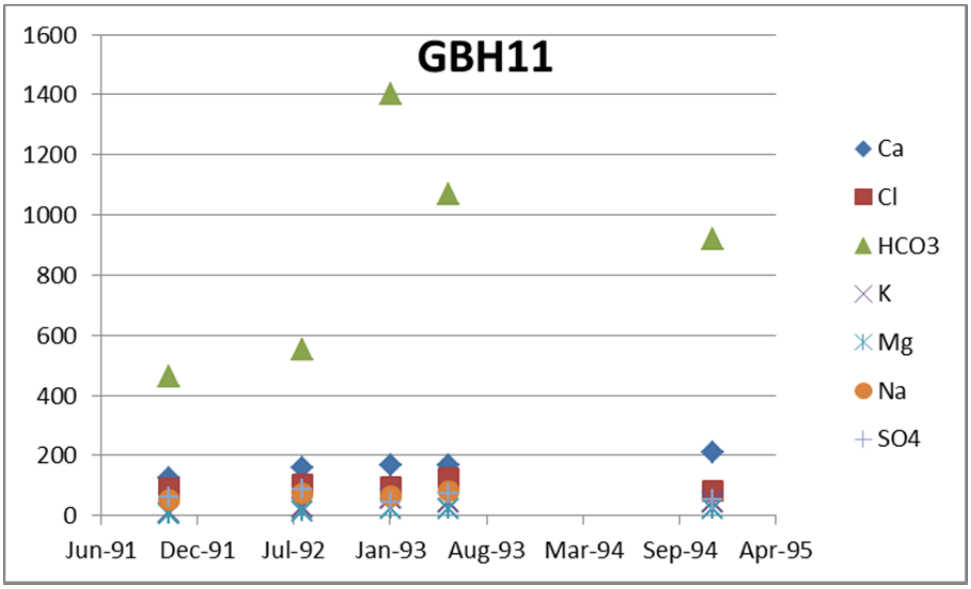

Figure E11 GBH11 major elements time series

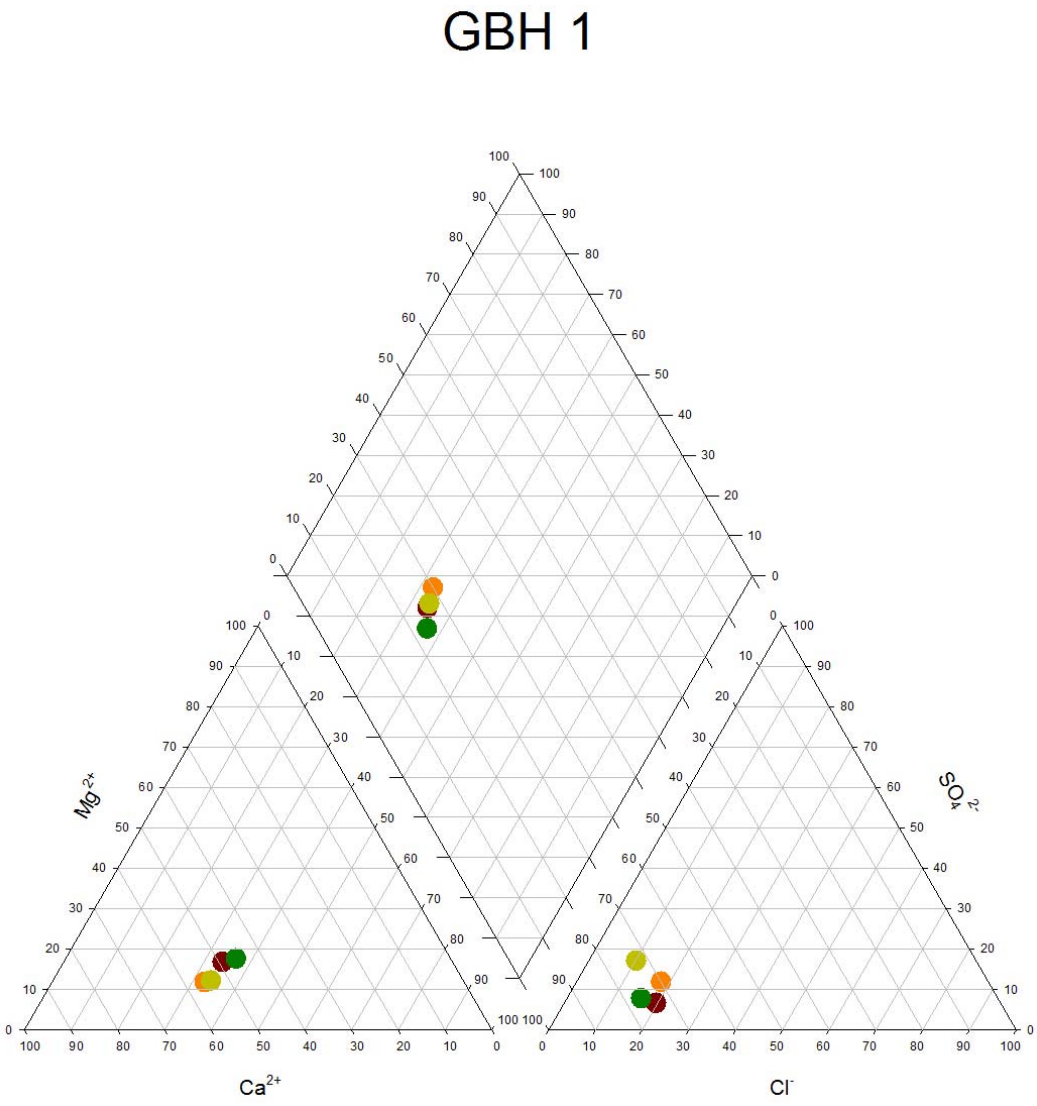

Figure E12 GBH1 Trilinear plot. December 1994 data is incomplete and not plotted.

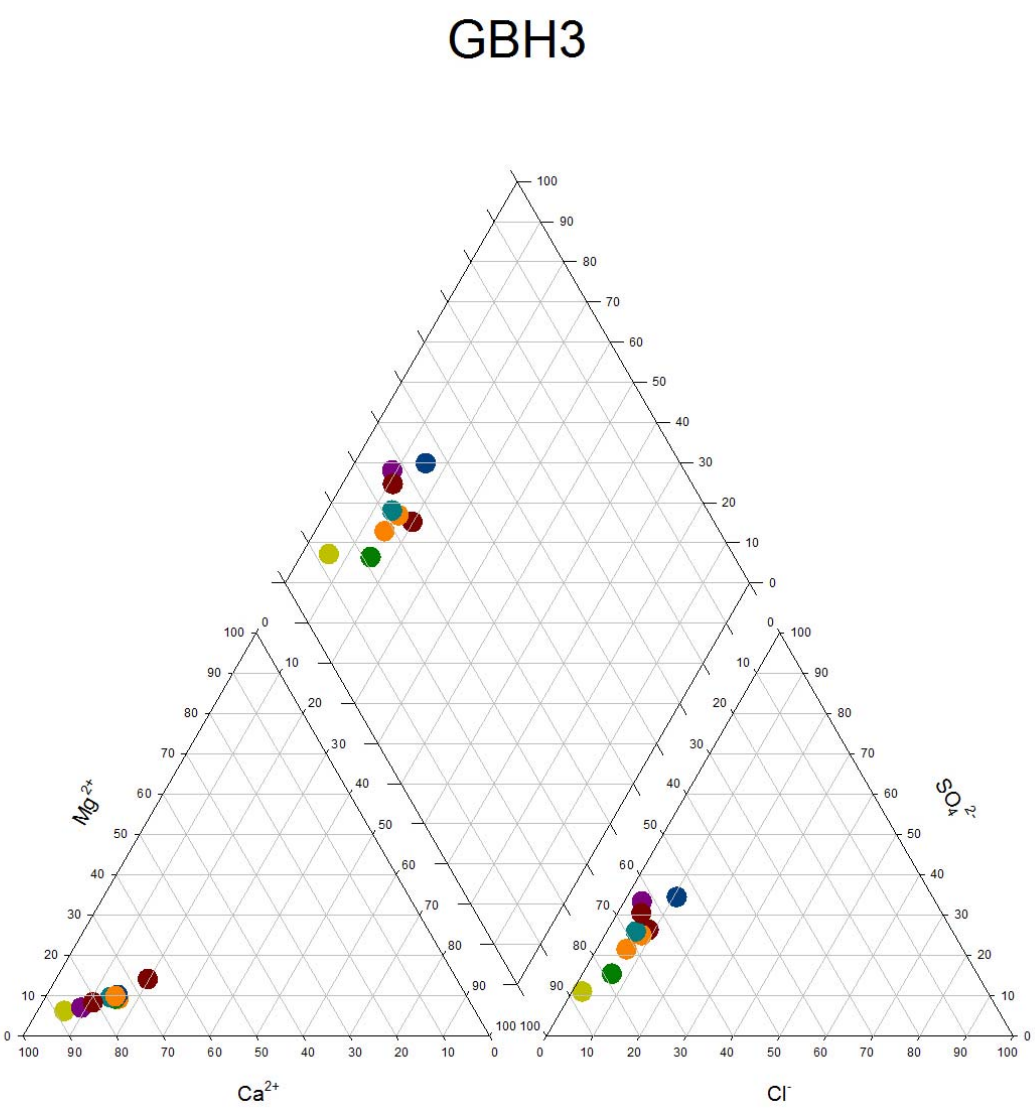

Figure E13 GBH3 Trilinear plot. December 1994 data is incomplete and not plotted.

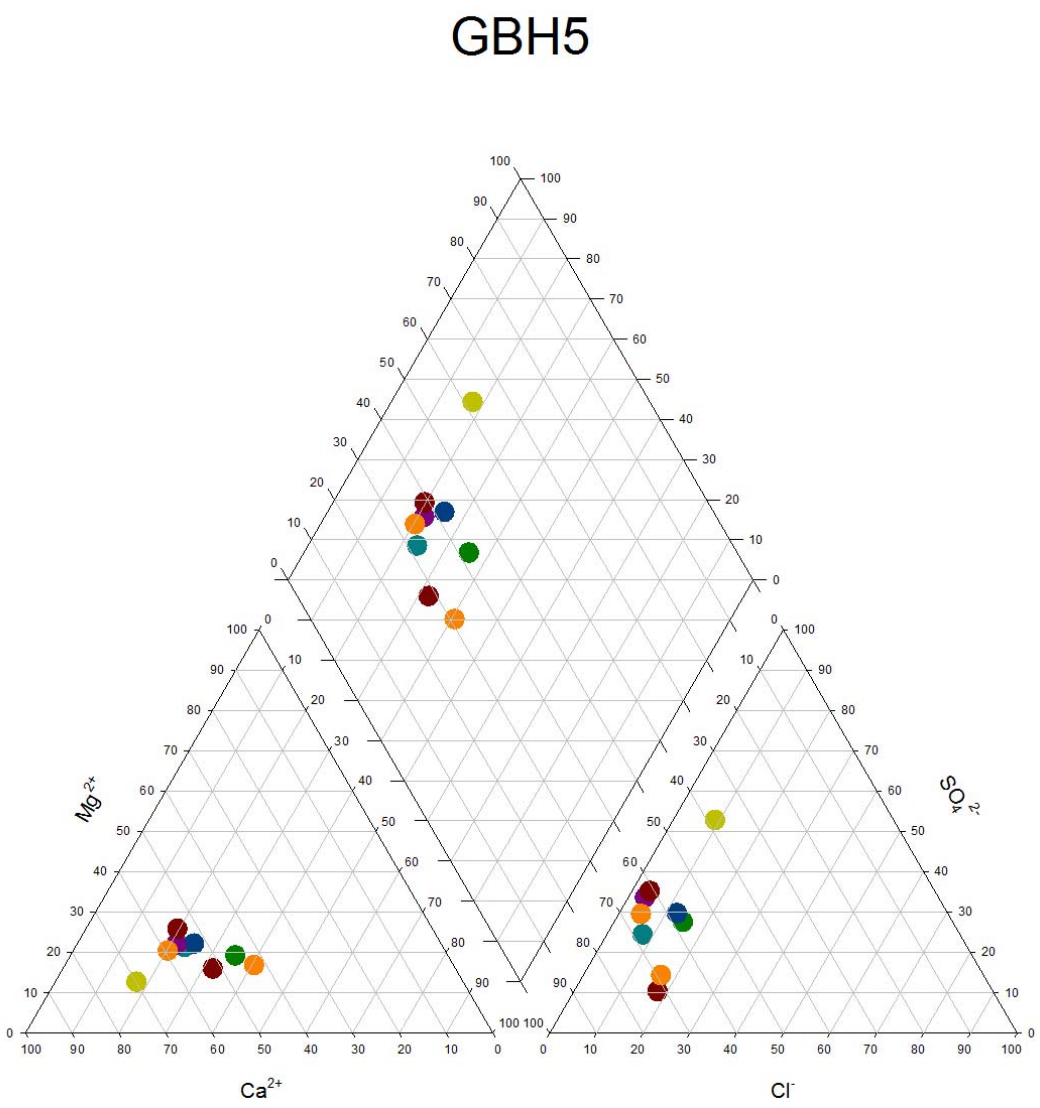

Figure E14 GBH5 Trilinear plot. December 1994 data is incomplete and not plotted.

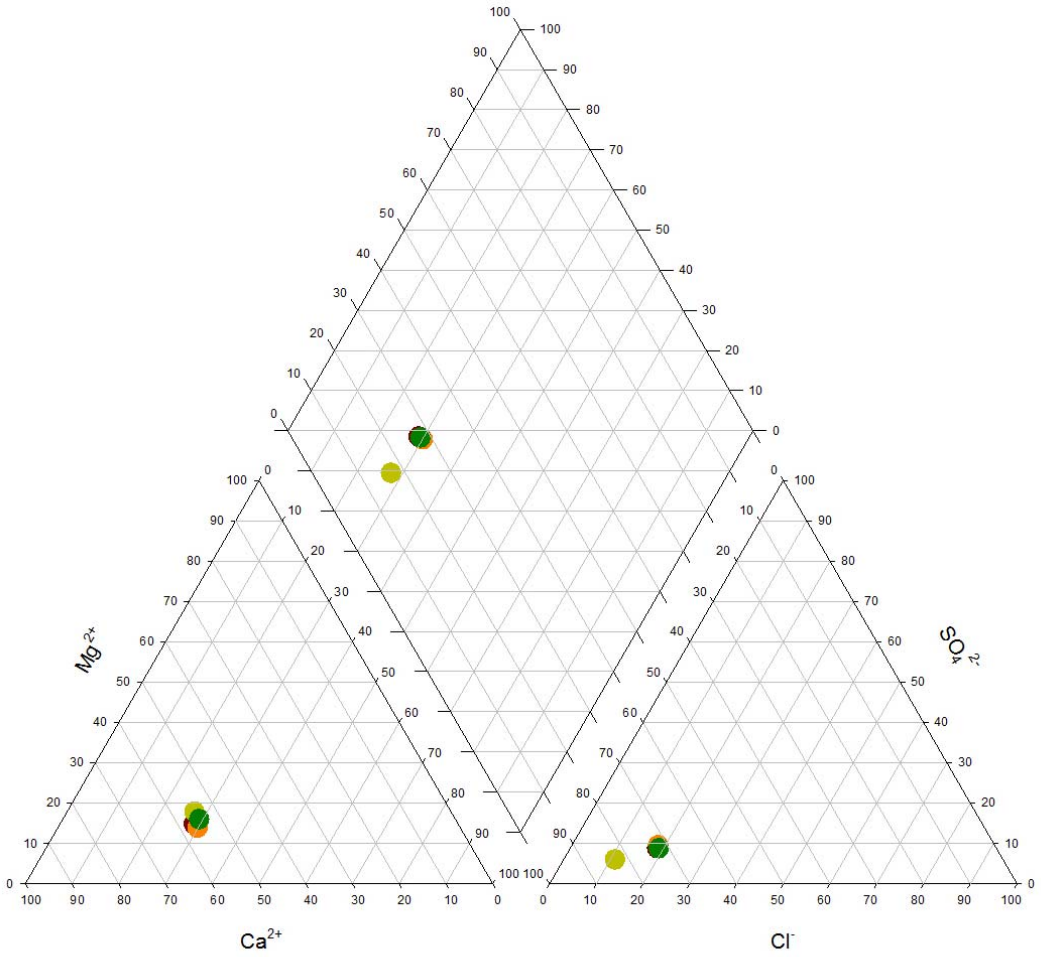

Figure E15 GBH7 Trilinear plot. December 1994 data is incomplete and not plotted.

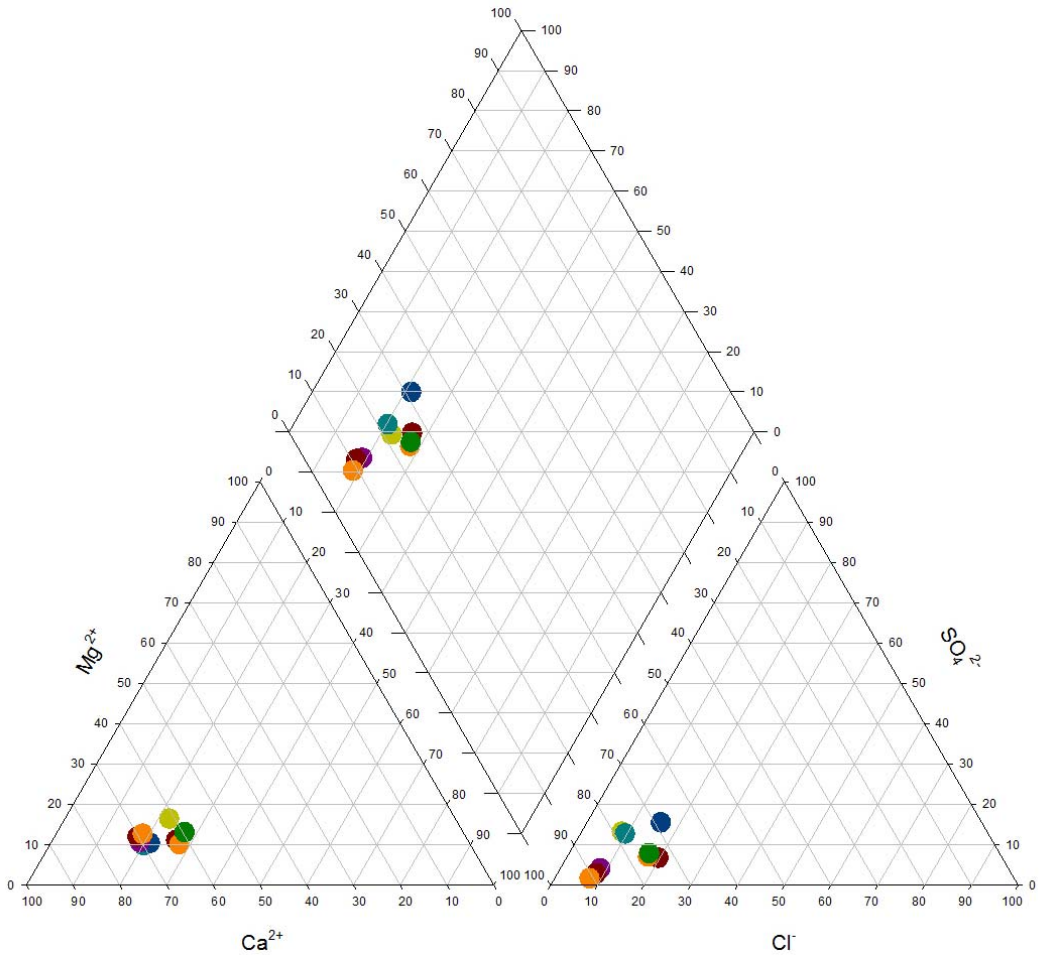

Figure E16 GBH9 Trilinear plot. December 1994 data is incomplete and not plotted.

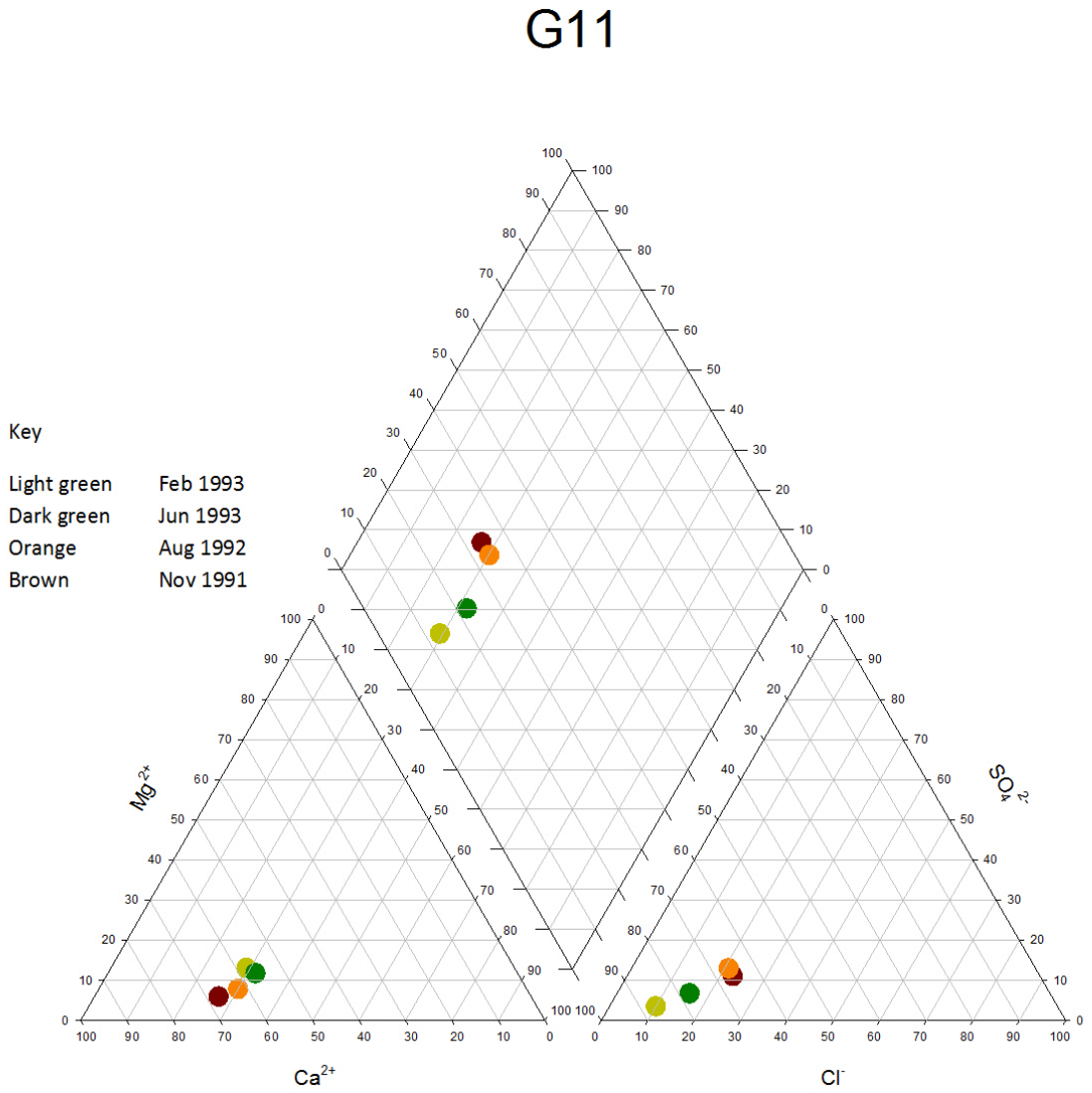

Figure E17 G11 Trilinear plot. December 1994 data is incomplete and not plotted.

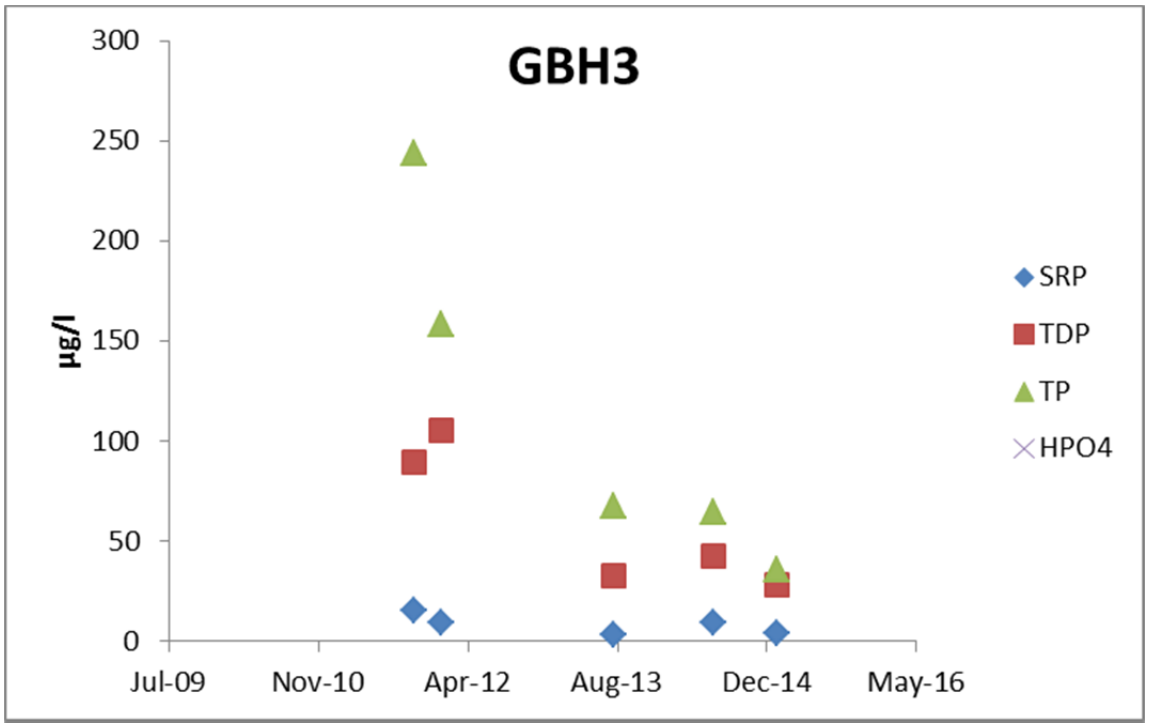

Figure E18 GBH3 phosphate chemistry time series

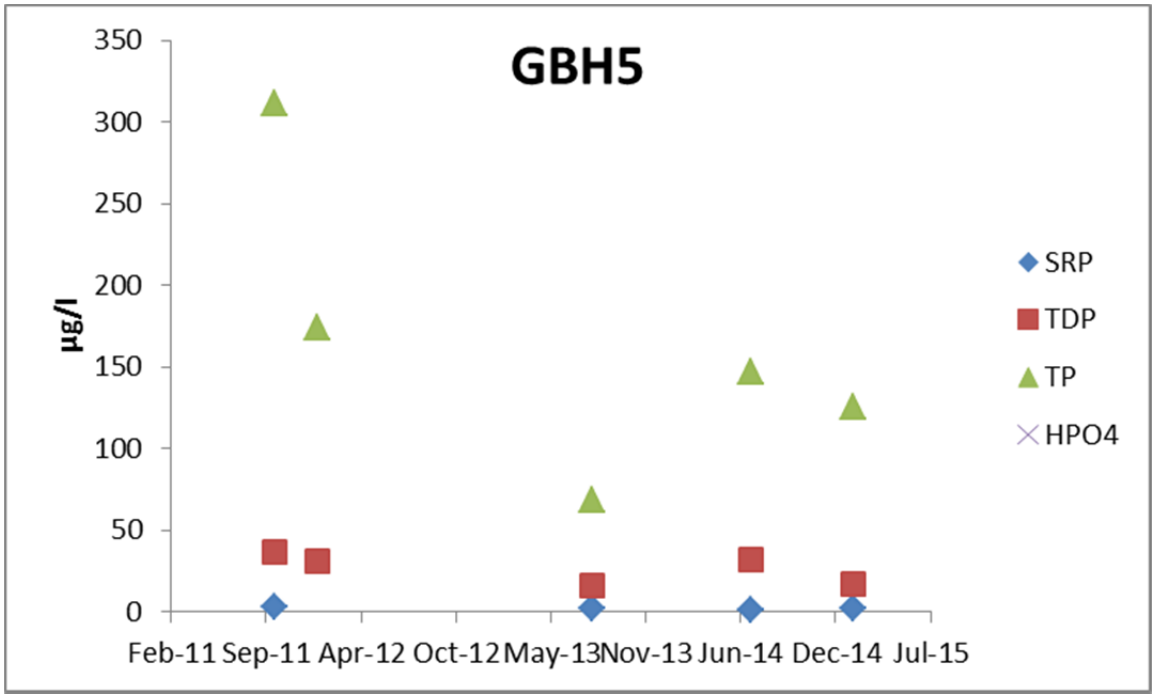

Figure E19 GBH5 phosphate chemistry time series

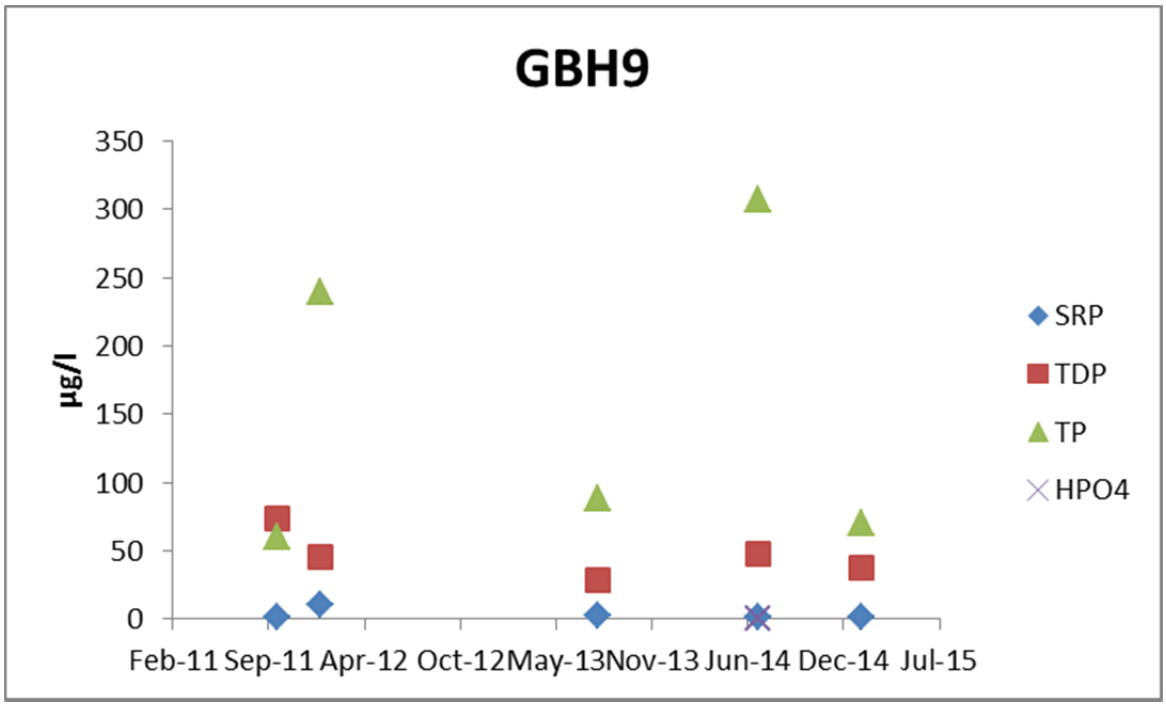

Figure E20 GBH9 phosphate chemistry time series

Table E1. Selected Burgess field data.

Site	Ca	Mg	Na	K	HCO_3	Cl	SO4	NO2	NO3	TON	NH4	pH	SEC
	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l		µS/cm
GBH1													
n	5	5	4	5	5	5	5			5	5	6	6
min	107	14.7	68.8	13.8	628	69	66			<DL	30.3	6.7	1178
max	166	34.5	106	43.4	1003	143	157.2			5.8	66.3	7.6	1777
median	154	29.9	90.3	38.6	844	95	84.4			0.6	47.7	6.8	1520
average	143.6	26.2	88.9	32.7	814	104.4	97.44			1.7	48.9	6.9	1498
GBH3													
n	8	8	7	8	8	8	10	5	5	5	10	8	9
min	132	6	7.8	5.6	300	8	59		<DL	0.1	1.2	6.4	640
max	440.2	28.4	54.2	48.5	1053	60.5	429.9	<DL	5.59	1.1	45.0	8.1	2110
median	228	20.0	41.2	30.6	728	46.5	240.4		0.15	0.2	23.5	6.6	1496
average	256.2	18.7	38.5	27.0	728	40.1	232.4		1.32	0.4	22.9	6.8	1389
GBH5													
n	10	10	9	10	10	10	10	5	5	5	10	9	9
min	126	30.2	52.9	43.2	429	29.4	80		2.55	0.4	9.6	6.7	1438
max	318	60.9	103.2	64.8	863	107	735.5	<DL	16.2	31.2	88.5	7.5	2680
median	194.2	42.2	58.4	52.6	764	71.5	285.5		5.85	3.2	69.1	6.9	1902
average	193.8	42.6	69.8	53.6	741	70.3	310.3		6.89	8.66	63.6	7.0	1904
GBH7													
n	5	5	4	5	5	5	5			3	5	5	5
min	127	19.1	56.3	30.3	581	72	56			<DL	40.9	6.8	1189
max	230	31	65	35.9	1221	100	70			0.9	97.4	7.2	1907
median	136	24.1	59.1	34.8	651	89	62.6			0.2	56.1	6.9	1399
average	153	24.5	59.9	33.4	797	88.6	62.9			0.4	63.1	6.9	1470
GBH9													
n	10	10	9	10	10	10	10	5	5	3	10	11	9
min	164	15.7	43.4	20.3	388	48.5	20.2	<DL	0.41	0.1	9.6	6.6	1403
max	259.5	29.2	71.7	40.1	1373	121.0	178.9	0.17	47.75	1	156.1	7.2	2430
median	183.4	20.6	50.2	34.3	879	74.8	67.4	0.05	0.84	0.15	67.7	6.8	1610
average	196.9	21.7	55.5	31.1	903	79.6	74.4	0.08	10.38	0.42	73.0	6.9	1735
G11													
n	5	5	4	5	5	5	5			3	5	6	6
min	125	6.7	50.8	10.6	462	83	45.3			<DL	12.6	6.5	1042
max	210	23.1	80.6	56.4	1403	126	85.7			1	186.1	7.3	2420
median	166	21	68.6	42.6	921	95	61			0.2	91.3	6.8	1900
average	165.6	16.8	67.2	36.1	881	99.8	63.9			0.45	88.7	6.8	1788

Site	TDP	TP	SRP	HPO_4	Al	As	B	Ba	Br	Cd	Co	Cr	Cs	Cu	F
	µg/l	µg/l	µg/l	mg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
GBH1															
n							3			3					
min							1600								
max							2100			<DL					
median							1700								
average							1800								
GBH3															
n	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
min	28.0	36.0	3		2	1.6	<DL	119.5	0.25	0.02	4.17	0.32	0.02	<DL	0.14
max	105	244.1	15	<DL	4	5.9	1615	140.6	0.47	0.09	5.11	0.53	0.02	5	0.18
median	42.6	67.2	9		4	5.0	1019	135	0.39	0.05	4.39	0.40	0.02	2	0.15
average	59.5	114	8		3.2	3.9	1009	133.8	0.37	0.05	4.48	0.41	0.02	2.4	0.16
GBH5															
n	5	5	4	5	5	5	8	5	5	8	5	5	5	5	5
min	16.1	68.3	1		1	2.1	1699	83.5	0.22	<DL	7.62	0.24	<DL	<DL	0.16
max	37.0	311.4	3	<DL	5	5.2	2300	121.8	0.40	4.30	11.61	0.31	0.02	1.7	0.20
median	30.9	147.0	2		2	3.6	1903	93.7	0.27	0.04	10.69	0.28	0.01	0.4	0.17
average	26.7	165.2	2		2.4	3.4	1962	99.28	0.30	0.61	10.13	0.27	0.01	0.6	0.17
GBH7															
n							3			3					
min							600								
max							800			<DL					
median							600								
average							667								
GBH9															
n	5	5	5	5	5	5	8	5	5	5	5	5	5	5	5
min	29.1	59.7	1	0.0	3	13.2	543	149.5	0.40	<DL	2.08	0.57	0.04	<DL	0.05
max	73.4	307.0	11	0.5	7	22.3	922	335	0.70	0.02	4.43	1.31	0.19	5.1	0.13
median	45.7	88.0	2	0.1	3	18.5	700	162.4	0.47	0.02	2.70	0.92	0.07	0.9	0.12
average	46.8	152.8	3.6	0.1	4.2	17.5	685	219.9	0.51	0.02	2.97	0.89	0.10	1.6	0.11
G11															
n															
min															
max															
median															
average															

Site	Fe total	Li	Mn	Mo	Ni	Pb	Rb	Sb	Se	Si	Sn	Sr	U	V	Zn
	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l	µg/l
GBH1															
n	3		1												
min	800		2000												
max	3363		2000												
median	1541														
average	1901														
GBH3															
n	8	5	6	5	5	5	5	5	5	5	5	5	5	5	5
min	1000	65.0	100	0.69	<DL	0.02	15.13	0.20	0.10	7.43	0.13	1111	1.34	<DL	4.0
max	8567	98.0	1260	0.82	27.7	0.11	18.76	0.46	0.25	9.21	0.20	1319	3.25	0.20	93.8
median	2901	82.0	772	0.70	19.7	0.03	18.15	0.34	0.20	8.10	0.18	1201	2.29	0.20	52.2
average	3475	80.4	751	0.74	21.4	0.05	17.62	0.32	0.17	8.34	0.17	1191	2.23	0.16	55.4
GBH5															
n	8	5	6	5	5	5	5	5	5	5	5	5	5	5	5
min	145	108.0	807	0.21	13.2	<DL	8.81	0.09	<DL	7.42	0.15	745	0.69		1.3
max	14901	144.0	1000	0.43	16.3	0.10	10.29	0.11	0.40	13.9	0.26	993	0.86	<DL	8.3
median	4006	131.0	914	0.30	14.8	0.03	9.43	0.10	0.25	7.94	0.18	876	0.83		6.6
average	5161	128.6	904	0.30	14.6	0.05	9.54	0.10	0.25	9.06	0.19	869	0.80		5.1
GBH7															
n															
min															
max															
median															
average															
GBH9															
n	8	5	6	5	5	5	5	5	5	5	5	5	5	5	5
min	10097	23.0	238	0.68	6.1	0.06	13.25	0.16	<DL	6.69	0.36	688	0.10	<DL	6.0
max	24508	47.0	600	0.80	17.1	0.24	24.67	0.35	0.40	8.02	0.98	902	0.25	0.30	51.5
median	18995	27.0	309	0.77	7.1	0.08	15.31	0.19	0.30	7.36	0.46	795	0.15	0.20	12.0
average	18529	31.4	358	0.76	8.8	0.13	17.66	0.22	0.31	7.41	0.57	777	0.16	0.22	19.6
G11															
n	3		1												
min	1758		300												
max	23700		300												
median	21000														
average	15486														

Note: Data below the detection limit have been replaced with half detection limit concentrations for the calculations. Data from 1992 to 1994 for Cr, Cu, Ni, Pb and Zn have been deleted from the dataset due to high detection limits. Ag, Be, W, Ce, Ti, Zr excluded as below or near DL.