Danish Ministry of the Environment
Environmental Protection Agency

Ecological risk assessment of contaminated sites

Experiences and status in four European countries, The Netherlands, Norway, Sweden and The United Kingdom

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Ecological risk assessment of contaminated sites

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Content

Forord

Jordforurening i Danmark bliver i dag næsten udelukkende håndteret med henblik på at beskytte befolkningen og grundvandet. Dette er i fuld overensstemmelse med de fastsatte indsatsområder i jordforureningsloven, men nogle af de forurenede grunde, vi kender i dag, ligger ved beskyttede naturområder, hvor forureningen kan påvirke dyr og planter og det nærliggende overfladevand.

De primære indsatsområder i jordforureningsloven er beskyttelse af drikkevandsressourcer og forebyggelse af sundhedsmæssige problemer. Jordforureningsloven åbner op for at regioner undtagelsesvist kan prioritere en indsats uden for lovens primære indsatsområder, og en beskyttelse af miljøet som levested for dyr og planter har indtil videre kun været sporadisk på forurenede grunde i Danmark. Implementeringen af EU´s vandrammedirektiv og habitatdirektiv afstedkommer et behov for at kunne vurdere, hvorledes jordforurening påvirker de omkringliggende vandområder, samt det terrestriske miljø, der hvor de forurenede arealer befinder sig. Da der ikke foreligger megen erfaring på dette område i Danmark, har det været relevant at indsamle international viden fra lande, som har et større erfaringsgrundlag. De nuværende rammer og metoder for risikovurdering af miljøeffekter er derfor indhentet i fire lande, Holland, England, Sverige og Norge. Dette er sket ved en gennemgang og sammenfatning af officielle dokumenter og rapporter, samt ved et personligt interview af en eller flere centrale myndighedspersoner i de respektive lande.

Sammenfatning og konklusioner

Denne rapport bygger på indsamling af viden og erfaringer med lovgivningen, risikovurderingen og håndteringen af forurenede grunde i fire forskellige lande, Norge, Sverige, Holland og Storbritannien. Indsamlingen af viden er dels sket gennem trykte medier, hjemmesider m.m., dels gennem et målrettet personligt interview med nøglepersoner hos myndighederne i de fire lande. Denne rapport har målrettet indsamlet viden om forurenede grunde, som er relevant for risikovurderingen af terrestriske økosystemer og overfladevand.

Der eksisterer en lang række fællestræk såvel som forskelle i de fire undersøgte lande. Fælles for alle lande er et lovsæt, som under forskellige forudsætninger aktivt tillader de kompetente myndigheder at kræve informationer, som muliggør risikovurderingen af terrestriske økosystemer og overfladevand. Forudsætningerne herfor kan variere fra en simpel mistanke til konkrete konceptuelle modeller, som tydeliggør en sammenhæng mellem forurening og de økosystemer, som ønskes beskyttet.

Generelt har alle indført et princip, som pålægger forureneren, såfremt denne kan identificeres, at betale for eventuelle kortlægninger, afværgeforanstaltninger og oprydning. Alle lande åbner dog også op for, at ejeren af grunden, uanset om denne har ansvar for forureningen, kan pålægges at betale udgifterne eller del heraf. I alle lande eksisterer der ligeledes nationale puljer, som i større eller mindre omfang bidrager til at løse konkrete oprydningsopgaver. Den nationale indsats er baseret på et mere eller mindre formaliseret og specificeret relevansprincip, som først og fremmest prioriterer oprydning af områder, som udgør en risiko for den humane sundhed. Norge og Sverige, for eksempel, prioriterer dog også risikohåndteringen af overfladevand relativt højt, mens sedimenter spiller en større rolle i f.eks. Holland og Norge, end de tilsyneladende gør i Storbritannien og Sverige.

Alle fire lande har i mere eller mindre detaljeret grad udarbejdet tekniske anvisninger på, hvordan risikovurderingen af terrestriske økosystemer og overfladevand skal foretages. Som oftest indeholder disse en række generiske vand- og jordkvalitetskriterier, som er fastsat på baggrund af internationale accepterede metoder. På vandområdet har de fleste lande relateret deres vandkvalitetskriterier til de gældende kriterier i vandrammedirektivet, mens der på jordområdet forekommer visse nationale forskelle for de enkelte forureningskomponenter. Når det drejer som om mere steds-specifikke risikovurderinger af det forurenede område, er der større forskelle landende imellem. Mens behovet i Sverige og Norge som oftest vurderes fra sag til sag, så har Storbritannien og Holland f.eks. publiceret relativt velbeskrevne metoder til mere avancerede risikovurderinger af jordforurening, der blandt andet indeholder brugen af populationsmoniteringer og mere avancerede laboratorieforsøg med den forurenede jord.

Konkluderende kan det nævnes, at alle fire undersøgte lande har elementer af risikovurderingen af terrestriske økosystemer og overfladevand i deres regulering af forurenede grunde. Alt afhængigt af hvori dette skal anvendes, kan der derfor uddrages værdifulde erfaringer og viden fra hvert enkelt af de undersøgte lande, som kan tilpasses til danske forhold, såfremt det skulle blive aktu-

elt at udvikle et nationalt koncept for risikovurderingen af terrestriske økosystemer og overfladevand.

Summary and conclusions

Information and experience on risk assessment, management and legal regulation of contaminated sites from four selected countries, Norway, Sweden, The Netherlands and England, has been compiled. The compilation of information has been through written material, i.e. reports, official web pages etc., and a targeted interview with selected persons within the relevant ministries or agencies in the selected countries. Special attention within this project has been paid to the ecological risk assessment of contaminated sites and adjacent fresh water systems.

A wide set of similarities as well as differences exist in the four countries. Common for all countries is specific legal regulations that enable the competent authorities to request specific information needed for a risk assessment, provided a number of requirements exist. Such requirements may vary from suspicion based on historical use of the site alone to site-specific conceptual models linking the source of pollution to the (ecological) receptors of concern through specified pathways.

In general, all countries have imposed “the polluter pays” principle, meaning that in cases where the polluter(s) can be identified, the cost or part of the cost of remediation can be imposed on these. In all countries, the owner of the contaminated sites can also be held responsible for the necessary remedial actions, provided the polluter cannot be identified and/or the pollution dates way back before the current legislation.

All countries have, however, allocated national funds of resources to aid or fully conduct risk assessment or remediation in prioritised areas. It varies to some extent between countries how the prioritisation is made, ranging from informal non-specified practise to prioritise human health above risk to ecosystems, as seen in for example Norway and Sweden, to more formal prioritisation systems, as the scoring system for prioritising risk in the UK. Even within ecological risk assessment, different (informal) prioritisations exist. For example, Norway and The Netherlands prioritise risk assessment of contamination in sediments in e.g. harbours and ditches higher than Sweden and the UK.

All four countries have included ecological aspects in their risk assessment, by at a minimum including ecotoxicological aspects in their derivation of soil screening levels. All countries have formerly (or unformally) listed ecological systems as a target of protection, which in principle should undertake an environmental risk assessment in order to evaluate potential damage. The UK has defined a score system for assessing the severity of soil pollution used in connection with the national funding scheme of soil remediation, which gives highest priority to human health followed by fresh water system ecology and, finally, property, whereas countries like The Netherlands, Norway and Sweden in principle equate the need of human and ecological risk assessment for all sites. However, in practical terms all countries prioritise the use of national funding for remediation of sites posing a risk to human health above the risk to ecosystems.

The level of detail regarding ecological risk assessment varies greatly across the four selected countries, with The Netherlands and the UK having more detailed framework for ecological risk assessment reaching beyond the use of generic soil screening levels. UK, for example, has published a set of detailed scientific reports on aspects ranging from the overall framework to specific guidance on the use of ecological surveys and bioassays in the site-specific risk assessment of contaminated soils (see footnote 12). The Netherlands are currently developing a framework for using the so-called TRIAD[1] approach for site-specific ecological risk assessment, combining the use of soil screening values with ecological surveys and laboratory-based bioassays.

Regarding adjacent waters, all countries include potential risk to fresh water ecosystems in their assessment schemes. Prevention of dispersion to e.g. Water Frame Directive areas is frequently prioritised in the allocation of funding and initiation of remediation activities in e.g. Norway and Sweden. Typically, the assessment is based upon a simple comparison of modelled or monitored fresh water concentrations, with established water quality objectives taking the obligations arising from the Water Frame Directive into consideration. No published scheme for site-specific assessment of risk to fresh water ecosystems has been identified in this report beyond the use of generic water quality objectives in any of the countries.

In summary, it can be concluded that all of the four investigated countries have elements of ecological risk assessment of the soil and fresh water ecosystems in their regulation of contaminated sites that operate in concert. Depending on the context, valuable knowledge can be obtained from each of the selected countries to develop a potential framework for ecological risk assessment of contaminated sites in Denmark.

[1] Jensen, J & Mesman, M 2006, Ecological Risk Assessment of Contaminated Land: Decision support for site specific investigations, RIVM Report no 711701047, Bilthoven, NL. ISBN 90-6960-138-9

1 Introduction

In Denmark, approximately 27,000 sites were registered as contaminated or potentially contaminated in 2010. A new smaller survey in one of the regions of Denmark, a comparison between the location of contaminated sites and the location of protected nature areas, showed that approximately 10% of the contaminated sites were located on areas protected by the EU Habitat Directive or by national legislation. Nevertheless, till date Denmark has not (systematically) been assessing risk to terrestrial habitats and fresh water recipients. This is a logical consequence of the Danish Soil Act, which specifically lists the primary targets of protection from contaminated soil, as human safety and drinking water. It is, however, possible that the Water Frame Directive and the Habitat Directive in EU may call for a change of the Danish Soil Act in order to open up for assessments and remediation triggered by ecology or water quality of the recipients. To ensure that decisions are taken on the best possible foundation, the Danish EPA and policy makers are interested in experiences from other comparable countries. In this context, information and experience from four selected countries, Norway, Sweden, The Netherlands and England, has been compiled.

The compilation of information has been through written material, i.e. reports, official web pages etc., and a targeted interview with selected persons within the relevant Ministries or Agencies in the selected countries. The interviews were conducted in the period from April to September 2009. The following Agencies and contact persons have been helpful with interviews and written material:

- Norway, Norway's Climate and Pollution Agency (Klif)[2], Sjur Andersen
- Sweden, Swedish Environmental Protection Agency (Naturvärdsverket), Helena Furst
- The Netherlands, Ministry of Housing, Spatial Planning and Environment (VROM), Murk de Roos
- England, Environment Agency, Danielle Ashton

The views and conclusions made in the present report, however, exclusively represent the author and not the interviewed persons.

This report only briefly addresses the issue of contaminated land management in four selected countries, with special emphasis on ecological risk assessment and risk to recipients. It is intended to give an overview of this very complicated matter. Hence, no effort has been made to present the (technical) details in the various assessment frameworks and legal background. For more details and/or an updated situation, the readers should refer to the involved Agencies, which all have very good English home-pages[3].

[2] Formerly Statens Forurenings Tilsyn (SFT)
[3] N: www.klif.no; S: www.naturvardsverket.se; NL: www.vrom.nl; UK: www.environment-agency.gov.uk.

2 Norway

2.1 Legal background

Contaminated soils are primarily regulated in Norway through the Pollution Act from 1981. In principle, all kinds of pollution, including emission of hazardous substances to soils, are prohibited by law and can be penalized unless special provision is given by authorities. It is emission and contamination as such that are prohibited and regulation is, therefore, in its foundation not based on a risk assessment approach and acceptable limits of emission, but rather a prevention approach.

The Norwegian Contamination Act not only specifies that the polluter-pays principle is in operation, but is extended to a specification that the responsible legal entity can be found among either 1) the entity that pollutes or historically polluted the environment, 2) the entity that initiated activities that pollute or historically polluted the environment or 3) the entity that currently possesses the source of emission (e.g. industrial activities or contaminated areas) that pollutes or historically polluted the environment. The latter opens up for the possibility that the current land owner can be regarded as the responsible legal entity, despite the fact that the contamination was conducted by previous land owners and the current land-owner obtained the land without knowing about the pollution.

The stipulations to the law indicate that the authorities should chose the responsible entity - or entities in cases where responsibility is shared among the three listed above - based on a judgement on who is closest or best suited to solve the problem. In the majority of cases, the prioritisation by the authorities is the polluter first (provided they still are a legal entity) and hereafter the current land-owner in cases where these may differ. The responsible entity, identified by the authorities, can be forced to conduct site investigations and follow-up remediation. Also, consultants or entrepreneurs operating at a contaminated site, e.g. in rehabilitation of brownfields, can be forced to conduct investigations and/or remediation. In summary, the authorities have a large degree of freedom in identifying the legal entity and to enforce various remedial actions.

The regional authorities, or Klif, are the overall authority in handling and managing the risk of contaminated soils in Norway. The regional authority has the main responsibility for a set of industries, including all aspects of pollution, prevention and remediation. Klif has the authority and main responsibility for the remaining activities and industries.

In 2000, the Norwegian government launched new environmental targets for contaminated sites. A large national mapping, assessment and remediation project was launched and funded with the aim to map 600 significantly polluted sites in Norway and to divide these in A- and B-listed sites. Problems at the former sites needed to be solved, e.g. by remediation, by 2005, and for the latter the environmental status and need for further action should be mapped. The objectives were all achieved by the year 2005 and some of the list B sites

were even remediated. Most of the cost of the 2005-plan was covered by non-public stakeholders, e.g. polluter or land-owner. In total, 800-900 million NOK have been used by these stakeholders in a 5 year period. Generally, it has been easier to obtain consensus with stakeholders about the need for assessment/mapping than actual remediation. Nevertheless, very few cases have been taken to court so far, most likely due to the fact that the Pollution Act specifies that any owner of contaminated land in principle can be held responsible according to the Act. In case of negotiations with stakeholders, these have focused on e.g. joint public-stakeholder effort and/or an expanded time frame for remediation. The few court cases have mostly been due to a claim of disproportion between cost and benefit. In these cases, it is up to the land-owner or polluter, and not the authorities, to justify that the environmental effects are absent or minimal. In other words, in cases where the authorities can justify, based on reasonable documentation, a potential hazard from a polluted site, they can legally require the stakeholder to investigate and, prospectively, clean up the site. Risk of spreading of contaminants to e.g. adjacent fresh or marine ecosystems should also be prevented according to the Pollution Act.

2.2 Risk Assessment Framework

The risk assessment of contaminated soils in Norway is primarily based on the use of generic quality objectives or soil screening values (SSV), in Norwegian: "Norm-values". The SSV for the most sensitive land-use are based on the lowest of the SSV for human health and ecosystem health (soils, sediment and water). The Norm-values are a first tier assessment, and exceeding these is solely an indication that further work is needed in order to derive a more site specific risk assessment. In the national selection of substances with Norm-values, the WFD has played a role, but additional substances are included on the list as well, according to the national list of prioritised potentially hazardous substances.

In order to avoid large regional differences and differences between various consultancies in their use of e.g. operational targets like accept criteria, a set of fixed classes of environmental state (CES) (***in Norwegian: Tilstandsklasse***) has been defined. Five classes have been identified as listed in the Table 2.1 below.

Table 2.1. The five classes of environmental states (Tilstandsklasser) as defined in Norway.

Class of env. state	Description of state	Upper limit
1	Very good	Norm value[4]
2	Good	Human health accept criteria
3	Moderate	Human health accept criteria
4	Bad	Human health accept criteria
5	Very bad	Level of contamination where soil is considered as hazardous waste

[4] Examples of Norwegian Normvalues and hazadous waste limits are presented in Annex A. the Normvalues are based on as well human health as ecotoxicological aspects.

The various human health based accept criteria are calculated on the basis of risk assessment tools developed by Klif. The specific models and calculations are not presented in this report. Examples of the five CES are presented for a set of heavy metals in Table 2.2 below.

Table .2.2. The five Norwegian classes of environmental state (CES) (Tilstandsklasser) for a set of heavy metals

Environmental state/Substance (mg/kg)	CES 1	CES 2	CES 3	CES 4	CES 5
	Very good	Good	Moderate	Poor	Very poor
Arsenic	<8	8-20	20-50	50-600	600-1000
Lead	<60	60-100	100-300	300-700	700-2500
Cadmium	<1.5	1.5-10	10-15	15-30	30-1000
Mercury	<1	0-1	1-4	4-10	10-1000
Copper	<100	100-200	200-1000	1000-8500	8500-25000
Zink	<200	200-500	500-1000	1000-5000	5000-25000
Chrome (III)	<50	50-200	200-500	500-2800	2800-25000
Chrome (VI)	<2	2-5	5-20	20-80	80-1000
Nickel	<60	60-135	135-200	200-1200	1200-2500
PCB_7	<0.01	0.01-0.5	0.5-1	1-5	5-50

The risk assessment is scheduled in a tiered three step approach starting with an initial desk-top study, followed by a first investigation and ending with a main and final investigation. The outcome of the first investigation depends on whether the CES is acceptable for that specific land-use and soil depth. As mentioned above, the acceptable CES depends on the land-use and soil depth. In residential areas and kindergartens, the risk assessment can only stop at Step II in cases where the CES is two or lower in the top soil (1 meter) or three or lower in the sub-soil (> 1 meter). Approximately the same conditions are in operation for agricultural and nature sites, whereas the limit for further action is, generally, one CES higher for urban and industrial areas. In the (final) step three of the tiered risk assessment framework, the following general rules can be applied: 1) in cases where CES is four, site-specific risk of dispersion of contaminants has to be included and 2) in cases where the CES is between 4 and 5, the site-specific risk of dispersion of contaminants and the risk to human health has to be conducted. If the soil contamination exceeds the criteria for CES-5, the soil has in all cases to be removed and treated as hazardous waste.

Ecological risk assessment is only conducted in cases where the norm-value is exceed and there is a sensitive ecosystem located on the site or at nearby adjacent waters. The Pollution Act specifically states that dispersion of contamination should be prevented.

Contamination of e.g. sediment, lake and river ecosystems, are important issues when attempting to prevent future pollution, e.g. in authorisation of new dump sites, and when handling historically contaminated sites. Prevention of dispersion to for example WFD areas is, therefore, frequently prioritised in the allocation of funding and initiation of remediation activities. It is, therefore, generally a high priority to assess and prevent dispersion to e.g. marine or fresh water systems. Norway (Klif) has developed models and risk assessment methods for dispersion and risk to aquatic and sediment ecosystems. In cases where the contaminated site disperses a complex set of hazardous substances, a site specific risk assessment of the pore water has to be conducted through ecotoxicological tests with the undiluted pore- or ground water.

Currently, no national framework exists on how to conduct risk assessment of the terrestrial ecosystems and the risk assessment is, generally, conducted on a case-by-case basis. In a few cases, site-specific risk to soil ecosystems has been evaluated e.g. through the use of various bioassays. The studies were used to identify the remediation targets.

The terrestrial habitats are regulated by the Directorate of Nature Conservation. No formal initiative to combine the maps of contaminated sites and the areas of nature conservation has been made. Hence, there are no official statistics of the frequency of habitats being located on or in the vicinity of contaminated areas. Nevertheless, the local authorities have access to this information, and it is part of the checklist in the mapping and description of contaminated sites to consider whether sensitive ecosystems are located on the site or within the distance of dispersion.

2.3 Soil Remediation

The Ministry of Environment provides an annual sum of money (in 2009 150.000.000 NOK) to finance investigations and remediation activities at contaminated sites that were polluted before the Pollution Act came into force or where the responsible entity has no or limited capability of funding the necessary activities. The funding is mainly allocated to remediation of contaminated sediments and secondarily contaminated soils, and to prevent pollution from “stranded” old abandoned fishing boats from e.g. Russia left on Norwegian territory.

The contaminated sites are registered in a dynamic and continuously developed national database. Contaminated sites have been mapped over the past years, and the database currently holds approximately 3000 sites. The current estimate of the final number of sites in Norway is approximately 4000. The identification of sites is based on systematic mapping of specific activities or industries (e.g. wood preserving sites, dump sites, airports and shipyards) as well as local county-based inventories. The latter are less stringent and most likely do not have complete coverage. Some industries/activities are not included in the data-base yet, of these gas- and petrol stations most likely are the most dominant in number of potentially contaminated sites not currently included in the inventories and mapping.

The GIS maps covering the contaminated sites can be accessed from the internet (www.klif.no/grunn/). The maps contain information such as name, number, location, county and type of site/activity, e.g. dump sites, shipyards and gas stations. Furthermore, coloured pictograms on the map indicate the level of contamination ranged as 01, 02, 03 and X. The definitions of these are: 01. Site remediated. 02. Contamination has been identified but not reme-

diated. No or limited conflict with current land-use and/or adjacent aquaculture. 03. Conflict with current land-use. X = Insufficient information. Conflict can be identified on the basis of national environmental quality objectives for soil, sediment or water. The Norwegian quality objectives are, as mentioned above, land-use dependent.

Finally, the maps and the database contain information on a more detailed search and information level about for example:

- The size and coordinates of the area,
- A complete list of investigations and case-specific documents with references to the unique case-numbers and documents
- The indentified contaminants and whether they have been verified by analytical means
- Indication of whether the contamination has been removed by remedial actions
- The case-specific historic legal actions and references to the used national or international legislation
- Indication of whether the site is covered by the national target of assessing and remediating 600 sites before 2005 (see below)
- Whether the case is closed or still open.

3 Sweden

3.1 Legal background

The Swedish Parliament (Riksdag) has adopted environmental quality objectives in 16 areas. The objectives define the quality and state of Sweden's environment and of its natural and cultural resources that are sustainable in the long term. Each year the Environmental Objectives Council reports to the Government on the progress that has been made towards the environmental objectives. The 16 environmental quality objectives are defined in general terms. They are fleshed out by interim targets, of which there are currently 72. The interim targets refine the focus and time frame of the general objectives. Below, the two interim targets most relevant for contaminated land are listed:

> Studies will have been carried out and, where necessary, appropriate action will have been taken by the end of 2010 at all contaminated sites that pose an acute risk for direct exposure, and at contaminated sites that threaten important water sources or valuable natural environments, today or in the near future.
>
> Between 2005 and 2010, measures will be implemented at a sufficiently large portion of the prioritized contaminated sites to ensure that the environmental problem as a whole can be solved by 2050 at the latest.

To support these overall objectives and targets, a wide set of regulations are in place. Below is a short presentation of the legal framework associated with risk assessment of contaminated sites.

3.2 Risk Assessment Framework

Prior to an actual risk assessment, the Swedish Environmental Protection Agency (SEPA) (Naturvårdsverket) has listed a series of four different industrial branches-classes as a starting point for further evaluation. The branch-class one and two (smelters, gas-stations, dump-sites, wood preserving sites etc.) must automatically undertake a desk-top based ***risk classification*** as the first level of the risk assessment procedure. The various levels of the risk assessment include[5]:

1. Risk classification,
2. Basic risk assessment,
3. Comprehensive risk assessment.

[5] Naturvådsverket. Introduction to a method. For envetories and risk classification of contaminated sites. : ISBN 91-620-8093-8

For all three levels, a combined evaluation is done on the following four factors:

1. Contaminant hazard (depending on their chemical and physical properties)
2. Degree of contamination (concentration levels)
3. Fate and transport conditions (depending on the nature of the soil and on groundwater movements)
4. Sensitivity and protective value (risk of human exposure and its ecological value, e.g. natural conservation values on the site or in the neighbourhood)

Detailed guidelines on how to combine risk factors and collect the relevant data for risk assessments are published by the Swedish Environmental Protection[6]. The four aspects listed above are described more detailed below.

The first aspect, hazard assessment, deals with the risks that are associated with the hazardous properties of the contaminants present at the site. It is necessary to know in advance which contaminants are present. In the absence of analytical results from field studies, the hazard assessment must be based on information about activities previously conducted at the site, including any industrial processes and chemicals that may have been involved. The hazard assessment at this first level of the risk assessment could be (taking into consideration the need to always group data into four qualitative levels): a) contaminants classified as slightly hazardous or moderately harmful to health (e.g. calcium, magnesium, iron); b) contaminants classified as moderately hazardous or harmful to health or the environment (e.g. acetone, aluminium, zinc); c) contaminants classified as very hazardous or toxic (e.g. chrome, aromatic hydrocarbons, copper) or d) extremely hazardous or very toxic contaminants (e.g. mercury, arsenic, chlorobenzenes and chlorophenols).

The second aspect, contamination level, is concerned with the assessment of the severity of the effects that can be caused by the contaminant concentrations by comparing the soil concentration with generic guideline values and reference values from urban soils. Furthermore, it is necessary, in rough terms, to determine the level of every contaminant in each of the media where it is present, as well as the volume of contaminated material in order to assess the contamination level.

The third aspect, potential for contaminant migration, concerns how rapidly contaminants may be dispersed within and between various media, in concentrations and amounts that imply a risk for harmful effects. The magnitude of the risk is related to the size of the calculated or estimated migration rate. It is not necessary to determine the exact rate of migration, since that would require substantial resources. It is sufficient to carefully determine whether or not the spread of contaminants is currently in progress or likely to occur in the future and, in either case, to estimate the order of magnitude of the migration rate. The assessment is based on information about the geology and hydrology of the site and the chemical attributes of the environmental media.

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[6] Naturvådsverket, Report 5053. Methodes for Inventories of Contaminated Sites. Environmental Quality criteria. Guidance for data collection. ISBN 91-620-5053-2

The fourth aspect, sensitivity and protection value, deals with the severity of the consequences of contamination with respect to exposure of man and the environment. In order to do this, it is necessary to determine and describe the degree of exposure to which humans and the environment are currently subjected and are likely to be subjected to in the future. The level of risk is related to the sensitivity of exposed humans and to the degree of protection required for the exposed environment. The human health risk is evaluated at the individual level, which means that the risk is the same whether one or several persons are exposed. Risk to the environment is evaluated in terms of the effects on species and ecosystems. Examples of criteria for classifying the (need of) protection are given in Table 3.1.

Table 3.1. Examples of criteria for classifying the (need of) protection within the Swedish risk assessment framework.

Need of protection			
Slight	**Moderate**	**High**	**Very high**
Human Health			
A. No human exposure, e.g. small enclosed unused area	A. Slight occupational exposure. B. Groundwater not used for drinking, e.g. enclosed industrial area	A. Significant occupational exposure during work hours B. Slight exposure of children C. Ground- and/or surface water used for drinking D. Land used for crops or animal husbandry. E. Outdoor recreation area	A. Permanent residential area. B. Extensive exposure of children C. Ground- and/or surface water used for drinking
Ecosystems			
A. Heavily contaminated areas. B. Ecosystem heavily damaged by various uses and activities, e.g. landfills, spoil heap or asphalted area	A. Somewhat disturbed ecosystem B. Common ecosystem within region, e.g. typical forest or farmland	A. Relatively unusual ecosystem within region B. Exposure of individual species or ecosystems of great value, e.g. shorelines, sensitive watercourses, recreation areas and urban parks	A. Vulnerable ecosystems B. Site with individual species or ecosystems of especially great value, e.g. national parks, marine sanctuaries, and other areas in which the protection of endangered species and their habitats is considered to be of national interest

3.3 Risk Classification.

The first step in the evaluation of a potentially contaminated site is the risk or hazard classification. It functions as a tool for setting priorities and making decisions concerning additional investigations or remediation by quickly identifying areas in the country that may be most contaminated. The bases for a

risk classification are usually archive material, interviews, and visits to the area. In most cases, no samples will be taken at this level.

As mentioned above, four different aspects of the contaminated site are considered in order to make the classification, i.e. hazard assessment, contamination level, potential for migration and sensitivity/protection value. The risks associated with each of these four aspects are assigned one to four qualitative levels (slight, moderate, great and very great) as exemplified in Table 3.1. Finally, the four aspects are weighed together in a comprehensive assessment, on the basis of which the site is assigned to one of the four risk classes. Both current and future risks are evaluated – i.e. the risk associated with areas that are already contaminated, as well as the risk associated with adjacent areas which may be affected in the future due to the spread of contaminants.

The risk classification includes soil, groundwater, surface water, sediments as well as contaminated buildings. Landfills etc. are regarded as soil. As a general rule for the entire risk assessment framework, separate assessments are made for each contaminant and each of the media in which they occur.

At the end of the procedure, a comprehensive assessment and classification of the current and future risks posed by the contaminated area to human health and the environment is conducted. This is achieved by weighing together the hazard assessment, the contamination level, the potential for migration and the sensitivity and the protection value. As a result of the weighing, the site can be assigned to one of the following (risk) classes:

Class 1 – Very high hazard
Class 2 – High hazard
Class 3 – Moderate hazard
Class 4 – Low hazard

3.4 Basic Risk Assessment

Generic soil quality standards / guideline values

Step 2 in the risk assessment procedure - a basic risk assessment - is made only if risk classification, comparison with background concentrations, or other information indicates that an area is contaminated. This is the initial quantitative assessment of the contamination level, the risks as well as the need for remediation or further studies. The basic risk assessment is normally based upon a comparison of measured concentrations with generic or local guideline values in conjunction with a basic risk assessment. These guidelines indicate the contaminant concentration under which damaging effects on human beings and the environment are not expected to arise. The generic quality standards for soil (EQS for soil) developed in the middle of the1990´s and revised in 2008 are adapted to normal conditions in the contaminated area and are determined in order to provide protection to human health and the environment. The EQS for soil integrate risk to human health, risk to the terrestrial ecosystems and risk to the recipient waters and ground water via the inclusion of various transport models. Generally, the lowest value is used for the EQS. For human health, only 50% of the ADI is accepted to come from contaminated soil and/or drinking water.

Groundwater and surface water are, therefore, also protected against effects which occur as a result of the transport of contaminants. The model considers

the ground water as a source of drinking water and the ground water and surface water as a source for protection in it self separately. For organic pollutants, the EQS are based on species protection, i.e. ecotoxicological information, whereas for heavy metals the EQS are, typically, based on the background level or typical levels in uncontaminated areas. Regarding national surface water quality objectives, the SEPA has generally adopted the quality objectives from the Water Frame Directive, wherever these have been available.

Where applicable, guideline values are compared with the concentrations on the site in order to determine the degree of contamination and the need for remedial measures. For other media (e.g. groundwater, surface water and sediment), the measured concentrations are compared with other bases of assessment, such as drinking-water standards and various effect-based quality standards.

The Swedish Environmental Protection Agency has developed a model to derive guideline values for contaminated land[7]. The model is also available in the form of an Excel file, available for downloading via the homepage of the SEPA.

The generic guideline values for soil are developed taking the following into consideration:

- They are valid throughout the country and are set to protect both humans and the environment from undesirable effects. Humans are protected on the level of the individual. The environment is protected by securing the function of the land required for its intended use.
- They indicate a level which should not be exceeded to avoid the risk of undesirable effects. This does not mean, however, that a concentration above the guideline value will necessarily lead to these undesirable effects.
- They are not levels up to which it is acceptable to contaminate.
- They are to be regarded as recommendations and not legally binding values.
- They are valid for soil concentrations in locally defined areas, such as industrial premises that have been subject to contaminants from a point source. They are not intended to be environmental quality standards for large-scale impact or relevant for diffuse airborne contaminants.
- They are not synonymous with the acceptable residual concentrations to be stated in the specific requirements for a remediation project, since they do not take into account technology, economy and other general and individual interests.
- They are set in order to prevent spread of contaminants to the ground- and surface-waters that may pose a risk to human health if the groundwater is used as drinking water and have an undesirable environmental impact.
- They are applicable to soil samples that are analysed and otherwise handled in accordance with relevant methods.

[7] Naturvådsverket, rapport 5976, 2009. Riktvärden för förorenad mark. Modellbeskrivning och vägledning (In Swedish with a short English summary) . ISBN 978-91-620-5976-7

- They are calculated on the assumption that all measurable contaminants are available for migration and uptake in biota.
- They do not take into consideration the effects of interaction between contaminants.

An important part of the derivation of guideline values is the expected land use at the site. Land use determines the likely activities on the site and therefore determines which groups of people will be exposed to contaminants and to what extent exposure will occur. Land use also affects the degree to which protection of the soil environment is required on the site. The Swedish generic guideline values have, therefore, been derived for two different types of land use, ***sensitive land use*** (känslig markanvändning - KM) and ***less sensitive land use*** (mindre känslig markanvändning - MKM). Whereas the sensitive land use is defined as multiple land use with no potential restrictions, the less sensitive land use imposes certain restrictions in use, as it is limited to e.g. offices, industry of roads. Anticipated exposed people in these areas are workers potentially exposed during working hours and sensitive people (elderly and children) visiting the area only occasionally. Ground water protection is limited to a protection zone starting 200 meters from the source, whereas adjacent fresh water systems need to be protected also in the less sensitive land use areas. The assessment of health risks takes into account exposure caused by direct contact with the contaminated soil as well as indirect exposure that can occur by the transport of contaminants to air, groundwater, and plants. The final guideline value is the lowest of the values derived to protect health, soil environment, groundwater and surface water. In addition, a number of adjustments of the guideline values are made in order to avoid acute toxic effects and the occurrence of free-phase organic contaminants in soil. Finally, the guideline values are checked to ensure that they are not lower than the background concentrations, which occur naturally or which are a result of large-scale diffuse pollution.

Site specific considerations

Above is outlined how the SEPA has derived tools (EQS) to assess the risk for human health, risk to the terrestrial ecosystems, risk to the recipient waters and ground water. However, it is not compulsory to conduct a risk assessment for all of these receptors at all sites. Provided the assessor can demonstrate a sound justification that is accepted by the authorities and other stakeholders, some of the receptors can be left out of the risk assessment.

3.5 Comprehensive Risk Assessment

The purpose of Step 3 is the same as the basic assessment, i.e. to determine the degree to which a site is contaminated, and whether or not it needs to be remedied. A comprehensive risk assessment is done if no guidelines or limit values exist for the contaminants discovered, if the prerequisites for guidelines are not met, or if there is a great lack of certainty with regard to the risks. A high cost of remediation can also be a reason to do a comprehensive analysis that improves the certainty of the assessed need to reduce risk. A comprehensive assessment should always be done if it is suspected that the generic guidelines underestimate the environmental and health risks. The overall risk assessment procedures are the same as in Step 2, but compared to the basic risk assessment, local conditions are taken into greater consideration, just as the assessment is more quantitative and site-specific.

3.6 Soil Remediation

The regional counties are responsible for conducting the necessary inventories and prioritising the (remedial) intervention or other risk mitigation measures. All (potentially) contaminated sites are collected by the counties in regional databases. Furthermore, the SEPA collect and merge the databases from the 21 counties. No national GIS-based overview of the contaminated sites is currently available for the public, e.g. on the internet, although some regions have decided to show the locations on GIS based maps.

The counties are also responsible for to managing the Swedish nature reserves and other protected areas in accordance with national and EU regulations. In principle, a (GIS-based) comparison of the location of contaminated areas and protected areas would be possible, although it is not yet done on a national level. Groundwater resources as such are not regulated by the SEPA, but are regulated and managed by another national authority, The Geological Survey of Sweden.

In Sweden, approximately 80,000 potentially polluted sites exist, where there have been operations that may have caused contamination. Approximately 17.000 of these have been classified according to risk, whereas the rest have been classified according to historical or current on-site activities (industrial branches). It is estimated that there are approximately 1,400 sites where contamination may pose a major environmental and human health risk (Risk Class 1, very high risk – se more above). Further, 22,000 sites belong to Risk Class 2, high risk for environment and human health. It is a political target that the 1500 Class 1 sites all are remediated by the year 2050. It is anticipated that approximately half of these sites need governmental support.

If a party is identified as responsible for a contaminated area, then this is the liable party that implements the remediation and carries the costs regardless of the date of the pollution, as the first Swedish environmental regulation addressing this issue is from 1969. The property owner can also be held respon-

sible for remediation, even if they are not responsible for the pollution, if the property was purchased after 31 December 1998. The cost of treatment associated with exploitation is often carried by the property owner. In such cases, the latter carries out the clean up that is required, e.g. to transform a previous industrial area into a residential area.

The Swedish State can carry the costs in cases where there is no responsible party and the property was purchased before 31 December 1998. However, in order to receive a subsidy from the Swedish Environmental Protection Agency, issues of responsibility must be clarified. This is often determined through a special liability study. If it is shown that no one is currently liable, then the contaminated area can be the object of a government subsidy. The liability study may also conclude that an operator or a property owner is only partly responsible. To enable the clean up of such an area, it must be financed by several parties, for example the liable party, the state, and the municipality.

The Swedish Environmental Protection Agency (SEPA) manages the money and funds to investigate and remediate contaminated sites on a project level. A prerequisite for an agreement that is partly financed by a government subsidy is that the contaminated area is a priority area. The municipalities (local governments) apply for subsidies to their county administrative board (regional authority), who can apply to the EPA for subsidies. The subsidies cover a maximum of 90% of the costs, and the planned remedial measures must be approved first by the county administrative board. The remaining 10% of the remedial cost has to be covered by someone who is at the same time responsible for the overall economy and purchasing functions (a contractor). This function is called the remedial principal and can e.g. be a municipality, some other public authority or an urban developer.

There is a government ordinance that describes how a subsidy can be used. Each year, a regulatory letter is issued to convey government decisions as to which activities will be carried out the following year. More information regarding the use of a subsidy can appear in this context. Furthermore, the Swedish Environmental Protection Agency has published a Quality Manual that describes how subsidized remediation has to be implemented together with a description of the required results and reports. This manual also describes how the funds for the county administrative boards' supervisory work are to be managed. A subsidy can be used for:

- Inventories and investigations to find out if an area is contaminated
- Liability studies to try to identify a party that may be responsible for the contamination
- Studies needed to support the execution of remedial activities
- Remedial action
- Follow-up and evaluation of remedial action

On a national level, no quantitative overview of which priorities have been indicated in the various applications for remediation projects exist. In principle, all targets of protection should be considered, but the specific projects can, if properly motivated, exclude some of the targets of protection in the remediation objectives, e.g. ground water as drinking water or terrestrial ecosystems. Surface water and risk reduction to surface water ecosystems are, however, generally included as important elements in the remediation objectives, especially in the governmentally funded remediation projects. The SEPA has developed guidelines on how to conduct ecological risk assessment

of contaminated sites, which are about to be officially published. Among other things, these are based on a large knowledge based research programme, which was the start of Sustainable Remediation Action carried out between 2003 and 2009. The programme comprised more than 50 projects summarised in five areas: Site investigations, risk assessment, risk evaluation, risk communication and remedial measures, and several of these projects dealt with environmental risk assessment.

The size of the government subsidy for remediation has varied since it was introduced in 1999. In the recent years, it has been around SEK 500 million per year. Although no exact figure exists, it is estimated that the amount of money invested from private industries or investors is of similar size. In the period from 1999 to 2009, the national subsidies have paid for the remediation of approximately 80 sites. These are all cases, as described above, where there is no longer a responsible party to bear the cost. Within a specific remediation project, it is possible to initiate new research or try new techniques (pilot projects) if this is considered necessary in order to solve the problem, however, the main objective of the remediation is to eliminate the contamination, not to develop new techniques as such. In 2008, 70 % of the national funding was used on remediation and 12 % on inventories.

- Private operators have carried the costs of remedial measures for more than 1500 sites. Since 1999, investigations have been performed - or are in process of being performed - at approximately 500 sites with governmental means and at more than 3,000 sites with private means. All in all, this progress is well in line with the objectives established by the Swedish Government with regard to contaminated areas[8].

[8] Sweden's environmental objectives. In an interdependent world de Facto 2007. ISBN:91-620-1260-6.

4 The Netherlands

4.1 Legal Background

The statutory framework for soil policy is the Soil Protection Act (passed in 1987 and revised in 1994) and the Environmental Management Act. The point of departure of the legislation is that soil quality may not deteriorate, and where necessary the soil has to be cleaned up. Relevant legal instructions based on the Soil Protection Act include for example regulations of:

- Application and spreading of manure, sewage sludge and compost
- Discharge and dumping of liquids and solid waste materials
- Standards for building material and dredgings to be used in soil
- Harmful activities in the special Groundwater Protection Areas (ca. 400 km^2 of the country)

The main Ministries involved in soil and water management in The Netherlands are:

The Ministry of Transport, Public Works and Water Management works together with the water boards, provinces and municipalities to control and manage the quantity and quality of rivers, lakes, canals, ditches and waterways. They carry the prime responsibility for aquatic sediment and groundwater.

Dutch Ministry of Agriculture, Nature and Food Quality is responsible for the protection of ground water in agricultural areas as well as nature conservation and maintenance of biodiversity.

The Ministry of Housing, Spatial Planning and the Environment is responsible for the quality of the aquatic environment. Furthermore, they are responsible for soil policy and protection and facilitate lower tier authorities in implementing their policy, e.g. by setting up quality and emission standards for surface water, groundwater, soil and sediments.

In the Netherland, it is in principle the owner of the soil (also named ´initiator´) who is responsible for any actions needed on the site. In cases where the owner is not the polluter, the owner may try to involve the polluter, e.g. by law suites. Furthermore, national funding is available for subsidizing remediation. The level of subsidizes depends on whether it is the polluter who is the owner of the site or not (see more later).

As mentioned above, it is the ´initiator´ who is responsible for the quality of the soil. If the initiator has plans with the soil, then these plans have to be accepted by the competent authority (the local or provincial authority). The initiator could be a citizen who wants to construct a swimming pool in his garden or a product developer who wants to have a shopping centre built, but it could also be the local authority itself, which wishes to construct a housing project or a provincial authority planning a new provincial road. The initiator pays the costs of improving or cleaning up the soil.

The local authorities have a more limited role in rural areas and will, consequently, crosscheck their plans with the provincial authorities. The provincial authorities will support the local authorities that are unable to establish their soil quality. Enforcement of soil management is primarily in the hands of the supervisory authorities (the local and provincial authorities and the Inspectorate from the ministry).

With the issue of a recent Covenant (July 2009), various relevant ministries in The Netherlands announced their joint intention to remediate all so-called ***urgent sites*** involving risk to humans by the year 2015, or in any event to have the risks under control by 2015. By 31 December 2010 at the latest, a national overview of all temporary and permanent measures that have already been taken (or are planned to be taken) for each site with urgent risk to humans will be produced. For urgent locations involving other risks (ecology and risk of migration to ground water of fresh water), this overview will be completed by the end of 2015 at the latest. These overviews will only relate to ´urgent sites´ as defined in the Soil Protection Act (***Wet bodembescherming***).

According to this Covenant, the ministries will ensure that any necessary remediation shall have been completed by 2015 in all contaminated sites that require urgent remediation on account of the risks to humans, or that at a minimum temporary safety measures to adequately manage the risks should be in place at that date.

4.1.1 Contamination of fresh water and sediments

The relevant Parties shall harmonise the new soil remediation policy, including the policy on extensive groundwater contamination and contamination plumes, with the obligations arising from the Water Framework Directive and the Groundwater Directive. The relationship between soil and the Water Framework Directive and Groundwater Directive shall form part of the implementation programme, in which an incident-specific and an area-specific approach shall be regarded as equal alternatives.

Incidents of regional water bottom (sediment) contamination caused by a land-based point source on land, which need to be tackled in order to achieve the desired area quality or water quality as referred to in the Water Act, shall be tackled within five years after the urgency has been established. This needs to be done under the responsibility of the competent authority under the Soil Protection Act and in consultation with the manager under the Water Act.

Due to the near surface level of most groundwater in The Netherlands, ground water and surface waters are to some extent regulated similarly. Approximately 50% of the drinking water originates from ground water, the remaining 50 % from surface water. Drinking waters are generally treated before use.

4.2 Risk Assessment Framework

Environmental risk is evaluated by assessing the adverse effects that may occur as a result of poor environmental quality. Adverse effects can proliferate themselves in such important categories as human health, nature, food quality and water supply. The main actors in defining the risk assessment framework and its specific tools and guidelines are the RIVM (National Institute for Public Health and the Environment) and the Dutch Ministry of Environment (VROM).

4.2.1 Environmental risk limits and environmental quality standards

The derivation of environmental risk limits takes place within the process of 'International and national environmental quality standards for substances in the Netherlands' (INS), in order to facilitate environmental policy[9]. The four following ERLs are distinguished in the Netherlands: the negligible concentration (NC), the maximum permissible concentration (MPC), the serious risk concentration (SRC) and the maximum acceptable concentration for ecosystems (MAC_{eco}).

The method for deriving the MPC and MAC_{eco} for freshwater and marine water and the MPC for freshwater and marine sediment is the same as the guidance, which is part of the European Water Framework Directive (WFD)[10]. The methodology for MPC derivation for the soil compartment is based on the technical guidance document used for the European risk assessment for new and existing substances and biocides (REACH). The methodology for derivation of the remaining ERLs is based on specific Dutch procedures. These environmental risk limits (ERLs) serve as advisory values for the setting of environmental quality standards (EQSs). The Dutch Steering Committee for Substances has been appointed to set EQSs. The term EQS is used to designate all legally and non-legally binding standards that are used in Dutch environmental policy. In the Netherlands, the distinction between an ERL and an EQS is very strict. An MPC can be either a proposed value or a value that is set as an EQS when the Steering Committee for Substances decides to do so.

The environmental quality standards indicate when risks of a certain compound are considered negligible, when adverse effects may appear and at which concentration functions or species will be seriously affected. The functions and relations of ecosystem-based ERLs and EQSs are shown below in Table 4.1 where:

- NC equals Negligible Concentration
- MPC equals Maximum Permissible Concentration
- SRC_{eco} equals Serious Risk Concentration for the ecosystem

[9] P.L.A. van Vlaardingen and E.M.J. Verbruggen. 2007. Guidance for the derivation of environmental risk limits within the framework of 'International and national environmental quality standards for substances in the Netherlands' (INS). RIVM report 601782001/2007.Revision 2007

[10] Lepper P. 2005. Manual on the Methodological Framework to Derive Environmental Quality Standards for Priority Substances in accordance with Article 16 of the Water Framework Directive (2000/60/EC). Schmallenberg, Germany: Fraunhofer-Institute Molecular Biology and AppliedEcology.

Table 4.1. The functions and relations of ecosystem-based environmental risk limits (ERL) and environmental quality standards (EQS) in the Netherlands.

Description	ERL	EQS
The NC represents a concentration causing negligible effects to ecosystems. The NC is derived from MPC by dividing it by 100. This factor is applied to take into account possible combined effects.	NC (for air, water, soil, groundwater and sediment)	Target Value (for air, water, soil, groundwater and sediment)
The MPC is a concentration of a substance in air, water, soil or sediment that should protect all species in ecosystems from adverse effects of that substance. A cut-off value is set at the fifth percentile if a species sensitivity distribution of NOECs is used. This is the Hazardous Concentration for 5% of the species, the HC_5^{NOEC}	MPC (for air, water, soil, groundwater and sediment)	MPC (for air, water, and sediment)
The SRC_{eco} is a concentration of a substance in the soil, sediment or groundwater at which functions in these compartments will be seriously affected or are threatened to be negatively affected. This is assumed to occur when 50% of the species and/or 50% of the microbial and enzymatic processes are possibly affected.	SRC_{ECO} (for water, soil, groundwater and sediment)	Intervention Value (for soil, sediment and groundwater) after comparison with SRC_{HUM}

The ERLs should be expressed on the basis of Dutch characteristics, which is not directly comparable to the values used in the Water Frame Directive and the TGD for soils. The methodology for derivation of ERLs for soil and sediment makes use of the characteristics for Dutch "standard" soil, Dutch standard sediment and Dutch standard suspended matter, as they have been used in the past for ERL derivations at the Dutch national level. These characteristics are: the percentage of organic matter, which is proportional to the percentage of organic carbon, the percentage of clay, and the concentration of suspended matter in surface water. The ERL that is expressed in standard soil or sediment concentration should be recalculated to local soil or sediment conditions when a local concentration is compared with an ERL.

4.2.2 Serious Risk Concentrations (intervention value)

For deriving human-toxicological risk limits for soil, sediment and groundwater (SRC_{human}), the human-toxicological Maximal Permissible Risk (MPR) level was used in combination with the CSOIL exposure model (exposure to contaminated soil) or SEDISOIL exposure model (exposure to contaminated sediment). The ecotoxicological risk limits are based on the HC50, the concentration where 50% of the tested species and or processes in an ecosystem may encounter adverse effects, based on single-species laboratory studies. The lowest value of the SRC_{eco} and SRC_{human} is selected as the integrated SRC.

The majority of the integrated SRCs for soil and sediment are determined by ecotoxicological risks[11]. For most chlorinated aliphatic hydrocarbons, some aromatic compounds, all PCBs and dioxins in soil, the SRC_{human} is more stringent than the SRC_{eco}. For groundwater, the integrated SRCs are more often based on human risks than on ecotoxicological risks; especially the "maximum concentration in drinking water", which has turned out to be a critical parameter.

4.2.3 Tiered Risk Assessment

When soil contamination is suspected, the sites are investigated to determine whether a case of serious contamination exists. The urgency of remediation has to be determined in cases of serious contamination. This is done on the basis of a risk assessment and set of fixed set of protection target (see below). The risks are initially determined using a standard risk assessment. A generic model is used for this in which calculations for various points can be changed in line with the prevailing circumstances. As it is suitable for application in the field, this system can be used for any location in the Netherlands, barring water bottoms. The assessment is generic and errs on the safe side. In more complex situations, a more extensive risk assessment may be conducted which takes into account location-specific circumstances. Once a location-specific assessment has been made, decision-making must be based on it. The risk assessment is, as described in more detail below, carried out in the three steps. Steps 1 and 2, but not 3, are compulsory.

Step 1: Determining a case of serious contamination
The purpose of step 1 is to determine whether there is a case of serious contamination at the location. To aid this decision, soil concentrations are compared with Intervention Values (see above), which are generic soil quality standards used to classify historical soil contamination as seriously or not seriously contaminated. They are based on potential human and ecotoxicological risks. Based on this simple comparison and information about the size, location, current use of the site and existing exposure routes, a decision about urgency is made. This is determined on the basis of a detailed survey. Step 1 may lead to the following results:

- Not a case of serious or urgent contamination. If it is not a case of serious contamination, there is no need to determine whether unacceptable risks exist as a result of the contamination.
- Case of serious contamination, the assessment has to continue in Step 2, i.e. a standard risk assessment. In these cases, risk mitigation and, hence, risk assessment has to be in place within four years.

Step 2: Standard risk assessment
The purpose of step 2 is to determine whether unacceptable risks exist in the case of serious contamination. A standard risk assessment method is used to determine whether any risks are involved in the present and future use of the location that would have an unacceptable impact on humans, the ecosystem or from the point of view of the contamination spreading. Future use is determined by the initiator, but it must be within the scope provided by the land

[11] J.P.A. Lijzen, A.J. Baars, P.F. Otte, M.G.J. Rikken, F.A. Swartjes, E.M.J. Verbruggen and A.P. van Wezel. 2001. Technical evaluation of the Intervention Values for Soil/sediment and Groundwater. Human and ecotoxicological risk assessment and derivation of risk limits for soil, aquatic sediment and groundwater. RIVM report 711701 023.

use plan. The risk assessment method is generic, and parameters erring on the safe side have been chosen. The major tool in this standard risk assessment is a generic comparison of measured soil and groundwater concentrations with generic, but soil type dependent, intervention values.

Step 2 may lead to the following results:

No unacceptable risk. If it emerges from the standard risk assessment that the existing soil contamination poses no unacceptable risks in the location's present or future use, remediation need not be carried out urgently. However, a register of the limitations of the case of serious contamination is required. Moreover, the competent authority pursuant to the Soil Protection Act has discretion to determine whether management of any description is necessary.

Risk unacceptable and remediation is required urgently. If it emerges from the standard risk assessment that parts of the existing soil contamination pose an unacceptable risk in the location's present or future use, the critical parts of contamination requires remediation urgently.

Risk (apparently) unacceptable, but the assessment continues in Step 3, i.e. location-specific risk assessment. If it emerges from the standard risk assessment that all or part of the existing contamination poses unacceptable risks in the location's present or future use, there may be grounds for expecting a more specific risk assessment (Step 3) that may lead to a different conclusion. The competent authority according to the Soil Protection Act may also call for a location-specific assessment to be carried out, if it deems such an assessment is necessary for decision-making.

Step 3: Site-specific risk assessment
The purpose of Step 3 is to determine whether performing a site-specific survey would lead to a different conclusion from that of the standard risk assessment in Step 2. The result obtained in step 3 may also lead to better dimensioning of the remediation measures. It is up to the owner whether Step 3 should be initiated. It is up to the authorities, the owner and the associated consultancies to come up with site-specific risk assessment procedures. However, there are national initiatives to approve a suitable framework for site specific higher tier ecological risk assessment based on e.g. the TRIAD approach.

Step 3 may produce the following results:

No unacceptable risk. If it emerges from the site-specific risk assessment that the existing soil contamination poses no unacceptable risks in the location's present or future use, remediation need not be carried out urgently. However, a register of the limitations of the case of serious contamination is required. Moreover, the competent authority according to the Soil Protection Act has discretion to determine whether management of any description is necessary.

Risk unacceptable and remediation is required urgently. If the location-specific risk assessment leads to the same conclusion as the standard risk assessment in Step 2, it confirms that all or part of the existing soil contamination poses unacceptable risks in the location's present or future use. The parts of the case of serious contamination concerned will require remediation urgently.

4.3 Soil Remediation

A significant part of Dutch soil is polluted. Estimates put the number of sites which are in urgent need of being cleaned up at around 60,000. The clean-up operation in the Netherlands got under way in the early eighties. A review of soil clean-up policy, which was launched in 1997, meant an acceleration of the clean-up operation.

There are important rules for clean up in the form of the "Circular on target values and intervention values for soil remediation" amended in 2008, which indicates when clean up has to take place. The starting point for soil remediation in the Netherlands is that it will be carried out for all cases of serious contamination that result in unacceptable risks. The remediation criterion prescribes urgent remediation (see definition below) of at least parts of the site. If the situation gives cause, control measures may also be imposed for the remaining part of the contamination. The approach will differ from case to case. Legislation offers various options in aid of taking a flexible approach: phased remediation, partial remediation and temporary safety measures.

The soil remediation circular has the character of a directive and relates to historical cases of soil contamination (a duty of care has applied since 1987), but does not concern water bottoms. The remediation in the Netherlands operates within the definition of serious and urgent contamination given in the Soil Protection Act.

A case of serious contamination is deemed to exist if 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. There may in specific situations be a case of serious contamination in some cases, even though the intervention value has not been exceeded. If a location's soil is contaminated, but it is not a case of serious contamination, there is no need to determine whether remediation is an urgent matter, as improving soil quality cannot be prescribed on the grounds of the rules for soil remediation. This is because no risk or potential risk exists that would justify any such obligation.

If a case of serious contamination is determined, a potential risk exists that requires a form of remediation or management. The Soil Protection Act is concerned with determining whether the risk is such that urgent remediation is required owing to the present or future use of the soil (land use). The risks that could be a reason for urgent remediation are divided into:

a) Unacceptable risks for humans,
b) Unacceptable risks for the ecosystem,
c) Unacceptable risks of the contamination spreading to the surrounding area.

A case of **unacceptable risks for humans** and, hence, need of urgent remediation is deemed to exist if the location's present or intended use results in a situation in which:

- Chronic adverse impacts on health may occur;
- Acute adverse impacts on health may occur.

- Nuisance for humans (e.g. skin irritation and smells) can be demonstrated.

A case of **unacceptable risks for the ecosystem** is deemed to exist if the location's present or intended use means that:

- Biodiversity may be harmed (protection of species);
- Recycling functions may be disturbed (protection of processes);
- Bioaccumulation and biomagnification could occur.

A case of unacceptable risk of the **contamination spreading** to the surrounding area is deemed to exist in the following situations:

- The ecosystem or the soil's use by humans is jeopardised by contamination spreading through the groundwater and, thereby, presenting a nuisance to susceptible objects;
- An uncontrollable situation exists, for example:
  - there is a layer of floating groundwater contamination, which could be moved by activities and processes in the soil, which would result in the contamination spreading;
  - there is a layer of sinking groundwater contamination, which could be moved by activities and processes in the soil, which would result in the contamination spreading;
  - spreading contamination has resulted in major groundwater contamination and the contamination continues to spread.

The situations above outline the potential requirements that could trigger an urgent remediation However, it is also clear from the Soil Act that remediation – or risk mitigation, does not necessarily impose a remediation of the entire site. The Soil Protection Act is primarily concerned with removing the risks in a timely and flexible manner, which takes into account the situation/financial circumstances of the party obliged to carry out remediation operations. It should be clear from the „severity and urgency" decision which part of the case of serious contamination presents unacceptable risks and requires urgent and speedy remediation, and which part can be left for potential future action. For the non-remediated parts of a seriously contaminated site, long term control measures may be imposed. For example, monitoring of the potential groundwater contamination may be advisable. The Duty of Care principle in the Soil Protection Act outlines the need of owners to remediate all sites polluted after 1987 to the level of the soil Target Values. For sites polluted before 1987, the target of remediation depends on the future land use, i.e. this may be higher than the Target Values, as these are set for multi-functionality of soils.

This Soil Remediation Circular focuses on the shape given to the remediation criterion used to determine whether urgent remediation is necessary. The circular includes groundwater target values and a set of revised intervention values for soil and groundwater. Soil target values are published elsewhere[12], as these were not revised in 2008.

[12] NOBO: report on standardisation and soil quality assessment. Underpinning and policy-based choices for the soil standards in 2005, 2006, and 2007 (Ministry of Housing, Spatial Planning and the Environment, 2008)

Financing

The funding of soil remediation is regulated on the basis of the Soil Protection Act. In the Covenant on soil development policy and strategy for urgent sites from July 2009, an amount of approximately €893 million has been set aside in the current VROM budget in the programme period from 1 January 2010 to 31 December 2014. This amount covers research into soil contamination and remediation of severely contaminated sites. Furthermore, at least € 44 million is earmarked for the implementation of regional water bottom remediation. National subsidies are only allocated in cases where the pollution took place prior to 1987. In later cases, the polluter and/or the owner have to mitigate the risk at their own cost. In cases where the pollution occurred before 1987, a relatively higher degree of national subsidies can be obtained, in cases before 1975. In any case, no more than 60% of the total cost can be subsidized.

The Netherlands has 42 local competent authorities regarding soil contamination remediation activities. A competent authority is not necessarily the same as a local municipality, as some of these are too small. It is these competent authorities who apply for subsidies within the national funding scheme at the VROM. The local authorities will normally also look upon alternatives to remediation in their risk mitigation process, e.g. by spatial planning initiatives, sealing or other risk reduction measures.

5 England

5.1 Legal background

The contaminated land regime, which is set out in Part 2A (the contaminated land part) of the Environmental Protection Act 1990[13], was introduced in England on 1 April 2000 and on 15 September 2001 in Wales. A similar regime was introduced in Scotland on 14 July 2000.

Part 2A of the Environmental Protection Act 1990 is a piece of primary legislation which was introduced to provide a better way to identify and remediate contaminated land. It was introduced to identify and regulate the remediation of land, where contamination has resulted in significant harm to human health or the environment, or where there is a significant possibility of this happening. It also applies where controlled waters are, or are likely to be, polluted.

Part 2A represents the risk posed by land contamination to human health and the environment as a contaminant – pathway – receptor relationship. Each element occurs independently, but when occurring together they represent a risk:

> **Contaminant** – a substance that is in, on or under the land and has the potential to cause harm to human health or the environment, or to cause pollution of controlled waters.
> **Receptor** – in general terms, something that could be adversely impacted by a contaminant, including people, property, wildlife and water bodies.
> **Pathway** – a route or means by which a receptor could be exposed to a contaminant.

When dealing with land affected by contamination, the contaminant – pathway – receptor relationship is called a pollutant linkage. However, not all pollutant linkages identified from land contamination will result in significant harm or a significant possibility of significant harm. Nor will they cause or be likely to cause pollution of controlled waters. A significant pollutant linkage meets the statutory definitions for significant harm or pollution of controlled waters. It also forms the basis for a determination that an area of land is to be defined as contaminated land under Part 2A. It is the local authorities who have the responsibility of identifying, listing and handling contaminated areas in England.

As underlined above, another key issue in this context is the wording “significant harm”, “significant possibility” and “likely”. More specifically, under section 78A (2) of Part 2A of the Environmental Protection Act (1990), contaminated land is defined as:

[13] http://www.legislation.gov.uk/ukpga/1990/43/contents

Any land which appears to the local authority in whose area the land is situated to be in such a condition, by reason of substances in, on or under the land, that:

a. significant harm is being caused or there is a significant possibility of such harm being caused; or
b. pollution of controlled waters is being, or is likely to be, caused.

"Harm" is defined as: "harm to the health of living organisms or other interference with the ecological systems of which they form part, and in the case of man, includes harm to his property.

Further guidance on the definition of contaminated land is given in the publication ***Guidance on the Legal Definition of Contaminated Land*** issued by The Department for Environment, Food and Rural Affairs Defra), a Governmental Department in the UK (www.defra.gov.uk).

Despite the novel contaminated land regime to deal with historical contamination (Part IIA), it is anticipated that many contaminated sites will continue to be dealt with under the planning system. A key difference between the planning system and Part IIA, is that Part IIA deals with the contamination risk from a site in its current use, whereas the planning system requires that the proposed use is (re)considered. Therefore, the remediation requirements under the planning system can be wider than under Part IIA. Where remediation is carried out under the planning system, the site must be is in such a condition that it would still not meet the definition of contaminated land under Part IIA.

5.1.1 Main actors in the handling of contaminated sites

The contaminated land regime is jointly regulated by local authorities and Governmental authorities. Local planning authorities are responsible for ensuring that land contamination is dealt with through the planning system and that remediation takes place where it is required. The Environment Agency (EA) furthermore is responsible for protecting the water environment under a number of regimes. Through the Town and Country Planning system, a planning authority may consult EA where there may be a risk that pollution of 'controlled waters' may occur or may have occurred in the past (controlled waters are coastal waters, inland fresh waters and ground waters). The various roles are described in slightly more detail below:

Local Authorities: Local authorities are the principal regulators under contaminated land legislation. They produce strategies to identify potential contaminated land in their areas and they are responsible for deciding whether land is "contaminated land", as defined by the law. Once land is identified as contaminated land, they also have primary responsibility for ensuring that remediation takes place and for deciding who should be liable for the costs. Local authorities tend to liaise closely with the Environment Agency, particularly when sites may qualify as "special sites".

Defra: the Department for Environment, Food and Rural Affairs oversees contaminated land legislation (Part 2A of the Environmental Protection Act) and policy associated with it (e.g. negotiation of the proposed EU Soil Framework Directive). Defra also runs the Contami-

nated Land Capital Project Programme, which assists local authorities in investigating and remediating contaminated land.

CLG: The Department for Communities and Local Government oversees the planning system, including how land contamination should be dealt with under Planning Policy Statement 23. CLG also oversees policy on the development of brownfield land (e.g. in pursuit of the Government's housing targets).

Environment Agency: The Environment Agency has two main roles: 1) The Agency is the Government's principal scientific and technical advisor on contaminated land. In this capacity, the Agency has produced government-backed non-statutory technical guidance on various aspects of contaminated land. The Agency also assesses applications made under Defra's Contaminated Land Capital Projects Programme; 2) The Agency is the regulator of "special sites" under the Part 2A regime.

Health Protection Agency: The HPA is the Government's principal scientific and technical adviser on health effects of toxic substances. It works closely with the Environment Agency and the Food Standards Agency on producing technical guidance on contaminated land (as it relates to human health). The HPA also provides advice to local authorities in relation to specific cases of land contamination.

Natural England: Natural England is a non-departmental government body which aims to help conserve and enhance England's natural environment. It can provide advice on the impacts of land contamination on biodiversity and the natural environment and it works closely with the Environment Agency to provide guidance on these matters.

5.2 Risk Assessment Framework

5.2.1 Assessment of risk to ecosystems

In 1999, the Environment Agency and Defra initiated the development of an ecological risk assessment (ERA) framework for use in land quality assessments, as a number of regulatory regimes now require an ERA to be carried out. All these regimes are concerned, in one way or another, with assessing the risk of significant harm to an organism, an animal or a whole ecosystem. The EA carried out a public consultation on the framework for ecological risk assessment from December 2003 until February 2004 and work with industry to test the framework on real situations. The framework consists of a three-tiered risk assessment process (Fig. 5.1):

- Tier 1 of the risk assessment is a screening step based on a comparison of chemical analyses of site soils with a soil screening value (SSV) for the contaminants of potential concern.
- Tier 2 uses a choice of tools (ecological surveys and biological testing) to gather evidence for any harm to ecological receptors (plant and animal species) present at the site.
- Tier 3 seeks to attribute the harm to the chemical contamination.

The three Tiers in the risk assessment are, however, preceded by a desk study that reviews information about the site and nature of the contamination to

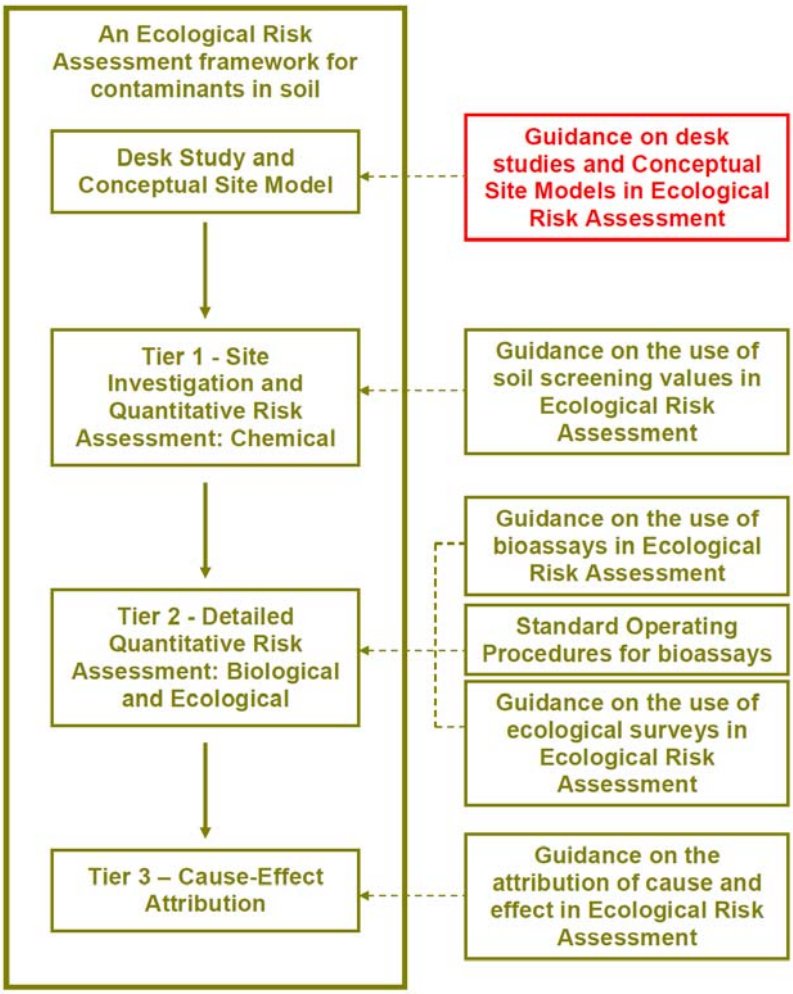
assess whether pollutant linkages are feasible. As a part of the initial desk study, a conceptual site model (CSM) has to be developed. A CSM is defined by the Environment Agency as: ***'a representation of the characteristics of the site in diagrammatic or written form that shows the*** possible relationships between contaminants, pathways and receptors'. A CSM is developed based on the information on potential sources, pathways and receptors gathered by the desk study. It is refined during any subsequent stages of risk assessment, as more information on potential pollutant linkages becomes available. The CSM helps to determine the way in which subsequent stages of risk assessment are completed and ensure each relevant potential pollutant linkage is followed up. A CSM used as part of an ecological risk assessment needs to: 1) incorporate the ecological information gathered during the documentary review (i.e. during the desk study); 2) represent this information in a way that best illustrates the possible relationship(s) between the potential source(s), pathway(s) and ecological receptor(s).

The ERA framework is supported by six guidance documents[14] covering the activities that can be employed at each of the tiers. Guidance is given on:

- Desk studies and Conceptual Site Models (ERA 2a)
- Use of soil screening values (ERA 2b)
- Use of bioassays (ERA 2c)
- Use of ecological surveys (ERA 2d)
- Attribution of cause and effect (ERA 2e)
- Standard Operating Procedures (SOPs) for bioassays (ERA 3).

[14] Science Report: SC070009/SR1. An ecological risk assessment framework for contaminants in soil ISBN: 978-1- 84432- 939- 7 October 2008.
Science Report: SC070009/SR2a Guidance on desk studies and conceptual site models in ecological risk assessment. ISBN: 978-1- 84432- 946- 5 October 2008
Science Report: SC070009/SR2c. Guidance on the use of bioassays in ecological risk assessment. ISBN: 978-1- 84432-948- 9 October 2008
Science Report: SC070009/SR2d. Guidance on the use of ecological surveys in ecological risk assessment. ISBN: 978-1- 84432- 951- 9 October 2008
Science Report: SC070009/SR2e. Guidance on the attribution of cause and effect in ecological risk assessment. ISBN: 978-1- 84432- 949- 6 October 2008
Science Report: SC070009/SR3. Standard Operating Procedures for bioassays. (Available to laboratories on request)

Figure 5.1. The overall framework for ecological risk assessment of contaminants in soil within the UK.



Identification of potentially contaminated ecosystems and ecological harm

As mentioned above, “ecological harm” is defined as: “harm to the health of living organisms or other interference with the ecological systems”. In more detail, ’Ecological harm’ within Part 2A is confined to specified receptors, as set out in the Statutory. In summary, these are any ecological system, or living organism forming part of such a system, within a location which is:

- A site of special scientific interest (SSSI) notified under section 28 of the Wildlife and Countryside Act 1981;
- A national nature reserve (declared under section 35 of the above act);
- A marine nature reserve (designated under section 36 of the above act);
- An area of special protection for birds (under section 3 of the above act);
- Any habitat or site afforded policy protection under paragraph 6 of Planning Policy Statement (PPS 9) on nature conservation;
- Any nature reserve established under section 21 of the National Parks and Access to the Countryside Act 1949;

- Any European site within the meaning of regulation 10 of the Conservation Regulations 1994 (Natural habitats etc.);
- Any candidate Special Areas of Conservation or potential Special Areas of Conservation given equivalent protection.

The actual list of sites based on the criteria listed above is elaborated and designated by national institutions like Natural England or local Wilde Life Trust or international institution like EU (e.g. Habitat Directive) and UN (e.g. World Heritage sites). This has the implication that ecological risk under Part 2A is only considered and evaluated at these pre-designated areas, i.e. ecological risk assessment with a lower level of protection at non-designated areas is not considered under Part 2A. However, in principle (although probably very rarely in reality), ERA could be conducted under other non-specified contaminated land regimes than Part 2A.

When considering the radius of the area to be covered by a desk study and CSM, risk assessors should take into account the potential site-specific contaminant–pathway–receptor linkages (pollutant linkages) rather than a fixed one. In most cases, 1-2 km will be sufficient to cover relevant potential pathways, but this may be extended up to 5 km where contaminants are likely to travel along pathways of little resistance. Risk assessors should, in any case, keep their decisions about the search radius under review and, where necessary, revise them in light of any further information that becomes available. Such information includes behaviour of contaminants of potential concern, including the potential for pathways to be present between contaminants and receptors. Such a pathway between potential receptors and the contamination may also include situations where the receptors use the contaminated locality for hunting / foraging.

In some instances, the area of potentially contaminated land may be coincident with a protected location, such as an old industrial facility within a large SSSI. In such cases, it may be evident to the risk assessor at an early point in the desk study and CSM process that there is a reasonable possibility of pollutant linkages to ecological receptors. The area to be covered by the risk assessment can, therefore, be established with some degree of confidence. In other cases, the nearest protected location may be further away, and the risk assessor may need to gather the other components of the documentary review (e.g. information on geology, hydrogeology, hydrology, possible contaminants, etc.) before being able to establish whether there is a reasonable possibility of pollutant linkages to ecological receptors.

Receptors and pathways of potential concern

Whenever it has been established that a link (pathway) between a protected location and a source of contamination exists, the next step is to identify, through consultation with the appropriate nature conservation organisation, which of the ecological systems or living organisms forming part of those systems within the protected location should constitute ´Receptors of Potential Concern´.

The Receptors of Potential Concern should be related to the functioning of the ecological system(s) within the protected location(s), to species of special interest within the protected location(s) or to those factors that affect the favourable conservation status of natural habitats at the protected location or species typically found there.

When the ´receptor of potential concern´ and the ´pathways of particular concern´[15] linking the source of contamination with the target of protection have been identified, the risk assessor needs to identify possible assessment and measurement endpoints in consultation with the appropriate nature conservation organisation and the regulator. This process involves defining the protection goals / conservation objectives, and how any impacts on them can be measured. This is necessary for subsequent tiers of risk. At this early stage of the process, the pathway does not need to be quantified, but rather made likely by imposing a line-of-evidence approach. Similarly, it has to be justified why to exclude a pathway and/or a receptor from the risk assessment.

In general, the decision trail and the line-of-evidence evaluations in the risk assessment procedure needs to be fully visible and agreed upon by stakeholders in the process before exiting or continuing the risk assessment and contaminated land management.

Assessment and measurement endpoints

An assessment endpoint is ***'an explicit expression of the environmental resource that is to be protected. It is defined operationally in structural terms (e.g. a population of a particular species) or functionally (e.g. supporting processes that are typical of a particular habitat).'*** In reality, it is rarely possible to carry out experimental analysis of species defined as assessment endpoints, because it is likely these species will be endangered or protected. The ERA process, therefore, uses surrogate measures, termed measurement endpoints. Measurement endpoints are ***'quantifiable indicators that relate directly to assessment endpoints, for example, viable offspring per adult female'.*** Measurement endpoints should be relevant to the assessment endpoint. If biological assays are used, then it should be possible to link the results of the assays to the functioning of the ecosystem or an organism forming part of such a system. Furthermore, measurement endpoints should be capable of determining how likely it is that harm is occurring, or will occur. If ecological surveys are used, then it should be possible to compare the outcomes to either historical data or to a similar uncontaminated site in order to assess the degree and extent of any adverse change. For the purposes of the ERA Framework, adverse change is defined as '***change in the growth, reproduction or mortality of organisms which endangers the functioning of the ecosystem, any species of special interest at that location, or the favourable conservation status of the natural habitats at that location or species typically found there***'. Where the functioning of an ecosystem is a concern, adverse change refers to significant changes in biodiversity or microbial activity/nutrient cycling etc. Where species of special interest are involved, adverse change refers to significant changes in abundance and distribution, survival and growth or reproductive success.

When the conceptual model is in place, as described in detail above, the initial site specific risk assessment can start in Tier 1 by a simple comparison of the soil concentrations with generic national soils screening values.

[15] Pathway of particular concern is defined as "One or more routes or means by, or through, which a receptor is being or could be exposed to, or affected by, a contaminant".

Soil screening values

Soil screening values (SSVs) are concentrations of chemical substances found in soils below which there are not expected to be any adverse effects on wildlife such as birds, mammals, plants and soil invertebrates, or on the microbial functioning of soils. If concentrations of a chemical are found above an SSV, this should prompt further investigation to examine whether there are any actual ecological risks. In cases where the soil concentrations are below the SSV, the assessment can stop.

The Environment Agency has used procedures set out in the European Commission's Technical Guidance Document for risk assessment to derive SSVs. However, because toxicity data for soil organisms are generally sparse, only SSVs for 12 substances commonly found at contaminated UK sites have been established to this date (Table 5.1). These are listed below. In cases where these 12 SSVs are insufficient, the assessor is requested either to consider whether alternative values agreeable to all stakeholders are available from other jurisdictions, e.g. US, Canada or The Netherlands, or move to Tier 2 of the ERA framework.

Table 5.1. List of Soil Screening Values (SSV) as published by the Environment Agency, UK[+]

Substance	Proposed SSV (mg/kg)	Basis for derivation
Benzo(a)pyrene	0.15[#]	AF of 10 on earthworm data
Cadmium[1]	1.15 (0.09[†])	SSD approach and an AF of 2
Chromium	21.1	SSD approach and an AF of 1
Copper[2]	88.4 (57.8)[*]	SSD approach and an AF of 1
Lead[3]	167.9	SSD approach and an AF of 2
Mercury	0.06	AF of 10 on springtail data
Nickel[4]	25.1 (20.3)[*]	SSD approach and an AF of 2
Pentachlorobenzene	0.0296[#]	Secondary poisoning value based on mammal data and an AF of 30
Pentachlorophenol	0.6[#]	SSD approach and an AF of 1
Tetrachloroethene[5]	0.01[#]	AF of 10 on microbial nitrification data
Toluene[6]	0.3[#]	AF of 50 on earthworm data
Zinc[7]	90.1 (72.5)[*]	SSD approach and an AF of 2

[+] Science Report: SC070009/SR2b. Guidance on the use of soil screening values in ecological risk assessment ISBN: 978-1- 84432-952- 6 October 2008

These SSVs were established for soil with 2% organic carbon) equating to 3.5% organic matter, assuming the latter contains 58% carbon). Therefore, the PÅEC should be normalised according to the percentage of organic matter in the soil under assessment.

[†] The secondary poisoning SSV is based on renal thresholds of terrestrial mammals. The value in brackets should be used where secondary poisoning is suspected.

[*] The generic SSV are insufficiently protective for certain soils and should b e adjusted to the site-specific conditions. The values in brackets are specific for a sandier soil with a pH of 6.5, an organic matter content of 2% and a clay content of 10%.

5.3 Remediation of contaminated sites

Responsible parties in contaminated land management

Local authorities are responsible for determining land that meets the definition of contaminated land under Part 2A. They make decisions to determine

sites based on appropriate, scientific and technical assessments of the land, using all relevant and available evidence, but typically the initial list of contaminated sites are based on historical data, maps etc. Local authorities keep records of determinations, including the exact area of land determined, the significant pollutant linkages on which the determination is based, and a summary of evidence and assessments used to make determinations. They identify interested persons, i.e. the owner of the land, anyone who occupies all, or part, of the land and anyone who may be responsible for remediating the site, and notify them that the site has been determined as ***contaminated land***. The person(s) who may be responsible for remediating the site is named an ´appropriate person´. An appropriate person, under Part 2A, is someone who is responsible for carrying out the remediation at a determined contaminated land site. There may be more than one appropriate person on any determined site. If this is the case, a number of individuals or a group of appropriate persons may share liability for remediation. There are two classes of appropriate person:

Class A: those persons who caused or knowingly permitted the pollutant in the significant pollutant linkage to be in, on or under the land.

Class B: a current land owner or occupier – but would only be liable if a Class A appropriate person cannot be found for a particular significant pollutant linkage.

In dealing with existing contaminated land, there are two main types of contaminated sites for the purposes of Government policy:

- Sites where there is a “voluntary” solution. Often, land is remediated as it is being redeveloped under the planning system, or because land owners want to increase the utility and value of their land. Wherever possible, the Government encourages voluntary remediation (as opposed to compulsory remediation under contaminated land legislation). Policy in this area is overseen primarily by the Department for Communities and Local Government (CLG).

- Sites where there is unlikely to be a voluntary solution. This includes contaminated sites, which have been developed without being cleaned-up; sites where remediation would be prohibitively expensive; and sites where the persons who polluted the land and/or the current owner is unwilling to deal with the problem voluntarily. It is mainly on these types of sites that contaminated land legislation comes into play.

While only local authorities are responsible for formally identifying ***contaminated land***, in some specific circumstances, the Environment Agency will become responsible for making sure sites are remediated. These are known as ´special sites´, under Part 2A that also meet one or more conditions set out in the Contaminated Land Regulations 2006. In England and Wales, the Environment Agency becomes the regulator for special sites once they are designated by a local authority. Special sites comprise contaminated land as defined under Part 2A that meet certain criteria. There are four main categories of special sites, and these are summarised below:

1. Water pollution – Sites where:
   drinking water supplies are affected
   water quality criteria are affected

the listed substances are affecting defined aquifers.

2. Industrial land use – Sites with:
   waste acid tar lagoons
   petroleum refineries
   explosives manufacture or processing
   authorised processes (for example Integrated Pollution Control sites, Pollution Prevention and Control sites and Environmental Permitting Regime sites)
   nuclear sites.

3. Defence
   land currently owned or occupied by the Ministry of Defence, etc.
   chemical weapons or biological agents manufacture, processing or disposal.

4. Radioactivity
   land affected by radioactivity from any substances.

In cases where contaminated land is identified - by the conceptual model for the site - as a source of pollution for adjacent freshwater or ground water systems, the actual risk assessment and risk management is not handled within the Part 2A in the Environmental Protection Act. Instead, the handling and management of the pollution is transferred to legislation, i.e. the Controlled Water Legislation, which is also regulated under the Environment Agency.

Magnitude of the problem and funding for remediation

The local authorities identify and list all contaminated areas within their borders. However, this information has not yet been – and will not in the nearest future be –compiled in a national list. Hence, no exact figure of the number of contaminated sites in England is publically available. However, a rough national survey by the Environment Agency revealed that approximately 4000 contaminated sites are located within 200 meters of one or more of the receptors defined in Part 2 A and listed above (***personal comm., EA***). This estimate is only indicative, as it is not based on validated site-specific conceptual models identifying source-pathway-receptor relationships and is, therefore, only indicative of the actual size of the problem, as site-specific conceptual models may show no linkage between the contaminated land and the protected area or may show a pathway between source and receptor of more than 200 meters.

In any case, remediation of 4000 sites by far exceeds the current available funding, for which reason a prioritisation needs to take place. It is up to the local authorities, or the EA in the cases of ´special sites´ (see above), to identify and create conceptual models for the sites where they find urgent assessment and action is needed. The Department for Environment, Food and Rural Affairs (Defra) will then prioritize the cases, typically starting with the cases where human exposure and potential risk is identified. Potential risk to ecological receptors will, typically, have lower priority than e.g. humans and buildings. Based on the priority given by Defra, the local authorities then have to take action to assess the risk. Many of the (smaller) authorities may not internally have the expertise on ecological risk assessment and may, hence, rely on consultancies and/or national institutions like EA or Natural England

for their assessment and the follow-up on the out-come of the assessment. The Environment Agency may reject specific assessments in case they deviate significantly from the imposed guidelines supporting the Part 2A of the Environmental Protection Act and published by the Agency.

Defra runs the Contaminated Land Capital Projects Programme. The funding is allocated within the overall budget for Defra allocated from the Spending Review given by the Treasury. Spending Reviews set firm and fixed three-year Departmental Expenditure Limits and through Public Service Agreements. The Contaminated Land Capital Projects Programme offers financial support to Local Authorities, including County Councils and National Park Authorities, in investigating and remediating contaminated land that falls under Part 2A of the Environmental Protection Act 1990, but only in cases where the local authorities have been unable to identify a ´responsible person´ or a ´liable party´. Over the last 10 years, the programme has funded over a thousand projects across England.

The Contaminated Land Capital Grant Programme is targeted at those sites considered to be of greatest national priority. Local Authorities receive funding for Part 2A works through their Revenue Support Grants, but investigation and remediation of contaminated land is often costly, so the Grant Programme exists as an additional source of funding for the highest risk projects. The system has two application windows each financial year, each lasting approximately six weeks.

The programme funds two types of work: 1) intrusive site investigations, which aim to find out whether a site is contaminated and, if so, to inform how it should be remediated; and 2) site remediation, which aims to ensure that contamination at a site will no longer pose a significant risk to people or the environment.

In essence, the Programme works as follows:

- A local authority applies to Defra for funding, explaining what a proposed project would involve, why it is necessary, and how much money it needs. All applications must be supported by a detailed scheme of works. This means that in most cases, the proposals will need to be paid by the project manager, or by consultants or contractors, prior to submission.

- Defra sends each application to the Environment Agency, whose assessors check the proposed project against technical merit and value for money principles, adjusting proposed work and costs if necessary. Each application is given a priority score, reflecting the risk the site poses to human health and the environment, as well as technical merit and value for money.

- Defra decides whether to pay (using priority scoring to sift bids if need be) and pays successful bids.
- The local authority does the work and reports back to Defra at quarterly intervals and on completion.

Defra and the Environment Agency use a prioritisation tool to assess the risk on contaminated sites and ensure that grant funding is targeted. The following issues will be considered in the priority score:

- Project history
- Project type
- Risk severity
- Technical merit and value for the money

In the scoring of the risk severity risks to human health will be given priority, particularly sites that include houses or other sensitive land-uses such as schools and allotments. The sensitivity of the receptors, the evidence of pathway-receptor linkages, the extent and nature of the contamination and the extent of human exposure to contamination will be considered. The land-use, extent of public access and footfall will also be taken into consideration on the site itself and adjoining land.

Sites that include sensitive habitats for wildlife and those posing a significant risk to principal aquifers will also be given particular consideration. The score system for risk severity is depicted below in order to give a picture of the priority of the various targets of protection, i.e. the rank of priority based on risk severity only is: Human > controlled waters > ecology > properties (Table 5.2). The score of the other three parts of the total priority score may change this ranking.

Table 5.2. The score system for risk severity as found in the prioritisation tool to assess the risk on contaminated sites and ensure grant funding launched by the Environment Agency and the Department for Environment, Food and Rural Affairs in the UK.

Humans	Low	25
	Medium	75
	High	125
	Severe	200
Controlled waters	Low	10
	Medium	25
	High	50
	Severe	100
Ecology	Low	5
	Medium	15
	High	40
	Severe	60
Property	Low	5
	Medium	10
	High	15
	Severe	25

Special consideration is given to the cases of Special Sites (see above), where the Environment Agency has its own Capital Grant Programme to fund the intrusive investigation and remediation of such sites.

It is likely that the programme will be over-subscribed, and therefore no guarantee can be given that projects will be funded. Furthermore, the programme should not be considered the only source of funding for contaminated land projects. Local authorities should make reasonable enquiries to find a liable party to pay for the remediation of a site prior to making an application for a grant under this programme. Defra and its assessors reserve the right to request evidence that such steps have been taken prior to assessing an application for remediation. If the site is considered as fulfilling the requirements for 'urgent remediation', it will be eligible even when a liable party has been identified. However, if at any time after the awarding of a grant costs are recovered from a liable party, the Local Authority must notify Defra so that those costs can be recovered by Defra.

Appendix A

Examples of Norwegian "Norm values"

Substance	Norm values (mg/kg)
Metals	
Arsenic	8
Lead	60
Cadmium	1.5
Mercury	1
Copper	100
Zinc	200
Chrome (total)	50
Chrome (VI)	2
Nickel	60
Cyanide-free	1
PCB	
Σ7PCB	0.01
Chlorinated pesticides	
Lindane	0.001
DDT	0.04
Chlorinated benzenes	
Mono-chlorobenzenes	0.03
1,2-Dichlorobenzene	0.1
1,4- Dichlorobenzene	0.07
1,2,4-Trichlorobenzene	0.05
1,2,3-Trichlorobenzene	0.01
1,3,5-Trichlorobenzene	0.01
1,2,4,5-Tetra chlorobenzene	0.05
Penta chlorobenzene	0.1
Hexa chlorobenzene	0.01
Volatile halogenated hydrocarbons	
Dichloromethane	0.06
Trichloromethane	0.02
Tricholorethene	0.1
Tetrachloride methane	0.02
Tetrachloride	0.01
1,2-Dichloroethane	0.01
1,2-Dibromoethane	0.004
1,1,1-Trichloroethane	0.1
1,1,2-Trichloroethane	0.01
Phenols and chlorinated phenols	
Phenol	0.1
Sum mono, di, tri, tetra chlrorophenol	0.1
Pentachlorophenol	0.006
PAH compounds	
Σ16PAH	2
Naphthalene	0.8

Substance	Norm values (mg/kg)
Fluorene	0.8
Fluoranthene	1
Pyrene	1
Benzo(a)pyrene	0,1
BTEX	
Benzene	0.009
Toluene	0.3
Ethylbenzene	0.2
Xylene	0.2

Summary
Information and experience on risk assessment, management and legal regulation of contaminated sites from four selected countries, Norway, Sweden, The Netherlands and England, has been compiled. The compilation of information has been through written material, i.e. reports, official web pages etc., and a targeted interview with selected persons within the relevant ministries or agencies in the selected countries. Special attention within this project has been paid to the ecological risk assessment of contaminated sites and adjacent fresh water systems.

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