enviroparks

APPENDIX 9.1

Information on pollutants

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INFORMATION ON POLLUTANTS

Ammonia

Ammonia is mainly derived from agriculture, primarily livestock manure / slurry management and fertilisers. A small proportion is also derived from variety of sources including transport and waste disposal. It can lead to damage of terrestrial and aquatic ecosystems through the deposition of eutrophying pollutants and through acidifying pollutants. It is a precursor to secondary Particulate Matter, and therefore contributes to the ill-health effects caused by PM_{10} and $PM_{2.5}$.

Benzene

Benzene has a variety of sources, but primarily arises from domestic and industrial combustion and road transport. Benzene is a recognised human carcinogen which attacks the genetic material and, as such, no absolutely safe level can be specified in ambient air.

1,3-Butadiene

1,3-Butadiene is mainly emitted as a result of the combustion of petrol, and thus vehicle emissions are the predominant source. 1,3-butadiene is a recognised genotoxic human carcinogen, and as such, no absolutely safe level can be specified in ambient air.

Carbon Dioxide

Levels of Carbon Dioxide are not considered directly by Air Quality legislation, however they are important due to their contribution to the greenhouse effect. The greenhouse effect is the warming of the earth's atmosphere, due to an increase in certain gases within it. These greenhouse gases are responsible for controlling the levels of radiation allowed into and out of the atmosphere, however an increase in the gases can lead to a reduced release of the radiation, and therefore an increase in the temperature experienced by the earth. Carbon Dioxide is probably the most important of the greenhouse gases as it accounts for the largest proportion of these trace gases and is currently responsible for 60 % of the enhanced greenhouse effect.

Under steady state conditions, the amount of carbon dioxide taken out of the atmosphere by plants is almost perfectly balanced with the amount put back into the atmosphere by respiration and decay. However, small changes as a result of human activities can have a large impact on this delicate balance. The burning of fossil fuels releases the Carbon Dioxide stored within them, and similarly, deforestation releases the Carbon stored in trees. Deforestation also results in less Carbon Dioxide

being removed from the atmosphere. Thus, whilst ambient levels of Carbon Dioxide do not have any direct health effects, the effect on the environment and the balances within the world's ecosystem can lead to the indirect health and lifestyle effects of extreme weather, the resultant impacts on disease, and effects on agriculture.

Carbon Monoxide

Carbon Monoxide is formed from the incomplete combustion of Carbon based fuels. The largest pollutant source is road transport, with residential and industrial combustion also making significant contributions. Carbon Monoxide substantially reduces the capacity of the blood to carry Oxygen to the body's tissues, and blocks important biochemical reactions in cells. People with existing diseases which affect delivery of Oxygen to the heart or brain, such as angina, are at particular risk of adverse side effects, although ambient concentrations in the UK are well below that at which health effects can occur.

Dioxins and Furans

Dioxins are a family of complex chemicals containing chlorine. There are several hundred Polychlorinated-p-Dioxins (PCDDs) and the related Polychlorinated-p-Furans (PCDFs), and some Dioxin-type compounds are toxic at very low levels. The most toxic is 2,3,7,8-Tetrachloro-Dibenzo-p-Dioxin, which is often referred to 2,3,7,8-TCDD, or just TCDD.

PCDDs and PCDFs have never been intentionally manufactured but are formed inadvertently by a number of human activities such as the burning of fuels and wastes, metallurgical processing and pulp and paper processing. They are also formed by several natural processes including forest fires and volcanoes. Within anthropogenic combustion processes, Dioxins are formed preferentially in the cooler, post combustion region, between temperatures of 450 – 250 ^{o}C, and thus the main control mechanism for minimising the formation of Dioxins is the minimisation of the period at which the flue gases pass through this temperature range. The main sources of Dioxin and Furan production in England and Wales, however, are metal processing operations.

Because Dioxins are formed in many types of uncontrolled combustion processes, there have been emissions to the environment throughout geological time, although natural sources are thought to contribute relatively little to present day background levels. Exposure levels have declined considerably in the UK since the 1970s when Dioxins were first recognised as highly toxic chemicals and actions to reduce pollution were introduced. However, Dioxins are highly persistent trace chemicals and can be found in soils, sediments in freshwater and the sea, plants and animals, including humans. They belong to the family of chemicals known as 'Persistent Organic Pollutants' (POPs), which are subject to international treaty agreements to reduce exposure. Due to their persistence, Dioxins may be transported for many thousands of kilometres from their original site of release by the processes of evaporation / re-suspension and re-deposition from the atmosphere. Dioxins bound onto soil particles can be transported large distances in rivers to deposit in freshwater and marine sediments.

Once released into the atmosphere, Dioxins exist both in the gas phase and can be bound to particles. Being highly insoluble in water, Dioxins bound to soils or sediments and are resistant to leaching out, degrading very slowly and so persisting for many years. Dioxins deposited onto grass (and to a lesser extent, soil) may be taken up by livestock and enter the human food chain in milk and meat. Dioxins in aquatic sediments can also enter the human food chain via fish. A wide range of toxicological effects have been observed in wildlife experimentally exposed to Dioxins. They range from chronic to acute effects and include reduction in reproductive success, growth defects, suppression of the immune system and development of cancer.

Heavy Metals

The term 'Heavy Metals' is a general collective term which includes metals such as Cadmium, Chromium, Copper, Mercury, Lead, Zinc, Arsenic and Boron. Combustion processes are the most important sources of Heavy Metals, particularly, power generation, smelting, incineration and use of internal combustion engines, however they are used widely in electronic components, machinery and materials.

As Heavy Metals are elements, they do not break down and are therefore persistent in the environment. Unlike many organic pollutants, which eventually degrade to Carbon Dioxide and Water, Heavy Metals will tend to accumulate especially in lake, estuarine or marine sediments. Many of the Heavy Metals group are toxic to organisms at low concentrations, however some, such as Copper and Zinc are also essential elements.

Hydrogen Chloride

Hydrogen Chloride occurs both naturally and through anthropogenic activities. The main source of Hydrogen Chloride releases are coal fired power stations, however, small quantities are also released from waste incineration processes.

Hydrogen Chloride is highly corrosive and attacks many metals, and stones such as limestone, resulting in the corrosion of buildings and other cultural monuments. It is also an irritant. The gas dissolves in water to form a strong acid which at high concentration is toxic to aquatic life. Due to its high solubility, Hydrogen Chloride has a tendency to wash out of the atmosphere in rain thus limiting the distance over which the releases may be spread. Certain types of soil and water bodies may be particularly sensitive to inputs of acid rain above defined critical loads, due to their naturally high acidity. Such sensitive areas are found in Scotland, Wales and other parts of upland Britain.

Hydrogen Fluoride

Hydrogen Fluoride is similar in source and nature to Hydrogen Chloride, being formed both naturally primarily through volcanic activity, and also through anthropogenic sources such as coal fired power stations and other high temperature industrial and combustion processes.

Hydrogen Fluoride is too reactive to persist for prolonged periods in the environment and is rapidly converted to other Fluorides, being neutralised through the formation of inorganic Fluoride salts. It is

a strong mineral acid capable of dissolving glass and attacking many metals, minerals and organic substances. Hydrogen Fluoride emissions can cause damage to plants and be harmful to cattle and domestic animals. It is very corrosive in solution. Fluoride accumulates in the teeth and bones of animals and high doses can cause abnormalities such as discoloration of teeth and skeletal deformities.

Oxides of Nitrogen

All combustion processes produce Oxides of Nitrogen (NO_x). NO_x is the term used for a combination of Nitrogen and Oxygen based species, such as Nitrogen Dioxide (NO_2) and Nitric Oxide (NO). NO_x from combustion is formed of approximately 95 % NO, however, this quickly reacts with Ozone in the atmosphere to form NO_2. Road transport is the main source of NO_x pollution, followed by the electricity supply industry and other industrial and commercial sectors.

NO_2 is associated with adverse effects on human health. At high levels NO_2 causes inflammation of the airways, and long term exposure may affect lung function and respiratory symptoms. NO_2 also enhances the response to allergens in sensitive individuals.

High levels of NO_x can have an adverse effect on vegetation, including leaf or needle damage and reduced growth. Deposition of pollutants derived from NO_x emissions contribute to the acidification and / or eutrophication of sensitive habitats leading to loss of biodiversity, often at locations far removed from the original emissions. NO_x also contributes to the formation of secondary particles and ground level ozone, both of which are associated with ill-health effects.

Ozone

Ozone is not emitted directly from any human-made source, arising instead from chemical reactions between various air pollutants, primarily NO_x and Volatile Organic Compounds (VOCs), initiated by strong sunlight. Formation can take place over several hours or days and may have arisen from emissions many hundreds, or even thousands of kilometres away.

Exposure to high concentrations may cause irritation to eyes and nose. Very high levels can damage airways leading to inflammatory reactions. Ozone reduces lung function and increases incidence of respiratory symptoms. Ground level Ozone can also cause damage to many plant species leading to the loss of yield and quality of crops, damage to forests and impacts on biodiversity.

Particulate Matter

Particulate Matter (PM) is categorised on the basis of the size of the particles (for example $PM_{2.5}$ refers to particles with a diameter of less than 2.5 µm). PM is made up of a wide range of materials and arise from a variety of sources. Concentrations of PM comprise primary particles emitted directly into the atmosphere from combustion sources and secondary particles formed by chemical reactions in the air.

Particulate Matter derives from both human-made and natural sources (such as sea spray and Saharan dust). In the UK the biggest human-made sources are stationary fuel combustion and transport. Road transport gives rise to primary particles from engine emissions, tyre and brake wear and other non-exhaust emissions. Other primary sources include quarrying, construction and non-road mobile sources. Secondary PM is formed from emissions of Ammonia, Sulphur Dioxide and Oxides of Nitrogen as well as from emissions of organic compounds from both combustion sources and vegetation.

Both short-term and long-term exposure to ambient levels of PM are consistently associated with respiratory and cardiovascular illness and mortality as well as other ill-health effects. The associations are believed to be causal. It is not currently possible to discern a threshold concentration below which there are no effects on the whole population's health.

PM_{10} roughly equates to the mass of particles less than 10 µm in diameter that are likely to be inhaled into the thoracic region of the respiratory tract. Reviews by the World Health Organisation (WHO) and Committee on the Medical Effects of Air Pollutants (COMEAP) have suggested exposure to a finer fraction of particles ($PM_{2.5}$, which typically make up around two thirds of PM_{10} emissions and concentrations) give a stronger association with the observed ill health effects, although the more coarse fraction between (PM_{10} – $PM_{2.5}$) also has some effects on health[(1)].

Poly Aromatic Hydrocarbons

There are many different Poly Aromatic Hydrocarbons (PAHs) emanating from a variety of sources, although Benzo[a]Pyrene (B[a]P) is often used as a marker for the most hazardous PAHs. The main sources of B[a]P in the UK are domestic coal and wood burning, fires (e.g. accidental fires, bonfires, forest fires, etc), and industrial processes such as coke production. Road transport is the largest source for total PAHs, but this source is dominated by species thought to be less hazardous than B[a]P.

Studies of occupational exposure to PAHs have shown an increased incidence of tumours of the lung, skin and possibly bladder and other sites. Lung cancer is most obviously linked to exposure to PAHs through inhaled air. Individual PAHs vary in their ability to induce tumours in animals or humans. The carcinogenic potency of some PAHs is unknown or uncertain. Individual PAHs have been classified by the International Agency for Research on Cancer, with three classified as "probably carcinogenic to humans", including B[a]P, and three classified as "possibly carcinogenic to humans".

Poly Chlorinated Biphenyls

Poly Chlorinated Biphenyls (PCBs) are a family of substances which are good electrical insulators. They are chemically stable, fire resistant and don't easily generate a vapour. PCBs were used as dielectric filler liquids in some types of electrical equipment such as transformers, switchgear, capacitors and in the starter units of fluorescent lights and fractional horsepower motors. They belong to the family of chemicals known as 'Persistent Organic Pollutants' (POPs), which are subject to international treaty agreements to reduce exposure. Due to their persistence, they break down slowly and can enter food chains. PCBs can cause a skin condition called Chloracne, which produces

pustules, blackheads and cysts[2]. In animals PCBs can cause damage to the liver, reduce the ability to fight infection, as well as other effects.

Sulphur Dioxide

UK emissions of Sulphur Dioxide (SO_2) have historically been dominated by combustion of fuels containing sulphur, such as coal and heavy oils by power stations and refineries. The main sources of SO_2 emissions are electricity generation, industrial and domestic fuel combustion, although total SO_2 emissions have decreased substantially, in line with changes in fuel use and commitments to international agreements. Exposure to significant levels of SO_2 causes constriction of the airways of the lung. This effect is particularly likely to occur in people suffering from asthma and chronic lung disease.

Sulphur Dioxide is also a precursor to secondary Particulate Matter and therefore can contribute to the ill-health effects caused by PM_{10} and $PM_{2.5}$. It has the potential to damage ecosystems at high levels, including through the degradation of chlorophyll, reduced photosynthesis, raised respiration rates and changes in protein metabolism. Deposition of pollution derived from SO_2 emissions also contribute to the acidification of soils and waters and the subsequent loss of biodiversity, often at locations far removed from the original emissions.

Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are a group of hydrocarbon based compounds which can be released from natural sources such as trees, vegetation, biomass, volcanoes, springs etc, accounting for approximately 80 % of the release, or man-made emissions, such as domestic and industrial activities, road, marine and air transport. Emissions of some VOCs e.g. Benzene and 1,3-Butadiene may have significant health consequences, due to their toxicity or carcinogenic characteristics, however VOCs in general have been associated with various atmospheric effects.

The main effect is of Ozone formation in the troposphere, known as ground level Ozone. In the presence of ultra-violet radiation from the sun, NO_x can react to form Ozone, and the presence of VOCs in the atmosphere accelerates this reaction. Ozone can cause damage to human and animal health, vegetation, and building materials when present at prolonged elevated concentrations.

REFERENCES

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