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Interim Health Risk Assessment of air quality monitoring results: Biffa Landfill, Redhill, Surrey

Non-Technical Summary

Public Health England (PHE) - Centre for Radiation, Chemical and Environmental Hazards (CRCE) have reviewed the available volatile organic compound (VOC) and hydrogen sulphide (H_2S) monitoring data collected in the vicinity of the Redhill Landfill site.

It is important to make a distinction between concerns about odour and any toxicological effect from exposure to airborne chemicals. The aim of this risk assessment is to interpret the available data in relation to potential toxicological effects.

The data provided to PHE by the Environment Agency (EA) have been compared to available health based air quality guidelines and standards or assessment levels for hydrogen sulphide and the individual VOCs identified. Where the concentrations in air are shown to be lower than appropriate standards or guidelines, it may be assessed that the risk to health is minimal.

However, it is useful to note the public concerns in relation to odours. The human nose is very sensitive to odours, and substances that are perceived as odorous are commonly present at levels below which there is a direct toxicological effect. Odours can cause nuisance amongst the population possibly leading to stress and anxiety. Some people may experience symptoms such as nausea, headaches or dizziness, as a reaction to odours even when the substances that cause those smells are themselves not harmful to health.

Odours often consist of a mixture of substances. Each chemical substance may be detected analytically, however this cannot be translated into what odour is perceived. The EA are continuing to monitor odour complaints. All efforts should be taken to reduce off-site odours to as low as is reasonably practical.

Scope

CRCE has reviewed the available air quality monitoring results, and assessed them with respect to potential risks to human health. All interpretations contained in this document are based on the monitoring results supplied to CRCE by the EA up to the 8th April 2014.

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Methodology

Air quality standards and assessment levels

The data provided to PHE have been compared to available health based air quality guidelines and standards or assessment levels for hydrogen sulphide and the identified VOCs. There are a variety of health based standards and assessment levels that have been calculated by a number of organisations. The hierarchy of standards and assessment levels is shown below:

- World Health Organisation (WHO) air quality guidelines
- UK air quality standards
- European air quality standards
- Other UK air quality assessment levels
- National air quality assessment levels (other than UK)

Air quality monitoring results and discussion

Volatile Organic Compounds (VOCs)

A range of chemicals classed as volatile organic compounds (VOCs) are usually present in ambient air from a variety of sources, and may also be found at landfill sites in varying concentrations. Some VOCs may have odorant properties i.e. have a smell, which are considered unpleasant, whereas other VOCs do not smell.

Air quality monitoring has been carried out by the EA to monitor VOC concentrations around the Biffa Redhill landfill site.

The data for the VOCs were collected using a passive sampling approach. Two sets of 4 diffusion tubes were deployed over two different time periods (1st set of 4 diffusion tubes were deployed for 17 days- 14/02/2014 to 03/03/2014; 2nd set of 4 diffusion tubes were deployed for 14 days- 03/03/2014 to 17/03/2014) at four locations around the landfill site, in residential areas. As such, the data show average concentrations of the identified VOCs in the air at the sampling locations, over roughly two 2-week averaging periods. For the first sampling period (14/02/2014 to 03/03/2014), two out of the four diffusion tubes were damaged and therefore the results have been discounted for those two tubes, so data from a total of 6 tubes were assessed.

Table 1 shows a summary of the identified VOC concentrations from the monitoring results, compared with available health based standards or assessment levels. Not all chemicals have stipulated UK air quality standards, assessment levels or WHO guidelines associated with them. Where this is the case, relevant alternative guidelines will be utilised for assessment of the reported concentrations of those chemicals in the air.

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Table 1: Summary of the identified VOCs

	Sample Location				WHO guideline or UK Air Quality standard	EA Environmental assessment level (EAL)[1]
Chemical	**Canalside/ Holmesdale Avenue**	**Paritt Road/ Goodworth Road**	**Oakwood Close**	**Chilmead Farm**	(µg/m^3)	(µg/m^3)
Acetone (µg/m^3)	10.9	<2	7.796	23.6	-	18100 [annual mean][1]
Benzene (µg/m^3)	4.0	3.3	5.6	5.6	5 UK Air Quality Strategy limit[2]	-
Cyclohexane (µg/m^3)	<2	<2	<2	2.2	-	-
Dichloromethane (µg/m^3)	<2	2.5	3.1	4.2	3000 [24 hour guideline]; 450 [weekly guideline] WHO Air quality guidelines[3]	-
Ethyl acetate (µg/m^3)	4.9	5.3	5.1	4.8	-	-
Hexane (µg/m^3)	21.8	20.9	22.6	32.3	-	720 [annual mean][1]
Heptane (µg/m^3)	<2	<2	<2	2.6	-	-
Isopropanol (µg/m^3)	4.9	5.0	<2	4.8	-	-
Methyl ethyl ketone (µg/m^3)	5.2	6.6	5.8	5.6	-	6000 [annual mean][1]
(ortho) xylene (µg/m^3)	2.4	<2	2.4	<2	-	4410 [annual mean][1]

[1] Environment Agency, H1 Environmental Risk Assessment - Annex F, v 2.2, December 2011 http://cdn.environment-agency.gov.uk/geho0410bsil-e-e.pdf

[2] Air Quality Strategy for England, Scotland and Wales , 2007. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69337/pb12670-air-quality-strategy-vol2-070712.pdf

[3] World Health Organisation, Air quality guidelines for Europe; second edition, Copenhagen, WHO Regional Office for Europe, 2000 http://www.euro.who.int/__data/assets/pdf_file/0005/74732/E71922.pdf

From the available data, the majority of the identified VOCs were significantly lower than the relevant air quality guidelines or standards, with the exception of benzene.

Benzene marginally exceeded the UK air quality standard (an annual average) at two locations (0.6 µg/m^3 above the comparator value of 5 µg/m^3 at Oakwood Close and Chilmead Farm). The data were collected over a two-week period; however, the relevant standard is an annual average. The use of an annual average value as a comparator is considered to be a conservative approach and the slight exceedance would not be expected to represent an increased threat to health. It is also useful to note that benzene is present in the environment from a number of different sources and the World Health Organisation (WHO)[3] has stated that ambient air concentrations of benzene in rural and urban areas are approximately 1 µg/m^3 and 5–20 µg/m^3 respectively (depending on the type of area). As such, it can be concluded that the health risk from the reported concentrations are low.

There is no WHO, European or UK air quality standard or guideline level for ethyl acetate. A review of literature located an occupational health threshold from the United States' National Institute of Occupational Health and Safety Administration (NIOSH)[4]. Ethyl acetate is a common ingredient in products such as nail varnishes, perfumes and wood lacquers and varnishes. The Association of Ecological Research Institutes (AGÖF)[4] in Germany reported average indoor air concentrations of ethyl acetate to be approximately 3– 22 µg/m^3; AGÖF have produced a Guidance value of 23 µg/m^3 for maximum indoor air concentrations. Similarly, an American study approximated (residential) indoor air concentrations of ethyl acetate being up to 31 µg/m^3. The Organisation for Economic Co-operation and Development (OECD)[5] has published outcomes of occupational health based studies for ethyl acetate, noting that inhalational exposure to air concentrations of approximately 7,00,000 µg/m^3 was without notable effect on health. The monitoring data results for ethyl acetate are significantly below all these values and therefore the recorded levels of ethyl acetate are not considered to be hazardous to health.

There is no WHO, European or UK air quality standard or guideline level for cyclohexane. However, the United States' Environmental Protection Agency (EPA) has derived a health-based inhalation Reference Concentration (RfC) for cyclohexane, of 6000 µg/m^3 over 24 hours[6]. The RfC is an estimate of the daily inhalation exposure of populations (including sensitive persons in the population) that is likely to be without an appreciable risk to health. Comparatively, cyclohexane

[4] AGÖF (The Association of Ecological Research Institutes) Germany, Guidance Values for Volatile Organic Compounds in Indoor Air,2013. http://agoef.de/agoef/oewerte/orientierungswerte_englisch.html#2

[5] OECD (Organisation for Economic Co-operation and Development), Screening Information Dataset (SIDS) Initial Assessment Report. Ethyl acetate. CAS No 141-78-6. SIAM 14 Paris, 2002. http://webnet.oecd.org/Hpv/UI/handler.axd?id=ce040b66-8367-47c0-aa41-599974654113

[6] United States' Environmental Protection Agency (US EPA), Cyclohexane (CASRN 110-82-7). http://www.epa.gov/iris/subst/1005.htm#refinhal

was detected at one location at an average concentration of 2.2µg/m^3, which therefore represents a minimal risk to health.

There is no WHO, European or UK air quality standard or guideline level for heptane. Heptane is a constituent of domestic fuel oil. However, the European Chemicals Agency (ECHA; an agency of the European Union) has published a Derived No Effect Level (DNEL)[7] of 447,000 µg/m^3, for long-term inhalational exposure to heptane. The monitoring data relayed a result of 2.6 µg/m^3 at one of the monitoring locations; as the reported concentration of heptane is significantly below the long-term DNEL, the reported concentration is not considered hazardous to health.

There is no WHO, European or UK air quality standard or guideline level for Isopropanol. The State of California's Office of Environmental Health Hazard Assessment (OEHHA) has produced a Chronic Reference Exposure Level (chREL)[8], which is a health-protective guideline level for continued inhalational exposure annually, for Isopropanol of 7000µg/m^3. It has been established[9] that the concentration in air for mild respiratory symptoms to occur are approximately 984,000 µg/m^3. The reported concentrations of Isopropanol were around 5µg/m^3; as such, the reported concentration is not considered hazardous to health.

Hydrogen Sulphide (H_2S)

Hydrogen sulphide was monitored by the EA and site operator Biffa. The EA have monitored for H_2S intermittently from the 24thFebruary 2014. Likewise, Biffa have monitored for H_2S, with 2014 data being generated from the 4th of February. The averaging periods for the Biffa and EA H_2S data points were between 1-3 minutes as they were spot samples, in keeping with the adopted monitoring methodology.

The World Health Organisation's guideline value for H_2S, is 150 µg/m^3 or 0.1 parts per million (ppm) over a 24-hour averaging period[3].

The data supplied have been analysed and compared with the WHO guideline value and they do not suggest that levels of hydrogen sulphide are consistently high enough to be considered hazardous to health. Ten of the monitoring results from Biffa and the EA were marginally over the WHO 24-hour guideline (Table 2). The use of a 24 hour guideline value as a comparator is considered to be a conservative

[7] The European Chemicals Agency (ECHA), Information on Chemicals- Heptane, http://apps.echa.europa.eu/registered/data/dossiers/DISS-9d977040-18be-0220-e044-00144f67d249/AGGR-c82cefd8-3dd2-4a77-8fbc-02095e32a107_DISS-9d977040-18be-0220-e044-00144f67d249.html#AGGR-c82cefd8-3dd2-4a77-8fbc-02095e32a107

[8] Office of Environmental Health Hazard Assessment (OEHHA), Air Toxicology and Epidemiology- Isopropanol, 2014. http://www.oehha.ca.gov/air/allrels.html

[9] International Programme on Chemical Safety (IPCS). Poisons Information Monograph (PIM) 290, Isopropyl Alcohol http://www.inchem.org/documents/pims/chemical/pim290.htm

approach and the slight exceedences would not be expected to represent an increased threat to health. The magnitude of these exceedences is also relatively small. Table 2 shows the concentrations which exceeded the WHO guideline value and the time and location of the exceedance.

Table 2: Summary of highest H_2S results (Biffa and EA data)

H_2S Samples above the WHO guideline value (0.1ppm)		
Location	**Date/Time**	**Concentration (ppm)**
Watercolours	04/02/2014 Morning	0.13
Redhill Station	04/02/2014 Afternoon	0.12
Cormongers cowfield end	06/02/2014 Morning	0.31
Cormongers cowfield end	08/02/2014 Morning	0.11
Cormongers cowfield end	10/02/2014 Afternoon	0.23
Chilmead farm	11/02/2014 Afternoon	0.20
Cormongers Lane	16/02/2014 Morning	0.11
Chilmead farm	26/02/2014 Morning	0.11
Cormongers Lane	16/03/2014 Morning	0.12
Goodworth Road (EA sample)	05/03/2014 Morning	0.12

Hydrogen sulphide is a gas which is notable for its rotten-egg type odour. It has an odour threshold of approximately 0.008ppm (11.0 µg/m^3) in air. A number of the data points in both the Biffa and EA monitoring data were above this odour threshold.
There are multiple sources of ambient H_2S. Hydrogen sulphide occurs both naturally and through human activity.

There is little in the way of published data on usual urban air concentrations of hydrogen sulphide, however, the World Health Organisation[3] has reported normal or 'background' concentrations to be approximately 0.0002 ppm. Likewise, the United States' Department of Health and Human Services estimated typical urban concentrations being at or below 0.0001ppm[10].

[10] U.S. Department of Health and Human Services, Agency for Toxic Substances and Disease Registry (ATSDR), Toxicological profile for Hydrogen Sulfide, 2006. http://www.atsdr.cdc.gov/ToxProfiles/tp114.pdf

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Conclusions

Overall the results for hydrogen sulphide and the identified volatile organic compounds from the available monitoring data are not high enough to be of concern toxicologically and are therefore unlikely to pose an appreciable risk to the nearby residents' short or long term health.

This interim health risk assessment is based on the currently available monitoring data. PHE understands that further air quality monitoring is to be undertaken by the Environment Agency and this report will be updated as appropriate when such data is available.

PHE recommends that all measures are taken to reduce the off-site odours from the landfill site, as it is acknowledged that odours can affect an individual's wellbeing.

Guidance

Health Protection Agency, Odour - Frequently Asked Questions
http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1309970436356

Health Protection Agency, 2011, Impact on Health of Emissions from Landfill Sites
http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE18ImpactonHealthofEmissionsfromLandfillSites/