Sustainable Development — East Asia and Pacific Region

DISCUSSION PAPERS

International Experience in Policy and Regulatory Frameworks for Brownfield Site Management

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INTERNATIONAL EXPERIENCE IN POLICY AND REGULATORY FRAMEWORKS FOR BROWNFIELD SITE MANAGEMENT

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ACRONYMS AND ABBREVIATION

AAI	All Appropriate Inquiries
BBodSchV	Federal Soil Protection and Contaminated Sites Ordinance
CARACAS	Concerted Action on Risk Assessment for Contaminated Sites in Europe
CCME	Canadian Council of Ministers of the Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLARINET	Contaminated Land Rehabilitation Network for Environmental Technologies
CLEA	Contaminated Land Exposure Assessment
CSoQGs	Canadian Soil Quality Guidelines
DEFRA	Department for Environment, Food and Rural Affairs
EPA	Environmental Protection Agency
EPB	Environmental Protection Bureaus
EQS	Environmental Quality Standard
ESA	Environmental Site Assessment
HCVs	Health Criteria Values
ICRCL	Inter-departmental Committee on the Redevelopment of Contaminated Land
NCP	National Contingency Plan
NCSRP	National Contaminated Sites Remediation Program
NICOLE	Network for Industrially Contaminated Land in Europe
NPL	National Priorities List
PAHs	Poly-Aromatic Hydrocarbons
PRGs	Preliminary Remediation Goals
PRPs	Potential Responsible Parties
RBCA	Risk-Based Corrective Action
RSL	Regional Screening Level
TERESA	Register on Contaminated Land Remediation Technologies
TPHs	Total Petroleum Hydrocarbons
TSD	Transportation, Storage and Disposal
SARA	Superfund Amendments and Reauthorization Act
SCCL	Soil Contamination Countermeasure Law
SFD	Soil Framework Directive
SGVs	Soil Guideline Values
SSLs	Soil Screening Levels
SSG	Soil Screening Guidance
SVOCs	Semi-Volatile Organic Compounds
VOCs	Volatile Organic Compounds

FOREWORD

Land contamination is a serious environmental and developmental problem in many countries, including China. If managed well, some contaminated sites (also referred to as 'brownfields') can be an opportunity for urban renewal and development. Conversely, if brownfields are untouched due to legal concerns or lack of financial resources, or not properly remediated, they can present a serious threat to public health and the environment and become a barrier to local economic development.

Fortunately, developing countries like China do not need to re-invent the wheel. Developed countries, such as the U.S.A., Canada, and the European Union, have accumulated experience through many years of tackling brownfield problems and have developed comprehensive and proven frameworks for brownfield site management. This report summarizes international experience which may be useful in developing China's approach to brownfield site management by offering a review of the related policies, regulations, and standards in the U.S.A., Canada, EU, several EU member countries (UK, the Netherlands, and Germany), Japan, and other countries or regions. The report highlights the complexity of the problem, with so many parties involved and the difficulties surrounding liability. At the same time, it identifies potential solutions for dealing with these complexities.

While there is a great deal to learn from international experience, China faces a unique set of issues with regards to brownfield site management, including state-ownership of land, unprecedented speed of urban and economic development, as well as a high population density. Hence, finding a "solution with Chinese characteristics" is necessary. This requires the Chinese governments and professionals to not only actively learn from international experience, but also be creative in finding their own path in brownfield remediation and redevelopment. We sincerely hope that the review of international experience presented in this report will be useful to China; we also look forward to learning from the approach that China will eventually take to establish an effective management framework for brownfield remediation and redevelopment.

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EXECUTIVE SUMMARY

Brownfields are contaminated sites, the reuse and redevelopment of which may be complicated by the presence of hazardous substances and contaminants. Brownfields pose large risks to the environment and public health. Thus, cleaning up and reinvesting in brownfields is essential to relieve pressures on public health and the environment, and to mitigate potential social unrest. Additionally, proper contaminated site management reduces development pressures from green spaces and agricultural lands.

As proper management of brownfields is both a new and important issue in China, China can benefit by learning from the past experiences of other countries. This report presents an overview of policy and regulations on contaminated site management in four different regions: North America (the United States, Canada), Asia (Japan and Taiwan, China), Europe (European Union, United Kingdom, Germany, and the Netherlands) and Latin America (Brazil and Mexico).

United States: The United States contaminated land remediation framework largely comprises of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), better known as the Superfund Act, passed in 1980. The Superfund Act established the primacy of the "polluter pays principle", and holds a variety of parties (defined as potential responsible parties (PRPs) in the act) liable for the cleanup of historical land contamination. Furthermore, the Superfund Act authorized the US Environmental Protection Agency (US EPA) to compel any PRP, including current landowners which did not operate during the time of contamination, to pay for site remediation. Division of responsibility and costs between parties could then be left to the parties themselves. The drawbacks of the act include, among many, the unexpected large number of litigations caused, the unfair burden to small companies and a lack of involvement of state and local actors (leaving many decisions to federal authorities). In particular, the unlimited and uncertain liability for parties associated with contaminated lands scared away investors and developers, and caused the contaminated lands to remain idle, undeveloped, and with rusting facilities, to become brownfields. These drawbacks have over the years been gradually addressed during multiple rounds of the Superfund program reforms and Act amendments. Among them are the Small Business Liability Relief and Brownfields Revitalization Act (Brownfield Act) in 2002 and related brownfield initiatives and programs, which are well received by stakeholders, practical, and applicable to developing countries like China. Other lessons learned from the United States Superfund experience include that contaminated site management bears high costs and contamination containment may in many cases be more effective than site remediation.

Canada: The Canadian policy framework remains highly fragmented as site

contamination management remains a responsibility of the provinces. Thus, federal involvement remains limited to financial and technical assistance, as well as federal guidelines. The Canadian policy framework highlights the complexity of contaminated site management as many different jurisdictions may be involved in contaminated site management.

Asia: Japan and Taiwan (China) have mainly followed the US in terms of policy.

Europe: European policy remains highly fragmented among the EU member states, although a new Soil Framework Directive (SFD) is under consideration, which would make contaminated site management a responsibility at the EU level. The policies of three selected member states (the UK, Germany and the Netherlands) are particularly interesting in their risk-based approach, for example taking into consideration the intended use of a site for the establishment of target contaminant values. Dutch policy stands out in its view of soil as a non-renewable resource and its view of soil remediation as a process of restoring soil functions.

Latin America: As in many developing countries, currently there are no specific and comprehensive regulations for contaminated land remediation and redevelopment. But countries like Brazil and Mexico are moving towards addressing brownfield remediation and redevelopment issues.

The extensive experience from other countries in contaminated site management will facilitate China in rapidly developing an effective contaminated site management framework. In the past forty years, many developed countries have implemented contaminated site management frameworks, and many costly mistakes have been made, all of which China can learn from.

The following key conclusions can be drawn from the analysis of contaminated site management frameworks abroad:

- **Clear identification of stakeholders and allocation of responsibilities:** China needs to balance between the "polluter pays principle" and implementation efficiency, to avoid lengthy and costly litigation procedures which do not contribute to effective contaminated site management;
- **Safeguard policies to contain risks related to existing brownfields:** In many cases, rather than proceeding straight to remediation of a site, safeguards should be put in place to contain a site and minimize any immediate dangers to the public and damage to the environment;
- **Adoption of risk-based clean-up targets:** International experience shows that full remediation is often excessively costly, and that the optimal level of clean-up targets depends on the risks the site poses to its environment and the surrounding population, which in turn largely depend on the proximity of the brownfield to population centers and its intended use;
- **Financing mechanism:** Drawing on the experience of the USA and other countries, China needs to establish sustainable funding mechanisms for contaminated site clean-up activities, in order to accelerate remediation activities on the most urgent sites.

1. INTRODUCTION

1.1 CONTAMINATED SITE MANAGEMENT CHALLENGES IN CHINA

Recurring environmental incidents have led to increased public awareness of the threats of environmental pollution to public health and rapid urbanization is driving up land prices in Chinese cities. As a result of these developments, industrial plant relocations are numerous, particularly of heavily polluting industrial plants, such as pesticide, coke, steel plants, and chemical industry plants. These relocations are leaving behind many contaminated sites in the cities, sometimes with various pollutants, as well as complex and serious soil and groundwater contamination.

Redevelopment of these contaminated sites has led to injuries, and even deaths, of unprepared and ill-equipped construction workers, as a result of their exposure to dangerous fumes and toxic chemicals. Reports of such incidents in the media have caused social unrest, and caught the attention of the government at all levels. Public concerns over living in a residential building on a contaminated site have in fact led to contaminated lands lying idle and abandoned. A case in point is a site in Wuhan City, which has been abandoned since 2006 when contamination was discovered during construction. The government has since been sued for liability. Thus, there is mounting public pressure to safely decontaminate and redevelop these sites. As a result of this pressure, as well as high prices of real estate and other factors, more and more site investigations, risk assessments and cleanups of contaminated sites are taking place around China. In response, governments at both central and provincial levels are conducting policy studies and scientific research projects, as well as funding technology development and remediation demonstration projects.

It has become increasingly clear that China needs a comprehensive policy, regulatory, technical, financial and management framework to effectively track, evaluate and clean up the numerous contaminated sites. Currently, China has no specific law regulating contaminated site remediation and management. Soil protection provisions do exist in some generic legislation, in the form of air and water protection laws, solid waste laws, and toxic substance control acts. However, due to their different objectives and scopes, they are often aimed at different aspects of the issue. As a result, existing provisions, even if fully implemented, may not fully cover the whole range of threats related to site contamination. Hence, learning from the experiences of other countries is essential for the Chinese government to increase its capacity and preparedness to manage issues related to site contamination.

1.2 OBJECTIVES AND SCOPE OF THE STUDY

Contaminated site management is a broad topic that covers a wide range of regulatory, scientific, technological, financial and political aspects. The purpose of this study is to provide an overview of policies and regulatory frameworks for existing

contaminated site management and cleanup in developed and developing countries, to review the experiences and lessons learnt in these countries, and to make relevant recommendations for their application in China. The scope of this study does not cover financing mechanisms and technologies associated with contaminated site management.

The countries and regions covered by this report are the United States, Canada, the European Union, selected EU member states (United Kingdom, the Netherlands, Germany), Japan, China Taiwan, Brazil and Mexico. The following five chapters are devoted each to the US, Canada, Asia, Europe, and Latin America respectively. A summary, discussion and recommendations for the Chinese context are provided in Chapter 7.

2. UNITED STATES

2.1 POLICY AND REGULATORY FRAMEWORK

The United States framework for contaminated site management consists mainly of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) – also called the Superfund Act – passed in 1980, its amendments and associated programs. The drawbacks of this Act have been identified and addressed over the years by a series of changes, additions and reauthorizations.

2.1.1 Superfund Act

The issue of contaminated sites first came to the forefront in the US in the late 1970s following catastrophic and high-profile environmental incidents such as those in the Love Canal[1], the Times Beach, and the Valley of the Drums. In response, the US Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 1980). CERCLA is commonly referred to as the Superfund Act because it made provisions for a specific trust fund.

The Superfund Act was intended to provide the means to identify the responsible parties, to fund the cleanup of impacted sites under the "polluter pays principle", and to diminish the dangers and threats to public health and the environment posed by hazardous waste sites. The act stipulates that the polluter shall pay for the cleanup, or that the Environmental Protection Agency (EPA) pay for the cleanup first and subsequently sue the responsible parties for reimbursement. Under CERCLA, four classes of parties, termed "potential responsible parties" (PRP), may be liable for the contamination of a site. These PRPs are:

- the current owner or operator of the site (CERCLA section 107(a) (1));
- the owner or operator of a site at the time of disposal of a hazardous substance, pollutant or contaminant (CERCLA section 107(a) (2));
- the person who arranged for the disposal of a hazardous substance, pollutant or contaminant at a site (CERCLA section 107(a) (3)); and,
- the person who transported a hazardous substance, pollutant or contaminant to a site; that transporter must have also selected that site for the disposal of the hazardous substances, pollutants or contaminants (CERCLA section 107(a) (4)).

One of the most important provisions of the act is in establishing "strict, joint and several, and retroactive" liability for PRPs. "Strict and retroactive" means that regardless of whether a PRP actually engaged in or contributed to the contamination, and regardless of whether the act was legal at the time or not, a PRP is liable for site

[1] Love Canal is a neighborhood in Niagara Falls, New York, which became the subject of national and international attention, controversy, and eventual environmental notoriety following the discovery of large amounts of toxic waste that had been buried beneath the neighborhood by a chemical company which previously occupied the site. A survey conducted by the Love Canal Homeowners Association found that 56% of the children born from 1974-1978 had birth defects.

contamination and the Superfund Act authorizes the EPA to compel a PRP to initiate site remediation. "Joint and several" means that when two or more PRPs are found liable for site contamination, the EPA may collect the entire cleanup cost from any one of the parties, or from any and all of the parties in various amounts until the total cost is paid in full. In other words, if any of the PRPs do not have enough funds or assets to cover equal shares of the costs, the other parties must make up the difference. The EPA leaves the burden of dividing responsibilities and recovering the costs to the PRPs themselves. Although this approach has the advantage of relieving the EPA of dividing responsibilities between PRPs, it has also led to massive litigations among parties, in which "deep pocket" parties were in a better position to legally protect themselves, leading to unfair disadvantages to small enterprises.

CERCLA authorizes two kinds of response actions:

- Removal actions. These are typically short-term response actions, which are taken to address spills or imminent spills requiring prompt response. Removal actions are classified as: (1) emergency; (2) time-critical; and (3) non-time-critical. Removal responses are generally used to address localized risks such as abandoned drums containing hazardous substances, contaminated surface soils posing acute risks to human health or the environment, etc.
- Remedial actions. These are usually more long-term response actions than a removal action. Remedial actions permanently and significantly reduce the risks associated with releases or threats of releases of hazardous substances. Although the risks addressed by remedial actions are serious, they lack the time-criticality of a removal action, and include such measures as preventing the migration of pollutants and neutralization of toxic substances.

CERCLA also entailed the revision of the National Oil and Hazardous Substances Pollution Contingency Plan, commonly referred to as the National Contingency Plan (NCP). The NCP is the US federal government's blueprint for responding to both oil spills and hazardous substance releases; it can be found at 40 C.F.R Part 300. The NCP provided the guidelines and procedures needed to respond to releases and threats of releases of hazardous substances, pollutants, or contaminants. The NCP also established the National Priorities List (NPL). The NPL, which appears as Appendix B to the NCP, primarily serves as an information and management tool for the EPA, and helps the Agency prioritize sites for cleanup. The NPL is updated periodically. The identification of a site for the NPL is intended primarily to guide the EPA in:

- determining which sites warrant further investigation and assessment regarding the nature and extent of the human health and environmental risks associated with the sites;
- identifying what CERCLA-financed remedial actions may be appropriate;
- notifying the public of sites the EPA believes warrant further investigation; and,

- serving notice to potentially responsible parties that the EPA may initiate CERCLA-financed remedial action.

2.1.2 Superfund Amendments and Reauthorization Act (SARA)

When CERCLA was passed in 1980, the authorities were ill-prepared. Little was known about the nature and extent of site contamination in US; and technologies for contaminated site cleanup were very limited. As a result, the cleanup of the superfund sites was slow and costly. In addition, the law kept the enforcement and many other superfund activities at the federal level, leaving the states and local communities insufficiently engaged. Most importantly, money in the trust fund quickly ran out. The Superfund Amendments and Reauthorization Act (SARA) amended the CERCLA on October 17, 1986; the amendment re-authorized and enlarged the fund. SARA, to a large extent, reflects the American experience in implementing the complex Superfund program during its first six years; it made several important changes and additions to the program, namely it:

1. stressed the importance of permanent remedies and innovative treatment technologies in cleaning up hazardous waste sites;
2. required Superfund actions to consider the standards and requirements found in other State and Federal environmental laws and regulations;
3. provided new enforcement authorities and settlement tools;
4. increased State involvement in every phase of the Superfund program;
5. increased the focus on human health problems posed by hazardous waste sites;
6. encouraged greater citizen participation in making decisions on how sites should be cleaned up; and
7. increased the size of the trust fund.

2.1.3 Small Business Liability Relief and Brownfields Revitalization Act (Brownfield Act)

The serious liability entailed by the Superfund Act keeps potential land developers and investors away from contaminated sites, leaving many contaminated lands abandoned or idling. They are referred to as brownfields. Brownfields are the "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant" (definition from Public Law 107–118). In the early 1990's, the U.S. Conference of Mayors stated that 'brownfields' are one of the most critical problems facing cities. EPA estimates there were 0.5 to 1 million Brownfield sites in the U.S. The escalating brownfield problem has led to several major amendments to the Superfund Act; one important amendment is the Small Business Liability Relief and Brownfields Revitalization Act (Brownfield Act). This act provides for liability relief as follows:

1. Small business liability exemption (*de micromis* exemption): Exempts PRPs disposing of <110 gallons of liquids or <200 pounds of solids and small businesses that disposed of only MSW from liability for NPL cleanup;

2. No future federal enforcement: Parties doing cleanups under state voluntary programs are protected against future Superfund enforcement;
3. Migrating pollution: The act provides protection from having to clean up pollution from an off-site source;
4. Due diligence: The act allows the so-called "due diligence" (DD) defense for innocent perspective purchasers to fend off Superfund liability. The precondition for the due diligence defense is that the purchaser must have conducted "all appropriate inquiries" (AAI) prior to acquisition. AAI entails that all appropriate inquiries or investigations of a property's environmental conditions must be undertaken, as well as a professional assessment of potential liability for any contaminations. In this respect, the EPA accepts the American Society for Testing and Materials (ASTM) E1527-05 standards on what constitutes AAI. If the party follows the ASTM's AAI standards, it satisfies innocent landowner defense, which allows the party to avoid potential Superfund liability.

The Brownfield Act also provides funds for site assessment, cleanup and community job training for brownfield redevelopment. The Brownfield Act appears to be quite successful and is gaining wider support from stakeholders, such as local residents, land developers, landowners, investors and local government. The program also funds the involvement of NGOs in brownfield assessment.

2.2 CLEAN-UP CRITERIA

Cleanups falling under the Superfund program must assure protection of health and the environment, and be cost-effective in both the long-term and the short-term. SARA furthermore requires that cleanups meet applicable federal and state environmental standards, but the EPA may waive a requirement when:

- the action is part of a larger remedial action that will meet the standards;
- compliance would result in a greater risk than alternative options;
- compliance is impractical from an engineering perspective;
- an equivalent standard of performance is attained;
- in the case of a state standard, the state has not consistently applied the standard elsewhere; or,
- meeting the standard does not provide a balance between the need for protection of health and the environment at the facility, and the availability of amounts in the fund to respond to other sites that also present a threat.

SARA specifically requires cleanups to meet the Safe Drinking Water Act's recommended maximum contaminant levels (RMCLs), and the Clean Water Act's water quality criteria. Under SARA, the EPA is directed to choose permanent remedies when possible, as opposed to burying wastes in landfills. If a nonpermanent treatment is employed, EPA must review the site every five years to see if it presents a threat. States are given the opportunity to take an active role in choosing the cleanup method.

In the initial stages of the Superfund, contaminant removal and permanent cleanup were the main objectives. However, as high costs, technical impracticability and other obstacles became apparent over time, risk management became the main focus in setting cleanup standards. A common concept in brownfield discussions is the 'risk-based approach'. With a risk-based approach, it is recognized that contamination does not, in itself, pose risks to the environment and general public (receptors). For there to be a risk to environment and public, there also need to be pathways to convey and expose the hazards; and there need to be sensitive receptors. Thus, different environmental settings and land use will lead to different levels of risk. Rather than just considering the option of "complete and permanent" removal of contaminants, under a risk-based approach, the risk is managed either by containing the contamination, setting restrictions on land use, or cleaning up the contaminations to an acceptable risk level. Currently, the Risk Based Corrective Action (RBCA) approach, developed by the ASTM, is used by most states as a framework for developing risk-based clean up criteria (refer to Table 2-1 below).

Presented below are two widely cited sets of guidelines, in the US and internationally, related to cleanup standards.

2.2.1 USEPA Soil Screening Guidance (SSG)

In 1996, the EPA issued the Soil Screening Guidance (SSG), a set of guidelines developed by the Agency to help standardize and accelerate the evaluation and cleanup of contaminated sites. The SSG provides site managers with a tiered framework for developing risk-based, site-specific soil screening levels (SSLs). SSLs are not national cleanup standards; instead, they are used to identify areas, chemicals, and pathways of concern at sites that need further investigation through the Remedial Investigation /Feasibility Study and those that require no further action under CERCLA. In general, areas with measured concentrations of contaminants below SSLs may be exempted from further federal attention; if actual contaminant concentration in the soil is at or above SSLs, further study, though not necessarily cleanup, is warranted. The three-tiered framework includes a set of conservative and generic SSLs, a simple site-specific approach for calculating SSLs, and a detailed site-specific modeling approach for more comprehensive consideration of site conditions in establishing SSLs. In 2002, the EPA updated the 1996 SSG, keeping the soil screening framework in the original guidance while adding new scenarios and exposure pathways, and incorporating new modeling data. Over time, the EPA has been increasingly focusing on site-specific development of SSLs (USEPA 2002).

2.2.2 EPA Region 9 Preliminary Remediation Goals (PRGs) and Regional Screening Levels (RSL)

This set of guidelines, often called R9 PRGs for short, not only provides soil cleanup values in a table form, but also has detailed technical information on calculating site-specific cleanup goals. PRGs are frequently updated with toxicity values and

chemical physical constants. Exceeding a PRG suggests that further evaluation of contamination risks is appropriate.

PRGs are chemical concentrations that correspond to fixed levels of risk (i.e. either a one-in-a million [10^{-6}] cancer risk or a non-carcinogenic hazard quotient of 1 in soil, air, and water) (USEPA, 1996).

Though their initial purposes or intended uses were different, in practice SSLs and PRGs are both derived from risk screening processes and function in similar ways. As a result, recently Region 9 PRGs have been harmonized with the risk-based screening levels used by Regions 3 and 6 into a single table: "Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites." These updated (May 2010) screening levels, along with a detailed user's guide and supplementary tables, can be accessed directly at USEPA website[2]. In addition, the website contains a Screening Level Calculator to facilitate calculations of site-specific screening levels.

2.2.3 State Guidance Documents and Values

Each state has the jurisdiction and responsibility to protect the environment in accordance with Federal Law (e.g. Clean Water Act, the Clean Air Act), and to enact laws as required. Most states have adopted a risk-based approach. However, each state interprets "risk-based" differently. Most states provide the methods for determining site-specific cleanup levels (refer to Table 2-1 for State Guidance Documents and Values)

2 See: http://www.epa.gov/region9/superfund/prg/index.html.

Table 2-1 Summary of State Guidance Values, Standards and Programs

States	Criteria
Alabama:	Risk-based Corrective Action
Alaska:	Contaminated Sites Program
Arizona:	Soil Remediation Levels
Arkansas	ADEQ Hazardous Waste Division
California	OEHHA Standards/CHHSLs/Soil Screening Numbers/San Francisco Board of Water Screening Levels
Colorado	Soil Remediation Objectives
Connecticut	Remediation Standard Regulations (RSRs); Proposed Remediation Standard Regulations
Delaware	Remediation Standards Guidance
Florida	Soil Cleanup Target Levels
Idaho	Risk Evaluation Manual
Illinois	Risk-Based Cleanup Objectives
Indiana	Risk Integrated System of Closure (RISC)
Iowa	Statewide Standards for Soils in the Land Recycling Program
Kansas	Risk-Based Standards
Kentucky	Preliminary Remediation Goals (PRGs)
Louisiana	Risk Evaluation/Corrective Action Program (RECAP)
Maine	Remedial Action Guidelines for Contaminated Soils Maximum Exposure Guidelines (MEGs)
Maryland	Generic Numeric Cleanup Standards for Groundwater and Soil
Massachusetts	Massachusetts Contingency Plan (MCP)
Michigan	Part 201 Generic Cleanup Criteria
Minnesota	Soil Reference Values (SRVs)
Mississippi	Target Remediation Goals (TRGs)
Missouri	Cleanup Action Levels in Missouri (CALM)
Missouri	Risk-Based Corrective Actions for Tanks and Other Programs
Montana	Risk-Based Screening Levels (RBSLs)
Montana	Voluntary Cleanup and Redevelopment Act
Nebraska	Risk-based Screening Levels
New Hampshire	Risk Characterization and Management Policy
New Jersey	Soil Cleanup Criteria
New Mexico	Soil Screening Levels (SSLs)
New York	Determination of Soil Cleanup Objectives and Cleanup Levels
Ohio	Generic Cleanup Numbers
Oregon	Risk-Based Concentrations
Pennsylvania	Medium Specific Concentrations (MSCs)
Rhode Island	Metals Background Levels
South Carolina	Risk-Based Corrective Action for Tanks

States	Criteria
South Dakota	Look-Up Tables
Tennessee	Cleanup Criteria for Petroleum Contaminated Sites
Texas	State Cleanup Levels
Utah	RCLs for UST Sites
Virginia	Voluntary Remediation Program Risk Assessment Guidance
Washington:	Cleanup Levels and Risk Calculations (CLARC)； Site-specific Levels
West Virginia	Risk-Based Concentrations (RBCs)
Wisconsin	Remediation Levels
Wyoming	Soil Cleanup Levels Look-Up Table Under the Voluntary Remediation Program

Sourced from: http://www.cleanuplevels.com/

2.3 SUPERFUND CLEANUP PROCESS

The Superfund cleanup process begins with site discovery or notification to the EPA of possible releases of hazardous substances. Sites are discovered by various parties, including citizens, State agencies, and EPA Regional offices. Once discovered, sites are entered into the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), the EPA's computerized inventory of potential hazardous substance release sites. EPA then evaluates the potential for a release of hazardous substances from the site, following the steps listed in Table 2-2 outlining the Superfund Cleanup Process. Community involvement, enforcement, and emergency response can occur at any time in the process.

Table 2-2 Superfund Cleanup Process

PA/SI	Preliminary Assessment/Site Inspection Investigations of site conditions. If the release of hazardous substances requires immediate or short-term response actions, these are addressed under the Emergency Response program of the Superfund.
NPL Listing	National Priorities List (NPL) Site Listing Process Listing of the most serious sites identified for possible long-term cleanup.
RI/FS	Remedial Investigation/Feasibility Study Determination of the nature and extent of contamination, assessment the treatability of site contamination and evaluation the potential performance and cost of treatment technologies.
ROD	Records of Decision Recording which cleanup method will be used at NPL sites. When cleanup costs exceed US$25 million, they are reviewed by the National Remedy Review Board.
RD/RA	Remedial Design/Remedial Action Preparation and implementation of plans and specifications for applying site remedies. The bulk of the cleanup usually occurs during this phase. All new fund-financed remedies are reviewed by the National Priorities Panel.
Construction Completion	Construction Completion Completion of physical cleanup construction, although this does not necessarily indicate whether final cleanup levels have been achieved.
Post Construction Completion	Post Construction Completion Ensures that Superfund response actions provide long-term protection of human health and the environment. Included here are Long-Term Response Actions (LTRA), Operation and Maintenance, Institutional Controls, Five-Year Reviews and Remedy Optimization.
NPL Delete	National Priorities List Deletion Removes a site from the NPL once all response actions are complete and all cleanup goals have been achieved.
Reuse	Site Reuse/Redevelopment Cooperation with communities and other partners, to seek local know-how and investigate local planning and development needs. Return hazardous waste sites to safe and productive use.

Sourced from: http://www.epa.gov/superfund/cleanup/index.htm

2.4 SUPERFUND REFORMS AND LESSONS FOR CHINA

The Superfund Act, by any standard, is one of the most comprehensive laws regulating contaminated site cleanup and management. Not only has it been pivotal in contaminated site management in US, it also has contributed a great deal to contaminated site management framework development in many other countries, including Japan and Canada. Many countries mirrored the Superfund Act for drafting their own regulations.

While widespread public and political support for cleaning up the contaminated sites persists in the US, the Superfund has been burdened with disagreements and controversy from its inception. The CERCLA was passed in the last days of the 96th Congress in a reactive flurry over the Love Canal disaster. Over the years, and especially in the earlier years, concerns and criticisms on the Superfund program have mainly focused on the following areas (Powell 1998):

1. **Liability**. The law established the principle of "strict, joint and several, and retroactive" liability. While supporters claim it has successfully changed US hazardous waste management and corporation environmental behavior, critics say it has also led to massive litigation and entails an unfair burden to innocent and small business parties. Most importantly, it has resulted in many contaminated sites remaining idle and undeveloped, the so called "brownfields". These brownfields in turn cause many community problems such as decrease of tax basis and revenues, and increase of unemployment.

2. **Efficiency**. The law was passed in response to public outcry and in a political rush. In the first 9 years of implementation, the program was hindered by problems and challenges such as duplicate and inefficient procedures, lack of detailed policy and specific regulations, lack of technical knowledge on site contamination, unrealistic expectations of the cleanup progress, unavailability of effective and proven cleanup technologies, and unrealistic risk assessment and cleanup standards. As a result, the Superfund program was widely perceived to be slow and costly.

3. **State, local and public participation**. Initially the law did not involve the states and local communities. Thus, it lacked support from local communities, and it remained unable to effect environmental justice for impoverished inner cities where brownfields were concentrated. In fact, as the Superfund Act, in its early stages, did not consider the future use of sites, it separated local land planning and land redevelopment from the cleanup and management process of the contaminated lands.

Faced with mounting criticism in the course of the late 1980's, the EPA began promoting administrative changes to improve the Superfund program in 1989 by publishing the "90-Day Study," which focused on aspects of effective enforcement, expediting cleanup response, and encouraging community participation. In June 1991, the EPA convened

another 30-day study task force whose work culminated in initiatives to: (USEPA, 1994)

1. set aggressive cleanup targets;
2. streamline the Superfund process;
3. prioritize high risk sites;
4. accelerate private party cleanups;
5. refocus the debate on Superfund progress; and
6. review risk assessment and risk management policies.

Both the "90-Day Study" and the "30-Day Study" provided the framework for the first set of Superfund administrative improvements. Based on these studies, the EPA initiated Superfund Round 1 Reform, which was announced in June 1993. This reform encompassed nine new initiatives that were designed to:

1. increase enforcement fairness and reduce transaction costs;
2. improve cleanup effectiveness and consistency;
3. expand meaningful public involvement; and
4. enhance the states' role in the Superfund program;
5. In addition, the EPA adopted eight continuing initiatives from the 90- and 30-day studies that were designed to improve the overall efficiency, effectiveness, and fairness of the Superfund program.

Following Round 1, the EPA conducted Round 2 and 3 in 1995, in an effort to provide a new mandate for the Superfund program. Mostly due to political reasons[3], the Superfund reauthorization failed in 1995.

While there are many lessons that may be drawn from the Superfund's experience over the last three decades, the three key lessons can be drawn for China from the Superfund experience include:

1. Although the "polluter pays principle" is fair in theory, it may run into insurmountable problems when put to practice where numerous polluters may have contributed to a site's contamination, as in the case of China's numerous landfills, or dumping sites;
2. Removal of contaminants from relocated industrial sites may not be the only or even the final objective: management of contaminant exposure risk, and its resulting threats to public health and the environment may be more important; and
3. Remediation of contaminated sites can be very costly. Sustainable revenues and dedicated funds are required to support remediation of land contamination. Priorities include developing mechanisms for land remediation and establishment of environmental remediation funds.

[3] The elections of 1994 brought a Republican majority to both the House of Representatives and the Senate. The new Congress did not share some of the basic assumptions of its predecessors regarding the Superfund Act. In fact, many of the newly elected members of Congress favored repealing the Act altogether

2.5 PROCEDURE OF BROWNFIELD REDEVELOPMENT

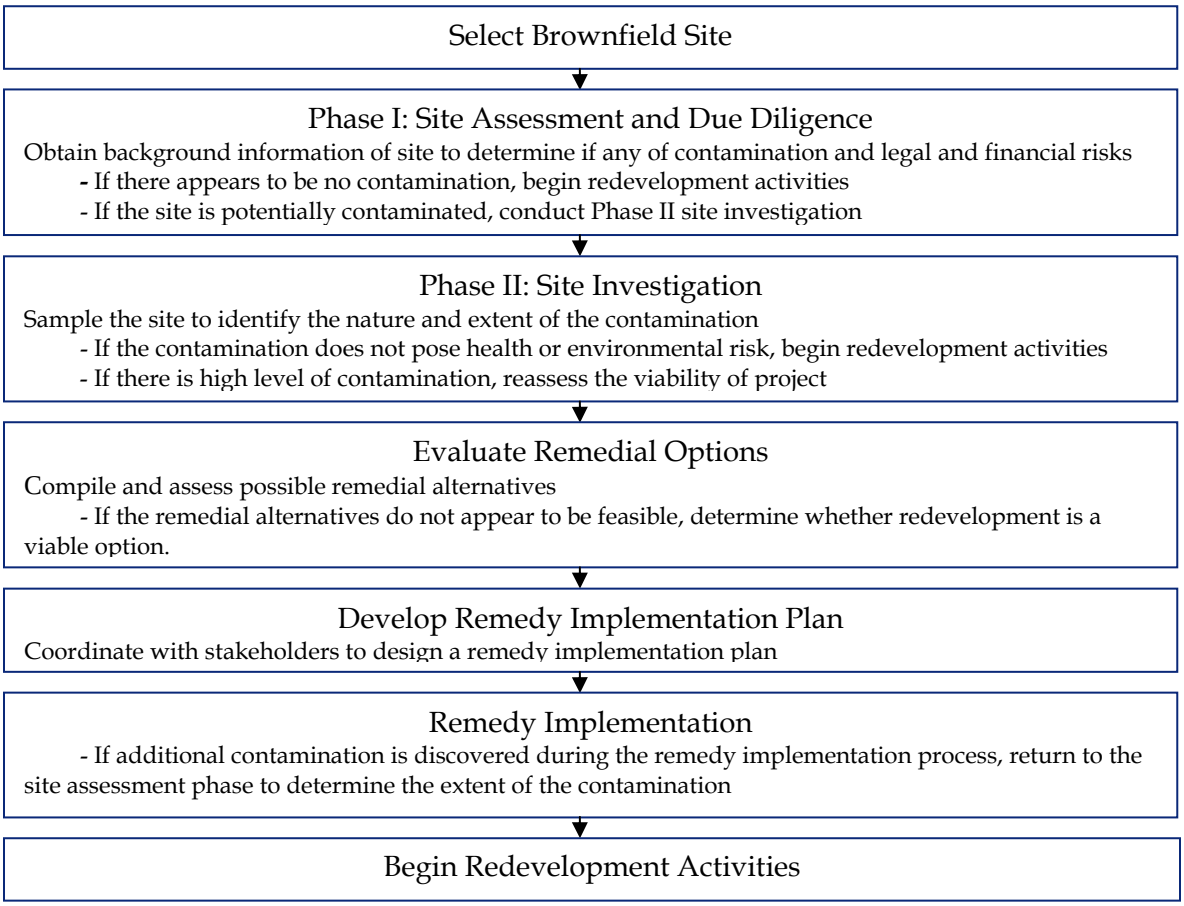
Lessons learnt from and reforms undertaken regarding the Superfund Act and its associated superfund programs led to the Brownfield Act of 2002 and brownfield programs. Figure 2.1 below presents the procedure of brownfield redevelopment. Unlike the lengthy and complicated superfund site cleanup procedure, brownfield procedure is simpler and more streamlined. In brief, to develop a site, whether polluted or not, developers have to conduct the Phase I environmental site assessment (ESA) as a due diligence process to satisfy the AAI requirement for future liability defense. If no contamination is observed, developers can proceed with the site as normal real estate development. If evidence of contamination exists, Phase II site assessment should be conducted. During Phase II, the developers have to conduct a more careful investigation to identify the type, quantity, and extent of the contamination. Based on this information, the developers have to propose remedial options that are both environmentally acceptable and financially feasible (Li Xin, 2011).

On the government's side, each governmental level assumes different responsibilities. Typically, federal and state governments set up remediation standards and rules on liability designation, which form the regulatory framework for environmental site assessment as well as risk and liability assessment. In some cases, apart from supervision, the government does not intervene in land redevelopment processes unless the developer violates certain rules. However, in the past ten to twenty years, governments, especially local governments, have become more and more active in providing technical, financial and policy support to private parties in order to facilitate the revitalization of distressed areas.

Local communities are one of the key resources for government supervision, as these have first-hand knowledge of the site's history and demand for site planning and design, and ultimately are the final beneficiaries of the site improvement. Among the stakeholders, local communities are most concerned about the area's future as their immediate interests are linked to the project development. Over decades, public scrutiny of environmental behavior has been placed in a paramount position: legislators have been creating opportunities for community participation, and the EPA requests public hearings and public filings of all property-related documents, in order to ensure public participation and information transparency.

In effect, evidence has shown that the success of a project depends on whether it incorporates the concerns of all stakeholders into the process.

Figure 2-1 Redevelopment Process of Brownfield Act of 2002



Source: Li Xin, 2011 (with author modifications)

3. CANADA

3.1 POLICY AND REGULATION

Canadian soil pollution laws tend to be adopted on the provincial level and vary among jurisdictions. However, most provincial regulations share the following features: the "polluter pays principle"; retroactive liability for polluters; non-polluters may also be held liable, on the basis of control of either the contaminating activity or the contaminated site; and personal liability, in some cases for officers and directors. In effect, Canadian regulations are therefore quite similar to the regulations under the American Superfund Act.

At the federal level, the technical guidelines, encompassing contaminated sites, have been set by the cross-province coordination council, the Canadian Council of Ministers of the Environment (CCME). It was the CCME in 1989 (nine years after the passing of the US Superfund Act) that took its first major step in dealing with the contaminated sites problem in Canada, by establishing the National Contaminated Sites Remediation Program (NCSRP), which was designed to provide both human and financial resources to jurisdictions across the country, to carry out the processes of identifying and assessing contaminated sites and remediating high-risk 'orphan sites' (i.e. abandoned sites without proprietors), as well as to conduct research on issues such as remediation technologies, liability policies, and clean-up criteria (Sousa, 2001).

Canada has established the Federal Contaminated Site Management Framework, an integrated package of policies and best practice advisories for the establishment of a consistent approach to the management of federal contaminated sites. In 2003, the government established the Federal Contaminated Site Accelerated Action Plan, to quicken the remediation of contaminated sites for which the federal government is responsible, especially of those that pose greatest risks to human health and the environment.

Relevant legislation and administrative policies at the federal level include the 1998 "Canadian Environmental Protection Act", the 1996 "Guidance Manual for Developing Site-specific Soil Quality Remediation Objectives for Contaminated Sites in Canada", and the 1997 "Recommended Canadian Soil Quality Guidelines" (Rodrigues, 2009).

Each Canadian province and territory is responsible for the development of their own remediation criteria and guidelines for contaminated site management, as well as the procedures for site-specific risk assessment implementation. In British Columbia and the Yukon Territory, a stronger regulatory approach to direct the remediation and redevelopment process has been taken, whereby comprehensive legislation dealing with contaminated sites has been developed and all aspects of the management of this process have been assigned to an overseeing environmental department. Other regions, such as Ontario, Alberta, Manitoba, Nova Scotia, New Brunswick, Prince Edward Island,

and Quebec, have adopted non-enforceable guidelines for clean-up and redevelopment activities, allowing the private sector greater leeway to regulate its own activities. The remaining regions, such as Saskatchewan, Newfoundland, and the Northwest Territories which are in the process of updating their policies, are taking an approach that is similar to the latter.

The Canadian Legislation, Policy and Guideline List for Contaminated Sites are provided in Appendix B. The basic framework is very similar to the US framework.

3.2 CLEAN-UP CRITERIA

In Canada, the provinces and territories are responsible for developing their own generic criteria and guidelines for site-specific clean-up. The national guidelines, developed and updated by the CCME (1991, 1996, 1997), contain both generic indices and suggestions for developing site specific criteria. These have been directly adopted only by the Northwest Territories and Manitoba; the other regions have used these primarily as a basis for developing their own criteria. Clean-up criteria are legally binding standards in British Columbia and the Yukon Territory, while the other provinces employ more flexible guidelines that are not legally enforceable. Some regions have recently based their clean-up approach on the Risk-Based Corrective Action (RBCA) model used in the US. (Rodrigues, 2009).

3.2.1 Interim Canadian Environmental Quality Criteria for Contaminated Sites

Two sets of criteria -- site assessment criteria and site remediation criteria -- are used for the investigation of contaminated sites and the definition of clean-up goals in Canada. National guidelines comprise both generic soil quality criteria and guidance for developing site-specific criteria. The NCSRP has published environmental quality guidelines for soil and water for initial assessment purposes (Assessment Criteria) and for setting remedial targets for specific land use (Remediation Criteria).

The Interim Assessment criteria present approximate background concentrations, which serve as benchmark values against which the initial assessment of the degree of contamination at a site can be made. The Interim Remediation Criteria for soil are presented in the context of three types of land use, namely: agricultural; residential /parkland; and commercial/industrial. The criteria are generally protective of human and environmental health for specified uses of soil and water at contaminated sites.

3.2.2 Canadian Soil Quality Guidelines

Canadian Soil Quality Guidelines (CSoQGs) consider both human health and ecological receptors. The final guidelines are set to protect the more sensitive of the two. CSoQGs can be used as a benchmark to evaluate the need for further investigation or remediation with respect to a specified land use. Guidelines are applied to identify and classify sites, to assess the general degree of contamination at a site and to determine the

need for further action and as a basis for remediation objectives.

3.3 Contaminated Site Remediation Framework

Components of the Contaminated Site Remediation Framework (CSRF) include:

- site assessment;
- identification of risks to the environment and human health;
- evaluation of different remediation and risk management options;
- selection of a remediation technology or risk management option;
- completion of an environmental assessment of the proposed clean-up technology;
- implementation of a remediation or site management strategy; and
- post-remediation monitoring.

3.4 National Contaminated Site Remediation Program (NCSRP) vs. the Superfund Program in the United States

There are several similarities between the NCSRP and the U.S. Superfund program. Both programs are based on the "polluter pays principle", and both programs use a system of prioritization that allows those sites considered as "highest risk" to be addressed first.

Originally funded primarily through a tax on the chemical and petrochemical industries, the U.S. Superfund is used to address contamination of old and abandoned sites, regardless of ownership. Action on seriously contaminated sites may take place before costs have been recovered from responsible parties. The NCSRP only covers contaminated sites under federal responsibility. Provinces, municipalities and private landowners are responsible for contaminated sites under their jurisdictions.

The Superfund program cleans up the nation's uncontrolled hazardous waste sites and deals with emergency response activities, such as spills. The NCSRP program does not deal with emergency response. In Canada, the polluter is generally responsible for all costs and actions needed to bring an emergency under control, as well as the clean-up of any hazardous substances. Government agencies at the provincial, territorial and federal levels have a shared responsibility for ensuring this work is effectively carried out and for providing technical assistance as required. Which agency is responsible for a specific case, is determined by the location of the emergency and the affected environment (land, water, inland, coastal, northern, etc.)[4].

[4] See: http://www.federalcontaminatedsites.gc.ca.

4. ASIA

4.1 OVERVIEW OF THE ASIAN SITUATION

Soil and groundwater contaminations in the Asian region arise from rapid industrialization and poor environmental management. Policy and regulatory frameworks in Asia have lagged behind those in the US, Canada and Europe, but are now evolving rapidly. Most Asian countries do not have specific regulations for soil and groundwater contamination management. Provisions for site/soil contamination management are indirectly regulated or embedded in general statements of environmental law. Most policies and legislation are of a highly general nature. Responsibility, liability and standards are often not clearly defined, although the basis for most regulations is the "polluter pays principle". However, this principle is only applicable when the polluter can be identified. If this is not the case, liability falls back on the current owner or the government. To enforce this properly, better legislation will need to be formulated.

Japan and Taiwan (China) are exceptions. In general, having followed the US, they have comprehensive regulations in place, and have adopted a risk-based approach to site remediation (thus keeping pace with the US framework). Their regulations have adopted the "polluter pays principle", also in addition to setting up remediation funds, similar to the Superfund approach in the US.

4.2 JAPAN

Unlike many Asian countries, Japan has a relatively advanced soil and groundwater regulatory framework in place.

4.2.1 Soil

Soil pollution legislation was first issued in August 1991, and amended in 1994 under the Basic Environmental Law. The Soil Pollution Control Law, 2002, listed specific contaminated industrial sites and substances, and allowable concentrations.

The approach taken in Japan is that certain industrial categories require soil assessment, such as petrochemical, polluting factories and oil refineries. If a company does not fall under one of the listed categories, it is not required to do an assessment. These regulations seem to be focused more on soil than on groundwater, even though they do include groundwater regulations. There are currently 25 chemical substances listed with soil quality standards that the Japanese EPA can use for evaluation.

Japanese regulations do not address the determination of liable or responsible parties.

The Japan Soil Contamination Counter-measure Law (SCCL) was recently amended and announced in April 2009. The drivers for such amendments were:

- An increased number of soil contamination cases were found by means

of self-inspection (voluntary effort). Information about contaminated sites needed to be available publicly to encourage better management;

- Soil excavation and removal was previously performed regardless of the presence of any health risk. The need was felt for a framework in which remediation methods correspond to the degree of severity of contamination and the level of environmental and public health risk, namely taking into account whether there are any sensitive receptors in the vicinity and whether there are pathways for exposure of the contamination to the environment and public.
- There was a perceived need for proper management of excavated soil, following cases of improper disposal of contaminated soil.

The amendments became effective on April 1, 2010 (Ohta, 2010).

The pre-April 1st SCCL set out specific statutory limits for 25 specified harmful substances. If any of these substances were found in concentrations that exceeded the relevant limits, and there was a human health risk, then the land will be classified as a designated area ("Designated Area").

The Amended SCCL includes Designated Areas that contains one or more of the specified substances in amounts that exceed the statutory contamination threshold. Depending on the existence or likelihood of a risk to human health (i.e., risk of inhalation of the contaminated soil or the substance, or ingestion e.g. by drinking contaminated groundwater), Designated Areas are divided into two sub-classifications. More specifically, under the Amended SCCL, the Designated Areas are sub-classified into (i) areas requiring remediation; and (ii) areas where authorities must be notified when the area is developed, and then registered accordingly. Additionally, the amendments provide for remediation measures that must be implemented for each sub-classification.

- **Areas requiring remediation**

Land is placed in this sub-category when:

- the soil contains one or more of the 25 specified substances at levels above the statutory threshold in the Amended SCCL;
- this contamination causes, or will likely lead to, damage to human health either by inhalation, ingestion, bodily contact or by drinking groundwater contaminated with the substance in question.

For these areas, the prefectural governor requires any persons who own, administer or occupy the land ("Landowners etc.") to implement measures such as raising the ground level, containing the contamination, and any other implementation measures that are specifically required, including monitoring the contaminated groundwater. Further, making any other changes to the land itself for development or other reasons are, as a general rule, prohibited.

- **Areas where authorities must be notified in the case of development**

This designation applies to land which contains one or more of the 25 specified substances at levels above the statutory

threshold, but where contamination does not cause, or is unlikely to cause, damage to human health. For land in this category, remediation is not required until the land is to be developed, at which time the Landowner etc. is required to give prior notification to the prefectural governor and the area must be remediated in accordance with the stipulations of the relevant Ministerial Ordinance.

If this newly created sub-classification of land becomes common and well accepted in real estate transactions, then it is possible that brownfield issues in Japan may be resolved to some extent. However, because the new amendments also further regulate excavation and the removal of contaminated soil, this will increase excavation and removal costs, and Landowners etc. may refuse to take these remedial measures. Instead, Landowners etc. may abandon contaminated land as unsellable and/or not beneficial to develop if remediation is required. This sub-classification would then result in an expanded number of designated brownfields, but not necessarily any improvement in brownfield remediation.

The Amended SCCL also:

- Includes provisions that trigger a soil investigation whenever changes are made to an area of land over 3,000 square meters in size;
- Aims to make soil contamination reporting and investigations an expected component of real estate transactions. The success of these new measures will depend on the level of public awareness of soil contamination;
- Enables Landowners etc. to identify the existence of soil contamination through a voluntary investigation, and request the prefectural governor to categorize the land as a Designated Area based on the results of the voluntary investigation if necessary;
- Strictly regulates the disposal of any contaminated soil by requiring that (i) the level of contamination of the 25 substances must be checked before any soil is excavated and removed from the site, (ii) the removed soil must be treated by a licensed factory or plant, (iii) a license will now be required in order to remove/transport, dispose of and treat the contaminated soil, (iv) a manifest system must be adopted.

4.2.2 Groundwater

The Environment Protection Agency established the Environmental Quality Standard (EQS) for groundwater in March 1997.

There is a list of 24 chemical substances with groundwater quality standards. These apply to all groundwater with the aim of protecting public water resources. Groundwater usage in Japan is not very common but it is used in some remote areas. Accidental releases of harmful substances and oil must be reported immediately, and responsible industries will have to pay a compensation if human health or the environment are affected.

The Ordinance on Prevention of Groundwater Contamination came into force on August 1, 2008, in Shiga Prefecture (in the Kinki Region) of Japan. This was the first ordinance in Japan that catered for groundwater pollution prevention as well as pollution clean-up measures.

This ordinance attracted attention due to the obligation to investigate lands and facilities that were decommissioned prior to the enforcement of the SCCL.

The ordinance also required that monitoring wells be installed in facilities that handle hazardous substances, and that groundwater monitoring reports be submitted to relevant authorities.

4.3 TAIWAN, CHINA

Taiwan (China) regulations, to a large extent, mirror the US Superfund program. Taiwan has a regulatory framework in place which is governed by the Taiwan Environmental Protection Administration (EPA), and operates under the Soil and Groundwater Pollution Remediation Act of February 2000. It is based on the "polluter pays principle".

Polluted sites are classified based on the Soil Pollution Control Standards and Groundwater Pollution Control Standards. A detailed database of polluted sites is maintained. Contaminated sites are grouped into two categories:

Pollution Control Site: The source of soil and groundwater pollution on the site has been identified and concentrations have exceeded the Soil and Groundwater Pollution Control Standards.

Pollution Remediation Site: The site has been assessed and the information disclosed to the public by the Taiwan EPA; and the site seriously endangers the national health and living environment.

Information about a site is required to be entered by the occupying enterprise into an online database system, the Tier-I and Tier-II Risk Assessment System, which has been developed by the Taiwan EPA. The system classifies the site according to its risk level.

The polluter of a remediation site is required to draw up a "Remediation Plan", but the polluter can conduct their own risk assessment and set site-specific remedial targets to replace the generic standards for certain uses by considering three main pathways: ingestion, dermal contact, and inhalation of air from the soil. Site-specific remediation plans are subject to approval by the Taiwan EPA.

The Taiwan EPA has established the Soil and Groundwater Pollution Remediation Fund, a fund similar to the US Superfund, to deal with the legal, administrative, and remediation costs where responsible parties cannot be identified. This fund is financed by a specific tax on polluting industries, such as the petroleum, petrochemical and manufacturing industries.

5. EUROPE

This chapter reviews contaminated site management in the European Union (EU) as a whole, and three of its member countries — the U.K, Germany, and the Netherlands.

5.1 CONTAMINATED SITE MANAGEMENT FRAMEWORK

During the last 20 to 30 years, soil protection policies have been developed and implemented in a stepwise manner, both nationally (particularly in the UK, the Netherlands and Germany) and at the EU level. Plans for the introduction of measures and requirements for EU Member States to prevent new soil contamination and remediate existing soil contamination include the development of inventories of contaminated sites and the definition of targets for prioritization of remediation actions. These plans are expected to have important consequences for soil management practice and national soil policies across Europe. (Rodrigues, 2009)

The EU directives allow the union to play a role in overseeing environmental policy-making related to contaminated sites. As a first step towards a more comprehensive EU policy-making strategy regarding contaminated sites, a White Paper on Environmental Liability was prepared to help harmonize the environmental legislation of member states (European Commission, 1997). The White Paper, however, deals with future contamination, whereas past contaminations are still covered under individual state policies.

In addition, several coordinating agencies and programs have been set up by industry, researchers and member states in order to disseminate and exchange scientific information regarding contaminated sites in Europe and abroad, including:

- CARACAS: Concerted Action on Risk Assessment for Contaminated Sites in Europe;
- CLARINET: Contaminated Land Rehabilitation Network for Environmental Technologies;
- NICOLE: Network for Industrially Contaminated Land in Europe;
- NATO/CCMS: Evaluation of Demonstrated and Emerging Technologies for the Treatment of Contaminated Land and Groundwater.

Soil protection has not, to date, been subject to a specific legislative instrument at the EU level. A number of aspects directly or indirectly related to soil contamination and remediation issues are addressed by waste, water, chemical, impact assessment, environmental liability, and air quality policies. These policies (that are not primarily oriented towards soil protection) focus mostly on regional rather than local contamination and are limited when dealing with historical contamination and site development issues. A summary of these polices is provided in Table 5-1.

Table 5-1 EU Environmental Policy Related to Contaminated Aspects

EU Environmental Policies		Diffuse soil contamination aspects		Local soil contamination aspects	
		Directly	Indirectly	Directly	Indirectly
Waste	Waste Framework Directive (2006/12/EC, codified version of Directive 75/442/EEC as amended)				√
	Directive 91/689/EEC on Hazardous Waste, amended in 1994				√
	Directive on the Disposal of Waste Oils (75/439/EEC amended in 2000)				√
	Landfill Directive (1999/31/EC)				√
	Sewage Sludge Directive (86/278/EEC)	√			
	Directive2006/21/EC on the management of waste from the extractive industries	√		√	
Water	Water Framework Directive (2000/60/EC)	√			
	Nitrates Directive (91/676/EEC)	√			
	Urban Wastewater Treatment Directive (91/271/EEC)		√		
	Bathing Water Directive (2006/7/EC)		√		
Air	Air Quality Framework Directive (96/62/EC) and its Daughter Directives		√		
	Directive on National Emissions Ceilings (2001/81/EC)		√		
	Directive on Integrated Pollution Prevention and Control (96/61/EC)	√			
	Directive on Large Combustion Plants (LCPD) (2001/80/EC)		√		
Chemicals	Thematic strategy on the sustainable use of pesticides	√			
	Directive on Biocidal Products (98/8/EC) 62	√			
	Directive 91/414/EEC on plant protection products	√			
Impact assessment	Environmental Impact Assessment Directive (85/337/EEC amended in 1997 and 2003)	√		√	
	Strategic Environmental Assessment Directive (SEA) (2001/42/EC)	√			
Environmental liability	Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage			√	

Source: Rodrigues, 2009.

5.2 STRATEGIES

The view of soil as a non-renewable resource is gaining wide support in the European Union. The sustainable development strategy 6th Environment Action Program (6th EAP) for the years 2000–2010 features seven thematic strategies, including one on soil protection.

5.2.1 Thematic Strategy on Soil Protection

In order to address contaminated site identification and remediation, in September 2006 the Commission adopted a proposal for a Thematic Strategy on Soil Protection. This Strategy contains a proposal for a Soil Framework Directive (SFD). This proposal requires Member States to prevent soil contamination, to make an inventory of contaminated sites and to remediate the sites identified. Member States are also required to take measures to raise awareness and to promote the transfer of knowledge and experience on sustainable soil usage. This can include exchange of information such as that on the best available technologies for the remediation of persistently organic pollutants (POPs)-containing sites (EC NIP, 2007).

The Commission aims to develop grounds for a common risk-based strategy to manage historical contamination based on a step-by-step approach that would include the collection of information on the full extent of site contamination problems in all Member States, on associated risk evaluation and on prioritization of remediation needs.

5.2.2 EU Soil Framework Directive

As discussed above, the Sixth Community Environment Action Program called for the development of a soil-protection strategy. Prior to this, soil had not been subjected to a specific protection policy at the EU level, although some elements of soil protection can be found in other EU policies, for example those involving areas such as water, waste, chemical, pesticide and industrial pollution prevention, as well as the protection of nature. A common framework was justified in order to articulate the efforts of the member states to improve the protection of soil and its sustainable use, to control trans-boundary soil-degradation effects, to protect aquatic and terrestrial eco-systems, and to preclude the distortion of competition between economic operators.

Work to address this policy gap has culminated in the Thematic Strategy on Soil Protection, ((Com 2006) 231 final) as discussed above and the proposal for a new directive establishing a framework for soil protection ((Com 2006) 232 final) (Papanicolaou, 2007).

Briefly, the proposed Directive includes the following elements:

1. The establishment of a common framework to protect soil on the basis of the principles of preservation of soil functions, prevention of soil degradation, mitigation of its effects, restoration of degraded soil and integration with other sectorial policies;
2. The requirement to identify, describe and assess the impact of various sectorial policies on soil-degradation processes aiming to protect soil functions;

3. The requirement for land users to take precautionary measures when their intended use of soil can be expected to significantly hamper soil functions;
4. An approach to soil sealing to ensure a more rational use of land and to maintain as many soil functions as possible (in essence a policy drive prioritizing brownfield redevelopment);
5. The requirement to identify the areas at risk of erosion, organic matter decline, salinization, compaction and landslides, and an establishment of national program and measures;
6. Measures to limit the introduction of dangerous substances into soil, to avoid an accumulation in soil that would hamper soil functions and create a risk to human health and the environment (currently there are an estimated 3.5 million contaminated sites in Europe);
7. The requirement to establish an inventory of contaminated sites, a mechanism for funding the remediation of orphan sites, a soil-status report and a national strategy for identified contaminated site remediation.

The fact that the EU has treated soil as a non-renewable resource, and is trying to tackle soil pollution issues from a sustainable planning and development view, can be a valuable lesson to developing countries. Treating soil as a non-renewable resource implies that any remediation approach must take into account the sustainable use of the site and the functions of the soil. The EU Soil Framework Directive covers many of these aspects. Chapter III of the Proposal, titled "Soil Contamination", directly covers contaminated site management. It consists of two sections: Section One: Prevention and Inventory, and Section Two: Remediation. Some key aspects are summarized below:

5.2.2.1. Prevention and Inventory

Article 9 places Member States under the obligation to take appropriate measures to limit intentional and unintentional introduction of dangerous substances into the soil, in order to avoid accumulation that would hamper soil functions or pose significant risks to human health and the environment. It will be up to each member state to decide what the 'appropriate measures' will be. The article excludes the introduction of substances due to air deposition and due to a natural phenomenon of exceptional, inevitable and irresistible character.

Article 10 introduces an EU-wide definition of contaminated land: "Sites with a confirmed presence caused by man, of dangerous substances of such a level that member states consider they pose a significant risk to human health or the environment" (dangerous substances are those substances within the meaning of Council Directive 67/548/EC and Directive 1999/45/EC). It is thus up to each member state to judge which sites within their jurisdiction are contaminated — a common approach is not, therefore, guaranteed. Member states will be obliged to identify and draw up a national inventory of such sites, taking into account a risk evaluation based on the current and approved future use of the land. The inventory will be made public and reviewed every five years. The procedure for identification of contaminated sites is set out

in Article 11. Within five years of the Directive coming into force, Member States are to have identified the location of those sites where potentially soil-polluting activities referred to in Annex II are taking place, or have taken place. Annex II lists 11 categories of sites, being establishments where dangerous substances are, or were, present in quantities equal to, or in access of, the amounts indicated in Part 1 and 2, column 2 of Annex I to Council Directive 96/82/EC.

The responsible authorities are to measure the concentration of dangerous substances on sites where levels are potentially dangerous to human health and the environment. On-site risk assessments will have to be carried out for those sites, covering at least 10% of sites within 5 years, 60% within 15 years and the remainder within 25 years.

Article 12 provides that, when a site on which a potentially polluting activity is taking place, or for which official records show that it has taken place is sold, the owner of the site or the prospective buyer will have to make a soil-status report available to the competent authorities and to the other party. The soil-status report will have to be issued by an authorized body or a person appointed by the member states. This report is to include the following details:

- the background history of the site, as available from official records;
- a chemical analysis determining the concentration levels of the dangerous substances in the soil, limited to those substances that are linked to the potentially polluting activity of the site;
- the concentration levels at which there are sufficient reasons to believe that the dangerous substances in question pose a significant risk to human health or to the environment.

The member states are to establish the methodology necessary for the determination of concentration levels and to authorize the bodies that can provide the reports. As with the definition of contaminated sites, there does not appear to be any obligation for all member states to adopt a common approach.

5.2.2.2. Remediation

Having identified the contaminated sites, the member states are obliged to ensure that these are then remediated so that they no longer pose any significant risk to human health and the environment. In addition, appropriate mechanisms are to be set up by each state to fund the remediation of the contaminated sites where the polluter cannot be identified or cannot be held liable under European or national legislation, or may not be made to bear the cost of remediation.

Within seven years of implementation, the member states must draw up national remediation strategies including: remediation targets, a prioritization strategy, starting with those sites that pose a significant risk to public health, a timetable for implementation, and allocation of funds. The remediation strategy has to be made public within eight years and is to be reviewed every five years.

5.2.3 Status of the EU Soil Framework Directive

At the time of preparation of this report, the Framework Directive was at a draft stage. The Directive has met strong resistance from Malta, the UK, Austria, the Netherlands, Germany, and France, as these are concerned about the implementation methods and costs of the proposal in each member country. Another concern, mirroring relevant debates in the US and Canada, is whether soil contamination may be considered to be a trans-boundary issue, like air and water pollution, which would justify EU-level legislation. Resistance from certain commercial interest groups, including real estate trade associations, will focus on the disclosure of compulsory soil-status reports to the regulator. These commercial interest groups believe that the Directive will not only increase the cost of transactions, but that it may attract unwanted third-party attention in certain circumstances. Technology transfer, market maturity of individual member countries, and business interests are all obstacles to a union-wide directive.

5.3 CLEAN-UP CRITERIA IN EUROPEAN COUNTRIES

Table 5-2 provides an overview of general practices for the identification and characterization of contaminated sites in 23 European countries. The overriding aspect of all these measures is that risk-based soil quality objectives (particularly risks posed to public health and the environment) are guiding the process. In some cases, risk-based national guideline values and norms have been developed for an effective and comparable classification of contaminated soils. These thresholds also represent different levels of soil contamination and risks posed, which require different actions, such as soil contamination investigation, risk assessment and/or remediation. Guideline values are non-enforceable in most countries. In some countries, quality objectives and remediation targets are defined through site-specific risk analysis, and specific guidelines for the development of risk assessments are available. Furthermore, some European countries apply multi-tiered approaches, combining both the use of screening guideline values for preliminary identification of contaminated sites, and site-specific risk assessment for more detailed investigations.

Table 5-2 Overview of General Practices for the Identification and Characterization of Contaminated Sites in Twenty Three European Countries

Country	Most common approach for the classification of contaminated sites and definition of clean-up criteria	Specific contaminated land policy
Austria	Site-specific risk assessment	Yes
Belgium (Flanders)	Site-specific risk assessment (exposure assessment)	Yes
Bulgaria	Norms of maximum admissible contents of hazardous substances in the soil	No
Czech	"ABC" limit values: A — background values; B — Possible	No

Country	Most common approach for the classification of contaminated sites and definition of clean-up criteria	Specific contaminated land policy
Republic	adverse effects; C — Significant risk to human health and the environment. Risk assessment approach for 'B' cases.	
Denmark	Risk-based guideline values	Yes
Estonia	Target values and guidance values (based on risk to public health)	Preliminary
Finland	Risk-based guideline values	No
France	Site-specific risk assessment (tiered approach: preliminary site investigation; simplified risk assessment; detailed risk assessment)	No
Germany	Risk-based soil screening values (trigger values) and action values	Yes
Hungary	Limit values for soil and groundwater: A: background values; B: Threshold values of contamination; C: Threshold values of measures; D: target values. (based on Dutch, German, US EPA and Canadian guidelines)	Preliminary
Italy	Original 'limit value' approach has been included into a 'risk-based' multi-tier approach: Tier 1 — screening values or contamination threshold values; Tier 2 — site-specific target levels or risk threshold values	Yes
Latvia	Threshold values (Dutch threshold values used as reference)	No
Lithuania	Standards for contaminated soil and groundwater drafted (in line with Dutch threshold values). Site-specific simplified risk assessment.	No
Norway	Tiered approach: Tier 1 — generic target values (threshold values (TVs) based on existing Dutch and Danish guidelines); Tier 2 — site specific risk assessment (when TVs are exceeded); Tier 3 — Detailed investigation	Part of "Pollution Control Act" and several specific Guidelines
Poland	Standards for environmental protection are generally based on fixed regulatory limits, but still no generic values for contaminated land. US EPA methods often used in site-specific risk assessments.	No
Portugal	Guideline values — Ontario (Canada) guideline values used as reference	No (under development)
Slovakia	Target values or permissible levels (former Dutch threshold values list was adapted in 1994)	Yes
Slovenia	Limit, warning and critical concentration values of dangerous substances in soil	Yes
Spain	Screening/guideline values and site-specific risk assessment	Yes
Sweden	Site-specific risk assessment (exposure assessment). The Swedish EPA defined guideline values for levels in polluted soils, for the most sensitive types of land-uses	No

Country	Most common approach for the classification of contaminated sites and definition of clean-up criteria	Specific contaminated land policy
Switzerland	Site-specific risk analysis. Intervention values for leachate and gaseous phase.	Yes
Netherlands	Risk-based norms (criteria): target values and intervention values	Yes
United Kingdom	Site-specific risk assessment based on Source–Pathway–Receptor approach and on the definition of "pollutant linkage". Soil Guideline Values have been derived using the Contaminated Land Exposure Assessment (CLEA) model for three land uses.	Yes

Source: Rodrigues, 2009.

5.4 UNITED KINGDOM

5.4.1 Contaminated Land Framework

In the UK, the first institutional mechanism to address contaminated land issues was the Inter-departmental Committee on the Redevelopment of Contaminated Land (ICRCL), which was set up in 1976 with the role of providing guidance on human health hazards arising from the re-use of contaminated land, and coordinating advice on remedial measures. The ICRCL published the Guidance Note 59/83 (the 2nd edition, dated July 1987), to guide practitioners dealing with the various hazards and types of contamination. This note defined 'trigger values' (threshold and action values) for three main groups of contaminants and for different planned land uses. These trigger values were formally withdrawn in 2002 by DEFRA (Department for Environment, Food and Rural Affairs).

Currently, contaminated land in the UK is identified on the basis of risk assessment. In England, Scotland and Wales, the contaminated land regime is implemented through The Contaminated Land Regulations which enforce Part IIa of the Environment Protection Act (1990). Section 57 of Part IIa was introduced into the Environment Protection Act (1990) by the Environment Act (1995) and was implemented in April 2000 in England, in July 2000 in Scotland and in July 2001 in Wales. Part IIa introduced a new statutory regime for the identification, assessment and remediation of contaminated land in the UK. In response, DEFRA and the UK Environment Agency have developed risk-based procedures for assessing harm from contaminated sites to ecosystems (including surface waters) and human receptors. Comprehensive packages of technical guidance relevant to the assessment of health risks arising from long-term exposure to soil contaminants have been published by DEFRA and the UK Environment Agency. Following a revised approach towards contaminated land management, the UK has chosen to develop guideline values rather than standards, for the

assessment of risks within the overall policy context of ensuring that land is suitable for its actual or intended use. (Luo, 2008)

A risk-based approach has been adopted for the management of contaminated land in accordance with UK policy as set out in the "Framework for Contaminated Land". This requires remedial action to be taken where:

- the contamination poses unacceptable actual or potential risks to health or the environment;
- there are appropriate and cost-effective means available to do so, taking into account actual or intended use of the site;
- remediation may also take place on a "voluntary" basis, for instance as part of a redevelopment program.

The assessment and management of land contamination risks involves three main components:

- the source (i.e. the contamination)
- the receptor (i.e. the entity that could be affected)
- the pathway (i.e. the route by which a receptor can come into contact with the contamination).

5.4.2 Criteria

A multi-tiered approach was developed for the assessment of risks to both humans and ecosystems. The first requirement (Tier 1) for a human health risk assessment is the identification of linkages between the contaminant, the receptor(s) and the pathway in a properly justified conceptual model. Tier 2 is a Generic Quantitative Risk Assessment evaluation and Tier 3 is a Detailed Quantitative Risk Assessment. Soil Guideline Values (SGVs) were calculated for use in Tier 2 assessment through the Contaminated Land Exposure Assessment (CLEA) model. These SGVs are in fact intervention values that when exceeded may trigger further assessment or remedial action. The CLEA model is partially probabilistic and overall exposure needs to be calculated using the probability distribution functions of exposure parameters for each receptor. It should be emphasized that this approach is advocated to allow prioritization of sites for further investigation and subsequent "determination" of the significance of potential exposure on a contaminated site (requiring remediation within a defined period). The involvement of the local community in the decision making process from the earliest stages of the implementation of risk management is strongly encouraged by the UK contaminated land management system. Moreover, soil remediation is closely linked to the planning regime and land development process.

The Environmental Agency and DEFRA has published SGVs for 10 substances (DEFRA 2008). These SGVs are based on Health Criteria Values (HCVs) and describe the concentration of contaminants in soil at which there would be minimal risk to human health in four modeled generic land use situations:

- residential with gardens;
- residential without gardens;
- allotments, and
- commercial/industrial.

The HCVs describe a level at which substances might pose either no appreciable risk or a minimal risk to human health, depending on whether the substance is a threshold or non-threshold substance. The Environmental Agency and DEFRA have published HCVs for 23 substances, including dioxins.

5.4.3 Model Procedures for the Management of Land Contamination

In September 2004, the Environment Agency published the Model Procedures for the Management of Land Contamination (CLR 11, 2004). The Model Procedures were developed to provide the technical framework for a risk management process when dealing with land contamination. The process involves identifying, and taking appropriate action to deal with land contamination in a way that is consistent with government policies and legislation within the UK. The procedure is presented in Figure 5-1.

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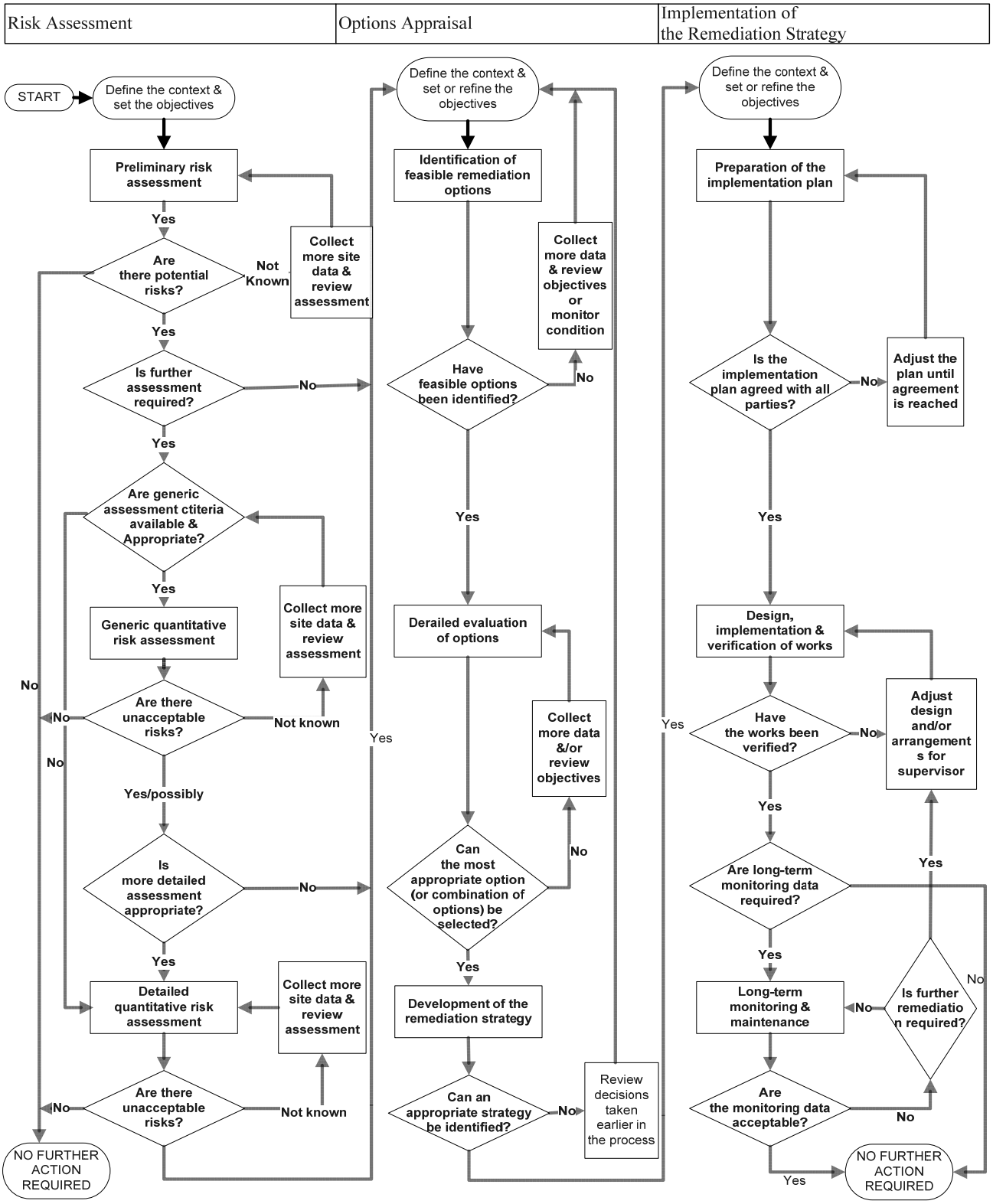
Figure 5-1 Model Procedures for the Management of Land Contamination in the UK



5.5 GERMANY

5.5.1 Framework for Contaminated Site Management

The German Federal Soil Protection Act came into force in 1998, and the accompanying sublegal regulations in 1999. The Federal Soil Protection Act (FSPA) provides the measures to protect and restore soil functions. The Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV) translates the act into specific requirements relating to contaminated site soil protection and remediation. (Rodrigues, 2009)

The BBodSchV describes the main regulations for the identification, investigation and assessment of contamination, and for the planning and execution of remediation. The regulations cover:

- backfill of materials onto or into the soil (pursuant to BBodSchV Article 6).
- requirements and values for the identification, investigation and initial assessment of suspected contaminated sites (BBodSchV Article 8 (1), No. 1 and 2).
- requirements and values for the prevention of hazards and the remediation of harmful soil changes (harmful impacts on soil functions that are able to bring about hazards) and contaminated sites (BBodSchV Article 8 (1), No. 3).

5.5.2 Risk-based Standards

The Act includes three types of risk-based standards: trigger values (concerning soil-to-human, soil-to-plant, and soil-to-groundwater pathways), action values (concerning soil-to-human and soil-to-plant pathways) and precaution values (to prevent new soil pollution). Whenever possible, considerations on the contaminants' bioavailability are to be included in exposure assessments.

Trigger Values: When trigger values are exceeded, further investigation and assessment of whether the site is contaminated or not is necessary. (Federal Soil Protection Act, Art.8)

Action Values: When action values are exceeded, it is usually an indication of the presence of a contaminated site, meaning that corrective measures are required to meet the provisions to prevent harmful soil changes. The corrective measures include excavation and associated transport, disposal and treatment (TSD) of excavated soil materials, remediation of the soil and contaminated sites, especially regarding the rehabilitation objective, containment and other safeguarding measures, protection and land use restriction measures.

5.6 THE NETHERLANDS

5.6.1 Framework of Contaminated Sites

The Netherlands was one of the pioneering EU Member States to establish specific legislation on soil protection. Soil remediation was given a legal status in 1983, and in 1987 the Dutch "Soil Protection Act" came into force. The first steps of the Dutch soil policy included the definition of legal norms (intervention values) to regulate soil clean-up as part of a multifunctional remediation approach. Soil policy developments in the last 20 years in the Netherlands also included the

revision of remediation criteria, developments on soil quality objectives and risk assessment procedures, increase in flexibility for local authorities in regulating contaminated land, encouragement of local participation in the decision making process, a distinction between mobile and immobile cases of soil contamination, and the stimulation of private funding for soil remediation. (Rodrigues, 2009)

A new framework of soil quality standards has been developed within the scope of the Dutch Soil Quality Decree, which entered into force in January 2008. This framework includes broad national standards derived for ten different soil functions, simplified into three broad categories: residential areas; nature/ agriculture; and industry, on the basis of human health risks, ecological risks and agricultural production. It also includes a system to develop local standards. In brief, the new system of standards comprises target values (based on Dutch background values), intervention values (based on serious risk levels, determines the remediation urgency), and National Soil Use Values (to determine remediation targets based on specific soil use related risks levels).

The National Soil Use Values are general soil quality standards to determine suitability for a specific type of soil use, although local authorities may choose to develop their own Local Soil Use Values. If soil concentration values at a defined site surpass the intervention values, a stepwise risk assessment system (Soil Remediation Criterion) is applied to define the urgency of remediation.

Below is a quick list of related regulations for site contamination in the Netherlands:

1983 — Interim Soil Remediation Act
1987 — Soil Protection Act
1993 — Landfill (Soil Protection) Decree
1994–1998 — Circulars on Intervention Values for Soil Remediation
1996 — Soil Protection Act (revised)
1998 — Circular on Remediation Regulations Soil Protection Act
1998 — Storage in Underground Tanks Decree
1999 — Building Materials Decree
2000 — Circular on Target Values and Intervention Values for Soil Remediation (rescinded by the amended Soil Remediation Circular 2008 on 1 October 2008/Soil Quality Decree on 1 July 2008）
2004 — Soil Protection Act Appointment of Competent Authority Municipalities Decree, (amended)
2005 — Industrial Sites Compulsory Soil Survey Decree (amended)
2006 — Soil Remediation Financial Provisions Decree (amended)
2006 — Uniform Remediation Decree/Decision
2007 — Soil Remediation Financial Provisions Regulations (amended)
2006 — Soil Protection Act (revised)
2007 — Soil Protection Act Register of Limitations Regulations
2008 — Soil Remediation Circular 2008
2008 — Soil Quality Decree

5.6.2 Remediation Criteria — Stepwise System

The following remediation criterion method is used to determine whether unacceptable risks

exist for humans, for the ecosystem or of the contamination spreading to the groundwater: (VROM Circular, 2006)

Step 1: Determining a Case of Serious Contamination

In the first step, a detailed survey is used as the basis for determining whether there is a case of serious contamination. A case of serious contamination is deemed to be present when the average concentration measured of at least one substance is higher than the intervention value in a soil volume of at least 25 m^3 in the case of soil contamination, or a pore-saturated soil volume of at least 100 m^3 in the case of groundwater contamination.

In a few specific situations there may be a case of serious contamination even if the concentrations are below the intervention values. This applies to what are termed susceptible land use functions: vegetable garden/allotment, places where there are volatile compounds in the groundwater in combination with high groundwater levels or unsaturated soil underneath buildings.

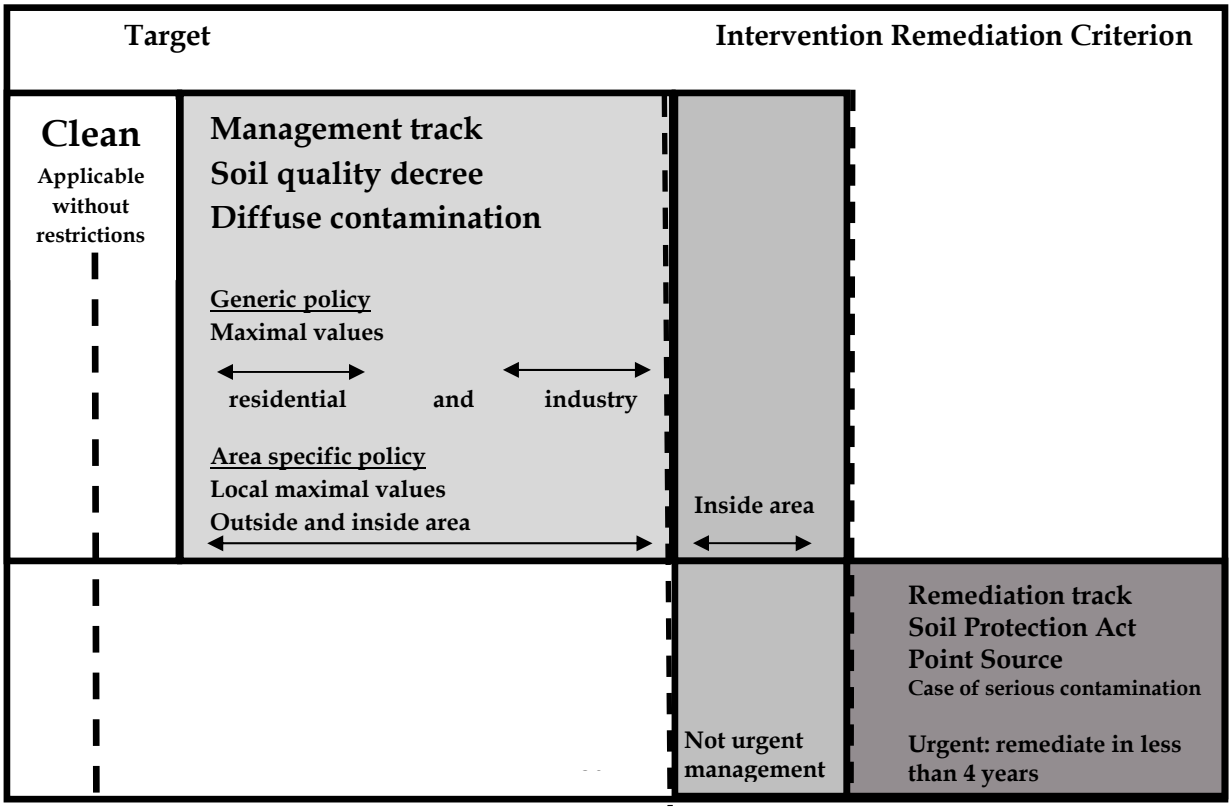
Step 2: Standard Risk Assessment

The second step is a generic model calculation. The model calculation can be based on the results of the detailed survey. A distinction is made between risks for humans, the ecosystem and of the contamination spreading.

Step 3: Location-Specific Risk Assessment

Step three consists of making additional measurements and/or additional model calculations. Concentration figures calculated using the model can be replaced in the model calculations by the figures for concentrations measured at the location. This makes the third step more location specific. Measurements or additional model calculations need not be made for every component of the generic model calculation.

Figure 5-2 Remediation criteria — Stepwise system



5.6.3 Dutch Target Values, Soil Remediation Intervention Values and Indicative Levels for Serious Contamination

1) Target Values

The target values indicate the level below which there is sustainable soil quality. In terms of curative policy, this means that the target values indicate the level that has to be achieved to fully recover the functional properties of the soil for humans and plant and animal life. In addition, the target values give an indication of the benchmark for environmental quality in the long term, on the assumption of negligible risks to the ecosystem. The target values derive from the Integrated Environmental Quality Standards project (called INS), and were published in December 1997. The INS target values have been included in the Circular on Target Values and Intervention Values for Soil Remediation (2000) with a few exceptions. The INS target values are underpinned by a risk analysis wherever possible and apply to individual substances. The same target values for soil and sediment as in the present circular, which applies to soil remediation policy, are included in the Fourth Report on Water Management (NW4).

2) Soil Remediation Intervention Values

The soil remediation intervention values indicate the level above which the functional properties of the soil are seriously impaired, and threaten human health, as well as plant and animal life. They are representative of the level of contamination above which there is a case of serious soil contamination.

The soil remediation intervention values are based on extensive studies of the National Institute for Public Health and Environmental Protection (RIVM) of both human and eco-toxicological effects of soil contaminants. Human toxicological effects have been quantified in the form of concentrations in the soil above which the so-called maximum permissible risk (MPR) for humans may be exceeded. For non-carcinogenic substances this corresponds to the Tolerable Daily Intake (TDI). For carcinogenic substances this is based on an additional chance of cancer incidence of 10^{-4} for lifetime exposure. It is assumed that all exposure routes are operational. (Dutch VROM, 2000)

3) Indicative Levels for Serious Contamination

The RIVM's proposals for intervention values have resulted in intervention values not being set for a number of substances. Indicative levels for serious contamination are provided for these substances. The indicative levels have a greater degree of uncertainty than the intervention levels. The status of the indicative levels consequently is not equal to the status of the intervention levels. Contaminant values falling under or above the indicative levels therefore do not have immediate consequences on a decision about the gravity of the contamination considered by the competent authority. Hence, the competent authority should bear in mind other considerations besides the indicative levels when deciding whether there is a case of serious contamination.

6. LATIN AMERICA

6.1 OVERVIEW OF THE LATIN AMERICAN SITUATION

In general, like other developing countries, Latin American countries lack specific legislation on contaminated land and soil protection. Basic issues such as permission and licensing of site reutilization, contamination liability, and public funding of abandoned sites have not been resolved. Nevertheless, some old industrial sites are beginning to be reused, and the conversion process is generally happening without their environmental history being thoroughly investigated and remediated. Soil quality is not yet a factor taken into account in urban planning and land use.

Brazil and Mexico are countries in Latin America with comparatively advanced legal and institutional frameworks with respect to contaminated site management. Both have conducted cases of successful brownfield redevelopment. Contaminated site management and brownfield redevelopment policy and regulatory framework in these two countries are presented below.

6.2 BRAZIL

Due to their strong local legislative powers (much different from other countries in Latin America), local governments in Brazil play a major role in contaminated site management – similar to the role of local governments in Canada and the EU. Therefore, while national governments are pivotal promoters of contaminated site management and brownfield redevelopment in other Latin American countries, local governments in Brazil, with the leading example of São Paulo State, undertake the primary responsibility for contaminated site management.

Presently, similar to other developing countries around the globe, contaminated site management and brownfield redevelopment in São Paulo State are covered under existing general laws on pollution control, such as the São Paulo State Law 996 and its ordinance of 1976. Moreover, São Paulo State addresses the issue of the contaminated land mainly by means of implementing of institutional guidelines and directives, such as the guideline values for soil and groundwater, and the directives for risk assessment and investigation procedures presented in "Manual de gerenciamento de areas contaminadas" (CETESB,1999). But the State has also prepared a new draft bill for soil protection and contaminated site remediation.

São Paulo State has established well-developed inventories of contaminated sites, using which 2000 sites have been registered, investigated and partly remediated. Successful reutilization of contaminated land depends on the establishment of standards for soil use and close cooperation between environmental and local planning authorities. In São Paulo, attempts to streamline the licensing process for construction projects have been made. The reuse of contaminated soils is directed by soil use-related guideline values, and the contamination situation is proposed to be fixed in the public registry of

the property. Almost all new real estate and building projects have to undergo an environmental site assessment.

The CAIXA, Brazil's main financer of urban development, housing and basic sanitation, whose several residential building projects have suffered financial and juridical losses due to late detection of soil contamination, has implemented risk management procedures and environmental site assessment tools in the credit sector, based on environmental due diligence. The procedures and tools guide the loan business regarding housing construction on former commercial and industrial sites with suspected soil or groundwater contamination.

6.3 MEXICO

Responsibility and liability with regard to contaminated site management and brownfield redevelopment in Mexico is regulated under the Solid Waste Act of 2003, which was reviewed in 2006. Special guidelines regarding permission for real estate transfer and regulation liability is under development. Authorization of reuse of contaminated sites is established in the risk assessment and remediation framework.

A recent ordinance defines the procedures for contaminated site investigation, risk assessment and remediation, as well as legal responsibilities (SEMARNAT, 2006). In addition, Mexico has set soil quality and remediation standards for soil contaminated by hydrocarbons, PCB and heavy metals.

Mexico is presently building up its inventory of contaminated sites and potentially contaminated sites, called SISCO (Sistema Informático de Sitios Contaminados), and has started a program for national priority sites. Brownfield redevelopment is seen as an opportunity to finance or co-finance the often costly cleanups of the sites, returning them to the economic cycle after remediation. The strategy to finance the remediation of Mexico's priority contaminated sites is geared towards its re-usage. The remediation of some priority sites in Mexico is financed by public funding, as the federal government is responsible for contaminated site management. In the case of contaminated sites of the petrochemical industry, a PEMEX (Petróleos Mexicanos) refinery in Mexico DF entirely finances contaminated site remediation.

7. SUMMARY, DISCUSSION AND RECOMMENDATIONS

7.1 SUMMARY AND IMPLICATIONS FOR CHINA

The review of policy and regulatory frameworks for contaminated site management in developed and developing countries indicates that there are both similarities and differences between contaminated land and associated risk management approaches across the world. Summarized below are the most relevant elements in various frameworks, and their implications for establishing an effective site contamination management framework in China:

1) Liability and the "Polluter Pays Principle"

In general, most international policy and regulatory frameworks uphold the "polluter pays principle", although determining liability on site contamination cases is not always an easy task. Several countries have defined specific approaches to assign legal responsibilities, manage orphan sites, and to combine private and public funding for site remediation and redevelopment.

In the US, the Superfund Act is intended to recover cleanup costs from potential responsible parties (PRPs). Though implementation has been highly controversial and time- and budget consuming, most stakeholders would agree that the "polluter pays principle" has effectively changed corporate environmental behavior. The following lessons can be drawn from the experience of the US Superfund:

- It is important to find ways to assign liability for sites where numerous parties may have contributed to the pollution, such as landfills and dumping sites.
- Ways must be found to effectively limit legal and administrative costs to government parties and small businesses, which result from the risk of liability for site remediation.
- Regulators and enforcement agencies need to consider the limited effectiveness of pursuing minor parties which are not in a position to contribute significantly to the costs of cleanup.
- Site cleanup is extremely costly and the sustainability of funding mechanisms must be ensured (the Superfund trust is running out of money and currently relies on general fiscal revenue allocation).

In the UK, on the other hand, the private sector drives and funds the majority of land development and remediation projects. In some countries, as in the Netherlands, there is a hierarchy in terms of liability. This hierarchy starts with the polluter. If the polluter is not in a position to significantly contribute towards the cleanup costs, responsibility shifts to the land owner. If the land owner is not in a position to contribute towards the cleanup costs, responsibility shifts to the government. There are specific mechanisms for the protection of innocent land owners.

In China, land is owned by the government. Most industrial sites are plants owned by state-owned-enterprises (SOEs). If the owner or operator is first in line to cover site cleanup, responsibility will ultimately fall on the state. Assignment of liability for activities involving joint ventures, and regarding landfills and dumping sites, will not be an easy task, as seen in the US Superfund program.

2) Central/Federal Government vs. Local Authorities

In the US, most Federal Laws delegate regulatory authority to approved state programs. Each state has jurisdiction and responsibility to protect the environment in accordance with Federal Law (e.g. Clean Water Act and the Clean Air Act. However, the 1980 CERCLA did not delegate the authority to state and local governments, and early implementation of the law proved to be less effective. Subsequent reforms and amendments (SARA) have allowed the Superfund to facilitate effective collaboration with state and local communities.

Regulating interventions in contaminated sites is often complicated by the division between federal and state responsibilities. Federal intervention is required when soil and groundwater contamination are trans-boundary issues. The issue is an ongoing debate in the European Union, where the Soil Framework Directive remains at a draft stage, and is unlikely to be finalized in the short term.

Action on the national, regional and local levels is required to reach soil quality objectives. A shared responsibility scheme is likely to be more realistic and may make best use of resources at different levels. The government at federal and central levels could focus on overall risk policies, technological research and development to share with the states. Provincial and local governments have their unique land development needs, as well as specific planning and zoning constraints and advantages, and could therefore implement contaminated site redevelopment projects in a more suitable and cost effective way.

In the case of China, the brownfield site management policy and regulatory framework needs to consider the unique characteristics of China, such as large differences between different regions in terms of economic and social development, availability of supporting infrastructures, such as landfills and transportation, storage and disposal (TSD) facilities, enabling capacities such as knowledge and technical skills, site pollution history, the extent and nature of site contamination, and, most importantly, population density and thus the consequences of exposure risk. Therefore, regional and phased approaches seem to be prudent in establishing the framework.

3) Historical vs. Current and Future Contamination

In the US, the Superfund deals specifically with historical abandoned sites; the law is retroactive. In the Netherlands, the cut-off date for the definition historical contamination is 1987. For contamination prior to 1987, the responsible party may adopt a risk-based approach immediately and the state will

support remediation. For contamination after 1987, responsibility falls on the responsible party to have the contamination "cleaned as quickly as possible, irrespective of concentration and risk of pollutants".

In general, existing EU policies concerning soil protection do not apply to contamination which occurred prior to its entry into force. Historical contamination is expected to be addressed by the proposed EU Soil Framework Directive.

In China, most state-owned enterprises have gone through some form of ownership restructuring; the dates of these ownership changes are traceable. However, few such transactions have been accompanied by environmental site assessment (ESA) or AAI to define baselines or reference points. Thus, whether China will set a certain cutoff date for historical pollution liability is still a matter of debate. However, China should develop regulations to prevent pollution and avoid the creation of future contaminated sites.

4) Land Use Options and Cleanup Approaches

Even in cases where earlier national policies have emphasized multifunctional remediation (permanent contaminant removal), as in the US and the Netherlands, the general tendency now is to move towards "fitness-for-use" remediation objectives in most developed countries. In some cases where generic criteria have been developed, these values are developed based on the types of specific future land uses, which are normally categorized by agriculture, residential, and industrial/commercial use. Site-specific risk assessments and cleanup targets are generally conducted considering present and future land use of the site under investigation.

In China, most industrial sites are located in cities and are sometimes in prime real estate areas. After redevelopment, these sites may be used for residential or commercial purposes. Thus, returning the contaminated sites to pristine status at first may seem prudent and attractive. However, most of these sites have a pollution history of over half a century or longer, and due to urgent need for redevelopment, the time available for remediation is very constrained. High cleanup costs and time constraints for development mean that it is not feasible to clean sites to the extent that they are suitable for any use. Technologies may not even be available to effectively reach some stringent cleanup targets. Other potential land uses, such as an industrial park or even a golf course, may be a more economical and practical choice.

Fortunately, China has strong central and provincial planning capabilities, and simple state-ownership of lands. This can be a great advantage in coupling future land use with site remediation.

5) Acceptable Risk Levels and Social, Economic and Political Impacts

In most countries, soil screening values are based on the application of exposure and toxicological modeling. "Acceptable risk" for non-threshold compounds (carcinogens) is expressed in terms of incremental lifetime cancer risk and ranges between 10^{-6} and 10^{-4} in different countries. For example, 10^{-4} is

commonly used in the Netherlands, while 10^{-6} is used in the US, and 10^{-5} is adopted by many countries, including Germany and Sweden. For threshold substances, the exposure concentration is deemed acceptable up to a threshold dose (based on toxicological evidences and assessment factors), in all countries.

The establishment of risk-based screening and cleanup values has scientific, socio-economic and political consequences. Social, economic, political and scientific issues can often be highly interlinked and difficult to distinguish from one another.

The wide range for "acceptable" thresholds can be interpreted as a political choice, but the implementation in risk assessment procedures is not solely political. "10^{-6} excess lifetime cancer risk" should not simply be treated as a quantitative statement about risk, as "1 incremental cancer over 1 million exposed persons". The significance of "10^{-6} excess lifetime cancer risk" has to be judged in relation to the conservative assumptions adopted in the risk estimation and finally compared to the level of risk posed by other sources, such as the risk of inhalation of contaminated air (air pollution vs. soil pollution) or risks from smoking (as it is estimated under the same conservative assumptions). In practice, "10^{-6} excess lifetime cancer risk" is an operational threshold agreed between policy makers and scientists based on judgments of conservatism, public perception, and social and economic acceptability of implications; it is therefore a matter of convention. (Ferguson and Denner, 1994)

Another key aspect in cleanup standard development is the establishment of the exposure conceptual model, namely the identification of potential pathways of exposure to contaminated soil for human and ecological receptors. It can be interpreted as a scientific issue, however it is not solely scientific. By defining the potential receptors of concern and types of use of the land, the conceptual model sets the type of use which the land has to be safeguarded for, and the extent of protection for the most sensitive subgroups of the population. The conceptual model, therefore, is "conventional" and based on both political and scientific judgment. The merging of scientific and political judgment is present in both screening and site-specific risk assessment, but is clearly more relevant in the screening due to the application of standard conceptual models. The emphasis in this text on "conventional" aspects is not to say that scientific and political issues in risk assessment cannot be distinguished. On the contrary, it is important that "conventional" components of risk assessment are clearly identified to make the interaction between scientists and decision makers more transparent and efficient. (Carlon, 2007)

7.2 RECOMMENDATIONS

Based on the review of the policy and regulatory framework in other countries and regions, the following concluding recommendations for a policy and regulatory framework on contaminated sites in China can be made. The framework should include:

- a specific regulation which requires risk management and clearly specifies how to

implement risk-based assessment and cleanup approaches, and ensures that all regulatory instruments are consistent with the aforementioned risk-based approach;

- acceptable risk-based policy which balances environment and public health protection, technical practicality, and social, economic and political impacts;
- realistic criteria and clear procedures which set screening values, action levels, and site-specific clean up targets; when screening values are exceeded, clear guidance must be provided regarding site investigation, risk assessment and site remediation, as well as exit mechanisms for "no further action" and site closure;
- a prioritizing system to determine the different levels of risk and urgency in contaminated land management;
- institutional arrangements which assign clear responsibilities and authority to the central, regional and local governments, in order to most effectively implement site assessment and cleanup, and to minimize inconsistency between different government levels and differing local interpretations;
- quality assurance and quality control (QA/QC) and performance monitoring mechanisms for external third party independent oversight, and public and local community participation;
- management tools for site inventory, case study database, liability records for knowledge sharing, and for the assessment of social and economic impacts and adjusting related policies and regulations;
- safeguard requirements which refer to environmental covenants and deed restrictions to allow for flexible and cost-effective risk management, smooth property transfer and assurance of pollution liability, minimize the spread of contaminants and limit risk exposure;
- provisions focusing on future land use and zoning, soil quality and functions, and outcomes and benefits of remediation;
- capacity building, a set of technical requirements, guidelines and procedures, engineering manuals to enable practitioners and officials to adequately implement site assessment and clean up;
- provisions which not only tackle historical and existing contaminated sites, but also monitor and prevent future site contamination.

7.3 CONCLUSIONS

The extensive experience from other countries in contaminated site management will facilitate China in rapidly developing an effective contaminated site management framework. In the past forty years, many countries have implemented contaminated site management frameworks, and many costly mistakes have been made.

The following key conclusions can be drawn from the analysis of brownfield site management frameworks abroad:

- **Clear identification of stakeholders and allocation of responsibilities:** China needs to balance between the "polluter pays

principle" and implementation efficiency, to avoid lengthy and costly litigation procedures which do not contribute to effective contaminated site management, and to ensure funding and procedures which can be applied when the original polluter cannot be identified or is unable to sufficiently contribute;

- **Safeguard policies to contain risks related to existing brownfields:** Given the limited amount of resources and the large number of sites needing remediation, in many cases rather than a thorough site remediation, safeguards should be put in place to effectively contain a site and minimize any immediate dangers to the public and damage to the environment;
- **Adoption of risk-based clean-up targets:** International experience shows that full remediation is often excessively costly, and that the optimal level of clean-up targets depends on the risks the site poses to its environment and the surrounding population, which in turn largely depend on its proximity to population centers and its intended use. Adopting risk-based clean-up targets has emerged as good practice;
- **Financing mechanisms:** Drawing on the experience of the USA and other countries, China needs to establish sustainable funding mechanisms for contaminated site clean-up activities, so that remediation activities on the most urgent sites can be sped up, in some cases take place even before it is certain who will ultimately pay for it.

APPENDIX

A. US STATUTES, REGULATIONS, POLICIES AND GUIDELINES REGARDING CONTAMINATED SITES

Statutes

CERCLA

The Comprehensive Environmental Response, Compensation and Liability Act of 1980, known as the Superfund Act, was enacted to address abandoned hazardous waste sites in the U.S. The law has subsequently been amended, by the Superfund Amendments and Reauthorization Act of 1986 (SARA), and the Small Business Liability Relief and Brownfields Revitalization Act of 2002.

Oil Pollution Act of 1990

The Oil Pollution Act of 1990 provides authority to respond to spills of oil.

Regulations

- National Contingency Plan (NCP)
  The National Oil and Hazardous Substance Pollution Contingency Plan (NCP) is the regulation that implements CERCLA and the Oil Pollution Act under the response program. It provides the blueprint for responding to both oil spills and hazardous substances releases.

- Subpart O
  The Subpart O regulation applies to CERCLA-authorized grants to States. It complements EPA's general financial assistance regulation and establishes requirements for Superfund cooperative agreements and Superfund States Contracts (SSCs) that are specific requirements under CERLCA. This regulation outlines the use and payment of state cost sharing requirements in the Superfund program.

Policy and Guidance

I. Institutional Control-Specific

- *Institutional Controls: A Citizen's Guide to Understanding Institutional Controls at Superfund, Brownfields, Federal Facilities, Underground Storage Tank, and Resource Conservation and Recovery Act Cleanups*, February 2005, OSWER 9355.0-98, EPA-540-R-04-003,
- *Strategy to Ensure Institutional Control Implementation at Superfund Sites*, September 2004, OSWER 9355.0-106,
- *Institutional Controls: A Guide to Implementing, Monitoring and Enforcing Institutional Controls at Superfund, Brownfields, Federal Facility, UST and RCRA Corrective Action Cleanups*, (Draft), February 2003, OSWER 9355.0-89, EPA 540-R-04-002,
- *Institutional Controls: A Site Manager's Guide to Identifying, Evaluating and Selecting Institutional Controls at Superfund and RCRA Corrective Action Cleanups*, September 2000, OSWER 9355.0-7-4FS-P, EPA 540-F-00-005.

II. Remedy Selection

- *National Oil and Hazardous Substances Contingency Plan*,
- *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents,*

- *Rules of Thumb for Superfund Remedy Selection*, August 1997, OSWER 9355.0-69, EPA 540-R-97-013,
- *Role of Costs in the Superfund Remedy Selection Process*, September 1996, OSWER 9200.3-23FS, EPA 540/F-96/018,
- *Land Use in the CERCLA Remedy Selection Process,* May 1995, OSWER 9355.7-04,
- *CERCLA Orientation Manual,* October 1992, EPA/542/R-92/005,
- *Role of Baseline Risk Assessments in Superfund Remedy Selection Decisions*, April 1991, OSWER 9355.0-30,
- *Getting Ready: Scoping the RI/FS*, November 1989, OSWER Directive 9355.3-01FS1,
- *Guidance for Conducting RI/FS under* CERCLA, October 1988, OSWER Directive 9355.3-01, EPA 540/G-89/004.

III. Related Specifically to Remedy Updates

- Strategy to Ensure Institutional Control Implementation at Superfund Sites, September 2004, OSWER 9355.0-106,
- *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*, July 1999, OSWER9200.1-23.P, EPA 540-R-98-031.

IV. Ground Water Remedies

- *Use of Alternate Concentration Limits (ACLs) in Superfund Cleanups*, July 19, 2005, OSWER Directive 9200.4-39,
- *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*, April 1999, OSWER Directive 9200.4-17P,
- *Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites*, October 1996, OSWER Directive 9238.1-12, EPA/540/R-96/023,
- *Methods for Monitoring Pump and Treat Performance, Part 2*, June 1994, ORD publication, EPA/600/R-94/123,
- *General Methods for Remedial Operation Performance Evaluation,* January 1992, ORD publication, EPA/600/R-92/002,
- *A Guide to Remedial Actions for Contaminated Ground Water*, April 1989, OSWER Directive 9283.1-2FS, Fact Sheet for 1988 Guidance,
- *Guidance on Remedial Actions for Contaminated Ground Water at Superfund Sites*, December 1988, EPA/540/G-88/003.

V. Media- and Contaminant-Specific Guidance

- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites*,
- *Principles for Managing Contaminated Sediment Risk at Hazardous Waste Sites*, February 2002, OSWER Directive 9285.6-08,
- *Abandoned Mine Site Characterization and Cleanup Handbook*, August 2000, Region 8, 9, and 10 publication, EPA 910-B-00-001,
- *Conducting Remedial Investigations/Feasibility Studies at Municipal Landfills*, February 1991, EPA 540/P-9/001,
- *Guidance on Remedial Actions for Superfund Sites with PCB Contamination*, August 1990, OSWER 9355.4-01, EPA 540/G-90/007.

VI. Post-Construction Completion

- *NCP Guidance on O&M*
- *Close-Out Procedures for National Priorities List Sites*, January 2000, OSWER Directive 9320.2-09A-P, EPA 540-R-98-016,

- *Comprehensive Five-Year Review Guidance*, June 2001, OSWER No. 9355.7-03B-P, EPA 540-R-01-007
- *Operation and Maintenance in the Superfund Program*, May 2001, OSWER 9200.1-37FS, EPA 540-F-01-004
- *O&M Report Template for Ground Water Remedies (With Emphasis on Pump and Treat Systems)*, April 2005, OSWER 9283.1-22FS, EPA 542-R-05-0101,
- *Transfer of Long-Term Response Action (LTRA) Projects to States*, July 2003, OSWER 9355.0-81FS, EPA 540-F-01-021.

VII. Land Use/Reuse

- *Guidance for Preparing Superfund Ready for Reuse Determinations*, February 2004, OSWER 9365.0-33,
- *Reusing Superfund Sites: Commercial Use Where Waste is Left on Site,* Feb. 2002, OSWER 92330.0-100,
- *Reuse Assessments: A Tool to Implement the Superfund Land Use Directive,* June 2001, OSWER 9355.7-06P,
- *Reusing Superfund Sites: Recreational Reuse of Land above Hazardous Waste Containment Areas,* March 2001, OSWER 9230.0-0-93, EPA 540-K-01-002

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B. CANADIAN LEGISLATION, POLICY AND GUIDELINE LIST FOR CONTAMINATED SITES

Legislation

- *Canadian Environmental Protection Act, 1999*
- *Fisheries Act*
- *Canadian Environmental Assessment Act*
- *Arctic Waters Pollution Prevention Act*

Policies

- *Treasury Board Policy on Management of Real Property,*
- *Treasury Board Reporting Standard on Real Property,*
- *Treasury Board Policy on Accounting for Costs and Liabilities Related to Contaminated Sites,*
- *Indian and Northern Affairs Canada Contaminated Sites Management Policy (offers guidance on the management of contaminated sites located on reserve lands, on federal lands north of the 60th parallel, and on any other lands under the responsibility of Indian and Northern Affairs Canada),*
- *Indian and Northern Affairs Canada Mine Site Reclamation Policy for the Northwest Territories,*
- Calls for better management of the Northwest Territories' natural resources to ensure that mining operations do not leave behind environmental or health hazards and a financial burden for the Canadian taxpayer.

Guidelines

- *National Classification System for Contaminated Sites (NCSCS) – Guidance Document,* CCME (2008) (a method for evaluating contaminated sites according to their current or potential adverse impact on human health and the environment),
- *Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products,* CCME (2003),
- *Recommended Principles on Contaminated Sites Liability,* CCME (2006) (The publication updates CCME's principles dealing with contaminated site-related liability by adding another principle that provides for the possibility of transfer of environmental regulatory liability for a contaminated site from the seller to the buyer under specific conditions established by governments, which would assure site clean-up. The new principle promotes the redevelopment of brownfields and vacant and underutilized commercial properties across Canada, while ensuring human and environmental safety.),
- *Federal Contaminated Sites Guidance on Human Health Risk Assessment in Canada,* Health Canada,
- *Federal Contaminated Sites Risk Assessment in Canada Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment (PQRA),*
- *Federal Contaminated Sites Risk Assessment in Canada Part II: Health Canada Toxicological Reference Values (TRVS),*
- *Federal Contaminated Sites Risk Assessment in Canada Part III: Guidance on Peer Review of Human Health Risk Assessments for Federal Contaminated Sites in Canada,*

- *Addressing Psychosocial Factors through Capacity Building: A Guide for Managers of Contaminated Sites* (The guide provides an introduction to understanding the psychosocial effects of individuals living and working near a contaminated site.).

Technical Assistance

- TAB #1: Jar Headspace Analytical Screening Procedure
- TAB #1B: Understanding Organic Vapor Survey Findings
- TAB #2: Site Assessment Procedures
- TAB #3: Electromagnetic Surveys & Ground Penetrating Radar
- TAB #4: Sampling & Analysis of Hydrocarbon Contaminated Soil
- TAB #5: Sampling & Analysis of Hydrocarbon Contaminated Groundwater
- TAB #6: Alternative Field Screening Methods
- TAB #7: Developing a Terms of Reference for Contaminated Site Remediation
- TAB #8: When is a Site "Clean"
- TAB #9: Emergency Response Procedures at a Contaminated Site
- TAB #10: Health & Safety Procedures for Contaminated Sites
- TAB #11: Legislation Applicable to the CSRP
- TAB #12: Developing a Community Relations Program for Contaminated Sites
- TAB #13: Soil Remediation Low Temperature Thermal Desorption
- TAB #14: Contaminated Sites Remediation Framework (CSRF) -Environment Canada
- TAB #15: Risk Assessment — Application and The Screening Process
- TAB #16: Risk Assessment — Exposure Model, Toxicity Analysis and Evaluation
- TAB #17: Risk Management For Contaminated Sites - Framework
- TAB #18: Risk Management For Contaminated Sites — Acceptable and Unacceptable Risk
- TAB #19: Intrinsic Remediation — An Introduction
- TAB #20: Intrinsic Remediation — Biodegradation
- TAB #21: Intrinsic Remediation — Attenuation Mechanism and Contaminant Transport
- TAB #22: In-Situ Remediation Technologies For Contaminated Sites
- TAB #23: Ex-Situ Remediation Technologies For Contaminated Sites
- TAB #24: Remediation Technologies For Groundwater Contamination
- TAB #25: A Basic Outline of Ontario's Land-Use Guidelines
- TAB #26: Restoration Criteria in Ontario's Land-Use Guideline
- TAB #27: Expedited Site Characterization: Process
- TAB #28: Expedited Site Characterization: Criteria for Selecting Tools and Technologies
- TAB #29: Expedited Site Characterization: Tools and Technologies

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Environmental and natural resources management issues are an integral part of the development challenge in the East Asia and Pacific (EAP) Region. The World Bank's Environment Strategy in the East Asia and Pacific Region has provided the conceptual framework for setting priorities, strengthening the policy and institutional frameworks for sustainable development, and addressing key environmental and social development challenges through projects, programs, policy dialogue, non-lending services, and partnerships. This study provides a forum for discussions on good practices and policy issues within the development community and with client countries.

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