Reclamation of Contaminated Land

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Preface

Land contamination has been recognised as a challenge to present and future generations resulting from previous industrial and waste disposal practices. This book is a result of the authors' desire to make sure that the risks from land contamination are effectively understood and adequately managed in a context of wise stewardship of resources. It is written for those embarking on their journey in contaminated land management – those final year undergraduate and postgraduate students pursuing an option in contaminated land. It is also intended for those who are of necessity caught up in the maelstrom land contamination occasionally causes in commercial practice during the buying, selling, leasing and redevelopment of land.

Over the past 6 years we have been privileged to have been involved in some of the most exciting projects in contaminated land. Our activities in consultancy, research and teaching have given us unique insights into what contaminated land managers need to know, what they frequently do not know and therefore what they need to learn. We hope that this book will find a place on shelves and desks and will wear out with constant reference during specific projects. This book is not intended to be an all encompassing manual (such as Bardos and Nathanail, *Contaminated Land Management Handbook*, Thomas Telford, London, 2004) or a ready reference guide for the practitioner (such as Nathanail, Bardos and Nathanail, *Contaminated Land Ready Reference Guide*, EPP & Land Quality Press, 2002). Rather it is an introduction to a complex, multifaceted and fascinating topic that straddles research and practice and spans science, engineering, public policy and legislation.

If you would like to find out more about the authors please visit our web sites: www.lqm.co.uk and www.r3environmental.co.uk

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We also pay tribute to the late Colin Ferguson for his contributions to the field, and the authors' experience, and, without whom the authors may never have met.

1
International policy

This chapter is based on, and updates, a paper written by the late Colin Ferguson summarising the policy outcomes of the EC concerted action CARACAS (Ferguson, 1999). The purpose of this chapter is mainly to provide a short and easily accessible review of land contamination policy and practice in Europe and USA. Further details can be found in Ferguson and Kasamas (1999), Judd and Nathanail (1999) as well as at www.clarinet.at. and www.cabernet.org.uk.

Twenty or so years ago, land contamination was usually perceived in terms of relatively rare incidents, with poorly known but possibly catastrophic consequences for human health and the environment. Several incidents attracted major media attention, e.g. Love Canal, NY; Times Beach, MO; Lekkerkerk, the Netherlands; Minimata, Japan. Consequently, politicians and regulators responded by seeking maximum risk control: pollution should be destroyed, removed or contained completely. The Superfund programme in the USA, which was largely a response to Love Canal and a few other highly publicised sites, initially focused on 'the worst 100 sites in the nation'. Even today, after over 25 years and the expenditure of many billions of dollars, the number of US sites remediated under the Superfund programme amounts to only a few hundred. Increasingly, sites on the US National Priorities List (NPL), i.e. the so-called Superfund sites, are being remediated with no access to Superfund monies.

Today land contamination is no longer perceived in terms of a few severe incidents, but rather as a widespread infrastructural problem of varying intensity and significance that is an inheritance from past industrial and waste disposal practices. It is now widely recognised that drastic hazard or contaminant control, e.g. cleaning up all sites to background concentrations or to levels suitable for the most sensitive landuse, is neither technically or economically feasible nor is such control compatible with sustainable development. To give an example, in 1981 about 350 sites

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in the Netherlands were thought to be contaminated and possibly in need of remedial action. By 1995 the number had grown to 300,000 sites with an estimated cleanup cost of 13 billion Euro. Similar circumstances exist in most other industrialised countries. Consequently, although the need for policies to protect soil and groundwater is recognised, strategies for managing contaminated land have moved towards **fitness for use**. More recently, explicit recognition has been given to the need to return to beneficial use formerly developed and now abandoned or derelict land in order to regenerate urban areas, minimise the consumption of greenfield land and contribute to sustainable landuse management. Such a 'brownfield' land is sometimes contaminated to the extent that remediation is required before it can be put to a new use. However, the terms 'brownfield' and 'contaminated' are not synonymous.

Land contamination remains high on the agenda of environmental and regeneration programmes in much of Europe and North America. The Ad Hoc International Working Group on Contaminated Land and the Common Forum were formed to facilitate dialogue and collaboration.

The Ad Hoc International Working Group on Contaminated Land is an informal forum for international exchange and cooperation (http://www.adhocgroup.ch/index.html). Its principal purpose is to provide a forum, open to any country, in which issues and problems of contaminated land and groundwater can be discussed and information freely exchanged to the benefit of all participants.

In 1994, a Common Forum for Contaminated Land in the European Union was established by member states, the Commission of the European Communities (CEC) and the European Environment Agency (EEA). The Common Forum had several key objectives:

1. to facilitate better understanding of each member state's approach to tackling the problems of land contamination;
2. to identify thematic areas for EU-wide cooperation;
3. to make recommendations on technical and practical issues to CEC and EEA;
4. to enhance the dialogue between the various international initiatives concerned with land contamination and regeneration.

One outcome of the Common Forum's first meeting (held in Bonn in 1994) was a recommendation to promote an EU-wide project on assessing the risks from contaminated sites. This led to the Concerted Action on Risk Assessment for Contaminated Sites (CARACAS), an initiative funded

by the CEC under its Environment and Climate Programme and supported by the participating countries with individual accompanying measures. The project was initiated by the German Environment Ministry and coordinated by the Federal Environment Agency (Umweltbundesamt). The work programme of CARACAS, which started in early 1996 and finished in 1998, was carried out by more than 50 scientists and policy specialists from 16 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

The work of CARACAS focused on seven areas:

1. human toxicology
2. ecological risk assessment
3. fate and transport of contaminants
4. site investigation and analysis
5. models
6. screening and guideline values
7. risk assessment methodologies.

The findings of CARACAS were published in two volumes (Ferguson *et al*., 1998; Ferguson and Kasamas, 1999). The first volume covers the scientific basis for risk assessment, largely structured according to the topic areas listed above. Six years after its publication, it remains a definitive distillation of the principles of risk assessment that should be known to all risk assessors. This may be downloaded from www.lqm.co.uk. The second volume provides authoritative reviews of policy and practice relating to risk assessment of contaminated sites in the 16 contributing countries. This includes details of policy background, legislation, technical approaches used for risk assessment, key technical guidance documents, and contact details for policy and technical specialists in each country. An updated version of this information is available at www.clarinet.at and www.cabernet.org.uk.

Within Europe the responses of governments, industry and the public to the problems posed by contaminated land have differed from country to country, both in nature and in relative timing. The UK, for example, was a pioneer in its early use of soil trigger concentrations as a decision-support tool in risk assessment and in the adoption of the suitable-for-use policy (ICRCL, 1987; DoE, 1994; DEFRA and Environment Agency, 2002 and in preparation). Readers should note that the ICRCL (1987) guidance was formally withdrawn by DEFRA in December 2002.

Chapter 2 discusses the UK situation in more detail. In contrast, the Netherlands and Germany espoused a multi-functionality or omni-functionality philosophy until the mid-1990s and only relatively recently adopted a risk based, suitable-for-use approach to assessing and managing contaminated land.

National policies have had unforeseen consequences. For example, Denmark's Contaminated Sites Act dates back to 1983. However, the Act and its subsequent revisions raised considerable problems for some innocent homeowners. Therefore, as a supplement to the Act, a special system for remediation of residential sites was introduced in 1993 with the Act on Economic Blight to Family Housing on Contaminated Land (popularly known as the Loss of Value Act).

Germany was another pioneer in establishing systems for identifying, assessing and dealing with land contamination. However, a multiplicity of legal requirements and standards for soil remediation evolved in different parts of Germany. It was no mean achievement politically to persuade the various Länder and city authorities to adopt uniform risk assessment criteria under the Federal Soil Conservation Act, which came into force in March 1999.

In the Netherlands, public concern following the Lekkerkerk incident led to an inventory of seriously contaminated sites being drawn up in the early 1980s. Dutch approaches to assessment and remediation of contaminated land have been very influential internationally, and Dutch generic guideline values (A, B, C values and their successor-integrated intervention values) have been used, and sometimes misused, in many other countries. In 1997, the Dutch policy of cleaning up contaminated sites for multi-functional (or omni-functional) use was replaced by the less rigid fitness-for-use approach now favoured by other European countries.

Not all European countries have evolved specific legislation for contaminated land. In France, for example, the key policy document is a Ministerial Directive, dated December 1993, which is part of a very general 1976 law on environmental protection. This has proved to be a suitable framework for regulating and providing guidance on contaminated sites. Remediation of orphan sites is funded by a tax on hazardous industrial waste which was introduced in February 1995. The French water agencies (Agences de l'Eau) also provide grants and low-interest loans for site investigation and clean up.

Portugal, in contrast, is a relative latecomer and has not yet compiled data on contaminated sites, nor established national methodologies or

explicit criteria for their assessment and remediation. In response to these needs, the Portuguese Government has recently established a Soil Pollution Development Centre, integrated with the Waste Institute. The Institute is now working on a strategy for contaminated site management, building on information and experience from other countries as well as Portuguese experience of major site remediation (e.g. the Expo'98 site in Lisbon). The site was a former port and industrial area including an oil and gas refinery and tanks which closed down or were relocated.

There are certain fundamental principles on which most European and North American countries appear to agree:

- the need to prevent or limit future pollution;
- the 'polluter pays' principle, usually with a mechanism for helping innocent landowners;
- the precautionary principle;
- the use of risk-based philosophy for identifying, prioritising and assessing the need for remedial action.

The European Integrated Pollution, Prevention and Control Directive has created a uniform framework for avoiding or removing new pollution arising from industrial activity.

However, in spite of a convergence of philosophy, there appear to be large differences in the practice of assessing and managing land contamination risks in the various countries. There is a little research on these differences and their implications. What research there is shows that the differences pertaining to:

- the extent to which the designs of site investigation and risk assessment are integrated and the role of risk assessment-driven data quality objectives in those designs;
- the use of generic guideline values as decision-support tools and the methods for deriving such values;
- whether or not socio-economic considerations are factored into guideline values and other risk assessment methodologies; decision-support procedures for identifying optimal remedial strategies; and procedures for communicating risks and benefits with relevant stakeholders.

These differences inevitably affect the cost of dealing with land contamination from one country to another. Such cost differentials, in

turn, will affect company profits, business confidence, attractiveness of a country or region to inward investors, etc. Differences in risk management outcome might also affect public health and levels of ecosystem protection and/or the perception of these.

A major issue for all industrialised countries is how to reduce the cost of dealing with land contamination without compromising public health and water quality, or business confidence in the benefits of land regeneration and sustainable use of soil. These issues were addressed by the Contaminated Land Rehabilitation Network for Environmental Technologies (CLARINET) that started the work in July 1998 and finished in 2001. Like CARACAS, it was also funded under the CEC Environment and Climate Programme and by accompanying measures from the participating countries. The primary objective of CLARINET was to develop recommendations for effective, and cost-effective, rehabilitation of contaminated sites in Europe focusing on socio-economic as well as technical issues. The overall conclusion of CLARINET was that a risk-based approach to land management is an essential component of sustainable redevelopment of urban land (Vegter *et al*., 2002).

At a European level, there is an increasing recognition that land contamination is only one factor in the successful reclamation and return to beneficial use of derelict and abandoned industrial land. Other environmental factors include the presence of redundant infrastructure and services, abandoned foundations and underground voids that may contain hazardous or otherwise difficult-to-handle materials. Social and economic factors probably dominate the redevelopment strategy of an area or particular site. There is a need to maintain social coherence and to mitigate social pathogens such as drug abuse, violence and burglary. Without a successful economy, the finances to sustain society, to enhance quality of life and to protect the environment will not be available.

This recognition of the need for an integrated approach to reclamation of formerly developed land has given rise to several European initiatives. The Concerted Action on Brownfield and Economic Regeneration Network (CABERNET) is a multidisciplinary network comprising eight expert stakeholder groups that aims to facilitate new practical solutions for urban brownfields. Its vision is to 'Enhance rehabilitation of brownfield sites, within the context of sustainable development of European cities, by the provision of an intellectual framework for coordinated research and development of tools' (www.cabernet.org.uk).

The Regeneration of Urban Sites and Cities in Europe (RESCUE) project is comparing practice in England, France, Poland and Germany in

order to distil elements of best practice in urban brownfield regeneration (www.rescue-europe.com). These two initiatives are likely to result in a long-term improvement in the awareness and application of the sustainable solutions to brownfield sites across Europe.

European policy initiatives continue to evolve. At the time of writing the Groundwater Draughter Directive is being discussed by the European Parliament and the Soil Thematic Strategy is being draughted by the European Commission.

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2

UK policy

The UK Government policy on contaminated land is set out in Annex 1 of DETR circular 02/2000, '*Contaminated Land*', published on 20 March 2000 (Department of the Environment, Transport and the Regions, 2000). The specific objectives that underlie the Government's approach to land contamination are:

- to identify and remove unacceptable risks to human health and the environment;
- to seek to bring damaged land back into beneficial use; and
- to seek to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

We are increasingly conscious of the harm that our activities can cause to the environment, and the harm to people or the loss of quality of life that can result from environmental degradation. Various estimates have been made of how much land in the UK may be affected by contamination. The Parliamentary Office of Science and Technology (1993) referred to expert estimates of between 50,000 and 100,000 potentially affected sites across the UK, with estimates of the extent of land ranging between 100,000 and 200,000 ha. This is some 0.4–0.8% of the UK land area. More recently, the Environment Agency (1999a,b) estimated that there may be some 300,000 ha of land in UK affected to some extent by industrial or natural contamination (approximately 1.2% of the UK land area).

The United Kingdom has recognised the need to manage activities in a way that minimises the risks of environmental damage, while at the same time ensuring economic growth and social progress. The interaction between people and the environment is complicated and difficult to quantify. It is not easy to judge where the balance should lie between environmental protection and economic and technological progress.

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Environmental risk assessment is a key element in the appraisal of these complex problems and in formulating and communicating the issues so that transparent and equitable policy, regulatory or other decisions can be taken (DETR, Environment Agency and CIEH, 2000).

In the United Kingdom, Part IIA of the Environmental Protection Act (EPA) 1990 provides a new regime for the control of specific threats to health or the environment from historic land contamination given the current use of the land. The Act is supported by Statutory Guidance issued by the Secretary of State (Department of the Environment Transport and the Regions, 2000), the Scottish Parliament and the Welsh Assembly for England, Scotland and Wales, respectively. The Town and Country Planning Act (TCPA) 1990 and similar provisions in Scotland control risks where a change in landuse is being proposed. Planning law is supported in England by Planning Policy Guidance Note 23 that deals with land affected by contamination, in Scotland by Planning Advice Note (PAN 33) and in Wales by a Technical Advice Note. PPG 23 is due to be replaced by a planning policy statement from ODPM shortly.

2.1 Case studies

Incidents such as the detection of hexachlorobutadiene in houses (http://www.project-pathway.com), the redevelopment of Enfield Lock (Friends of the Earth and the Enfield Lock Action Group Association, 2000), the landfill gas explosion at Loscoe (Williams and Aitkenhead, 1991) and in Warwickshire provided the impetus for advances in scientific understanding, policy and practice.

2.1.1 51 Clarke Avenue, Loscoe

At 6.30 a.m., 24 March 1986, the bungalow at 51 Clarke Avenue, Loscoe, Derbyshire, was completely destroyed by a methane gas explosion. Three occupants of the house were badly injured. Although natural gas was supplied to the bungalow and there were nearby shallow coal workings, gas samples taken from the wreckage soon after the explosion were found to be generally similar to landfill gas which is typically composed of 60% methane and 40% carbon dioxide. The gas was eventually traced to a landfill site 70 m from the bungalow (Williams and Aitkenhead, 1991).

During the public inquiry, it became apparent that signs of ground heating had been detected approximately 100 m beyond the boundary of the landfill some years before the explosion but that phenomenon had been

misinterpreted as a shallow burning coal seam. Had the geology of the area and the geochemistry of methane been known to the investigators at that time, it is possible that the landfill would have been identified as the source of the methane and the Loscoe area protected from the dangers of uncontrolled migration of such a dangerous gas (http://freespace.virgin.net/craven.pendle/programme/events_01_02.htm#DerbyshireDisasters).

2.1.2 Project Pathway

In 1993 ICI initiated Project Pathway – a voluntary assessment of the risks to environment and people from more than 160 years of industrial activity on and around the Runcorn site in northwest England. Initial work around Weston Quarries in Runcorn centred on a historical review of company and public documentation, interviews with current and former employees and residents in the area (http://www.project-pathway.com/index.htm).

Part of the project looked at the potential for vapour migration from the Weston Quarries to nearby houses. Data from a series of boreholes around the edge of the quarries and indoor air monitoring indicated the presence of hexachlorobutadiene (HCBD) at unacceptable levels in some nearby houses. Residents in homes where HCBD was detected were offered temporary hotel or rental accommodation at ICI's expense. A house purchase policy was introduced in January 2000 to allow residents in the zones to move permanently if they wish. Since then, the housing market in Weston has been returning to normal and the policy has served its original purpose. Also in January 2000, all homeowners within zones defined by ICI were offered a 20-year house value protection guarantee to reassure them that they would not be financially disadvantaged if they wished to stay in their homes. This policy remains unchanged. ICI refined the analytical techniques and found only a small number of households had HCBD at unacceptable levels. However, their communication and compensation plan extended well beyond those few properties. A local health authority report found reversible kidney dysfunction in some Halton residents, but could not attribute these to land contamination.

2.2 Part IIA of the Environmental Protection Act 1990

Contaminated land is identified on the basis of risk assessment. Within the meaning of Part IIA of the EPA, land is 'contaminated land' where it appears to the Local Authority in whose area the land is within, by

reason of substances in, or under the land, that: '(a) significant harm is being caused or there is a significant possibility of such harm being caused; or (b) significant pollution of controlled waters is being, or is likely to be, caused'. Controlled waters include groundwater, rivers, lakes, etc. Part IIA was introduced into the EPA 1990 by s57 of the Environment Act 1995 and amended by the Water Act 2003 (www.hmso.gov.uk). It came into effect in April 2000 in England, July 2000 in Scotland and July 2001 in Wales.

The lead regulators for Part IIA are the local authorities, who already had responsibility for dealing with effects on public health from land contamination and for controlling developments on or near contaminated sites. The Environment Agency of England and Wales (as well as the Scottish Environment Protection Agency in Scotland) has specific responsibilities for dealing with land designated as special sites. Special sites are contaminated land which:

- causes serious water pollution (e.g. results in pollution of major aquifers by List 1 substances as listed in the Groundwater Directive);
- might be difficult to remediate due to the presence of certain specific substances (e.g. an acid tar lagoon);
- is already regulated by the Environment Agency or SEPA (e.g. an oil refinery);
- would be best served by a single point of contact (e.g. land currently occupied by the Ministry of Defence).

2.3 The source–pathway–receptor pollutant linkage concept

The United Kingdom follows the widely recognised source–pathway–receptor pollutant linkage concept for assessing risks from contaminated land. A phased approach is preferred for the collection of site data (BSI, 2001), with early formulation of a conceptual model (see Chapter 5) which can be refined as further data are gathered. Importance is placed on thorough assessment of all relevant data about a site, and on making defensible decisions on risks based on appropriate and sufficient data. Remedial action aims to control, modify or destroy pollutant linkages that present unacceptable risks (see Chapter 7).

For many years, the UK has operated an approach to contaminated land risk assessment in which precautionary threshold trigger values are used as screening levels for some of the commoner soil contaminants (ICRCL, 1987). In the context of direct human health risks, these trigger values are being replaced by Soil Guideline Values (SGVs) derived using

the CLEA model (DEFRA and Environment Agency, 2002). The generic SGVs are derived employing the same procedures and algorithms used to derive site-specific assessment criteria, but applied to standard land-use scenarios (residential with or without plant uptake), allotments and (commercial/industrial) characterised by specific exposure assumptions. Derivation of site-specific assessment criteria, based on exposure and toxicity assessments, is carried out where SGVs are not available, not appropriate, or where particularly complex or sensitive site circumstances require it. Guideline values may, therefore, be used for risk assessment as long as the risk assessor can demonstrate that:

- the assumptions underlying the SGVs are relevant to the source–pathway–receptor circumstances of the site in question;
- any other conditions relevant to use of the values have been observed (e.g. the sampling regime and the methods of sample preparation and analysis);
- appropriate adjustments have been made to allow for differences between the circumstances of the land in question and those assumed in deriving the guideline values.

The SGVs not only reflect the different classes of landuse but also, where appropriate, reflect soil type, soil pH, soil organic matter, etc. When SGVs are not available or their use is not appropriate, other risk assessment methods may be used so long as they are appropriate, authoritative and scientific.

The use of guideline values rather than standards allows flexibility and offers scope for professional judgement to be applied.

It is more difficult to derive generic soil guidelines for groundwater protection. This is because most of the key variables (thickness and attenuating capacity of soil and bedrock, depth to water table, proximity to abstraction points, etc.) are highly site specific. The Environment Agency has developed guidance on a tiered approach to assessing risks to groundwater. This includes simple screening approaches and progressively more sophisticated risk assessment methods for use where the circumstances justify the additional cost. The guidance emphasises the importance of an adequate conceptual model of the local and regional hydrology. In essence, site-specific soil concentrations are determined that will ensure groundwater concentrations at a compliance point do not exceed Drinking Water Standards or other groundwater-specific environmental quality standards (Scottish Executive, 2003).