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Checklists for the Investigation and Risk Assessment of Contaminated Sites in Flood Risk Areas

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Checklists for the Investigation and Risk Assessment of Contaminated Sites in Flood Risk Areas

by

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Checklists for the investigation and assessment of CS in flood risk areas

1 Purpose and principles of the checklists

These checklists will serve as a hand guide for a first visit in properties, which are containing suspected sites to be contaminated by substances being hazardous to water. Within a staged processing the checklists aim at a pre assessment of the risk potential in properties and a first investigating visit to evaluate suspected contaminated sites and to complete the data base for those sites.

The purpose of this first site visit is to find out:

- whether immediate action is needed
- whether and where further investigations or measures should be taken
- where highly contaminated zones are suspected/confirmed

The data collected in the checklists should deliver the basis to assess if further steps are necessary to enhance the safety level of contaminated sites in flood risk areas. It includes the following information:

- Hydrological data to estimate whether the investigated site is really endangered by flooding (flooding potential)
- General data, which should give information about location, extension type, ownership structure of the site and about any precedent investigations
- An evaluation of the hazard situation answering the following questions:
 - Is there an indication of potential hazards at the site?
 - Is the site assessment with regard to the site's risk potential completed or is it necessary to record further data?
 - Which additional information is already available and could be used for the assessment?
 - Is an assessment possible or is a further data record or investigation necessary?

Examples are given for remedial actions and measures for a sustainable solution of the contamination situation and to protect water from impact of the polluted site. They will help the conductor

- To complete the data for a risk assessment and
- To indicate solutions for the investigated site.

Definitions for the specific terms used in this document are given in the following chapter.

2 Definitions

Properties

Land, which was formerly used by industry, military or agriculture and is mostly consisting of several sites of different use. As a result of the use properties can include contaminated sites.

Sites

A site is a part of a property, which is specified by its location and its former specific use over the years. Therefore different sites in one property could also vary in their condition, because of their miscellaneous types of use. As a result of the former use sites may be contaminated by improper handling of hazardous substances.

Sites suspected of being contaminated (suspected contaminated sites)

These are sites suspected of having harmful impacts on soil, soil functions or water which may lead to risks or significant harm to human health and the environment. Sites suspected of being contaminated comprise

- closed-down waste disposal installations (former waste disposal sites) and other sites, at which wastes have been treated, stored or disposed of in the past, and
- closed down industrial installations (former industrial sites) and other sites, at which environmentally hazardous substances have been handled,

which could cause hazards to human health and the environment.

Contaminated sites:

Contaminated sites are suspect sites which have been confirmed as being contaminated and /or subject to harmful soil changes.

Highly contaminated zones (hot spots):

Hazardous substances at contaminated sites are not usually distributed evenly across the whole site, but are concentrated at locations where the chemicals were handled or stored.

3 Scope of application

The checklist applies to all properties containing suspected contaminated sites in flood risk areas. The case of flooding includes, besides flooding,

- backflow from water bodies or sewer systems or
- a rise of the groundwater table as a result of long-term flood events.

The following sites are covered by the scope of the checklist:

- Sites suspected to have high potential for posing a hazard to water,
- sites contaminated as a result of former industrial activities and former waste disposal operations, and
- closed-down plants and plant components containing water endangering substances,

which are not effectively secured and might present a hazard to water in case of flooding.

Radioactively contaminated sites do not fall within the scope of this checklist, nor do sites presenting a potential hazard due to genetically modified organisms.

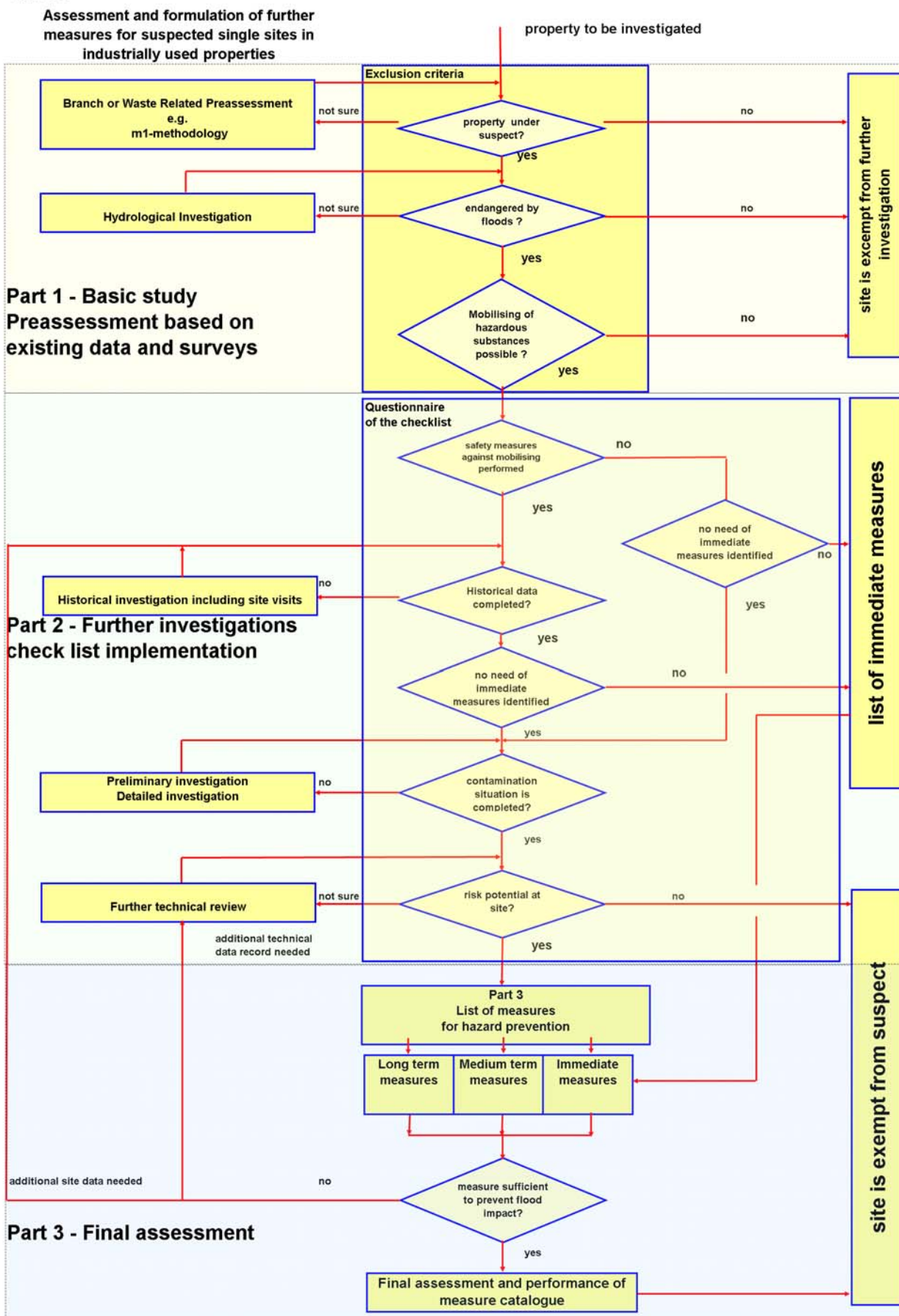
Facilities covered by this checklist include, for example:

- Underground installations
- Surface facilities
- Above-ground storage systems within buildings
- Components of closed-down plants
- Former waste disposal sites

The proceeding of the checklist is based on the idea that hot spots have to be identified at contaminated sites, which could exist in a property. An exemplary structure in figure 2 shows how the terms “property”, “site” and “hot spots” have to be understood.

Although the checklist is designed primarily to assess the risk potential for water bodies arising from properties in flood risk areas, the checklist also gives information about potential hazard for other goods to be protected. **If after application of the checklist, a site is considered as safe with respect to impacts of flooding, (see also figure 1), it still might contain risks for other goods such as human health, which have to be investigated within the conventional past contamination treatment.**

Figure 1:



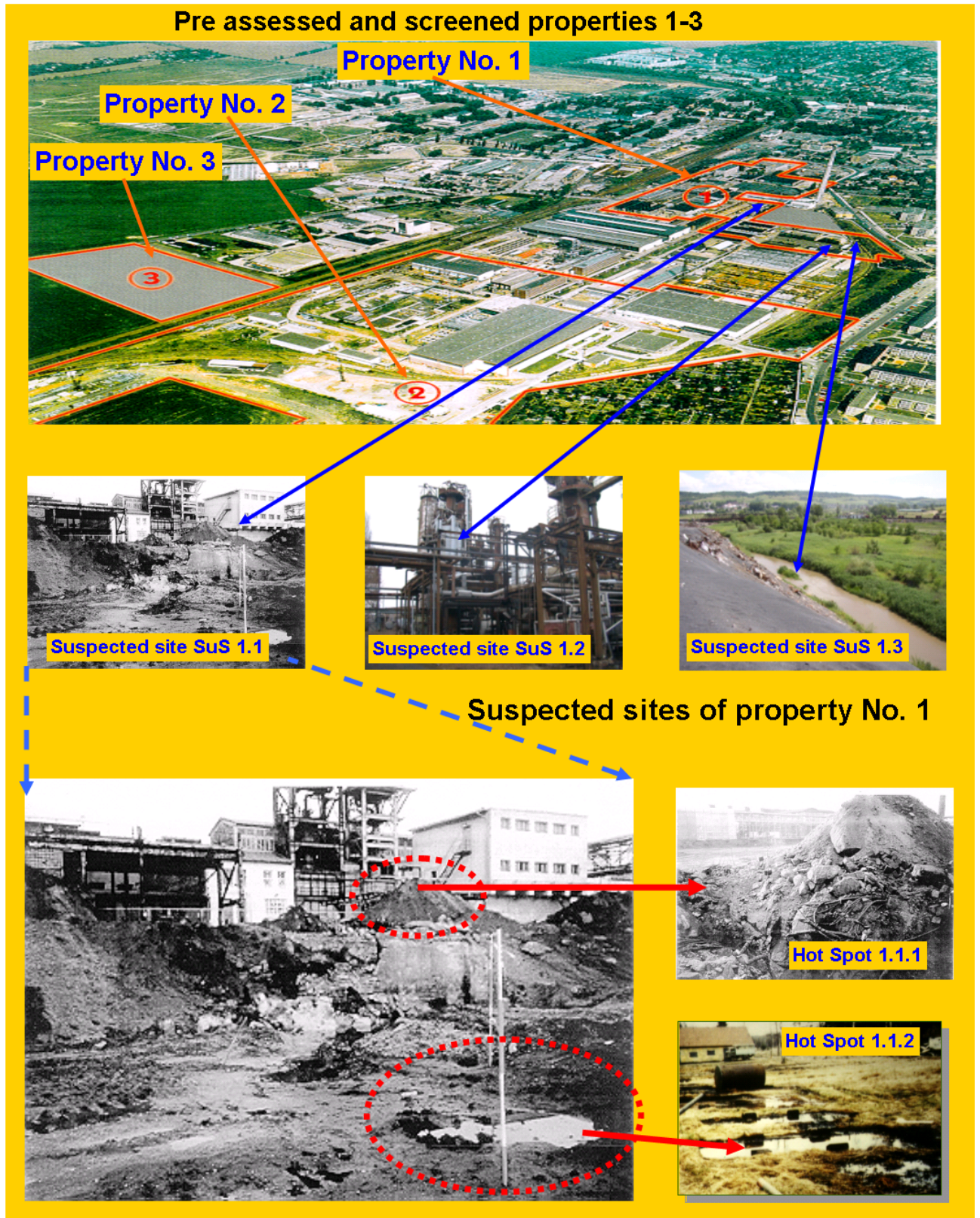


Figure 2: Illustration of an exemplary property including suspected contaminated sites and hot spots

4 Description of the procedure

The checklist consists of three parts which include the following templates

- Part 1- Basic study (desk study) – Pre-assessment of the property, which is containing suspected contaminated sites (see chapter 5)
- Part 2 - Further investigations of suspected contaminated sites for visits and assessment. (separated in different checklists for abandoned industrial installations, uncontrolled waste disposals, waste water treatments and sites of presumed former incidents and hazards.) ((Check list implementation, see chapter 6)
- Part 3 - List of measures for prevention of hazard caused by flood events. (Findings and conclusions based on the collected data) (see chapter 7)

Figure 1 describes the procedure of the risk assessment to be performed for the suspected contaminated sites.

4.1 Part 1 - Basic study:

The basic study is a precondition for the check list implementation indicating, if a property is under suspicion to include potentially contaminated sites like shown in figure 2, which have to be investigated further. If further investigation becomes necessary, the sites should be visited and historically recorded by specific checklists, which include the questionnaire about former specific land use and its possible resulting contamination.

The basic study includes

- Compilation of fundamental data
- Pre assessment of the hazard potential at the property
- Estimation of the flooding potential
- Estimation of the mobility potential of the polluted volume
- Ranking of the property

The fundamental data should serve as a data base for the responsible authority or operator to indicate if further site investigations are needed for a special property. Depending on the available data, an estimation of the information level has to be made to identify the needs of further investigation.

The objective of the pre-assessment is to find out, if there is a reasonable suspect of hazard potential in case of flooding. For this assessment a screening of the property is needed, where the risk potential is very high. For this screening methodologies have to be used, which operate with different risk values. These risk values should be related to branch or waste specific toxic potentials. Depending on a threshold value for the risk, which is to be defined by the Danube Countries themselves, the properties should be screened and classified as hazardous and non hazardous to water in case of flooding¹.

The estimation of the flooding potential should give information, if the property is really endangered by floods. If not, there is no need of further site investigation with regard to risks caused by flooding (the site may still be hazardous for groundwater or other goods). If there is a flooding danger it has to be estimated, if there is also a danger of mobilising hazardous substances in case of a flood incident. In sum the properties will be assessed in form of priority values, which help to prioritise the properties with regard to their toxic potential and their potential to discharge hazardous substances into surface water.

If the basic study indicates a flood risk and a potential mobility of hazardous substances, further investigations are necessary.

As far as obvious needs of measures can already be identified, a preliminary list of immediate measures should be elaborated. (Measures could be e.g. immediate visiting of the site, prevention measures like proscription of site entrance).

¹ In an exemplary screening of sites in the Danube river basin the m1-methodology was used, where the toxic potentials of the sites were estimated on the basis of concretised practical experience (see appendices 1 and 2). The exemplary methodology is described in appendix 3. The risk values in this methodology ranged between 0 and 55. All sites with a value higher than 35 were classified to be hazardous.

The screened properties should be ranked at this assessment stage

- at first with regard to the determined risk value
- secondly with regard to the need of further investigation or of elaboration of immediate measures (which has to be defined by the authorities) and
- thirdly with regard to the size of the investigated property

4.2 Further site investigations:

The need of further investigations or of immediate measures at the site should be identified through site visits combined with the application of the checklist questionnaire shown in figure 1. The questionnaire of the checklist will answer the following questions:

- Are available data about the site is completed?
- Is the need of immediate measures identified?
- Is it possible to describe the contamination situation?
- Is the risk of the site definitely confirmed?
- Which measures have to be done next?

Besides to the necessary immediate measures further investigations are mostly identified to close the information gap about the investigated sites. These further investigations consist of the following stages:

- Historical investigation combined with site visits
- Preliminary investigations
- Detailed investigations
- List of safety measures

The check list questionnaire will only consider the first steps of the historical investigation. Contaminated sites in flood risk areas have to be investigated predominantly with regard to the impact to surface water in case of a flood event. All other impacts are subjects for investigation in the field of conventional treatment of contaminations.

In the checklists the actual risk of an investigated site will be assessed on the basis of calculated water risk indices, which are based on estimated amounts of water hazardous substances with regard to their water risk class.

Any more detailed information has to be elaborated separately by performance of the investigation stages, which are described in the following.

The remediation proposal is not considered in the checklist questionnaire in part 2 but within the list of measure in part 3 (see also chapters 4.3 and 7).

1 Stage – Historical investigation combined with site visits

The historical investigation is aiming at a completion of all aspects of former industrial use in a site, which could cause hazard to water or soil in case of flooding. It helps to narrow the range of possible hazardous substances to be investigated. In this step all available information about the former use is searched and analysed, to get as much information about the site and possible hints about contamination. Information is found in archives, old manufacturing and construction files, documents of authorities etc. Interviews with former employees, neighbours, mayors are also a valuable source of information. The aim of this step is to determine possible pathways or hot spots for spreading of contaminants and possible impacts on water, soil and air and to exclude irrelevant impacts.

The gathered data arising from historical investigation has to be verified and concretised by a site visit, which should be recorded in a checklist. The objective of this check list is to gather all identified suspicious facts, which gives information about needs of immediate measures/actions and further investigation steps relevant for the enhancement of the safety level at site.

² In an exemplary screening of sites in the Danube river basin the m1-methodology was used, where the toxic potentials of the sites were estimated on the basis of concrete practical experience (see appendices 1 and 2). The exemplary methodology is described in appendix 3. The risk values in this methodology ranged between 0 and 55. All sites with a value higher than 35 were classified to be hazardous.

If in the first step no need of immediate action is identified, but the site can not be exempt from suspect to be hazardous, a preliminary investigation is necessary in the second step.

2. Stage Preliminary investigation

The objective of the preliminary investigation is to assess the hazard for the relevant pathways and protected objects under impact, determined during the historical investigation. The assessment is based on analyses of the harmful substances distribution, data about the possibilities for their migration in case of flooding, as well as the prognosis about their load in the protected objects (means water body) under impact. If in the second step no need of immediate action is identified, but the site can not be exempt from suspect to be hazardous, a detailed investigation is necessary in the third step.

3. Stage - Detailed investigation

The objectives of the detailed investigation are:

- Final hazard assessment for the particular suspected contamination case (the suspected case is either dropped out, or accepted as a past contamination case)
- Setting of criteria for further treatment (e.g. parameters for monitoring or preliminary remediation objectives for the remediation investigation. Therefore a proposal for medium and long term safety measures and action for hazard prevention has to be elaborated in the fourth step. The concretion of these measures should be based by well founded reviews or analysis.

4.3 Assessment and list of safety measures

Based on these findings the sites can be prioritised and a list of safety measures can be proposed which include

- Immediate measures to enhance the safety level
- Preparatory measures to complete data, which are necessary to concretise safety measures for the investigated site.
- Prevention measures to mitigate the impacts of flood events in contaminated sites
- Remedy measures aiming at
 - elimination or reduction of pollutants (*decontamination measures*),
 - Prevention or reduction of pollutants spreading in a lasting way, without eliminating the pollutants themselves (*Securing containment measures*) or
 - elimination or reduction of harmful changes in soil's physical, chemical or biological characteristics
- Protection and Restriction measures, aiming at a prevention or reduction of hazard impact for health and environment, especially usage restrictions.

Examples for short, medium and long term measures are listed in the following.

Short-term measures:

Preparatory measures

- *Preliminary investigation has to be started, if the risk potential is not well known*
- *In case of further hazard suspicion a detailed investigation has to be started, if the contamination situation is still not completely identified*
- *A hydro geological survey should be started, if the risk of flooding is not quantified sufficiently*
- *A concept for active remediation or safety measures must be elaborated for a cost prognosis and for the elaboration of cost variants*
- *Steady Supervision or monitoring of the sites with regard to stability and dimension of the safety dams are necessary.*

Safety measures

- *Protection and restriction measures such as:*
 - *Danger sign for contaminated area*
 - *Closure of the contaminated area*
- *Excavation and disposal of small volumes of contaminated soil (hot spots)*
- *Sealing of surfaces (suitable for heavy metal contamination)*
- *Capsulation of contaminated volume (suitable for mixed contaminants)*

Medium-term measures:

Preparatory measures

- *Conception for excavation and treatment of contaminated volume for example by washing (heavy metals or persistent substances) or by bioremediation (organic substances)*
- *Conception of evasion area for floods*
- *Conception of optimizing the dimensions of the river dams*
- *Concept for relocation of large deposits*

Safety measures

- *Bioremediation of medium sized oil contaminated area*
- *Stabilising of river dams*
- *Installation/optimisation of alarm systems*

Long-term measures:

- *Relocation of the deposits*
- *Securing measures for strong rain events*
- *Securing for large amounts of melting snow*
- *Adaptation of the river bed or the river dam*
- *Rain water storage basins*
- *Recultivation of flood plains*

5 Part 1- Basic study (desk study)

Preassessment of the property suspected of being contaminated

5.1 Basic Data about the Investigated Property

The basic data should give the following information about the investigated property which may consist of several suspected sites:

- General data
- History of the property use
- Location description
- Status of the property

5.1.1 General data

The following questionnaire is aiming at a completion of the general data base to give conductors the necessary sufficient data framework for further investigations and to show the state of the present information level.

Notation of the property/ No.: _____

Timeframe of the visits: first visit: _____ last visit: _____

Federal State _____

County _____

Township/district _____

Address Postcode: _____ Street and street number: _____

Location inside locality outside locality marginal area

specified: _____

Is there a general information available?

Yes No,
if no, the data have to be collected

if yes, please specify

Property size _____ [ha]

Contact person (authority) _____

Telephone _____

Telefax _____

E-Mail _____

Responsible Processor _____

Contact person (authority) _____

Telephone _____

Telefax _____

E-Mail _____

Cadastral number _____

Coordinates _____

Further sources of information should be listed according to Table 1:

Source	Name	Contact person	Address/ Telephone
authorities			
Enterprise			
Institute			
Contemporary Witness			

Table 1: List of further sources of information

5.1.2 History of the property use

The listing of the former use of the property should give information and indicators for possible contamination. If the use is only supposed but not confirmed, a historical investigation can help to prove the suspicion. The former use should be listed as shown in Table 2

Time frame	Former use	presumed	confirmed	Probable contamination
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	
		<input type="checkbox"/>	<input type="checkbox"/>	

Table 2: List of former use of the site

5.1.3 Description of the location

The description gives information, in which area the property is located and which sensitive bordering area could be harmed. Table 3 gives an overview of the possible areas

Area	bordering	inside
Industrial area	<input type="checkbox"/>	<input type="checkbox"/>
Mixed-use zone	<input type="checkbox"/>	<input type="checkbox"/>
Residential area	<input type="checkbox"/>	<input type="checkbox"/>
Hospital	<input type="checkbox"/>	<input type="checkbox"/>
Nature protection area	<input type="checkbox"/>	<input type="checkbox"/>
Landscape conservation area	<input type="checkbox"/>	<input type="checkbox"/>
Recreation area	<input type="checkbox"/>	<input type="checkbox"/>
Agriculturally used area	<input type="checkbox"/>	<input type="checkbox"/>
Forest area	<input type="checkbox"/>	<input type="checkbox"/>
Drinking water protection zone	<input type="checkbox"/>	<input type="checkbox"/>
Standing water body	<input type="checkbox"/>	<input type="checkbox"/>
Body of flowing water	<input type="checkbox"/>	<input type="checkbox"/>

Table 3: Compilation of sensitive bordering areas

Additional information
(special remarks to the
site condition):

5.1.4 Status of the property

This questionnaire gives conductors information about the present situation of the property and the present activities at site aiming at the completion of relevant investigation and safety activities.

Is there any information about the ownership structure and the responsibility for the property available?

- Yes No

If the ownership structure or Status of enterprise is not known, a historical investigation has to be started. Contemporary witness must be found.

If yes, is the status of enterprise known

- Yes No

If no, further data record on cadastral register has to follow

If yes,

Status	yes	no
closed		
With formal document		
Operating		
With permit		
Listed for control		
No administrative act before		

Has the site already been investigated with regard to the hazard potential?

Yes

No

if no go to 5.2

if yes, which investigation

- Initial risk assessment
- Historical investigation
- Preliminary investigation
- Detailed investigation

Was the suspicion of contamination confirmed?

Yes

No

if no, further investigation must be started if there is still a strong suspicion of contamination. If there is no strong suspicion the sites should be handled in the framework of the regular handling of contaminated sites.

If yes, were contaminated area(s) identified?

Yes

No

if no, the detailed investigation must be started. If the detailed investigation shows no further suspicion, the sites should be handled in the framework of the regular handling of contaminated sites.

if yes, were remedy measures already taken to prevent hazards in case of flooding?

Yes

No

if no, plan for remedy action should be started

if yes, which measures?

Identification of measures

If there is already an impact to surface water then perform

Removal of contaminants

- Excavation of contaminated soil
- Relocation and disposal of waste
- Relocation and intermediate storage of waste
- Drainage and intermediate storage of leachates

If not, but an impact to surface water is already expected

Remediation/decontamination of contaminated sectors

- Bioremediation
- Soil washing
- Thermal treatment
- Leachate drainage and treatment

If a direct impact to surface water is not expected but in case of a flood eventp, the following measures could be also performed:

Protective and restrictive measures

- Sealing of surface
- Encapsulating of contaminated volume
- Building of safety dams
- Restoration of safety dams
- Monitoring and Control
- Restricted use of the property
- Prohibition to access
- Closure of the property

5.1.5 Estimation of the information level

Based on the gathered data, the information level is

- 1 – Very low
- 2 – Low
- 3 – Medium
- 4 – Sufficient
- 5 – High

For the decision making, please consider the following table. The Table 4has to be understood as a clue for a rough classification of the information level about the property

Priority regarding information level	Information level	Initial assessment	Historical investigation	Property visit	First list of immediate measures	List is proved and confirmed	Preliminary investigation	Preliminary risk assessment confirmed	Detailed investigation	Detailed risk assessment confirmed	Proposal of remedy measures	Remediation proposal confirmed
1	very low	+	-	-	-	-	-	-	-	-	-	-
2	low	+	+	+								
3	medium	+	+	+	+	+						
4	sufficient	+	+	+	+	+	+	(+)	(+)	(+)		
5	high	+	+	+	+	+	+	+	+	+	+	+

+ applicable

(+) limited applicable in case of further investigation needs

Table 4: Proposal for classification of the information level

5.2 Preassessment of the hazard potential of the contaminants

To assess the hazard potential the dimension of the contamination (in m² or m³) and the substance, the type of waste itself or the industrial sector have to be known. Based on this data an estimation of a risk value could be done, like exemplary done in the m1-methodology.

5.2.1 Dimension of the contamination

known estimated not known

Area _____ sqm

Contaminated volume _____ m³

5.2.2 Substance/contaminant

known estimated not known

Specified: _____

5.2.3 Industrial branch classification code

This question should help to find out, which present and former industrial use is known in this area. It should be specified by the industrial branch specification code exemplary shown in annex 1 (Please list codes, if there is a relationship with one or more industrial branches)

Resulting Risk class according to the branch related risk value in chapter 10:

Risk Value according to (e.g. M1-methodology):

5.2.4 Waste Codes (according to European Waste Catalogue)

This question should help to find out, which waste was accumulated during the industrial processes or which waste was or even is actually disposed at the site. It should be specified by the waste codes according the European waste catalogue shown in annex 2 in a table like shown beneath.

Waste code	waste type	amount (Mg)	Probable risk class	Proportion in %

Table 5: List of the accumulated, handled or disposed waste at the site

Resulting Risk class according to the waste related risk value in chapter 9:

Risk Value according to (e.g. M1-methodology):

5.2.5 Results of the hazard potential pre assessment - Determination of the risk value

For the screening of those properties, which might include sites probably contaminated with hazardous substances, the determined risk values have to be compared with a threshold value, which should be defined by the authorities themselves. Also the classification, which risk values are considered to be significantly higher than to the threshold value can be fixed³ by the authorities.

The urgency for safety measures on a property is depending on the defined priority value, which should be classified according to the ratio between risk value and threshold value as described in Table 6.

Priority value regarding impact of the substance	Risk	Risk value compared to threshold value is			
		Significant higher	higher	lower	Significant lower
1	Low				✓
2	Medium			✓	(✓)
3	High	✓	✓		
4	Very high	(✓)			

✓ Applicable (✓) Applicable if estimation is confirmed by survey

Table 6: Proposal for the classification of the priority values regarding the substantial hazard

The suspicion of risk is confirmed, if one of the resulting risk values is higher than the defined threshold values. If both risk values are lower than the defined threshold values, a further investigation of the property is still necessary, if the suspicion of contamination can not be totally excluded by surveys.

The result of this risk estimation is to be fixed in Table 7

Result of the assessment	Branch related risk r_B	Waste related risk r_W
Resulting risk value:		
Threshold risk value r_T :		
Priority with regard to the impact of the substance		

Table 7: Result of the substantial risk estimation

Short term measures:

- If there is no information given, assess the actual hazard potential by searching indications for former industrial use.
- If indications of contamination are given, perform a historical investigation to concretise the contamination potential.
- Perform a first visit of the property using the checklist.

³ (E.g. threshold value is 50 percent of the maximum risk value and the risk is considered very high, if the risk value is 30 percent higher than the threshold value).

5.3 Estimation of the flooding potential

The objective of this questionnaire is to find out, if there is a reasonable suspicion of a risk of flooding. If a risk of flooding is confirmed for a property containing hazardous substances, a further investigation of the property must follow in any case if the mobility of the contaminant is high.

How often is a flood expected?

- Decennial Every thirty years Every hundred years

How did a flood occur?	Yes	No	Not sure
High water			
Back pressure from bodies of water or canals			
Rising groundwater levels as a result of extended periods of high water			
Which data confirmed the danger of flooding ?	Yes	No	Not sure
Monitoring data			
Hydrological surveys			
contemporary witness			
Other reports			
Is the whole property endangered by flooding or only parts??	Yes	No	Not sure
Whole site			
Parts, but close to contaminated zones			

Danger of flooding is

- very high high medium low

Resulting priority regarding flooding potential: _____

For the decision making process please consider the Table 8 beneath:

Priority value regarding flooding potential	Flooding danger is	If probability of flooding in years is				If flooding situation is	
		< 10	< 30	<100	>100	estimated	confirmed
0	Very low				✓	x	
1	Low				✓	x	
				✓			x
2	Medium			✓		x	
			✓				x
3	High	✓				x	
			✓				x
4	Very high	✓					x

Table 8: Proposal for the classification of the priority values regarding the flooding potential

Short-term measures:

- If no data is available a hydrological investigation has to be started to clarify, if a property is endangered to be flooded. (see also medium term measures)

Medium and long term measures:

- If the property is in a flood risk area, it has to be investigated if measures for the enhancement of safety level in the suspected property are necessary. If yes, they must be planned and realised, e.g. stabilisation of old dams or building of new dams.

5.4 Estimation of the mobility potential of the contaminant

The objective of this questionnaire is to find out, if the contaminant or even the soil, which contains the contaminant, is mobile in case of flooding. If a danger arising from this mobility has to be expected, safety measures should be considered to lower the risk. If a high danger resulting from the mobility is confirmed for a property, which contains hazardous substances, a further investigation of the property must follow, if the risk of flooding is also very high.

Information is existing Yes No**If yes go to the next question**

if no, visit of the property sites must be performed, or even additional surveys must be started
(see also short term measures at the end of this chapter).

Where does the contaminant exist? (please fill in Table 9)

Hazardous substance	in	Not saved	Safety measures performed			
			Removal or clearance	Against uncontrolled dismantling	Retention basin or dam	Sealing
	<input type="checkbox"/> Landfill					
	<input type="checkbox"/> Leachate					
	<input type="checkbox"/> Dump or pit					
	<input type="checkbox"/> Tank farm above ground					
	<input type="checkbox"/> Tank farm under ground					
	<input type="checkbox"/> Storage basin					
	<input type="checkbox"/> Storehouse					
	<input type="checkbox"/> Barrels					
	<input type="checkbox"/> Bags					
	<input type="checkbox"/> others					
Potential that hazardous substances or contaminated volume can be mobilized in case of flooding (Mobility potential)						
<input type="checkbox"/> very high <input type="checkbox"/> high <input type="checkbox"/> medium <input type="checkbox"/> low <input type="checkbox"/> very low						

Table 9: Compilation of relevant aspects for the assessment of the mobility potential

Table 9 should give information about the present situation, where the contaminant is located. According to the data scheduled in this table the investigator can assess the mobility potential of the contaminant. The mobility potential could be assessed depending on the expected hazard impact and the performed safety measures to prevent a the impact. The assessment should be carried out according to the following table. (please see Table 10).

Potential of mobility depending on hazard impact and performed measures					
Expected hazard impact	Safety measures performed				
	Removal or clearance	Against uncontrolled dismantling	Building of Retention basin or dam	Covering or sealing	No measures
Human	Very low	Low	Low	Very low	Medium
Shockwave	Very low	Medium	Low	Low or medium	Very high
Heavy rain events	Very low	low	Medium	Very low	High or Very high
High water	Very low	Very low	Low	Very low or low	Medium or high

Table 10: Proposal for the classification of the mobility potential

For the classification of the listed impact in view to the relevance for the investigated location, please consider the following remarks:

- Human impact is mainly characterized through activities which lead to contaminants loss in installations caused by improper locking or fixing.
- Shockwave could cause significant destruction on dams, retention basins and installations, which will lead to a contaminant discharge. Shockwave could appear predominantly in narrow valleys. Since the flood event occurred in the river Elbe the dimension for narrow should be newly defined.
- Heavy rain events could cause an instability of constructions, which lead to a less function ability of safety installations (e.g. safety dams, groundings or retention basins).
- High water could cause a raising and destruction of underground storage facilities, an instability of constructions and a mobilizing of contaminants in unsaturated contaminated volume.

The danger arising from the emission of the contaminated volume, which is hazardous to water, depends on one hand on the mobility potential of the contaminated volume and on the other hand on the solubility of the harmful substance. So also the solubility of the relevant contaminant has to be considered in this assessment.

Solubility of the substances					
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
very high	high	medium	low	very low	

Based on the estimation of the mobility potential and the solubility of the contaminants the danger of contaminants emission should be determined. Table 11 shows a proposal to classify this danger with regard to these factors.

Solubility of the substances	Very high	High	Medium	Low	Very low
Mobility potential of the contaminated volume					
Very high	Very high	Very high	High	Medium	Low
High	Very high	High	Medium	Medium	Low
Medium	High	High	Medium	Low	Very low
Low	High	Medium	Medium	Low	Very low
Very low	Medium	Medium	Low	Low	Very low

Table 11: Proposal for the classification of the danger of contaminants discharge with regard to the mobility of the contaminated volume and the solubility of the contaminants

According to the determined danger the priority values are defined as follows:.

Priority value regarding mobility of the contaminated volume and solubility of the contaminant	Danger from contaminant emission	Estimated situation, please mark with a cross
0	Very low	<input type="checkbox"/>
1	Low	<input type="checkbox"/>
2	Medium	<input type="checkbox"/>
3	High	<input type="checkbox"/>
4	Very high	<input type="checkbox"/>

Short-term measures:

- *Is no conclusive data available, data research has to be started. Contact to water management agencies is necessary.*
- *If no data is available about the mobility potential of contaminants in case of flooding, a hydro geological investigation has to be started, if the flooding potential is high or very high.*
- *To avoid human impact abandoned installations have to be removed, cleared or sealed.*
- *Prove the stability of dams and the dimension of retention basins, if they are sufficiently dimensioned and constructed for shock wave events or heavy rain events. If the investigation does not affirm an adequate dimensioning start to reconstruct old buildings or build new safety installations.*
- *Prove if mobilising of contaminants caused by high water could be avoided by sealing of contaminated volume or locking of installations*

Medium term measures

- *Build sufficiently dimensioned dams and retention basins to mitigate the impact of shockwave and heavy rain events.*
- *To avoid the impact of shockwave remove installations and contaminated volume from the flood risk area*

5.5 Preliminary ranking of the property

The site is ranked according to the average of the afore mentioned priority values (substance, flooding potential, mobility)

$$A_p = \text{sum of priority value}/3$$

A_p = Averaged priority value

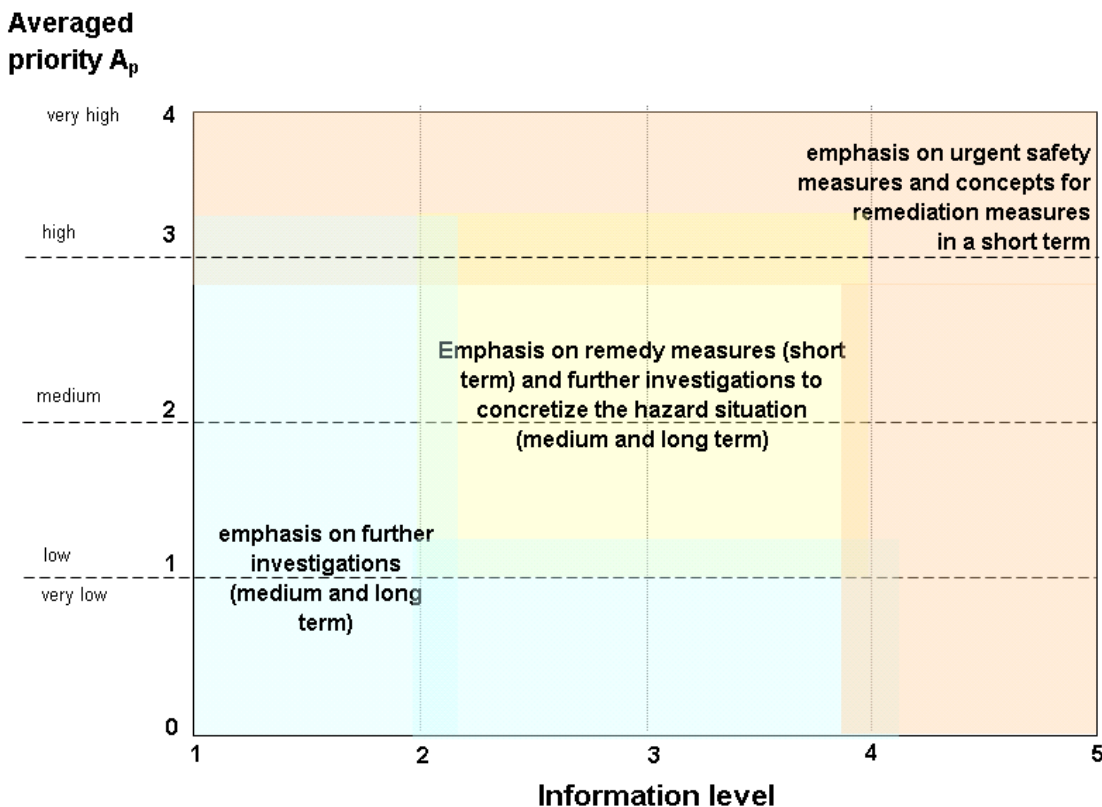
If two properties have the same A_p , the ranking is determined secondly by the information level. The higher the information level the higher the need for active safety or remedy measures). If the properties are ranked with regard to their risk potential and their need for urgent measures the property with low need of investigation are higher ranked than properties with higher need of investigation.

If the need of further investigation is also the same, the size of the property is determining in a third step (which site could be easier investigated/ remediate in a short time).

According to the figure 2 the sites should be classified, if there is need for immediate measures and/or further investigation.

Immediate measures necessary	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Remedial measures (short and medium term) necessary	<input type="checkbox"/> Yes	<input type="checkbox"/> No
Further investigation necessary	<input type="checkbox"/> Yes	<input type="checkbox"/> No

Figure 2:
Classification of the preassessed property according to averaged priorities vs. information level



As shown in figure 2, the following requirements on measures result with regard to the information level:

- If priorities for mobility and flooding danger are very high immediate measures to rise the safety level are necessary
- If the information level is lower than 2, there is a necessity for further investigation to affirm the estimated priorities for mobility and flooding danger (especially if these potentials are very high or high, which makes immediate measures necessary)
- If substance priority and mobility are very high, but flooding danger is very low, measures should depend on the results of further investigations. The same is valid if substance priority and flooding danger are very high and the mobility is very low.

The following immediate measures in case of identified flooding danger should be taken into consideration

- If the property is endangered by high water, stability and dimensions of dams have to be proved.
- All technical facilities in this property have to be proved with regard to safety requirements.
- If the property is endangered by back pressure, all safety facilities of the sewerage system have to be proved. (Impermeability, swing type check valve, storage tank for process water, rain storage reservoir etc.)
- In case of rising groundwater levels, stability of tank systems has to be proved and it has to be proved if rising groundwater is touching a relevant contamination hot spot, which leads to a contamination displacement.
- In case of rising groundwater levels and heavy rain events, stability of dams have to be proved with regard to danger of being eroded.

In case of identified high mobility measures such as

- Excavation of contaminated volume
- Sealing of the surface

should be taken into consideration.

6 Part 2 - Further Investigations of Suspected Contaminated Sites in Properties

This form has to be completed for each suspected site inside of a property. It comprises

- Checklists for questionnaire and data compilation to classify the suspected site
- Assessment of the probable environmental impact of the suspected site in case of flooding
- Proposal for measures
- Summarized results and preliminary assessment of the site
- Photo documentation and description of the site

All contaminated sites are listed in their specific checklists, where the estimated water risk class equivalents (according to risk class 3) are determined. At least in a summarized list, where all sites of one property are listed, the sum of the water risk equivalents and the water risk index WRI should be calculated, which gives the information about the potential impact of the contamination to the surface water. This value gives no information about the actual risk, but it helps to prioritize the properties and the single sites, which of them have the highest need for immediate measures and which need must be affirmed at first by further investigation (e.g. how mobile are the contaminants in the polluted zone).

6.1 Front Page of the checklist for the suspected site investigation

Name of the property: *model factory* _____
Site description *production line for acryl nitrile* _____
Sequential number of the suspected site *e.g. SuS02* _____
Used Map *Land register map 2003_11_03 1: 10.000* _____

A property can contain several sites with different former uses. Figure 3 shows an exemplary structure of the checklists. The checklists are built up to four different kind of suspected contamination.

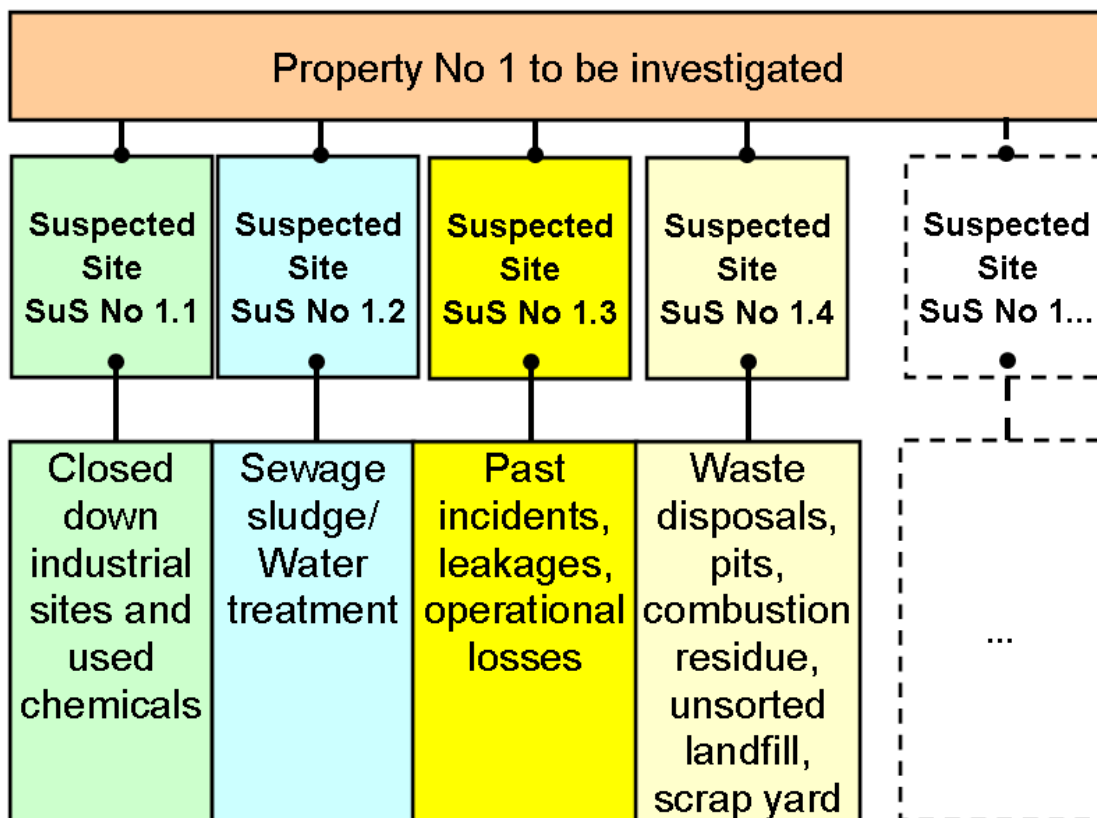


Figure 3: Exemplary structure of the checklists

Please mark with a cross the correct item for the special site in the property to be investigated. Multiple crossing is possible, if the site includes more than one of the items.

- ⁴ Closed down industrial sites and ⁵ used chemicals (see further checklist chapter 6.2)
- Sewage sludge/ Water treatment (see further checklist chapter 6.3)
- Other sources of contamination, past incidents, leakages, operational losses (see further checklist chapter 6.4)
- Waste disposals, pits, combustion residue, unsorted landfill, scrap yard (see further checklist chapter 6.5)
- Summarized results and preliminary assessment of the site (see table 14 in chapter 6.6)

6.2 Hazard potential of closed-down plant facilities and used chemicals

This questionnaire should help to specify hazard potential of closed down installations including operating supplies. It helps to concretise the need for immediate measures. All specified suspected sites in this property, where hazardous substances and chemicals seemed to be used during the industrial production have to be listed in a table.

6.2.1 Basic data

Name of the property:

model factory _____

⁴ Number of closed down industrial sites

⁵ Number of used chemicals

Site description *production line for acryl nitrile* _____
Sequential number of the suspected site *e.g. SuS02* _____
Used Map *Land register map 2003_11_03 1: 10.000* _____
Classification according branch catalogue _____
Suspected Substance _____
Water risk Class _____

6.2.2 Questionnaire and data compilation

Short description of the installation:

Are the installations already removed?

Yes No

if yes go to 6.2.3

if no, please list the remaining installations in Table 12:

Identity Number	Quantity	installation	Volume in m ³	Weight (approx.) t	Installation is built			Installation is			
					Above ground	underground	On water surface	emptied	saved against updrift	saved against leakage	sealed
SuS-1.01	5	<i>tank</i>	10		<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
					<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Table 12: List of installations

6.2.3 Assessment of the probable environmental impact

Suspected/estimated amount of contaminants in the installations in kg _____

Water risk equivalent⁶ of the residues in kg _____

Is the underground of the installation affected by pollution? (Proof according organoleptic test)

Yes No not sure

if not sure, start a preliminary investigation by chemical analysis of the soil

if yes,
estimate the amount of contaminants in the polluted volume in m³ _____

Water risk classification according waste or branch catalogue _____

Water risk equivalent of the waste in kg _____

Sum of water risk equivalent in kg _____

⁶ Related to the water risk class 3

6.2.4 Proposal for safety measures:

Examples of actions:

Short-term measures:

- *If vessels and pipelines are containing hazardous substances, emptying of vessels and pipeline and environmentally safe disposal of the content is necessary.*
- *After emptying dismantling and removing of the plant facilities has to be completed*
- *If measures are already taken, prove if they are sufficient to avoid hazard incidents*
- *Concept for working safety must be considered*

The following measures are necessary if the underground vessel or pipeline can not be emptied, removed and are not sufficiently protected against uplifting:

- *Increase the coverage with earth, or*
- *install a concrete slab which covers the vessel, or*
- *Anchor with steel tapes which are secured to a concrete slab.*
- *Demonstrate that the protection against uplift is sufficient.*

The following measures are necessary if high contaminated zones under the installations are suspected::

- *A preliminary investigation has to be carried out, if high contaminated zones are suspected but still not identified.*
- *A detailed investigation has to be started, if either the contamination dimension is not known exactly or the risk is not confidently excluded by preliminary investigation.*
- *If the further investigations reveal contamination and indicates a hazard for water, remedial measures are needed*

Medium term measures:

- *If site treatment is not feasible in the short time, monitoring of the site is necessary*
- *If the contamination dimension is known, but remedy measures were not taken so far, preparation of a remediation concept is needed with measures like*
 - *excavation of tank and contaminated soil*
 - *sealing of the contaminated volume*
 - *bioremediation or disposal of contaminated soil*
 - *extraction of oily phases*
- *In case of concreted contamination situation, remedial measures have to be chosen with regard to cost effectiveness and expected result to be achieved. The more mobile the contaminants are*
 - *an excavation,*
 - *degradation or*
 - *removal**of contaminants is preferable to other safety measures like sealing.*
- *The conception of remedial measures should consider also natural attenuation processes*
- *Concept for working safety must be considered*

Long-term measures:

- *If sealing will be removed during future civil works, vessels and pipelines must be also removed.*
- *Concept for working safety must be considered*

6.3 Sewage sludge/Waste Water Treatment

6.3.1 Basic data

Comments: Investigation of the waste water treatment is only necessary, if the product of Pop. Equivalent $10^{WRC} > 100.000$*

Treatment is existing yes no

if not go to 6.5

WRC= Water risk class of the treated water contaminants: _____

Population equivalent of the waste water treatment: _____

Product: _____

If product is lower than 100.000 go to 6.4

If not, go to 6.3.2

6.3.2 Questionnaire and data compilation

Treatment condition

Treatment facility	still in action		condition			sealed	
	yes	no	good	bad	unpredictable	yes	no
Sewerage system							
Sewage plant							
Sump, dry well							

If treatment is still in action, is it protected against flooding?

Yes No

If yes, how

- By dams
 treatment consists of closed tanks and vessels
 By retention basin
 Others, please specify _____

If no, how should it be protected

- By dams
 treatment consists of closed tanks and vessels
 By retention basin
 Others, please specify _____

Sewage sludge disposal

Sewage sludge is/ was disposed/treated

at site out of the site

If at site, is the site protected against flooding?

- Yes No

If yes, how

- By dams
 treatment consists of closed tanks and vessels
 By retention basin
 Others, please specify _____

If no, how should it be protected

- By dams
 By retention basin
 Others, please specify _____

6.3.3 Assessment of the probable environmental impact

Volume of the disposed sludge: _____ m³

Classification according waste catalogue _____

Calculated WRC3-equivalent: _____ kg

6.3.4 Proposal for safety measures:**Short term measure:**

- *If no water treatment is specified but there is still a suspicion of treated process water, look for disposed material within the industrial site*
- *If water treatment is specified and still in action, look for the residues coming up from the treatment.*
- *Prove safety of dams with regard to their stability and dimension according estimated tide.*
- *If water treatment is specified but not in action,*
 - *look for the disposal of remaining residues in treatment facilities, storage or sedimentation tanks,*
 - *sealing of the outlet pipes is necessary.*
- *If sewage sludge is treated and disposed at site, look for the safety and stability of the deposits in case of flooding and heavy rain events.*

If the waste water residues are high loaded with water hazardous substances the following measures could be relevant in medium and long term.

Medium term measure:

- *Elaboration of a safety concept for waste water treatment residues, disposed at site.*

Long term measure:

- *Excavation or sealing of the disposed residues.*

6.4 Past incidents, leakages, operational losses

6.4.1 Basic data

Name of the property: model factory

Site description: production line for acryl nitrile

Sequential number of the suspected site: e.g. SuS02

Used Map: Land register map 2003_11_03 1: 10.000

Classification according branch catalogue: _____

Suspected Substance: _____

Water risk Class: _____

6.4.2 Questionnaire and data compilation

In Table 13 former incidents at the suspected site are listed. This table helps to identify hidden contaminated zones, which are suspected but still not confirmed by preliminary or detailed investigation. On that basis the need of further investigation will be formulated, which helps to substantiate the relevant risk areas. Hints for that could be former incidents, leakages or operational losses, which occurred at the site. Usually those hints could be only given by contemporary witness or a log of the enterprise. The amount of the substance set free has to be estimated. With the given water risk class for the substance a water risk equivalent related to the water risk class 3 will be calculated as a size for the environmental impact to the water body. This equivalent is calculated with regard to a mobilization of the whole contaminated volume in case of flooding. It does not consider natural attenuation processes, which have taken place over the years and led to a decrease of the pollution.

Year	Local point.	Hazard incident			Contaminants and water risk class	Estimated amount in kg	WRC3-equiv.
		accident	leakage	operational loss			
1954	Tank 01	x			Ammonia 2	10.000	1000
1973	Reactor03		x		Acrylnitril 3	10.000	10.000
Sum of WRC3							11.000

Table 13: Example for the listing of former incidents

How is the suspicion confirmed

- By contemporary witness
- By documents of the authorities
- By actual investigation
- Other sources, please specify _____

6.4.3 Proposal for safety measures (see also proposal at the end of this chapter):

Short term

Medium term

Short term measure at the office:

- *If Point 6.4.2 can not be answered but there is a reasonable suspicion, which has to be verified, further investigation is necessary.*
- *Proof of consistency of the elaborated information through site visits and interviews with contemporary witnesses.*

Short term measure at site:

- *It has to be proved, if facilities are still existing and have to be emptied and/or removed, if yes remove all vessels, tank and pipes. Residues of the substances hazardous to water have to be disposed in an environmentally friendly way.*
- *It has to be proved, if soil under the removed facilities is affected by pollution, if yes, excavate and relocate contaminated volume. Excavated soil has to be disposed on safe landfills.*
- *If large areas of soil are contaminated, a concept for alternative remediation or safety measures is needed.*

Medium term measure at site:

- *Further investigations should clarify the extension and risk of the contamination, if the suspicion is affirmed by historical investigation. If the results show a significant hazard potential a plan for remediation measures is needed.*
- *In case of large sites, a priority list of measures for several contamination hot spots has to be elaborated.*

6.5 Waste disposal sites

6.5.1 Basic data

Name of the property: *model factory* _____
 Site description *production line for acryl nitrile* _____
 Sequential number of the suspected site *e.g. SuS02* _____
 Used Map *Land register map 2003_11_03 1: 10.000* _____
 Kind of waste _____
 Classification according waste catalogue _____
 Suspected Substance _____
 Water risk Class _____

The investigation of waste disposal sites includes also pits, combustion residue, unsorted landfill, scrap yards.

6.5.2 Questionnaire and data compilation

6.5.2.1 Kind of disposal

The kind of disposal gives a hint, if the hazard potential of the disposal is high or low in case of flooding.

Disposal was

Regular Irregular

If regular, name and address of the liable operator _____

Did further disposal out of this site operate?

Yes No

If yes, which type of disposal? _____

Waste was disposed in

Landfills
 Disordered deposit
 Combustion residues
 Communal deposits
 Filling of pits
 Tips
 Tips at slope
 Filling of depressions
 Combination
 Other please specify _____

6.5.2.2 Safety

Does a leachate collector system exist?

Yes

No

If yes, is the leachate treated

Yes

No

if no, list results of chemical analysis to prove, if treatment is necessary.

Is landfill body safe and/or stable against flood events?

Yes

No

Unpredictable

if unpredictable, survey about the dam static must be made.
If no, dam stability must be enhanced.

Are safety systems like dams or landfill liner system provided?

Yes

No

If yes, which kind of:

Dam

Cover system

Leachate collector system

Liner system

Other, please specify: _____

if no, which kind of measures are necessary

Dam

Cover system

Leachate collector system

Liner system

Other, please specify: _____

Are safety systems demonstrable stable against flood events?

Yes

No

Periodical Control and monitoring of the landfill body is

Done

Not done

Periodical Control and monitoring of the safety systems are

Done

Not done

6.5.3 Assessment of the probable environmental impact

Estimated capacity of the disposed volume

- | | | |
|-------------|----------------|--------------------------|
| No | | <input type="checkbox"/> |
| < 1.000 | m ³ | <input type="checkbox"/> |
| < 5.000 | m ³ | <input type="checkbox"/> |
| < 10.000 | m ³ | <input type="checkbox"/> |
| < 50.000 | m ³ | <input type="checkbox"/> |
| < 100.000 | m ³ | <input type="checkbox"/> |
| < 200.000 | m ³ | <input type="checkbox"/> |
| < 300.000 | m ³ | <input type="checkbox"/> |
| < 400.000 | m ³ | <input type="checkbox"/> |
| < 500.000 | m ³ | <input type="checkbox"/> |
| < 600.000 | m ³ | <input type="checkbox"/> |
| < 700.000 | m ³ | <input type="checkbox"/> |
| < 800.000 | m ³ | <input type="checkbox"/> |
| < 900.000 | m ³ | <input type="checkbox"/> |
| < 1.000.000 | m ³ | <input type="checkbox"/> |
| > 1.000.000 | m ³ | <input type="checkbox"/> |

WRC of the disposed substances:

Calculated WRC3-equivalent: _____

Resulting WRI: _____

6.5.4 Proposal for safety measures:

Short term

Medium term

Short-term measures:

- *Irregular waste disposal sites should be displaced if one has to assume that the waste contains hazardous substances. The waste should be disposed in regular waste management facilities.*
- *If the capacity and/or safety are not known, further investigation is necessary*
- *If leachate is collected, analyzing of the quality for the determination of the probable hazard potential*
- *If leachate is not treated, monitoring of the outlet with regard to hazard potential and elaboration a list of immediate measures is necessary (e.g. conception of a retention basin or a urgent removal of the contaminated volume, if the volume is too big, a remediation concept has to be elaborated in medium term)*
- *If leachate treatment is existing, prove the stability and dimension of the installation in case of a flood event.*

Medium term measures:

- *The larger sites should be sealed and saved against heavy rain events and direct impact by floods. Therefore a concept has to be elaborated based on hydro geological data.*
- *If the contaminated volume can not be removed a concept for a leachate treatment has to be elaborated. Depending on the leachate constituents the treatment has to include mechanical, chemical or biological process stages, which are designed to be stable against flood incidents or they are located outside of the flood risk area.*
- *If the safety of the deposit can not be guaranteed a concept for a deposit displacement must be elaborated.*
- *Control and monitoring of safety systems with regard to dimension and stability of the deposit slope*

Long -term measures:

- *Realisation of a drainage and treatment of the leachate and surface water arising from the deposit.*
- *If the hazardous substances are at risk to be washed away, a concept has to be elaborated considering measures such as relocation or sealing/encapsulation with regard to their efficiency and cost effectiveness. The measures suited best, should then be implemented.*

6.6 Summarized results and preliminary assessment of the site

Name of the property: *model factory*_____

Site description *production line for acryl nitrile*_____

Sequential number of the suspected site *e.g. SuS02*_____

Used Map *Land register map 2003_11_03 1: 10.000*_____

Table 14 shows the data compilation of all investigated objects of one site, which were taken as a summary from the checklists in chapter 6.1 – 6.5.. The summarized results of the investigation give a complete overview about

- the estimated environmental situation,
- the estimated risk to water bodies in case of flooding and
- a list about necessary measures to enhance the safety of the site.

Investigated site	Number	WRC3 [kg]	WRI
<i>SuS 02</i>			
Past incidents, leakages, operational losses			
Closed-down plant facilities			
Waste water treatment			
Waste disposal			
Sum			

Table 14: Compilation of all investigated objects of one site

Further action

7 Part 3 –List of measures

All identified and gathered measures have to be compiled and separated in immediate measures (short term) and investigations (medium and long term). The measures have to be concretised. The measures will fixed in a time schedule and specified with the responsible operator. Examples are shown in Table 16 and Table 17.

7.1 Proposed immediate measures

Investigated site	Identified action needed							Formulated measures	date	responsible
	Proof of stability	Improving of the dam stability	Improving of the dam dimension	Decontamination measures	Removal of contaminants	Sealing or encapsulation	Anchoring, fixing or locking			

Table 16: Proposal immediate measures

7.2 Proposed investigation measures for further proceeding in medium and long term

Investigated site		Identified information gap							Formulated measures	date	responsible
Name	located	State of the art	Situation unidentified/ unknown	no activities planned or started	Historical investigation	Preliminary investigation	Detailed investigation	remediation investigation not completed			

Table 17: Proposal for investigation measures

Comments:

- *If the situation at site is not identified or not known, a historical investigation, a site visit and should be performed.*
- *If no activities are planned or started, a concept for remedial actions must be elaborated if the assessments suggest a high risk at site. The measures should be more concretised in the further investigation steps..*
- *If urgent measures are completed, the site has to be controlled or monitored to verify the success of the measures.. A concept for following safety measures with lower priority can be now concretised. (E.g. further investigation of other areas of the industrial site with lower hazard suspicion).*
- *If the contamination history is completed and suggests a high risk at site, a preliminary investigation should follow.*
- *If the preliminary investigation is completed, a concrete answer must be given, if a risk is existing or not. A concept for a detail investigation must follow, if high risk is still suspected but not totally proved.*
- *If the detail investigation is completed, a concrete answer must be given, if there is a hazardous impact to water in case of flooding caused by the investigated substances. If yes, a concept for concrete measures must be elaborated in a remediation investigation.*
- *If the remediation investigation is completed, the best solution must be announced for tendering. The best offer in question of technical and cost effectiveness should be realized.*
- *If the remediation is completed, monitoring and technical control of the effectiveness of the measure must follow.*

8 Appendix 1 – Waste Related Risk Values

9 Appendix 2 – Branch Related Risk Values

10 Appendix 3 – Description of the M1-Methodology