National Program for Rehabilitation of Polluted Sites in India

Guidance document for assessment and remediation of contaminated sites in India

Volume II – Standards and checklists

1st Edition, March 2015




Ministry of Environment and Forests
GOVERNMENT OF INDIA

Volume II
Introduction

Introduction to Volume II of the Guidance document for assessment and remediation of contaminated sites in India

This document encloses Volume II of the Guidance document for assessment and remediation of contaminated sites in India.
In this Guidance document the technical aspects of entire process of intervention in a contaminated site, from its earliest identification to post remediation measures, is described in a sequence of fourteen distinct Steps. This set of Steps covers all activities that are performed in dealing with such a site. Wherever applicable, this Guidance document refers to these fourteen Steps. The same Steps, with identical descriptions, are also used in correlation with the non technical aspects, i.e. legal, financial and institutional, of dealing with polluted sites.

The fourteen Steps are visualised in figure II.1 below.

Figure II.1 The fourteen Steps in the site assessment and remediation process

Identification	Planning	Implementation	Post remediation
• Step 1: Identification of probably contaminated sites • Step 2: Preliminary investigation • Step 3: Notification of polluted site • Step 4: Priority list addition	• Step 5: Remediation investigation • Step 6: Remediation Design, DPR • Step 7: DPR approval and financing	• Step 8: Implementation of remediation • Step 9: Approval of remediation completion	• Step 10: Post remediation plan • Step 11: Post remediation action • Step 12: Cost recovery • Step 13: Priority list deletion • Step 14: Site reuse

This Guidance document is organised as a set of documents, arranged in three Volumes:
Volume I Methodologies and guidance
Volume II Standards and checklists
Volume III Tools and manuals

Volume I is the core of the Guidance document set. It presents guidance and instructions as to how to perform each of the fourteen Steps in the site assessment and remediation process. The correlation among the Steps is shown, to enable the user to see what happened before the Step he is involved in and what should happen after completion of that Step. Centred around a concise description of actions to perform the Step the user is involved in, the guidance details aspects for an effective performance, like data needed and where these may be found, and control

mechanisms. Wherever relevant, the guidance includes references to Volume II and III and to websites and documents. Volume I is set up in such a way that it may be used in capacity building. It also includes an introduction for aimed at decision makers.

This **Volume II** contains reference data in various forms. Engineers dealing with contaminated sites may use Volume II on a day to day basis to refer to data, standards, criteria and checklists. Every one of these is linked by a reference to one or more descriptions of Steps in Volume I. Therefore this Volume II document should be used in conjunction with the other two Volumes.

Volume III contains more extensive data like technical manuals. Examples of manuals presented in Volume III include a Site Inspection Protocol, points of attention for laboratory testing, an overview of available remediation techniques, and methods for the evaluation of remediation options. Like Volume II, Volume III is intended for day to day reference by engineers dealing with contaminated sites.

Contents of Volume II

Volume II

1-a Example petition format for identification of probably contaminated sites

Volume II-1-a
Example petition format for identification of probably contaminated sites

1 Introduction

This information is most relevant for Step 1, Identification of probably contaminated sites. During the data collection information regarding newly recognized probably contaminated sites may be partly derived from petitions, reports, complaints etc. from local or state level agencies, general public and NGOs received by the competent authority. The use of a standardised petition format will improve the completeness and quality of the information necessary for submission of a well-founded petition for which below an example petition format is provided.

2 Example petition format for identification of probably contaminated sites

Example petition format for identification of probably contaminated sites
The completed form should be delivered to the nearest office of the competent authority.

Objective of this petition
This petition provides the site details and background information related to a probably contaminated site.

Applicant Details

Name of petitioner	
Address	
Email	
Telephone number	

Site Details, (please provide a description where possible)

Relation of the petitioner to the site:
Owner of the site, tenant of the site, occupier or resident of the site or nearby site, use of the site for specific purpose, etc.

Site Location and description:
Address or coordinates. Attach a plan, sketch map / drawing with landmark information clearly identifying the site. If not possible describe the surrounding area and distance to notable landmarks, roads, rivers, etc.

Description of the landuse:
Habitation settlement/residential, agricultural land, commercial, industrial, forests, park, water body, waste land, or other (one or multiple types of landuse can be described).

Description of the signs of suspected contamination:
For example: well water that is discoloured or with bad taste or smell; unpleasant smells related to waste material or soil surface; human and animal health problems not related to general diseases or lack of food and water; damaged crops, plants or trees not to be related to lack of water or nutrients; . containers containing suspected chemical substances.

Description of substances involved:
If possible please provide a description on the substances including symbols and / or labels on containers, chemical name (common name), solid/liquid/gas form, type of smell and colour.

Description of possible cause of the contamination:
Presence of (former or existing) industry buildings, materials stockpiles, industrial process equipment, storage tanks, broken pipelines, illegal dumping etc.

Description of previous involvement of local or regional governmental agencies regarding contamination of the site (if applicable):

Date of receipt of the petition:
Reference number:

Volume II

1-b Checklist relevant data for identification of probably contaminated sites

Volume II-1-b
Checklist relevant data for identification of probably contaminated sites

1 Introduction

This information is most relevant for Step 1, Identification of probably contaminated sites. During the data review information regarding new probably contaminated sites may be partly derived from petitions, reports, complaints etc. from local, state level agencies, government agencies, general public and NGOs received by the competent authority or they may be collected by reviewing registers and plans. The data necessary for identification of probably contaminated sites are described in the below checklist.

2 Checklist relevant data for identification of probably contaminated sites

No.	Topic	Explanation	Data Provider / Source	Obligatory	Status	Comments
	Administrative elements					
1.0	State name		Provided by source	Yes		
1.2	Site name		Provided by source	Yes		
1.3	Address	Street, Street number, Postal code, City	Provided by source	Yes		
1.4.1 1.4.2 1.4.3	GPS coordinates /and elevation:	Latitude, longitude and altitude in center of the site entered as decimal	Provided by source or established based on address	Prefereably		
1.5.1 1.5.2 1.5.3	Land use	Current land use Previous land use Future land use	Provided by source or established based on address or site visit	Prefereably		
1.6.1 1.6.2 1.6.3	Owner	current owner previous owner contact with owner	Provided by source			
	Essential information for decision on step 1					
1.12	Industry type, which has caused contamination	Selection from a non-exhaustive list of industries	Provided by source and assessed according to list	At least one of item 1.12, 2.2, 2.3, 2.4 and 2.6 shall be stated		
2.2	Type of contamination according to definition from MoEF	Effluent, Air, Municipal Solid Waste, Bio-Medical Waste, Hazardous Waste, Ship Break Waste or Any other.	Provided by source and assessed according to list			
2.3	"Industrial processes" which caused the contamination	According to Schedule I – Hazardous Wastes Rules, 2008	Provided by source and assessed according to list			
2.4	Type of hazardous waste	According to Schedule I – Hazardous Wastes Rules, 2008	Provided by source and assessed according to list			
2.6	Contaminants of concern - CoC - (chemical name(s))	Multiple contaminated can be selected	Provided by source and assessed according to the chemicals listed in the Screening Levels and Response Levels			

	Useful information but not essential in step 1					
3.1	Geology at the site (is the groundwater geologically protected?)	Broad description of the typical stratigraphical sequences from topsoil to deepest acquifer	Provided by source or search on website of Central Groundwater Board, Ministry of Water Resources: http://cgwb.gov.in/	Prefereably		
3.4	Is the site within a groundwater recharge zone?	Area with drinking water interest: - Potable water supply; - Acquifer potential - Minor acquifer/Non potable water	Provided by source or search on website of Central Groundwater Board, Ministry of Water Resources: http://cgwb.gov.in/	Prefereably		
3.5.1 3.5.2	Drinking water intake; distance to nearest well and number of wells within 1 km of site	Private wells Public wells	Provided by source or search on website of Central Groundwater Board, Ministry of Water Resources: http://cgwb.gov.in/	Prefereably		
4.2	Name and distance to nearest surface water body (m)			Prefereably		
4.3	Type of Surface Water Body	Pond, Small lake, Large lake, Small river/stream, Large river, Wetland or Other		Prefereably		
4.4	Any sensitive use of surface water?	Drinking water, Irrigation, Use in commercial food production, Water recreational area, Fishing or Other		Prefereably		
4.5	Distance to Sensitive Ecological areas (m)	E.g. reserves, wetland		Prefereably		
5.2.3	Approximated Population within 1 km from the site			Prefereably		
12.1	Name of institution / source which has identified the site as 'probably contaminated'	Point out institution(s) and contact person	Provided by source	Yes		
-	Reason why the site is considered as 'probably contaminated'		Provided by source	Yes		

Explanatory Notes:
No.: the numbers relate to the topics in the database of contaminated sites
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

2.1-a Checklist prequalification for site investigation

Volume II-2.1-a
Checklist prequalification for site investigation

1 Introduction

This information is most relevant for Step 2, Preliminary investigation, and Step 5, Remediation investigation. The investigation activities is usually commissioned to an independent third party investigator, typically a specialized organization (agency, research institute, consultants, contractors and laboratories), where teams of specialists are involved in assessment and remediation projects. This checklist is also useful for Task 8.3, Execution, supervision and verification of remediation works.

The client who contracts out this assignment may be a private person, private organization or the local, State or Central authority. This checklist provides support for the client in the selection of a specialized agency. To ensure a good quality investigation, it is vital that this third party can demonstrate the expertise, skills and compliance relevant for the assignment. Where available, it is preferable if this is supported by relevant accreditations.

At the outset, it is very important that the client provides clear Terms of Reference (ToR), which should at least include the objectives of the investigation, the required output and the possible constraints. Without a clear ToR the third party may interpret the situation differently resulting in the proposed activities not leading to the required output. Furthermore, in case more than one party is requested to tender an offer, an unclear ToR can lead to differences that render a fair comparison impossible. If the client is a private organization it may be advisable to contact the competent authority for assistance.

2 Checklist for prequalification for site investigation

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main aim of the appointment	
Date of recording	
Recording official	

Prequalification criteria for selection of the specialized organization (aspects marked * may only be relevant for projects with an estimated cost threshold value of for remediation of 10.000.000 Rupee);	**Status**	**Comments**
Information about the Firm: Firm's Background and registration Financial background* such as - tax clearance by financial authority (have all taxes been paid		

during the last 3 years? - ... other examples? Type of firm – Pvt. Ltd..- Proprietary – Partnership Work experience Professional liability insurance		
Technical capability: Firm's work experience Field technique equipment Accredited laboratory (refer explanation below) Laboratory equipments Labours (skilled & unskilled) Staff experience in similar projects		
Management capability: Cost control Schedule / time Control Quality Management System* Quality assurance* Number of technical and non-technical staff Experience in social aspects regarding investigation of sites for environmental reasons.		
Past experience: Scale of projects completed Type of projects completed Experience in local area Five projects of similar type completed Time overruns in past projects* Cost overruns in past projects* Quality achieved in past project*		
Health and safety policy: Safety management system Accidents in past projects Insurance of personnel		
Use of Information Technology & Services: Project Management Software Personnel knowledge in IT / Software Level of Technology		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Accreditation Standards for Laboratory

For field work and laboratory testing quality assurance can substantially improve the quality of the deliverables. In India, for a great number of laboratory activities accreditation schemes have been implemented. It may be anticipated that in future similar schemes may be implemented for field work and for chemical analysis of soil, sediment and groundwater samples.

Accreditation is considered as the first essential step for facilitating mutual acceptance of test results and measurement data. Confidence in accreditation is obtained by a transparent system of control over the accredited laboratories and an assurance given by the accreditation body that the accredited laboratory fulfils the accreditation criteria at all times. Accredited laboratories can objectively state conformance of specified products or services to specified requirements.

The Government of India has authorized NABL as the accreditation body for testing and calibration laboratories. NABL is a registered society under the Societies Registration Act 1860. It operates as an autonomous body under the aegis of in the Department of Science and Technology (DST), Ministry of Science and Technology, Government of India. NABL has been established with the objective of providing Government, Industry Associations and Industry in general with a scheme of laboratory accreditation which involves third-party assessment of the technical competence of testing and calibration laboratories.

In the current global scenario an essential pre-requisite of trade is that any product or service accepted formally in one economy must also be free to circulate in other economies without having to undergo extensive re-testing. To ensure that this principle is upheld accreditations granted by foreign accreditation bodies are also valid in India, provided the granting body has signed the ILAC MRA (International Laboratory Accreditation Co-operation Mutual Recognition Agreement) for the relevant accreditation standard.

Preferably, the laboratory testing of samples from contaminated sites should be carried out by laboratories working under internationally recognized accreditation standards. The laboratory accreditation services to testing and calibration laboratories are provided in accordance with ISO/ IEC 17025: 2005 ‘General Requirements for the Competence of Testing and Calibration Laboratories’.

NABL Accreditation is currently given in dozens of fields and disciplines or groups. The criteria for standard laboratories for relevant fields for contaminated sites can be found in the following links:

- NABL General information brochure, NABL-100 document, 201206291037-NABL-100-doc.pdf
- NABL specific guidelines for chemical testing laboratories, NABL-103 document, 201206281205-NABL-103-doc.pdf

Volume II

2.1-b Screening and response levels

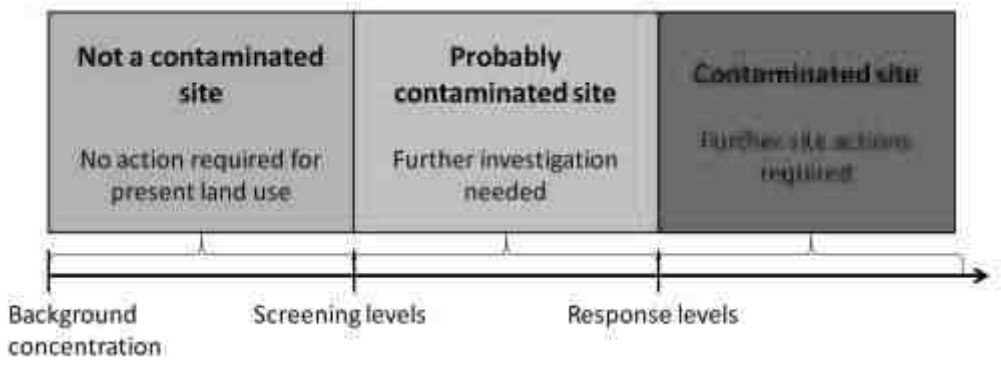
Volume II-2.1-b
Screening and Response levels

1 Introduction

This information is relevant for various Steps and Tasks in the assessment and remediation process.
Screening and Response levels are important to assess the level of contamination.

Screening levels are generic concentrations of hazardous substances in soil and sediments, groundwater and surface water at or below which potential risks to human health or the environment are not likely to occur and where no further investigation and assessment is needed. These Screening levels are distinguished for land use.

Response levels are generic concentrations of hazardous substances in soil and sediments at or above which it is very likely there is threat to human health or the environment, that may be imminent. At or above this level some form of response is required to provide an adequate level of safety to protect public health and/or the environment.



Note that that for certain contaminants such as Persistent Organic Pollutants, no background concentrations should be used, as there is no natural background for these substances.

2 Screening and Response levels

The table on next pages provides the Screening and Response levels.

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
1,1,1-Trichloroethane (TCA)	Halogenated aliphatic compounds	5000	15	0,1	5	50	50	-	-	-					-	-
1,1,2,2- Tetrachloroethene (PCE)	Halogenated aliphatic compounds	5000	8,8	0,1	0,2	0,5	0,6	-	0.03	0,04	-	-	-	-	110	-
1,1,2,2-Tetrachlorethane	Halogenated aliphatic compounds	5000		0,1	5	50	50	-			-	-	-	-	-	-
1,1,2-Trichloroethane	Halogenated aliphatic compounds	5000	10	0,1	5	50	50	-	-		-	-	-	-	-	-
1,1,2-Trichloroethene (TCE)	Halogenated aliphatic compounds	5000	2,5	0,01	0,01	0,01	0,01	-	0.005	0,02	-	-	-	-	21	-/50
1,1-Dichloroethane	Halogenated aliphatic compounds	5000	15	0,1	5	50	50	-	-		-	-	-	-	-	-
1,1-Dichloroethene	Halogenated aliphatic compounds	5000	0,3	0,1	5	50	50	-	0.014		-	-	-	-	-	-
1,2,3,4-Tetrachlorobenzene	Halogenated aromatic compounds	50	2,2	0,05	2	10	10	-	-		-	-	-	-	1,8	-
1,2,3,5-Tetrachlorobenzene	Halogenated aromatic compounds	50	2,2	0,05	2	10	10	-	-		-	-	-	-	-	-
1,2,3-Trichlorobenzene	Halogenated aromatic compounds	50	11	0,05	2	10	10	-	-		-	-	-	-	8	-
1,2,4,5-Tetrachlorobenzene	Halogenated aromatic compounds	50	2,2	0,05	2	10	10	-	-		-	-	-	-	-	-
1,2,4-Trichlorobenzene	Halogenated aromatic compounds	50	11	0,05	2	10	10	-	-		-	-	-	-	24	-
1,2-Dichlorobenzene	Halogenated aromatic compounds	50	19	0,1	1	10	10	-	-	1	-	-	-	-	0,7	-
1,2-Dichloroethane	Halogenated aliphatic compounds	5000	6,4	0,1	5	50	50	0,003	0.005	0,003	-	-	-	-	100	-/5
1,2-Dichloroethene	Halogenated aliphatic compounds	5000	1	0,1	5	50	50	-	-	0,05	-	-	-	-	-	-
1,2-Dichloropropane	Halogenated aliphatic compounds	5000	2	0,1	5	50	50	-	-	0,04	-	-	-	-	-	-
1,2-Dichloropropene (cis and trans)	Halogenated aliphatic compounds	5000		0,1	5	50	50	-	-		-	-	-	-	-	-
1,3,5-Trichlorobenzene	Halogenated aromatic compounds	50		0,05	2	10	10	-	-		-	-	-	-	-	-
1,3-Dichlorobenzene	Halogenated aromatic compounds	50		0,1	1	10	10	-	-		-	-	-	-	150	-
1,4-Dichlorobenzene	Halogenated aromatic compounds	50		0,1	1	10	10	-	0.005	0,3	-	-	-	-	26	-
1,4-Dioxane		-		-	-	-	-	-	-	0,05	-	-	-	-	-	-
2,3,4,6-Tetrachlorophenol	Halogenated aromatic compounds	50		0,05	0,5	5	5	-	0.1		-	-	-	-	-	-
2,4,6-Trichlorophenol	Halogenated aromatic compounds	50		0,05	0,5	5	5	-	0.005	0,2	-	-	-	-	-	-
2,4-Dichlorophenol	Halogenated aromatic compounds	50		0,05	0,5	5	5	-	0.9		-	-	-	-	-	-
2,4-Dichlorophenoxyacetic acid (2,4-D)	Pesticides (Phenoxy herbicide)	-		-	-	-	-	0,03	-	0,03	-	-	-	-	-	-
3-Iodo-2-propynyl butyl carbamate	Pesticides, Carbamate	-		-	-	-	-	-	-		-	-	-	-	1,9	-
Acenaphthene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤	-	-		-	-	-	-	5,8	-
Acenaphthylene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤	-	-		-	-	-	-	-	-
Acridine	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤	-	-		-	-	-	-	4,4	-
Aldicarb	Pesticides, Carbamate	-		-	-	-	-	-	0.009	0,01	-	-	-	-	1	54,9/11
Aldrin	Pesticides, Organochlorine	50	0,32	-	-	-	-	0.00003	0.0007	0,00003	-	-	-	-	0.004	-
Aliphatics nonchlorinated (each)	Non-halogenated aliphatic compounds	-		0,3	-	-	-	-	-		-	-	-	-	-	-
Aluminium	Metal	-		-	-	-	-	0.03	-		-	-	-	-	Variable	5000/5000
Ammonia (total)	Inorganic	20000		-	-	-	-	0,5	-		5			5	Table	-
Ammonia (un-ionized)	Inorganic	-		-	-	-	-		-		-	-	-	-	19	-
Aniline	Organic	-		-	-	-	-		-		-	-	-	-	2,2	-
Anthracene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	0,012	-
Antimony (metallic)	Inorganic	50	22	20	20	40	40		0.006	0,02	-	-	-	-	-	-
Arsenic	Metal	50	50 (76)!	12	12	12	12	0,01	0.01	0,01	0,2	0,2	0,2	0,2	5	100/25

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
Asbestos		5000	100	-	-	-	-		-		-	-	-	-		-
Atrazine	Pesticides, Triazine	-	0,71	-	-	-	-	0.002	0.005	0,002	-	-	-	-	1,8	10/5
Barium	Inorganic	20000	-	750	500	2000	2000	0.7	1.0	0,7	-	-	-	-	-	-
Benzene	Monocyclic aromatic compounds	50	1.1	0.05 ¤	0.5 ¤	5 ¤	5 ¤		0.005		0,01*	-	0,01*	0,01*	370	-
Benzo(a)anthracen	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	0,018	-
Benzo(a)pyrene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		0.00001		-	-	-	-	0,015	-
Benzo(b)fluoranthene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	-	-
Benzo(k)fluoranthene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	-	-
Beryllium	Inorganic	50		4	4	8	8		-		-	-	-	-	-	100/100
Boron	Inorganic	-		2	-	-	-	0,5	5.0		-	-	-	-	1.5mg/L	5000/5000
Bromacil	Pesticides	-		-	-	-	-		-		-	-	-	-	5	0,2/1100
Bromoxynil	Pesticides, Benzonitrile	-		-	-	-	-		0.005		-	-	-	-	5	0,33/11
Cadmium	Metal	50	13	1,4	10	22	22	0.003	0.005		2	1	-	2	Equation	5,1/80
Calcium	Inorganic	-		-	-	-	-	75	-		-	-	-	-	-	-/1000000
Captan	Pesticides	-		-	-	-	-		-		-	-	-	-	1,3	-/13
Carbaryl	Pesticides, Carbamate	-	0,45	-	-	-	-		-		0.01	-	0.01	0.01	0,2	-/1100
Carbofuran	Pesticides, Carbamate	-	0,017	-	-	-	-		0.09		-	-	-	-	1,8	-/45
Chlordane	Pesticides, Organochlorine	50	4	-	-	-	-		-		-	-	-	-	0.006	-/7
Chloride	Inorganic	-		-	-	-	-	250	-		-	-	-	-	or 120 mg/L	Variable/-
Chlorothalonil	Pesticides	-		-	-	-	-		-		-	-	-	-	0,18	crops)/170
Chlorpyrifos	Pesticides, Organophosphorus	5000		-	-	-	-	0,03	0.09	0,03	-	-	-	-	0,002	-/24
Chromium (total)	Metal	-	-	64	64	87	87		0.05	0,05	2	2	-	2	-	-
Chromium, hexavalent (Cr(VI))	Metal	50	50 (78)!	0,4	0,4	1,4	1,4	0.05	-		0,1	2	-	1	1	8/50
Chromium, trivalent (Cr(III))	Metal	5000	180	-	-	-	-		-		-	-	-	-	8,9	4,9/50
Chrysene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	-	-
Cobalt	Inorganic	5000	190	40	50	300	300		-		-	-	-	-	-	50/1000
Coliforms, fecal (Escherichia coli)	Biological	-		-	-	-	-		-		-	-	-	-	-	mL/-
Coliforms, total	Biological	-		-	-	-	-				-	-	-	-	-	mL
Colour	Physical	-		-	-	-	-	5 Hazen Units	-		-	-	-	-	Narrative	-
Conductivity	Physical	-		2 dS/m	2 dS/m	4 dS/m	4 dS/m		-		-	-	-	-	-	-
Copper	Metal	5000	190	63	63	91	91	0.05	-	2	3	3	-	3	Equation	Variable/variabl e
Cyanazine	Pesticides, Triazine	-		-	-	-	-		0.01	0,0006	-	-	-	-	2	0,5/10
Cyanide	Inorganic	50	50	0,9	0,9	8	8	0.05	0.2	0,07	0,2	2	0,2	0,2	5 (as free CN)	-/-
Cyanobacteria	Biological	-		-	-	-	-	-	0.0015		-	-	-	-	-	-/-
Debris	Physical	-		-	-	-	-	-	-		-	-	-	-	-	-/-
Deltamethrin	Pesticides	-		-	-	-	-	-	-		-	-	-	-	0,0004	-/2.5
Di(2-ethylhexyl) phthalate	Phthalate esters	-		-	-	-	-	-	-		-	-	-	-	16	-/-
Di-n-butyl phthalate	Phthalate esters	-		-	-	-	-	-	-		-	-	-	-	19	-/-

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
Di-n-octyl phthalate	Phthalate esters	-		-	-	-	-	-	-		-	-	-	-	-	-/-
Dibenz(a,h)anthracene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤	-	-		-	-	-	-	-	-/-
Dibromochloromethane	Halogenated methanes	5000		-	-	-	-	0.1	-		-	-	-	-	-	-/100
Dicamba	Pesticides, Aromatic Carboxylic Acid	-		-	-	-	-		-		-	-	-	-	10	0,006/122
DDT Total (Dichloro diphenyl trichloroethane; 2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane)	Pesticides, Organochlorine	50	1,7	0,7	0,7	12	12	0,001	-	0,001	10*)	-	10*)	10*)	0.001	-/30
DDD (Dichloro diphenyl dichloroethane, 2,2-Bis (p-chlorophenyl)-1,1-dichloroethane)	Pesticides, Organochlorine	50	34	-	-	-	-	0,001	-	0,001	-	-	-	-		-
DDE (Dichloro diphenyl ethylene, 1,1-Dichloro-2,2-bis(p-chlorophenyl)-ethene)	Pesticides, Organochlorine	50	2,3	-	-	-	-	0,001	-	0,001	-	-	-	-		-
DDT (Dichloro diphenyl trichloroethane; 2,2-Bis(p-chlorophenyl)-1,1,1-trichloroethane)	Pesticides, Organochlorine	50	1,7	-	-	-	-	0,001	-	0,001	-	-	-	-		-
Dichlorobromomethane	Halogenated methanes	5000		-	-	-	-	-	-		-	-	-	-	-	-/100
Dichloromethane (Methylene chloride)	Halogenated aliphatic compounds	5000	3,9	0,1	5	50	50	-	0.05	0,02	-	-	-	-	98,1	-/50
Dichlorophenols	Chlorinated phenols	50	22	0,05	0,5	5	5	-	0.9		-	-	-	-	0,2	
Diclofop-methyl	Pesticides	-		-	-	-	-	-	-		-	-	-	-	6,1	0,18/9
Didecyl dimethyl ammonium chloride	Pesticides	-		-	-	-	-	-	-		-	-	-	-	1,5	-
Dieldrin	Pesticides, Organochlorine	50	-	-	-	-	-	0.00003	-	0.00003	-	-	-	-		-
Diethylene glycol	Glycols	-		-	-	-	-	-	-		-	-	-	-	-	-
Diisopropanolamine	Organic	-		180	180	180	180	-	-		-	-	-	-	1600	2 000/-
Dimethoate	Pesticides, Organophosphorus	5000		-	-	-	-	-	-	0,006	-	-	-	-	6,2	-/3
Dinoseb	Pesticides	-		-	-	-	-	-	0.01		-	-	-	-	0,05	16/150
Dissolved gas supersaturation	Physical	-		-	-	-	-	-	-		-	-	-	-	Narrative	-
Dissolved oxygen	Inorganic	-		-	-	-	-		-		-	-	-	-	-	-
Endosulfan	Pesticides, Organochlorine	50	4	-	-	-	-	0.0004	-		10*)	-	10*)	10*)	0,003	-
Endrin	Pesticides, Organochlorine	50	-	-	-	-	-		-	0,0006	-	-	-	-	0.0023	-
Ethylbenzene	Monocyclic aromatic compounds	20000	110	0.1	5	50	50		-	0,3	-	-	-	-	90	-/2.4
Ethylene glycol	Glycols	-		960	960	960	960		-		-	-	-	-	192 000	-
Fluoranthene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	0,04	-
Fluorene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	3	-
Fluorine		5000		-	-	-	-		-		-	-	-	-		-
Fluoride	Inorganic	5000		200	400	2000	2000	1.0	1.5	1,5	2	15	-	15	120	1000/variable
Glyphosate	Pesticides, Organophosphorus	5000		-	-	-	-		0.28		-	-	-	-	800	-/280
Heptachlor	Pesticides, Organochlorine	50	4	-	-	-	-		-		-	-	-	-	0.01	-/3
Hexachlorobenzene	Halogenated aromatic compounds	50	2	0,05	2	10	10		-		-	-	-	-	-	-/0.52
Hexachlorobutadiene	Halogenated aliphatic compounds	5000		-	-	-	-		-		-	-	-	-	1,3	No data
Hexachlorocyclohexane (HCH)	Pesticides, Organochlorine	50	-	0,01	-	-	-		-		-	-	-	-	0,01	-/4

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
Hexachlorocyclohexane (alfa HCH)	Pesticides, Organochlorine	-	17	-	-	-	-		-		-	-	-	-		
Hexachlorocyclohexane (beta HCH)	Pesticides, Organochlorine	-	1,6	-	-	-	-		-		-	-	-	-		
Hexachlorocyclohexane (delta HCH)	Pesticides, Organochlorine	-		-	-	-	-		-		-	-	-	-		
Hydrazine(s)		5000							-		-	-	-	-		-
Imidacloprid		-		-	-	-	-		-		-	-	-	-	0,23	-
Indeno(1,2,3-c,d)pyrene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	No data	-
Iron	Inorganic	-		-	-	-	-	0.3			3	3	-	3	300	5000/'-
Lead	Metal	5000	530	70	140	260	600	0.01	0.01		0,1	1	-	2	Equation	200/100
Lindane (gamma HCH)	Pesticides, Organochlorine	50	1,2	-	-	-	-	0.002	-		-	-	-	-		
Linuron	Pesticides	-		-	-	-	-		-		-	-	-	-	7	0,071/-
Lithium	Inorganic	-		-	-	-	-		-		-	-	-	-	-	2500/-
Malathione	Pesticide, Organophosphorus	5000		-	-	-	-	0.19	0.19		10	-	10	10		-
Manganese	Inorganic	-		-	-	-	-	0.1			2	2	-	2	-	200/-
Mercury (inorganic)	Metal	50	36	6,6	6,6	24	50	0.001	0.001		0,01	0,01	-	0,01	0,026	-
Methoprene		-		-	-	-	-		-		-	-	-	-	Organism	-
Methyl tertiary-butyl ether (MTBE)	Aliphatic ether	-		-	-	-	-		-		-	-	-	-	10 000	-
MCPA (Methylchlorophenoxyacetic acid (4-Chloro-2-methyl phenoxy acetic acid; 2-Methyl-4-chloro phenoxy acetic acid)	Pesticides	-	4	-	-	-	-		0.1		-	-	-	-	2,6	0,025/25
Methylmercury	Organic	5000		-	-	-	-		-						0,004	-
Methylparathion	Pesticide, Organophosphorus	5000		-	-	-	-	0.0003	-		10	-	10	10		-
Metolachlor	Pesticide, Organophosphorus	50		-	-	-	-		0.05						7,8	28/50
Metribuzin	Pesticides, Triazine	-		-	-	-	-		0.08		-	-	-	-	1	0,5/80
Molybdenum	Inorganic	5000	190	5	10	40	40	0.07	.-	0,07	-	-	-	-	73	Narrative/500
Monobromomethane	Halogenated aliphatic compounds	5000		-	-	-	-		-		-	-	-	-	-	-
Monochlorobenzene	Halogenated aromatic compounds	50	15	0,1	1	10	10		0.08		-	-	-	-	1,3	-
Monochloromethane	Halogenated aliphatic compounds	5000		-	-	-	-		-		-	-	-	-	-	-
Monochlorophenols	Chlorinated phenols	50	5,4	0,05	0,5	5	5		-		-	-	-	-	7	-
Naphthalene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	1,1	-
Nickel	Metal	5000	100	50	50	50	50	0.02	-	0,07	3	3	-	5	Equation	200/1000
Nitrate	Inorganic nitrogen compounds	20000		-	-	-	-	45	45	50	10	-	-	20	13 mg/L	-
Nitrate + Nitrite	Inorganic nitrogen compounds	20000		-	-	-	-		-		-	-	-	-	-	NO3+NO2-N
Nitrite	Inorganic nitrogen compounds	5000		-	-	-	-		-	3	-	-	-	-	60 NO2-N	-/10 000 NO2-N
Nonylphenol and its ethoxylates	Nonylphenol and its ethoxylates	-		5,7	5,7	14	14		-		-	-	-	-	1	-
Nutrients		-		-	-	-	-		-		-	-	-	-	Framework	-
n-hexane	Aliphatic hydrocarbon	-		0.49/6.5 #	0.49/6.5 #	6.5/21 #	6.5/21 #		-		-	-	-	-	-	-
Parathione	Pesticide, Organophosphorus	5000							-		-	-	-	-		-
Pentachlorobenzene	Halogenated aromatic compounds	50	6,7	0,05	2	10	10		-		-	-	-	-	6	-
Pentachlorophenol	Halogenated aromatic compounds	50	12	7,6	7,6	7,6	7,6		0.06	0,009	-	-	-	-	0,5	-

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
Permethrin	Pesticides, Organochlorine compounds	50		-	-	-	-		-		-	-	-	-	0,004	-
Phenanthrene	Polycyclic aromatic hydrocarbons (PAH)	50		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	0,4	-
Phenolic compounds (as C6H5OH)	compounds	5000	14	0,1	1	10	10	0.001	-		1	5	-	5	-	-
Phenols (mono- & dihydric)	Aromatic hydroxy compounds	5000		3,8	3,8	3,8	3,8		-		-	-	-	-	4	-/2
Phenoxy herbicides	Pesticides	-		-	-	-	-		-		-	-	-	-	4	-/100
Phosphorus (as P)	Inorganic	20000		-	-	-	-		-		5	-	-	-	Framework	-
Phthalic acid esters (each)	Phthalate esters	-		30	-	-	-		-		-	-	-	-	-	-
Picloram	Pesticides	-		-	-	-	-		-		-	-	-	-	29	-/190
PCBs (Polychlorinated biphenyls)	Polychlorinated biphenyls	50	1	0,5	1,3	33	33	0.0005	-		-	-	-	-	0.001	-
Poly cyclic Hydrocarbon (PAH)	Polycyclic aromatic hydrocarbons (PAH)	-	40					0.0001	-		-	-	-	-	-	-
Polychlorinated dibenzo-p-dioxins/dibenzo furans	Polychlorinated dioxins and furans	-	0,00018	4 ng TEQ.kg-1	4 ng TEQ.kg-1	4 ng TEQ.kg-1	4 ng TEQ.kg-1		-		-	-	-	-	-	-
Propylene glycol	Glycols	-		-	-	-	-		-		-	-	-	-	500 000	-
Pyrene	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	0,025	-
pH	Inorganic Acidity, alkalinity and pH	-		6 to 8	6 to 8	6 to 8	6 to 8	6.5-8.5			5,5 - 9,0	5,5 - 9,0	5,5 - 9,0	5,5 - 9,0	6.5 to 9.0	-
Quinoline	Polycyclic aromatic hydrocarbons (PAH)	-		0.1 ¤	1 ¤	10 ¤	10 ¤		-		-	-	-	-	3,4	-
Reactive Chlorine Species	Inorganic Reactive chlorine compunds	-		-	-	-	-		-		-	-	-	-	0,5	-
Salinity	Physical	-		-	-	-	-		-		-	-	-	-	-	-
Selenium	Inorganic	50		1	1	2,9	2,9	0.01	0.01	0,01	0,05	0,05	-	0,05	1	Variable/50
Silver	Inorganic	5000		20	20	40	40	0,1	-		-	-	-	-	0,1	-
Simazine	Pesticides, Triazine	-		-	-	-	-		0.01	0,002	-	-	-	-	10	0,5
Sodium adsorption ratio		-		5	5	12	12		-		-	-	-	-	-	-
Streambed substrate	solids Total particulate matter	-		-	-	-	-		-		-	-	-	-	Narrative	-
Styrene	Monocyclic aromatic compounds	20000	86	0,1	5	50	50		-	0,02	-	-	-	-	72	-
Sulfolane	Organic sulphur compound	-		0,8	0,8	0,8	0,8		-		-	-	-	-	50 000	500
Sulphate	Inorganic Inorganic sulphur compounds	-		-	-	-	-	200	-		-	-	-	-	-	No data
Sulphur (elemental)	Inorganic Inorganic sulphur compounds	50000		500	-	-	-		-		-	-	-	-	-	-
Suspended sediments	solids Total particulate matter	-		-	-	-	-		-		-	-	-	-	Narrative	-
Tebuthiuron	Pesticides	-		-	-	-	-		-		-	-	-	-	1,6	tame hays, and
Tellurium		50		-	-	-	-		-		-	-	-	-		-
Temperature	Physical Temperature	-		-	-	-	-		-		above				Narrative	-
Tetrachloromethane	Halogenated aliphatic compounds	5000	0,7	0,1	5	50	50		-		-	-	-	-	13,3	-/5
Tetrachlorophenols	Halogenated aromatic compounds	50	21	0,05	0,5	5	5		0.1		-	-	-	-	1	-
Thallium	Inorganic	50		1	1	1	1		-		-	-	-	-	0,8	-
Thiophene	Miscellaneous organic compound	-		0,1	-	-	-		-		-	-	-	-	-	-
Tin (inorganic)	Inorganic	5000		5	50	300	300		-		-	-	-	-	-	-
Tin (organic)		50		-	-	-	-		-		-	-	-	-	-	-
Toluene	Monocyclic aromatic compounds	20000	32	0.1	3	30	30		-	0,7	-	-	-	-	2	-/24
Total dissolved solids (TDS)	solids	-		-	-	-	-	500	-		100	600	200	100	-	00
Total hydrocarbons (TPH) (mineral oil)		50000	5000	-	-	-	-	0,5	-		10	20	10	20	-	-

Chemical Name	Chemical Groups	Soil (Screening and Response Levels)						Groundwater for drinking water (Screening levels) [4]			Surface water Quality (Screening levels)					
		Levels in soil (HW Rules, 2008) [1]	**Response levels** (Dutch Inter-vention levels) [2]	**Screening levels** Soil Quality Guidelines for the Protection of Environmental and Human Health [3]				Indian Standard for Drinking Water * (Maximum acceptable concentra-tion)	Guidelines for Canadian Drinking Water Quality	WHO guidelines for Drinking water	The Environment (Protection) Rules, 1986 Schedule VI General standards for discharge of environmental pollutants				Canadian Water Quality Guidelines for the Protection of **Aquatic Life**	Canadian Water Quality Guidelines for the Protection of **Agriculture**
				Agricultural	Residential/-parkland	Commer-cial	Industrial				Inland surface water	Public sewers	Land for irrigation	Marine coastal areas	Longterm in Freshwater	Irrigation/-Livestock
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	µg/L	µg/L
Toxaphene	Pesticides, Organochlorine	50		-	-	-	-		-		-	-	-	-	0.008	-/5
Triallate	Pesticides, Carbamate	-		-	-	-	-		-		-	-	-	-	0,24	-/230
Tribromomethane	Halogenated aliphatic compounds	5000		-	-	-	-		-		-	-	-	-	-	-/100
Tributyltin	Organotin compounds	50		-	-	-	-		-		-	-	-	-	0,008	-/250
Trichlorfon		-		-	-	-	-		-		-	-	-	-	0,009	-
Trichloromethane (chloroform)	Halogenated aliphatic compounds	5000	0,7	0,1	5	50	50	0,2	-	0,3	-	-	-	-	1,8	-/100
Trichlorophenols	Halogenated aromatic compounds	50	22	0,05	0,5	5	5		0.005		-	-	-	-	18	-
Tricyclohexyltin	Organotin compounds	-		-	-	-	-		-		-	-	-	-	-	-/250
Trifluralin	Pesticides, Dinitroaniline	-		-	-	-	-		-	0,02	-	-	-	-	0,2	-/45
Triphenyltin	Organotin compounds	50		-	-	-	-		-		-	-	-	-	0,022	-/820
Turbidity	solids Total particulate matter	-		-	-	-	-	1 NTU	0.1-1.0 NTU		-	-	-	-	Narrative	-
Tungsten compounds		5000		-	-	-	-		-		-	-	-	-	-	-
Uranium	Inorganic	-		23	23	33	300		0.0s	0,015	-	-	-	-	15	10/200
Vinylchloride	Halogenated aliphatic compounds	5000	0,1	-	-	-	-		0.002	0,0003	-	-	-	-	-	-
Vanadium	Inorganic	5000		130	130	130	130		-		0,2	0,2	-	0,2	-	100/100
Xylene	Monocyclic aromatic compounds	20000	17	0.1	5	50	50		-	0,5	-	-	-	-	-	-
Zinc	Metal	20000	720	200	200	360	360	5	-		5	15	-	15	30	-/50000

NR: No relaxation

¤: CCME (Canadian Council of Ministers of the Environment). 1991. Interim Canadian environmental quality criteria for contaminated sites. CCME, Winnipeg.

#: coarse/fine sediment.

!: xx (yy): xx is value from HWR 2008; yy is Dutch Intervention values. In this case levels from HWR are used because these are lowest.

*: IS: 10500:2012

[1] referring to schedule II of the Hazardus Waste rules, 2008. These levels are not relevant for the assessment of contaminated sites, but may apply if during remediation material is excavated, transported and disposed of or treated.
Note: the total content of the various substances in categories 50, 5000, 20000 and 50000 are indicated, should not exceed specified levels to be determinated as hazardous waste.

[2] referring to Dutch intervention values which represent a level above which unacceptable risks may occur. The risk model by which these levels were determined takes into account a residential situation where people live and partly eat crops from the site. In this way these levels provide a relatively low level of risk, i.e. a conservative approach. The levels in this list are fixed number, no dependency on soil characteristics has to be applied.

[3] referring to CCME Canadian Environmental Quality Guidelines, these levels represent a level of negligible risk and provide a level that is regarded to enable a healthy functioning system for different types of land use.

[4] Groundwater for drinking water Screening levels: If Indian Standard for Drinking Water is not available for that parameter first referring to Guidelines for Canadian Drinkwater Quality and secondly to WHO Guidelines for drinking water.

Volume II

2.1-c Checklist preliminary site assessment report

Volume II-2.1-c
Checklist preliminary site assessment report

1 Introduction

This information is most relevant for review of the result of Task 2.1, the preliminary site assessment report. Below table provides the elements of such a report. These elements relate to the list of contents of the Site Inspection Form – Template of the *Site Inspection Protocol, Volume III-2.1-i.*

2 Checklist preliminary site assessment report

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the preliminary site assessment	
Date of recording	
Recording official	

No.	Topic	Obligatory	Status	Comments
1	Existing and general information (to be filled in before Site Inspection)	Yes		
2	Overall assessment of data and data gaps (assessed before Site Inspection)	Yes		
3	On site Reconnaissance	Yes		
4	Off site Reconnaissance	Yes		
5	Miscellaneous	Yes		
6	SITE map	Yes		
7	Sampling	Yes		
8	Overall assessment of pathways, exposure, impacts and contamination	Yes		
9	Draft Conceptual site model (CSM)	Yes		
10	Photographic Record	Yes		
11	Analysis results from sampling (table with results from sampling)	Yes		
12	Data sheet with extract of existing data from Geoenviron database – prior to Site Inspection	Yes		

Explanatory Notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

2.2-a Checklist investigation strategy preliminary site investigation

VII-2.2-a Checklist investigation strategy preliminary site investigation

1 Introduction

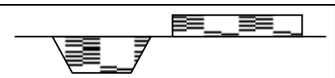
This information is most relevant for task 2.2 preliminary site investigation.
The starting point for the preliminary site investigation is the typology of the contaminated site. For each type of contamination a different investigation strategy is recommended in order to achieve the investigation objective efficiently. The objective of a preliminary site investigation is to identify all sources of contamination and the relevant pathways to the receptors of concern.
When investigating a site a specific investigation protocol should be developed based on the typology. This site specific investigation protocol should pay attention to the following elements:

- Screening and sampling technical equipment;
- Sampling pattern and depth of samples, number of samples and use of composite samples;
- Analytical test parameters / determinants required;
- Quality Assurance / Quality Control procedures such as use of field blanks/trips blanks, procedures to avoid cross contamination by sampling equipment etc.

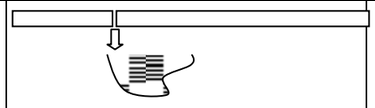
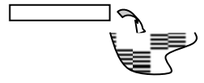
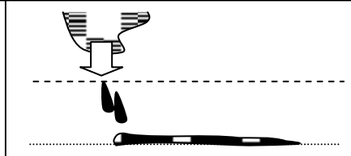
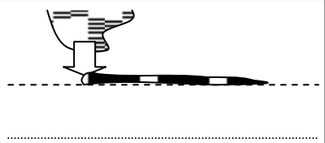
The table below provides a basis for the field investigation strategy including the sampling pattern based on the typology of the contamination and its field characteristics. In case more specific site information is available the general type can be made more site specific by using the Conceptual Site Model (CSM). The Based on the CSM the investigation protocol may be specified to a greater detail, regarding assessment of the contamination levels of the source and the major pathways and receptors of concern.
General notes:

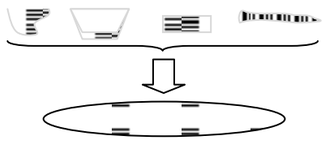
- At one contaminated site more than one type of contamination can occur. For each type of contamination and for each source a separate investigation strategy has to developed first but the investigation activities can be combined to result in an efficient investigation.
- There is always some uncertainty about the representativeness of the samples to actual site conditions due to variation in local conditions which can affect the vertical and lateral distribution of contaminants.
- Composite samples may enable a cost effective efficient investigation of the average concentration levels in contaminated soil or sediment. Composite samples can be made up to a maximum of ten individual samples. The individual samples have to be taken from layers with same soil/sediment characteristics. In case individual samples have different olfactory characteristics, they should not be mixed in the composite sample but they should be tested in the laboratory individually. Composite sampling is not applied for groundwater or surface water and in case of volatile contaminants.

2 Field investigation strategy based on typology

Type	Activity	Icon with typical field situation (cross-section)	Field characteristics	Field investigation strategy	Indication sampling pattern and number of samples
S1	Solid phase contamination (land bound)				
S1-a	Mixing the soil with contaminated material or materials containing contamination, not including agricultural activities.		• May be a thick layer of contaminated material. • Not always visually recognisable (possibly covered with natural soil material). • Relatively heterogeneous composition. • Shape depends on the mixing process.	• If location of source is not known screening methods can be first step for rough indication • If the composition is heterogeneous screening techniques may help to find the most contaminated spots where sampling should be carried out. • If location of source is roughly known sampling of soil and waste material is carried out. • If no spots are identified the samples are evenly distributed over the location of the expected source. This evenly distribution may be influenced by the accessibility of a sampling spot (rather sample of not-covered material in stead of a sample from material below a sealed surface (road, building). • Depth of samples at least to level of contaminated material (based on historical informatial, screening results or visual and olfactory evidence during sampling).	• For non-lineair sources a sampling grid can be used. Rough indication for number of borings from which samples are obtained: 2-4 borings per acre, with a minimum of 2 per source. • Rough indication for number of samples to be tested: 0.25-1 per acre. • For linair sources a cross section of borings is carried out within certain distance intervals. Rough indication of intervals: 1 cross section per 20-50 meters. Per cross section 3-5 borings and for each cross section 1 sample is obtained. • Composite samples made of a maximum of 10 samples before laboratory testing is possible to get indication of average concentration levels. Composite samples are only allowed for components with immobile and non-volatile character (heavy metals, PCB's, most PAH's and pesticides).
S1-b	Embankment, filling of pits or depressions, filling of surface waters with contaminated material or materials containing contamination. E.g. a former dumpsite.		• May be a thick layer of contaminated material. • Not always visually recognisable (possibly covered with natural soil material). • Composition may either be homogeneous or heterogeneous. • Shape is determind by former or present topography, lineair as well as non-linair shaped source may occur.		

Type	Activity	Icon with typical field situation (cross-section)	Field characteristics	Field investigation strategy	Indication sampling pattern and number of samples
				• In case different layers of contaminated material within one source are expected for each layer a sample should be collected. • In case the source of the contamination is expected at great depth below surface and the contaminants may dissolve relatively easy, a water sample from a groundwater well may be more efficient than sampling of soil at great depth.	
S1-c	(Bulk) storage of contaminated material or materials containing contamination (leftovers after having removed the stored materials). (Industrial) activities in which contaminated solids are used. 'Leftovers' of incineration and burning of material. Demolition and construction of contaminant containing constructions (e.g. asbestos).		• Shallow layer of contaminated material. • Material present at the surface and visually recognisable. • Relatively homogeneous composition.	• Same applies as above. • With regard to depth of samples, maximum depth can be 0,5-1 meter depending on expected depth of source.	• Same applies as above. • With regard to number of borings and samples it is possible to use less than the average mentioned above because of the relative homogenity of the material.
S1-d	Adding material containing contamination through agricultural activities (e.g. pesticides, fertilizers or additives to animal feed).		• Shallow layer of contaminated material. • Material present just below the surface. • Visually not recognisable. • Relatively homogeneous composition.		
S1-e	Atmospheric deposition (roads, railway, industries) of emissions or windblown dust.		• Shallow layer of contaminated material. • Material present at the surface. • Visually not well recognisable. • Relatively homogeneous composition.		
S1-f	Deposition by flooding or washing.		• Shallow layer of contaminated material. • Material present at the surface. • Visually sometimes recognisable. • Relatively homogeneous composition.		
	Solid phase contaminations (water bound)				
S2	Contaminated open water sediments.		• The material to be investigated consists of the soil/sediment and parent material beneath the surface water body. • Exact location of the source cannot be identified visually. • Lineair (canals, rivers, creeks) as well as non-lineair (lakes, ponds) shaped sources are common.	• Screening methods are not appropriate. • The site is divided in different investigation areas. Per unit area a number of samples are collected. • Samples are evenly distributed over the area. • Depth of samples is related to depth of the sediment layer. The result of the boring from which samples are obtained may provide a first indication of this depth, although during this step delineation is not primary objective. • The effect of contaminated sediment on the surface water quality can be checked by sampling of the surface water (taking into account background quality of the water).	• For non-lineair sources a sediment sampling grid can be used. Rough indication of number of investigation unit areas: 0.5-1.5 per square root of the surface area (acre). Rough indication for number of borings: 6 borings per unit area, with a minimum of 2 per source. • Indication for number of samples to be tested: 1 composite sediment sample per unit area, for laboratory testing. • For linair sources a cross section of borings in the sediment is carried out within certain distance intervals. Rough indication of intervals: 1 cross section per 500-2,500 meters. Per cross section 3-5 borings and for each cross section 1 composite sample for laboratory testing.

Type	Activity	Icon with typical field situation (cross-section)	Field characteristics	Field investigation strategy	Indication sampling pattern and number of samples
	Liquid phase contaminations				
L1-a	(Business) activities involving fluids e.g. solvents, lubricants, paint, etc.		• Sometimes visually or olfactory recognisable point source. • Dispersion in shallow soil layers depends on soil characteristics, possibly at great depth.	• Identify core of the source, visually or olfactory or with help of screening methods. • Samples in the core or very near to the core. • Depth of sample is 0.5 m below level of core (maximum depth for this preliminary site investigation step: 5 meters below surface).	• Number of borings is 2-5 (related to a surface of 250-2,500 acres). • Per core 1 sample of apparently most contaminated material is tested in laboratory. • Depending on soil composition and sensory observation of the bored material a composite sample can be tested. In case of volatile components composite samples are not possible and groundwater should be sampled.
L1-b	Storage of liquids that contain contaminations in tanks or barrels (either storage on surface or subsurface).		• Often not visually or olfactory recognisable point source because of subsurface release of products. • Dispersion in shallow soil layers depends on soil characteristics, possibly at great depth.		
L1-c	Transfer and transport of fluids through piping. Weak point are couplings, pressure regulators, valves, breakpoints and the passage through foundations / buildings.		• Often not visually recognisable point source because of subsurface release of products. • Dispersion in shallow soil layers depends on soil characteristics, possibly at great depth.		
L1-d	Spills or leaks of liquids. (either on surface or in rivers/lakes) Note. Possibly leading to type S2 or P2.		• Visually well recognisable point source. • Dispersion in soil and sediment as described for Types P2 and S2.		
	Liquid waste related				
P1-a	Dense Non-Aqueous Phase Liquid (DNAPL) in permeable soil. (bulk density > water)		• A liquid that is both denser than water and is immiscible in water or does not dissolve in water. • DNAPLs tend to sink below the water table when spilled in significant quantities and only stop when they reach less impermeable soil layer/impermeable bedrock. Their penetration into an aquifer makes them difficult to locate and remediate.	• Identify core of the source. • Samples in the core or very near in the direction of the groundwaterflow. • Depth of samples is to the level of a less permable layer. The depth of the less permeable layer may be determined using screening investigation techniques. • Visual or olfactory observations of drilled material 0.5 m below level of core (maximum depth for this preliminary site investigation step: 5 meters below surface). • Because of required depth of the samples necessary to investigate DNAPLs this investigation is may be too extensive for the preliminary site investigation. If the site already is regarded as contaminated site it is recommended to investigate during the detailed site investigation.	• Sampling pattern and number of samples are customized, based on the Conceptual Site Model.
P1-b	Light non-aqueous phase liquid (LNAPL) in permeable soil. (bulk density < water)		• Groundwater contaminant that is not soluble and has a lower bulk density than water. • Once LNAPL infiltrates through the soil, it will stop at the water table.	• Identify core of the source. • Samples in the core or very near in the direction of the groundwaterflow. • Depth of boring is 0.5 m below groundwater level and filter of monitoring well has to be placed in such a way that is crosses the LNAPL layer. • In case of deep groundwater levels the necessity of this investigation during this stage of the assessment of the site has to be considered.	• Sampling pattern and number of samples are customized, based on the Conceptual Site Model.

Type	Activity	Icon with typical field situation (cross-section)	Field characteristics	Field investigation strategy	Indication sampling pattern and number of samples
	Leached or dissolved contaminants				
P-2	Groundwater contamination due to spreading of leachate or dissolved contaminants in a permeable soil.		• The size, concentration and extension of the contamination are depending on many aspects: the area where the source of the contamination is present (e.g. a large area of the source will result in a large area of the plume), the chemical properties of the components of the contamination (e.g. more mobile components will cause larger volume of the contaminated plume), the geological stratigraphy (e.g. vertical barriers may prevent spreading of groundwater or force it into a certain direction) and soil structure (e.g. high permeability will cause larger volume of the plume), the hydrogeological situation and the period the contamination is already present in the groundwater.	• Based on the field characteristics a hypothesis of the form and extension of the plume of contaminated groundwater is developed and from that a decision can be made how data of the contaminated groundwater should be collected. • Screening techniques may be used or samples can be obtained from e.g. monitoring wells. • Monitoring wells can be placed after carrying out borings (by hand) or drillings (motor driven) or using probes equipment.	• Depending on the form and length of the plume a pattern of groundwater sampling points may be developed. • For point sources with a clear core of the source (maximum surface is 0.25 acre) a number of 1 sample reaches • In case of larger sources of contamination a number of 0.25-1 per acre may be applied. • From each monitoring well a groundwater sample shall be tested in laboratory for the most relevant parameters.

Volume II

2.2-b Checklist preliminary site investigation report

Volume II-2.2-b
Checklist preliminary site investigation report

1 Introduction

This information is most relevant for review of the output of Task 2.2, a preliminary site investigation report. The checklist below provides the elements that may be included in such a report. The specific situation determines which elements are required in a given report.

The topics in the checklist may be used as elements in Terms of Reference for the investigation of a specific site.

2 Checklist preliminary site investigation report

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the preliminary site investigation	
Date of recording	
Recording official	

No.	Topic	Data Provider / Source	Obligatory	Status	Comments
Name of investigating agency and report date					
Site identification					
	State name	Provided by client	Yes		
	Site owner	Provided by client			
	Site name	Provided by client	Yes		
	Address	Provided by client	Yes		
	GPS coordinates /and elevation: latitude and longitude in centre of the site entered as decimal	Provided by client or established based on address	Preferably		
	Current land use	Provided by client	Preferably		
Introduction					
	Purpose and scope of the investigation	Provided by client	Yes		
	Explanation of the structure of the report	Investigating agency	Preferably		
Site description					
	Explanation of information sources	Investigating agency	Yes		
	History of site use (ownership, operators, users, raw materials, waste related activities, permits, etc)	Investigation agency (Client, informed parties, discussion with local people, district administration and government databases)	Yes		

	Environs of the site (land use, groundwater use, use of water bodies, estimated number of residents or onsite workers, estimated distances to sensitive use, etc.)	Investigating agency (partly provided by government agencies)			
	Climate data (precipitation, temperature and derived information/estimated parameters such as evapo-transpiration and groundwater recharge rate estimated from this data				
	Geology and hydrogeology (stratigraphy, aquifers, depth and permeability of subsurface layers, possible karst features, etc.)	Provided by source or search of website of Central Groundwater Board, Ministry of Water Resources: http://cgwb.gov.in/	Yes		
	Hydrology and surface water (distance from site to water bodies, migration paths of rainfall to surface water, drainage, flooding patterns)				
	Results from previous investigations or incidental data	Client	If relevant		
	Result of site inspection	Investigating agency	If applicable		
	Hypothesis on type and characteristics of the contamination	Investigating agency	Yes		
	Features / targets for investigation	Client and investigating agency	If relevant		
Investigation Strategy					
	Draft Conceptual Site Model	Investigating agency	Yes		
	Screening and sampling strategy	Investigating agency	Yes		
	Fieldwork screening methods (rapid assessment tools)	Investigating agency	If applicable		
	Exploratory hole / sample location pattern (grid or targeted) and numbers of samples (soil, sediment and groundwater) , including benchmark / background samples	Investigating agency	Yes		
	Parameters for laboratory testing and chemical analysis methods / detection limits	Investigating agency	Yes		
	Applied method for quality control (QA/QC)	Investigating agency	Yes		
Results and interpretation					
	Site conditions during fieldwork (e.g. dates, weather conditions, access to locations, etc.)	Investigating agency	Yes		
	Visual / olfactory evidence of contamination	Investigating agency, fieldwork personnel	Preferably		
	Results of screening techniques (if applied)	Investigating agency, fieldwork personnel	If applied		
	Description of ground conditions and subsurface structure (borehole / exploratory hole log description)	Investigating agency, fieldwork personnel	Yes		

	Selection of samples to be tested	Investigating agency, engineer	Yes		
	Laboratory test results	Laboratory reports	Yes		
	Comparison of laboratory test results to standards (Screening levels and Response levels)	Investigating agency	Yes		
Conclusions and recommendations					
	Does the site meet the definition of 'Contaminated Site'? (yes/no/uncertain)	Investigating agency	Yes		
	Relevant sources, pathways and receptors (soil exposure and air pathways, groundwater pathways, surface water pathways). Updated Conceptual Site Model.	Investigating agency	Yes		
	Recommendation for: • further investigation (yes/no); • notification as contaminated site (yes/no) leading to prioritisation and remediation investigation; • temporary safety measures if in the present situation significant risks to human health or environment are expected.	Investigating agency	Yes		
Annexes					
	Topographical map of area with location of the site	Client of investigating agency	Yes		
	Detailed site survey plan with location of sampling points	Investigating agency	Yes		
	Methods of fieldwork and laboratory testing	Investigating agency	Preferably		
	Borehole / exploratory excavation logs with explanation codes	Investigating agency, fieldwork personnel	Yes		
	Relevant screening and response levels	Competent authority	Yes		
	Laboratory results (including original reports) of sample analyses (soil and groundwater separately)	Laboratory	Yes		
	QA/QC results	Investigating agency			
	Photographic record	Investigating agency	Preferably		

Explanatory Notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

2.2-c Checklist review and approval preliminary site investigation report

Volume II-2.2-c Checklist review and approval preliminary site investigation report

1 Introduction

This information is most relevant for Step 2, Preliminary Investigation. The report of the preliminary site investigation is to be reviewed by the competent authority to prepare the decision by the appropriate official.
The checklist below provides the points of attention for the review.

2 Checklist review and approval preliminary site investigation report

The checklist below can be used to review the preliminary site investigation. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the preliminary site investigation	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist preliminary site investigation report	Evaluation if the report contains the elements necessary for a preliminary site investigation (refer Volume II-2.2-b)	Yes		
2	Skills and accreditations	Evaluation if the specialized agency or consultant charged with the preliminary site investigation meets the required skills and accreditations (refer Volume II-2.1-a)	Yes		
3	Stakeholder rights and interests	Evaluation if stakeholders have been involved during the course of the investigation.	Yes		
4	Points of interest to assess the results of the investigation	• All sources, pathways and receptors are identified; • Samples have been taken to assess the level of contamination of the sources and the transport via pathways • The activities to analyse the results of the investigation and comparison with the Screening and Response levels are clearly described; • Uncertainties that can have effect on the investigation result are indicated explicitly;	Yes		

		• Is cross checking of third party values required, e.g. samples and laboratory testing?			
5	Conclusion	Can preliminary site investigation report be approved? If not, which further information is required?	Yes		

Explanatory Notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

3-a Checklist restrictions to site use and temporary safety measures

VII-3-a Checklist restrictions to site use and temporary safety measures

1 Introduction

This information is most relevant for Step 3 Notification.

Results of (preliminary) investigation of a site may indicate actual or potential threats for human health or for the environment. In such a situation it may be necessary to organize a quick response to these threats, especially in case remediation measures are not expected to be implemented in the near future. In such a situation, restrictions to the current site use or emergency hazardous waste removal can be imposed and, to ensure proper implementation, temporary safety measures can be taken.

The checklist below provides examples for these site use restrictions and temporary safety measures regarding the protection of human health. Where surface water is involved, these measures can be applied when the water quality is negatively impacted by a contaminated site (e.g. by diffusion from contaminated sediments), or when in the current situation effluents from industrial processes and sewerage are still being discharged and are reaching, directly or indirectly, the surface water.

Measures regarding ecology (plants and animals) are part of the later steps in the process of remediation of a site. The same applies to measures regarding the prevention of threats for situations of future land use.

2 Identification of site use restrictions and temporary safety measures

The checklist below can be used to identify potential site use restrictions. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)				
Main results of the preliminary site investigation				
Date of recording				
Recording official				
Annexes#)				
Current land use	**Potential restrictions to site use when concentration levels in soil or sediment in contact zone*) exceed Response levels**	**Conclusion on whether restrictions should be applied (Yes/No) and remarks**	**Potential restrictions to site use when concentration levels in groundwater or surface water exceed Screening levels**	**Conclusion on whether restrictions should be applied (Yes/No) and remarks**
Habitation settlement/residential or school or playground or garden/park	Prohibit use of the site for current purpose. Prevent new building activities.		Prevent contact with or consumption of groundwater or surface water.	
Industrial or other commercial land	Prevent contact of labor with contaminated material. Prevent new building activities.		Prohibit extraction of groundwater or use of surface water, unless being used not for sensitive purposes (e.g. cooling water in an industrial process).	
Agricultural land	Testing of concentration levels in grass or crops and if these exceed product quality levels, prohibit the consumption of crops and prohibit livestock.		Prohibit use of drinking water for livestock and use of groundwater for irrigation.	
Forests and other natural area	Discourage or prohibit access to site.		Prohibit extraction of groundwater or use of surface water.	
Waste land	Discourage or prohibit access to site.		Prohibit extraction of groundwater or use of surface water.	
Open water body	Prevent contact with contaminated sediment.		Prevent contact with or consumption of surface water.	
Mixed and Other land use	To be derived from above suggestions.		To be derived from above suggestions.	

*) contact zone means the top level of soil and sediment (between 0.0 and 1.0 meters below the surface)

#) Annexes may include a more detailed description of site use restrictions to be imposed or temporary safety measures to ensure implementation of these, and, if applicable, a map clearly showing the area or areas on which imposed measures apply

3 Examples of temporary safety measures

Potential temporary safety measures to prevent unacceptable risks from contact with contaminated soil or sediment:

- Restrict public access to a site by placing fencing and/or by security;
- Discourage access to a site by posting warning signs;
- Assessing the need to temporarily relocate population;
- Physical emergency removal of (most) hazardous substances;
- Stabilizing waste sources such as leaking drums;
- Applying shallow top coat of clean material on locations where obvious contaminated material is present;
- Applying cover on unpaved surfaces.

In case of imminent health hazards these measures should be implemented immediately.

Potential temporary safety measures to prevent unacceptable risks from contact with contaminated groundwater and surface water:

- Temporary treatment of extracted groundwater / surface water;
- Closing groundwater extraction wells;
- Providing alternative supply of fresh water for consumption or for agricultural purposes;
- Discouraging or prohibiting use of water for bathing or swimming.

In case at a contaminated site contamination of soil, sediment, groundwater or surface water still takes place from spills measures should be taken to prevent this new contamination referring to the regulations of Section 7 of Environment (Protection) Act 1986 and to Section 3 and Schedule I of Environment (Protection) Rules, 1986.
In India there are a number of methods and measures available and used to contain or arrest a spill from a broken/damaged circular pipeline and fittings:

- There are devices which include an adaptor sleeve clamp with a provision to reasonably secure and block the liquid leakage from the pipeline. The leakage arresting device is provided in a form of ready for installation to block leakages even in locations / units requiring high standard of safety. These devices can be indigenously prepared at sites and applied or are readily available in the market.
- There are other measures adopted to contain the online leak by application of different metal putties such as Express Titanium Putty and Sticks, Steel Putty, Bronze Putty, Aluminium Putty, Underwater Putty etc. depending upon the method of characteristics (MOC) of leaking pipeline.
- Urethane impregnated, water activated special pipe tap kits designed to permanently stop live leakage up-to 4” diameter and 60 PSI are also available and used.
- Pipe Sealer is used to seal and lock threaded pipes and fittings leakages.
- Single component room temperature vulcanizing silicone sealant that forms rubber like material is widely used in leak sealing.

Volume II

4-a Checklist information for application prioritization system

Volume II-4-a
Checklist information for application prioritization system

1 Introduction

This information is most relevant for Step 4 Priority list addition. The text below presents additional guidance for the parameters needed to apply the prioritisation system. This should serve the performing party in acquiring the correct parameters.

For detailed guidance on the prioritisation algorithm we refer to the Report of Prioritization of sites (part of NPRPS-Inventory and mapping of contaminated sites, COWI, Feb. 2015).

2 Additional guidance

Table: list of parameters and initial parameter values (source: Report of Prioritization of sites, COWI Feb. 2015)

Para-meter	S-P-R *	Description	Basis	Range	Data Source
C	Source	Source concentration	Marks as Low, Med, High or Ratio to Screening Level	0 – 10	To be obtained from Site Inspection in Task 4 and/or from previous investigation performed at the site
Q		Quantity of source	Volume, or Low, Med, High	0 - 10	To be obtained from desktop study and/or Site Inspection in Task 4
T		Toxicity Factor	A list of Chemicals	0 - 10	Obtained from the GeoEnviron Database (Internationally classification)
M		Mobility Factor	List – chemical characteristics	0 - 10	Obtained from the GeoEnviron Database (Internationally classification)
F	Pathway	Pathway factor	Conn x Att (see description below)	1 - 1.2	To be calculated based on Conn and Att
		Conn (Containment)	Site Report	0 - 0.1	Technical judgement based on site access
		Att (Attenuation)	Pathway, tables	0 - 0.1	Reflecting directness of path to receptor. Can be obtained from US values
L	Recep-tors	Land use at the site	Scoring Low, Med, High Risk	0 - 10	Same classification used in Stage I prioritization
P		Population at risk	Estimated within 1 km. Log(pop) or Low, Med, High	0 - 10	Same classification used in Stage I prioritization
S		Sensitivity of receptor	Professional judgement; Scoring Low, Med, High	0 - 10	Based on observation from Site Inspection e.g. part of the population is particularly at risk or disadvantaged. Based on observed exposure to contaminants, observed impacts and generally emergency response considerations (observed conditions that may warrant immediate or emergency action (e.g. heavily contaminated groundwater/surface water used for drinking water or direct contact to heavily contaminated soil)

Para-meter	S-P-R *	Description	Basis	Range	Data Source
G		Groundwater system at risk	Use/importance of aquifer; Low, Med, High	0 - 10	Same classification used in Stage I prioritization
SW		Surface water at risk	Use/importance of surface water; Low, Med, High	0 - 10	
E		Sensitive ecosystems	Distance to designated reserves, etc.; Low, Med, High	0 - 10	Scoring based on distance and type of sensitive ecosystems

*: Source – Pathway – Receptor

Source

The source term is a measure of the scale and risk of the critical contaminant. This is in common with most of the systems reviewed, the approach here uses one "dominant" contaminant, but it is possible to use a combination where there are high values for several different contaminants.

The basic source term is the concentration (C) of the pollutant at the site in relation to the relevant screening value. This number can be a score reflecting the extent of the over-standard compared to the screening value. With limited sampling this parameter can be based on a professional judgement. Where there is a very wide range of high values across sites, the logarithm of the values can be used. The current uses of the site are taken into account by selecting the screening value appropriate for that land use. In cases where there is no information on the concentration (or where the sampling data is very limited or unreliable), it is possible to use estimates of the typical levels of contamination using data from similar sites or informed judgments.

To characterize the source better, terms are added for the quantity (Q), the toxicity (T) and the mobility of the contaminant (M).

The quantity is scored in terms of an estimate of size (small, medium, large). This factor can also be used to reflect a source that is a cluster of industries, where the value of Q is increased to capture the overall scale of the collective source. This is equivalent to the CEPI factor for the scale of industrial activity.

Toxicity scores are based on specific characteristics of the contaminant, as recorded in the scientific literature. The scores have been defined according to the toxicity as classified by the Department of Environment in England (DOE), and are available in the GeoEnviron database.

Mobility scores are based on specific characteristics of the contaminant, as recorded in the scientific literature. The scores have been defined according to the toxicity as classified by the Department of Environment in England (DOE), and are available in the GeoEnviron database.

Pathway
The pathway term is a measure of how direct the path from the source to the receptor is. In this model, it is structured to be a modifier of the source term.

For sites where the critical receptor is actually on the site (for example people living on polluted land), then the pathway is direct and the pathway factor (F) is unity. A land use risk factor (L) is incorporated to reflect a generalized concept of the pathway and receptor, in cases where there is little information on these. Where the receptors are off-site, then some reduction in the risk will occur, based on two main factors. First, the existence or provision of containment (or restriction of access) will reduce exposure to the source. Second, distance from the source will normally reduce the exposure (simple geometry shows that the concentration will drop with increasing radius from the site) unless there is a narrow and direct pathway (such as prevailing winds, a defined groundwater plume or a waterway).

The factor F is therefore a function of (i) containment, and (ii) attenuation. Containment is estimated in terms of the “Access to the site from local communities”. Attenuation depends on the pathway and requires judgment to assess, but there is some guidance from international practice, which suggests the appropriate ranges. The approach used is based on the parameters: distance to private wells; distance to public wells; distance to the nearest habitation.

Receptor
The fundamental receptor is the population potentially exposed (P), and in the present formulation, additional receptor parameters can be used for groundwater (G), surface water (W) and for sensitive environments (E). These parameters are added to the human receptor score. This means that a site which has many impacts will get a high score, while a site that has serious ecological impacts, but limited human ones (for example) will be given a score to reflect this risk. Plausible values for these parameters are being tested empirically.

The fundamental receptor is the population potentially exposed (P). This is calculated based on approach described in the Site Inspection Report. The relevant population has to be identified in order to characterize P. This will be estimated based on distance (population within 1 km of radius). The population at risk a can be determined from readily available maps (whether hard copy or GIS).

The current “Land use” at the site (L) is also included as a parameter although it is our experience from Task 1 (data collection), that information about land use can be difficult to obtain in a desktop study. The classification of land use has been defined by MoEF: Agricultural land, Waste land, Water bodies, forests, Habitation settlement, Commercial, Industrial, Mixed, Other, Not known.

Groundwater (G) and surface water (SW) at risk are included in the receptor parameters. These parameters are added to the human receptor score. Generic information can be obtained from the Central Ground Water Board and State Governments for Rivers. More specific information can be obtained during site visit/investigation.

Where the data required is not available, implementation of the method can be based on assumptions. In such cases, we propose to assume a worst case scenario for each situation. Further information should then be collected in order to verify assumptions made and further refine the priority listing. Hazard scores in relation to ground and surface water receptors is taken into account based on the industry profile. Furthermore, the use/importance of the groundwater and surface water is also incorporated in the score.

Scoring for sensitive ecosystems are based on distance and type of ecosystems. If an ecosystem is not near the site, a low value will be given for the specific site.

The model includes a sensitivity factor (S) which would signify that the exposed population (or environment) were particularly at risk or disadvantaged.

Volume II

5.1-a Checklist Detailed site investigation report

Volume II-5.1-a
Checklist detailed site investigation report

1 Introduction

This information is most relevant for Task 5.1 Detailed site investigation in Step 5, Remediation investigation.
A detailed site investigation provides clear information on the extent of the nature, extent and concentrations of the substances at the contaminated site and on the site conditions.
The checklist below provides the points of attention for the detailed site investigation report. In a way it can be regarded as a table of content for the report. For specific sites some of the elements can be found not applicable.

The topics in this checklist may be used as elements in Terms of Reference for the investigation of a specific site.

2 Checklist detailed site investigation report

The checklist below can be used to identify and assess the content of the detailed site investigation. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the detailed site investigation	
Date of recording	
Recording official	

Content of detailed site investigation report	Status	Comments
Introduction and background information • Description of the site (e.g. name, address, site plan and size); • Reason for the detailed site investigation; • Summary of the previous investigations at the site; • Information of the parties involved in the remediation investigation process and allocation of their roles; • Scope of the investigation; • Explanation of the structure of the report.		
Site situation • The lay-out on the site (present land use, infrastructure, buildings, use of the surrounding area, included natural features such as lakes, rivers, streams found at least partially within the boundaries of the property) and in the area beyond the site covering the pathway;		

• Description of history of the land use and possible causes of the contamination (included constructed features such as, underground storage tanks, lagoons, ditches, sumps within buildings, and waste storage areas); • Typology of the contaminated site; • Geology, geohydrology and soil structure and ground conditions of the site in case of contaminated soil and groundwater (depth of groundwater, thickness of aquifers, seasonal groundwater fluctuations; the lithology and vertical permeability of the unsaturated zone; the stratigraphy, structure, geometry, porosity, hydraulic conductivity, storage properties, transmissivity, and groundwater flow direction of the saturated zone). • If monitoring or drinking water wells have been installed: review of the monitoring results; include data why and when a well was installed and by whom and technical data (depth, filter length, monitoring data, sample and lab methods) • Soil survey information at a scale of 1:20 000 or larger; on-site map and appropriate cross-sections showing soil types, soil depth and other soil parameters that may be related to location and extent of contaminants; • Climatic conditions (precipitation, seasonal variations, estimated infiltration rates); • Morphological and hydraulic aspects including e.g. seasonal variations in water level and floods and and areas affected by floods to estimate the impact of contaminated sediments.		
Investigation strategy • The conceptual site model (CSM) with the combinations of source-pathway-receptor) of concern. A detailed description of the present contamination with characteristics (parameters, concentration, extent in horizontal and vertical direction, mobility, density); • Data gaps in the CSM and points for investigation; • Screening and sampling technical equipment; • Sampling rationale and design (media, locations, pattern and depth of samples), including background samples; • Number of samples; • Screening of observations wells or necessity for drilling new wells; • Methods for establishing stratigraphy and characteristics of subsurface layers; • Analytical test parameters / determinants required.		
Fieldwork and laboratory testing • Description of executed activities; • Site conditions during fieldwork (e.g. dates, weather conditions, access to locations, etc.) • Visual / olfactory evidence of contamination • Results of screening techniques (if applied) • Description of ground conditions and subsurface structure (borehole / exploratory hole log description) or water body; • Selection of samples to be tested; • Laboratory test results; • Quality assurance and quality control; • Possible deviations from sample plan and reasons involved.		

Analysis and interpretation of exploratory data • Comparison of laboratory test results to standards (Screening levels and Response levels); • Description of situation of the contamination in the various media (soil, groundwater, sediment, surface water, air, biota) including depth and extent of contamination and including estimated quantity of polluted media; • Implications of contamination, soil structure and general physical, chemical, ecological and spatial site conditions for remediation options; • (Seasonal) contour maps of groundwater flow and explanation of estimated groundwater processes; • Possible influence of seasonal climatological situation on groundwater and surface water; • Contour maps and cross-sections to show spatial distribution of contaminants; graphical displays that present the available data in their spatial context; sample values for data on maps or cross-sections; colors; grey scales, or symbols to high-light the locations of the highest sample values; • Updated Conceptual Site Model, identifying sources, pathways and receptors.		
Conclusions and recommendation • Conclusions on the scope and objectives of the investigation with clear indication of known data gaps and possible uncertainties; • Recommendations for ° further investigation; ° temporary safety measures if in the present situation significant risks to human health or environment are expected. This may include monitoring of a contaminated plume in groundwater.		
Annexes • Topographical map of area with location of the site • Detailed site survey plan with location of sampling points • Methods of fieldwork and laboratory testing • Borehole / exploratory excavation logs with explanation codes • Relevant screening and response levels • Laboratory reports • Calculations or modelling results and explanation characteristics of the model used • Maps indicating contamination of soil, sediment and groundwater • Background literature and sources • Photographic record		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

5.2-a Checklist risk assessment report

Volume II-5.2-a
Checklist risk assessment report

1 Introduction

This information is most relevant for Task 5.2, Risk Assessment. The table below presents a checklist of all elements a report on risk assessment may contain. As such, it may serve the performing consultant as well as the reviewing authority. It should be noted that the selection of elements any specific report should contain depends on the specific situation. Therefore, any review should be preceded by an analysis of which elements are relevant for the situation at hand.

The report on risk assessment may be integrated into the report of the detailed site assessment.

2 Checklist risk assessment report

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the risk assessment	
Date of recording	
Recording official	

Content of Risk assessment report	**Status**	**Comments**
Introduction and background information • Description of the site (e.g. name, owner, address, site plan and size, GPS-coordinates); • Summary of the previous investigations at the site; • Information of the parties involved in the assessment and remediation process and allocation of their roles; • Reason for and objectives of risk assessment.		
Site situation • The situation of the contamination at the site (present land use, infrastructure, buildings, use of the surrounding area); • Description of history of the land use and cause of the contamination; • Description of area with respect to existing land use, demographic profile, social economic and environmental conditions of the people in receptor areas, flora and fauna; • Comparison of concentration levels against Screening and Response levels.		

Content of Risk assessment report	Status	Comments
Relevant source-pathway-receptor combinations • The conceptual site model (CSM) with the combinations of source-pathway-receptor of concern. A detailed description of the present contamination with characteristics (parameters, concentration, extent in horizontal and vertical direction, mobility, density); • Relevant exposure pathways, preferably illustrated with diagram.		

Results of generic quantitative risk assessment modelling
• Tool/model used to quantify risks
• Site-specific information used for modelling
  ○ Representative concentrations in soil, sediment and groundwater
  ○ Size of contamination in soil (3D)
  ○ Size of contamination in groundwater (3D)
  ○ Size of the site (contaminated and not contaminated)
  ○ Level of groundwater
  ○ Soil type (%organic matter, % clay, grain size, hard rock)
  ○ Surface water in the environment
  ○ Drinking water extension in the environment
  ○ Groundwater flow direction and estimated speed
  ○ Use of the contaminated site and the vicinity
  ○ Establishment of the site (buildings, basements, roads, crops)
  ○ Receptors on-site and off-site
• Model results and comparison to critical exposure value		

Results of detailed quantitative risk assessment • Reason for detailed quantitative risk assessment • Collection of additional information (methodology used for obtaining data) • Data obtained, e.g. contaminants investigated, contaminant concentration levels in the relevant contact media (e.g. air, dust), relevant specific circumstances • Results		
Conclusions and communication • Clear statement on unacceptable risks identified • Possible uncertainties and information gaps, necessity for further investigation • Recommendations for further steps, setting remediation options and development of remediation options		

Explanatory notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

5.3-a Background information for setting remediation objectives

Volume II-5.3-a
Background information for setting Remediation objectives

1 Introduction

This information is most relevant for Task 5.3 Development of remediation options. In developing effective targets for remediation it is important to discuss the policy goal on contaminated sites. This is related to the definition of contaminated sites, the inventory of sites and the technical, financial, legal and organisational possibilities to implement the NPRPS.

Contaminated sites are defined by situations which pose existing or imminent threats to human health and/or the environment. Remediation should be aimed at reducing these threats. The threats have been determined for the present or expected future land use. An important decision needed from the competent authority is the form(s) of land use and the level of protection the remediation should take into account. A sensitive form of land use (e.g. residential area) requires more remediation effort than a less sensitive form of land use (e.g. industrial area). This with respect to human health as well as regarding the ecological value of an area.

To reduce the threats for an intended form of land use an intervention is required in the source-pathway-receptor-combination of a specific situation. This means that either the source needs to be reduced, the pathway between source and receptor needs to be cut off or the receptor needs to be protected or removed. Section 5.4 in Volume II presents options for such remediation interventions.

The key issue is to what level the threats should be reduced. In this regard, there are three options to consider:

Approach 1, Generic total threat reduction in soil, sediment or groundwater
Implementation of the approach of generic total threat reduction is aimed at reducing the identified threats to zero level, rendering the site fit for any use (‘multifunctional’). Internationally, ‘zero’ is most commonly translated into ‘as low as technically achievable’. To achieve this the source of the contamination needs to be removed or treated completely, as contaminant concentration levels need to be reduced to background levels.

Approach 2a, Generic fitness for use threat reduction in soil or sediments
Implementation of the approach of generic fitness for use threat reduction in soil or sediment is aimed at reducing threats to a generic acceptable level given the site's present and/or future use. To achieve this:

- The constituents in the source of the contamination need to be removed or treated to a generic level set for the present and/or intended future land use, or
- The pathway from contamination to receptor needs to be cut off, or
- The receptor needs to be protected or removed.

Approach 2b, Cost effective groundwater approach
Implementation of the cost effective groundwater approach is aimed at reducing threats to an acceptable level, while the remediation action is still cost effective. To

achieve this contaminants are removed from the pathway to a degree where the costs of the removal is in balance with the amount of contaminants (mass) removed from the pathway. Contaminants in the source of the contamination are removed or treated to such a degree that this action benefits the actions in the pathway. Whenever the receptor is threatened it needs to be protected.

Approach 3a, Site specific fitness for use threat reduction in soil or sediments
Implementation of this approach is aimed at reducing threats to a site-specific acceptable level given the site's present and/or future use. To achieve this:

- The contamination needs to be removed to a predetermined site-specific level at which the contamination is considered to present no threat. This remediation level is based on site-specific risk assessment and is typically less strict than the generic (robust for all uses) level, or
- The pathway of the contamination to the receptor needs to be cut off exactly according to a specific use and spatial planning of the site, or
- The receptor needs to be protected or removed.

The required remediation efforts are most comprehensive in approach 1), less in approach 2a),most limited in approach 3a) and cost balanced in approach 2b). Conversely, the flexibility of the present and future land use and absence of restrictions and required efforts for monitoring and control increase from approach 3) to approach 1). Figure II-5.3-a.1 below illustrates this for soil and sediments and figure II-5.3-a.2 for groundwater.

Figure II.5.3-a.1 Remediation effort and consequences for the different approaches to remediation of soil or sediment

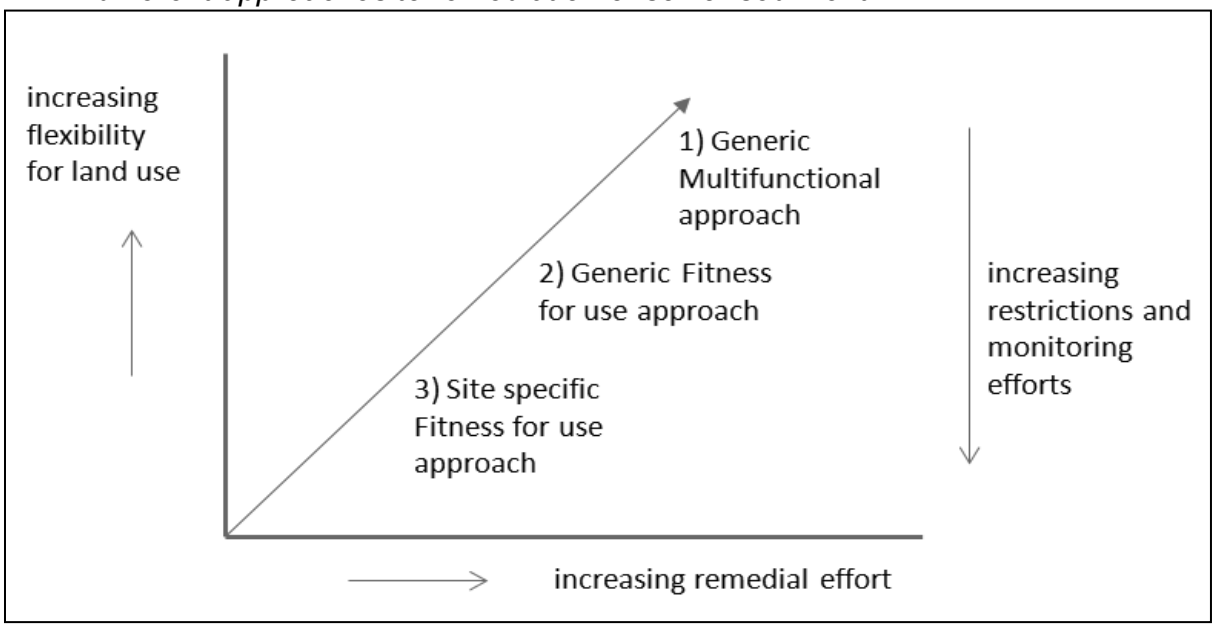
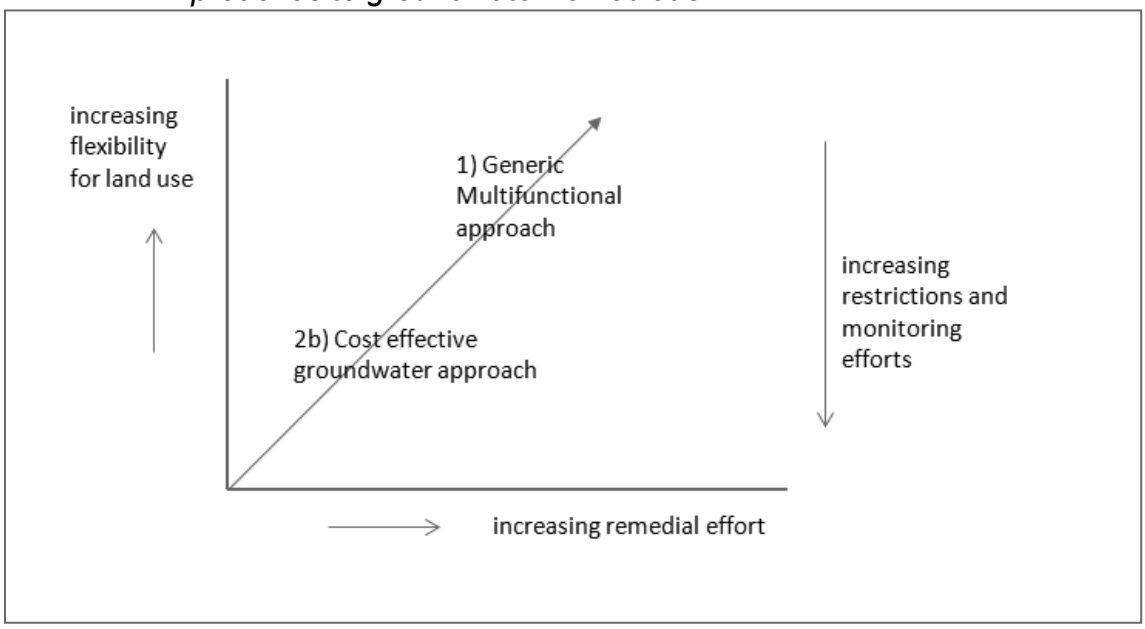


Figure II-5.3-a.2.2 Remediation effort and consequences for the different approaches to groundwater remediation



2 Standards based approach: multifunctional remediation

In most of the countries presently dealing with soil remediation the wheels have been set in motion by major incidents. Especially where these cases received widespread media attention governments were quick to respond. The clearest example of this is the United States where, barely a year after Love Canal became a household name, the federal Comprehensive Environmental Response and Liabilities Act (CERCLA) came into force (1980). Perhaps most remarkable was the fact that, aside from the development of regulation, the (sometimes huge) funds needed for concrete action also came swiftly. This was the case in the US, but also in the Netherlands, where, as in the US, a residential district built on top of a dangerous chemical waste dump (in Lekkerkerk) was the catalyst. The examples mentioned here had impact across national borders, as was the case with the Seveso explosion in northern Italy, which prompted other countries and the EU into action.

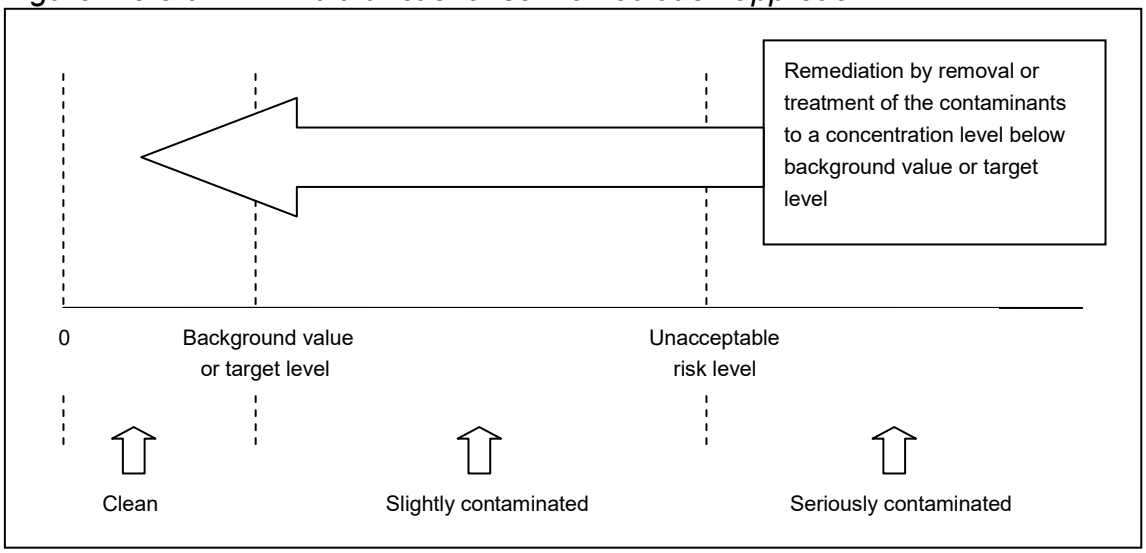
As the incidents were major, created clear danger to human health and to the environment in general, regulations in those early days tended to be strict. The front running countries, especially in Europe (e.g. Denmark and the Netherlands), generally adopted the principle of multifunctionality, meaning they aimed at remediating all contaminated land to pristine conditions. This would entail the restoration of soil quality from an intervention value back to a standard target level or natural background level regardless of site characteristics or site use. The objective of this approach was to reach a situation in which the remediated sites would be fit for all use after remediation. To reach this objective, all contaminated sites would need to be remediated back to pristine conditions.

This approach also meant a standard based approach, consisting of either complete removal or removal to a specific concentration, where criteria did not take into ac-

count the present or future use of the site. The obvious advantage of this approach is a simple, very clear decision-making system, easy to apply and hardly giving any space for discussion as the target levels are well defined and non negotiable.

If multifunctional soil remediation is impossible for site specific reasons containment of the contamination is a fall back option. As this containment needs to reach a situation comparable to complete removal it needs to be designed in such a way that its application results in the lowest possible emission and multiple site use options. Figure II.5.3-a.2 demonstrates the multifunctional soil remediation approach.

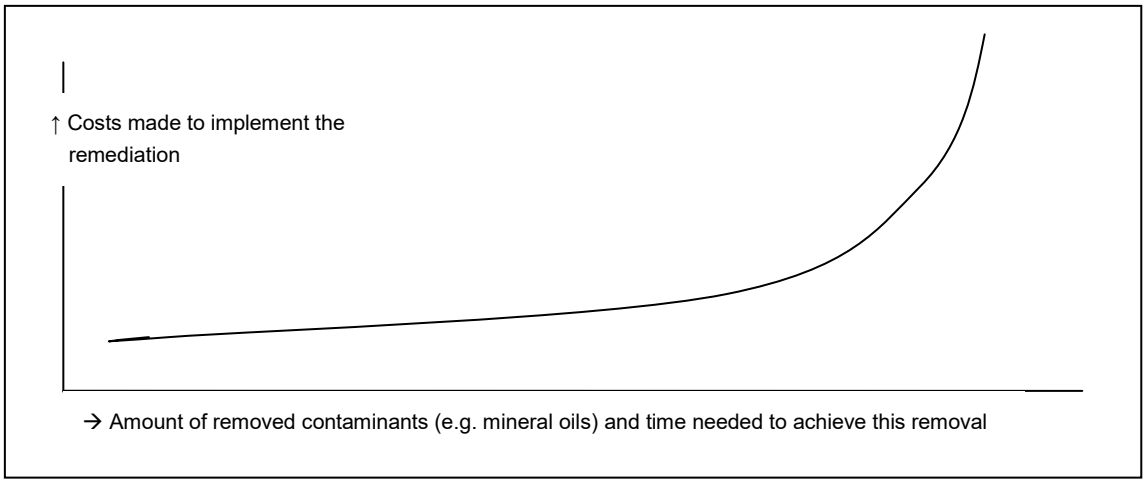
Figure II.5.3-a.2 Multifunctional soil remediation approach



The notion that “multifunctionality should be the ultimate aim of contaminated land remediation, as being the only truly sustainable option” certainly seems a defendable one. Especially if we consider the direct link that was made almost one on one in those days between soil contamination and very serious threats to human health. Actually, the Netherlands has long defended the principle of multifunctionality in practice. Even after a study in the early 1990s had shown that pursuing this strategy would amount to an estimated cost of € 45 billion (equivalent to close to € 75 billion or U$ 100 billion of today). Or, as it was translated then, even with more than € half a billion per annum (to be borne by a population of around 17 million) it would take a full century for the operation to be completed. This example illustrates what became clear elsewhere as follows: “[multifunctionality] may not be technically feasible, nor economically viable in the short term.”

An example, showing the costs and inefficiency of a multifunctional remediation approach: the removal of the final ‘drop’ of mineral oil from a mineral oil contaminated soil is a technical challenge disproportionate to its achievement. The same goes for the costs, as well as for the energy needed: the extraction of the last drop is likely to demand much more energy than represented by the drop itself. Figure II.5.3-a.3 demonstrates this principle, which helps to determine a site based optimum in the remediation target to be established.

Figure II.5.3-a.3 Principle of soil remediation efficiency



Note. Scales in this figure are arbitrary

During the first half of the 1990s the idea also gained ground that (re)development was actually slowed down considerably ('stagnation' was the word used) by the soil contamination on many urban, and otherwise prime, sites. This raised the question whether the policies in place influenced this stagnation in any way. Looking back, this certainly seems to be the case: the more stringent the policy leaned towards a standard based multifunctional approach, the higher the cost of remediation would be, leading to a significantly reduced interest in (potentially) contaminated sites by developers. Even in the densely populated areas of north-western Europe the economically best option often was to develop a Greenfield.

While some countries, notably Finland, the Netherlands and Switzerland, have retained, at least in theory, the ultimate goal of multifunctionality, risk based criteria tied to land use are presently in use in most countries.

With the drawbacks of the multifunctional approach apparent, that does not mean this approach has been phased out completely: it is still used in specific circumstances. For instance, in case the contaminated area is small, the costs of a multifunctional approach are relatively low. And a standard based approach may well be the most appropriate option for the liable party when his policy is to avoid any future liability issues.

3 Risk based approach: fitness for use remediation

From the previous Section we can digest that the multifunctional soil remediation approach is generally speaking not necessary from a health and environmental point of view, economically not feasible and not sustainable. The general response has been the introduction of a risk based approach. This approach focuses on the removal or treatment of contaminants as far as needed to reach a quality fit for one or more specific functional site uses, assessing all unacceptable risks prior to remediation. The result is an approach with “less stringent generic criteria tied to risk and future land use, and more flexible site-specific risk assessment and clean up procedures”.

This approach can be based on either generic target levels for different types of land use or on site specific target levels. In either case, within this fitness for use approach the remediation measures can provide a generic protection level for a form of land use or can be directed to a very specific spatial design of the intended land use. An example to illustrate this: for a residential area the remediation measures can be designed with maximum flexibility of the exact use of land within the boundaries of the site. In this way everywhere houses can be built and gardens with crops can be situated everywhere. However, remediation measures can also be designed for a very specific spatial plan for a residential area: this enables contamination levels below roads and buildings to be higher than the concentration levels in the gardens. While this way remediation efforts can be limited this approach also results in more restrictions for future use of the site, and this specific spatial site plan needs to be maintained and monitored.

In this ‘fitness for use’ approach the risks the contamination poses to human health and the environment are decreased to a level acceptable for the present land use. In case land use is expected to change in the near future, present as well as projected land use can form the basis for this approach. A basic principle that has been retained in taking the step towards a risk based approach is called the ‘stand still’: for each site reuse or redevelopment the soil and groundwater quality should at least be fixed or improved.

Figures II.5.3-a.4 and II.5.3-a.5 show the principle of the ‘fitness for use’ (risk based) approach.

Figure II.5.3-a.4 'Fitness for use' approach of the source: reducing levels of contamination in soil

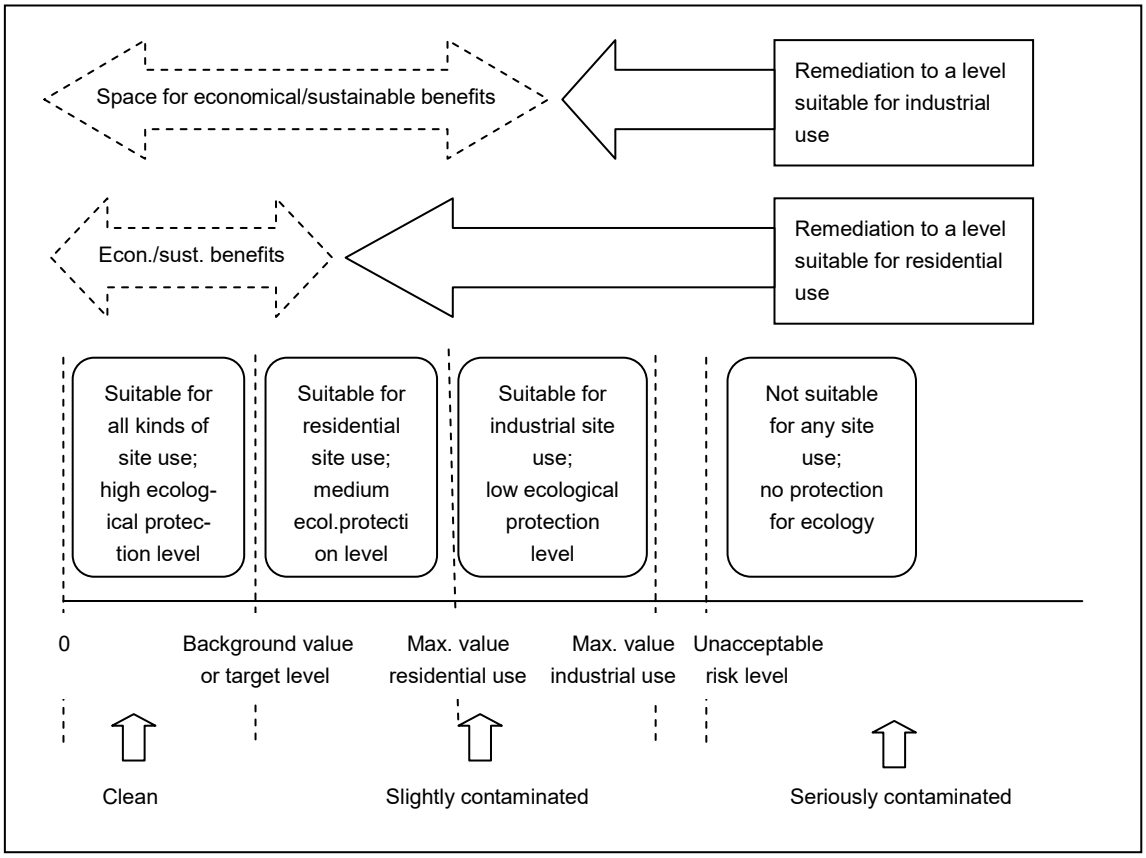
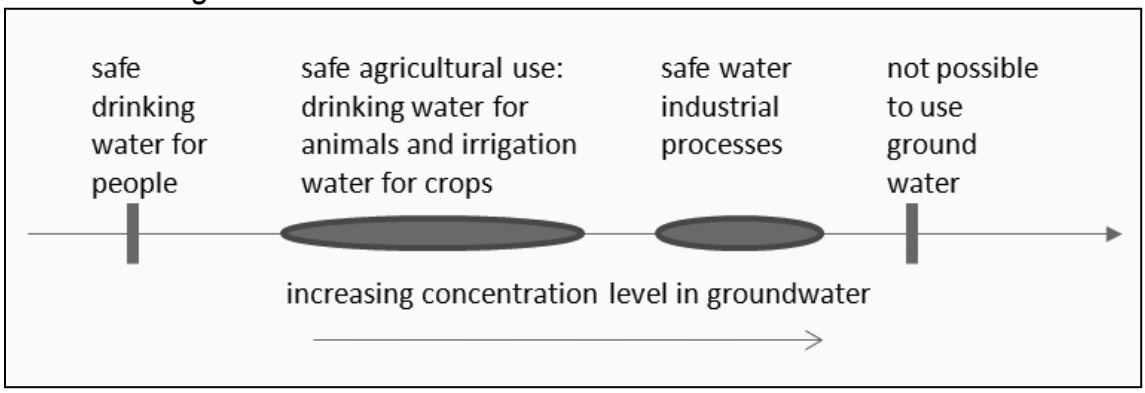


Figure II.5.3-a.5 'Fitness for use' approach of the source: reducing levels of contamination in groundwater



For each source-pathway-receptor-combination this approach can be used. In cases of immobile soil contamination, such as many heavy metals, this will result in assessing the quality of the top layer only, as the quality of this part of the soil is responsible for most human and environmental risks. The assessment of mobile contaminations is presented in Section 5 Cost effective groundwater approach.

In case only the top layer has to be assessed, much effort can be saved on the assessment of the contamination below the top layer. Using this approach, a risk based site management framework can be built, providing an opportunity to balance between a scientific underpinning of the assessments and pragmatism to deal with con-

taminated sites, anticipating site specific or region specific preconditions. The maximum values for site use offer basic safety warranties.

A contamination without any receptors does not present any risks. In case it is decided to remediate such a contaminated site anyway, e.g. to improve the quality of an aquifer to meet drinking water standards, there may be time to consider alternative remediation options. At this point even more cost effective remediation approaches come into view.

A more recent development is to combine sustainability aspects with the 'fitness for use' approach, offering a balance between human health and environmental protection versus the opportunity to reuse contaminated soil and to optimize economic aspects of site redevelopment. This approach offers a lot of space for economical and sustainable benefits without any public health or safety sacrifices. When developing a national program for remediation of multiple contaminated sites, these benefits are crucial for the feasibility of the complete program.

4 Preliminary conclusion for applicability in India

From the Sections 2 and 3 above it can be derived that a standard based approach is, in comparison with a risk based approach, relatively simple and easy to understand, also for non professionals. This characteristic can help in drawing support, especially from residents, when proposing remediation solutions. On the other hand, a standard based approach is less flexible: once the standards have been set the system in a way determines which decisions need to be taken in individual cases. Experience shows that this can lead to remediation approaches hardly taking into account the local situation. Moreover, the standard based approaches have shown a tendency to require considerably more financial means.

By contrast, a risk based approach is aimed specifically at developing remediation options fitting the local situation. Furthermore, a risk based approach in assessing remediation options seamlessly fits on to the site assessment phase, which usually includes risk assessment to determine the need to remediate. Also, in a risk based approach, individual site specific targets for remediation sometimes can be combined with other target values, e.g. drinking water standards. A risk based approach, however, requires more data, in particular on the local situation. In most cases, the investment in acquiring these data yields larger returns later, by saving significantly on the costs of the remediation, which, after all, is aimed at the specific situation.

India is a cost sensitive market, meaning that any solution needs to use local components, hardware, engineering, skill level of operators, level of automation, etc. India is also very diverse, geographically, as well as socially, culturally and ethnically. This means the general approach should enable stakeholders to tailor remediation options to any local situation. This has implications at all levels of abstraction, from the regional cultural situation right down to the practical level, taking into account aspects such as the availability of electric power.

Based on the above, the risk based approach seems, in general, to provide the best opportunities for India. Having said that, it should be noted that the risk based ap-

proach also requires more knowledge than the standard based approach. This is an important point considering soil remediation is a nascent profession in India at the time of writing this document. Therefore, development of a sound structure for knowledge development and dissemination merits due attention.

5 Cost effective groundwater approach

This information is most relevant for Tasks 5.4 and 5.5, in cases where the remediation option to be selected involves dealing with groundwater contamination.

Contamination in groundwater can spread to huge volumes and contaminate large areas. In areas where groundwater or downstream surface water is used as a drinking water source, groundwater contamination is likely to affect this strategic and fundamental asset.

Figure II.5.3-a.3 illustrates that remediation of contaminated groundwater can be very cost intensive and can take a long time. In cases where costs are expected to be too high, it could be interesting to consider cost effective approaches. Costs and amount of contamination to be removed are balanced with the functional use of the groundwater. Such an approach is only possible if there are no actual risks to human health or the environment, or where these risks can be addressed during the remediation phase, or in case pre-consumption treatment of local produced groundwater is feasible. This is because cost effective approaches of groundwater contaminations often mean a long term remediation process such as natural attenuation (NA) or long term groundwater management.

Basic principles of cost effective groundwater approaches are:

- maximum use of natural attenuation techniques;
- long term monitoring of potential hazards;
- assessing sources of spreading. As the remediation of the source of spreading is a relatively cost intensive operation, the remediation of the source can be balanced to the level of spreading which is acceptable;
- use of fall back scenarios only in case of unacceptable spreading (actual threatened receptor).

Cost effective remediation of groundwater offers opportunities for alternative solutions by combining different groundwater uses. For example, a costly pump and treat remediation of a groundwater contamination can be combined with other parties using groundwater for industrial use or irrigation. After having treated the contaminated groundwater it can be offered for use by other parties or even for drinking water supply, thereby effectively reducing the remediation costs. If necessary, a temporary drinking water piping system can be implemented as a safety measure before and during the remediation works.

Volume II

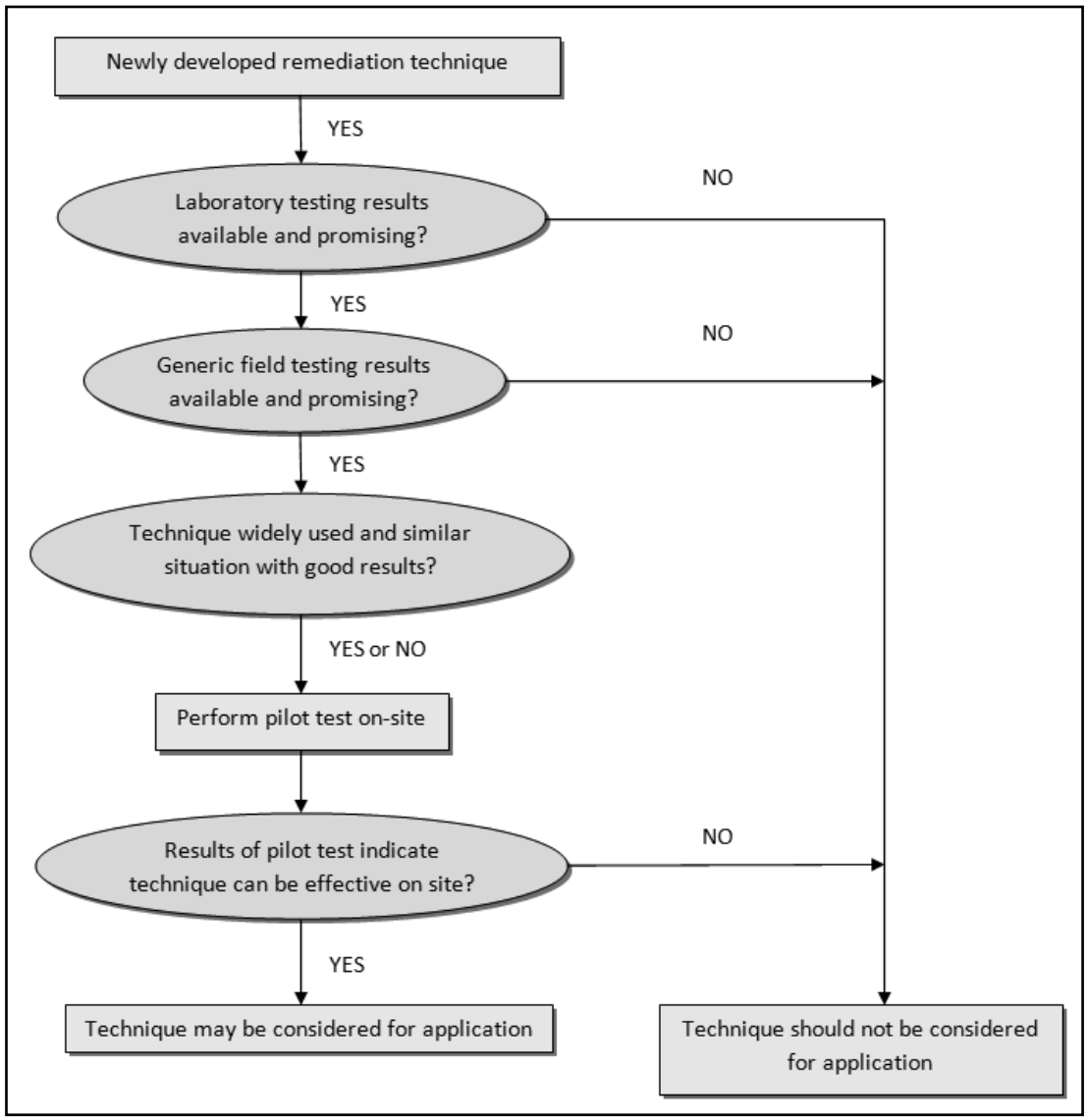
5.4-a Flowchart application newly developed remediation techniques

Volume II-5.4-a
Flowchart application newly developed remediation techniques

1 Introduction

This information is most relevant for Task 5.4, Development of remediation options. A remediation technique must be technically proven before it can be applied with any guarantee of success. This means a newly developed remediation technique needs to be tested, first under laboratory circumstances, but eventually also in the field, before it should be considered for application at a specific site.
The flowchart below presents guidance on the process of considering newly developed remediation techniques for application.

2 Flowchart application newly developed remediation techniques



Volume II

5.5-a Checklist criteria for comparison and appraisal of remediation options

Volume II-5.5-a
Checklist Criteria for comparison and appraisal of remediation options

1 Introduction

This information is most relevant for Tasks 5.4 Development of remediation options and Task 5.5 Selection remediation option.

All remediation options should meet the main aim for remediation: reducing the significant risk to an acceptable level. In case this level is not reached by a remediation option, either additional measures are necessary or the remediation option is not appropriate for the case at hand.

The applicability and expected success of remediation options can be assessed using criteria. These criteria can be divided into two groups:

Generic criteria that should be assessed, regardless of the setting of the site:

- Risk reduction potential: degree to which health and environmental risks are reduced beyond the target level of remediation, offering an extra surplus of risk reduction or protection. Applicable to both immobile and mobile contaminants.
- Technical success potential: technical complexity, implementability, robustness (intrinsic capacity of the technical measures to accommodate changes in circumstances or performance), and the availability of technical capacity.
- Cost and benefits. Included are:
  - Costs for activities like post remediation actions and measures needed due to failure of originally planned measures;
  - Benefits due increased value of the site and to combined implementation with site redevelopment.
- Sustainability: influence of the remediation on other environmental aspects, e.g. air quality, space, ecology, waste, energy.

criteria of which the assessment will depend on site specific circumstances and preconditions:

- Time: time needed to implement the remediation objective. Note: the time needed to implement post remediation actions is considered as a cost and/or social aspect.
- Post remediation site use: degree to which the site can be used for present, planned or not yet known site uses regarding its technical characteristics.
- Social criteria: social acceptance and impacts:
  - Physical Impacts to neighbourhood such as noise, dust, odour, traffic;
  - Changes in the way the local communities function;
  - Changes that could affect the site usage by communities.

The selection of remediation options is a balancing act: one option can be favourable regarding one criterion but can have a negative score on other criteria.
Below, the elements for consideration in the appraisal and selection of remediation options are presented for each criterion.

Elements for consideration for the generic criteria

Criterion: risk reduction potential

- Level of risk reduction: the more the level of risk is reduced the more guarantees can be given the remediation will be adequate and more forms of land use can be practised without threats to health or environment;
- Phasing of remediation: stepwise improvement of a site's situation is preferable when final targets can be met in the future. Provided that most important actual risks are in sight and dealt with as needed. Stepwise improvement means a reduction in remediation efforts and provides more opportunity for natural breakdown of contaminants;
- Size of contamination source: total removal or treatment of the constituents at contaminated sites with a relatively small and well accessible source of contamination is preferable;
- Volume of contamination: the volume of contamination that could be left on site is often too small compared to the efforts required to remove all of it. The extra efforts include the design process of a ‘fitness for use’ approach, remediation actions that are likely to be required if the site will be redeveloped again after a period of time or post remediation actions for management of the contaminations remaining on site;
- Surrounding area: when in a larger area more than one site is contaminated it often makes sense to develop a management strategy for the approach of the whole area rather than taking extensive remediation measures only at that specific site;
- Removal of load: the more kilograms of contamination is removed from the soil, the more the remediation will have a long term impact. Condition however is that the constituents have not been transformed into more toxic or mobile components;
- Liability: in certain cases third parties choose to avoid any risk of liability. In those cases, a remediation where all contamination is removed or treated is the best bet to not end up with post remediation obligations;
- Options for alignment with other developments: if remediation of a site is combined with the redevelopment of the site the redevelopment influences the selection of the remediation option. The alignment of the remediation design to the redevelopment plan (and vice versa). In some cases, land use planning may have to be adapted to the contamination situation, e.g. considering remediation of a former toxic waste dump for agricultural or housing purposes would require high costs, whereas the use as an industrial area may be very cost-effective.

Criterion: technical success potential

This criterion involves technical complexity, implementability, robustness (intrinsic capacity of the technical measures to accommodate changes in circumstances or performance), and the availability of technical capacity.

- Robustness: the remediation measures should remain effective, also under changing conditions or in case of poor maintenance. The measures should be 'simple if possible, and complex only when necessary';
- Stage of development of remediation technique: in case a remediation technique has only proven itself on a laboratory scale, no guarantees for reaching the remediation objective can be given. Proven remediation techniques should be preferred, innovative techniques may be considered after a well documented field trial shows potential success. Pilot tests may help to establish whether the technique is applicable under the specific situations at hand. This means a newly developed remediation technique needs to be tested, first in laboratory circumstances, but eventually also in the field, before it should be considered for application at any given site;
- Risk of failure: when risk of failure of the remediation strategy is considerable, additional costs to implement a fall back scenario should be taken into account.

Criterion: costs and benefits
- Costs for post remediation actions and extra measures needed due to failure;
- Benefits due to increased value of the site and to alignment of implementation with site redevelopment;
- Total budget of the redevelopment and, within that, means available for remediation measures.

Criterion: sustainability
- Influence of the remediation on other environmental aspects, e.g. air quality, space, ecology, waste, energy.

Elements for consideration for the site specific criteria

Criterion: time

This criterion is about the time needed to reach the remediation objective. Note: the time needed to implement post remediation actions is considered as a cost and/or a social aspect.
- Time aspects: the longer a remediation takes the higher the risk of 'loss of control'. Especially in case long term post remediation measures should be taken, this is an important element.

Criterion: post remediation site use

This criterion is about the degree to which the site can be used for present, planned or not yet known site uses regarding its technical characteristics. Examples of this are 1) A complex and high-tech system (walls, interception system, ...) will be out of balance when changes on the site are made. A flexible system can easily accommodate those changes during its lifespan, 2) The more of the contaminants is removed during the remediation phase, the less risks will emerge in case of site use changes, and 3) Changes in site conditions can remobilize contaminants immobilized during the remediation phase.
- Disinvestments in case of site use changes: the more costs are spent on physical measures, the more costs are lost in case these measures need to be removed during future redevelopment. This can be avoided by later site use restrictions, but these will be difficult to maintain. A better solution is offered if this is considered as a design starting point;

- Time available for remediation: in case of a redevelopment plan a short and high cost remediation approach can be selected just to prepare the site within certain planning limits for the actual redevelopment. In cases where little time is left for remediation, a standard based high cost remediation approach taking only little time, might be selected.

Social criteria: social acceptance and impacts

- Physical Impacts to neighbourhood such as noise, dust, odour, traffic;
- Changes in the way the local communities function;
- Changes that could affect the site usage by communities;
- The degree to which a function fitted remediation may be aligned with redevelopment objectives.

Volume II

5.5-b Checklist Remediation investigation report

Volume II-5.5-b
Checklist Remediation investigation report

1 Introduction

This information is most relevant for Task 5.5 Selection remediation option. The investigation leading to the selection of the most applicable remediation option is reported in a Remediation investigation report. This checklist presents the aspects that should be addressed in such a report. This general checklist should be adjusted for a specific situation.

2 Checklist Remediation investigation report

The checklist below can be used to identify and assess the content of the detailed site investigation. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the Remediation investigation	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	**CSM and risk assessment**				
	A	Historical information of the site including subsequent site and groundwater use, industrial processes leading to soil contamination	Yes		
	B	Geology	Yes		
	C	Geohydrologie	Yes		
	D	Description of all contaminations (sources) including spreading processes (pathways)	Yes		
	E	Description of risks (receptors)	Yes		
2	**Remediation objectives**				
	A	Risks to be remediated	Yes		
	B	Objectives of the remediation	Yes		
	C	Requirements of the remediation including other activities which are executed simultaneously (redevelopment)	Yes		
	D	Stakeholders	Yes		
	E	Funds	Yes		
	F	Other legislation to be met	Yes		
	G	Preconditions to be met with the remediation	Yes		
3	**Description remediation options**				
	A	Technical aspects to achieve the remediation objective an requirements	Yes		
	B	Effects on surrounding and counter measures: sound, noise, soil vibration, groundwater drop, traffic hinder (intensity and duration), stability of soil	Yes		
	C	Practical aspects of implementation: preparation of / on the site, safety measures	Yes		
	D	Measurements / sampling program to verify the progress and final result of the implementation phase	Yes		

	E	Communication with stakeholders prior to, during and after the remediation	Yes		
	F	Production and/or usage of: energy, soil, air, water and activities or technical measures to dispose of products	Yes		
	G	Risks and countermeasures during implementation: technical, planning, concentration levels	Yes		
	H	Legal aspects: permits and legal constraints	Yes		
	I	Planning: preparation phase, implementation, extensive phase of in situ techniques, post remediation measures	Yes		
	J	Post remediation measures: description of residual contaminations and subsequent technical and management measures necessary to prevent future human and ecological risks and risks of spreading of the contaminations	Yes		
	K	Costs: implementation, post remediation phase and risks	Yes		
	L	Point for further investigation during DPR or pilot phase	Yes		
4	**Evaluation of possible remediation options**				
	A	Points for evaluations	Yes		
	B	Method for evaluations	Yes		
	C	Evaluations of options (qualitative or quantitative)	Yes		
	D	Selection of most favourable remediation option	Yes		
	E	Point for further investigation during DPR or pilot phase			
5	**Annexes**				
		Maps, x-sections, tables technical schemes	Yes		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

5.5-c Checklist review and approval Remediation investigation report

Volume II-5.5-c
Checklist Review and approval Remediation investigation report

1 Introduction

This information is most relevant for Step 5, Remediation investigation. The report of the Remediation investigation is to be reviewed by the competent authority to prepare the decision by the appropriate official.
The checklist below provides the points of attention for the review.

2 Checklist review and approval Remediation investigation report

The checklist below can be used to review the preliminary site investigation. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the Remediation investigation	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist Remediation investigation report	Evaluation if the report meets all elements for a Remediation Investigation Report VII-5.5-b.	Yes		
2	Skills and accreditations	Evaluation if the specialized agency or consultant charged with Remediation investigation report meets the required skills and accreditations.	Yes		
3	Stakeholder rights and interests	Evaluation if the stakeholder rights are guaranteed. A thorough stakeholder involvement offers a good basis for securing stakeholder warranties.	Yes		
4	Third party values	Validation by third parties of key elements to evaluate potential risks of individual options [1)].	Yes		
5	Points of interest to assess the results of the Report	• Is any remediation option with potential better result missing? • Are the remediation objectives of all described options likely to be reached when implementing these options? • Are all options well described to make a final selection? • Does the evaluation / ranking of all options meet all objectives and requirements set (including those from other legislation)?	Yes		
6	Conclusion	Can Remediation investigation report be approved? If not, which further information is required?	Yes		

1 e.g. risk assessment calculations, samplings, results of pilot testing

Explanatory notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

6-a Checklist DPR including verification plan

Volume II-6-a
Checklist DPR including verification plan

1 Introduction

This information is most relevant for Step 6, Remediation design, DPR.
The design of the remediation is meant to detail out the selected remediation option into separate activities. These technical and organisational aspects of these activities and their environmental impact should be described in Detailed Project Report or remediation design plan (DPR).

The checklist below provides the points of attention when designing the remediation activities. In a way it can be regarded as a table of content for DPR. The elements of a verification plan are included in this table. For specific sites some of the elements can be found not applicable.

2 Checklist DPR including verification plan

The checklist below can be used to identify and assess the different elements of the DPR. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the DPR	
Date of recording	
Recording official	

Content of DPR	Status	Comments
Introduction and background information • Description of the site (e.g. name, owner, address, GPS-coordinates, site plan and size); • Reason for the remediation; • Summary of the previous investigations at the site; • Information of the parties involved in the remediation process and allocation of their roles.		
Site situation • The situation of the contamination at the site (present land use, infrastructure, buildings, use of the surrounding area); • Description of history of the land use and cause of the contamination; • Typology of the contaminated site; • Geology, geohydrology and soil structure and ground conditions of the site in case of contaminated soil and groundwater.		

• Morphological and hydraulic aspects in case of contaminated sediments in surface water and seasonal variations in water level; • The conceptual site model with the combinations of source-pathway-receptor) of concern. A detailed description of the present contamination with characteristics (parameters, concentration, extent in horizontal and vertical direction, mobility, density);		
Remediation approach • Objective of the remediation related to regulatory requirements and the selected remediation option; • Combination of the remediation with reconstruction activities at the site, possible impact on planning and results of the remediation measures and description of measures to manage this impact; • Targets levels of the remediation to be achieved; • Remediation techniques to be used: technical description; • Stages in the remediation process (if appropriate); • Necessity of a pilot testing of the remediation technique.		
Detailed description of the remediation process • Preparation activities: ° removal of buildings, infrastructure, foundations, tanks in order to achieve access to the contaminated material; if removal is not possible, which working constraints will have to be dealt with; ° mobilisation of equipment to the site; ° necessary staff during the remediation; ° organising the working and storage areas at the site; ° possible access limitations to parts of the site or the neighbouring area; ° availability of suitably licensed treatment or disposal capacity off site; • Overview of the necessary permits and licenses; • Measures necessary to prevent damage or nuisance (such as dust, odours, noise and dirt on roads) on the site and in the surrounding area (including possible transport of removed waste to a treatment or disposal site); • Measures to improve sustainability aspects (e.g. reducing energy); • When excavation of soil or dredging of sediment is part of the remediation strategy: ° size and contours of the excavation (area and depth); ° estimated volume of material to be excavated (in-situ and after excavation) and destination of the material (on-site rearranging or off-site treatment or disposal, for which the procedures of HWR-2008 may apply); ° necessary abstraction of groundwater; ° in case of dredging sediment: necessary preparation on the water way, lake, river or canal; ° temporary storage of material in depots; ° quality of the clean material to be used to replace the removed contaminated material;		

- When groundwater abstraction is part of the remediation strategy:
  - Pattern and depth of wells;
  - Volume and planning of the abstraction period;
  - Results model calculations of the groundwater remediation;
  - Method of discharging abstracted water and necessary treatment;
- When in-situ techniques are part of the remediation strategy:
  - Equipment to be installed (indication, pattern and specific location);
  - Maintenance activities during the active phase of the remediation;
- Checkpoints during the remediation process and action levels or other criteria for assessment the intermediate results;
- Possible effects of the remediation measures and mitigating activities to be carried out to minimize these effects;
- Possible uncertainties in the situation (e.g. the delineation of the contamination is not very detailed at one side of the location) and ways of dealing with these risks.
- Planning of the remediation activities (project implementation schedule);
- Programme for supervision and environmental verification;
- Suggestions for sampling, testing and other measurements related to verification (to be elaborated further in a verification plan):
  - what are be the key parameters to verify the success of the progressing remediation;
  - which monitoring equipment should be installed before and during the remediation.
- Expected restrictions to future land use after finalizing the remediation activities;
- Identification of the need for post remediation activities;
- Health and safety aspects during the remediation:
  - possible exposure to contaminated material by skin contact, ingestion or inhalation;
  - necessary measures to prevent these risks (description of these measures to be elaborated in step 8);
  - safety measures regarding equipment and transport.
- Record keeping, use of a log;
- Estimation of costs, with distinction between costs for installing equipment, short term measures and costs for long term remediation and maintenance. Sometime an analysis of risks and variation of the costs;
- Insurance;
- Communication aspects in the process of implementation of the remediation. These communication aspects are related to restrictions and nuisance during the remediation and the possible restriction for land use in the final situation. Relevant stakeholders for the communication should be indicated;
- Maps, drawings, calculations must be added as annexed to the remediation design report.

Content of verification plan This Section presents a generic checklist for a verification plan, being part of the Detailed Project Report. In this verification plan the activities are described for verifying the results of the remediation.		
Supervision and environmental verification • Description of the tasks of the supervision and environmental verification of remediation works; • Possible response actions to deal with uncertainties; • Critical points in the remediation process where the progress should be assessed, a list of critical points during the remediation is given below (examples are the moment where an excavation; has reached its ultimate boundaries. Before supplementing with clean soil/material samples should be taken from the pit wall and bottom. Another example is a check on reaching the intended depth for a groundwater extraction or treatment unit and verifying the number and pattern of extraction wells); • Log with daily information of the site: remediation activities; verification activities; visits of regulators, accidents, injuries; etcetera; • Results of sampling and testing the quality of removed or treated contaminated material and the quality of remaining soil or sediment; • Results of (periodical) testing of the quality of surface water or groundwater; • All executed measurements to check health and safety aspects and compliance with environmental permits and licenses;		
Communication • Overview of institutions and persons involved (names, addresses, telephone numbers, email); • Appointments on communication with stakeholders (authorities, companies, community, press); • Procedure for reporting for critical and non critical deviation of the DPR; • Procedure for reporting incidents and accidents at the site during the remediation; • Planning of reporting interim and final results in an evaluation report to the authority.		
Monitoring programme • For long-term remediation projects where in-situ techniques are used or where groundwater is extracted and remediated monitoring of interim results is a very important activity to verify if the remediation results are heading in the right direction; • Part of the monitoring programme is a planned sampling and testing strategy for the quality of soil, groundwater, sediments or surface water (if appropriate); • Criteria for the evaluation of interim results of the remediation (e.g. the concentration gradient of a parameter in groundwater); • Action levels for evaluation or response actions.		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

6-b Example format cost estimation remediation

Volume II-6-b
Example format cost estimation remediation

1 Introduction

This information is most relevant for Step 6, Remediation design, DPR.
All remediation activities descried in the DPR are summarized and a costing is made for each of these activities. These activities do not only involve the technical measures of the remediation. The preparation of the work, including costs for demolishing building or replacement of inhabitants may be involved as well. The costs for management, supervision and verification of the remediation works should be included as well. The previous costs of investigation of the site and preparation of the remediation design may be summarized to the total of relevant costs.

2 Example format cost estimation remediation

An overview of cost elements of a remediation is presented in this Example format. The costing should include volumes, amounts and unit prices.

Some of the cost elements may be estimated quite accurately, some elements may be difficult to estimate. It may be useful to apply a bandwidth for elements which have large impact on the total costs.

Estimation of remediation costs

VII-6-b Example format cost estimation remediation Excavation

example: soil excavation, off site treatment of soil, groundwater abstraction and treatment

no	discription activities	unit	cost / unit	quantity	amount (INR excl taxes)
A	**Preparation remediation**				
	surveying of site lay out	item			
	establishing boundaries of remediation site and install temporary fences with signs	item			
	construction of temporary access road to the site	item			
	installing and renting temporary office space for contractor and project manager	week			
	removal of surface covering (asphalt etc.)	m2			
	removal of surface covering (vegetation)	m2			
	removal of buidlings or other objects on the site	item			
	mains: installation of water & electricty to the site	item			
	sub-total preparation of remediation				
B	**Excavation of contaminted soil**				
	Excavation of non contaminted soil and transport to depot on site	m3			
	Excavation of contaminted soil	m3			
	transport of contaminated soil for off-site treatment or landfilling	M1			
	delivery and transport to the site of non contaminated soil	m3			
	reuse of non contaminated soil from the site	m3			
	filling of excavation pits with non contaminated soil including compacting	m3			
	repaving of surface	m2			
	replanting of the site	m2			
	sub-total excavation of contaminated soil				
C	**Groundwater remediation: installation of abstraction wells and treatment plant for contaminated water**				
	borings for installation groundwater abstraction wells. Depth 20 m-bg including well screens	item			
	undergound mains: piping for water including underground installation, electricity for wells	m1			
	installation of pumps to be installed in wells (deepwells)	item			
	well covering for abstraction wells	item			
	preparation of site for location treatment plant	item			
	on site installation of treatment plant. Capacity 10-20 m3/h	item			
	connecting wells etc. to equipment	item			
	start up process treatment plant	item			
	sub total installation of wells and treatment plant				
D	**General costs**				
	on-site guidance & project management during excavation and installation of groundwater remediation	weeks			
	permitting	item			
	preparation of contract and tendering of the works	item			
	insurances	item			
	general costs, contracting costs	item			
	subtotal general costs				
E	**Off-site treatment contaminated soil**				
	off-site treatment or lanfdilling of contaminated soil	MT			
	sub-total treatment contaminated soil				
	total investment (A, B, C, D, E)				
	Operational costs groundwater remediation				
F	**Operation groundwater remediation**				
	operation of water treatment plant incl. minor adjustments	month			
	maintenance treatment plant and abstraction wells etc	month			
	electricity consumption kwh/year	month			
	groundwater sampling on the site and surrounding area for verification remediation process	item			
	groundwater analyses verification remediation process	piece			
	project management groundwater remediation	month			
	report on remediation progress	piece			
	final report evaluation on the remediation	item			
	subtotal groundwater remediation				
	total operational costs (F)				
	Total costs excluding taxes				-

type of unit is depending on the activity

this section should specify all contracting actions before actual remediation sta

this section should specify all actions related to the excavation of contaminate

site for the soil treatment should be known before remediation start

this section should specify all actions related to the installation of the groundw

this section includes mainly project management issues carried out by a consu

the method for soil treatment should be known before remediation start

this section includes the operational costs for the groundwater remediation

Estimation of remediation costs

VII-6-b Example format cost estimation remediation SVE

example: soil vapor extraction and in-situ air sparging

no	discription activities	unit	cost / unit	quantity	amount (INR excl taxes)
A	**Preparation remediation**				
	surveying of site lay out	item			
	establishing boundaries of remediation site and install temporary fences with signs	item			
	construction of temporary access road to the site	item			
	installing and renting temporary office space for contractor and project manager	week			
	mains: installation of water & electricty to the site	item			
	sub-total preparation of remediation				
B	**Pilot plant soil vapor extractie & air sparging**				
	design of pilot plant	item			
	installation soil vapor extraction wells incliding drilling and well material	piece			
	installation air sparging well incliding drilling and well material	piece			
	installation of SVE and air sparging equipment	item			
	piping for the wells and connection to SVE-blower and Air sparging compressor	item			
	base line measurement soil and groundwater before start pilot	item			
	start pliot and initial measurements	item			
	monitoring during pilot (various measurements and sampling)	week			
	analyses (soil air, water) during pilot	piece			
	operational costs SVE and air sparging during pilot	week			
	report pilot including assessment of application and design details for full scale remediation	item			
	sub-total pilot				
C	**Installation of soil vapor extraction & air sparging system**				
	borings for installation of SVE and air sparging wells	item			
	installation of SVE wells, depth 5 m -bgs	piece			
	installation of air sparging wells , depth 10 m -bgs	piece			
	undergound mains: piping for SVE and air sparging underground installation	m1			
	installation of SVE and air sparging equipment for full scale remediation	item			
	installation for off gas air treatment: activated carbon	item			
	connecting varius well etc. to equipment for SVE and air sparging	item			
	sub total installation of SVE and air sparging and off gas treatment plant				
D	**General costs**				
	on-site guidance & project management during installation of in-situ systems	weeks			
	permitting	item			
	preparation of contract and tendering of the works	item			
	insurances	item			
	general costs, contracting costs	item			
	subtotal general costs				
E	**Off-site treatment contaminated soil**				
	off-site treatment or landfilling of contaminated soil	MT			
	sub-total treatment contaminated soil				
	total investment (A, B, C, D, E)				
	Operational costs in-situ remediation				
F	**Operation SVE & air sparging**				
	operation of soil vapor extraction system	month			
	maintenance and replacing activated carbon off gas treatment plant	month			
	electricity consumption kwh/year	month			
	removal of installations including off gas treatment plant	item			
	sub-total operation in-situ system				
G	**Project management in-situ remediation**				
	soil gas sampling on the site verification remediation process	item			
	ground & groundwater analyses verification remediation process	piece			
	project management in-situ remediation	month			
	analyses (soil air, water)	piece			
	report on remediation progress	piece			
	final report evaluation on the remediation	item			
	subtotal project management				
	total operational costs (F+G)				
	Total costs excluding taxes				-

this section should specify all contracting actions before actual remediation sta

a pilot plant is not allways required

this section includes mainly project management issues carried out by a consu

this only applies for the core drillings of the wells

in-situ remediations require various measurements to control all the systems a

Volume II

7-a Checklist review and approval Detailed Project Report

Volume II-7-a
Checklist review and approval Detailed Project Report

1 Introduction

This information is most relevant for Step 6, Remediation design, DPR. The Detailed Project Report of the specific site is to be reviewed by the competent authority to prepare the decision by the appropriate official.
The checklist below provides the points of attention for the review.

2 Checklist review and approval Detailed Project Report

The checklist below can be used to review the DPR. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the DPR	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist Detailed Project Report including verification plan	Evaluation if the report meets the elements necessary for a DPR (see VII-6-a)	Yes		
2	Skills and accreditations	Evaluation if the specialized agency or consultant charged with the DPR meets the required skills and accreditations	Yes		
3	Stakeholder rights and interests	Evaluation if the stakeholder rights are guaranteed. A thorough stakeholder involvement offers a good basis for securing stakeholder warranties. Have the results of the environmental and social impact assessment been shared with relevant stakeholders?	Yes		
4	Points of interest to assess the results of the remediation	• The remediation objectives according to the selected remediation option (in task 5.5) should be met; • The remediation should be technically well feasible; • The results of the environmental and social impact assessment are acceptable and within regulatory permits. Additional measures will be applied where negative impact of the remediation measures may occur;	Yes		

		• There are clear criteria to assess the progress and final result of the remediation; • The activities to verify the progress and results of the remediation are clearly described; • Uncertainties which may have effect on the remediation result are indicated explicitly and the DPR provides scenarios and measures in case these uncertainties will occur.			
5	Conclusion	Can Detailed Project Report be approved? If not, which further information is required?	Yes		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

8.1-a Checklist permits for remediation works

Volume II-8.1-a
Checklist permits for remediation works

1 Introduction

This information is most relevant for Step 8, Implementation of remediation.
This Section presents a checklist of the regulatory permits, licenses and/or consents that should be applied for during the preparation and authorization (Task 8.1).

This is a generic checklist, to be adjusted to the situation of a specific remediation project. Depending on the local or regional regulations the necessary permits and licenses will vary. Aspects relating to land ownership and land use are not included in this checklist.

2 Checklist permits for remediation works

The checklist below may be used to identify and assess the required permits. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the DPR: description of remediation design	
Date of recording	
Recording official	

Permit, license, consent	Status	Comments
Environmental Clearance (to be confirmed from competent Authority) (Clearance from MoEF) • Environmental Clearance will include Environmental Impact Assessment, Public Hearing etc. as stipulated in EIA notification SO.1533 dated 14.09.2006		
Preparation of the site (permission from Urban development) • Demolition or removal of buildings or infrastructure; • Cutting trees; • Constructions in canals, rivers or lakes anticipating dredging of sediment.		
Waste management licenses (permission from Pollution Control Board) • License to excavate or extract polluted material at the site and to store it temporarily; • Way of treatment of this material at the site (mobile plant for on-site treatment);		

• Transportation of waste material (distance, final destination, means of transport, route of transport with impact of dust and noise on inhabitants along the route).		
Groundwater abstraction and purification permits (Permission from Ground Water Board) • Groundwater abstracted from the soil per day; • Groundwater abstraction from wells (volume, radius of influence);		
Treatment and discharge of water (Permission from Pollution Control Board) • Installation and operation for treatment/purification of extracted groundwater; • Discharge of treated water into surface water or sewage system.		

Explanatory notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

References:

- EIA so1533.pdf
- The Water (Prevention and Control of Pollution) Rules 1975.pdf
- THE AIR (PREVENTION AND CONTROL OF POLLUTION) RULES, 1982.pdf
- The Environment (Protection) Rules, 1986.pdf
- HWRulesFinalNoti240908.pdf
- MSW Rules 2000.pdf
- The Bio-Medical Waste (Management and Handling) Rules, 1998.pdf
- The Noise Pollution (Regulation and Control) Rules, 2000.pdf
- The Plastic Waste (Management & Handling) Rules, 2011.pdf
- THE PUBLIC LIABILITY INSURANCE RULES, 1991.pdf
- Central Motor Vehicles Rules 1989.htm
- MODEL RULES FA 1948.htm
- The Chemical Accidents (Emergency Planning, Preparedness, and Response) Rules, 1996.pdf
- National Green Tribunal Act 2010.pdf

Volume II

8.2-a Checklist prequalification for remediation

Volume II-8.2-a
Checklist prequalification for remediation

1 Introduction

This information is most relevant for Step 8, Implementation investigation. The remediation works may be appointed to a third party, typically a contractor. This checklist is also useful for Step 11, Post remediation activities.

The client who contracts out this assignment may be a private person, private organization or the local, State or Central authority. This checklist provides support for the client in the selection of a contractor. To ensure a good quality remediation, it is vital that this third party can demonstrate the expertise, skills and compliance relevant for the assignment. Where available, it is preferable if this is supported by relevant accreditations.

At the outset, it is very important that the client/organization responsible for remediation provides clear Terms of Reference (ToR), which should at least include the objectives of the remediation, the required output and the possible constraints. These should be described in the bid document, developed in Task 8.2 Contracting. Without a clear bid document the third party may interpret the situation differently resulting in the proposed activities not leading to the required output. Furthermore, if more than one party is requested to tender an offer, an unclear bid document can lead to differences that render a fair comparison impossible. If the client is a private organization it may be advisable to contact the competent authority for assistance.

2 Checklist for the prequalification for remediation

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main aim of the appointment	
Date of recording	
Recording official	

Prequalification criteria for selection of the specialized organization	**Status**	**Comments**
Information about Firm: Firm's Background; Firm's Registration; Firm's Class Certificate; Bank Solvency; Banking History; Tax History; Liability History;		

Black Listing History; Joint ventures / tie ups; Type of firm – Pvt. Ltd..- Proprietary – Partnership; Work experience: Bid capacity.		
Financial capability: Financial statement & Profit & Loss of last 5 years; Return on net worth ratio; Quick ratio; Current ratio; Asset turnover ratio; Ratio of Fixed assets / long term Liabilities; Debt ratio; Insurance of equipment; Working capital.		
Technical capability: Firm's building work experience; Equipment and Plant ownership by the contractor; Onsite laboratory equipments; Experienced project managers / civil engineers / electrical engineers; Labours (skilled & unskilled); Training programme for the personnel; Personnel experience in similar projects; Job expertise.		
Management capability: Business evaluation; Change in core Management; Head office organization structure; Coordination & safe administration; Number of technical staff; Number of non-technical staff; Failure to complete past project; Current work load; Research & Development.		
Construction capability: Cost control; Schedule / time Control; Quality Management System; Quality assurance; Resource Management; Number of Sub-contractors & Work load on sub-contractor; Method of procurement.		

Past experience: Scale of projects completed; Type of projects completed; Experience in local area; Similar type of 5 projects completed; Time overruns in past projects; Cost overruns in past projects; Quality achieved in past project. Experience in social aspects regarding investigation of sites for environmental reasons.		
Reputation condition: Arbitration History; Trade History; Past relationship with Client / consultant; Awards; Past projects claims History; Termination of contract; Relationship with sub-contractor.		
Health and safety policy: Safety management system Accidents in past projects Insurance of personnel		
Use of Information Technology & Services: Project Management Software Personnel knowledge in IT / Software Level of Technology		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

8.3-a Checklist Health and Safety plan

Volume II-8.3-a
Checklist Health and Safety plan

1 Introduction

This information is most relevant for Task 8.3 Execution, supervision and verification remediation works, and for Step 11 Post remediation action.

2 Checklist Health and Safety plan

The checklist below provides the elements that should be included in any Health and Safely plan for a soil remediation project. For specific sites some of the elements can be found not applicable. The checklist may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Contractor	
Supervisor	

Content of Health and Safety plan	Status	Comments
All onsite workers should be provided with the following materials • Jackboots, resistant to chemicals and with a safety sole (steel plate); • Liquid tight overall; • Liquid tight gloves; • Safety helmet. Additional materials in case the presence of toxic fumes or dust (e.g. asbestos) is expected: • breath and eye protection; • measurement instruments.		
Measures in preparation of remediation • Prepare Health and Safety plan; • Start log; • Mark “contaminated zone” and mark “clean zones”; • Ensure availability of first aid materials and relevant first aid knowledge; • Inform onsite workers on relevant Health and Safety aspects, through oral and written information and education.		
Hygiene during remediation measures • Limit the number of people needed in the contaminated area; • Work with machines as much as possible; • Have onsite workers work on the windward side of the contamination whenever possible; • Prohibit observation by means of smelling; • In case of handling barrels full protective measures (including breathing protection) apply (see above);		

Content of Health and Safety plan	Status	Comments
• Forbid eating, drinking and smoking in the contaminated area; • Ensure that, whenever people leave the contaminated area, boots are cleaned and coveralls are left in the contaminated area; • Prevent the generation of dust (e.g. by spraying water); • Ensure availability of face and breath protection throughout; • Forbid open fire. Machinery: • Ensure any excavating equipment is provided with overpressure cabin and dust filter.		
Optional measurements during remediation measures • PID (Photo Ionization Detector); • Toximeter (gas testing vials); • Cyanide measurements; • H_2S-measurements; • Active coals vials; • Personal air sampling by badges (attachment of badges near inhalation zone); • Explosion meters (oxygen-explosion meter).		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

8.3-b Checklist supervision and verification remediation measures

Volume II-8.3-b
Checklist supervision and verification remediation measures

1 Introduction

This information is most relevant for Task 8.3, Execution, supervision and verification remediation measures. The performance of supervision and verification of remediation measures is usually commissioned to an independent third party environmental supervisor

2 Checklist supervision and verification remediation measures

The checklist below provides the elements that should be monitored during supervision and verification of remediation measures. For specific sites some of the elements can be found not applicable. The checklist may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Summary of remediation works	
Date of recording	
Contractor	
Recording supervisor	

Supervision and verification of remediation measures	**Status**	**Comments**
Supervision and verification (technical) *Elements for supervision and verification plan* • Outline supervisor tasks; • Potential response actions to deviations from remediation plan; • Critical activities in the remediation process. A list of these is presented in the table below this one. *Elements for ongoing supervision and verification* • Log on daily progress of remediation, supervision and verification measures, like visits by regulators; • Results of sampling and testing the quality of removed or treated contaminated material and the quality of remaining soil or sediment; • Results of (periodical) testing of the quality of surface water or groundwater; • Results of all measurements performed to check health and safety aspects and compliance with environmental permits and licenses;		
Communication *Elements for supervision and verification plan* • Contact information of institutions and persons involved (names, addresses, telephone numbers, email addresses); • Agreed actions concerning communication with stakeholders (authorities, companies, community, press);		

Supervision and verification of remediation measures	Status	Comments
• Procedure for reporting critical and non critical deviation from the DPR; • Procedure for reporting incidents and accidents at the site during the remediation; • Planning of reporting interim and final results in an evaluation report to the authority; • Verification of results of remediation has to be carried out by a party independent from contractor, owner, occupier and other stakeholders. *Elements for ongoing supervision and verification* • Record events concerning communication and their results in the daily log.		
Monitoring (only in long-term remediation projects) *Elements for supervision and verification plan* • Sampling and testing strategy for monitoring the quality of soil, groundwater, sediments or surface water (whatever is appropriate); • Criteria for the evaluation of interim results of the remediation (e.g. the concentration gradient of a parameter in groundwater); • Action levels for evaluation or response actions.		

Explanatory notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Critical activities during remediation

Critical activities during remediation	Aim and most relevant elements of activity
Installation of systems for management or isolation or in situ remediation	Affix systems (withdrawals, cleansing, retaining walls) needed to create the desired (management) situation
Controlling of operating systems	Assess whether commissioned systems comply with technical requirements
Sampling of excavated material	Assess potential reuse options of excavated material. Classify according to HWR (2008) to determine hazardous waste
Assessing excavated material for processing capabilities	Clear and correct manner of assessment
Sampling of air or water	Correctly perform sampling and analysis of effects on environment
Assessing the processing capabilities of air or water (discharge, purify)	Correct and honest manner considering possible processing options based on sampling results
Checking progress of remediation measures	Clear management of the implementation process on quality, quantity and time
Recording of and approving delivery of the work undertaken	Clear determination that meets objective or design work carried out and change (transfer) responsibilities
Documenting of agreements prepared during execution of remediation measures (technical, organizational, financial)	Clear commitment of appointments, arguments which may lead to changes to the original plan of specifications and conditions
Final check of excavated material (soil and groundwater)	Clear provision end situation
Evaluation of work undertaken	Interpretation and assessment of work undertaken, as well as the end result achieved in relation to objective of the remediation
Preparing remediation evaluation report	Clear documentation of basic information and information during the execution and outcome of the remediation

Critical activities during remediation	Aim and most relevant elements of activity
Assessing whether management or post remediation activities are needed	Assess whether remediation can be considered as completed or that the after-care phase must be restarted or management
Commissioning of systems	Set of systems that these both individually and jointly meet the technical and environmental conditions for the management and aftercare
Assessing need for modification of systems	Assess whether and which additional measures are needed to systems individually, or collectively, to work better
Drafting of post remediation programme	Picture of programmatically monitoring, maintenance and replacement activities
Determining restrictions for land use	Unambiguous picture of restrictions as a result of measures selected must be made to the use of the location
Drafting report on post remediation activities	Unambiguous commitment of basic information, objective and approach/programming during post remediation phase
Running post remediation programme	Structured system to perform work to maintain and monitor for proper operation
Evaluation of results of implementation programme	Interpretation and evaluation of work carried out and the results obtained in relation to objective
Provision necessary modifications work, installations or objective	Assess whether and which additional measures are needed to meet the objective of ensuring better, or to what extent adjustment of the objective is necessary
Determining progress or end of management or post remediation phase	Unambiguous determination of the status of the project in relation to the objective

Volume II

8.3-c Checklist remediation evaluation report

Volume II-8.3-c
Checklist Remediation evaluation report

1 Introduction

This information is most relevant for Task 8.3, Execution, supervision and verification remediation works, and for Step 9, Approval remediation completion.

2 Checklist Remediation evaluation report

The checklist below provides the elements that should be included in the Remediation evaluation report. For specific sites some of the elements can be found not applicable. The checklist may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the remediation	
Date of recording	
Recording official	

Content of Remediation evaluation report	**Obligatory**	**Status**	**Comments**
Introduction and background information			
Site metadata (e.g. name, owner, address, GPS-coordinates, site plan and size)	Yes		
Reason for the remediation	Yes		
Summary of the previous investigations and the situation of the contamination at the site (description of history of the land use and the conceptual site model with the applicable combinations of source-pathway-receptor)	Yes		
Agreed remediation objectives and target values	Yes		
Overview of the relevant permits and licenses	Yes		
Summary of the remediation strategy	Yes		
Summary of the intended activities during verification according to the agreed verification plan, including methodologies used for data collection and interpretation	Yes		
Information of the parties involved in the remediation process and their roles	Yes		
Remediation process			
Selected remediation option and specific techniques used	Yes		
Sequential overview of performed remediation activities and parallel supervising and verification activities	Yes		
Summary of incidents and performed mitigating measures	If applicable		
Summary of deviations from the original remediation plan and performed mitigating measures. Including analyses of technical (remediation goal and levels), financial (development of costs compared to the initial cost estimate and	If applicable		

Content of Remediation evaluation report	Obligatory	Status	Comments
contracted activities; note for evaluation purposes only to optimize future site remediations), legal (e.g. site reuse restrictions) and organisational aspects (consequences for post remediation).			
Results of the remediation: ° volume of waste, soil or sediment removed or treated; ° volume of groundwater or surface water removed or treated; ° volume and quality of (liquid) waste transported off-site; ° volume and quality of material imported to the site; ° data on the quality of capping layers or barriers (including depth, thickness, permeability); ° information on permanent remediation installation (for in-situ treatment or containment of the contaminated site); ° Annexes with the original test results, photographs, drawings, measurement results, registration documents etc.	All elements that are applicable		
Results of verification measurements (e.g. sampling of extracted material or sampling of pit wall)	Yes		
Results of monitoring of the remediation progress or the attainment of remediation target (e.g. testing surface water or groundwater quality)	If applicable		
Results of the monitoring to demonstrate compliance with health, safety and environmental requirements (according to the health and safety plan and the regulatory permits, licenses and consents)	Yes		
Conclusion on the remediation results			
Description of the situation after completion of the works, supported by a review of the conceptual site model and a description of the rate of contaminant mass reduction and/or removal	Yes		
A conclusion on the effects of deviations of the performed activities, related to the activities as planned in the DPR	If applicable		
Clear conclusion on whether the remediation objectives have been met	Yes		
Identification of the need for post remediation action, and if that is the case, description of monitoring and maintenance requirements to ensure that the performed remediation action remains effective and that the residual contamination will not cause risks for human health or the environment	Yes		
Restrictions to future land use and activities	If applicable		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

9-a Checklist review and approval Remediation completion

Volume II-9-a
Checklist review and approval Remediation completion

1 Introduction

This information is most relevant for Step 9, Approval remediation completion. The results of the remediation have been described in an evaluation (or clean-up) report which is to be reviewed by the competent authority to prepare the decision by the appropriate official. The checklist below provides the points of attention for the review.

2 Checklist review and approval Remediation completion

The checklist below can be used to review the remediation evaluation (clean-up) report. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the remediation	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist Remediation evaluation report	Evaluation on whether the Remediation evaluation report meets the requirements of the Checklist Remediation evaluation report (Volume II-8.3-c)	Yes		
2	Verification of the remediation	Results of the verification of the remediation results by an independent third party	Yes		
3	Skills and accreditations	Evaluation on whether the specialized agency or consultant responsible for the preparation of the Remediation evaluation report meets the required skills and accreditations	Yes		
4	Validity of values	When doubting results: cross-check third party values	If necessary		
5	Stakeholder rights and interests	Evaluation on whether the stakeholder rights are guaranteed. A thorough stakeholder involvement offers a good basis for securing stakeholder warranties	Yes		
6	Long term guarantees	Evaluation if the Remediation evaluation report offers adequate long term guarantees for risk protection and liability. Aspects involved are: A Technical aspects B Legal aspects C Financial aspects D Management aspects	Yes		
7	Conclusion	Can remediation completion be approved? If not, which information has to be provided or which activities have to be carried out?	Yes		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

10-a Checklist Post remediation plan

Volume II-10-a
Checklist Post remediation plan

1 Introduction

This information is most relevant for step 10, Post remediation plan (PRP).
Such a plan is required only when a remediation is completed while leaving residual contaminations at the site. In such cases site use restrictions are likely to be in force, and technical measures may be necessary to prevent future human and ecological risks and risks of spreading of the residual contaminations.

The post remediation plan describes all the technical and supporting management activities such as monitoring, maintenance, repairs and corrective actions to keep a remediated site in such a state as to prevent future risks. The post remediation plan should provide for a long term guarantee to the competent authority for a long lasting and adequate risk control.

The checklist below provides a comprehensive overview of elements a full scale post remediation plan may contain. The checklist indicates for every element whether it is obligatory. The post remediation plan is forwarded to the competent authority for approval.

2 Checklist Post remediation plan

Site ID (Name User and Owner, Address, GPS-coordinates)	
Summary of Post remediation plan	
Date of recording	
Recording official	

No.		Topic	Obligatory	Status	Comments
1		Conditions and basic data			
	A	Description of the site and the already executed assessment and remediation steps. What was the initial remediation target and what has been the result of the remediation.	Yes		
	B	Delineation of the contamination still present at the site, based on the authorized final cleanup report. This should include the Conceptual Site Model and, if available, a model describing the geohydrology and geographical distribution of the contamination.	Yes		
	C	Description of and data on the post remediation measures. This should include the objective and technical aspects of the remediation including applicable drawings with all technical details (e.g. a cross section drawing of the composition of a cover layer; a map with the precise situation of monitoring wells with indication of depth of the wells).	If applicable		
	D	If applicable a prognosis on the functioning of the post remediation measures over time and an overview of processes that may affect this functioning in the future (e.g. for a cover layer the possibility that degradation occurs due to specific forms of land use).	If applicable		

No.	Topic		Obligatory	Status	Comments
	E	Site use restrictions related to the contamination still present and related to the post remedial activities. These restrictions have to be taken into account both on the site itself as well as outside the site.	Yes		
2	Methodology for development of the PRP				
	A	Description of the post remediation measures.			
	B	Overview of critical deviation points and action levels to be developed in a set of clear criteria for action (e.g. the depth of a cover layer after remediation was 1.5 meters. In that case the action level can be 1.3 meters. If the result of monitoring indicates a depth of 1.2 meters at a certain point an action has to take place).	Yes		
	C	Description of the post remediation measures and if applicable associated maintenance.	Yes		
	D	Monitoring and maintenance program, developed on the basis of: • the forecast on the functioning of the post remediation measures and the processes that may affect this functioning. The effects of seasonal variations are taken into account; • applicable permits; • Site (re)use and/or (re)development activities.	Yes		
	E	The program describes the sampling, inspection and/or measuring program (only if applicable): • the quality of the soil, (ground)water, air and/or sediments. The effects of spatial variation in monitoring data are taken into account; • the quality and functioning of the post remediation system and checks on specific equipment.	If applicable		
	F	Calamity plan, describing actions in case of emergencies (e.g. change in groundwater flow direction leading to a situation where polluted groundwater will flow in the direction of houses leading to the action of prevention measures on evaporation of volatile components from soil. Another example is the erosion of a cover layer leading to a situation where contact of people with contaminated material can take place again. This leads to an action to restore the cover layer).	Yes		
3	Analysis and evaluation				
	A	Description of the status of the post remediation situation (i.e. the post remediation system and its delineation) at the time of writing the PRP, including deviations from the situation as described in the authorized final cleanup report.	Yes		
	B	Evaluation of the deviations in the post remediation situation described above. This should include the description of mitigating measures to restore the original situation in case of non critical deviation points and suggestions for implementation of measures to correct critical deviation points.	Yes		
4	Management and finance				
	A	The responsible party including contact information	Yes		
	B	Organisation of tasks and responsibilities	Yes		
	C	Planning of all activities	Yes		
	D	Procedure in case of violation of site use restriction or intended site use changes (e.g. redevelopment)	Yes		
	E	Cost estimation of the various activities	Yes		

Explanatory Notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

10-b Checklist review and approval Post remediation plan

Volume II-10-b
Checklist review and approval Post remediation plan

1 Introduction

This information is most relevant for Step 10, Post remediation plan. The report of the Post remediation plan is to be reviewed by the competent authority to prepare the decision by the appropriate official.
The checklist below provides the points of attention for the review.

2 Checklist review and approval Post remediation plan

The checklist below can be used to review the Post remediation plan. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main conclusions of the Post remediation plan	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist Post remediation plan	Evaluation if the PRP meets the Checklist Post remediation plan (Volume II-10-a)	Yes		
2	Skills and accreditations	Evaluation if the specialized agency or consultant charged with the design and drawing of the PRP meets the required skills and accreditations	Yes		
3	Stakeholder rights and interests	Evaluation if the stakeholder rights are guaranteed. A thorough stakeholder involvement offers a good basis for securing stakeholder warranties	Yes		
4	Long term guarantees	Evaluation if the PRP offers adequate long term guarantees for risk protection and liability. Aspects involved are:	Yes		
	A	Technical aspects			
	B	Legal aspects			
	C	Financial aspects			
	D	Management aspects			
5	Conclusion	Can Post remediation plan be approved? If not, which further information is required?	Yes		

Explanatory Notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: remarks to be entered by reviewer on the results for this topic

Volume II

11-a Checklist Post remediation status report

Volume II-11-a
Checklist Post remediation status report

1 Introduction

This information is most relevant for step 11 Post remediation action.
Post remediation measures may go on for years or even decades. This necessitates updates on the status of the post remediation measures at regular intervals, to be reported in a Post remediation status report. This checklist presents the aspects that should be addressed in such a report. This general checklist should be adjusted for a specific situation.

2 Checklist Post remediation status report

No.	Topic		Obligatory	Status	Comments
1	Introduction				
	A	Client name, site owner, GPS-coordinates, contact details	Yes		
	B	Type of contamination and description whether the contamination is present in soil, sediment, surface water or groundwater	Yes		
	C	Cause and goals for activities and summary of the Post remediation implementation plan (PRIP) applicable for the site	Yes		
	D	Definition of assumptions, including general assumptions described in the Post Remediation Plan (PRP) and translation to the PRIP's			
	E	Status of the remediation measure and contaminations as described in the latest Remediation works report or if more recent the latest PRSR including of a description of the optimized processes implemented since the latest PRSR	Yes		
	F	Report reading instructions	Yes		
2	Background information				
	A	Site metadata, like site address, surface area, site owner name and contact details, present and intended future use, land register details and geographical coordinates			
	B	Reference to the authorized final cleanup report, including its title, author, project number and date), and data on the listing of the site in the NPRPS, including the relevant formal listing decision	Yes		
	C	Historical data and site description, including type of (past and current) industrial activities and site assessments. Of the latter, data should be included on the title, consultant, project number, date and the assessment's framework	Yes		
	D	Detailed description, including maps and soil profiles, of the remaining contamination, for soil, sediment, surface water or groundwater. This should include data on the type of contamination, its geographical distribution, (maximum) measured values and a reference to contamination map(s)	Yes		
	E	Detailed description of technical and management measures and necessary technical equipment	If applicable		
	F	Description of site use and site use restrictions	Yes		
	G	Description of the site ownership legal situation	Yes		
	H	A list of all post remediation measures stakeholders, including the names of the organizations, contact details, and names of contact persons	Yes		
	I	Description of general organizational aspects	Yes		
	J	Description of necessary permits and exemptions	Yes		
	K	Referring to the Post remediation plan and the approval of it by the authorities	Yes		

	L	Clear definition of the boundaries where the post remediation activities are related to	Yes		
	M	Referring to previous PRSR's	Yes		
3	Implementation of post remediation activities				
	A	Chronological description of the executed activities	Yes		
	B	Results of the monitoring (measurements and observations with indication of parameter, time and place, referring to maps of the monitoring system). In annexes of the PRSR all detailed documentation should be added	Yes		
	C	Conclusions on changes in e.g. concentration values in groundwater or direction of groundwater flow, referring to action values	Yes		
	D	Executed repair, maintenance or mitigating measures of non critical deviation points	Yes		
	E	Bottlenecks which have proved to be and description of the executed actions after discovery of these kind of occurrences			
	F	Critical deviation points and suggestions for mitigating measures including technical, financial, time and organisational aspects	Yes		
4	Conclusions and recommendations				
	A	Evaluation of the results of the post remedial activities referring to the intention and to the action levels as described in the PRP	Yes		
	B	Critical or non critical deviations which have occurred during the post remediation period. Evaluation of the cause of these deviations and suggestions for mitigating measures	If applicable		
	C	Suggestion for possible adjustments in the post remedial activities	If applicable		
	D	Suggestion for exit of post remediation phase including data or procedure proving the validity of this exit	If applicable		

Explanotary notes:
Status: yes (information available), no (information not available), action (essential information, must be collected)
Comments: possibility for remarks by reviewer on the results for this topic

Volume II

11-b Checklist review and approval Post remediation status report

Volume II-11-b
Checklist review and approval Post remediation status report

1 Introduction

This information is most relevant for Step 11, Post remediation action. The results of the post remediation action have been described in a Post remediation status report (PRSR) which is to be reviewed by the competent authority to prepare the decision by the appropriate official.
The checklist below provides the points of attention for the review.

2 Checklist review and approval Post remediation status report

The checklist below can be used to review the Post remediation status report. It may be copied and filled in as if it were a form.

Site ID (Name User and Owner, Address, GPS-coordinates)	
Main results of the Post Remediation action	
Date of recording	
Recording official	

No.	Topic		Obligatory	Status	Comments
1	Checklist Post Remediation Status Report	Evaluation if the Post Remediation Status Report (PRSR) meets the requirements of the Checklist Post Remediation Status Report (Volume II-11-a)	Yes		
2	Validation of the PRSR	Results of the validation of the PRSR by an independent third party	Yes		
3	Skills and accreditations	Evaluation if the specialized agency or consultant charged with the design and drawing of the Post Remediation Plan meets the required skills and accreditations	Yes		
4	Validity of values	When doubting results: cross-check third party values	If necessary		
5	Stakeholder rights and interests	Evaluation if the stakeholder rights are guaranteed. A thorough stakeholder involvement offers a good basis for securing stakeholder warranties	Yes		

6	Long term guarantees	Evaluation if the Post Remediation Plan offers adequate long term guarantees for risk protection and liability. Aspects involved are:	Yes		
	A	Technical aspects			
	B	Legal aspects			
	C	Financial aspects			
	D	Management aspects			
7	Conclusion	Can Post remediation activities be approved? If not, which information has to be provided or which activities have to be carried out?	Yes		