International Real Estate Society Conference '99

Co-sponsors: Pacific Rim Real Estate Society (PRRES)
Asian Real Estate Society (AsRES)

Kuala Lumpur, 26 – 30 January 1999

IDENTIFICATION AND MANAGEMENT OF CONTAMINATED LAND

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Keywords: Contaminated land, environmental risk, management, identification, remediation.

IDENTIFICATION AND MANAGEMENT OF CONTAMINATED LAND

Abstract

Contaminated land is a liability to the owners, occupiers, financiers and insurers. Apart from health problems and threats to the ecosystem, it causes rental and capital value reduction, and legal and financial liabilities. To safeguard the stakeholders' interest, it is required to properly manage both contaminated and potentially contaminated property. The conventional property management methods are applicable subject to modification to include identification of contamination on the land, assessment of the environmental risk and preparation of a dedicated management program.

Contaminated land management can be broadly categorised into macro-level and micro-level. The former is management carried out by the government and the latter by private individuals. This paper focuses on the micro-level of management and aims at providing stakeholders, property managers, valuers and other interested persons. It concludes that with proper management, even contaminated property can be a valuable asset.

Introduction

Land contamination has become a major concern of the community, in particular, among landowners, occupiers, financiers and insurers. Apart from threats to human health and the environment, it also reduces property value and leads to legal and financial liabilities. Governments around the world have passed environmental laws to regulate this problematic environmental issue. For example, in Britain, the Environment Act 1995 was passed to regulate contaminated land (Syms, 1997). In Australia, State and Territory governments have enacted laws, such as the Environment Protection Act 1970 (Vic), the Environmental Protection Act 1994 (Qld) and the Contaminated Land Management Act 1997 (NSW), etc. to deal with this issue.

In general, the environmental laws impose a legal duty on owners, occupiers and financiers to look after contaminated land. Accordingly, interested parties need to check if their land is contaminated. Purchasers also need to take care when buying land. Except in countries or states where the law requires the vendors to disclose if the land is or potentially contaminated, the rule of "caveat emptor" or "buyer beware" still applies. Accordingly, identification and management of contaminated land are becoming a mandate for buying, owning or occupying land.

Contaminated land management can be broadly categorised into macro-level and micro-level. The former is management carried out by the government and the latter by private individuals. This paper focuses on the micro-level of management and aims at providing stakeholders with the necessary background information about management of contaminated land. It covers common causes of land contamination, methods of identification, common remediation methods, and contaminated land

management methods. It concludes that with proper management, contaminated property can also be a valuable asset.

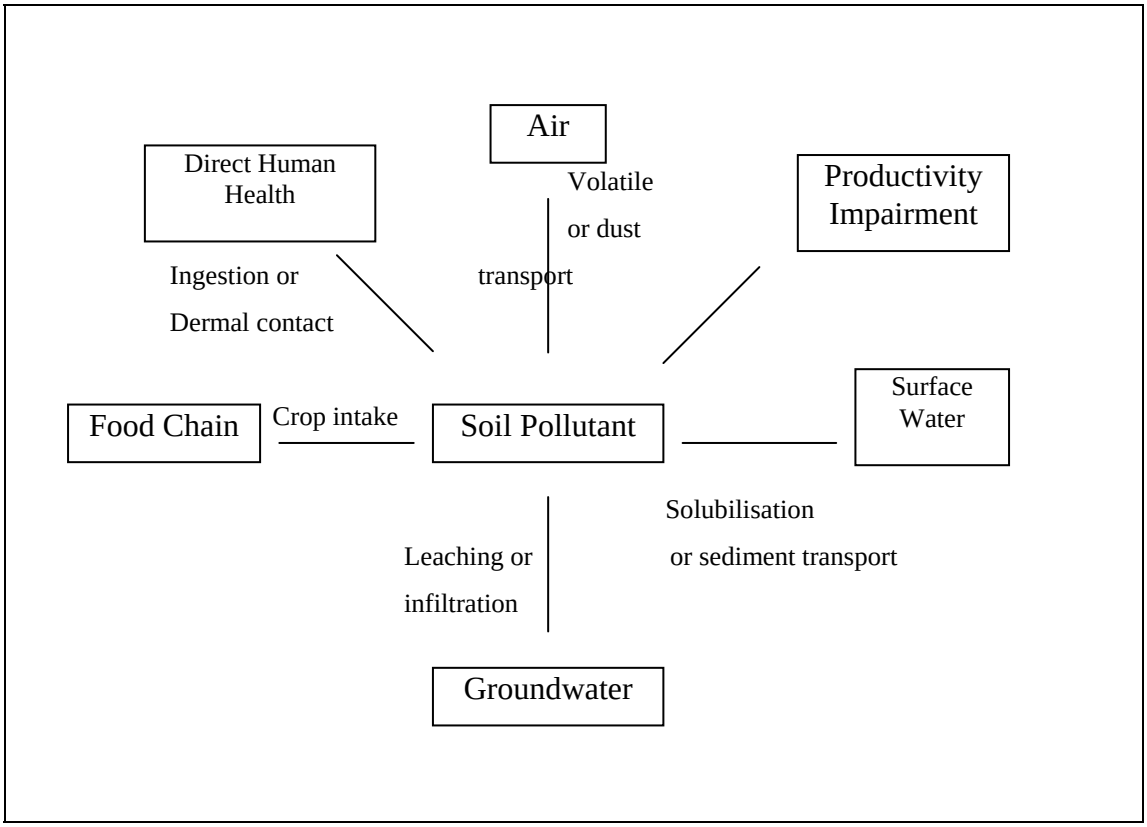
Causes and impacts of land contamination

There are many causes of land contamination. Basically land may become contaminated due to the presence of natural or artificial contaminants. Natural minerals like asbestos, uranium, etc. may contaminate land if they are disturbed or exposed. Land contamination due to undisturbed natural minerals is rare. More often than not, land contamination is due to human activities such as industrial productions, farming, and accidents, etc. The contaminants are generally in the form of products, by-products and wastes. A list of common toxic contaminants is reproduced Annex 1. A detailed one can be found in Appendix 4 of the "Environmental Guidelines: Assessment, Classification and Management of Non-Liquid Wastes" (NSW EPA, 1997).

The Australian And New Zealand Guidelines For The Assessment And Management Of Contaminated Sites (commonly known as the ANZECC Guidelines) lists 30 industries and land uses that are known to have been associated with land contamination (ANZECC & NHMRC, 1992). A similar list is also included in the "Contaminated Land Practice Standard" by the Australian Institute of Valuers and Land Economists (AIVLE, 1994). It contains 67 items and incorporates most of the ANZECC Guidelines items. The list is reproduced in Annex 2.

The contaminants in the soil may affect human and the environment in a number of ways. The impacts can be seen from Figure 1 below:

Figure 1: Impacts of contaminated land on human and the environment



Source: ANZCECC & NHMRC, 1992

The contaminants are dangerous because they can be ignitable, corrosive, reactive, and/or toxic. They may infect human, animals and plants with diseases, upset the ecosystem, and affect materials and structure used on land. Most contaminants are either organic or inorganic chemicals. Some are synthetic compounds that are resistant to biodegradation and chemical degradation, they are soluble in fats and can be accumulated in animal body. E.g. PCBs (polychlorinated biphenyls) are carcinogenic (causing cancer) and teratogenic (affecting unborn baby); TCDD (tetrachloro-dibenzo-para-dioxin), commonly known as dioxin, is highly toxic and is both carcinogenic and teratogenic.

Information about the toxicity of individual chemicals and compounds may be obtained from reference books like Klaassen (1995) and Rodricks (1992), medical practitioners, the respective Environment Protection Authorities (EPA) or health authorities. Information can also be obtained from Internet sites such as Chemicals in the Environment: OPPT Chemical Fact Sheets (www.epa.gov/docs/chemfact/) and Environmental Toxicology Concepts and Information About Specific Chemicals (www.iet.msu.edu/toxdocs.htm), etc.

In the absence of proper management and precaution, hazardous substances may be carried away by groundwater and surface water to pollute other land, and hence extend the boundaries of affected environment. In view of the imminent hazard, one should avoid contacting or staying near any chemicals, suspicious substances or polluted soil when visiting a site. Assessment of toxicity is

therefore an important part of environmental risk assessment of a contaminated site. Apart from the threat to human health and the ecosystem, it should be aware that property value can also be significantly affected. Therefore, contaminated land needs to be properly managed.

Management of Contaminated Land

Real estate is an important component in an investment portfolio. Comparing to stocks and shares investment, real estate needs more active management. Conventional property management includes acquisition of property, leasing of property, rent collection, property repair and maintenance, and disposal of property. The objective is to maintain income flow to the owner with a view to maximise the owner's wealth by buying and selling property. In relation to contaminated property, there is an additional objective.

The provisions of environmental laws and pubic expectation have imposed a new social objective. This new objective is to "select a socially acceptable and cost effective management strategy which mitigates threats to and provides protection for public health, welfare and the environment as well as allowing flexibility in the future use of the land." (ANZECC & NHMRC, ibid, 1992, p.41)

There are two levels of contaminated land management, ie, macro and micro levels. This paper focuses on the micro level of management, and the macro level will be covered briefly. At the macro level, the government is responsible for the management of contaminated land within its jurisdiction. The respective EPAs are charged with the responsibility to administer the relevant environmental laws. In general, the laws provide for the classification, identification, registration, and remediation of contaminated land. Liability is generally imposed on the basis of "polluter pays" principle.

At the micro level, contaminated land is managed by individual landowner/occupier or an appointed property manager. To effectively manage contaminated property, it is required to identify both current and future environmental risk. To meet the requirements, conventional property management approach has to be modified and extended to incorporate identification of contamination, environmental risk assessment, and the taking of appropriate remedial measures to correct the environmental problems.

Identification of Land Contamination

Identification of land contamination is essential for property investment and management. Without knowing the extent of contamination, it is difficult for a valuer to advise accurately the value of the property to the client. It follows that an owner or investor is unable to assess the likely liability arising from the contaminated land, while a property manager is unable to design the appropriate management strategy for the property. It is evident that environmental audit has become a tool for the management of contaminated property (Hadley, 1994).

There are basically three stages of site investigation in Australia:

Stage 1 - Preliminary site investigation

A stage 1 investigation is the preliminary assessment of any contamination on the site. It includes the following steps:

- an investigation of site history
- a physical site inspection
- a basic sampling and analysis to determine the presence of contamination, and
- a report is prepared

Stage 2 – Detailed site investigation

If the Stage 1 investigation shows further investigation is required, a detailed site investigation is carried out to assess:

- the concentration of various contaminations
- the volume of soil to be remediated
- the leachability and mobility of contaminants
- any contamination of groundwater, and
- any possibility of off-site migration of contaminants.

Stage 3 – Health and environmental assessment and determination of remediation plan

The results from the Stage 2 investigation provide information to determine the potential "human exposure and environmental impact" of the contaminants on the existing and intended land uses. If the intended use will cause unacceptable levels of human exposure or unacceptable impact on the environment, then, depending on the conditions, a partial or full remediation, or other land contamination management strategy has to be implemented. A health and environmental risk assessment has to be carried out, and a site specific remediation plan has to be prepared.

(DoE, Qld, 1998)

It is interesting to note that in the USA, there are also three phases of environmental site assessment. In a Phase I environmental site assessment, only determination of site history and a walkover inspection is carried out. It does not include a basic sampling program. When the Phase I assessment indicates that further investigation is required, a Phase II environmental site assessment is recommended. In essence, the Phase II assessment is to carry out a detailed site investigation that includes sampling and analysis (Quandt, 1997). Owing to its similar nature to Phase II assessment, a Phase III assessment is not generally carried out.

Site investigation should be carried out by an environmental expert. In Australia, environmental audit in New South Wales, Queensland and Victoria has to be done by a qualified expert under the relevant laws. An environmental auditor in New South Wales and Victoria has to be accredited/appointed under the laws. The stakeholders and property managers should ensure that an accredited environmental auditor is employed for the job.

A site history can be compiled with reference to information such as "original site plans, local authority zoning records, flammable and combustible liquids licence details, sewerage/trade waste and stormwater drainage plans, aerial photographs, environmental licences, etc." (DoE, Qld, 1998, p.27). Other information such as "previous land uses, previous industries supported, products manufactured, wastes produced, chemical storage and transfer areas, discharges to land, product spills and losses, geographical survey maps" also provide valuable reference (ANZECC & NHMRC, ibid, 1992, p.14).

A cross-reference of the past land use with the land uses listed in Annex 2 can reveal if the land is potentially contaminated. In addition, the *Suggested Environmental Assessment Checklist* at Appendix 3 of the AIVLE's "Contaminated Land Practice Standard" provides helpful guidance to identify potentially contaminated land.

In regard to site inspection, a walkover inspection may discover traces of land contamination. "If you can see it, smell it, or hear it, there will probably be a negative impact on property value." is a helpful rule of thumb for carrying out site inspection (Kinnard, 1992). Apart from noting any contamination of soil, building fabric, and ground water attention should be paid to the following indicators:

- any empty chemical container, tanks, pits, pipelines, drains;
- fill material with disturbed and discoloured areas of soil;
- chemical and/or unusual odour;
- discoloured and poor quality surface water;
- evidence of waste treatment practices;
- differences in vegetative growth compared with adjacent area, ie evidence of phytotoxicity.

(Turezynowiez, 1991)

Sampling and analysis are required in both Stage I and Stage 2 investigations. Sampling in a Stage I investigation is a part of the preliminary site assessment that is intended to determine if contamination exists. It is carried out in areas where the site history research shows that possible contaminating activities have been conducted. Sampling in a Stage 2 investigation is more detailed and depends on the findings of the preliminary assessment. The depths and positions of samples depend on "site history, soil morphology and the need to sample to natural ground where fill material is present." (DoE, Qld, 1998, p. 27).

At the moment, the ANZECC Guidelines and the Australian Standard AS4482.1-1997, *Guide to the Sampling and Investigation of Potentially Contaminated Soil, Part 1: Non-Volatile and Semi –Volatile Compounds* and other guidelines provide guidance in the investigation and sampling of soil and groundwater (Ramsay, 1998). Draft guidelines for Data Collection, Sample Design & Reporting of Data, Laboratory Analysis Of Potentially Contaminated Soils, and Assessment Of Groundwater Contamination have been included in the discussion paper *Towards A National Environment*

Protection Measure for the Assessment of Contaminated Land (NEPM) released on 13 July 1998 by the National Environment Protection Council Committee. It is envisaged that uniform guidelines will soon be available in Australia.

Determination of Environmental Risk

If a site is found to be contaminated, it does not mean that it is useless or valueless. In general, the existing use of the land can be continued unless prohibited by the environmental law. The mere fact that the land is contaminated is not an offence. It matters only if the contamination "is causing harm or has the potential to do so" (RICS, 1996). Accordingly it is necessary to assess exactly the amount of environment risk involved. The environmental risk assessment process involves four stages:

- "data collection and evaluation of the chemical condition of the site;
- toxicity assessment of contaminants;
- exposure assessment for the population on or near the site;
- risk characterisation."

Risk characterisation is a process to evaluate the potential for adverse health effects to occur, evaluate uncertainty and summarise risk information (ANZECC & NHMRC, ibid, 1992, p. 30).

At present in Australia, the Environmental Investigation Threshold- (ANZECC B levels) is used to determine if a site is suitable for any use while the Dutch Intervention Values (DIVs) are used to determine if a site is suitable for unrestricted industrial/commercial use. If the soil contamination level exceeds the ANZECC B levels, the site is not suitable for sensitive uses such as residential, childcare centre, etc. If it exceeds the DIVs, the site is not suitable even for industrial/commercial use, and a clean up or appropriate management strategy has to be implemented. In other words, if the contamination level is below the ANZECC B levels, the land is unrestricted for any beneficial uses. If the concentration is below the DIVs, it indicates the land is good for industrial/commercial uses (Ramsay, ibid,1998)..

The NEPM has suggested the use of two benchmarks for soil criteria and investigation levels:

1. Health-based Investigation Levels (HILs) -- benchmarks for contamination that may affect human health,
2. Regional Environmental Investigation Levels (REILs) – benchmarks for contamination that may affect ecological diversity in Australia.

These benchmarks are aimed to prompt a site assessment to determine if unacceptable health risks exist and the nature and magnitude of environment risks, rather than being *de facto* cleanup or response levels (NEPCM, 1998). They are to confirm and continue the flexible approach recommended in the ANZECC Guidelines. Very often a site may have some contamination which is acceptable for its existing or less sensitive future uses . If the pre-determined soil criteria are to be strictly adopted as

cleanup standards, remediation will be overdone at the expense of unnecessary time and cost. The flexible approach recognises the different characteristics of individual sites, such that the site-specific data leads to site-specific remediation which is based on "acceptance criteria which will ensure that public health, local amenity and soil, air and water quality are protected." (ANZECC & NHMRC, ibid, 1992, p.9).

Remediation

An objective in management of contaminated land is to remove legal and financial liabilities and to restore property value. To achieve the objective, remediation action in respect of the contaminated land has to be taken. The choice of remedial action depends, among other factors, on the environmental risk associated with the contamination. It should be noted that environmental risk arises because of the presence of the following factors:

- the hazard of the contaminant source;
- the presence of a receptor (human or the ecosystem); and
- a pathway for disseminating the hazard.

(Parker, 1996)

Threat to human health and the ecosystem cannot occur unless all the factors are present. Remedial actions, such as restricting access to the contaminant source, reducing exposure time, isolating the contaminant source, removing the contaminant source, etc. are effective measures to deal with environmental risk.

As far as removal of contaminant source is concerned, there are different clean up methods. The common ones include:

1. On site treatment

The contaminants are destroyed or broken down while the soil remains in-situ or excavated on site. Eg. bioremediation, land farming, vertical mixing and chemical fixation.

2. Off site treatment

The contaminated soil is excavated, removed from the site and taken to a depot for treatment. Eg. high temperature incineration, soil washing, thermal absorption, particle-size separation, chemical treatment like base-catalysed dechlorination (BCD), ball-mill pulverisation, and super-critical fluid extraction.

3. Off site disposal

The contaminated soil is excavated and removed from the site for disposal at a controlled landfill. Given that it is a controversial issue to allow transport of contaminated soil on public roads, it is unlikely that the authority will approve this mediation method today.

4. Containment on site

This method is to keep the contaminated soil in-situ and to restrict access to it and prevent leaking and leaching by suitable means, such as encapsulation and capping.

(NSW EPA, 1995)

In addition to the above, recycling may also be an acceptable remediation method. E.g. silver is recovered from recycling silver bromide used in the photo processing industry. However, given the high cost of recycling, this method is feasible only for end products with high value.

The choice of remediation method is a multi-criteria decision making process and depends on a number of factors as shown in the following expression:

Method = f(real and perceived environmental risk, intended use, community opinion, statutory requirements, remediation standards, technology, time, cost)

Of the factors, the importance of perceived environmental risk should not be underestimated. While the actual environmental risk may be low, a high perceived risk may scare off potential buyers and tenants. The marketability and property value can be substantially affected. Accordingly, any remediation program should include provision to minimise the negative impact of perceived risk.

In consultation with the client and the relevant authorities, the environmental expert is able to choose an appropriate method of remediation. The correct choice of remediation method may not only be cost effective but also save time. For example, in 1996, the method of "optimal bioremediation treatment" was used to clean up 6,000 tonnes of hydrocarbon-contaminated soils at the petroleum company Ampol's Lytton refinery near Brisbane. The clean up was well ahead of the 12-month target completion time and there was a cost saving of 25% over alternative remediation technologies (WM&E, 1997). It is evident that if the remedial action is appropriate, expensive clean-up can be avoided and the financial resources can be used for more productive purposes (Parker, ibid, 1996).

Other Management Techniques

The fact that the property is free from contamination or the condition is acceptable at present does not mean that there will be no problem in the future. To help prevent future environmental problems, effective property management has to be introduced. In this regard, there should be a clear corporate environmental policy and environmental management system as outlined below.

In the past, "end of the pipe" treatment was a common approach to deal with wastes. Companies considered environmental compliance and site clean-up as the "cost of doing business" (Nestel & others, 1996). In recent years, the tide of environmental consciousness coupled with legal obligation has caused companies to pay more attention to their activities on the land. As there is increasing consumer demand for green products and services, companies understand that having a good corporate environmental policy and effective contaminated land management program will not only improve

their image but also their position in a competitive market. For example, the McDonald's Restaurant Group has responded to public appeal to replace polystyrene with paper for packaging of hamburgers.

The following sections outline the incorporation of an environmental management system in a property management program and how to extend conventional property management techniques to cater of contaminated properties.

Corporate Environmental Policy and EMS

To help organisations to address environmental issues systematically and improve their environmental performance, the International Organisation for Standardisation (ISO) prepared the ISO 14000 series of environmental standards in 1991. These standards are based on the ISO 9000 series quality management standards and aimed at helping organisations formulate an effective environmental management system (EMS).

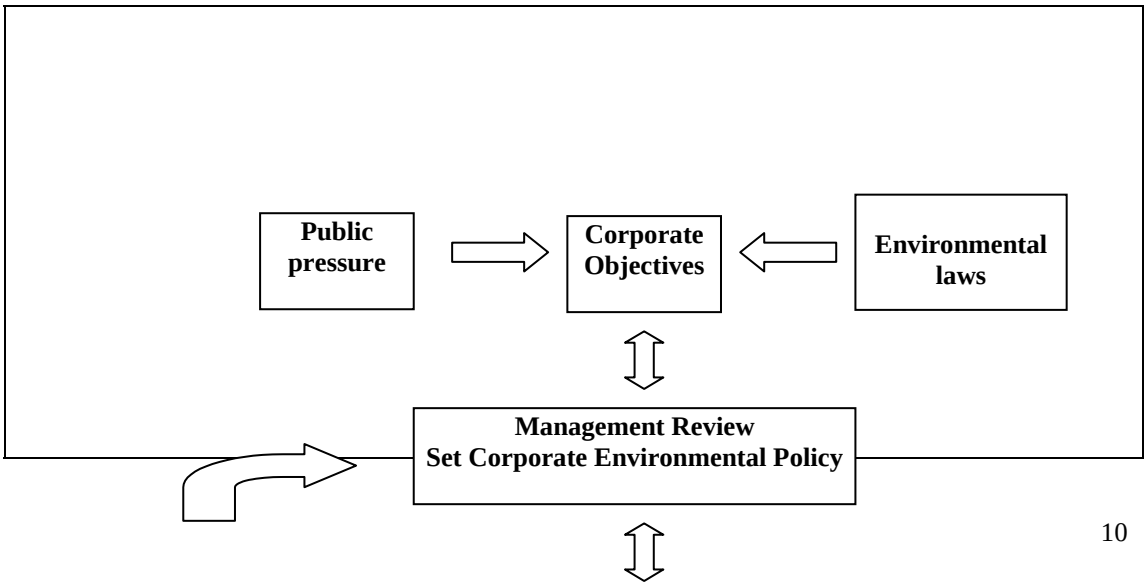
With an effective EMS, companies can:

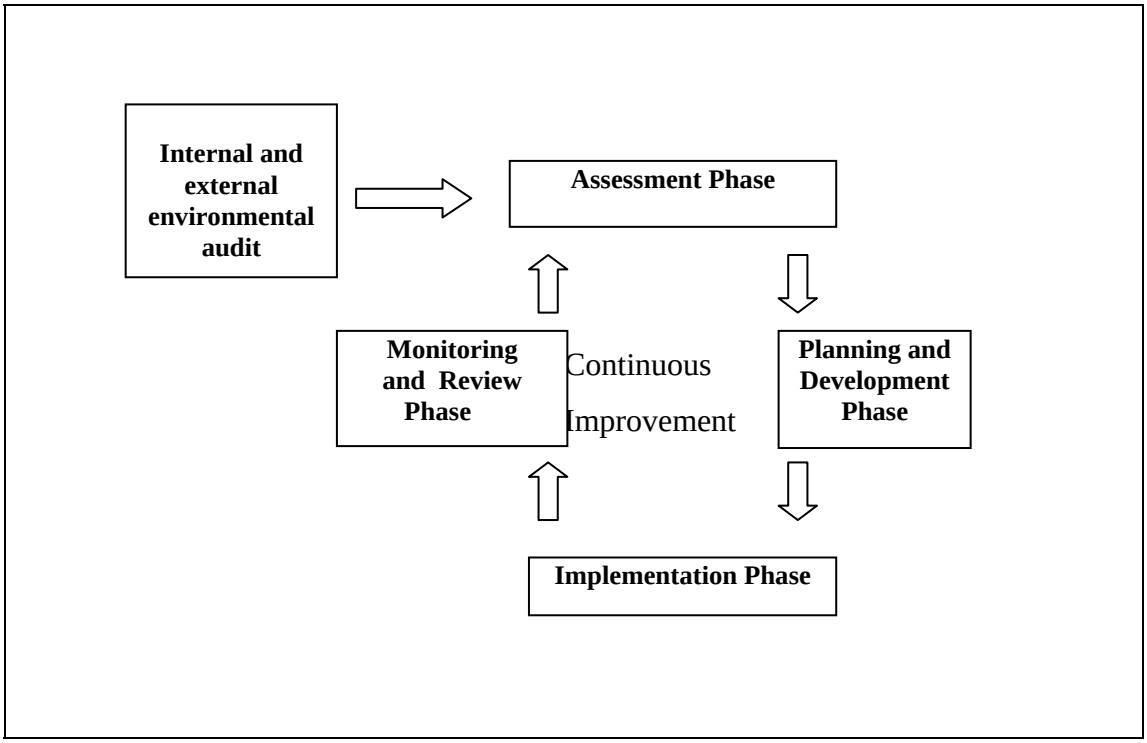
- create an environmental policy;
- set objectives and targets;
- implement a program to achieve those objectives;
- monitor and measure its effectiveness, correct problems; and
- review the system to improve it and the overall environmental performance.

(Tibor & Feldman, 1995)

It should be noted that the ISO 14000 series of environmental standards do not supersede the relevant laws, "implementation of these standards on their own does not confer immunity from prosecution for breaches of environmental laws" (Izmir, 1996). The standards only provide guidelines for preparing an EMS rather than establish absolute environmental performance requirements. Companies still need to comply with the requirements of relevant environmental laws. Nevertheless, an effective EMS will help companies comply with legal requirements. A typical EMS model is shown in Figure 2 below.

Figure 2: A typical EMS model





Source: Adapted from ANAO, 1996

In the above model, an organisation needs to carry out specific tasks in each of the four phases:

Assessment Phase

- *recognise the corporate policy context;*
- *determine legal compliance requirements; and*
- *assess environmental risks.*

Planning & Development Phase

- *develop corporate environmental strategies and performance indicators;*
- *consider performance in relation to other relevant organisation; and*
- *gain the commitment of senior management for action.*

Implementation Phase

- *implement an environmental management strategy;*
- *allocate resources to balance environmental risks and the costs of potential actions; and*
- *align and integrate environmental management system with existing management systems.*

Monitoring & Review Phase

- *measure, monitor and evaluate performance;*
- *report financial and environmental performance outcomes; and*

- *implement continuous improvement to maintain best practice.*

(ANAO, 1996)

Companies may adopt a corporate policy and EMS to suit their own needs. While it may take some time to see the results, the company will eventually benefit the decision made today.

Extension of Conventional Management Techniques

Under the current environmental laws, owner occupiers are liable for damage to the environment. Where the property is let, the landlord is concerned about that if the property is polluted by the tenant, the rental, market value, and marketability of the property will be adversely affected. Under the 'polluter pays' principle, the tenant who caused the pollution is responsible for legal and financial liabilities. However, if the pollution is discovered after the tenant has quitted or bankrupted, the landlord may be held liable for the tenant's remediation liabilities.

Despite the said disadvantage, a contaminated or potentially contaminated property, is still a valuable asset to the owner if it is properly managed. For example, the PortAir Industrial Estate in Botony Bay, Sydney, has won the owner the 1998 Property Council of Australia Best Managed Industrial Estate in New South Wales (MacKay, 1998).

The conventional property management techniques may help ease the landlord's concern through tenant selection, lease preparation and enforcement. To safeguard the landlord's interest, it is necessary to select the best tenant for the letting. The tenant's environmental credential should be checked, in this regard, an environmental risk rating of tenants may have to be introduced (RICS, ibid, 1996). The prospective tenant's corporate environmental policy can help the property manager in making decision.

Regarding lease preparation, the lease document should be carefully drafted, apart from repair and maintenance liabilities; separate and specific clauses relating to environmental responsibilities, lessee to indemnify lessor and lessor's right to inspect the premises should be included (Kyle & Baird, 1995). Sample clauses are reproduced in Annex 3. A perfectly written lease is useless without good enforcement. MacKay (ibid, 1998) suggests that a property manager should inspect the premises once a month to make sure the tenant has performed its contractual duties. Strict action has to be taken to enforce the lease conditions. The extra management hassle brought about by contaminated property may increase a property manager's workload by 1% to 2%. The extra work is rewarded by the performance of the property in the investor's portfolio.

It has been mentioned earlier that environmental audit has become an important tool for the management of contaminated property. Where land contamination is a concern, an environmental audit should be carried out by the landowner prior to letting or sale, to make sure that the property is not

affected by contamination. This will boost the marketability of the property, and, if a mortgage is required, facilitate the loan approval procedure of the financial institution. A landlord may consider inserting a clause in the lease document to require the tenant to carry out an environmental audit before rent review and expiry of the lease.

To avoid loss due to a biased environmental audit report from the vendor, a prospective investor should always arrange for an independent environmental audit report. The investor may, depending on the site characteristics, have to pay $A3,500 to $25,000 for a Stage 1 investigation report (Ramsay, ibid, 1998). This is a small amount when compared to the possible million dollars liability if the property is purchased without having an independent site audit. Annex 4 is a checklist which shows what to look for in a good environmental audit report.

A good environmental audit report should include recommendations on how a property can maintain and enhance its value. For example, the PortAir Industrial Estate has 20,000m^2 of corrugated super six asbestos roofing. Apart from advising tenants and contractors of the presence of asbestos, the owner also adopts proper management by suitable signage, the maintenance of an asbestos register and regular testing. The property is able to retain its existing roof for the medium term. On the other hand, the owner provides the environmental protection infrastructure such as truck wash bays, bunding of tanks where chemicals are stored, site retention of storm water and grease traps/triple interceptors on the premises. These measures help maintaining the value of the asset. (Mackay, ibid, 1998).

Finally, if the owner or occupier may consider transferring the financial risk by taking an environmental insurance. By doing so, it is possible to partially or wholly transfer the risk to the insurers.

Conclusion

Contaminated land has caused a lot of concerns among all walks of life. Apart from health risk and impact on the environment, owners, occupiers and financiers are concerned about the possible legal and financial liabilities. With the enactment of relevant laws in this area, the legal liability of stakeholders has been clarified.

Nevertheless, contaminated land is generally regarded as a liability rather than an asset. If choices are available, investors and tenants will avoid choosing a contaminated or potentially contaminated property. To restore the utility, marketability, and market value of the property and to reduce legal and financial liabilities, it is necessary to have an effective management program. Conventional property management focuses on maintaining cash flow and maximising the wealth of the owner. Management of contaminated land, however, requires more than that. Apart from achieving the conventional property management objectives, there is also an additional social objective, i.e. to select a socially acceptable and cost effective strategy that minimises threats to and provides protection for public health, welfare and the environment.

To achieve all the objectives, conventional property management techniques such as property maintenance and repair have to be extended to cover identification and assessment of environmental risk, and the taking of appropriate remedial measures. Today, an effective contaminated land management program should include identification of land contamination, environmental risk assessment and remedial measures. The lease document should contain appropriate environmental clauses to safeguard the landowner's interest. To further enhance the quality of a management program, consideration should be given to incorporate an EMS under the ISO 14000 series of environmental standards.

Given proper management, even a contaminated or potentially contaminated property can be a valuable asset. The Best Managed Industrial Estate Award to the PortAir Industrial Estate vividly demonstrates this point. An effective management program may help avoid expensive clean-up cost and free up financial resources for more beneficial purposes. Since a proper management strategy cannot be formulated without the help of a good environmental audit report, the stakeholders should ensure that an environmental audit report is prepared before any property acquisition and letting. For owner occupiers, a periodic environmental audit can help updating the environmental performance on the land.

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Annex 1

Common Toxic Contaminants

Organic Chemical	Inorganic Chemical
Benzene	Arsenic
Benzo(a)pyrene	Beryllium
Carbon tetrachloride	Cadmium
Chlorobenzene	Chromium (total)
Chloroform	Cyanide (amenable)
o-Cresol	Cyanide (total)
m-Cresol	Fluoride
p-Cresol	Lead
Cresol (total)	Mercury
2,4-D	Molybdenum
1,4-Dichlorobenzene	Nickel
1,2-Dichlorobenzene	Selenium
1,2-Dichloroethane	Silver
1,1-Dichloroethylene	
1,1-Dichloromethane	
2,4-Dinitrotoluene	
Ethylbenzene	
Methyl ethyl ketone	
Nitrobenzene	
Polycyclic aromatic hydrocarbons (total)	
Phenol (non-halogenated)	
Styrene (vinyl benzene)	
1,1,1,2- Tetrachloroethane	
1,1,2,2-Tetrachloroethane	
Tetrachloroethylene	
1,1,1-Trichloroethane	
1,1,2-Trichloroethane	
Trichloroethylene	
2,4,6-Trichlorophenol	
2,4,5-Trichlorophenol	
Toluene	
C6 – C9 petroleum hydrocarbons	
C10 – C36 petroleum hydrocarbons	
Vinyl chloride	
Xylenes (total)	

Source: NSW EPA, 1997.

Annex **2**

Specific industries and land uses associated with site contamination

1. Abattoirs and Animal Processing Works
2. Acid/alkali plant and formulation
3. Agricultural Activities (Vineyards, Tobacco, Sheep Dips, market Gardens)
4. Airports
5. Alumina Refinery Residue Disposal Areas
6. Asbestos production, and disposal
7. By-Product Animal Rendering
8. Bottling Works
9. Breweries
10. Brickworks
11. Car Wreckers
12. Cement Works
13. Cemeteries
14. Ceramic Works
15. Chemicals manufacture and formulation
16. Coal Mines and Preparation Plants
17. Defence Works
18. Docks
19. Drum Reconditioning Works
20. Dry Cleaning Establishments
21. Electricity Distribution
22. Electroplating and Heat Treatment Premises
23. Ethanol Production Plants
24. Engine works
25. Explosives industries
26. Fertiliser Manufacturing Plants
27. Gas works
28. Glass Manufacturing Works
29. Horticulture/Orchards
30. Industrial Tailings Ponds
31. Iron and Steel Works
32. Landfill Sites
33. Lime Works
34. Marinas and Associated Boat Yards
35. Metal treatment
36. Mineral Sand Dumps

37. Mining and Extractive Industries
38. Munitions Testing and Production Sites
39. Oil Production, Treatment and Storage
40. Paint Formulation and Manufacture
41. Pesticide Manufacture and Formulation
42. Pharmaceutical Manufacture and Formulation
43. Photographic Developers
44. Piggeries
45. Plant Nurseries
46. Plastic or Fibreglass
47. Power Stations
48. Prescribed Waste Treatment and Storage Facilities
49. Printed Circuit Board Manufacturers
50. Properties Containing Underground Storage Tanks
51. Radioactive Materials, Use or Disposal
52. Railway Yards
53. Research Laboratories
54. Sawmills and Joinery Works
55. Scrap Yards
56. Service Stations
57. Sewerage Works
58. Smelting and Refining
59. Sugarmill or Refinery
60. Tanning and Associated Trades (eg Fellmongery)
61. Timber Treatment Works
62. Transport/Storage Depots
63. Tyre Manufacturing and Retreading Works
64. Waste Treatment Plants in which Solid, Liquid Chemical, Oil, Petroleum or Hospital Wastes are Incinerated, Crushed, Stored, Processed, Recovered or Disposed of.
65. Wood Storage Treatment
66. Wood Treatment Facility
67. Wood Preservation

Source: Australian Institute of Valuers and Land Economists, 1994.

Annex 3

Sample lease conditions

Lessee's environmental responsibility

Lessee shall not permit or conduct any activity on the premises which would violate, or cause lessor to be in violation of applicable laws, statutes, ordinances, rules, regulations, policies, orders and determinations of any governmental authority pertaining to health or the environment (collectively the Applicable Law), including, but not limited to, [the appropriate laws in the country], nor which would cause the presence of any substance or the existence of any condition, or the threatened release of any substance in, on, or under the surface of the premises, or the occurrence of any event in which any substance has been disposal of or released on, in or from the premises in any manner not permitted under Applicable Law such that Applicable Law would require (i) a report or other notices of such condition or event to any federal, state or local governmental agency or (ii) remodel, treatment, or other procedures or remedial action with respect to such conditions or event in order to bring the premises into compliance with all Applicable Law or (iii) contribution by any current or former owner or operator of the premises towards removal, treatment or other procedures or remedial action required by or that may be brought under Applicable Law with respect to the premises or any other sites or location affected by such condition or event.

Lessor indemnified

Less agrees to indemnify and save Lessor harmless from any and all liabilities, damage, expense, cause of action, suits, claims or demands (unless due to the acts, omissions, negligence or fault of the Lessor) arising from injury to person or damage to property on the leased premises, or upon the abutting sidewalks or curbs, and to save Lessor harmless from any and all liabilities arising from Lessee's failure to perform any of the terms, conditions and covenants of the lease required to be performed by Lessee.

Inspection of premises

Lessee agrees to permit Lessor and its agents, and any mortgagees of the leased premises, to come upon and inspect the premises at all reasonable times, and to come upon the premises if necessary to perform any act which Lessee has failed to perform as provided in [this lease agreement]

Source: Kyle R.C., & Baird F.M., 1995.

Annex 4

Checklist for a Good Environmental Audit Report

Item	Considered in Assessment/Report
Site History	
Aerial photographs viewed	
Property title	
Council records	
Site occupants	
Previous environment assessment	
Site inspection	
Description of site	
Underground storage tanks (USTs)	
Other facilities	
Wastes	
Soil Sampling Program	
General site and targeted locations	
Phot-Ionisation Detection (PID)	
Odours/staining described	
Fill considered	
Comprehensive analytical program	
QA/QC	
Field duplicates to primary laboratory (QC)	
Field duplicates to secondary laboratory (QA)	
Accuracy of results considered	
Data Interpretation	
Summarised	
Critically discussed	
Recommandations	
Follows from data in the report	

Source: Ramsay, 1998.