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INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND

Notes on the redevelopment of scrap yards and similar sites

ICRCL

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INTERDEPARTMENTAL COMMITTEE ON THE REDEVELOPMENT OF CONTAMINATED LAND - NOTES ON SCRAP YARDS AND SIMILAR SITES

SUMMARY

Sites used for the breaking-up of redundant or obsolete manufactured items, such as vehicles, electrical equipment, machinery etc, are among the most commonly encountered examples of contaminated land. They occur predominantly in and around urban areas, though sites in rural areas are also known. Contamination of such sites is due to various substances, particularly metals and oils, whose presence can significantly affect either human health, plant growth, or cause deleterious effects to building materials and essential services. These hazards may need to be taken into account when redevelopment schemes involving the use of such sites, particularly for housing, agriculture, or amenity, are planned.

The nature and degree of contamination depends on the activities carried out on the sites concerned. It will usually be necessary to carry out a site survey for contamination before a redevelopment scheme for a given site can be finalised.

These Notes have been prepared to assist those concerned with the redevelopment of scrap yard sites in ensuring that contamination problems are properly evaluated and allowed for in the design of their schemes.

I. INTRODUCTION

1. Scrap yards and similar sites are among the most common examples of contamined land for which redevelopment schemes may be proposed. Such sites can present difficulties, particularly for certain end uses, and in general they must be adequately assessed before the details of redevelopment schemes can be finalised. General guidance on the assessment and redevelopment of contaminated land is given in ICRCL 59/83(1).

2. The hazards which may require consideration on scrap yard sites include the following possibilities:

i. presence of potentially toxic substances which can affect human health, plant growth, animals etc.

ii. potential combustibility of contaminated fill materials (eg oil-soaked soil, paper, plastics).

iii. potential chemical attack on building materials, including service pipes and cables.

iv. emission of flammable, asphyxiant or corrosive gases.

v. possible presence of radioactive materials.

vi. problems associated with odour, site drainage and surface run-off.

vii. general untidiness and lack of control over the activities carried out on site, including the tendency for fly-tipping and illicit disposal of hazardous wastes.

3. These Notes attempt to describe the main problems which may be encountered, but they may not all occur on a particular site. Thus it is stressed that each site should be assessed individually. Before deciding on the form of redevelopment for a given site, there should be consultation between, for example, planners, architects, valuers, building control officers, environmental health officers, engineers and developers.

4. The Notes have been prepared from information readily available and from limited experience, thus they are of an interim nature and may be revised from time to time. Any comments or suggestions for their improvement should be sent to the Secretary of the Interdepartmental Committee at the address given at the end of the notes.

II. ORIGIN OF CONTAMINATION

5. The contamination found on scrap yard sites arises from the operation of various activities, of which the following are typical examples:

i. Dismantling of motor vehicles, aircraft etc.

ii. Storage and dismantling of plant and machinery.

iii. Metal cleaning, sorting and recovery particularly for recovery of non-ferrous metal values.

iv. Recovery of electrical components from equipment and appliances of various types.

v. Burning of cables to recover copper and of vehicle batteries to recover lead, and of inflammable materials to reduce bulk.

vi. Crushing and fragmenting of bulky ferrous scrap to provide feed for blast furnaces.

vii. Burning of rubber tyres etc.

6. The techniques employed include: cleaning and degreasing using various liquids or solvents; metal cutting and burning using both mechanical and flame methods; volume reduction eg by crushing, etc.

7. Operation of these techniques can cause contamination in several ways, such as:

i. leakages, spillages and deliberate release of liquids from the items being broken up, for example of oil, acid, paint, grease etc.

ii. deliberate release of filling fluids from certain types of electrical equipment, such as transformers, capacitors etc.

iii. production of finely-divided particulate metal dust and small fragments of dismantled articles.

iv. dumping of unwanted residues such as ashes, oily wastes, sludges etc.

v. aerial liberation and re-deposition of particles from combustion.

8. The substances causing contamination are derived from the manufacture and use of items, as well as from their dismantling and disposal. However the processes which are used for the latter purposes are those which give rise to the particular problems associated with scrap yard sites.

III. NATURE OF CONTAMINATION AND POTENTIAL HAZARDS

9. The following groups of contaminants can be present on scrap yard sites:

i. Metals, particularly the following: arsenic, antimony, barium, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, tin and zinc.

ii. Non-metals, including cyanides, chlorides, fluorides, phosphorus, sulphides, sulphates etc.

iii. Acids, for example hydrochloric, phosphoric, sulphuric etc.

iv. Alkalis: degreasants, ammoniacal liquors etc.

v. Organic substances, including oils, cleaning and degreasing fluids, solvents, PCBs etc.

vi. Miscellaneous materials including radioactive substances (possibly present in luminous paints and instruments), plastics, rubber etc.

10. The contaminants can be present in a variety of forms including liquid and solid wastes, sludges etc. It is impossible to generalise over their distribution on the site, since the surface will frequently be covered with particulate metal dust which in places will show the effects of disposal of waste liquids such as oils. It may be necessary to determine both the lateral and vertical distribution for all the above types of pollutants, depending on the proposed use of the site.

11. The hazards which may need to be considered include the following:

i. Presence of toxic materials.

ii. Potential combustibility of waste materials.

iii. Effects on building materials.

vi. Emissions of toxic or flammable gases.

v. General problems of site drainage and stability.

The relative importance of these potential hazards will vary, depending on the proposed end use of the site, as well as on the actual degree of contamination. Thus firm decisions on the form of end use best suited to a particular site should not be taken until the condition of the land has been properly assessed.

Presence of toxic elements

12. Some of the metals which may be present on scrap yard sites are essential in trace quantities to the health of crops and animals, eg zinc, copper, iron, molybdenum, manganese etc. Others, such as lead, cadmium, mercury, nickel and arsenic, may be harmful at relatively low concentrations. For most elements the difference in concentration between levels at which beneficial effects or toxic effects occur is relatively small. The concentrations of metals may be such as to present hazards to site workers or subsequent users or occupants of a site, and to animals or plant life. A survey for toxic elements will usually be required when sites are developed or undergo a change of use, particularly when the intended use is sensitive to the presence of such elements.

13. The availabilities of trace elements in soils and their uptake by crops depends on complex interactions between several factors, including soil structure and pH, crop species and cultivars, chemical behaviour etc. Uptake of metals by

crops could in some cases increase the concentrations of certain toxic metals (eg cadmium, lead and mercury) in the human food chain. Cadmium is relatively easily taken up by plants but only very slowly released from human body tissues, and is of particular concern. Lead and mercury are less readily taken up and translocated from the roots of most crop plants.

14. In addition to the uptake of metals by crops grown for human consumption, there is the possibility of direct ingestion of contaminated materials. Grazing animals may ingest up to 20-30% w/w of soil together with the vegetation they consume, and a minority of young children suffer from the condition known as pica (the habitual ingestion of non-food materials which can include soil). The presence of finely-divided particulate metallic materials on most scrap yard sites may increase this risk, besides requiring precautions to control dust during site clearance and construction work.

15. Typical concentration ranges for various elements in agricultural soil are given in the following table. Concentrations in excess of these ranges are frequently observed on scrap yard sites as shown in the following examples.

Element	Normal Concentration Range in agricultural soil (mg/kg dry soil)	RANGES FOUND ON TYPICAL SCRAP YARD SITES		
		SITE A	SITE B	SITE C
Zinc	10 - 300	80 - 12000	50 - 7000	14000 - 56000
Copper	2 - 100	20 - 9000	20 - 10000	1000 - 16000
Nickel	5 - 500	20 - 350		400 - 3000
Chromium	5 - 500			
Cadmium	0.1 0 1.0	0.5 - 50	10 - 1500	40 - 130
Lead	2 - 200	150 - 7400	200 - 20000	8000 - 12000
Mercury	0.1 - 0.3	0.2 - 0.4	0.5 - 1	
Molybdenum	2			
Arsenic	0.1 - 40			
Selenium	0.2 - 0.5			0.7 - 60
Boron	2 - 100			
Manganese	5 - 500			

16. It is not possible to define concentrations of contaminants that would be deemed unacceptable on a specific site. Each site needs to be judged on the basis of all the data available. The assessment needs to take into account the end use to which the site is to be put and the exposure routes for those likely to be at risk. However, an example is provided by cadmium for which concentrations above about 3mg/kg (parts per million) may be undesirable if the land is intended for allotments or the production of crops for human consumption. Some tentative "trigger concentrations" for different land uses have been published (ICRCL 59/83). "Trigger concentrations" are values below which a site can be regarded as uncontaminated: they should not be interpreted as the maximum permissible concentrations, nor do they define sites where remedial action is essential. See ICRCL 59/83.

17. In addition to metals, other potentially toxic substances may be present on scrap yard sites. The presence of significant concentrations of PCBs (polychlorinated biphenyls) has been reported on some sites where electrical equipment has been stored or broken up. PCBs are used in a variety of applications, for example as dielectric fluids in capacitors; also in the oils used for filling transformers, heat exchangers etc. These liquids were frequently poured into the ground at sites where the above types of equipment were dismantled in order to recover re-usable components. Being chemically inert and resistant to biodegradation, PCBs and similar compounds are likely to remain in the soil or

other fill materials for long periods. Their presence is likely to be of concern from the point of view of toxicity and because of the difficulty in arranging for disposal of the contaminated soil. The volumes of material affected by PCBs can be considerable, thus adding significantly to the overall costs of cleaning up the site and disposing of the undesirable material.

18. At certain sites where military equipment (such as aircraft, vehicles etc) has been dismantled, the possibility of radioactive contamination may have to be investigated. The problem arises from the use of luminous paints (eg in instrumentation) which introduces a low level (usually) of radioactivity into the surface deposits on sites where this activity has been operated.

19. Other materials which may be present and can be of potential toxic significance, for example by direct contact with the skin or by inhalation, include:

i. dilute or concentrated acids, such as those used in lead-acid vehicle batteries, de-rusting and anti-fouling paints, etc;

ii. heavy metal dusts, for example lead dust and fumes resulting from the burning of lead-acid battery cases;

iii. phenolic substances, present in some types of oils likely to be among those encountered on a scrap yard site, or can be produced by operations such as the burning of tyres;

iv. vapours produced by the evaporation of organic solvents and similar substances;

v. asbestos, used for example in certain vehicles and railway rolling stock;

vi. waste lubricating oils, which can represent a hazard through skin contact, and can contain organo-metallic compounds.

Potential combustibility

20. The practice of disposing of oily wastes and other flammable materials on scrap yard sites could increase the risk of combustibility of the soil or other fill material present. In addition, processes such as the burning of batteries, tyres and other components are frequently carried out on such sites and these could provide a source of ignition for potentially combustible substances.

21. The general principles which relate to combustion are basically quite simple but their application in practice is far from easy. For combustion to occur, there must be material present which is combustible, its ease of ignition is important, and an ignition source must be present at some time. Furthermore, oxygen to support combustion and ventilation to eliminate products of combustion must be available. There are in addition other factors such as the topography of the site and the position of the water table. It should be noted that these governing factors may be modified by the construction and development process, and the absence of any fire to date does not provide an adequate degree of assurance about the future.

22. To assess potential problems the proportion of combustible material present may need to be determined. This can be measured in a variety of ways: ash, moisture, volatile matter, fixed carbon etc, together with calorific value. The indications so far are that, as in the case of conventional solid fuels, such measurements are often inter-related. The most widely used criterion is Calorific Value (CV) which is the measure of the heat that can be released from a sample after complete combustion in excess oxygen.

23. Samples with higher calorific values, lower ash contents and higher carbon contents are possibly more likely to be combustible than others. It is not yet certain how the results of such measurements should be interpreted, but for the present it seems unwise to use measurements of calorific value as the sole indicator of the combustibility of soil or fill materials on a site. Recent experimental studies at the Fire Research Station have shown that smouldering can propegate in samples whose calorific values approximated to those of soils which did not smoulder under the same test conditions (a typical loamy soil may have a CV of about 1.7 MJ/kg). These preliminary findings suggest that samples with calorific values of above 10 MJ/kg are almost certain to sustain smouldering whilst those with CV below 2 MJ/kg are less likely to do so.

24. Specialist advice on problems of combustibility is obtainable from the Fire Research Station, Borehamwood, Herts (tel. 01-953-6177).

Effects on building materials

25. Some of the materials present may present problems due to their potential for attack on building materials. Sulphate and acid attack on concrete are the most obvious, but there may be enhanced corrosion of metals and attack on plastics, eg pipes, protective coatings to metals, 'O' rings etc. There is little direct evidence on these latter problems but certain plastics materials are particularly susceptible to damage by oily substances. Useful guidance regarding the corrosivity of soil is provided in British Standard Code of Practice 1021:1973 on 'Cathodic Protection'. These problems, and the need to protect water supplies from contamination may necessitate service trenches etc being backfilled with only clean material and protected so as to prevent ingress of aggressive or potentially harmful waters. In some instances it has been considered necessary to encase the water supply pipe inside an oversize conduit, or to use specially resistant materials for constructing the distribution and connecting mains. Statutory undertakings should be consulted as early as possible during the planning of the development.

Emissions of toxic or flammable gases

26. Certain materials which may have been disposed of on scrap yard sites may give rise to emissions of toxic or flammable gases. The presence of oily liquids in the soil or fill material is likely to be the most obvious source of such emissions but other constituents may also need to be considered:

i. Methane is a non-toxic gas which, in sufficient concentration, acts as an asphyxiant. Its density is approximately half that of air. It is flammable at concentrations between 5% and 15% in air. In certain situations accumulations of methane can lead to explosions.

ii. Hydrogen sulphide is a highly toxic, flammable gas and can also exhibit similar explosive characteristics to methane. The explosive limits are 4.3 to 45.5% in air.

iii. Carbon dioxide is an asphyxiant. It is denser than air and any build up in any confined space, including for example deep excavations or pits, is potentially hazardous.

27. The problems represented by the presence of methane and other gases are discussed in detail in the notes on landfill sites in this series (ICRCL 17/78). Other sources of information and advice on gas-related hazards include the Health and Safety Executive, the Fire Research Station (01-953-6177) and the Environmental Safety Group at Harwell (0235-24141). The local Environmental Health Department may also often be able to provide guidance and may have available suitable monitoring equipment. Sites known or found to be producing methane will

in general require detailed investigation to determine the distribution and maximum rate of emission over a realistic period (probably at least 6 months) before the layout and design of any redevelopment scheme can be finalised.

Site drainage and stability

28. Unless suitable provisions are made to control drainage and surface run-off from scrap yards there may be a risk of pollution of water. This is probably more likely to concern surface watercourses rather than underground aquifers, but with appropriate precautions these possibilities can be minimised and they should not represent a major constraint on redevelopment, at least from the viewpoint of site clearance and reconstruction. The discharge of oily liquids into sewerage systems during site excavation works is undesirable and should be avoided. If the method of construction involves the use of piling, then attention should be given to the possibility that pathways may be created by which polluting liquids within the soil or fill materials may reach an aquifer. Where this is a risk the Regional Water Authority should be consulted.

29. In relation to site stability and suitability for structural purposes, the precautions needed will depend on the local conditions, such as site geology and hydrogeology, previous history etc. The British Standard Code of Practice for Foundations (CP 2004) states that, 'All made ground should be treated as suspect, because of the likelihood of extreme variability'. On most scrap yard sites there may be little data available about what activities have been operated or on which parts of the site waste materials were deposited. It should be remembered that the proportion of the fill that is examined when boreholes are put down in a typical site investigation is very small. Excavation of a number of trial pits may yield more information. Detailed guidance on site investigation for engineering purposes is given in British Standard Code of Practice 2001 which is currently being revised.

IV. SITE ASSESSMENT

30. The main objectives of site assessment are:

i. To identify the various buildings or other structures present on the site.

ii. To identify the various types of materials present and to ascertain their distribution over the site area.

iii. To obtain information on the extent and degree of contamination both on and below the land surface. The information thus obtained can be used to evaluate the suitability of the site for various possible modes of redevelopment.

A detailed site assessment should only be omitted in cases where sufficient knowledge of the site history and ground conditions already exists, or for certain low-grade end-uses (eg hard cover for vehicle parking) which do not depend on extensive remedial measures to make the site suitable for redevelopment. A British Standards Institution technical committee (EPC/47), Land Quality) has drafted a code of practice for the investigation of contaminated sites, and this should be consulted for detailed guidance.

Preliminary stages

31. The first stage in site assessment should consist of the collection and examination of available maps, plans, aerial photographs and other records relevant to the site. In some cases the local authority or Factory Inspectorate will have useful information and the regional water authorities may be able to identify former owners or operators of sites where the processes operated involved discharge of effluents or trade wastes. Certain subsequent uses of sites, eg for waste disposal, may be documented in records kept by local government authorities. In recent years, waste disposal sites have required licences issued under the provisions of Part I of the Control of Pollution Act 1974. The issue of such licences is administered by waste disposal authorities (County Councils in England, District Councils in Wales), and these bodies should be able to provide information on the types and quantities of waste materials deposited at such licensed sites.

32. Having obtained such information as is available, a site visit should be made in order to correlate the documentary evidence with the conditions actually existing at the site. Particular attention should be paid to the surface topography and site layout, as these features can provide useful indications of the types of waste materials likely to be present.

Site Surveys

33. After ascertaining the site layout and history in general terms, the next stage of site assessment is to identify the wastes and other materials present and to specify locations where more detailed investigation is required.

34. During the site visit, the various types of materials present on or above the site surface should be identified and recorded on a site plan. Attention should be given to possible infilled areas and structures. The locations of such areas will depend on the site layout, but may not be readily apparent at the time of investigation. Old plans, aerial photographs etc will often be the best indication of the locations of possible infilled structures.

35. The next stage in the site survey is the collection of samples for analysis, in order to determine the extent and distribution of contamination both laterally and vertically over the whole area of the site.

36. For materials present as discrete deposits on the surface or in infilled structures, the number of samples taken should be sufficient to characterise the materials in broad terms. Since it is probable that such deposits will need to be removed from the site as part of the redevelopment plan, enough information should be obtained for such materials to indicate their general composition and any special hazards, and to satisfy the local waste disposal authority. A complete chemical assay may not be necessary.

37. At most sites, a detailed and systematic soil survey will be required. The sample locations should be based on a grid pattern, the grid interval spacing being chosen so as to give adequate numbers of samples for the particular site under investigation. On large sites, typical grid intervals of 50m or 100m may be adequate, while closer spacings (eg 10m or 25m) may be needed for smaller sites or for selected areas of larger sites intended for sensitive end uses such as allotments, gardens etc.

38. When the sampling intervals and locations have been decided, samples should be collected (by means of either trial pits or boreholes) of the immediate surface layers and of the sub-surface materials at varying depths, for example 0-100 or 150mm; 0.5m; 1.0m etc. The use of trial pits excavated by means of a mechanical digger permits samples to be taken at depths of up to about 3m, and allows visual observations of the sub-surface ground conditions to be made readily, including the nature of the materials present and the levels at which water is encountered. For sampling at greater depths, use of boreholes is necessary.

39. Comprehensive analysis of all samples collected for examination of a site can be costly and time-consuming, and for some end uses may not be necessary. To avoid unnecessary time and expense, the analyses to be carried out on samples should be related to the particular immediate needs for the information: the samples can always be retained for further examination, or fresh samples collected, should a more detailed study be needed. The scope of the sampling programme should also be related to the type of development envisaged and the stage it has reached, for example a pre-purchase survey is likely to be less comprehensive than that needed to provide data on which detailed plans for remedial treatment and subsequent development can be based.

40. In the majority of schemes for redevelopment of scrap yard sites, the most sensitive end use will be housing where gardens or allotments are to be provided, and crops intended for human consumption may be grown. Hazards to construction workers on sites also need to be considered. The Factory Inspectorate of the Health and Safety Executive should be consulted at an early stage of any proposed construction activity. Thus the principal considerations are likely to be:

i. Human health effects, including the safety of workers on the site during clearance and redevelopment, and the health of future residents.

ii. Phytotoxic effects.

iii. Effects on construction materials.

41. The chemical analysis likely to be required depends on the proposed use of the site and may include the following: arsenic, boron, cadmium, chromium (trivalent and hexavalent), copper, lead, mercury, nickel, selenium, zinc, pH, chloride, fluoride, sulphide and sulphate. Of these the "total" concentrations of arsenic, cadmium, lead, and the "plant-available"* concentrations of boron, copper, nickel and zinc are of particular importance. It should be noted that although copper, nickel and zinc are the elements usually considered when assessing phytotoxicity, many other elements (eg arsenic, cadmium and lead) are also toxic to plants and may need to be considered. The determinations of pH,

*The method of determination should be specified for plant-available concentrations.

chloride, sulphide and sulphate should be carried out on both the solid samples and on water extracts from them where appropriate (see for example BRE Digest 250 and Current Paper -/79). Samples of ground water or other liquids encountered should also be collected for analysis.

42. Attention should also be given to the possible presence of toxic wastes eg cyanides, and a careful watch kept for waste asbestos. The amount and type of oily material should be assessed, for example by determining the quantity of organic material extractable in water or in solvents such as toluene or cyclohexane. Where the preliminary information suggests that such materials are likely to have been introduced on to the site, a proportion of the samples should be analysed for specific types of organic substances such as PCBs, and the level of radioactivity should also be checked.

43. Whilst the foregoing includes most of the determinands likely to be required for site assessment in the majority of cases, local knowledge and conditions should be considered as appropriate and the above list modified accordingly. Any site investigation team engaged to assess for example foundation requirements should be made aware of the possibility of contamination, so that maximum use can be made of their borehole data and in order that the workers concerned are aware of potential hazards to their health and safety.

44. If the site investigation has been carried out according to the suggested sequence,adequate information should have been obtained to assess the degree and general distribution of contamination on the whole site. If necessary, particular areas of the site can then be investigated in greater detail to define 'clean' areas or regions of excessively high contamination. Consideration can then be given to the nature of possible remedial measures required to render the site safe for the purposes of the proposed redevelopment. It is important to retain flexibility in the design of redevelopment schemes until the degree and pattern of contamination at any given site has been established. This should be allowed for in terms of time, site layout and remedial measures.

45. The data obtained from site investigation should enable the significance of the contamination to be assessed. Consideration can then be given as to the remedial measures needed to make the site suitable for the proposed end use (where this is known). Where the eventual end use of the land is not yet decided it will be more difficult to specify the essential remedial measures.

46. One possibility that may need to be considered is that the site cannot be made suitable for the intended use at an acceptable cost, and consequently an alternative use may have to be considered. On larger sites where comprehensive development is planned it may be possible to allocate land for housing, schools, open space, industry etc in such a way that hazards are minimised and the need for extensive remedial treatment reduced. There may be advantages in locating areas of hard cover such as roads, parking areas and industrial development over zones with particularly severe soil contamination.

V. REMEDIAL MEASURES

47. The available options for dealing with soil contamination can be broadly classified as (i) removal; (ii) treatment (iii) covering up. The approach to be adopted in any particular case depends on the nature, degree and extent of contamination, and can vary within a given site.

48. The depth of contamination will depend on the characteristics of the sub-soil. On clay soils there may have been little penetration beneath the top surface, but on sandy soils contamination may have affected greater depths of soil. When contamination is restricted to a relatively thin layer, complete removal may be economic:some clearance of waste materials from the site may in any case be needed before redevelopment can proceed. When contamination is present to considerable depths there may be little advantage in removing materials unless the newly exposed surface is significantly less contaminated than the existing one.

49. Where significant contamination of soil is present, it is often preferable to provide a sufficient depth of cover to enable all services to be installed within the clean material. If however it is necessary to excavate service trenches through contaminated ground, the trenches should be cut oversize and filled with clean material before installation of the services. When this procedure is used, appropriate precautions should be taken to minimise risks of re-contamination caused by any subsequent excavation of the serivce trenches. The statutory undertakings particularly the water supply authority, should be consulted about their special requirements, if any. Some statutory water undertakings have special provisions in their bye-laws concerning the installation of mains through contaminated land. It is considered that in some circumstances, such as a burst water main, back-siphonage could occur, resulting in the introduction of polluting substances into the water supply.

50. If contaminated materials have to be removed from the site for disposal the local waste disposal authority (see para 31) should be consulted. Highly contaminated materials may require to be disposed of as "special waste" under the provisions of Section 17 of the Control of Pollution Act 1974.

51. If the quantities involved are small and the development plan permits, it may in some cases be possible to dispose of the material on site, eg by burial. In a few cases special on-site disposal facilities have been created to deal with wastes excavated from sites being redeveloped, but such wastes are still subject to the provisions of Part I of the Control of Pollution Act 1974 and the consent of the waste disposal authority is still required. It may also be necessary to take note of the possibility of water pollution, or of potential combustibility (eg from generation of methane) when any new on-site deposit of waste is created.

52. It should be noted that liquid and semi-solid wastes can break out through some covering materials due to the effects of excessive loading through compaction or as the result of disturbance. Rather than allowing such materials to remain on site and covering them over, it may be preferable to remove them during site clearance operations. Appropriate precautions should be taken to minimise risks of water pollution, which can largely be prevented by the adoption of "good housekeeping" methods during site clearance and reconstruction.

53. It may sometimes be useful to take action to control the pH of contaminated topsoil or subsoil, by incorporation of lime or by placing a layer of limestone between clean cover materials and underlying contaminated ground.

54. Whatever remedial measures are adopted the aim should be to ensure that they are durable, ie continue to be effective for the required time period, and robust, ie practical and not unduly sensitive to bad workmanship.

VI. REFERENCES

Other notes in this series include:

1. Guidance on the assessment and redevelopment of contaminated land ICRCL 59/83.

2. Notes on the redevelopment of landfill sites. ICRCL 17/78.

3. Notes on the redevelopment of gasworks sites. ICRCL 18/79.

4. Notes on the redevelopment of sewage works and farms. ICRCL 23/79.

5. Notes on the fire hazards of contaminated land. ICRCL 61/84.

6. Asbestos on contaminated sites. ICRCL 64/85.

Available from the following address:

Central Directorate on Environmental Pollution
Room A.324
Department of the Environment
Romney House
43 Marsham Street
LONDON
SW1P 3PY
(Tel 01 212 5464)

General enquiries should be directed to the Secretary of the Interdepartmental Committee, Room A.342 at the above address (telephone 01-212-6462). Professional advice on the specific problems of individual sites can be obtained from specialist consultants with appropriate experience.