

Cornwall Drive Waste Site
Ambient Air Monitoring Study
Environment Agency

14 February 2014

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1. Introduction

This report describes the ambient air monitoring survey carried out in the vicinity of a licensed waste transfer station at Cornwall Drive, St Pauls Cray, Orpington, BR5 3JB (the site). The site is operated by Waste4Fuel Limited and is permitted by the Environment Agency (the Agency) under the waste management regulations.

The site operates under Waste Management Licence no. 103312 and receives and transfers general skip waste. The storage capacity at the site is 5,000 tonnes plus a 10% excess with an annual throughput of 150,000 tonnes. At present waste stored on the site is in excess of the licensed capacity. Spontaneous fires are a relatively frequent occurrence. In November 2013 the Environment Agency obtained a High Court injunction against Waste4Fuel Limited, which requires the company to remove all combustible waste from the site by 1st May 2014.

Atkins Limited was commissioned by the Agency to undertake ambient air monitoring for a wide range of volatile organic compounds in the vicinity of the site. The measurement technique employed was selected as it would be capable of detecting certain compounds associated with the products of combustion from the residual smouldering of waste at very low concentrations, well below the established health related thresholds.

The Agency requested Atkins undertake this monitoring on Wednesday 22nd January 2014, in order to obtain measurements when the site was not actively on fire. (It is noted that there was a spontaneous waste fire at the Waste4Fuel site the following day, reportedly the tenth fire in the last year.)

This report describes the monitoring locations, the prevalent meteorological conditions, and the sampling and analytical methods employed. An interpretation of the results is provided in the context of the Environment Agency environmental assessment levels¹ (EALs) for air quality, set for the protection of human health. The full laboratory report is provided as an Appendix.

¹ H1 Environmental Risk Assessment, Annex F Air Emissions, v2.2 December 2011. Environment Agency

2. Methodology

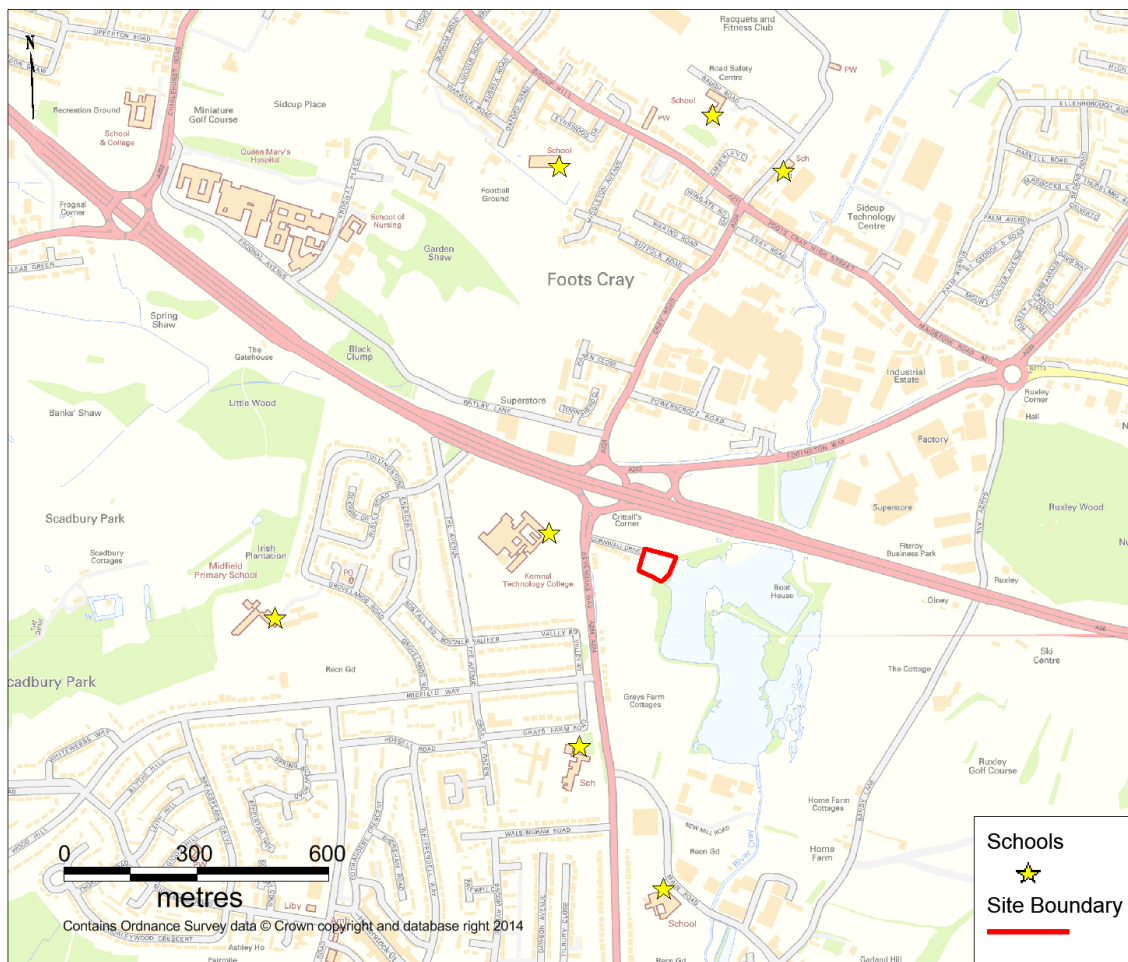
2.1. Site Description

The Waste4Fuel Limited site is shown in Figure 2-1. Access to the site is via Cornwall Drive, a street where the closest residential properties are located. There are also residential properties within approximately 100 metres to the west of the site on Sevenoaks Way A224. To the south west of the site is the built up urban residential area, Valley Road being 200 meters from the site. To the south of the site are found retail and office premises off of Main Road and New Mill Road.

The A20 Sidcup bypass is within 100 metres to the north of the site. To the north north west there are houses in Townshend Close, north of the bypass. Beyond the A20 and Edginton Way A223 to the north and north east is a predominantly industrial area, other than a small number of residential units off Powerscroft Road over 250 metres to the north east of the site.

There are numerous schools and academic institutions within a kilometre of the Cornwall Drive site, as indicated by yellow stars on Figure 2-1. The nearest, Kemnal Technology College, is 250 metres to the west of the site.

Figure 2-1 Site Location Plan



2.2. Sampling and Analytical Procedure

In selecting the sampling procedure, consideration was given to the general advice regarding environmental monitoring provided to the Agency from Public Health England². The final sampling strategy is broadly in line with those recommendations. The Public Health England advice also references their research paper by JC Wakefield entitled 'A toxicological review of the products of combustion'³, containing a wide range of information regarding the potential effects of smoke inhalation.

The methodology adopted was a very highly sensitive sampling and analytical procedure capable of detecting a wide range of organic compounds at low concentrations in ambient air. The ambient air samples were taken using pumped Tenax adsorption tubes. Tenax is a porous polymer that is particularly appropriate for the collection of VOCs as it has both good adsorption and thermal properties.

The samples were subsequently analysed by SGS-MScan, a UKAS accredited laboratory, using thermal desorption onto a gas chromatograph to separate the numerous organic compounds, linked to a mass spectrometer detector to identify individual compounds. The analytical method is able to detect a wide range of organic compounds at very low concentrations, including those associated with waste degradation products and those associated with residual smouldering of waste within the stockpiled materials.

2.3. Meteorological Conditions

During the sampling period on Wednesday 22nd January 2014 the weather conditions were stable, a dry day with scattered clouds and a light wind from the south west. Details of the meteorological records from Biggin Hill, located approximately 10 kilometres to the south west of the Waste4Fuel site, are shown in **Error! Reference source not found.**

Table 2-1 Biggin Hill Meteorological Data for 22nd January 2014⁴

Time GMT	Temperature °C	Humidity %	Sea Level Pressure kPa	Wind Direction	Wind Speed km/h	Conditions	Wind Dir Degrees
11:50 AM	7	93	1006	SW	7.4	Mostly Cloudy	220
12:20 PM	7	93	1006	SW	9.3	Scattered Clouds	220
12:50 PM	8	93	1006	SW	11.1	Scattered Clouds	230
1:20 PM	8	87	1006	SW	9.3	Scattered Clouds	220
1:50 PM	8	81	1006	SSW	11.1	Scattered Clouds	210

Direct observations made on-site of wind direction during the first sample period from 12:30 at Cornwall Drive were 220 to 240 degrees, and at 12:45 at the downwind location sampling point were noted as 240 degrees. The third sample at the site boundary was directly in the lee of the waste material and hence no clear wind direction was evident, although there was not thought to be any change in overall weather conditions at that time.

² Email of 23/12/13 from Adrienne Dunne, PHE Specialist Environmental Public Health Scientist, to Jon Griffin, Environment Agency.

³ http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1267025520632

⁴ Data taken from Wunderground website,
http://www.wunderground.com/history/airport/EGKB/2014/1/22/DailyHistory.html?req_city=NA&req_state=NA&req_statename=NA&MR=1

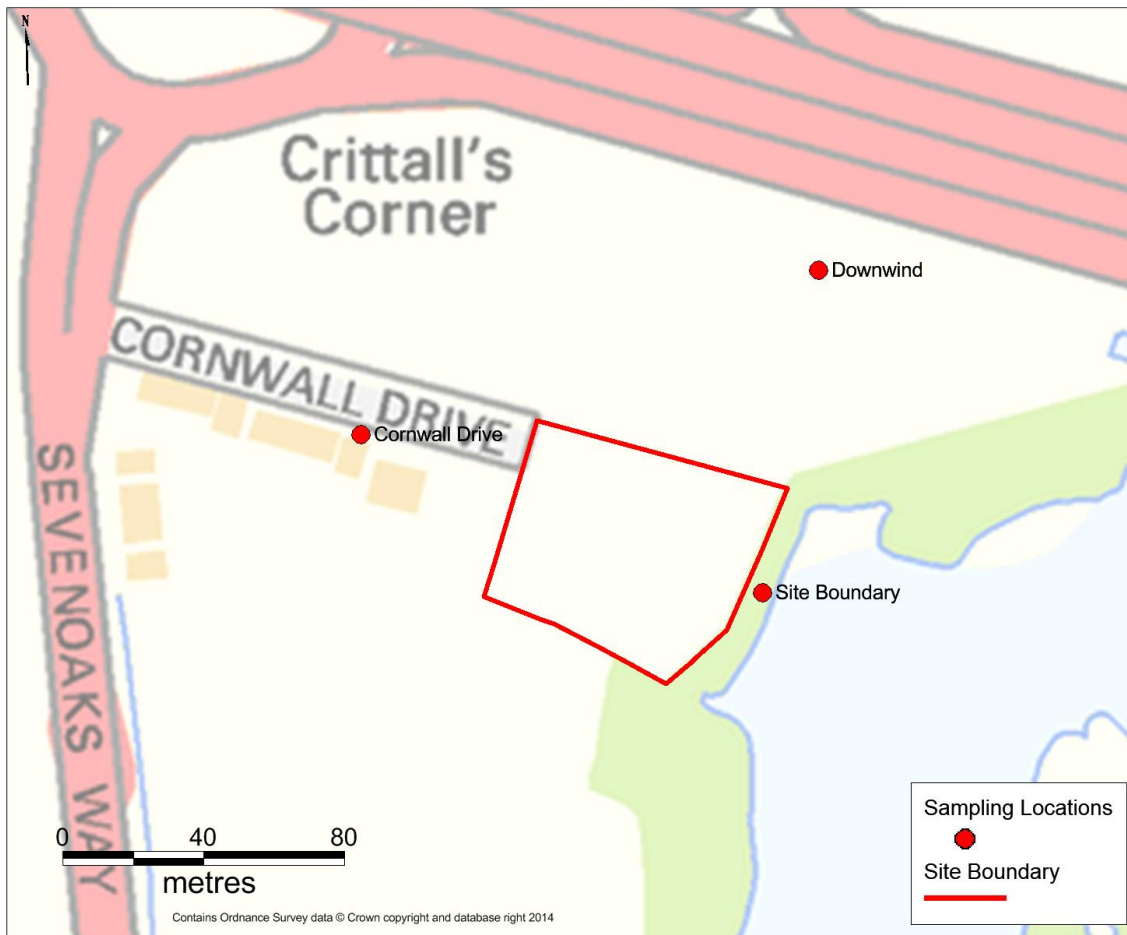
2.4. Sampling and Observations

On arrival at the site on 22nd January 2014, and in the light of prevailing weather conditions, three sampling locations were selected, (upwind, downwind and site boundary as per Public Health England advice), and agreed with Agency staff.

Samples were taken at a residential location on Cornwall Drive, 45 metres to the west of the site entrance, and at a second location downwind of the waste site at a distance from the site boundary similar to that of the residential location. A third sample was taken at the downwind site boundary itself. At each location Tenax adsorption tube samples were taken by means of a pre-calibrated pump. Samples were taken in duplicate concurrently, using a fixed sample volume over 14 minutes. An additional pair of Tenax tubes was also used as a 'travelling blank'.

Sampling commenced at 12:20 and the three duplicate samples were completed by 13:30. The site boundary drawing in Figure 2-2 is annotated to show the sampling point on Cornwall Drive, the downwind sampling location to the north east of the site and the site boundary monitoring point. Views of the three sampling locations are provided in Appendix A in Figure A-1 to Figure A-3.

Figure 2-2 Site Boundary and Sampling Locations



Sampling commenced outside the property named "Tregony" on Cornwall Drive at 12:20, the downwind location at 12:46 and the eastern site boundary at 13:15. Sampling was completed by 13:30.

There was no evidence of combustion in the waste pile during the sampling exercise. There was no odour evident during sampling at Cornwall Drive upwind of the waste site, whereas there was a faint odour characteristic of waste at the downwind location. The odour strength was more pronounced at the site boundary during the final sample period, where the waste smell tended to be of a more putrescible nature than would be typical of relatively recent waste material.

Given the south westerly wind direction during the air sampling exercise, there would be no influence from vehicular emissions from the A20, although emissions from traffic on the A224 Sevenoaks Way may be a factor to consider in the interpretation of the results. There were no industrial emission sources or combustion sources evident in the area at the time of the survey. The sampling point in front of Tregony, Cornwall Drive, was near parked cars and a wheelie bin, and close to a metal grill covering the drainage gully at the edge of the paved area, all potential sources of volatile organic compounds.

It was noted that mobile plant was in operation within the Waste4Fuel site during the monitoring exercise. The fuel tanks and engines of such plant are also potential sources of VOCs, and unburnt hydrocarbons will be present in the plant exhaust gases.

3. Results

The results have been evaluated in the context of the H1 Annex F EALs for the protection of human health.

As the sampling was carried out when the site was not actively on fire, it is considered appropriate to use the more stringent long term EALs, rather than the higher concentrations given as short term EALs, which may be appropriate for a brief intense exposure such as might result from an active fire. This is clearly a conservative approach as the spot sampling period was just 15 minutes.

The laboratory also provided odour thresholds for certain specific compounds identified in the samples. These findings are also noted.

3.1. SGS M-Scan Laboratory Report

The laboratory report is reproduced in Appendix B. This provides full details of the sampling and analyses undertaken and includes a discussion of the results.

Table 1 of the report lists over one hundred organic compounds found in the samples and blank, most of which are identified from the mass spectra with reference to the laboratory computer library. The table also presents the odour thresholds of specific compounds where appropriate. The laboratory reports concentrations in terms of nanograms per litre (ng/l); note that this is numerically equivalent to concentrations in air expressed in units of micrograms per cubic metre ($\mu\text{g}/\text{m}^3$).

The laboratory report states that:

“A range of compounds were detected, the majority were measured at concentrations of less than 5 ng/l. These included: alcohols, ketones, aldehydes, acids, acetates, chloro- containing compounds, sulphur containing compounds (including sulphides), alkyl substituted benzenes, saturated and unsaturated aliphatic, aryl and aromatic hydrocarbons.”

The report notes that the downwind and downwind boundary samples are similar, whereas that from Tregony on Cornwall Drive (“House”) differed from these samples. This is described as follows, (the times (min) mentioned are the elution times from the gas chromatograph):

“A number of components were detected and measured at low levels only in the “House” sample and not in the other two samples. These included; dimethyl disulphide (11.60 min) and dimethyl trisulphide (17.70 min) together with 3-methyl butanal (8.87 min). Higher levels of benzene (9.19 min), 2, 4-dimethyl heptene 14.01 min, ethyl benzene (14.76 min) and styrene (15.52 min) were measured in the “Downwind” and “Downwind Behind East of Boundary” samples, compared to the “House” and “Travelling Blank. Naphthalene was detected only in the “Downwind” and “Downwind Behind East of Boundary” samples. Generally the levels of these compounds tended to be higher in the “Downwind” compared to those measured in the “Downwind Behind East of Boundary” sample.”

For ease of reference, a summary of the full results is presented in Table 3-1. This table includes the compounds mentioned above, also those with odour thresholds, and in addition those compounds having long term EALs where available.

It is evident that the travelling blank gives a similar magnitude result to the actual site samples in the case of a number of compounds, as for instance in the case of pentane, indicating caution is appropriate in considering the very low reported absolute concentrations.

A graphic showing a selection of the principal volatile organic compounds is in Figure 3-1. This clearly shows the compounds having higher concentrations at the downwind locations than found in the upwind sample at the property. These compounds tend to be those potentially originating in fuel and plant equipment exhaust, with certain exceptions such as in the case of styrene.

Table 3-1 Summary Results with Odour Thresholds and Long-term EALs

Run Time, mins	Assignment	Measured Concentration, ng/l				Odour Threshold, ng/l	Long Term EAL, µg/m ³
		Tregony, Cornwall Dr	Downwind	Downwind E Boundary	Travel Blank		
2.40	Methanol	20	20	15	13	190000	2660
2.50	1-Butene	nd	2.4	0.81	0.73	1200	
2.60	n-Butane	1.9	3.3	1.7	2.0	490000	14500
3.43	Ethanol	1.6	1.2	0.57	0.4	55000	
3.83	2-Methyl butane	0.97	2.6	0.93	2.5	-	6000
4.13	2-Propenal	0.08	0.12	0.04	0.06	410	
4.21	Acetonitrile	2.0	4.0	2.4	4.3	170000	680
4.28	Acetone	0.88	1.9	2.4	1.4	35000	18100
4.34	Isopropanol	0.66	0.9	0.93	1.2	26000	9990
4.38	n-Pentane	2.5	7.3	5.5	3.4	95000	
5.39	Dichloromethane	1.6	1.3	0.7	1.2	100000	700
5.57	Carbon disulphide	0.18	0.91	nd	nd	300	64
6.25	2-Methyl pentane	0.30	1.2	0.92	0.79	-	
6.26	Cyclopentane	0.32	1.4	0.4	0.5	-	
6.66	Acetic acid	1.3	3.1	1.1	1.3	360	250
6.71	3-Methyl pentane	0.09	0.18	0.1	0.16	-	
6.82	Methyl vinyl ketone	0.12	nd	nd	nd	570	
6.90	1-Hexene?	nd	2.4	1.4	nd	-	
7.00	Butanal	0.05	nd	nd	nd	28	
7.14	2-Butanone	0.5	0.6	0.05	0.09	23000	6000
7.16	n-Hexane	nd	0.63	0.91	0.16	79000	720
7.63	Ethyl acetate?	0.05	0.09	nd	nd	9800	
8.14	Tetra-hydrofuran	nd	0.35	0.21	0.05	11000	
8.78	C ₆ H ₁₂ alkene	nd	1.0	0.53	nd	-	
8.87	3-Methyl butanal	0.17	nd	nd	nd	8.1	
9.04	1-Butanol	0.05	nd	nd	0.07	1500	
9.19	Benzene	1.1	13	11	0.41	12000	5*
9.20	Cyclohexane	0.05	0.08	0.07	0.04	78000	
9.23	Carbon tetrachloride	0.02	0.02	0.04	nd	120000	130
10.10	n-Heptane	0.24	0.92	0.71	0.11	41000	
11.60	Dimethyl disulphide	4.1	nd	nd	nd	48	
12.21	Toluene	2.8	7.1	5.9	0.33	5900	1910
14.01	2,4-Dimethyl heptene	nd	4.9	3.4	nd	-	
14.76	Ethyl benzene	0.23	5.8	4.3	nd	29000	4410
14.71	m- /o- Xylene isomers	0.79	1.4	0.88	0.06	1750	441
15.40	n-Nonane	0.05	0.44	0.37	nd	6800	
15.52	Styrene	0.12	5.7	2.6	0.12	630	800
15.61	o-Xylene	0.21	0.45	0.32	nd	3800	

Run Time, mins	Assignment	Measured Concentration, ng/l				Odour Threshold, ng/l	Long Term EAL, µg/m ³
		Tregony, Cornwall Dr	Downwind	Downwind E Boundary	Travel Blank		
16.34	(1-Methylethyl)-benzene	nd	0.82	0.61	nd	-	
16.63	a-Pinene	nd	0.3	0.2	nd	3900	
17.29	Benzaldehyde	2.2	2.4	1.5	1.4	190	
17.30	Phenol	2.2	0.4	2.1	0.4	430	200
17.37	1,3,5-Trimethyl-benzene	0.04	0.3	0.81	nd	1100	1250
17.70	Dimethyl trisulphide	0.25	nd	nd	nd	8.7	
17.75	n-Decane	0.07	1.5	0.79	nd	4400	
18.01	1,2,4-Trimethyl-benzene	0.11	0.49	0.15	nd	780	1250
18.25	2-Ethyl-hexanol?	nd	0.37	0.2	nd	1300	
19.69	Acetophenone	1.6	2.0	2.7	0.52	1800	
20.10	Nonanal?	0.12	0.43	0.3	0.22	13	
21.13	Benzoic acid	5.3	2.0	3.2	2.1		
22.14	Decanal	nd	0.45	0.34	0.26	5.9	
22.49	Naphthalene	nd	0.19	0.07	nd	79	530

*UK Air Quality Strategy Objective for benzene, annual mean.

nd = not detected (i.e. below limit of detection for that compound)

? = tentative assignment by the laboratory

3.2. Interpretation of Results

3.2.1. Odour

The three compounds that were identified at low levels only in the Tregony, Cornwall Drive, sample (3-methyl butanal, dimethyl disulphide and dimethyl trisulphide) are shown in bold type in Table 3-1. The aldehyde, 3-methyl butanal, was found at a concentration of 0.17 ng/l which represents 2% of the very low odour threshold of 8.1 ng/l. The two sulphur compounds, dimethyl disulphide and dimethyl trisulphide, were found at concentrations of 4.1 ng/l and 0.25 ng/l respectively. These concentrations represent 8.5% and 2.8% of the respective characteristically low odour thresholds for organic sulphur compounds.

The five compounds noted as being present at higher concentrations in the downwind and boundary samples (benzene 2, 4-dimethyl heptene, ethyl benzene, styrene and naphthalene) are also highlighted in the table. These compounds were generally found at very small fractions of the odour threshold (well below one percent) and hence would not be noticeable.

In the Tregony, Cornwall Drive sample only one other substance, benzaldehyde, was marginally above 1% of the odour threshold (i.e. two orders of magnitude below the concentration at which odour may be just detected), as was the case for the downwind sample. This substance was, however, found in only slightly lower concentrations in the site boundary sample and the travelling blank.

On the basis of the above measurements, none of the measured organic compounds considered in isolation is at a sufficiently high concentration to cause a perceptible odour at any of the locations monitored.

3.2.2. Human Health

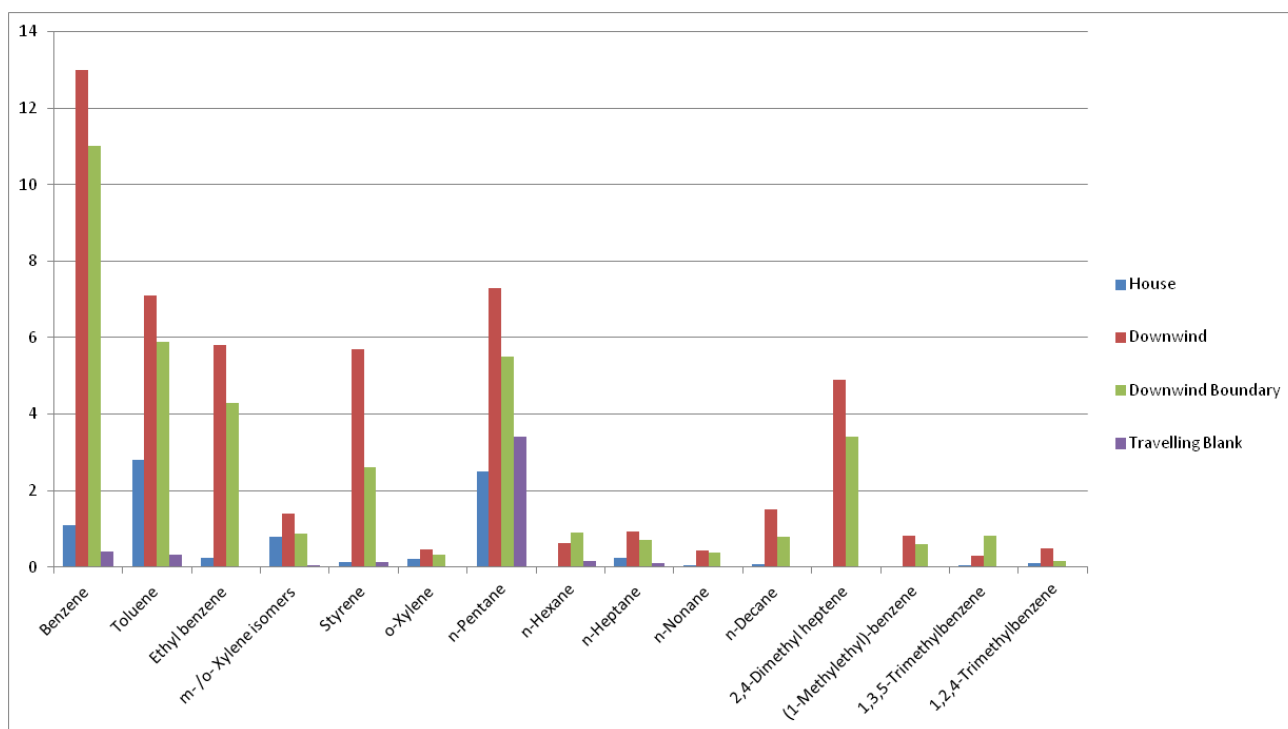
All the compounds found in the samples have been evaluated in the context of the long term EALs where applicable, and in the case of benzene, the UK Air Quality Strategy objective of $5 \mu\text{g}/\text{m}^3$ as an annual mean concentration. Note that the short sample times do not allow a direct comparison with annual average criteria, as the criteria relate to exposure over a period of 12 months. These spot sample results in close proximity to the waste site are to be considered as an indication of conditions at the time of sampling; the results are likely to differ on another occasion.

The benzene concentration was $1.1 \mu\text{g}/\text{m}^3$ at the upwind location at Tregony, Cornwall Drive, but was higher than the AQS objective at the downwind location and the site boundary location, $13 \mu\text{g}/\text{m}^3$ and $11 \mu\text{g}/\text{m}^3$ respectively. Although these results are not representative of long term exposure, it does suggest that the waste site is a potential source of benzene. This compound is not, however, a combustion product and in the urban environment is generally associated with evaporative emissions from vehicles. It was noted that there was mobile plant in operation within the site during the monitoring exercise and hence this may be the source. As the result at Tregony was lower, it is unlikely that the nearby A road is a contributing factor.

Of the other compounds identified, all but a few were below one percent of the long term EAL. In the downwind sample, carbon disulphide and acetic acid were found at concentrations representing 1.4% and 1.2% of the EAL. Phenol was found at concentrations of approximately 1.1% in both the Cornwall Drive and site boundary sampling locations; the downwind result for phenol, some 20% lower, was the same as the travelling blank.

There is hence a margin of at least two orders of magnitude between the compounds identified and their respective long-term EALs; in many cases there is an even greater margin of several orders of magnitude.

Figure 3-1 Principle Volatile Organic Compound Concentrations, ng/l



4. Conclusions

Atkins Limited undertook ambient air monitoring for a wide range of volatile organic compounds in the vicinity of the Waste4Fuel Limited site on 22nd January 2014. The measurement technique employed is highly sensitive and is suitable to detect at very low concentrations a wide range of organic compounds, including those associated with waste degradation products and those associated with residual smouldering of waste within the stockpiled materials.

The site was not on fire during the sampling; there was a prevailing south westerly wind. Samples were taken at a residential location in Cornwall Drive, and at a location downwind of the waste site at a distance similar to that of the residential location. A third sample was taken at the downwind site boundary.

The laboratory results were evaluated in the context of the long term EALs set by the Environment Agency for the protection of human health. For specific compounds the results were also considered in the context of odour thresholds where appropriate.

A few substances, namely an aldehyde and two organic sulphides, were found at higher concentrations upwind of the waste site on Cornwall Drive. The sensitive analytical procedure employed found these highly odorous substances at extremely low concentrations that were between one and three percent of the respective odour thresholds. The source of these compounds is uncertain, but is not considered to be combustion; they potentially may be associated with the nearby drainage gully or waste bin at the property.

There were a small number of substances that were found in higher concentrations in the downwind and site boundary samples than in the upwind location on Cornwall Drive. At these downwind locations the spot sample concentrations of benzene were found to be approximately double the AQS objective concentration (this criterion is applicable to annual average exposure). Benzene, and other hydrocarbons, may be associated with emissions from the waste site, for example evaporative emissions from site plant.

Other than for benzene at the two downwind locations, the substances detected are at negligible fractions of their respective long-term EALs, and hence of no consequence in terms of human health. With regard to benzene, whilst the long-term objective was exceeded there is no suggestion based on the spot sampling that there would be exceedences at any relevant location over a period of a year. These spot sample results in close proximity to the waste site are to be considered as an indication of conditions at the time of sampling; the results are likely to differ on another occasion.

None of the measured organic compounds are at a sufficiently high concentration to cause in isolation a perceptible odour at any of the locations monitored. It should be noted however that individual response to odour is variable, and that combinations of various odorous compounds can affect the perception of odour.

Appendices

Appendix A. Sampling Locations

A.1. Sample Location Photographs

Figure A-1 Sample A - Tregony, Cornwall Drive



Waste pile visible in background beyond property

Figure A-2 Sample B - Downwind Location



Waste site boundary visible in background; sampling equipment in foreground

Figure A-3 Sample C - Site Boundary Location



Waste visible behind plastic sheeting above boundary fence.

Appendix B. Analytical Report

B.1. SGS M-Scan Report

The analytical report on the samples taken in the vicinity of the Waste4Fuel Limited site on 22nd January 2014 is attached in this Appendix.

Roland Woodbridge

Atkins
Woodcote Grove
Ashley Road
Epsom
KT18 5BW

roland.woodbridge@atkinsglobal.com

+44(0)1372756013

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