

Waste recycling, treatment and disposal sites

*landfills and other waste treatment or
waste disposal sites*

Industry Profiles, together with the Contaminated Land Research Report series, are financed under the Department of the Environment's contaminated land research programme.

The purpose of these publications is to provide regulators, developers and other interested parties with authoritative and researched advice on how best to identify, assess and tackle the problems associated with land contamination. The publications cannot address the specific circumstances of each site, since every site is unique. Anyone using the information in a publication must, therefore, make appropriate and specific assessments of any particular site or group of sites. Neither the Department or the contractor it employs can accept liabilities resulting from the use or interpretation of the contents of the publications.

The Department's Contaminated Land Research Report series deals with information needed to assess risks; procedures for categorising and assessing risks; and evaluation and selection of remedial measures.

General guidance on assessing contaminated land and developing remedial solutions which is complementary to the Department's publications is provided by the Construction Industry Research and Information Association (CIRIA).

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DOE Industry Profile

Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites

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Preface

DOE Industry Profiles provide developers, local authorities and anyone else interested in contaminated land, with information on the processes, materials and wastes associated with individual industries. They are not definitive studies but they introduce some of the technical considerations that need to be borne in mind at the start of an investigation for possible contamination.

Every site is unique. Investigation of a site should begin with documentary research to establish past uses. Information on the site's history helps to focus a more detailed investigation. This knowledge needs to be supplemented by information on the type of contamination that may be present and where on site it may be found. Profiles give information on the contamination which might be associated with specific industries, factors that affect the likely presence of contamination, the effect of mobility of contaminants and guidance on potential contaminants.

The date when industrial practices first commenced on a site and its location are important clues in establishing the types of operations that may have taken place, so each profile provides a summary of the history of the industry and its likely geographical spread within the United Kingdom.

Profiles should be read with the following reservations in mind:

individual sites will not necessarily have all of the characteristics described in the profile of that industry;

practices can vary between sites and change over time;

as practices change, problems of possible contamination may also change;

the profile may refer to practices which are no longer followed, and may omit current practices which avoid contamination.

The risks presented by contaminated sites depend on the nature of the contaminants, the targets to which they are a potential threat (such as humans or groundwater) and the routes or pathways by which they reach these targets. The current or proposed use of a site and its environmental setting are crucial in deciding whether treatment is necessary and if so, the methods to be used. Some sites may not need treatment.

The information in profiles may help in carrying out Control of Substances Hazardous to Health (COSHH) assessments for work on contaminated land - see Health and Safety Guidance Note HS(G) 66 *Protection of workers and the general public during the development of contaminated land*, Health and Safety Executive, 1991, and *A guide to safe working practices for contaminated sites*, Construction Industry Research and Information Association, 1995.

Note: the chemical names given to substances in this profile are often not the modern chemical nomenclature, but the names used historically for those substances.

Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites

1. Background

This profile deals with the following types of waste management facilities:

- waste transfer stations
- landfill sites
- household/commercial waste incinerators.

The discussion of landfill sites in this profile includes the disposal of hazardous waste in them. Another profile in this series (see Section 4) considers the treatment of hazardous waste by incineration and by physical, chemical and biological methods.

1.1 History

1.1.1 Legislation

In the 19th Century there was a growing appreciation that such matters as a good water supply, the provision of sewers and the removal of nuisances were, in the words of the Royal Commission on Public Health of 1868, 'necessary for civilized social life'. Parliament first gave local authorities permissive powers to remove nuisances and after 1866 made their removal compulsory. Energetic Victorian local authorities passed by-laws to enable them to collect and dispose of waste.

The chief landmarks in national legislation on the waste management have been:

Various 19th Century Public Health Acts gave local authorities the power to inspect for and remove accumulations or deposits prejudicial to health or a nuisance.

Under the Public Health Act 1936 local authorities could provide places for the deposit of waste (landfills) and plant or apparatus for treating or disposing of waste (incinerators, pulverisers, bulldozers etc). The Act also gave local authorities power to buy and sell waste.

The Town and Country Planning Act 1947 established the principle that planning permission is required for waste management sites.

The Local Government Act 1972 created waste disposal authorities (WDAs) which brought more resources and experience to bear on the management of landfills.

The Deposit of Poisonous Waste Act 1972 was implemented to control the deposit of industrial wastes on to land and into water. It became an offence to deposit poisonous, noxious or polluting waste in a manner likely to cause a hazard to health or the environment.

The Control of Pollution Act 1974 (COPA) introduced the concept of site

licensing for all disposal facilities for controlled waste (defined in the Act as household, commercial and industrial waste). The site licence was concerned mainly with the types of waste to be handled and the operation of the site. Site licensing began in 1976. Regulations for hazardous or 'special' waste were introduced under COPA in 1980.

The Environmental Protection Act 1990 (EPA) gave Waste Regulation Authorities (WRAs) the sole responsibility for the regulation of waste management in their areas.

EPA introduced the concepts of the Duty of Care for all wastes and Integrated Pollution Control (IPC) of wastes from the most polluting industries. The Act also provides a much enhanced system of licensing control on the management of waste and prevents a site operator surrendering his licence unless the site is unlikely to cause pollution of the environment or harm to human health.

The Environment Act 1995 created the Environment Agency which inherited the functions of Her Majesty's Inspectorate of Pollution (HMIP), the National Rivers Authority (NRA) and the WRAs on 1 April 1996.

1.1.2 Waste transfer stations

A number of cities were operating transfer stations at the beginning of the 20th Century. In Manchester, transfer stations were located within the city and wastes were sent from them, by road, railway wagons and barges, to two very large landfill sites outside the city. Some sorting of the waste was carried out at Manchester's transfer stations at this period.

Mechanised transfer stations were first built during the early 1930s. Compaction and baling operations may have been combined with sorting, screening and salvage operations (for example for paper, cardboard, rags, metals, bottles).

Modern transfer stations have been developed for the purpose of transferring waste from collection vehicles into larger vehicles for transport to landfill sites and may include plant to undertake sorting, segregation, compaction and baling of waste.

1.1.3 Landfill sites

Landfill sites were originally small informal and uncontrolled tips used by local authorities or industry for the disposal of waste to land. As urban sites became more scarce, larger sites were developed towards the edges of towns and cities.

The Report of the Working Party on Refuse Disposal (DOE 1971) defined controlled landfilling as 'the deposit and compacting of waste on land in shallow layers, and covering the exposed surfaces with inert material to form a seal'. The Report traced the origins of controlled landfilling to recommendations issued by the Ministry of Health in its annual report of 1931-32. Bradford Corporation pioneered controlled landfilling in the 1920s.

Prior to the 1970s the majority of sites had little or no engineering control of wastes beyond that provided by the local topography and geology. However, changes in legislation and increased awareness of the potential for causing harm to the

environment has led to a widespread improvement in operating practices and environmental protection at landfill sites.

Since the 1970s the trend has been to develop larger landfills (often with capacities greater than 5 million m³) which are sited away from urban centres.

On 31 March 1994 there were 3435 current landfill licences in Great Britain.

1.1.4 Incineration

The first successful waste incineration furnace was constructed in Manchester in 1876; between this date and 1914 some 338 incineration plants were constructed in the United Kingdom. Household waste at the time contained large portions of ash from domestic grates and dust and early incinerators were used to reduce the bulk of the waste. Fly ash and clinker residues left after incineration were used for road base and other building purposes or were deposited in a local landfill.

Between 1968 and 1976, about 45 incinerators were constructed in the United Kingdom for municipal solid waste (MSW). Five of these contained heat recovery facilities, two of which provided direct power generation.

In 1995 there were 20 MSW incinerators in operation.

1.2 Location

Waste handling and disposal sites are, and have been, widely distributed throughout the United Kingdom.

The Report on the Working Party on Refuse Disposal (DOE 1971) noted that the following sites have been used for landfills:

low lying land, marshland, saltings and foreshores, land in river valleys, some moorland and poor agricultural land

valleys, disused railway cuttings, disused canals, ponds and ravines

mineral excavations, for example stone quarries, claypits, gravel pits and chalk pits and 'flashes' created by mining subsidence.

The Report commented that generally, but not always, landfill sites have been selected where land could be improved by filling or raising of levels.

Under the Town and Country Planning (General Development Procedure) Order 1995 WRAs held information on old landfill sites in order to provide details to local planning authorities. This information holding function has now been transferred to the Environment Agency.

Incinerators have traditionally been located close to, or within, centres of population. More recently, this practice has been reinforced with the development of combined heat and power (CHP) schemes.

2. Waste management operations

2.1 Waste collection and transfer stations

Household waste, a significant proportion of commercial waste and some industrial waste have traditionally been collected by local authorities or private sector waste management companies acting under the management of local authorities. The balance of commercial and industrial waste is collected by private sector companies.

The majority of waste is transported by road, but some is transported by rail and barge. Waste may be transported directly to waste disposal sites such as landfills or incinerators, or it may pass through waste transfer stations where it is subject to processes such as sorting, compaction and baling prior to transfer to waste disposal sites. Transfer stations may be licensed to receive special waste, but this is not common.

At some transfer stations waste is converted to pellets of refuse derived fuel (RDF).

Waste collection sites (civic amenity sites) are often located at transfer stations for use by the public for the disposal of bulky wastes, difficult materials such as oil and paints, garden and other organic wastes. Recently some sites have received materials for recycling.

DOE Waste Management Papers 1 (A Review of Options: A memorandum providing guidance on the options available for waste treatment and disposal) and 4 (Licensing of Waste Management Facilities) describe the main characteristics of present day transfer and treatment plants (see Section 4).

2.2 Landfill sites

2.2.1 Landfills accepting domestic, industrial and commercial waste

The two basic principles of controlled landfilling set out in the Ministry of Health annual report of 1931-32 were the deposition of waste in compacted layers and the application of covering layers of inert material. These practices were intended to control nuisances such as odours, litter, flies and rodents and also reduce the risk of fires within the landfill. Similar principles are generally applied to modern landfill sites but whereas older landfills were simply progressively filled in layers, modern landfills generally comprise a number of engineered cells.

In older landfills, lining materials were not used on the base or sides of the site prior to accepting waste and there was little control over the effects of the wastes on the surrounding environment. Modern landfills take one of two forms: containment sites or attenuation and dispersal sites. Attenuation and dispersal sites are developed after consideration of the characteristics of the expected leachate and the underlying and surrounding strata. They rely upon the slow release of leachate, and use physical, chemical and biological processes operating within the waste and in the underlying strata to reduce the levels of potential pollutants. At containment sites leachates are contained by pre-existing low permeability strata or by the application of lining materials.

Older sites tended to receive minimal restoration, with any capping generally consisting of a thin layer of soil. Modern landfill restoration typically makes use of

low permeability capping materials and sites are mounded to encourage run-off of surface water, thereby reducing the amount of rainfall infiltrating the landfill and hence the volume of leachate generated.

Section 39 of the Environmental Protection Act 1990, brought into force in 1994, sets out the procedure for the surrender of waste management licences by operators. Certificates of completion can only be issued by the Environment Agency if it is satisfied that the site is unlikely to cause pollution of the environment or harm to human health. DOE Waste Management Paper 26A (Landfill completion - a technical memorandum providing guidance on assessing the completion of licensed landfill sites) gives advice on the surrender of licences (see Section 4).

The waste that could be accepted at a landfill may have been described in the planning permission before site licensing was introduced in 1976. Descriptions were often very broad, for example 'trade waste', and a wide variety of wastes may have been legitimately accepted.

2.2.2 Landfills accepting hazardous/special waste

The term 'hazardous waste' is not defined in United Kingdom legislation because all waste can be considered hazardous waste if it is disposed of incorrectly. However, the United Kingdom legal definition of 'special waste' is generally understood to represent the most hazardous waste. The Control of Pollution (Special Waste) Regulations 1980 define special waste as any controlled waste which consists of or contains one or more listed substances which by reason of their presence make the waste dangerous to life or flammable. DOE Waste Management Paper 23 (Special wastes: a technical memorandum providing guidance on their definition) provides advice on the examination of wastes according to the criteria contained in the Special Waste Regulations 1980. New special waste regulations are expected to come into force in the summer of 1996 (see Section 4).

Landfill of special waste has generally been by a system of co-disposal, whereby the beneficial chemical, biological and physical processes associated with the biodegradation of household waste are used to aid the decomposition and detoxification of the special waste. Techniques vary, but solid special wastes are generally incorporated into the waste mass at the working face. Some special wastes, for example asbestos, are delivered in sealed bags and placed in a separate excavation within the body of the landfill. Drummed solid wastes were usually deposited in the working face of the landfill or in special areas, depending on the terms of the site licence. Liquid wastes not in drums may be incorporated within the waste mass by discharging them into trenches cut into previously deposited refuse, into lagoons, or by direct injection into the body of the landfill. The Special Waste Regulations 1980 require that the location of any special waste deposit at a landfill site must be recorded on a site plan.

DOE Waste Management Paper 26B (Landfill design, construction and operational practice) gives information on the landfilling of special waste.

The treatment of hazardous waste by incineration and by physical and chemical methods is discussed in the profile on hazardous waste treatment plants (see Section 4).

2.2.3 *Leachate and landfill gas*

Leachate and landfill gas are produced as a result of the decomposition of waste materials within a landfill site. Much is now known about the processes by which wastes decompose and, in summary, the three main phases of waste decomposition are:

Aerobic decomposition, which very rapidly uses the oxygen present in the waste body.

Hydrolysis and fermentation of cellulose and other biodegradable materials by bacteria to produce simpler organic compounds such as volatile fatty acids and ammonia.

Establishment of bacteria which consume the simple organic compounds to produce a mixture of methane and carbon dioxide (with various trace constituents such as hydrogen sulphide, organosulphur compounds and ethene) that is released as landfill gas.

The process of decomposition may take decades. Landfill leachates can be highly polluting, depending on the rate of the decomposition of the types of waste deposited and the decomposition processes at work. High concentrations of volatile fatty acids may appear at an early stage, followed by longer term releases of ammonia and some metal ions. The generation of methane often starts fairly early in the decomposition process.

DOE Waste Management Papers 26B (Landfill design, construction and operational practice) and 27 (Landfill Gas: a technical memorandum on the monitoring and control of landfill gas) give more information.

2.3 Incinerators

2.3.1 *Household/commercial waste incinerators*

The main function of early municipally owned incinerators was to reduce the bulk of waste. Ashes were used for road building and other building purposes or were sent to landfill. With the main aim being bulk reduction, there was little emphasis in early incineration on either combustion efficiency or heat recovery. Instrumentation was basic and there was little scope for optimising combustion via the controls. Early designs of incinerators used flat grates employing natural draught and were loaded and operated by hand. There may have been basic apparatus to reduce emissions (generally by use of electrostatic precipitators).

Design specifications were improved throughout the 1960s and 1970s, the period when most existing incinerators in the United Kingdom were built. The chief objectives were to reduce particulates in chimney emissions and hence the visual appearance of the plume, and, in larger facilities, to install acid gas control.

Improvements were made to the method of feeding waste into the incinerator, the design of the grate, the use of forced draughts, and the design of combustion chambers and of controls to improve combustion efficiency.

The basic components of modern incinerator complexes are:

- reception area and storage bunker where screening may be carried out (ash and fines being disposed of to landfill, and ferrous metals and other materials being separated for resale)
- crane for loading feed hopper
- feed hopper, from which refuse feeds into the incinerator
- grate and stoker
- combustion chamber
- ash storage area.

The incineration of hazardous waste is discussed in the profile Hazardous waste treatment plants (see Section 4).

2.3.2 Waste from incineration

Wastes from the incineration process and their methods of disposal are:

Ash, fines, ferrous metals and other materials screened out prior to incineration	Either landfilled or sold.
Furnace ash and clinker from the combustion process	Sent to landfill.
Furnace quench water	Treated and discharged to sewer.
Condensate resulting from cooling of the combustion gases	Treated and discharged to sewer or landfilled.
Spent liquors from any wet gas scrubbing	Treated and discharged to sewer or taken to wastewater treatment facilities by tanker.
Fly ash and sludges from gas cleaning	Landfilled.
Residual emissions	Discharged to atmosphere.

3. Contamination

The contaminants on a site will largely depend on the history of the site and on the range of materials handled there. DOE Industry Profiles usually include a list of potential contaminants associated with the industry discussed but no list is provided in this profile because waste management facilities, taken as a group, may be contaminated by a large range of substances. Contamination at an individual site could be restricted to a limited range of substances. It is recommended that an appropriate site investigation be carried out to determine the exact nature of the contamination associated with an individual site. Investigations should take site history into account.

3.1 Factors affecting contamination

3.1.1 Waste transfer stations

The extent of contamination at a waste transfer station is likely to depend largely on whether or not operations were undertaken on hardstanding and the methods used for controlling surface water run off. Many sites may have used soakaways or interceptor pits if they discharged the run-off to sewers. Areas of possible contamination may be located by reference to site drawings of drainage pathways.

Fuels and oils for waste transfer vehicles may have been stored on site and spillages and leaks from tanks and pipework may have caused contamination.

3.1.2 Landfill sites

Landfill gas is generally present throughout a landfill area and may vent to the atmosphere or migrate into ground around the landfill. Its main constituents are methane and carbon dioxide, present typically in a ratio of 60:40 in actively gassing landfills containing biodegradable waste. Trace components may include hydrogen, hydrogen sulphide, organosulphur compounds, aliphatic hydrocarbons and halogenated hydrocarbons. Landfill gas is colourless and has a broadly neutral buoyancy in air.

Landfill leachates are generated in all sites and may continue to be produced for many years after the closure of a site. Leachates from recently started landfills are generally slightly acidic. They contain simple organic compounds (which are readily broken down) and ammonia. They may contain iron and other metals and inorganic compounds which have been dissolved from the residual wastes. These leachates have a higher Biochemical Oxygen Demand (BOD) than those generated in older landfills and are potentially highly polluting. Leachates from older, more stabilised, landfills also contain ammonia, but metals are not usually present in high concentrations with the possible exception of iron.

Capping materials may also become contaminated, especially on older landfills where caps are shallow and poorly engineered.

Landfills may contain drummed special waste including asbestos. These may be present throughout the landfill and there is unlikely to be a record of their presence or location at older sites. Some special liquid wastes are potentially highly mobile. There is the potential for spread of contamination during site investigation or development, especially where drums are damaged or open.

3.1.3 Incinerators

The operation of incinerators produces two distinct types of ash: furnace ash, which is left in the combustion chamber after incineration, and fly ash which is recovered from gas cleaning and emission control processes. Both are generally disposed of to landfill.

Furnace ash contains non-combustible material such as clinker, glass, ceramics, large metal items, unburnt organic matter and masonry. In addition, it may contain heavy metals and organic compounds such as polychlorinated dibenzo-p-dioxins (dioxins), polychlorinated dibenzofurans (furans), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Fly ash has a similar composition except that it has no large particulate material and the concentration of certain heavy metals, dioxins and furans may be one or two orders of magnitude greater than in furnace ash.

Wastewater from the quenching of the hot ash contains unburnt organic material and particulates from the incinerator residues and is acidic. It may be associated with ash storage areas, underground tanks, sumps or leaking pipes and may have contaminated both surface and groundwater.

Both furnace and fly ash may be found concentrated in specific storage areas. However, on older and smaller incineration sites, housekeeping standards may not have been as strict, and widespread contamination by ash may be found.

Waste may also be generated from any flue gas scrubbing operations. Wet systems produce liquors and sludges which contain the neutralisation products of the acid gases and the contaminants associated with fly ash. Dry systems produce a solid waste consisting of the gas cleaning agents (for example lime, bicarbonates or carbon) and the contaminants associated with neutralised acidic flue gases and fly ash.

After gas cleaning processes, residual emissions from incinerators are discharged to the atmosphere. These emissions may contain dusts, particulates, heavy metals, acidic gases (such as hydrogen fluoride, hydrogen chloride and sulphur dioxide) and carbon monoxide. Contamination due to past atmospheric emissions at incinerator sites may be concentrated around the site of the chimney (from condensate running down the sides) or dispersed across the site and beyond (by plume emissions). The extent of any contamination will depend upon the method of operation of the incinerator, including such factors as plume moisture content and exit velocity, chimney height and meteorological conditions.

Fuel oil may have been stored on site for use in auxiliary burners. Leaks and spillages may have occurred from storage tanks and pipework.

3.2 Migration and persistence of contaminants

At landfills, there is a risk of contamination of surface water through leachate break-out. There is also a risk of contamination of groundwater where it flows through a site or where leachate is able to drain into it from the base of the landfill. The extent of this contamination and the movement of leachate within the landfill is governed by the permeability of the wastes, the degree of infiltration of surface water, the depth of the water table, the movement of groundwater through the site and the permeability of the surrounding geology. If leachate is unable to drain away from some areas of the landfill, it may be found in isolated perched pockets above the main body of leachate within the waste.

The significance of the risk to groundwater depends on the position of the water table and the properties of the soil structure. Generally, the higher the organic matter and clay content within the soil, the greater the adsorption of organic contaminants and the lower their mobility. Conversely, the greatest migration of contaminants occurs in coarse-grained sands and gravels with little organic content. The less soluble compounds which become adsorbed on to clay or organic matter may cause water pollution long after the original source has been removed, as a result of the chemical continuing to desorb into soil-water. The risk from organic contaminants in the soil to current and potential water supplies may therefore be considerable.

Stabilised landfills may contain a wide range of residual contaminants, including organics, for example phenols and polyaromatic hydrocarbons (PAHs), inorganics, for example cyanides and sulphates, and metals, for example lead, cadmium and zinc. Contaminants may be relatively immobile in stabilised landfills, but the more soluble organic and inorganic components may continue to be leached out by infiltrating water.

The migration of landfill gas through waste and surrounding strata is determined by several factors, including the gas pressure within the landfill, changes in atmospheric pressure, gas concentration gradients, the gas permeability of the surrounding strata and any displacement of gas by changes in water levels. Within highly permeable strata, especially where the gas is confined, it may migrate several hundred metres from the landfill.

The organic contaminants in ash are generally of low water solubility and are not likely to migrate significantly from landfill or from other contaminated areas. The high pH (alkalinity) of furnace ash combines with the relatively large particle size to limit the solubility of the metals present. However, metals found in fly ash are significantly soluble in water, particularly in acidic environments, since the pH of the ash is nearer to neutral (and may even be acidic). The solubility is also enhanced because of the large surface area and small particle size of fly ash.

The movement of metals through the soil is significantly retarded by the presence of clay minerals and organic matter. The solubility of some metals (for example copper, zinc and lead) may increase under acidic conditions. In other cases the relationship is more complex. For example, trivalent chromium is more soluble under acidic conditions, whereas the solubility of hexavalent chromium is increased under both acidic and alkaline conditions and arsenic may become more soluble at higher pH levels.

4. Sources of further information

4.1 Organisations

For information concerning landfills and other waste treatment or waste disposal industries in the United Kingdom, the following organisations should be consulted:

AEA Technology
National Environmental Technology Centre
353 Harwell
Didcot
Oxfordshire
OX11 0RA

Environmental Services Association
(formerly National Association of Waste Disposal Contractors)
Mountbarrow House
6-20 Elizabeth Street
London
SW1W 9RB

Institute of Wastes Management
9 Saxon Court
St Peter's gardens
Northampton
NN1 1SX

Waste Management Information Bureau
F6
Culham
Oxfordshire
OX14 3DB

4.2 Sources of information concerning the activities described in this profile

Aspinwall and Company Limited. *SITE FILE digest of authorised waste treatment and disposal sites in Great Britain*. First Edition 1987. Updated quarterly. Subscription via MacMillan Direct.

Bevan R E. *Notes on the science and practice of the controlled tipping of refuse*. The Institute of Public Cleansing, 28 Portland Place, London, 1967.

Crowhurst D and Beever P F. *Fire and explosion hazards associated with the redevelopment of contaminated land*. Information Paper IP2/87. Garston, Building Research Establishment, 1987.

Higginson A E. *The salvage potential of domestic refuse*. Paper to the Institute of Public Cleansing, 28 Portland Place, London, 18 November 1960.

ICRCL. *Notes on the development and after-use of landfill sites*. Note No 17/78. 8th Edition. Department of the Environment, December 1990.

Institution of Mechanical Engineers. *Refuse handling and processing*. Conference Proceedings, London, Mechanical Engineering Publications Ltd, 11 May 1978.

Robinson H D and Maris P J. *Leachate from domestic waste: Generation, composition and treatment – A review*. Technical Report TR 108. Stevenage, Water Research Centre, 1979.

Shults F. *Refuse disposal in Great Britain: Survey and prophecy*. Paper to the Institute of Public Cleansing, 28 Portland Place, London, 20 November 1960.

Stephen J. *Thomson's modern public cleansing practice: Its principles and problems*. 3rd Edition. The Technical Publishing Company Limited, 1951.

Williams P T. *A review of pollution from waste incineration*. Journal of the Institution of Water and Environmental Management, pp26–34, February 1990.

Woodfield M. *The environmental impact of refuse incineration in the United Kingdom*. Warren Spring Laboratory, September 1987.

Statutes and statutory instruments concerning waste management, mentioned in the text:

The Deposit of Poisonous Waste Act 1972.

The Control of Pollution Act 1974.

The Control of Pollution (Special Waste) Regulations 1980.

The Environmental Protection Act 1990.

The Environment Act 1995.

Case study including information relevant to this profile:

Paul V. *Bibliography of case studies on contaminated land: investigation, remediation and redevelopment.* Garston, Building Research Establishment, 1995.

Information on researching the history of sites may be found in:

Department of the Environment. *Documentary research on industrial sites.* DOE, 1994.

4.3 Related DOE Industry Profiles

Waste recycling, treatment and disposal sites: drum and tank cleaning and recycling plants

Waste recycling, treatment and disposal sites: hazardous waste treatment plants

Waste recycling, treatment and disposal sites: solvent recovery works

4.4 Health, safety and environmental risks

The Notes issued by the Chief Inspector of Her Majesty's Inspectorate of Pollution (HMIP) provide guidance for the processes prescribed for integrated pollution control in Regulations made under the Environmental Protection Act 1990. Of particular relevance is:

Her Majesty's Inspectorate of Pollution. *Waste disposal and recycling: municipal waste incineration.* Chief Inspector's Guidance to Inspectors. Process Guidance Note IPR 5/3. London, HMSO, 1992.

The Control of Substances Hazardous to Health (COSHH) Regulations 1994 and the Management of Health and Safety at Work Regulations 1992 are available from HMSO. Information on relevant health and safety legislation and approved codes of practice published by HSE publications are available from Health and Safety Executive Books, PO Box 1999, Sudbury, Suffolk, CO10 6FS (telephone 01787 881165), as well as HMSO and other retailers.

Information on the health, safety and environmental hazards associated with individual contaminants mentioned in this profile may be obtained from the following sources:

Howard P H. *Handbook of environmental fate and exposure data for organic chemicals*. Vols I and II. USA, Lewis Publishers, 1990.

Sax N and Lewis R. *Hazardous chemicals desk reference*. New York, Van Nostrand Reinhold Company, 1987.

Verschuieren K. *Handbook of environmental data on organic chemicals*. 2nd Edition. New York, Van Nostrand Reinhold Company, 1983.

4.5 Waste disposal and remediation options

Useful information may be obtained from the Department of the Environment series of Waste Management Papers, which contain details of the nature of industrial waste arisings, their treatment and disposal. A current list of titles in this series is available from HMSO Publications Centre, PO Box 276, London, SW8 5DT. Of particular relevance are:

Department of the Environment. *Refuse Disposal: Report of the Working Party on Refuse Disposal*. London, HMSO, 1971.

Department of the Environment. *A review of options: A memorandum providing guidance on the options available for waste treatment and disposal*. Waste Management Paper No 1. Second Edition. London, HMSO, 1992.

Department of the Environment. *Licensing of waste management facilities*. Waste Management Paper No 4. Third Edition. London, HMSO, 1994.

Department of the Environment. *Special wastes: A technical memorandum providing guidance on their definition*. Waste Management Paper No 23. London, HMSO, 1981. New edition in preparation.

Department of the Environment. *Landfilling wastes: A technical memorandum for the disposal of wastes on landfill sites*. Waste Management Paper No 26. London, HMSO, 1986.

Department of the Environment. *Landfill Completion - a technical memorandum providing guidance on assessing the completion of licensed landfill sites*. Waste Management Paper No 26A. London, HMSO, 1994.

Department of the Environment. *Landfill design, construction and operational practice*. Waste Management Paper No 26B. London, HMSO, 1995.

Department of the Environment. *Landfill Gas: A technical memorandum on the monitoring and control of landfill gas*. Waste Management Paper No 27. Second Edition. HMSO, 1991.

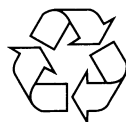
Department of the Environment. *Landfill sites: Development control*. Circular 17/89 (Welsh Office 38/89). London, HMSO, 1989.

Publications containing information on the treatment options available for the remediation of contaminated land sites, prepared with the support of the Department of the Environment's Research Programme, can be obtained from

National Environmental Technology Centre Library, F6, Culham, Abingdon, Oxfordshire, OX14 3DB.

A full list of current titles of Government publications on all aspects of contaminated land can be obtained from CLL Division, Room A323, Department of the Environment, Romney House, 43 Marsham Street, London, SW1P 3PY.

Advice on the assessment and remediation of contaminated land is contained in guidance published by the Construction Industry Research and Information Association (CIRIA), 6 Storey's Gate, Westminster, London, SW1P 3AU.



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DOE Industry Profiles

Airports
Animal and animal products processing works
Asbestos manufacturing works
Ceramics, cement and asphalt manufacturing works
Chemical works: coatings (paints and printing inks) manufacturing works
Chemical works: cosmetics and toiletries manufacturing works
Chemical works: disinfectants manufacturing works
Chemical works: explosives, propellants and pyrotechnics manufacturing works
Chemical works: fertiliser manufacturing works
Chemical works: fine chemicals manufacturing works
Chemical works: inorganic chemicals manufacturing works
Chemical works: linoleum, vinyl and bitumen-based floor covering manufacturing works
Chemical works: mastics, sealants, adhesives and roofing felt manufacturing works
Chemical works: organic chemicals manufacturing works
Chemical works: pesticides manufacturing works
Chemical works: pharmaceuticals manufacturing works
Chemical works: rubber processing works (including works manufacturing tyres or other rubber products)
Chemical works: soap and detergent manufacturing works
Dockyards and dockland
Engineering works: aircraft manufacturing works
Engineering works: electrical and electronic equipment manufacturing works (including works manufacturing equipment containing PCBs)
Engineering works: mechanical engineering and ordnance works
Engineering works: railway engineering works
Engineering works: shipbuilding, repair and shipbreaking (including naval shipyards)
Engineering works: vehicle manufacturing works
Gas works, coke works and other coal carbonisation plants
Metal manufacturing, refining and finishing works: electroplating and other metal finishing works
Metal manufacturing, refining and finishing works: iron and steelworks
Metal manufacturing, refining and finishing works: lead works
Metal manufacturing, refining and finishing works: non-ferrous metal works (excluding lead works)
Metal manufacturing, refining and finishing works: precious metal recovery works
Oil refineries and bulk storage of crude oil and petroleum products
Power stations (excluding nuclear power stations)
Pulp and paper manufacturing works
Railway land
Road vehicle fuelling, service and repair: garages and filling stations
Road vehicle fuelling, service and repair: transport and haulage centres
Sewage works and sewage farms
Textile works and dye works
Timber products manufacturing works
Timber treatment works
Waste recycling, treatment and disposal sites: drum and tank cleaning and recycling plants
Waste recycling, treatment and disposal sites: hazardous waste treatment plants
Waste recycling, treatment and disposal sites: landfills and other waste treatment or waste disposal sites
Waste recycling, treatment and disposal sites: metal recycling sites
Waste recycling, treatment and disposal sites: solvent recovery works
Profile of miscellaneous industries incorporating:
Charcoal works
Dry-cleaners
Fibreglass and fibreglass resins manufacturing works
Glass manufacturing works
Photographic processing industry
Printing and bookbinding works

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