European Union Network for the Implementation and Enforcement of Environmental Law

Financial Provision

Protecting the Environment and the Public Purse

Date of final report: 16 November 2018

Report number: 2018/20

Introduction to IMPEL

The European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) is an international non-profit association of the environmental authorities of the EU Member States, acceding and candidate countries of the European Union and EEA countries. The association is registered in Belgium and its legal seat is in Brussels, Belgium.

IMPEL was set up in 1992 as an informal Network of European regulators and authorities concerned with the implementation and enforcement of environmental law. The Network's objective is to create the necessary impetus in the European Community to make progress on ensuring a more effective application of environmental legislation. The core of the IMPEL activities concerns awareness raising, capacity building and exchange of information and experiences on implementation, enforcement and international enforcement collaboration as well as promoting and supporting the practicability and enforceability of European environmental legislation.

During the previous years, IMPEL has developed into a considerable, widely known organisation, being mentioned in a number of EU legislative and policy documents, e.g. the 7th Environment Action Programme and the Recommendation on Minimum Criteria for Environmental Inspections.

The expertise and experience of the participants within IMPEL make the network uniquely qualified to work on both technical and regulatory aspects of EU environmental legislation.

Information on the IMPEL Network is also available through its website at: www.impel.eu

Title of the report:	Number report:
Financial Provision – Protecting the Environment and the Public Purse	2018/20
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Executive Summary

At a meeting of the Network of heads of European Environment Protection Agencies (EPA Network) in Oslo in 2014, it was recognised that the cost of dealing with environmental liabilities arising from industrial operations too often fell to the public purse as a result of the failure of financial provisions. A project was set up to look at the extent of this problem across Europe, and identify what forms of financial provision are most likely to deliver secure and sufficient cover which is available to the regulator when needed.

The project aims are defined as the generation of a better understanding of the availability and suitability of financial tools. This should result in improved protection of the environment and the public purse, whilst ensuring compliance with the Polluter Pays Principle, and encouraging operator investment in pollution prevention.

The project, in 2017, produced a practical guide to assist regulators in making decisions about financial provision. It was concluded that further investigation of approaches to determining the amount of provision for unforeseen liabilities was needed, in particular to evaluate the potential for wider application of 3 pre-existing calculation tools. This report summarises the evaluation methodology and the conclusions of the evaluations.

The three approaches/methodologies analysed in this project developed in Spain, the Netherlands, and Ireland, have been designed for slightly different purposes and types of operators and in different policy contexts. The Spanish and Irish methodologies are already being applied to existing legislation. The Dutch method has been developed as an aid for a limited group of operational activities (Seveso companies and companies that fall under Annex I category 4 of the EU Industrial Emissions Directive (IED) (chemical industry), for which new legislation on financial security is currently being developed.

The three methodologies share common characteristics, for example, they all consider remediation of land and waters, take mitigation measures into account and contain or provide unit costs for remedial measures. The Irish and Spanish methods are both based on a risk assessment whilst the Dutch model is effects based.

The evaluation concluded that there is potential for wider application of the three methodologies in different jurisdictions, taking into consideration the specific purposes for which they have been developed. . The practical guide will be updated in the light of this report.
Disclaimer This report is the result of a project within the IMPEL network. The content does not necessarily represent the view of the national administrations or the Commission.

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1. Introduction

Operators engaged in activities that could degrade or harm the environment have environmental obligations. These could include restoring the environment for example following the closure of a mine or landfill (a foreseen obligation) or cleaning up the environment following a pollution incident (an unforeseen obligation). If the operator cannot bear the costs of these environmental obligations due to its insolvency or lack of available funds, then not only will the burden pass to society but there is a corresponding risk to the environment. This is the 'problem' with which the IMPEL financial provision projects have been concerned.

One means of increasing the likelihood that private funds will be available and therefore safeguarding the environment is to ensure that the operator makes appropriate 'financial provision' for its environmental liabilities. The operator provides and maintains evidence that adequate financial resources will be available to meet the costs of restoration or clean-up. To fulfil its role, financial provision must be:

- **secure** in the event of the operator's insolvency
- **sufficient** to cover all of the operator's environmental liabilities, and
- **available** when required

If these conditions are not satisfied, then the financial provision may fail. This may result in lengthy legal proceedings and, ultimately, a detrimental effect upon both the environment and the public purse.

The problem described above has been recognised by the Network of heads of European Environment Protection Agencies (EPA Network). The EPA Network held a workshop in Oslo in February 2014 and presented the outcome to the EPA Network plenary in Vienna in April 2014. The Vienna plenary agreed that the EPA Network (via its Better Regulation Interest Group (BRIG)) and the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) should seek to promote the development of pan-European guidance on the practicalities of providing financial security. The BRIG/IMPEL group met in October 2014 and agreed on the need to understand who is facing the issue and try to identify a solution to share around the networks. An application was subsequently made to IMPEL to support a project "Financial Provision – what works when?" The application received approval from IMPEL for delivery during 2016. The project report is available on the IMPEL Financial Provision webpage here. In 2017 the contents of the report were translated into a practical guide. This is available on the IMPEL Financial Provision webpage here. IMPEL approved a proposal for 2018 (see Terms of Reference at Annex 1) to evaluate the potential for wider application of three methods for calculating the amount of provision required for incidents and accidents. This report presents the evaluation. The practical guide will be updated in the light of this year's work.

2. Project Approach

2.1 Project Aim, Scope and Objectives

The Terms of Reference for the final phase of this 3 year project are provided in Annex I.

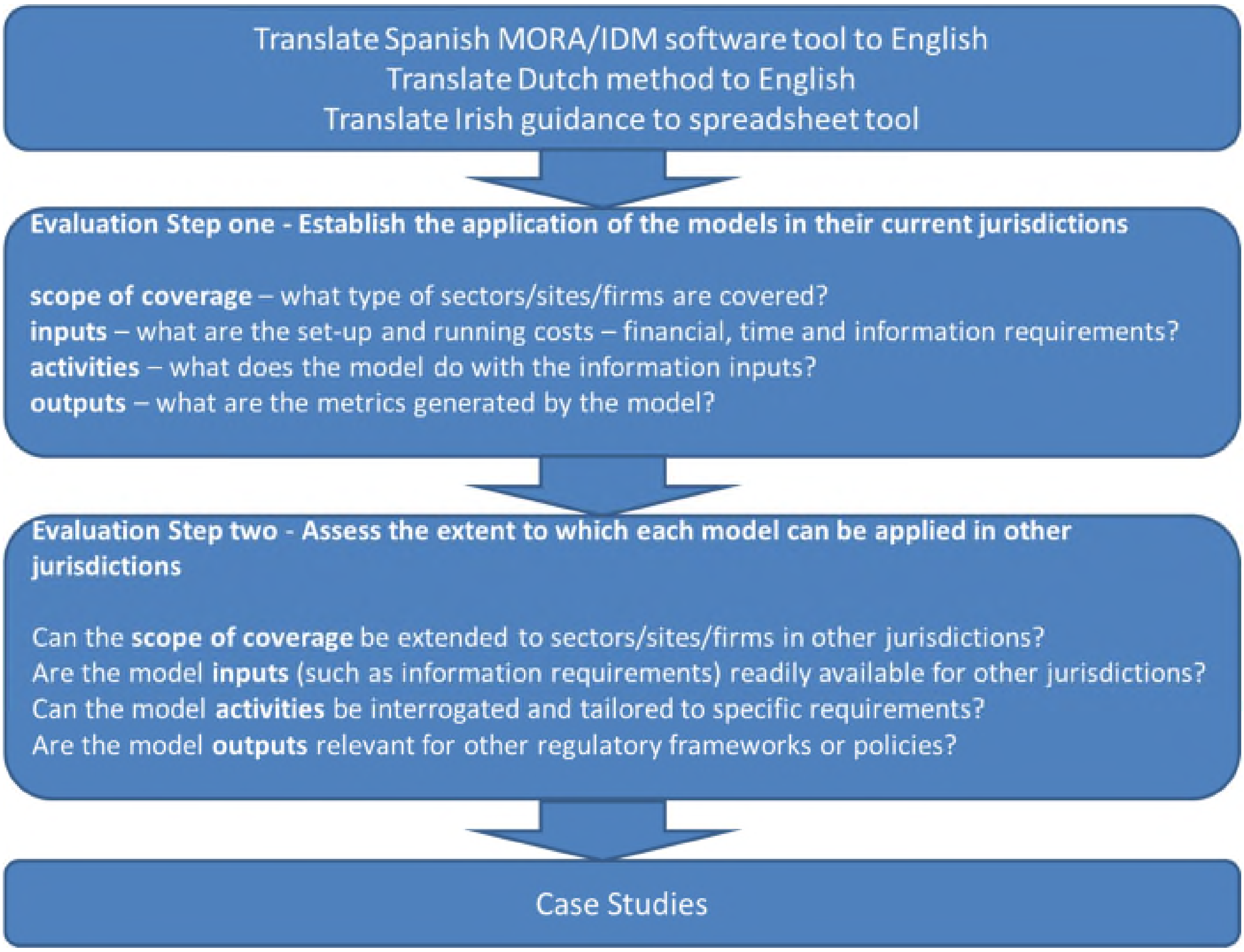
The aim of the overall project is to produce practical guidance that will better equip regulators and others to make informed decisions about financial provision for unforeseen and foreseen liabilities. The practical guide was published in 2017. It was acknowledged that there was a gap in understanding and availability to the regulator of tools for calculating the sufficiency of provision for incidents and accidents.

The aim of this year's project is to produce an evaluation of the potential wider application (to other jurisdictions) of the Dutch, Irish and Spanish models for calculating the amount of provision for incidents and accidents. The anticipated beneficial outcomes are improved confidence in decision making and potential benefits in terms of streamlining and reducing regulatory burden.

2.2 Project Methodology

The project was designed and executed by a project team comprised of representatives from IMPEL's member organisations along with representatives of the Dutch and Spanish Environment Ministries.

The methodology for the final phase of the project is shown below.


Translate Spanish MORA/IDM software tool to English
Translate Dutch method to English
Translate Irish guidance to spreadsheet tool
Evaluation Step one - Establish the application of the models in their current jurisdictions
scope of coverage – what type of sectors/sites/firms are covered?
inputs – what are the set-up and running costs – financial, time and information requirements?
activities – what does the model do with the information inputs?
outputs – what are the metrics generated by the model?
Evaluation Step two - Assess the extent to which each model can be applied in other jurisdictions
Can the scope of coverage be extended to sectors/sites/firms in other jurisdictions?
Are the model inputs (such as information requirements) readily available for other jurisdictions?
Can the model activities be interrogated and tailored to specific requirements?
Are the model outputs relevant for other regulatory frameworks or policies?
Case Studies

3. RESULTS

The English version of the MORA and IDM models is available at
https://servicio.mapama.gob.es/mora/login.action?request_locale=en

A google translation of the Dutch model is provided in Annex II. The original report is available at
https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2016/11/22/financiele-zekerheidstelling-voor-milieuschade-bij-majeure-risicobedrijven/Financi%C3%ABle+zekerheidstelling+voor+milieuschade+bij+majeure+risicobedrijven.pdf

The Irish methodology is available at
http://www.epa.ie/enforcement/financialprovisionforenvironmentalliabilities/.

The guidance is being considered for production as an electronic tool.

The results of the evaluation of the potential for application of the Spanish, Irish and Dutch methods for calculating sufficient provision for incidents and accidents, along with case studies are provided in Annexes III, IV and V. The evaluations are proceeded by a summary of how each method works.

4. CONCLUSIONS AND RECOMMENDATIONS

The three approaches/methodologies analysed in this project developed in Spain, the Netherlands, and Ireland, have been designed for slightly different purposes and types of operators and in different policy contexts. The Spanish and Irish methodologies are already being applied to existing legislation. The Dutch method has been developed as an aid for a limited group of operational activities (Seveso companies and companies that fall under Annex I category 4 of the EU Industrial Emissions Directive (IED) (chemical industry), for which new legislation on financial security is currently being developed.

The three methodologies share common characteristics, for example, they all consider remediation of land and waters, take mitigation measures into account and contain or provide unit costs for remedial measures. The Irish and Spanish methods are both based on a risk assessment whilst the Dutch model is effects based.

The three methodologies can only be used in different jurisdictions and in different Member States, taking into consideration the specific purposes for which they have been designed. .

The Spanish MORA tool has a GIS interface that can only be used only with Spanish cartography, and this should be tailored for use in other Member State. Nevertheless, this GIS interface is used to automatically input some information in MORA in terms of the features of the site and the potential resources damaged by the incident/accident being modelled, which is helpful to the user. This information can be modified and adapted to the specific characteristics of any facility in any Member State, and therefore, the MORA tool can be used in any Member State and for any jurisdiction that requires the calculation of recovery costs in case an incident/accident occurs.

In addition to the costs of primary remediation measures, along with prevention measures, that must be covered by the mandatory financial provision in Spain, the MORA tool also provides the cost of complementary and/or compensatory remediation measures.

Although the procedure for the determination of the amount of the financial security in Spain only requires monetisation of the reference scenario of a facility, the MORA software can be used to estimate the remediation costs of all the risk scenarios identified within the environmental risk analysis. This provides operators with valuable information for risk-management purposes, allowing them to plan the implementation of measures to reduce the probability of occurrence, or the consequences of a particular risk scenario within their facility.

Therefore the IDM and MORA tools, not only allow operators to determine the amount of mandatory financial security needed, but can also be very useful tools for the decision-making process of operators in the short, medium and long term and, in this way, contributes to the implementation of the prevention principle

The Irish tool can also be tailored for use in other jurisdictions. The user can add features specific to the site and the potential resources damaged by the incident/accident being modelled and therefore, the Irish tool can be used in any Member State and for any jurisdiction that requires the calculation of recovery costs in case an incident/accident occurs.

The Irish approach provides operators with a risk-management tool, whereby the operator identifies and evaluates plausible risks identifying the potential event that poses the maximum environmental liability. This allows the operator to identify the associated risks for each process, activity, and area.

These risks are ranked by priority considering their likelihood and consequence of occurrence, identifying mitigation (preventative) measures (in place or proposed), risk owners assigned and implementation timeframes specified as required. The mitigation measures assist the operators to assess potential occurrence, or the consequences of a particular risk scenario.

The plausible worst-case scenario must consider the impact of an event, e.g. stopping it, preventing further emissions/pollution, clean-up of emissions/pollution caused while considering in detail:

- types of materials lost
- quantity of materials lost
- pathways involved
- nature and extent of impact
- control and remediation measures required

Once agreed, the plausible worst-case environmental scenario is costed and in turn identifies the amount of financial security that is required.

The Dutch model could also be used in other jurisdictions to calculate the amount of finances needed for financial security, in particular, for Seveso companies and for IED Annex I category 4 companies (chemical industry). Application to other types of activities has not been studied so far. However, it does seem possible to apply the model to other activities, subject to specific adaptations for specific activities. since the model is understandable and simple in application.

The Dutch model provides an aggregated sum for the costs of soil and groundwater remediation, surface water treatment and dealing with the disposal/treatment of chemicals/wastes left on site following closure.

The table below provides a summary of the key features of each model that may be relevant to their wider application.

	Ireland Methodology	**Netherlands Methodology**	**Spain Methodology**
Environmental Media			
Soil	X	X	X
Groundwater	X	X	X
Surface water	X	X	X
Habitats	X	-	X
Species	X	-	X
Air	X	-	-
Applicable Legislation			
Directive 2004/35/CE on environmental liability	X		X
European communities (environmental liability) Regulations 2008	X		
Integrated Pollution and Prevention Control Directive (2008/1/EC)	X		
The Industrial Emissions Directive (2010/75/EU)	X		
Waste Framework Directive (2008/98/EC)	X		
The Landfill Directive (1999/31/EC)	X		
The Mining Waste Directive (2006/21/EC			
Omgevingswet, Omgevingsbesluit (entry into force foreseen by 1 January 2021); the model has been developed as helpful material for the application of the legislation by the competent authorities, it is not obligatory. Legislation on ELD can be found in the *Wet milieubeheer (Environmental Management Act).*		X	

Law on environmental liability (Ley 26/2007)			X
Water Law (Real Decreto Legislativo 1/2001) and Coast law (Ley 22/1988)			X
Waste and Soil Law (Ley 22/2011)			X
Habitats and Species Law (Ley 42/2007)			X
Operational Activity			
Unforeseen liabilities	Incidents	Incident at Seveo and IED Annex 1, category 4 installations	Incidents and accidents
Storage and shipping of Chemicals/wastes			
Language			
	English	Dutch, English translation in Annex II of this report	Spanish and English
Availability	Spreadsheet not available; Guidance fully available since 2014.	Available	Fully available since 2013
Cost to user	Free	Free	Free

Annexes

Annex I Terms of Reference

TOR Reference No.:	Author(s): Kim Bradley
Version: 1.1	Date: September 2017 revised October 2017 and November 2017
TERMS OF REFERENCE FOR WORK UNDER THE AUSPICES OF IMPEL	

1. Work type and title

1.1 Identify which Expert Team this needs to go to for initial consideration	
Industry Waste and TFS Water and land Nature protection Cross-cutting – tools and approaches -	☐ ☐ ☐ ☐ X
1.2 Type of work you need funding for	
Exchange visits Peer reviews (e.g. IRI) Conference Development of tools/guidance Comparison studies Assessing legislation (checklist) Other (please describe):	☐ ☐ ☐ x ☐ ☐
1.3 Full name of work (enough to fully describe what the work area is)	
Financial Provision: Protecting the Environment and the Public Purse – Phase 3	
1.4 Abbreviated name of work or project	
Financial Provision: Protecting the Environment and the Public Purse	

2. Outline business case (why this piece of work?)

2.1 Name the legislative driver(s) where they exist (name the Directive, Regulation, etc.)
• This is a broad issue which cuts across many legislative drivers and sectors for example Environmental Liability Directive, Landfill Directive, Mining Waste Directive, Water

Framework Directive, Industrial Emissions Directive, Seveso and relevant domestic legislation. It is relevant during the planning, operation and restoration stages of business.

2.2 Link to IMPEL MASP priority work areas	
1. Assist members to implement new legislation 2. Build capacity in member organisations through the IMPEL Review Initiatives 3. Work on 'problem areas' of implementation identified by IMPEL and the European Commission	☐ ☐ X

2.3 Why is this work needed? (background, motivations, aims,etc.)

The impact of direct environmental incidents as well as business insolvency resulting in risk to the environment must be protected against.

In cases where there is either an environmental incident which results in actual/potential harm to the environment or where a company becomes insolvent and can no longer meet its obligations, suitable financial provision can mitigate or prevent an impact on both the environment and/or the public purse.

Where appropriate, a financial provision mechanism should ensure that the provision is:

- Sufficient
- Secure
- Available when required

This terms of reference concerns the first of these: sufficiency.

Background

IMPEL approved funding for two years of the project, 2016 and 2017.

The findings from Year 1 confirmed the premise of the project, in that many IMPEL members have experienced challenges in calling upon financial provisions to meet environmental liabilities. The year 1 report presented approaches to financial provision across Europe, along with case studies where it has been both effective in providing protection against the problem of abandoned liabilities, and, on the other hand ineffective because it was not secure sufficient or available when required. Preliminary conclusions were provided, addressing the scope of the problem, the acceptability and availability of suitable financial provision mechanisms, and the role of regulators in ensuring financial provisions work in practice.

The key output from year 2 was the development of practical guidance in support of good regulatory process in financial provision that would better equip regulators and others to make informed decisions about financial provision for unforeseen and foreseen liabilities. The guide is expected to help regulators put in place financial provision that is secure, sufficient and available when required.

On the second criteria of sufficiency, the project has found that there are limited tools available for determining the amount of the provision for potential incidents/accidents (i.e. unforeseen liabilities) in particular. It also found that Spain and Ireland have such tools (the Spanish MORA model and the

Irish templates) for the determination of amounts of provision for unforeseen liabilities. The MORA tool is in Spanish.

This proposal seeks approval for funding for a final phase of the project to investigate the application of the Irish and Spanish tools in other jurisdictions. This is likely to require production of a version of the Spanish MORA tool with an English language user interface.

2.4 Desired outcome of the work (what do you want to achieve? What will be better / done differently as a result of this project?)

Regulators and operators will have a better understanding of the availability and suitability of financial tools resulting in improved:

- Protection of the environment
- Protection of the public purse
- Implementation of polluter pays principle
- Investment in pollution prevention

2.5 Does this project link to any previous or current IMPEL projects? (state which projects and how they are related)

This project follows on from and builds on the outputs of the IMPEL project Financial Provision – Protecting the Environment and the Public Purse (2016/2017).

3. Structure of the proposed activity

a. Describe the activities of the proposal (what are you going to do and how?)

Production of English language interface of MORA.
Production of spreadsheet (or similar) version of Irish methodology.
(Provisional – production of version of Netherlands methodology)
Project team review of the above.
Circulation of tools for testing
Production of short report on the findings of the testing.
Publication of links to tools (as appropriate) on the IMPEL webpage.

3.2 Describe the products of the proposal (what are you going to produce in terms of output / outcome?)

Output: An evaluation of the potential wider application (to other jurisdictions) or the Irish and Spanish models (and the Netherlands approach if available).

Outcome: confidence in decision making, potential benefits in terms of streamlining the process and reducing regulatory burden (this has been found in Spain where operators are aligning their datasets to be compatible with MORA).

3.3 Describe the milestones of this proposal (how will you know if you are on track to complete the work on time?)
See 3.1
3.4 Risks (what are the potential risks for this project and what actions will be put in place to mitigate these?)
This is a low risk project. The main risks are associated with delivery within the timescale. This will be managed by structuring the project with in-project milestones and timescales. These will be agreed at the first meeting of the project team. There will be a risk that EPAs and others may accept mechanisms for financial provision based on the information provided, and the financial provision subsequently proves to be defective or inaccessible. The risk will be managed by giving careful consideration to the advice given and the context in which it is presented.

4. Organisation of the work

4.1 Lead (who will lead the work: name, organisation and country) – this must be confirmed prior to submission of the TOR to the General Assembly)
Scotland and Ireland Kim Bradley (SEPA) Stephen McCarthy (Irish EPA)
4.2 Project team (who will take part: name, organisation and country)
Isaac Sanchez (Ministry of Agriculture, Food and Environment, Spain)
4.3 Other IMPEL participants (name, organisation and country)
Paul Corrigan (SEPA). We also expect participation from other IMPEL members who have participated in the project in previous years.
4.4. Other non-IMPEL participants (name, organisation and country)
Provisional – Nicolette Bouman (Netherlands Ministry of Infrastructure and Environment)

5. High level budget projection of the proposal. In case this is a multi-year project, identify future requirements as much as possible

	Year 1 (exact)	Year 2	Year 3	Year 4

How much money do you require from IMPEL?			1200	
How much money is to be co-financed			0	
Total budget			1200	

6. Detailed event costs of the work for year 3

	Travel € (max €360 per return journey)	**Hotel €** (max €90 per night)	**Catering €** (max €25 per day)	**Total costs €**
Event 1	500	600	100	1200
Project Team Meeting				
May 2017				
Edinburgh, Scotland or Madrid Spain				
4 (3 travelling)				
2				
Total costs for all events	500	600	100	1200

7. Detailed other costs of the work for year 3

7.1 Are you using a consultant?	No
7.2 What are the total costs for the consultant?	
7.3 Who is paying for the consultant?	
7.4. What will the consultant do?	
7.5 Are there any additional costs?	No
7.6 What are the additional costs for?	
7.7 Who is paying for the additional costs?	

7.8. Are you seeking other funding sources?	
7.9 Do you need budget for communications around the project? If so, describe what type of activities and the related costs	☐ No Namely:

8. Communication and follow-up (checklist)

	What		By when
8.1 Indicate which communication materials will be developed throughout the project and when ***(all to be sent to the communications officer at the IMPEL secretariat)***	TOR✓ * Practical Guidance report✓ * Project report✓ * Progress report(s)✓ Press releases News items for the website✓ * News items for the e-newsletter Project abstract✓ * IMPEL at a Glance ✓ Other, (give details):	x☐ ☐ ☐ x☐ x ☐ ☐ ☐ x☐ x ☐ ☐	As set out by IMPEL requirements shown in project plan and basecamp milestones
8.2 Milestones / Scheduled meetings (for the website diary)	See Basecamp		
8.3 Images for the IMPEL image bank	☐ Yes		
8.4 Indicate which materials will be translated and into which languages	All materials will be in English.		
8.5 Indicate if web-based tools will be developed and if hosting by IMPEL is required	Yes		
8.6 Identify which groups/institutions will be targeted and how	Regulators, European Commission, Financial provision sector through IMPEL member contacts, NGO's and industry		

8.7 Identify parallel developments / events by other organisations, where the project can be promoted	Scottish guidance on financial provision for the waste management sector, ELD Stakeholder Workshop, European Commission ELD multi-annual rolling work programme (MARWP)

*ˇ) Templates are available and should be used. *) Obligatory*

9. Remarks

Is there anything else you would like to add to the Terms of Reference that has not been covered above?

The European Commission has provided positive feedback on the outputs of the two previous year's projects and its support for this proposed project.

In case of doubts or questions please contact the IMPEL Secretariat.

Draft and final versions need to be sent to the IMPEL Secretariatin word format, not in PDF.

Thank you.

Annex II Translation of Dutch Methodology[1]

This chapter is a google translation of chapter 4 of the report *Financiële zekerheidstelling voor milieuschade bij majeure risicobedrijven,een model voor het categoriseren van majeure risicobedrijven, 22 november 2016, Berenschot (Financial Security for Environmental Damage at Major Risk Companies*). The introduction outlines the rationale behind the methodology. This is folllowed by presentation and explanation of the model itself.

4 THE MODEL

4.1 INTRODUCTION

(Further) development of line 4 on the basis of concrete cases.

Based on the results of the exploration of the lines of thought, we have converted line 4 (Reasoning from Cost Components) into a rudimentary model and further tested it. In concrete terms, in three of the six specialized (in Seveso companies) environmental agencies, we applied the model together with permit holders to concrete cases (ie: permits). This concerns the environmental agencies with the largest number of Seveso companies in the area that they cover, namely:

• DCMR Environmental Department Rijnmond Environmental Service: South Holland / Zeeland region, a total of 138 Seveso companies in the area;
• North Sea Canal Area environmental service: North Holland / Utrecht / Flevoland region, a total of 53 Seveso companies in the area;
• West Brabant Environmental Service: North Brabant region, a total of 53 Seveso companies in the area.

In the choice of cases, we have varied in factors that determine the size of the financial security in the model to gain sufficient insight into the financial consequences of the model:

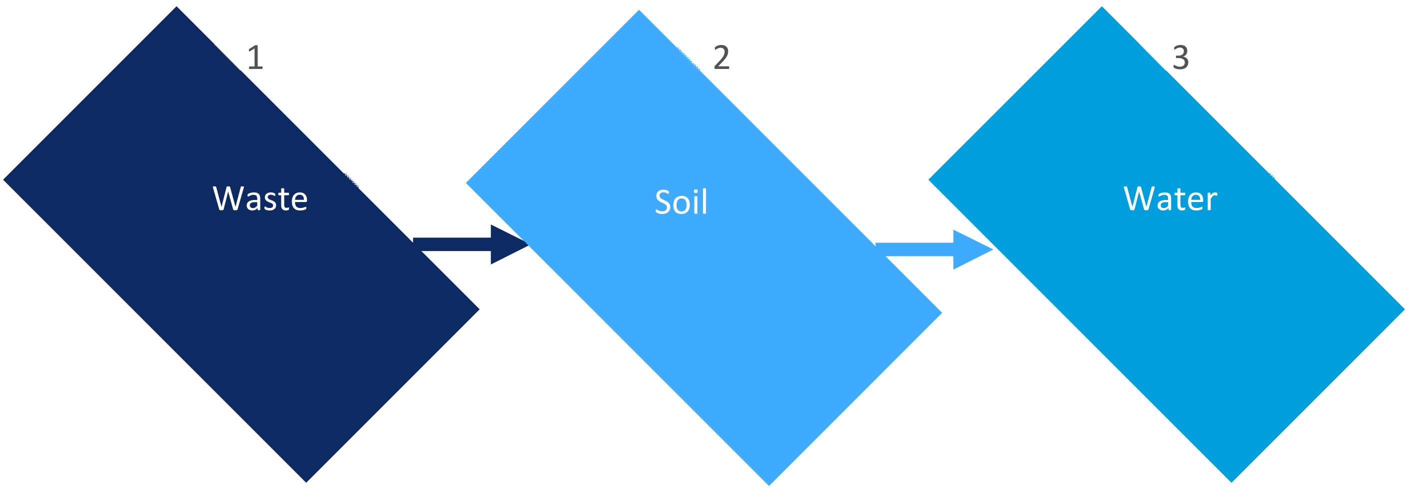
• company size in terms of quantities of substance and / or surface area
• type of storage facility: tank and bulk (packaged and non-packed stocks)
• effect-reducing measures
• installations: companies with and companies without production facilities
• location: at open water, not at open water

[1] This chapter is a google translation of chapter 4 of the report *Financiële zekerheidstelling voor milieuschade bij majeure risicobedrijven,een model voor het categoriseren van majeure risicobedrijven, 22 november 2016, Berenschot,* available at www.rijksoverheid.nl: https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2016/11/22/financiele-zekerheidstelling-voor-milieuschade-bij-majeure-risicobedrijven/Financi%C3%ABle+zekerheidstelling+voor+milieuschade+bij+majeure+risicobedrijven.pdf

We discussed the (practical) feasibility of the model. This means to what extent the required information is (already) available and to what extent it is possible to test the data adequately. The time required for completing the model was limited: about fifteen to thirty minutes per case.

Three components determine the amount of the financial security

The figure below presents the final result. As indicated in section 3.5, we distinguish three cost components. After this we explain the components and the system that we follow - based on the chosen starting points - to determine the amount of the financial security.



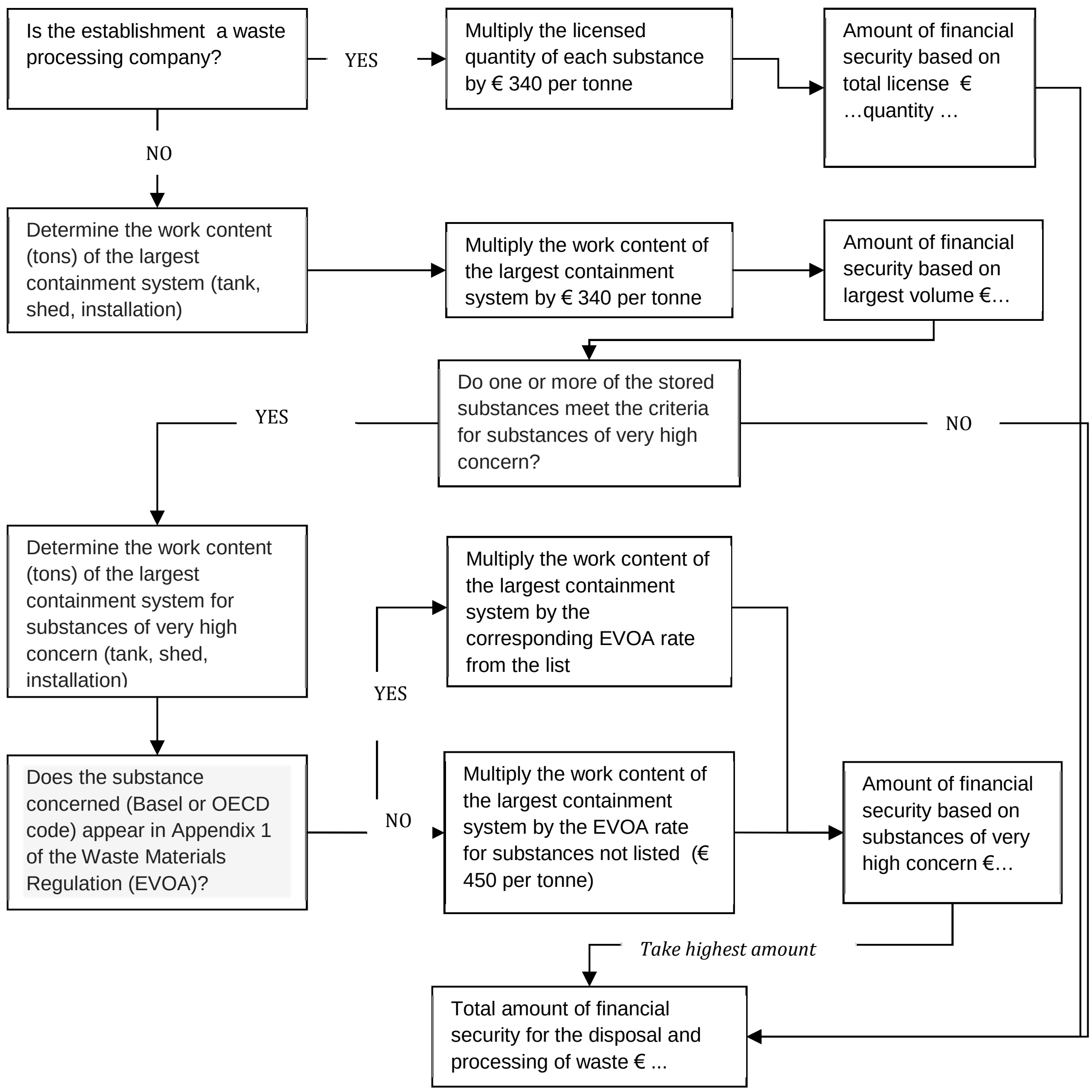
Amount of substance
Type of substance

Soil dependency dust
Soil permeability dust
Soil protection measures
Composition of soil
Surface of containment system

Location with respect to surface water
Detrimental effect of substance to water
Protective measures
Soil permeability of substance
Surface containment system

The total amount of the financial security is determined by adding up the calculated costs per component (I, II, III).

4.2 STEP 1: DETERMINE THE COSTS FOR THE REMOVAL AND PROCESSING OF WASTE



1. Determine whether there is a waste processing company. If so, multiply the authorization quantity for each substance with a rate of € 340 per tonne. You transfer the total amount of all substances to the total financial security. You can skip steps 2 through 6.

2. Determine the work content (tons) of the largest containment system (tank, shed or process installation). The largest containment system is the largest tank, warehouse or installation within the establishment in which environmentally hazardous substances are stored or processed. The compartmentalisation of the tank, shed or installation is not important here; the containment system is considered as a whole. Source documents are lists of tanks and substances as included in the environmental permit.

3. Multiply the work content of the largest containment system with a rate of € 340 per ton. Multiply the work content of the largest containment system with a rate of € 340 per tonne. The total amount is transferred to 'financial security based on the largest volume'.

4. Establish whether substances of very high concern (ZZS) are stored within the establishment. If so, also determine the work volume (tonnes) of the largest containment system of ZZS. ZZS are substances that meet the criteria as mentioned in Article 57 of the REACH Regulation (EC 1907/2006). If several ZZS are present, select the ZZS with the largest containment system. If there are no ZZS present, it is sufficient to base financial security on the largest volume (step 1) and fill in this amount with the total financial security. You can skip steps 5 and 6.

5. Calculate the size of the financial security on the basis of ZZS by multiplying the work volume of the relevant containment system by the corresponding rate. Re-establish the tariff on the basis of the list of substances (see step 2) and calculate the financial security on the basis of ZZS. Enter the amount under 'financial security based on ZZS'.

6. Take the highest amount. Finally, determine whether the financial security for ZZS is higher than the financial security based on the largest volume. Then take the highest amount as the starting point for financial security for the removal and processing of waste.

Proceed to step 2: determine the costs for soil and groundwater remediation.

<u>Background and explanation of the steps</u>

The variables and starting points for the waste component are explained in more detail below.
The basis for the financial security is quantity and type of substance
The most important factors for the decontamination costs of waste are the quantity and nature of the substance(s):
• the larger the volume of the containment system, the more waste to be treated;
• the more dangerous the substance and / or the more difficult to process, the higher the tariff per tonne.

Waste processing companies
• Waste processing companies occupy a special position within the Seveso companies. Due to the nature of the business activities (storage and processing of waste), it must be assumed for these companies that in the event of a bankruptcy (whether or not as a result of an incident) all stock must be regarded as waste. For this category of companies, the financial security is therefore calculated as the total quantity of substances licensed multiplied by the tariff.

Work volume of the largest containment system

• When calculating the amount of the costs, we assumed, based on various experts, the situation in which the volume of the largest containment system must be regarded as waste as a result of an environmental incident. The reasoning behind this is that substances - including stocks - can become waste as a result of an incident if it is no longer possible to say with certainty what is their chemical composition, because in most scenarios it is unlikely that more than one containment system will be affected at the same time, it has been chosen to take one containment system into the model. By choosing the largest containment system, it can be assumed that even less serious incidents are covered.

Negative value only

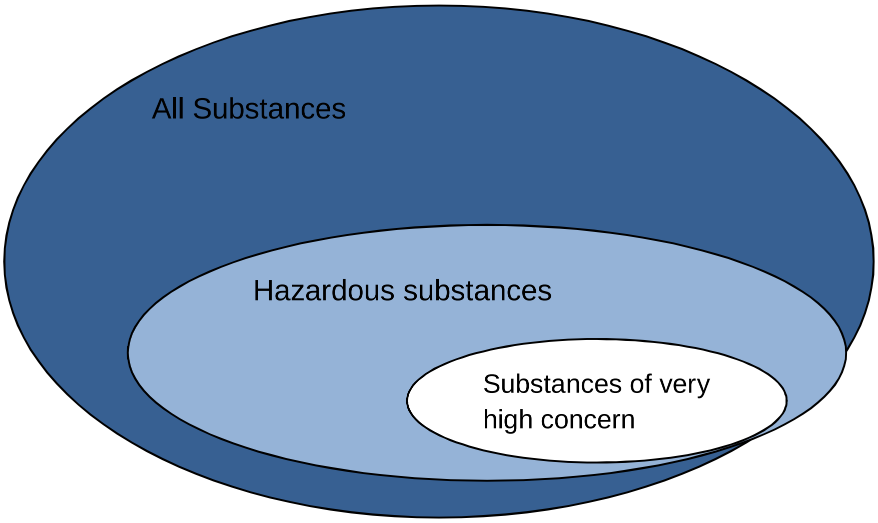
• Although the situation is not inconceivable that (a part of) the stock of the substance represents a positive value, because of the uncertainty about this positive value and the feasibility (simplicity, transparency, administrative burden) we opt for a conservative approach and we do not correct for any positive value of waste.

Substances of very high concern (ZZS)

If working with substances of very high concern (ZZS), it is conceivable that the removal and processing of these substances also in case of a smaller amount result in more costs than the removal of the substance that the company has stored in the largest containment system. In order to prevent that the financial security in that case is undeservedly lower, in the model the work volume of the largest containment system of a ZZS substance is compared with the financial security based on the work content of the largest containment system. The highest amount counts as total financial security for the disposal and processing of waste. This amount therefore also covers the lower costs for the disposal of the other (non-ZZS) substances.

EVOA rates leading

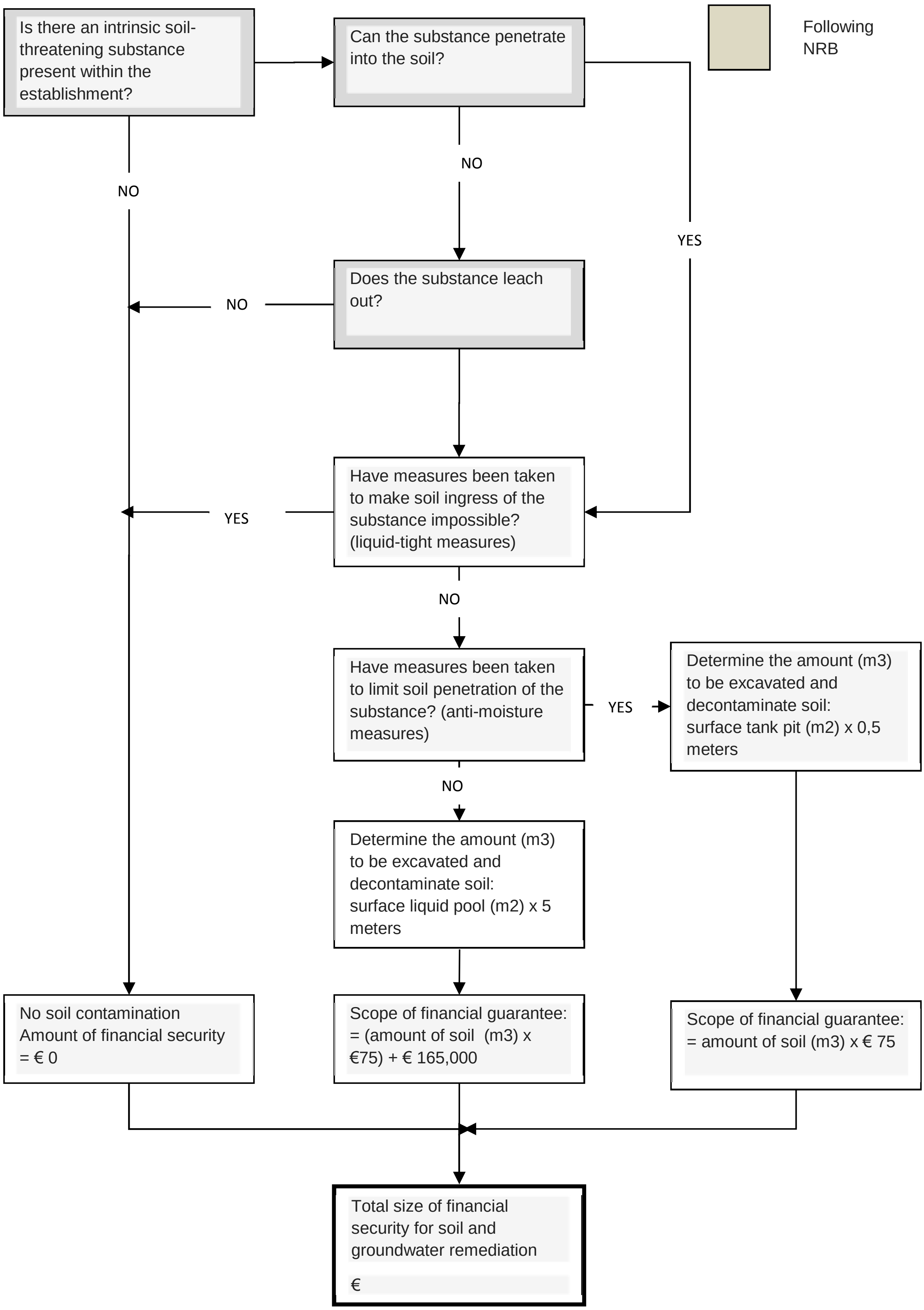
In order to determine the tariff, we seek to tie in with the basic principles of the Regulation on the EC Regulation on Shipments of Waste (EVOA). In the case of cross-border shipments of waste, the EVOA prescribes a financial guarantee to cover the costs that the Dutch government faces when taking a transport back if this can not be completed as planned or in the case of illegal shipment of waste. This provides a good basis for the pricing of the waste component in our model.



For example, hazardous substances are flammable, explosive or toxic. Substances of very high concern are substances that are hazardous to people and the environment. The identification of substances of very high concern follows from selection criteria laid down in Article 57 of the REACH Regulation (EC) 1907/2006. Substances with one or more of the following properties meet these criteria:

- carcinogenic (C)
- mutagenic (M)
- toxic for reproduction (R)
- persistent, bioaccumulative and toxic (PBT)
- very persistent and very bioaccumulative (vPvB)
- similar care (such as hormone-disrupting substances)

4.3 STEP 2: DETERMINE THE COSTS FOR SOIL AND GROUNDWATER REMEDIATION



1. Establish whether intrinsic soil-threatening substances are present in the establishment. For this please use the substances scheme of the Dutch Soil Protection Directive (see appendix 2, NRB). By intrinsic soil-threatening is meant that the substance as such can lead to soil contamination. If the substance is not soil-threatening, you can skip steps 2 to 8.

2. Determine whether the substance can penetrate into the soil. Secondly, you determine whether the substance can penetrate into the soil as such. Particularly important here is the appearance of the substance: solid, liquid, gaseous (see appendix 2, NRB).

3. Determine whether the substance can penetrate into the soil through leaching. Although solid or viscous substances as such do not penetrate easily into the soil, some substances can still penetrate into the soil through leaching - for example, when released into rainwater or fire-fighting water. If the substance can not penetrate into the soil, you can skip steps 4 to 8.

4. Determine whether provisions have been made that make soil ingress of the substance impossible. Liquid-proof facilities prevent a soil-threatening substance from penetrating the soil and being caught in time by a liquid-tight floor or drip tray. If liquid-tight provisions have been made, you can skip steps 5 to 8.

5. Establish whether provisions have been made that limit the soil penetration of the substance. Fluid retaining measures, such as an applied clay layer below ground level, limit the penetration of the substance into the soil, but the substance can nevertheless end up in the soil. Determine the amount of soil to be excavated and decontaminated. The amount of soil to be excavated is - depending on mitigation measures - multiplied by 0.5 meters or 5 meters with the area of the largest collection facility (tank pit). If there is no tank pit, take the calculated pool surface (part of company fireservice report).

6. Calculate the amount of financial guarantee for soil remediation. Calculate the financial guarantee for soil remediation by multiplying the amount of soil to be excavated and remediated by a rate of € 75 / m3. When there are no mitigating measures, groundwater pollution must also be taken into account. That is why in the latter case you add an item cost of € 165,000 to the financial security.

You can proceed to step 3: determine the costs for the purification and remediation of surface water.

Background and explanation of the steps

After the closure of a major risk company , soil contamination and groundwater contamination can occur within the plot. These contaminants must be remediated. Although the NRB can be used to determine the soil damaging nature, the NRB is based for mitigating measures on regular business activities and not on incidents. That is why the model uses the NRB as a starting point only in part (steps 1, 2 and 3).

Soil-threatening substances

Soil contamination is the situation where substances have entered into the soil as a result of human actions / actions and one or more of the functional properties that the soil has for humans, plants or animals is reduced or threatened. According to the Dutch Soil Protection Directive (NRB), a soil-threatening substance can affect the soil in five ways:

1. Mix with the soil
2. Chemical reaction with the soil
3. Spreading in the soil
4. Uncontrolled movement in the soil
5. Influence one or more functional properties of the soil for humans, plants and animals

Different types of soil pollution

In case of a company closure, there are three types of soil contamination: 1) historical soil pollution[2] 2) soil contamination as a result of regular operations and 3) soil contamination as a result of an incident. For the first two types of soil contamination there are already possibilities for financial security[3]. These do not therefore have to be included in the current instrument. For the model it is sufficient to determine the extent of the soil contamination that is the direct result of the incident.

If there is no soil-threatening substance present in the establishment or if a combination of measures has been taken to prevent soil contamination, the soil contamination component does not exist or is negligible.

Five factors determine the extent of the financial security

Five factors influence the potential soil and groundwater contamination and associated remediation costs.

Intrinsic soil contamination substances present

The soil-compatibility of substances can be determined on the basis of the substances scheme (Annex 2, part 3) of the NRB. A substance is considered intrinsically soil-threatening if the substance as such can cause contamination of the soil. A list of non-soil-threatening substances is included in the NRB's substances scheme.

Extent to which the substance can penetrate into the soil.

The extent to which the substance can penetrate into the soil is determined in particular by the aggregation state of the substance: gaseous, liquid (single or mixtures) or solid (coarse / fine) in combination with the soil composition. Gases are generally volatile and do not penetrate easily into the soil, even in liquid form. Liquid substances, on the other hand, penetrate into the soil more easily - depending on the viscosity - and can therefore end up in the groundwater. For solids, the finer the particles of the substance, the easier they can penetrate into the soil. Even if the substance cannot penetrate into the soil as such, soil contamination can still occur as a

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[2] 18 'Historical soil pollution' is soil pollution originating before 1 January 1987.

[3] See section 3.2.

result of leaching: a part of the substance is released into rainwater or fire extinguishing water and thus enters the soil in this way.

Soil protection measures.

There are various guidelines and regulations that prescribe soil protection provisions. Apart from specific regulations, directives or regulations, we see in practice two types of soil protection measures: measures that make soil ingress of the substance impossible (liquid-proof measures) and measures that limit the soil penetration of the substance (liquid-retaining measures).

By liquid-tight measures, we mean measures in this model that will prevent penetration of liquids into the soil (also) in the event of a serious incident (N.B. on this point we deviate from the definition of the NRB, in which the liquid-tight measures only relate to a leakage as a result of regular business activities). There is then no or very minor soil contamination.

In the application of liquid-repellent measures, the substance may penetrate into the soil as a result of an incident, but - assuming immediate action is taken - the depth is limited to the liquid-retaining facility. Experts indicate that in that situation limitedly (0.5m depth) needs to be excavated and remediated. The latter situation applies, for example, to a PGS29 tank storage facility without a liquid-tight tank pit. Such a 'mounded tank pit' is usually liquid, but not liquid-tight. In cases where no soil protection measures have been taken[4], the soil will have to be remediated to a depth of 5m, according to the experts

Soil permeability.

The composition of the soil determines the permeability of the soil; through a homogeneous clay soil almost no (liquid) substances permeate , while through a homogeneous sandy soil (liquid) substances permeate easily. It is assumed that through heterogeneous (composite) soil structures liquids permeate at a speed that lies between them.

The type of soil is - in addition to the material properties - very determinative of the extent to which the substance can penetrate into the soil. Experts indicated that without homogeneous clay soil - as natural liquid barrier - it is probable that groundwater contamination will occur in addition to soil pollution. Nowhere in the Netherlands is there naturally a homogeneous clay soil, so that in all cases where no mitigation measures have been taken for soil pollution, costs for groundwater treatment are also included in the financial security. In these cases, the model takes these costs into account by means of a set-up for groundwater purification.

Surface and amount of excavated soil

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[4] As a rule, major risk companies will generally be obliged to take soil protection measures, so this scenario does not occur much or even not at all.

Both in PGS 15: "Storage of packaged hazardous substances" and in PGS 29: "Surface storage of flammable liquids in vertical cylindrical tanks", collection facilities are required for the containment systems (sheds or tanks). Liquid-tight measures are required for storage, but in some cases liquid-repellent measures are also permitted, provided that these, in combination with other measures, lead to a negligible soil risk. It is assumed that in the case of a loss or containment scenario the substance may be released, but the liquid pool is limited by the collection facility (tank pit). In that case, the surface area of the largest reception facility determines the surface of the soil contamination. The amount of soil to be excavated is equal to that area multiplied by 0.5 meters (the depth of the excavation).

In the case that no tank pit is present, a leaked liquid can spread to a liquid pool. The surface area of this is difficult to determine in advance precisely because in practice it depends on several factors, such as the viscosity of the liquid, the subsoil and the quantity that has flowed out. The pool size can be calculated for different surfaces by means of effect modeling software.

In that case, the size of the liquid pool determines the area of the soil contamination. Companies to which this applies are obliged to submit these calculations to the competent authority. These calculations require a tailor-made approach and are therefore difficult to capture in our model.

Explanation of the rates

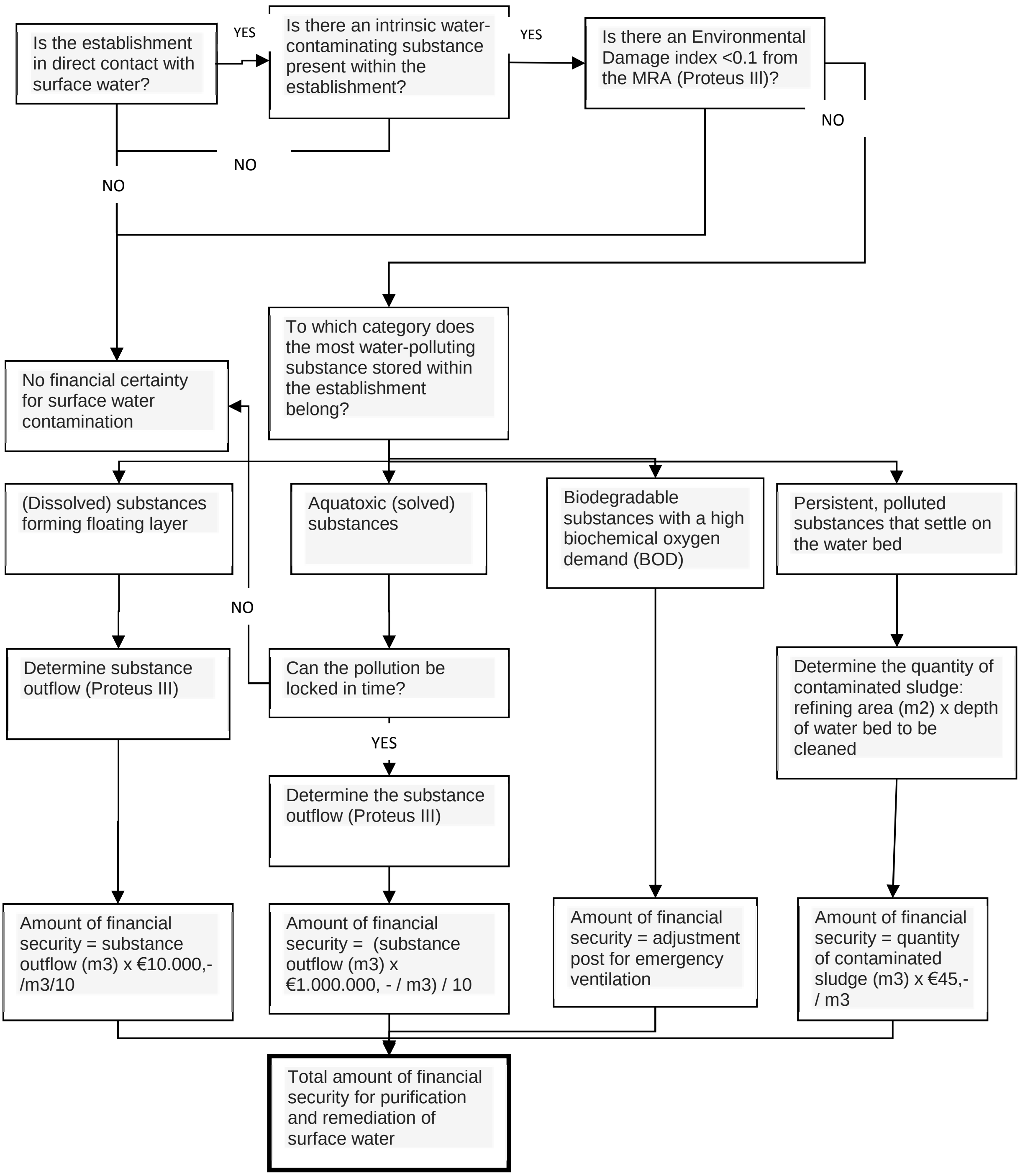
Soil remediation

For the excavation and decontamination of contaminated soil, a tariff of € 75 per m3 is used in the model. This is the sum of the average rate for the excavation and treatment of polluted soil that the Recovery and Management (water) Soil Quality Directive mentions. In practice, the costs for soil remediation will depend on the type of soil and the applied remediation technique, but for reasons of simplicity and practical usability we use an average rate. It is assumed that this rate will cover a good part of the remediation costs.

Groundwater treatment

There are many techniques available for the treatment of groundwater, but these can be broadly divided into horizontal and vertical extraction of groundwater. In practice, the costs for the treatment of groundwater will be determined by the applied technology, but for simplicity and applicability, we will use the model as the cost of a relatively simple purification installation for vertical extraction with a limited depth. An assumption is made of € 165,000 for this, which consists of the costs for construction and maintenance. The post is based on the indicators that are mentioned in the Recovery and Management (water) Soil Quality Directive.

4.4 Step 3: determine the costs for the purification and remediation of surface water



1. Determine whether the device is in direct contact with a water system (river, canal, lake, coastal area). The decisive factor is whether the substance can spread in the surface water in the event of an unforeseen discharge. A ring ditch that is in contact with a larger water system must therefore also be considered as surface water. If the establishment is not in contact with surface water, you can skip steps 2 to 6.

2. Establish whether there are water-hazardous substances stored within the establishment. For this you use the H-phrases H-400 to H-420 from the European CLP Regulation. If the substance belongs to one of the categories mentioned, it must be assumed that the substance is water-hazardous. If the substance is not water-hazardous, you can skip steps 3 to 6.

3. Determine by means of the Environmental Risk Analysis (Proteus III) whether there is an MSI <0.1. By means of the environmental risk analysis, the impact on the aquatic environment (environmental damage index, MSI) is determined on the basis of substance properties, effect limiting measures and the receiving water system. This effect is expressed in the MSI. Experts state that an MSI <0.1 is acceptable.

4. Determine to which category of substances the water-hazardous substances within the establishment belong. Floating layer forming substances are substances that do not dissolve and have a lower specific gravity than water. Aquatoxic substances are substances that dissolve in water and are toxic to the aquatic environment. Substances with a high biochemical oxygen demand (BOD) are substances that are intrinsically non-toxic to the aquatic environment, but remove oxygen from the water through biological decomposition processes. Persistent substances that settle are substances that, although not dissolving in water, or floating layers, are substances that easily adhere to the sediment.

5. Calculate (with Proteus III) the substances outflow of the unforeseen discharge. Using the Proteus III calculation model, you can calculate the amount of substances emitted (m3) in the event of an unforeseen discharge.

6. Calculate the potential remediation costs by multiplying 10% of the substances outflow by the decontamination / purification rate per m3. Depending on the type of substance, a remediation technique must be applied. The applied technique is decisive for the level of the remediation costs. A floating layer must be removed, volume contamination must be purified, with BOD substances the water must be aerated and with sedimenting substances the water bottom must be cleaned up with settling substances.

<u>Background and explanation of the steps</u>

After the termination of a major risk company, pollution of the surface water can occur outside the plot. This pollution must be remediated.

Three forms of aquatic environmental damage

An unforeseen discharge into the surface water of a water-hazardous substance may lead to three forms of damage to the aquatic environment:

1. Toxic effects (volume contamination)
2. Mortality of aquatic organisms due to oxygen deletion
3. The formation of floating layers

Five factors determine the potential remediation costs for surface water

There are five variables that determine the degree of water pollution.

Location of the establishment in relation to surface water
The location of the establishment and the proximity of surface water determine whether an (in) direct discharge on the surface water is plausible. If a Seveso company is not connected to surface water, then water contamination can be ruled out by an unforeseen discharge.

Detrimental effect to water of the substances present
The degree of aquatic hazard of the substances present determines the effect on the aquatic environment. The higher the toxicity, the greater the impact on the environment. The H-phrases H400 to H420 from the European CLP Regulation indicate the degree of danger to the aquatic environment. A toxic threshold value has been established per H-sentence
Environmental Risk Analysis (MRA) and Proteus III[5]

The 'state of safety technology (SVT)' prescribes the procedures, provisions and measures that reduce, among other things, the scale of unforeseen discharges with a negative effect on water quality. By means of an environmental risk analysis is calculated (with the calculation model Proteus III) what then on the basis of the substance present, the adjacent water system and the measures taken is the effect on the aquatic environment21. If the MRA shows that the effect (Environmental Damage Index) is acceptable (<0.1), it is not necessary to take into account costs for remediation of the water system that have to be included in the financial security.

Substance characteristics

The characteristics of the aquatic hazardous substance determines the nature of the contamination. A distinction can be made between four categories of substances with corresponding contamination:

a. Aquatoxic substances (dissolved substances): Aquatoxic substances cause negative environmental effects by dissolving in the surface water (volume contamination). The amount of discharged pollution and the toxicity (danger concentration) of the substance determine the amount of contaminated surface water. The greater the amount of contamination and / or the higher the toxicity, the higher the amount of contaminated surface water. The acute toxicity is expressed in the LD50 value of a substance: the concentration of a substance that leads to death in 50 per cent of a population during experimental conditions.

b. Biodegradable substances: Biodegradable substances have a negative influence on water quality due to their biochemical oxygen demand (BVZ). Through the decomposition process, oxygen is extracted from the water system, which can cause fish mortality. The greater the amount of pollution and / or the higher the BOD of the substance, the greater the amount of affected surface water.

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[5] For more information on the MRA and Proteus, see Rijkswaterstaat's Assessment Framework for residual risks of unforeseen discharges, Rijkswaterstaat (2013)

c. Floating layer forming substances (undissolved substances): Floating layer forming substances are substances that do not dissolve in water and because of their specific gravity (<1000 kg / m3) do not penetrate into the water column, but form a layer on the water. The thickness of the floating layer can vary with the type of contamination. The size of the floating layer is determined by the amount of contamination and the specific gravity of the discharged substance.

d. Persistent substances that settle: Substances which settle and adhere easily to the sediment, thus ensure pollution. The decontamination costs (financial security) consist of the dredging (excavation) of the sediment and the remediation of the contaminated sludge. The larger the contaminated surface of the sediment, the higher the costs will be.

Type of receiving surface water

The size and dynamics of the receiving surface water in which the discharge ends up determine its impact on the aquatic environment, ie the level of the remediation costs. In the assessment framework for unforeseen discharges of Rijkswaterstaat are distinguished in rivers and canals, lakes and ponds and coastal areas. The larger and more dynamic the receiving surface water, the smaller the impact on the aquatic environment. The type and volume of the surface water are expressed in a weighting factor. The effect volume is corrected with this weighting factor during the MRA, before the potential effect on the aquatic environment is determined. It is important that the contamination can be contained in time. If this is not the case, it dissolves and must be regarded as unforeseen discharges that can not be remediated and therefore do not entail any clean-up costs.

Remediation techniques and tariffs

• Floating layer removal. Floating agents must be removed from the water system by absorption. The costs for this are mainly determined by the quantity of unforeseen discharged substance and, to a lesser extent, the viscosity. For reasons of simplicity and applicability, we choose to calculate only with the amount of substance emitted. Seveso experts from Rijkswaterstaat indicate that the costs for floating layer removal amount to approximately € 10,000 per kg of discharged substance. These costs include collection, transportation, storage and processing.
• Water treatment. Aquatic substances must be removed from the water column by purification. For this it is first of all necessary that the substance can be enclosed in any way, so that the total effect volume can be purified. Research by order of Rijkswaterstaat shows that the costs for water purification are between € 500 and € 2000 per kg of pollution (Witteveen & Bos, 2007). As a rule of thumb, an amount of € 1000 per kg is used.
• Emergency ventilation. When BOD substances end up in the surface water, the only remedy is to aerate the water extra, in order to prevent massive fish mortality. An emergency ventilation

installation can be used for this. An adjustment post is included for the deployment of such an installation[6].

• Remediation of water bottom (dredging). If persistent substances adhere to the water bed, it must be remediated. The costs for dredging and transporting a contaminated water bed vary from € 1.5 to € 5 per m3, depending on the local conditions and the applied techniques. The costs for the processing and cleaning of dredging sludge are between the € 20 and € 60 per tonne of dry matter according to the recovery and management (water) soil quality guidelines, depending on the techniques used. Because of simplicity and applicability of the model, we therefore apply an average total rate of € 45 per m3.

Correction to the discharge formulas

The outflow quantities that are calculated using the Proteus calculation model (in the context of the environmental risk analysis) assume a maximum expected loss or containment scenario (worst case). This means that a correction of the outflow quantities is reasonable. A smaller-scale loss of containment (realistic case) is more likely. Especially when a company has taken mitigating measures. In addition, account must be taken of the fact that a substantial part of the contamination as a result of dissemination and natural degradation in time will not be culled and therefore there will be less clean-up costs. A substantial reduction factor does justice to the realistic case approach and practice.

[6] (At the time of publication of this report, the costs for an emergency aeration installation were not known.)

Annex III SPAIN

PART 1 Summary of how the Environmental Damage Index (IDM) and MORA models work

1. Procedure for the determination of financial provision in Spain

Law 26/2007, of 23 October on Environmental Liability, sets out in section 24.3 that the calculation of the mandatory amount of financial security must be based on an environmental risks analysis.

The Royal Decree 183/2015, that modifies the regulation that partially develops Law 26/2007, approved by Royal Decree 2090/2008, of 22 December, sets in article 33, the procedure of determining the mandatory financial security established. This procedure comprises the following phases:

- First, the operator has to identify the risk scenarios and their probability of occurrence.

- Second, the operator must estimate the **Environmental Damage Index (IDM)** associated with each risk scenario, following the steps established in annex III of the regulation that partially develops Law 26/2007.

  The Environmental Damage Index aims to estimate the damage associated with each risk scenario, and is based on several estimators of the amount of resources damaged and the remediation costs of the natural resources covered by the law. It offers a semi-quantitative result, ant it also allows ranking of the risk scenarios in terms of the potential environmental damages they might cause.

- The third step involves calculating the risk associated with each risk scenario, as the product of the probability of occurrence of the scenario and the Environmental Damage Index.

- In the fourth step, the scenarios with the lowest Environmental Damage Index associated, that make up for 95 per cent of the total risk, are selected.

- In the final step, the amount of financial security will be established as the primary remediation costs of the environmental damage associated with the scenario with the highest environmental damage index, among the scenarios selected in the fourth step (reference scenario). In order to do this:

  - The environmental damage caused by the reference scenario has to be quantified by the operator.

  - Secondly, the environmental damage caused by the reference scenario has to be monetized, that is to say, to calculate the cost of the primary remediation project.

For this purpose, operators can use the Environmental Liability Supply Model (**Modelo de Oferta de Responsabilidad Ambiental** or MORA). This is a voluntary free-cost software tool, developed by the Ministry for the Ecological Transition, to help operators calculating the recovery costs of natural resources under the scope of Law 26/2007.

Although the mandatory financial provision includes only the costs of the primary remediation measures, the MORA software also provides the costs of the complementary and/or compensatory remediation measures, if they are required.

- Finally, prevention costs will be added, with an amount at least 10% of the primary remediation costs.

2. *Environmental Damage Index (IDM) Estimate*

A. Theoretical Principles

The IDM represents a general model aimed at estimating an order or magnitude of the potential damage associated to each risk scenario. This allows comparing different scenarios, ranking them according to the procedure established in article 33 of the regulation that partially develops Law 26/2007, and selecting the reference risk scenario that will act as a base from which the financial security has to be calculated.

The IDM offers a semi-quantitative result that, under no circumstances can be interpreted as the value or cost of the damage associated to each scenario. Its calculation is based on a series of estimators of the primary remediation costs that are deduced from the cost equation of the methodology of the Environmental Liability Supply Model (MORA) for each agent-resource combination.

This model is divided into different sections aimed at each agent-resource combination, for which the use of a series of specific variables is proposed. Therefore, the IDM should be viewed as the aggregation of the different agent-resource combinations that correspond to each risk scenario. The different agent-resource groups for which the IDM equation can be used, are those shown in Table 1[7].

[7] In the context of the IDM estimation, it is necessary to clarify that the habitat is considered as the group of abiotic (such as the soil) and biotic (such as flora and fauna species) components that it comprises. With the aim of avoiding a double counting of these resources, in Table I the resource "habitat" does not appear, as it is considered that this will be recovered when repairing the resources that make it up (soil and flora and fauna species), which are specifically included in the table.

<table>
<tr><th colspan="3" rowspan="3"></th><th colspan="8">Resource</th></tr>
<tr><th colspan="3">Water</th><th rowspan="2">Continental shelf and seabed</th><th rowspan="2">Soil</th><th rowspan="2">Sea and estuary banks</th><th colspan="2">Species</th></tr>
<tr><th>Marine</th><th>Continental – Surface</th><th>Continental – Underground</th><th>Plants</th><th>Animals</th></tr>
<tr><td rowspan="15">Agent causing the damage</td><td rowspan="7">Chemical</td><td>Halogenated VOC</td><td rowspan="5">Group 1</td><td rowspan="7">Group 2</td><td rowspan="7">Group 5</td><td></td><td rowspan="7">Group 9</td><td rowspan="5">Group 10</td><td rowspan="7">Group 11</td><td rowspan="7">Group 16</td></tr>
<tr><td>Non-halogenated VOC</td><td></td></tr>
<tr><td>Halogenated SVOC</td><td></td></tr>
<tr><td>Non-halogenated SVOC</td><td></td></tr>
<tr><td>Fuels and NVOC</td><td rowspan="3">Group 7</td></tr>
<tr><td>Inorganic substances</td><td></td><td></td></tr>
<tr><td>Explosives</td><td></td><td></td></tr>
<tr><td rowspan="3">Physical</td><td>Extraction/Disappearance</td><td></td><td>Group 3</td><td>Group 6</td><td></td><td rowspan="2">Group 3</td><td></td><td>Group 12</td><td>Group 17</td></tr>
<tr><td>Inert waste discharge</td><td></td><td></td><td></td><td>Group 8</td><td></td><td></td><td></td></tr>
<tr><td>Temperature</td><td></td><td>Group 4</td><td></td><td></td><td>Group 4</td><td></td><td>Group 13</td><td>Group 18</td></tr>
<tr><td colspan="2">Fire</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Group 14</td><td>Group 19</td></tr>
<tr><td rowspan="4">Biological</td><td>GMO</td><td></td><td></td><td></td><td></td><td></td><td></td><td rowspan="2">Group 15</td><td rowspan="3">Group 20</td></tr>
<tr><td>Invasive alien species</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Virus and bacteria</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fungi and insects</td><td></td><td></td><td></td><td></td><td></td><td></td><td>Group 15</td><td></td></tr>
</table>

Figure 1. Agent-resource groups for the application of IDM. **Source:** Annex III of the regulation that partially develops Law 26/2007.

In this sense, any environmental damage will be evaluated in line with the agent-resource combinations identified in the previous table, that are established based on the remediation techniques that are currently available. The user should select the agent-resource combination or combinations that they consider relevant for the scenario that is being evaluated, and proceed to calculate the IDM using the equation that is described in the regulation that partially develops Law 26/2007.

The IDM estimation is based on the average primary remediation costs for each agent-resource combination contained within the MORA methodology. This information has been reclassified and transformed into a non-monetary numeric value.

In the equation of the IDM, the modifiers that allow for the estimation of the resources damaged, based on the amount of agent released (type B modifiers) are the characteristics of the damaging agent and of the environmental characteristics of the location. Likewise, modifiers of the unit cost estimator (type A modifiers) and the revision and control cost estimator (type C modifiers) have been identified.

The following figure shows the different types of modifiers (A, B and C) included in the IDM equation[8].

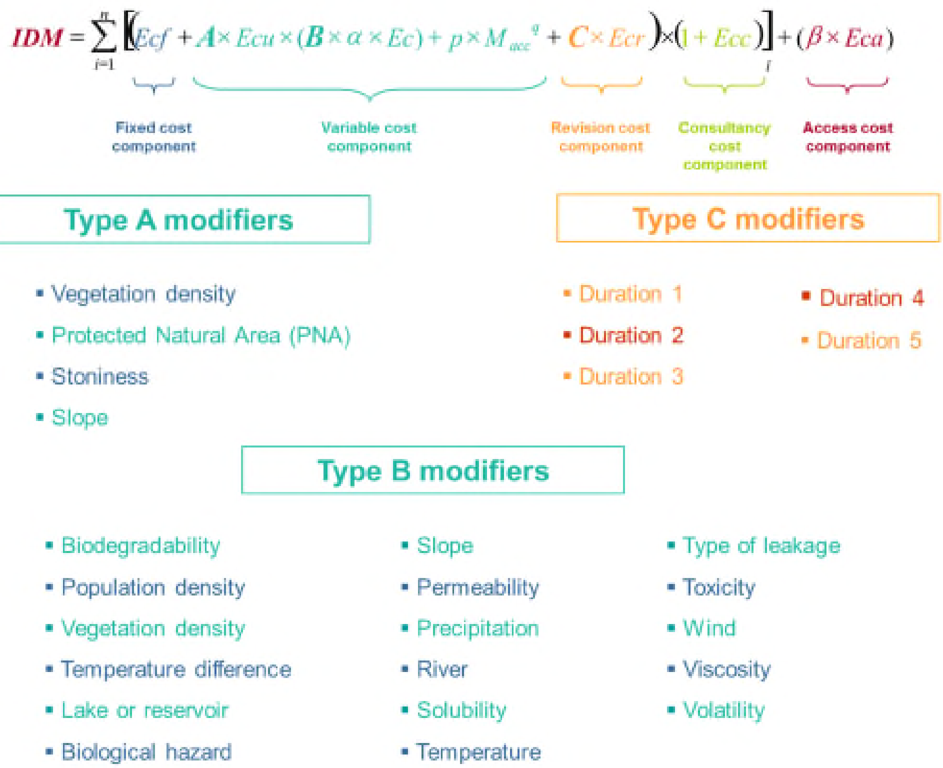


Figure 2. IDM Estimation: list of type A, B and C modifiers. **Source:** Ministry for the Ecological Transition.

[8] The complete description of the IDM equation can be found in the regulation that partially develops Law 26/2007 (https://www.boe.es/buscar/act.php?id=BOE-A-2008-20680), and in the IDM User Guide.

The result of the model is a numeric value that represents the consequences of the damage in a unit of measurement that, although it does not have a direct mathematical relationship with its monetary value, it maintains a relationship of proportionality between the amount of agent released that caused the damage, and the severity of the environmental consequences of each scenario. This allows raking the risk scenarios from greatest to lowest estimated value (the higher the IDM value, the greater the environmental consequences initially predicted).

B. Input parameters

The IDM estimation requires the following input data:

- Identification of the relevant accident scenarios.
- Selection of the types of the damaging agents
- Selection of the potentially affected natural resources.
- Determining of the location of the damaged caused in each accident scenario.
- Introduction of the values of the specific qualitative and quantitative variables for each agent-resource combination.

3. Modelo de Oferta de Responsabilidad Ambiental (MORA)

A. Objective

The aim of the Environmental Liability Supply Model (Modelo de Oferta de Responsabilidad Ambiental or MORA) is to help operators to calculate the recovery cost of natural resources potentially damaged, under the scope of Law 26/2007, of 23 October, using an economic evaluation based on the supply curve.

MORA is a voluntary tool that helps operators calculate the recovery costs of the reference scenario identified in the procedure for the determination of the mandatory financial security according to Law 26/2007.

The development of the MORA methodology and software tool includes the following steps:

- Evaluation of the available scientific and technical literature on remediation of environmental damages.
- Elaboration of a catalogue of remediation techniques.
- Designing a mechanism for selecting the best available techniques based on the provisions of Law 26/2007.
- Designing an economic model to systematize the economic evaluation of the environmental damages.

B. Input parameters

The MORA tool requires the following input data for calculating the recovery cost of the natural resources potentially damaged by a risk scenario.

- Identification of the damage location. It includes:
  - Coordinates
  - Accessibility
  - Distance to nearest road
  - Protected area
  - Infiltration risk
  - Groundwater body presence
  - Permeability
  - Slope
  - Species
  - Canopy cover
  - Trees age
  - Density
  - Land use
  - Animal species present

  The coordinates can be introduced in the MORA tool manually, or using a GIS tool included in the software, and the rest of the parameters are given automatically by the GIS database of the MORA tool.

- Identification of the agent/s causing the damage. They have to be classified into these categories:
  - Chemical
  - Physical
  - Fire
  - Biological

- Identification of the natural resource/s affected, and its extent. They have to be introduced using these units.

- Surface water (m3)
- Underground water (m3)
- Soil (tons)
- Habitat (Ha)
- Species (Nº individuals)

- Reversibility of the damage, based on:

    - Environment features
    - Damaging agent and extent
    - Evaluation of whether the cost is disproportionate
    - Evaluation of whether the time frame for the remediation is reasonable

For more information on the IDM and MORA methodologies and software tools, visit

https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/responsabilidad-mediambiental/modelo-de-oferta-de-responsabilidad-ambiental/

PART 2 Evaluation

IDM/MORA Owner - Spanish Environment Ministry, [Link to MORA/IDM]
Description
The Spanish methodology contains 3 elements: an environmental risk assessment (ERA), a tool for the calculation of the Environmental Damage Index (IDM) and the MORA tool to calculate the amount of financial provision for environmental liabilities under the ELD (primary/complementary and compensatory remedial measures for water, soil and biodiversity). The purpose of the methodology is: **1. to help operators in the determination of financial security required by Spain's Environmental Liability Directive (ELD) legislation;** **2. to provide information to help operators applying risk management measures; and** **3. to help operators and competent authorities prepare for the development of remedial measures in case an accident occurs.** **The approach has been developed to assist, primarily, operators, in fulfilling their obligations under the ELD and the corresponding Spanish legislation. The financial security requirements are not primarily driven by a requirement arising from the application for or granting of a permit, variation or transfer. Because the requirement is ELD driven it is relevant to all Annex III ELD operators, particularly Seveso, Industrial Emissions Directive and Extractive Waste Directive which are those obliged to have a mandatory financial provision. The scope of ELD Annex III is wide so it is relevant to many sectors, jurisdictions and regulatory regimes.** **MORA is a software tool with a GIS interface to import environmental data and to assist operators in the identification of natural resources and information of their baseline condition. However, this information can be modified by the user, and it allows the use of this tool even in other Member States.**

Operators are required to produce the ERA and calculate the Environmental Damage Index, using IDM for the risk scenarios identified within the ERA. They are required to submit a "responsible statement" to the competent authorities stating they have carried out the environmental risk analysis, have followed the procedure for the determination of the financial security, and in case the result is above 300.000 € or 2 Million €, that they have the appropriate financial security instrument covering the corresponding amount of money. The calculation of the amount of primary remediation costs of the reference risk scenario, that determines the amount of financial security, adding prevention measures (at least 10% of primary remediation costs), may be made using MORA or another methodology, but MORA is widely used. This process has to be performed and the financial provision in place from 31th October 2018, depending on the activity. Additionally, MORA provides the costs of complementary and/or compensatory remediation measures of the scenario modelled.

The aim is to estimate the costs of a reference risk scenario so users should check that this is consistent with the aim for the regulatory regime in their jurisdiction. Nevertheless, the MORA software can be used for estimating the recovery costs (primary, complementary and/or compensatory) of any risk scenario.

The tool is freely available in Spanish and English. The development and maintenance costs of the tools are borne by the Spanish Ministry.

Category	**Description**	Application in Spain Economy –balance the use of resources to achieve the right goals at a reasonable cost Efficiency – the right effort allocation – wise consumption of inputs on which	**Potential application in other jurisdictions**

		the work is completed Effectiveness – to achieve the objectives – to deliver on time what was expected	
Inputs – what are the set-up and running costs – financial, time and information requirements? What information needs to be inputted? Site, environmental, cost etc Are there any fixed inputs? Are the inputs readily available for other jurisdictions? What can be tailored?	The Spanish Ministry funded the development of the IDM and MORA software tools. The tools are under continual review to improve and maintain the service; these costs being borne by the Ministry. Annex III ELD operators, whilst required to calculate and put in place financial security to comply with the requirements of the Spanish ELD legislation, bear no costs associated with producing and maintaining the models. Operators will incur costs in obtaining the information to input into the model, particularly if they are not required to provide the	Economy - The development and maintenance costs of the tools may be considered to be off-set by the cost benefits to the operator of the digital tool, particularly the capability to import data via the GIS interface. Efficiency - The method has the efficiency benefits associated with a digital tool. Selections are made separately for each risk scenario which can involve a number of iterations where there are many risk scenarios. Particular highlights include the comprehensive drop down lists and GIS interface relevant to the Spanish	Availability of input information in other jurisdictions – the information would generally be expected to be provided as part of the permitting process. IDM and MORA provide menus (drop downs or tick boxes) for the easy selection of many inputs e.g. damaging agent, damaged resource, remedial measures. Inputs such as damaging agents and remedial techniques are typically common to all jurisdictions. Items not provided in these menus can be readily manually added. This will typically include jurisdiction and environmental specific factors such as soil, habitat, species type.

	information as part of the permitting process or otherwise produce an ERA. Operators may have their own tools for undertaking an ERA. IDM and MORA provide menus (drop downs or tick boxes) for the selection of many inputs e.g. damaging agent, damaged resource, remedial measures. Items not provided in these menus can be manually added. The variable inputs are as follows: In MORA: - Location (coordinates; accessibility; distance to nearest road; slope range; permeability range; natural resources present on the site (user have to select among those offered by the software)	jurisdiction; Effectiveness - Operators have reported it to be effective and user friendly. There is flexibility to add other inputs (e.g. other species, remedial techniques).	The unit remediation costs are embedded in the model. The costs are based on Agency experience and desk research. The Ministry intend to produce a catalogue of remedial measures including information on costs etc. This data must be cross checked for applicability in the jurisdiction in question. This may be of particular relevance to jurisdictions that may have high waste disposal costs, for example jurisdictions which are geographically isolated and/or have waste taxation regimes. It is possible to manually add a remediation technique and its unit remediation costs.

	- Damage extent quantification - Damage reversibility - Remediation techniques - Costs of consultancy, access and review and control (monitoring) In IDM: - Damaged resources (user have to select among those offered by the software) - Quantity of damaging agent - Depth to water table - Modifiers (degradability of the substance, soil permeability, cause of the discharge, viscosity and volatility of the substance, estimated duration of the damage) - Distance to the nearest road Fixed inputs (inputs that cannot		

	be changed) include In MORA: - Unit remediation costs In IDM: - Damaging agent (user have to select among those offered by the software) - Estimator of the remediation costs - Cost estimator for the access to the restoration site - Connection between the affected resource units and the agent units involved in the damage The GIS link in can be used to "import" geographically relevant information.		
Activities – what does the model	IDM allows to rank the risk	Economy - The tools deliver the	The model itself cannot be modified or

do with the information inputs? Can the "black box" be seen/understood/amended? Can the model activities be interrogated and tailored to specific requirements?	scenarios and MORA provides primary, complementary and compensatory remedial techniques and costs. The algorithms (black box) for both IDM and MORA can be seen and understood but not amended. The calculations are based on consequence not probability of occurrence. The valuation approach is resource equivalency analysis.	expected economic benefits of a software tool. Efficiency - The tools deliver the expected efficiency benefits of a software tool. Effectiveness – the "black box" is transparent and tamperproof.	tailored. It will be particularly relevant to jurisdictions and policies where the aim is to calculate a ballpark cost for primary, complementary and compensatory remedial measures. However, the user guide explains how to "de-select" complementary and/or compensatory remediation if there is no requirement for complementary/compensatory remediation for that regulation. The model activities are explained in the IDM and MORA user guides and the MORA methodology. They are available on https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/responsabilidad-mediambiental/modelo-de-oferta-de-responsabilidad-ambiental/
Outputs – what are the metrics generated by the model? Are they relevant to other	The report is generated by the MORA model and contains all the inputs and provides estimated costs and the remedial techniques	Economy - The tools deliver the expected economic benefits of the output being generated by the software tool.	The report is generated by the MORA model in English and will be relevant to other frameworks, jurisdictions which take a consequence based approach to

sectors/regulations/jurisdictions? Can the scope be extended to other sectors/regulations/jurisdictions. Is the aim and target audience relevant to other jurisdictions?	on which these are based. It also includes information where the user has selected a non standard option and the user's justifications for that. The IDM report is similar but provides the Environmental damage index for the risk scenarios (rather than costs and techniques)	Efficiency - The tools deliver the expected efficiency benefits of the output being generated by a software tool. Effectiveness – the outputs meet the regulators needs and are a transparent account of the modelling. It is expected that the use of a homogeneous approach will promote an even playing field.	calculating provision particularly where there is a requirement to provide for complementary and compensatory remediation. The outputs are relevant to a wide range of sectors and regulations because it is targeted at all ELD Annex III operators.

Part 3 Case Studies

Case Study 1

How the Environmental Damage Index (IDM) and MORA models work.

Case Study

1. Aim of the Case Study

The aim of this case study is to illustrate the way in which the IDM and the MORA methodology works within the procedure for the determination of the mandatory financial security foreseen in Law 26/2007.

This is a fictitious example where the substances, volumes, the probabilities and even the accident scenarios have been randomly selected. Therefore, there is not a specific facility that groups together all the identified scenarios and that has acted as a foundation for the drafting of this case study. Given that the only aim of this example is to illustrate the way in which the amount of financial security should be established, this hypothetical installation has been used with the aim of fulfilling the obligations established by the Law 26/2007.

2. Description of the Facility and Activity

In this section the substances that could cause damage to the environment will be outlined, as will the natural resources that could be affected and the environmental characteristics that could be determinants for the IDM estimation.

As a general rule, this section should contain a breve summary of the general activities developed and a description of the distinct phases that are carried out in the productive process in this particular facility. However, given that this practical example is not based on any specific sector of activity, nor is it therefore in a real facility, this part has been disregarded.

A. Substances

In this case study it has been taken that out of all the substances dealt with in the facility that is under study, there are only six that can damage the natural resources considered by Law 26/2007. The other substances have been considered either as not dangerous of that they are not dealt with in sufficient amounts in order to cause damage to the environment.

The following table describes the physical-chemical properties of each of these substances that are relevant for the IDM estimation.

Substance	Chemical-physical properties				
	Biodegradability	**Solubility[9]**	**Toxicity**	**Viscosity**	**Volatility**
Substance A	High	Slightly soluble	High	0.51 cps	High
Substance B	Medium	Insoluble	Medium	100 cps	Medium
Substance C	Low	1,400 mg/l	High	Medium	Medium

[9] Soluble at 20ºC

Substance D	Medium	67,000,000 mg/l	High	Low	High
Substance E	Low	290,000 mg/l	Medium	Medium	Medium
Substance F	Low	Insoluble	Low	Low	Medium

Table 1. Physical-chemical properties of the substances that are susceptible to cause damage to the environment. **Source:** Ministry for the Ecological Transition. Prepared based on safety sheets.

In the following table the previous table's numeric values have been reclassified to adapt them to the scales of the modifiers indicated in the new Annex III of the regulation which partially develops Law 26/2007.

Substance	Chemical-physical properties				
	Biodegradability	Solubility	Toxicity	Viscosity	Volatility
Substance A	High	Slightly soluble	High	Medium	High
Substance B	Medium	Insoluble	Medium	High	Medium
Substance C	Low	Very soluble	High	Medium	Medium
Substance D	Medium	Very soluble	High	Low	High
Substance E	Low	Very soluble	Medium	Medium	Medium
Substance F	Low	Insoluble	Low	Low	Medium

Table 2. Physical-chemical properties reclassified to the scales of the new Annex III of the regulation, which partially develops Law 26/2007 on the substances that are susceptible to cause damage to the environment. **Source:** Ministry for the Ecological Transition.

B. Natural resources

It is assumed that the land adjacent to the facility is not paved, thus the soil would be susceptible of being damaged. Furthermore, there is an area covered by a 45 year old pine forest which could also be affected by a hypothetical damage.

The facility is located inland (therefore it is not possible for sea water to be affected) and the nearest surface water bodies are at a considerable distance, so they can not be damaged. On the other hand, it has been assumed that there is an aquifer in the site and that the soil is permeable.

Therefore, the resources that could be affected are the soil, the groundwater body and that habitat.

C. Environment characteristics

In the following table some of the environmental characteristics that are relevant regarding the IDM application are stated.

Characteristic	Value
Depth of the aquifer	Shallow
Vegetation density	1,000 trees/ha
Protected Area	No
Stoniness	No
Gradient	4%
Permeability	Medium (silty sands)
Average annual precipitation	1,000 mm
Average annual temperature	12.5 ºC
Average wind speed	4.5 - 5 m/s

Table 3. Environmental characteristics of the facility. **Source:** Ministry for the Ecological Transition.

3. Environmental Risk Analysis

It is presumed that the facility that is the object of study has carried out its environmental risk analysis.

In this regard, the following table shows the different sources of danger identified in each site of the facility for this IDM application case study. Likewise the initiating events associated to each of these sources of danger are indicated.

Site	Sources of danger	Initiating event
Site 1	Substance A	Spillage of substance A from equipment
	Substance B	Spillage of substance B from deposit
	Substance C	Spillage of substance C from deposit
	Substance D	Spillage of substance D from pipelines
		Spillage of substance D from deposit
Site 2	Substance E	Spillage of substance E from equipment
	Spark	Fire in site 2
Site 3	Substance F	Explosion/Fire of substance F

Table 4. Identified sources of danger and initiating events **Source:** Ministry for the Ecological Transition.

It is important to highlight that in the fire in site 2 there is no substance associated to the initiating event, but this would be generated due to a spark, which is the source of danger that would cause the damage.

On the other hand, it is worth mentioning that for this case study it has been presumed that, in the case of substance D, the consequences of a gradual accident would significantly vary depending on if the substance pours from a pipeline or a deposit, as the volume would be double in the latter case. However, this may happen for various other reasons. For example, due to the storage of the substance and the place in which it enters into the process being located in different areas of the facility; each of them may have sufficiently different risks and prevention and avoidance measures for their environmental consequences to be the same, even if the volume poured into the environment was the same in both cases.

Finally, it is presumed that as part of the environmental risk analysis, the possible accident scenarios that could be caused by the initiating events considered, have been identified and diagrams have been drawn up of such events, with the calculation being carried out of the probabilities associated to the different accident scenarios proposed. The following table shows the hypothetical probability associated to each accident scenario.

Scenario		Probability
Code	**Description**	
S.1	Substance A spilled from equipment. Affected: soil and	2.01E-02
S.2	Substance B spilled from deposit. Affected: soil and groundwater.	2.13E-02
S.3	Substance C spilled from deposit. Affected: soil and groundwater.	5.91E-04
S.4	Substance D spilled from pipelines. Affected: soil and groundwater.	1.21E-03
S.5	Substance D spilled from deposit. Affected: soil and groundwater.	1.03E-03
S.6	Substance E spilled from equipment. Affected: soil and groundwater.	1.09E-03
S.7	Spilling of waters that put out a fire with Substance E dissolved. Affected: soil and groundwater.	3.11E-04
S.8	Fire and spilling of waters that put out a fire which affects the entire facility and goes outside with substance C dissolved. Affected: soil, habitat and groundwater.	3.23E-06
S.9	Spilling of waters that put out a fire in the sector of origin with Substance E dissolved. Affected: soil and groundwater.	2.15E-05
S.10	Spilling of water that puts out a fire that affects the whole facility but does not go outside with substance F. Affected: soil and groundwater.	7.75E-04

Table 5. Accident scenarios and the probability assigned to each of them. **Source:** Prepared by the authors.

4. Environmental Damage Index Estimation

Once the environmental risk analysis has been carried out and the possible natural resources that could be affected by each accident scenario have been analysed, the IDM estimation can be carried out. For this, different accident scenarios are extracted from the environmental risk analysis for which the IDM should be calculated.

First of all, agent-resource groups have been identified that can be applied in each scenario, as well as the type of agent involved. As the following table shows, given that in all cases the natural resources that could be affected by the damage are the soil, habitat and groundwater, the agent-resource groups in table 1 of Annex III of the Regulation that partially develops Law 26/2007 that come into play in the different accident scenarios considered in this case study are: 5 (damage to groundwater by chemicals), 9 (damage to the soil by chemicals) and 14 (damage to plant species by fire).

On the other hand, it is worth mentioning that, apart from substance D which is an inorganic substance, it is assumed that the other substances that intervene in the different accident scenarios are organic substances (all non-halogenated apart from substance A), thus the agent causing the damage would be classified in the groups: VOC, SVOC, NVOC[10].

Finally, in the case of group 14 that refers to fire damage to the habitat, it is important to bear in mind that it has been necessary to classify (pursuant to the categories established in Annex III of the Regulation for this group) the type of resource that would be damaged. As this refers to a 45 year old pine forest without protected plant species, the resource has been classified as a mature tree habitat with the diameters being over 20 cm.

Scenario		Types of agent	Type of Resource	Table 1 Group
Code	**Description**			
S.1	Substance A spilled from equipment. Affected: soil and groundwater.	Halogenated VOC	Groundwater	5
			Soil	9
S.2	Substance B spilled from deposit.. Affected: soil and groundwater.	Non-halogenated SVOC	Groundwater	5
			Soil	9
S.3	Substance C spilled from deposit.. Affected: soil and groundwater.	Non-halogenated VOC	Groundwater	5
			Soil	9
			Groundwater	5

[10] VOC: Volatile Organic Compounds.

SVOC: Semi-volatile Organic Compounds.

NVOC: Non Volatile Organic Compounds.

S.4	Substance D spilled from pipelines.. Affected: soil and	Inorganic	Soil	9
S.5	Substance D spilled from deposit. Affected: soil and groundwater.	Inorganic	Groundwater	5
			Soil	9
S.6	Substance E spilled from equipment. Affected: soil and groundwater.	Non-halogenated VOC	Groundwater	5
			Soil	9
S.7	Spilling of waters that put out a fire with Substance E dissolved. Affected: soil and groundwater.	Non-halogenated SVOC	Groundwater	5
			Soil	9
S.8	Fire and spilling of waters that put out a fire which affects the entire facility and goes outside with substance C dissolved. Affected: soil, habitat and groundwater.	Non-halogenated VOC	Groundwater	5
			Soil	9
			Habitat: Mature trees	14
S.9	Spilling of waters that put out a fire in the sector of origin with Substance E dissolved. Affected: soil and groundwater.	Non-halogenated VOC	Groundwater	5
			Soil	9
S.10	Spilling of water that puts out a fire that affects the entire facility but does not go outside with substance F. Affected: soil and groundwater.	Non-halogenated SVOC	Groundwater	5
			Soil	9

Table 6. Agent-resource groups assigned to each accident scenario. **Source:** Ministry for the Ecological Transition.

By identifying the different agent-resource combinations (groups) that correspond to each accident scenario, as well as the type of agent that causes the damage for each group, the IDM estimation module is then applied for each of the accident scenarios identified. Scenario S.1 will act as a way of example for the IDM calculation.

A. Substance A spilled from equipment (S.1)

On the first screen of the IDM estimation module, the agent "halogenated VOC" is selected.

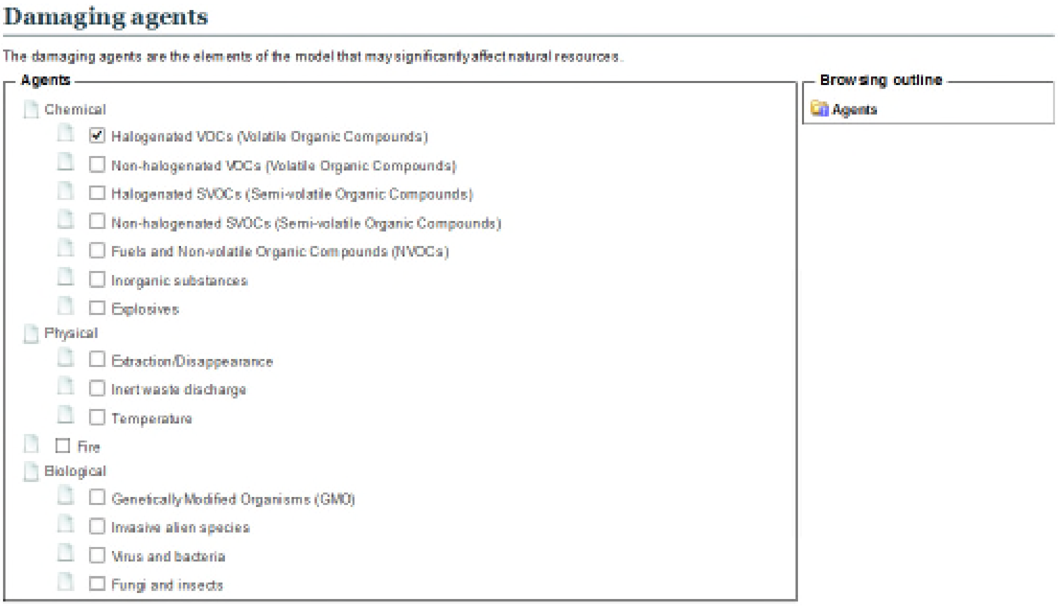


Figure 1. Screen for selecting the agent causing the damage for scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

Following on from that, the user will press the "next" button" and will go to the screen to select the resources that could be damaged by the accident. According to that indicated in Table 12, for this first scenario the resources soil and groundwater should be marked.

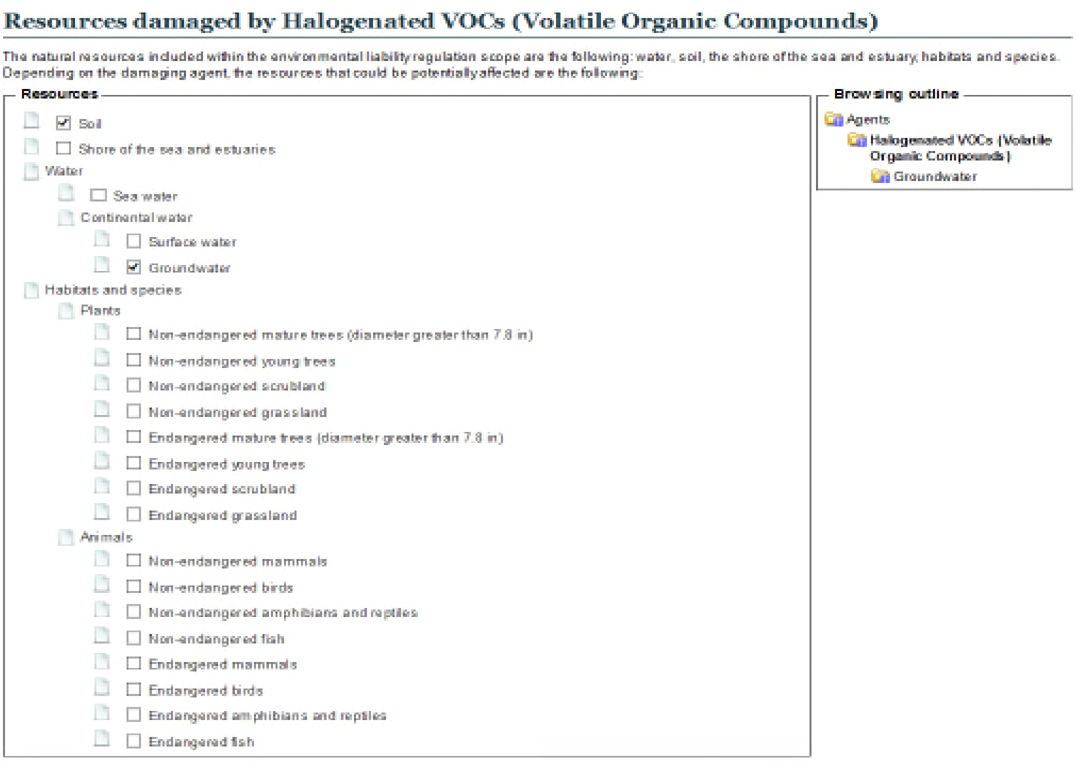


Figure 2. Screen for selecting the resources damaged in scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

The following screen shots will show the coefficients and modifiers that would be applied for each agent-resource combination (in this specific scenario: halogenated VOC-soil and halogenated VOC-groundwater).

As has been previously explained, the coefficients are fixed for each agent-resource combination. Therefore, the user will only have to complete the category that corresponds to each of the modifiers for this scenario, as well as the information regarding the total volume of the spill on the soil and the depth of the water table. Pursuant to the equation in section III of Annex III of the regulation, these two last pieces of data are used on the IDM estimation model to establish the distribution of the spill between the soil and groundwater.

That section indicates that in the case of combined damage to the soil and groundwater, the distribution of the volume that affects each resource will be carried out in terms of the aquifer level. This way it will be considered that, from the total volume spilled, part will stay in the soil whilst the rest will be filtered and will reach the groundwater body. The way each of these resources is affected will depend on the aquifer depth. If the aquifer level is shallow, the groundwater will be most affected, whilst if the level is deep, the soil will be most affected.

In the case of the accident scenario being analysed, it is taken that the total spill has been 25 m^3 and that the water table is shallow (see Table 9), thus the greater damage will affect the groundwater.

Additionally, in line with the data in Table 8 (data about the substance involved in the accident scenario) and Table 9 (environmental data such as the soil permeability), and presuming that this is a continual leakage and the estimated duration of the damage is less than 6 months, this screen for the case of soil damage would be completed as shown in the following figure.

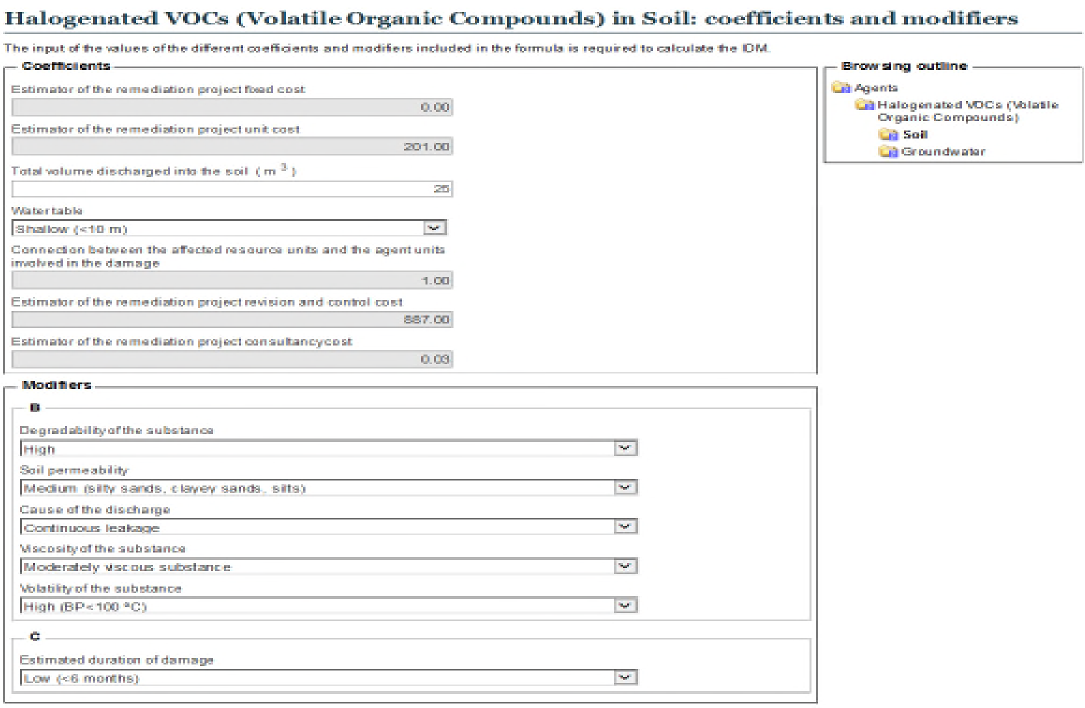


Figure 3. Screen showing the coefficients and modifiers regarding soil damage for scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

Likewise, the data would be completed regarding the damage to groundwater. For this, the data from tables 8 and 9 has been used and the assumption has been made that the damage will last less than three years.

It is worth pointing out that in both, soil damage and groundwater damage, the user should enter the total spilled amount (25 m^3) as it is the IDM estimation module that internally designates the amount to both resources in terms of what stays in the soil and what filters through the earth affecting groundwater.

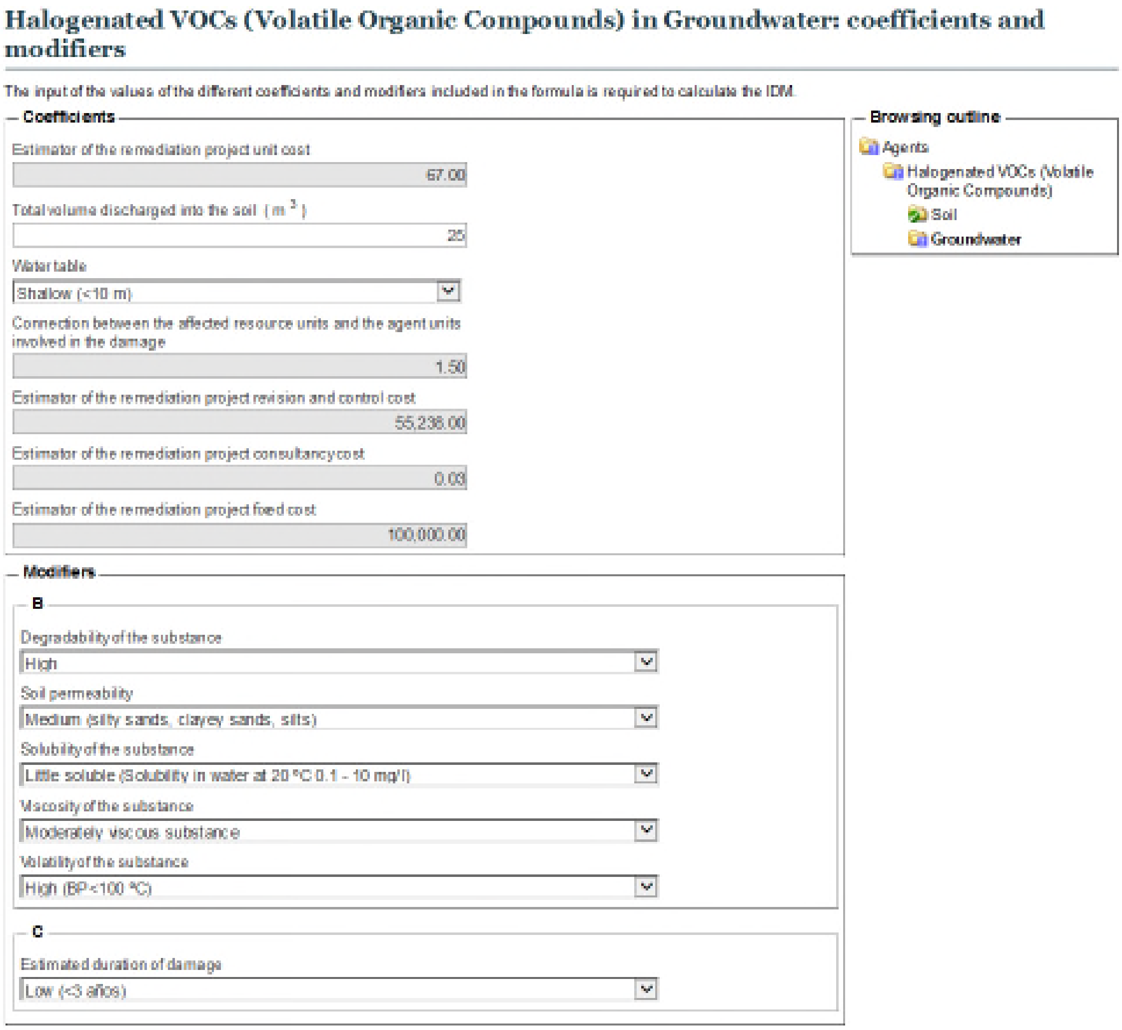


Figure 4. Screen showing the coefficients and modifiers regarding groundwater damage for scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

In the last step, the user should enter the distance to the nearest thoroughfare so that the IDM estimation module can estimate the costs for accessing the damaged area. This is due to the fact that should there not be a road to the damaged site, the estimation of the remediation cost will have to take into account for the constructing of a route to the affected area. Should this not be considered necessary, the screen corresponding to this estimation would be completed as shown in the figure below with the cost estimator for the access to the remediation site and the distance to the nearest road.

Figure 5. Screen for estimating the access costs for scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

The user will obtain the IDM value for the analysed scenario once all the data regarding this first scenario has been entered.

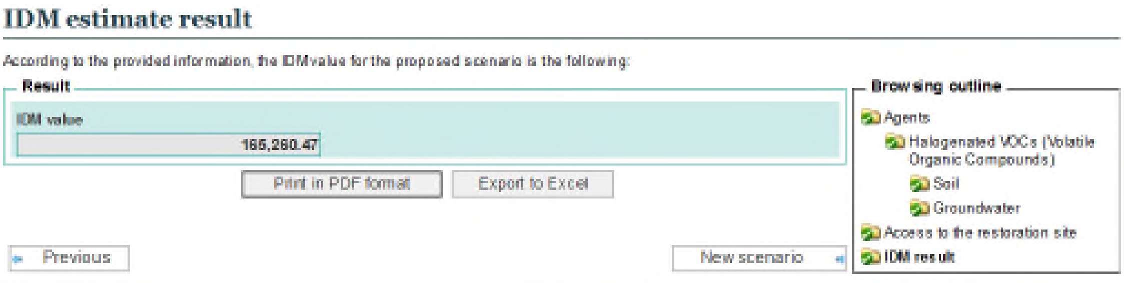


Figure 6. Result of the IDM estimation for scenario S.1 "substance A spilled from equipment". **Source:** IDM estimation module.

The IDM of the other identified scenarios will be calculated in a similar way, filling out the coefficients and modifiers that the module requires for each combination in each case. The results gained are summarised in the following table.

Scenario	IDM
S.1	165,260.47
S.2	182,798.33
S.3	243,645.77
S.4	165,763.87
S.5	170,718.98
S.6	186,843.24
S.7	188,026.63

S.8	498,962.09
S.9	264,330.51
S.10	343,419.57

Table 7. IDM estimation for each accident scenario. **Source:** Ministry for the Ecological Transition.

5. Selecting the Reference Scenario

Once the IDM has been estimated for each of the ten scenarios proposed for this case study, the reference scenario will be selected.

The way in which the reference scenario should be selected in order to establish the amount of financial security is that stated in the new wording of section 33 of the regulation which partially develops Law 26/2007. Thus, the steps to follow are the following:

1. *Calculation of the risk associated to each accident scenario as the product of the likelihood of the scenario occurring and the value of the IDM.*

   The risk is obtained as the probability between each scenario (Table 11) and the IDM estimation obtained for each of them (the value of the IDM obtained for each accident scenario can be seen in section 4: "Environmental Damage Index Estimate")

Scenario	Probability	IDM	Risk
S.1	2.01E-02	165,260.47	3,327.09
S.2	2.13E-02	182,798.33	3,895.42
S.3	5.91E-04	243,645.77	144.00
S.4	1.21E-03	165,763.87	201.12
S.5	1.03E-03	170,718.98	175.67
S.6	1.09E-03	186,843.24	203.66
S.7	3.11E-04	188,026.63	58.48
S.8	3.23E-06	498,962.09	1.61
S.9	2.15E-05	264,330.51	5.68
S.10	7.75E-04	343,419.57	266.15

Table 8. Risk associated to each accident scenario. **Source:** Ministry for the Ecological Transition.

2. *Selection of the scenarios with the lowest associated IDM that make up 95% of the total risk.*

   Once the scenarios have been ordered from highest to lowest IDM, the percentage of risk associated to each of them and the accumulated risk is calculated (see table below).

Scenario	Probability	IDM	Risk	% of Risk	Accumulated Risk
S.8	3.23E-06	498,962.09	1.61	0.02%	100.00%
S.10	7.75E-04	343,419.57	266.15	3.21%	99.98%
S.9	2.15E-05	264,330.51	5.68	0.07%	96.77%
S.3	**5.91E-04**	**243,645.77**	**144.00**	**1.74%**	**96.70%**
S.7	**3.11E-04**	**188,026.63**	**58.48**	**0.71%**	**94.96%**
S.6	**1.09E-03**	**186,843.24**	**203.66**	**2.46%**	**94.25%**
S.2	**2.13E-02**	**182,798.33**	**3,895.42**	**47.05%**	**91.79%**
S.5	**1.03E-03**	**170,718.98**	**175.67**	**2.12%**	**44.74%**
S.4	**1.21E-03**	**165,763.87**	**201.12**	**2.43%**	**42.62%**
S.1	**2.01E-02**	**165,260.47**	**3,327.09**	**40.19%**	**40.19%**

Table 9. Selection of the scenarios with the lowest IDM that make up 95% of the total risk. **Source:** Ministry for the Ecological Transition.

   Following that, the scenarios that make up 95% of the total risk are selected. Given that if only up to the fourth scenario is selected, only 94.96% is reached, not the 95% stated in the legislation, up to scenario S3 should be selected, with scenarios S.8, S.9 and S.10 being ruled out (written in grey).

3. *Using those with the highest IDM from the scenarios selected in the previous step as a scenario of reference in order to establish the amount of financial security.*

Scenario	Probability	IDM	Risk	% of Risk	Accumulated Risk
S.8	3.23E-06	505,194.39	1.63	0.02%	100.00%
S.10	7.75E-04	343,419.57	266.15	3.21%	99.98%
S.9	2.15E-05	264,330.51	5.68	0.07%	96.77%
S.3	**5.91E-04**	**243,645.77**	**144.00**	**1.74%**	**96.70%**
S.7	3.11E-04	188,026.63	58.48	0.71%	94.96%
S.6	1.09E-03	186,843.24	203.66	2.46%	94.25%
S.2	2.13E-02	182,798.33	3,895.42	47.05%	91.79%
S.5	1.03E-03	170,718.98	175.67	2.12%	44.74%
S.4	1.21E-03	165,763.87	201.12	2.43%	42.62%
S.1	2.01E-02	165,260.47	3,327.09	40.19%	40.19%

Table 10. Selecting the reference scenario **Source:** Prepared by the authors.

Therefore, the reference scenario in this case study would be scenario 3 (S.3) as, out of the scenarios selected in the previous step, this has the highest IDM. This scenario refers to the spill of substance C due to this substance spilling from a deposit located in site 1. The accident scenario to be evaluated could cause damage to the soil and groundwater.

6. Quantification and Monetisation of the Scenario of Reference

Once the scenario of reference for the determination of the amount of financial security of the installation that is subject of the analysis has been selected, it is necessary to quantify and monetize it.

A. Quantification of data

The natural resources susceptible to being damaged by scenario S.3 (spill of 350 m^3 of substance C) are soil and groundwater.

As it is not the aim of this case study to explain the way in which the reference scenario should be quantified, it has been assumed that the model developed by Grimaz *et al* (2007) has been used to estimate the amount of resources that could be affected. The result obtained by the model is an affected area of 28,000.09 m^3.

There will be a split between the resources soil and groundwater in the following way: soil damage 808.31 m^3 and groundwater damage 27,191.78 m^3.

B. Monetisation of data

Finally, it is necessary to monetize this scenario. For this monetization, the Environmental Liability Supply Model (MORA) has been used.

These are the parameters that have been entered in to MORA for the monetisation of the damage:

1. Coordinates for the point where the damage took place: the coordinates of a point in Spain that meets the environmental conditions indicated in section 2.C have been entered. *Characteristics of the Environment.*

2. Accessibility. It must be stated if the damaged site is accessible or not. In this case, it has been presumed that it is.

3. Slope range. The gradient corresponding to the coordinates entered for this example is 4%, thus the category "very low" has been selected.

4. Permeability. This is an area with silty sands (medium permeability according to the scales indicated in the regulation which partially develops of Act 26/2007, of 23 October for the modifications M_{B8} and M_{B9} of the IDM) and is of the order 10^{-10} (see Table 16 in section *6.A. Quantification of data*), the category "medium" has been selected.

5. Protected Area. Coordinates that, in line with that stated in section 2.C, do not correspond to a Protect Area have been selected. *Characteristics of the Environment*.

6. Agent causing the damage. This is damage caused by a biodegradable VOC.

7. Affected resources. The resources affected by the scenario of reference are the soil and groundwater.

8. Amount of resource affected. In the case of the soil, the MORA requires that the units are entered as tonnes of soil affected therefore it has been necessary to transform the unit of volume obtained in section 6.A. *Quantification of damage* (808,31 m^3) by using the soil density, the result of damaged soil can be obtained as 1,333.72 t. The amount of affected groundwater should be introduced in MORA in units of volume (m^3), therefore the data obtained in this same section can be used directly (27,191.78 m^3).

Once all of the information has been introduced into MORA, the results that are shown in the table below are obtained.

Resource	Damaged quantity	Technique	Primary cost (€)	Total (€)
Soil	1,333.72 t	*Landfarming*	112,996.05	607,697.15
Groundwater	27,191.77 m^3	Separation	494,701.10	

Table 11. Results of the MORA application. **Source:** Ministry for the Ecological Transition.

Therefore, the cost of the primary remediation of the damage to soil and groundwater that the scenario of reference (S.3) may cause would amount to 607,697.15 euros.

7. Financial Security

Based on the hypothesis that this study was carried out for a facility included in Annex III of Law 26/2007, and presuming that the facility does not have a the ISO 14,001 or EMAS environmental management system, the facility that is under study would be obliged to provide a mandatory financial security.

With the aim of considering the obligations regarding the prevention and avoidance of damages established in section 17 of Law 26/2007, and pursuant to that indicated in subsection 3 of section 30 of the law, at least an additional 10% must be added to the damage estimated in the previous section. In this case study, this amounts to 60.769,71€.

Therefore, the operator should provide a compulsory financial security of 668,466.87 €.

Additionally to the costs of primary remediation measures, that is what must be covered by the mandatory financial provision in Spain, plus prevention measures, the MORA software provides also the cost of complementary and/or compensatory remediation measures.

8. Further Considerations

Although the procedure for the determination of the amount of the financial security in Spain only requires de monetisation of the reference scenario of a facility, the MORA software can be used to estimate the remediation costs of all the risk scenarios identified within the environmental risk analysis.

This provides operators with a valuable information for risk-management purposes, allowing them to plan the implementation of measures to reduce the probability of occurrence, or the consequences of a particular risk scenario within his facility.

Therefore the IDM and MORA tools, not only allows operators to determine the amount of mandatory financial security needed. They can also be very useful tools for the decision-making process of operators in the sort, medium and long term, and this contributes to the implementation of the prevention principle on which Directive 2004/35/CE is based.

Case Study 2

How the Environmental Damage Index (IDM) and MORA models work.

Case Study Arable farm

9. Aim of the Case Study

The aim of this case study is to illustrate the way in which the IDM and the MORA methodology works within the procedure for the determination of the mandatory financial security foreseen in Law 26/2007.

Given that the only aim of this example is to illustrate the way in which the amount of financial security should be established, some data has been estimated, although with a realistic approach.

10. Description of the Facility and Activity

The facility is a farm that is 200 hectares in size and it produces cereals and potatoes.

The farm is in a low rainfall lowland area. Soils are loamy with some silt, sand and clay and a low organic matter content and a high hydraulic conductivity. Groundwater is quite shallow, 1-5m below ground level. Many streams cross the site with 10m buffer strips on each side. Parts of the farm are designated as SSSI and/or SAC for acid rich grassland and the farm is used by Natura species such as Great Crested Newt, Ranunculus penicillatus (stream water crowfoot) and Otters.

Vehicles are fuelled with diesel, which is stored in a 10,000 litre plastic filling station. This is double skinned, 3m in diameter and all the fill points and delivery hoses are within the bunded area. Fuelling is electrically driven rather than gravity fed. The main risk is ground contamination arising from small spills when refuelling vehicles, the likelihood of this happening is low.

Liquid fertiliser (ammonium sulphate [chafer] is stored in a 20,000 litre fibreglass tank and is protected from collision damage. The tank is not bunded and the fertiliser is discharged via gravity feed. The main risk is surface water and surface water dependent species (via field drains) and possibly groundwater contamination. The likelihood of a spillage during storage or filling is moderate.

50 tonnes of solid compound (N, P, K) fertiliser is stored in a dry shed of about 50m2 size. The main risk is soil contamination but the likelihood of this happening in any appreciable quantity is very low.

Pesticides are stored in a lockable shipping container with spill lip. The spill mix area is concrete and has a sump. The pesticides are a herbicide (roundup (glyphosate)) for the cereals and a fungicide (cymoxanil) for the potatoes. These are stored in 5 l plastic containers, which are triple rinsed and recycled once empty. The likelihood of a spillage is very low.

11. Environmental Risk Analysis

The Environmental Risk Assessment concluded that there are two main risks. These are:

Contamination of an area of soil of around 10m2 with diesel, as a result of refuelling spillages, and possible associated shallow groundwater contamination.

Release of up to 20,000 litres of liquid fertiliser over a 12 hour period (due to a procedural error during filling of the tank) to a surface water resulting in mortalities of salmon and trout up to around 10,000 individuals. There is also the potential for harm to the otters through consumption of contaminated dead fish and loss of their main food source.

12. Environmental Damage Index Estimation

Once the environmental risk analysis has been carried out and the possible natural resources that could be affected by each accident scenario have been analysed, the IDM estimation can be carried out.

The IDM is calculated for the 2 risk scenarios identified, using the IDM software tool.

In the case of the scenario 1 (contamination to soil and groundwater), a total volume discharged to the soil of 1 m3 of diesel has been assumed.

The results gained are summarised in the following table, and the full reports of the IDM tool are provided in annex I.

Scenario	IDM
S.1	2,541,010.13
S.2	161,047.53

Table 1. IDM estimation for each accident scenario. **Source:** Ministry for the Ecological Transition.

13. Selecting the Reference Scenario

Once the IDM has been estimated for each of the two scenarios proposed for this case study, the reference scenario will be selected.

The way in which the reference scenario should be selected in order to establish the amount of financial security, is that stated in the new wording of section 33 of the regulation which partially develops Law 26/2007. Thus, the steps to follow are the following:

4. *Calculation of the risk associated to each accident scenario as the product of the likelihood of the scenario occurring and the value of the IDM.*

   The risk is obtained as the probability between each scenario and the IDM estimation obtained for each of them (the value of the IDM obtained for each accident scenario can be seen in section 4: "Environmental Damage Index Estimate")

Scenario	Probability	IDM	Risk
S.1	3.23E-06	161,047.53	0.52
S.2	2.01E-02	2,541,010.13	510.75

Table 2. Risk associated to each accident scenario. **Source:** Ministry for the Ecological Transition.

5. *Selection of the scenarios with the lowest associated IDM that make up 95% of the total risk.*

Once the scenarios have been ordered from highest to lowest IDM, the percentage of risk associated to each of them and the accumulated risk is calculated (see table below).

Scenario	Probability	IDM	Risk	% of Risk	Accumulated Risk
S.2	2.01E-04	2,541,010.13	510.74	99.89	100
S.1	3.23E-06	161,047.53	0.52	0.11	0.11

Table 3. Selection of the scenarios with the lowest IDM that make up 95% of the total risk. **Source:** Ministry for the Ecological Transition.

Following that, the scenarios that make up 95% of the total risk are selected. Given that if only up to the fourth scenario is selected, only 94.96% is reached, not the 95% stated in the legislation, up to scenario S3 should be selected, with scenarios S.8, S.9 and S.10 being ruled out (written in grey).

6. *Using those with the highest IDM from the scenarios selected in the previous step as a scenario of reference in order to establish the amount of financial security.*

Scenario	Probability	IDM	Risk	% of Risk	Accumulated Risk
S.2	2.01E-04	2,541,010.13	510.74	99.89	100
S.1	3.23E-06	161,047.53	0.52	0.11	0.11

Table 4. Selecting the reference scenario **Source:** Prepared by the authors.

Therefore, the reference scenario in this case study would be scenario 2 (S.2).

14. Quantification and Monetisation of the Scenario of Reference

Once the scenario of reference for the determination of the amount of financial security of the installation that is subject of the analysis has been selected, it is necessary to quantify and monetize it.

C. *Quantification of data*

The natural resources susceptible to being damaged by scenario S.2 are salmon and trout (10,000 individuals) and otter (25 individuals). The potential harm to the otters since the damage occurs until full reintroduction of the salmon and trout could be additional modelled (as harm or death) in MORA, but for simplification purposes, in this example the damage to otters have been considered as the death of 25 individuals due to the consumption of contaminated dead fish.

D. *Monetisation of data*

Finally, it is necessary to monetize this scenario S.2. For this monetization, the Environmental Liability Supply Model (MORA) has been used.

These are the parameters that have been entered in to MORA for the monetisation of the damage:

9. Coordinates for the point where the damage took place: the coordinates of a point in Spain that meets the environmental conditions indicated in section 2.C have been entered. *Characteristics of the Environment.* These coordinates are not included in this case study, as it is a possible case study with no exact location.

10. Accessibility. It must be stated if the damaged site is accessible or not. In this case, it has been presumed that it is.

11. Slope range. The gradient corresponding to the coordinates entered for this example is "low"

12. Permeability. According to the information given in the description of the example, soils are loamy with some silt, sand and clay and a low organic matter content and a high hydraulic conductivity, therefore the category "medium" for permeability has been selected.

13. Protected Area. According to the description, there are Protect Areas

14. Agent causing the damage. This is damage caused by liquid fertiliser.

15. Affected resources. The resources affected by the scenario of reference are salmon and trout and otter.

16. Amount of resource affected. In the case of the salmon and trout, MORA requires the number of individuals damaged. In this case 10,000 individuals of trout and salmon (death), and 25 individuals of otter (death)

Once all of the information has been introduced into MORA, the results that are shown in the table below are obtained.

Resource	Damaged quantity	Technique	Primary cost (€)	Total (€)
Salmon and trout	10,000 individuals	*Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes*	218,435.41	587,612.09
Otter	25 Individuals	Breeding in captivity and introduction of specimens for replacement of Lutra	369,176.68	

Table 5. Results of the MORA application. **Source:** Ministry for the Ecological Transition.

Therefore, the cost of the primary remediation of the damage to soil and groundwater that the scenario of reference (S.2) may cause would amount to 587,612.09 euros.

15. Financial Security

With the aim of considering the obligations regarding the prevention and avoidance of damages established in section 17 of Law 26/2007, and pursuant to that indicated in subsection 3 of section 30 of the law, at least an additional 10% must be added to the damage estimated in the previous section (primary remediation costs). In this case study, this amounts to 58,761.20€.

Therefore, the operator should provide a compulsory financial security of 646,373.29 €.

Additionally to the costs of primary remediation measures, that is what must be covered by the mandatory financial provision in Spain, plus prevention measures, the MORA software provides also the cost of complementary and/or compensatory remediation measures. In this case, compensatory remediation measures for the S.2 scenario amounts to 40,856.93 € for the damage to otter, and 29,788.51 € for the damage to salmon and trout. This results in 70,645.44 € of compensatory remediation costs.

The full report of the monetisation carried out for this scenario S.2 with the MORA software, is in Annex I.

16. Further Considerations

Although the procedure for the determination of the amount of the financial security in Spain only requires de monetisation of the reference scenario of a facility, the MORA software can be used to estimate the remediation costs of all the risk scenarios identified within the environmental risk analysis.

This provides operators with a valuable information for risk-management purposes, allowing them to plan the implementation of measures to reduce the probability of occurrence, or the consequences of a particular risk scenario within his facility.

Therefore the IDM and MORA tools, not only allows operators to determine the amount of mandatory financial security needed. They can also be very useful tools for the decision-making process of operators in the sort, medium and long term, and this contributes to the implementation of the prevention principle on which Directive 2004/35/CE is based.

In this case study, the monetization of the scenario S.1 gives this result:

The natural resources susceptible to being damaged by scenario S.1 are soil and groundwater.

MORA requires as input data for calculating the recovery costs of contaminated land, tons of soil damaged. This requires knowing the depth of the soil damaged, and its density. For the purposes of this case study, we could estimate that the depth of the soil damaged is 0,5 m (therefore we have 5 m3), and a density of 1,5 g/cm3 (value estimated from the bibliography for silty soils).

With these assumptions, we have 7,5 tons of soil damaged.

As possible associated shallow groundwater contamination is mentioned in the Environmental Risk Assessment for this scenario, but there are no further data.

As it is not the aim of this case study to explain the way in which the reference scenario should be quantified, it has been assumed that the model developed by Grimaz *et al* (2007) has been used to estimate the amount of resources that could be affected, and its result is a contamination of 100 m3 of groundwater.

These are the parameters that have been entered in to MORA for the monetisation of the damage:

1. Coordinates for the point where the damage took place: the coordinates of a point in Spain that meets the environmental conditions indicated in section 2.C have been entered. *Characteristics of the Environment.* These coordinates are not included in this case study, as it is a possible case study with no exact location.

2. Accessibility. It must be stated if the damaged site is accessible or not. In this case, it has been presumed that it is.

3. Slope range. The gradient corresponding to the coordinates entered for this example is "low"

4. Permeability. According to the information given in the description of the example, soils are loamy with some silt, sand and clay and a low organic matter content and a high hydraulic conductivity, therefore the category "medium" for permeability has been selected.

5. Protected Area. According to the description, there are Protect Areas

6. Agent causing the damage. This is damage caused by diesel, as a result of refuelling spillages.

7. Affected resources. The resources affected by the scenario of reference are the soil and groundwater.

8. Amount of resource affected. In the case of the soil, the MORA requires that the units are entered as tonnes of soil affected. Therefore it has been necessary to transform the unit of volume 5 m3 by using the soil density, the result of damaged soil can be obtained as 7,5 t. The amount of affected groundwater should be introduced in MORA in units of volume (m^3), and it has been estimated a volume of groundwater contaminated of 100 m^3).

Once all of the information has been introduced into MORA, the results that are shown in the table below are obtained.

Resource	Damaged quantity	Technique	Primary cost (€)	Total (€)
Soil	7,54 t	*Landfarming*	17,756.61	258,936.45
Groundwater	100 m^3	Separation	241,179.84	

Table 6. Results of the MORA application. **Source:** Ministry for the Ecological Transition.

Therefore, the cost of the primary remediation of the damage to soil and groundwater that the scenario of reference (S.1) may cause would amount to 258,936.45 euros.

The MORA software provides also the cost of complementary and/or compensatory remediation measures. In this case, compensatory remediation measures for the S.1 scenario amounts to 178,713.47€ for the damage to groundwater, and 12,230.14 € for the damage to soil. This results in 12,230.14 € of compensatory remediation costs.

The full report of the monetisation carried out for this scenario S.2 with the MORA software, is in Annex I.

17. Annex I

In this section, the full reports of the IDM tool for risk scenarios S.1 and S.2, and the monetisation carried out for risk scenarios S.2 (reference scenario) and S.1 with the MORA tool are provided.

MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

Comisión Técnica de Prevención y Reparación de Daños Medioambientales

IDM Índice de Daño Medioambiental

ENVIRONMENTAL DAMAGE INDEX ESTIMATE

General data

Date of performance	10/03/2018

Damage

Agent	Resource
Fuels and Non-volatile Organic Compounds (NVOCs)	Soil

Coefficients

Concept	Value
Estimator of the remediation project fixed cost	0.00
Estimator of the remediation project unit cost	201.00
Number of agents involved in the damage	0.33
Connection between the affected resource units and the agent units involved in the damage	1.00
Estimator of the remediation project revision and control cost	887.00
Estimator of the remediation project consultancy cost	0.03

Modifiers

Concept	Value
Degradability of the substance	Medium
Soil permeability	Medium (silty sands, clayey sands, silts)
Cause of the discharge	Instantaneous leakage
Viscosity of the substance	Moderately viscous substance
Volatility of the substance	Low (BP>325 C)
Estimated duration of damage	Low (<6 months)

Damage

Agent	Resource
Fuels and Non-volatile Organic Compounds (NVOCs)	Groundwater

Coefficients

Concept	Value
Estimator of the remediation project fixed cost	100,000.00
Estimator of the remediation project unit cost	67.00
Number of agents involved in the damage	0.67
Connection between the affected resource units and the agent units involved in the damage	1.50
Estimator of the remediation project revision and control cost	55,238.00
Estimator of the remediation project consultancy cost	0.03

Modifiers

Concept	Value
Degradability of the substance	Medium
Soil permeability	Medium (silty sands, clayey sands, silts)
Solubility of the substance	Insoluble (Solubility in water at 20 C < 0.1 mg/l)
Viscosity of the substance	Moderately viscous substance
Volatility of the substance	Low (BP>325 C)
Estimated duration of damage	Low (<3 aos)

Access to the restoration site

Cost estimator for the access to the restoration	6.14
Distance to the nearest road (m)	0.00

Estimate result

IDM value	161,047.53

REPARATION COSTS REPORT

General data

Name: Arable Farm IMPEL project financial provision Case Study. Risk 1 soil and groundwater

Date of performance: 08/24/2018

Version: v2011/1

Operator: curso2 curso2

Location data

X coordinate: 462,131.71

Y coordinate: 4,474,392.52

SRS: UTM-ETRS 1989-

Parameters

Concept	Value	Original value
Accessibility	Yes	
Road distance	0	1048
Slope range	Low	Very low
	Very high	Medium
Protected Area	Yes	No

Damage

Agent	Resource	Quantity damage	Reversible
Fuels and biodegradable NVOCs	Groundwater	1,000.00 m3	Yes

Remediations

Primary

No. physical units to repair: 1,000.00m3

Waiting time: 6 Months

Remediation Separation

Remediation technique data

Concept	Value	Original value
Selected technique	Separation	Separation
Unit Cost	6.58	
Fixed cost	36,688.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	18	
Time unit	Months	
Efficiency type	Proven	

Primary remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		241,179.84		241,179.84
Total Remediation Technique		62,825.14		62,825.14
% VAT	21.00	10,903.54	21.00	10,903.54
% Contingency Security	20.00	8,653.60	20.00	8,653.60
Estimated Costs of Implementation Remediation technique		43,268.00		43,268.00
Total Consultancy		9,369.49		9,369.49
% VAT	21.00	1,626.11	21.00	1,626.11
% Contingency Security	20.00	1,290.56	20.00	1,290.56
Estimated Costs of Implementation Cosultancy		6,452.82		6,452.82
Total Revision and Control		168,985.21		168,985.21
% VAT	21.00	29,328.01	21.00	29,328.01

Name	%	Amount (€)	Original %	Original Amt. (€)
% Contingency Security	20.00	23,276.20	20.00	23,276.20
Estimated Costs of Implementation Revision and Control		116,381.00		116,381.00

Compensatory remediation

No. physical units to repair 37.55 m3

Waiting Time 6 months Discount rate 3.00

Remediation Separation

Remediation technique data

Concept	Value	Original value
Selected technique	Separation	Separation
Unit Cost	6.58	
Fixed cost	0.00	36,688.00
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	18	
Time unit	Months	
Efficiency type	Proven	

Compensatory remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		178,713.47		178,713.47
Total Remediation Technique		358.76		358.76
% VAT	21.00	62.26	21.00	62.26

Name	%	Amount (€)	Original %	Original Amt. (€)
% Contingency Security	20.00	49.42	20.00	49.42
Estimated Costs of Implementation Remediation technique		247.08		247.08
Total Consultancy		9,369.49		9,369.49
% VAT	21.00	1,626.11	21.00	1,626.11
% Contingency Security	20.00	1,290.56	20.00	1,290.56
Estimated Costs of Implementation Cosultancy		6,452.82		6,452.82
Total Revision and Control		168,985.21		168,985.21
% VAT	21.00	29,328.01	21.00	29,328.01
% Contingency Security	20.00	23,276.20	20.00	23,276.20
Estimated Costs of Implementation Revision and Control		116,381.00		116,381.00

Damage

Agent	Resource	Quantity damage	Reversible
Fuels and biodegradable NVOCs	Soil	75.00 t	Yes

Remediations

Primary

No. physical units to repair	75.00t

Waiting time: 6 Months

Remediation: Landfarming

Remediation technique data

Concept	Value	Original value
Selected technique	Landfarming	Landfarming

Concept	Value	Original value
Unit Cost	52.11	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	9	
Time unit	Months	
Efficiency type	Proven	

Primary remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		17,756.61		17,756.61
Total Remediation Technique		5,674.78		5,674.78
% VAT	21.00	984.88	21.00	984.88
% Contingency Security	20.00	781.65	20.00	781.65
Estimated Costs of Implementation Remediation technique		3,908.25		3,908.25
Total Consultancy		9,369.49		9,369.49
% VAT	21.00	1,626.11	21.00	1,626.11
% Contingency Security	20.00	1,290.56	20.00	1,290.56
Estimated Costs of Implementation Cosultancy		6,452.82		6,452.82
Total Revision and Control		2,712.34		2,712.34
% VAT	21.00	470.74	21.00	470.74
% Contingency Security	20.00	373.60	20.00	373.60
Estimated Costs of Implementation Revision and Control		1,868.00		1,868.00

Compensatory remediation

No. physical units to repair	1.96 t

Waiting Time 6 months **Discount rate** 3.00

Remediation Landfarming

Remediation technique data

Concept	Value	Original value
Selected technique	Landfarming	Landfarming
Unit Cost	52.11	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	9	
Time unit	Months	
Efficiency type	Proven	

Compensatory remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		12,230.14		12,230.14
Total Remediation Technique		148.31		148.31
% VAT	21.00	25.74	21.00	25.74
% Contingency Security	20.00	20.43	20.00	20.43
Estimated Costs of Implementation Remediation technique		102.14		102.14
Total Consultancy		9,369.49		9,369.49
% VAT	21.00	1,626.11	21.00	1,626.11
% Contingency Security	20.00	1,290.56	20.00	1,290.56

Name	%	Amount (€)	Original %	Original Amt. (€)
Estimated Costs of Implementation Cosultancy		6,452.82		6,452.82
Total Revision and Control		2,712.34		2,712.34
% VAT	21.00	470.74	21.00	470.74
% Contingency Security	20.00	373.60	20.00	373.60
Estimated Costs of Implementation Revision and Control		1,868.00		1,868.00

Road construction budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Road Construction		0.00		0.00
Total Road Execution		0.00		0.00
% VAT	21.00	0.00	21.00	0.00
% Contingency Security	20.00	0.00	20.00	0.00
Total Road Construction		0.00		0.00
Total Consultancy		0.00		0.00
% VAT	21.00	0.00	21.00	0.00
% Contingency Security	20.00	0.00	20.00	0.00
Estimated Costs of Implementation Cosultancy		0.00		0.00

Remediation summary

Agent-resource combinations of the accidental	Action type	Amount (€)
Fuels and biodegradable NVOCs in Groundwater	Primary remediation	241,179.84
	Compensatory remediation	178,713.47
	Complementary	0.00
	Subtotal	419,893.31

Agent-resource combinations of the	Action type	Amount (€)
Fuels and biodegradable NVOCs in Soil	Primary remediation	17,756.61
	Compensatory remediation	12,230.14
	Complementary	0.00
	Subtotal	29,986.75
Road Construction Budget		0.00
Primary remediation total (including road construction)		258,936.45
Compensatory remediation total (without including road construction)		190,943.61
Complementary remediation total (without including road construction)		0.00
Remediation total		449,880.06

ENVIRONMENTAL DAMAGE INDEX ESTIMATE

General data

Date of performance	10/03/2018

Damage

Agent	Resource
Fuels and Non-volatile Organic Compounds (NVOCs)	Non-endangered fish

Coefficients

Concept	Value
Estimator of the remediation project fixed cost	0.00
Estimator of the remediation project unit cost	5.00
Number of agents involved in the damage	40.00
Connection between the affected resource units and the agent units involved in the damage	100.00
Estimator of the remediation project revision and control cost	6,027.00
Estimator of the remediation project consultancy cost	0.03

Modifiers

Concept	Value
Population density	Medium density
Toxicity of the substance	Average
Estimated duration of damage	Low (rest of species)
Effect on a protected area	Possible influence to a PNA
Degradability of the substance	Medium

Damage

Agent	Resource
Fuels and Non-volatile Organic Compounds (NVOCs)	Endangered mammals

Coefficients

Concept	Value
Estimator of the remediation project fixed cost	0.00
Estimator of the remediation project unit cost	47,463.00
Number of agents involved in the damage	40.00
Connection between the affected resource units and the agent units involved in the damage	0.50
Estimator of the remediation project revision and control cost	6,027.00
Estimator of the remediation project consultancy cost	0.03

Modifiers

Concept	Value
Population density	Medium density
Toxicity of the substance	Average
Estimated duration of damage	High (mammals)
Effect on a protected area	Possible influence to a PNA
Degradability of the substance	Medium

Access to the restoration site

Cost estimator for the access to the restoration	6.14
Distance to the nearest road (m)	0.00

Estimate result

IDM value	2,541,010.13

REPARATION COSTS REPORT

General data

Name	Arable Farm IMPEL project financial provision Case Study. Risk 2 trouts and salmon
Date of performance	08/24/2018
Version	V2011/1
Operator	curso2 curso2

Location data

X coordinate	Y coordinate	SRS
462,131.71	4,474,392.52	UTM-ETRS 1989-

Parameters

Concept	Value	Original value
Accessibility	Yes	
Road distance	0	1048
Slope range	Low	Very low
Permeability	Very high	Medium
Protected Area	Yes	No

Damage

Agent	Resource	Quantity damage	Reversible
Fuels and biodegradable NVOCs	Lutra lutra (Death)	25.00 Ud.	Yes

Remediations

Primary

No. physical units to repair	25.00 Ud.

Waiting time: 6 Months

Remediation: Breeding in captivity and introduction of specimens for replacement of Lutra lutra

Remediation technique data

Concept	Value	Original value
Selected technique	Breeding in captivity and introduction of speciments for replacement of Lutra lutra	Breeding in captivity and introduction of speciments for replacement of Lutra lutra
Unit Cost	9,381.21	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	24	
Time unit	Months	
Efficiency type	Proven	

Primary remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		369,176.68		369,176.68
Total Remediation Technique		340,537.92		340,537.92
% VAT	21.00	59,101.62	21.00	59,101.62
% Contingency Security	20.00	46,906.05	20.00	46,906.05
Estimated Costs of Implementation Remediation technique		234,530.25		234,530.25
Total Consultancy		10,201.26		10,201.26
% VAT	21.00	1,770.47	21.00	1,770.47
% Contingency Security	20.00	1,405.13	20.00	1,405.13
Estimated Costs of Implementation Cosultancy		7,025.66		7,025.66
Total Revision and Control		18,437.50		18,437.50
% VAT	21.00	3,199.90	21.00	3,199.90

Name	%	Amount (€)	Original %	Original Amt. (€)
% Contingency Security	20.00	2,539.60	20.00	2,539.60
Estimated Costs of Implementation Revision and Control		12,698.00		12,698.00

Compensatory remediation

No. physical units to repair	1.13Ud.

Waiting time: 6 months

Discount rate: 3.00

Remediation: Breeding in captivity and introduction of specimens for replacement of

Remediation technique data

Concept	Value	Original value
Selected technique	Breeding in captivity and introduction of specimens for replacement of Lutra lutra	Breeding in captivity and introduction of specimens for replacement of Lutra lutra
Unit Cost	9,381.21	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	24	
Time unit	Months	
Efficiency type	Proven	

Compensatory remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		40,856.93		40,856.93
Total Remediation Technique		15,392.32		15,392.32
% VAT	21.00	2,671.39	21.00	2,671.39
% Contingency Security	20.00	2,120.15	20.00	2,120.15
Estimated Costs of Implementation Remediation technique		10,600.77		10,600.77
Total Consultancy		7,027.11		7,027.11
% VAT	21.00	1,219.58	21.00	1,219.58
% Contingency Security	20.00	967.92	20.00	967.92
Estimated Costs of Implementation Cosultancy		4,839.61		4,839.61
Total Revision and Control		18,437.50		18,437.50
% VAT	21.00	3,199.90	21.00	3,199.90
% Contingency Security	20.00	2,539.60	20.00	2,539.60
Estimated Costs of Implementation Revision and Control		12,698.00		12,698.00

Damage

Agent	Resource	Quantity damage	Reversible
Fuels and biodegradable NVOCs	Other Continental Fishes (Death)	10,000.00 Ud.	Yes

Remediations

Primary

No. physical units to repair	10,000.00 Ud.

Waiting time: 6 Months

Remediation: Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes

Remediation technique data

Concept	Value	Original value
Selected technique	Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes	Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes
Unit Cost	13.29	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	6	
Time unit	Months	
Efficiency type	Proven	

Primary remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		218,435.41		218,435.41
Total Remediation Technique		192,970.80		192,970.80
% VAT	21.00	33,490.80	21.00	33,490.80
% Contingency Security	20.00	26,580.00	20.00	26,580.00
Estimated Costs of Implementation Remediation technique		132,900.00		132,900.00
Total Consultancy		7,027.11		7,027.11
% VAT	21.00	1,219.58	21.00	1,219.58
% Contingency Security	20.00	967.92	20.00	967.92
Estimated Costs of Implementation Cosultancy		4,839.61		4,839.61
Total Revision and Control		18,437.50		18,437.50
% VAT	21.00	3,199.90	21.00	3,199.90
% Contingency Security	20.00	2,539.60	20.00	2,539.60
Estimated Costs of Implementation Revision and Control		12,698.00		12,698.00

Compensatory remediation

No. physical units to repair	224.07 Ud.

Waiting time	6 months	Discount rate	3.00
Remediation	Breeding in captivity and introduction of specimens for replacement of		

Remediation technique data

Concept	Value	Original value
Selected technique	Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes	Breeding in captivity and introduction of specimens for replacement of Other Continental Fishes
Unit Cost	13.29	
Fixed cost	0.00	
Multiplier	0.00	
Exponent	0.00	
Natural recovery time	6	
Time unit	Months	
Efficiency type	Proven	

Compensatory remediation budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Remediation		29,788.51		29,788.51
Total Remediation Technique		4,323.90		4,323.90
% VAT	21.00	750.43	21.00	750.43
% Contingency Security	20.00	595.58	20.00	595.58
Estimated Costs of Implementation Remediation technique		2,977.89		2,977.89
Total Consultancy		7,027.11		7,027.11

Name	%	Amount (€)	Original %	Original Amt. (€)
% VAT	21.00	1,219.58	21.00	1,219.58
% Contingency Security	20.00	967.92	20.00	967.92
Estimated Costs of Implementation Cosultancy		4,839.61		4,839.61
Total Revision and Control		18,437.50		18,437.50
% VAT	21.00	3,199.90	21.00	3,199.90
% Contingency Security	20.00	2,539.60	20.00	2,539.60
Estimated Costs of Implementation Revision and Control		12,698.00		12,698.00

Road construction budget

Name	%	Amount (€)	Original %	Original Amt. (€)
Total Road Construction		0.00		0.00
Total Road Execution		0.00		0.00
% VAT	21.00	0.00	21.00	0.00
% Contingency Security	20.00	0.00	20.00	0.00
Total Road Construction		0.00		0.00
Total Consultancy		0.00		0.00
% VAT	21.00	0.00	21.00	0.00
% Contingency Security	20.00	0.00	20.00	0.00
Estimated Costs of Implementation Cosultancy		0.00		0.00

Remediation summary

Agent-resource combinations of the accidental	Action type	Amount (€)
Fuels and biodegradable NVOCs in Lutra lutra (Death)	Primary remediation	369,176.68
	Compensatory remediation	40,856.93
	Complementary	0.00
	Subtotal	410,033.61

Agent-resource combinations of the accidental	Action type	Amount (€)
Fuels and biodegradable NVOCs in Other Continental Fishes (Death)	Primary remediation	218,435.41
	Compensatory remediation	29,788.51
	Complementary	0.00
	Subtotal	248,223.92
Road Construction Budget		0.00
Primary remediation total (including road construction)		587,612.09
Compensatory remediation total (without including road construction)		70,645.44
Complementary remediation total (without including road construction)		0.00
Remediation total		658,257.53

Annex IV Netherlands

PART 1 Summary of how the Netherlands method works

Introduction

The model has been developed as a helpful tool for competent authories (provinces) in the Netherlands to help determine the amount of financial security needed to cover the costs of remediation of environmental damage. The legislation containing a competency for the competent authorities (provinces) that allows for including provisions on financial security in the permit for a Seveso company is in preparation.

Assumptions

Based on the advice from the Council for the Environment and Infrastructure, consultations with stakeholders, working sessions with experts and the input of the advisory board group, a number of starting points and design criteria for the model were formulated. For determination of the amount of financial security needed assumptions are made that the company has an up-to-date and valid permit and that the company complies with its environmental obligations.

Furthermore the rationale behind the model is based on effects rather than risks, and the situation of a company closure (bankruptcy) as a consequence of an incident is taken as a starting point. This is because this type of company closure automatically also includes the public costs that can follow from a regular business termination.

Assuming that a company complies with its up-to-date permit, in the case of company closure (bankruptcy) due to an environmental incident, environmental costs arise for disposal of stocks and waste and the remediation of soil, surface and groundwater contamination. Non-environmental costs (eg economic damage) are not part of the model.

*The model**

The model for determining the amount of financial security needed has been systematically elaborated (chapter 4) and tested (chapter 5), using existing instruments as much as possible.
Permit providers can easily fill in the model with information that companies already must present in applying for the permit. The administrative and administrative burdens arising from the application of the model are hence minimal. After completing a limited number of steps, the application of the model results in an amount for the financial guarantee with which any non-recoverable environmental costs can be (largely) in case of company closure.

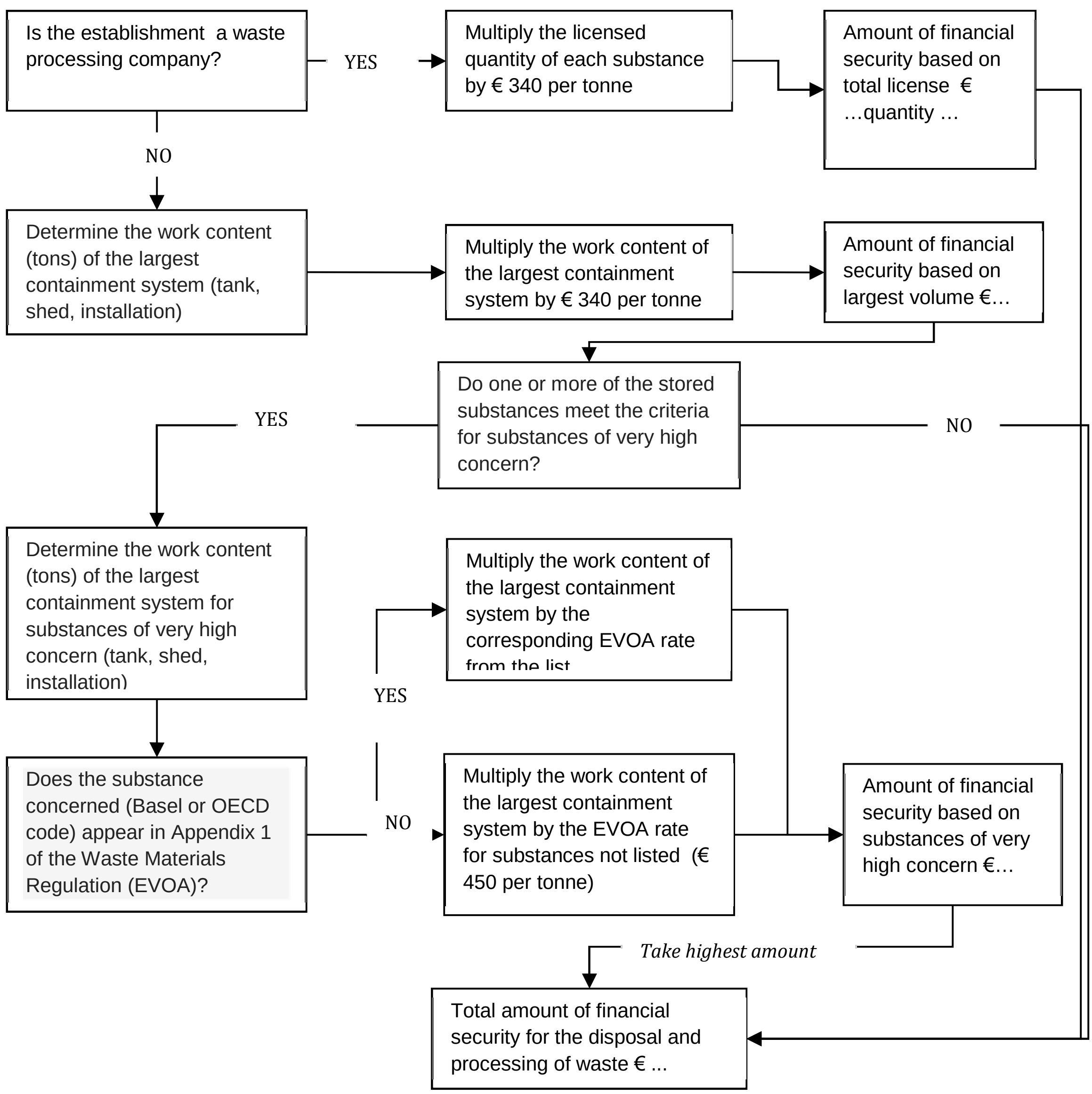
*In the development of the model, certain choices and assumptions were made, so that customization may still be needed. This means that the results of the research can help with one of the criteria (the amount of financial security) that play a role in the application or not of the competency to apply financial security. In addition, the balancing criteria in chapter 7 of the Environmental Decree (*Omgevingsbesluit*) still apply.

Three components determine the extent of the financial security:

1. Cost for removal and processing of waste;
2. Soil and groundwater remediation; and
3. Purification and remediation of surface water.

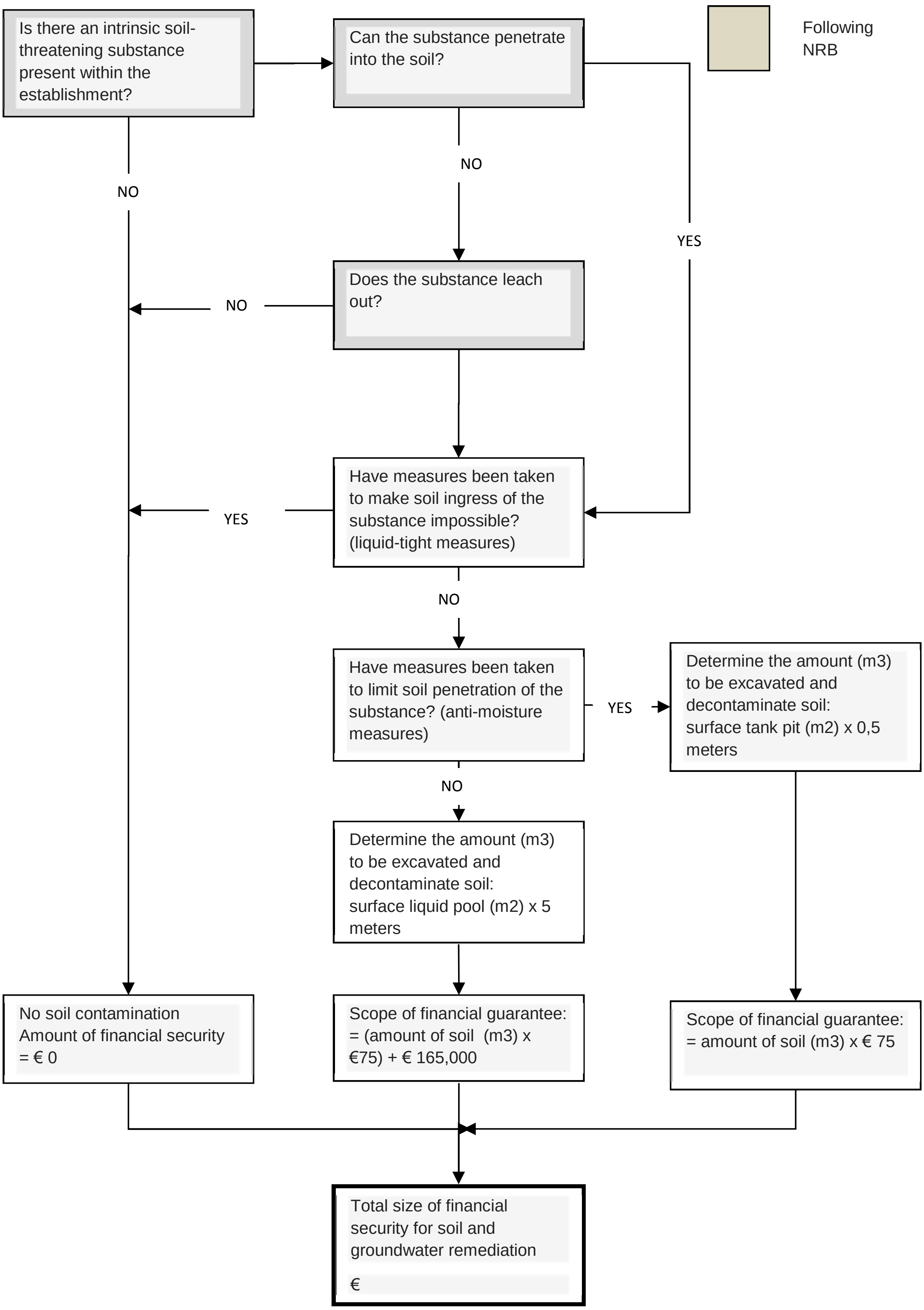
The total size of the financial security is determined by adding up the calculated costs of the three components. Further detail is provided below.

STEP 1: DETERMINE THE COSTS FOR THE REMOVAL AND PROCESSING OF WASTE



1. For waste processing companies, the authorization quantity for each substance is multiplied by a set rate per tonne.
2. For other companies the volume in tonnes of the largest containment system is multiplied by a set rate.
3. Where the substances stored are substances of high concern, the quantity in tonnes of the largest containment system is multiplied by a different rate depending on the classification of the substance.
4. The amount of financial security is the highest of 2 and 3 above.

STEP 2: DETERMINE THE COSTS FOR SOIL AND GROUNDWATER REMEDIATION



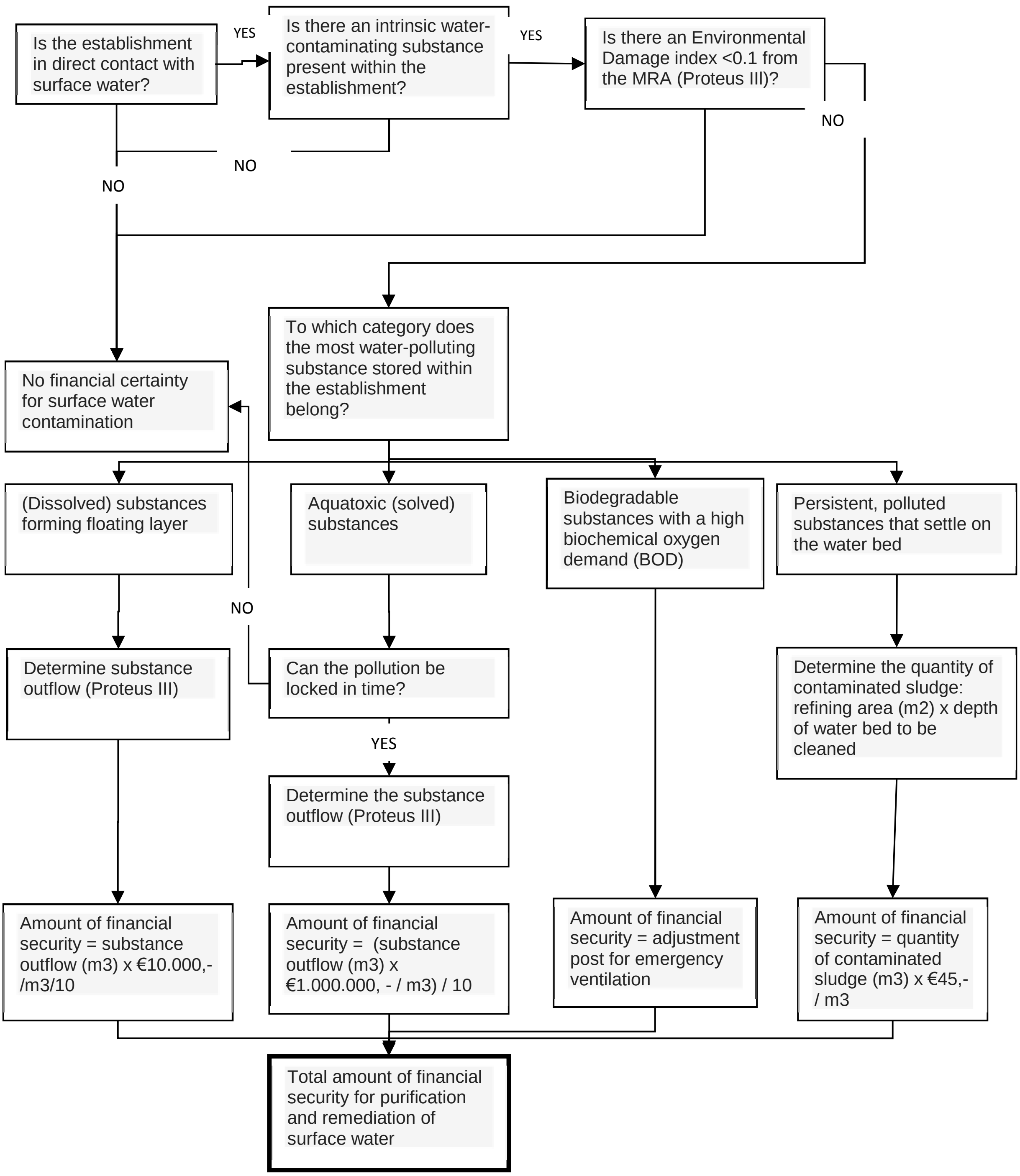
Financial security for soil and groundwater remediation is required for installations having soil threatening substances that have the potential to enter or leach into soil unless pollution prevention measures ensure that a release is impossible.

For other cases, financial security is calculated on the basis of the amount soil to be excavated and decontaminated. The amount of soil to be excavated is - depending on mitigation measures - multiplied by 0.5 meters or 5 meters with the area of the largest collection facility (tank pit).

The amount of financial guarantee for soil remediation is calculated by multiplying the amount of soil to be excavated and remediated by a unit rate per m3.

When there are no mitigating measures, an additional fixed amount is added to take into account groundwater remediation.

STEP 3: DETERMINE THE COSTS FOR THE PURIFICATION AND REMEDIATION OF SURFACE WATER



Financial security is required if the installation is connected to surface water and has water-hazardous substances stored within it.

An environmental damage index is determined using the Proteus III tool. Where this determines there is a risk the quantity/flow of the worst pollutant is calculated (for persistent pollutants that can settle on the bed of a water body an area based calculation is used instead). This amount is multiplied by a fixed unit rate depending on the type of substance.

PART 2 Evaluation

Financiële zekerheidstelling voor milieuschade bij majeure risicobedrijven (Financial security for environmental damage at major risk companies;) Commissioned by – Dutch Ministry of Infrastructure and Water Management https://www.rijksoverheid.nl/binaries/rijksoverheid/documenten/rapporten/2016/11/22/financiele-zekerheidstelling-voor-milieuschade-bij-majeure-risicobedrijven/Financi%C3%ABle+zekerheidstelling+voor+milieuschade+bij+majeure+risicobedrijven.pdf (in Dutch)
Description
– **The Dutch methodology is contained in Chapter 4 of publication, "Financial guarantee for environmental damage at major risk companies" (Berenschot, 2016). Its purpose is to provide a tool for regulators to estimate the amount of financial security needed to cover the taking of remedial measures for incidents and accidents and chemicals/wastes that may be left on site as a result of bankruptcy. The publication is in the Dutch language. A google translate of Chapter 4 is provided at Annex II. The flowcharts were translated by the Dutch Ministry of Infrastructure and Water Management.** **The methodology may be used to estimate the amount of financial provision for primary remedial measures for water (surface and ground), soil and waste. The amount is the combined amount of 3 separate calculations for soil and groundwater, waste and surface water. The surface water**

calculation uses the output of a Dutch Environmental Risk Analysis tool (PROTEUS III[11]) (https://www.helpdeskwater.nl/onderwerpen/applicaties-modellen/applicaties-per/vergunningverlening/vergunningverlening/proteus/). **The approach has been developed to assist, primarily, the regulators who issue permits, in determining the amount of provision for Seveso and IED Annex 1 Section 4 (chemical industry) installations.** **The method is not mandatory but may be incorporated in draft guidance in the future.** **The method would be suitable for production in spreadsheet form.**

Category	Description	Evaluation of Application in Netherlands	Evaluation of Potential Application in Other Jurisdictions
		Economy – reducing the costs of inputs – balance the use of resources to achieve the right goals at a reasonable cost Efficiency – the right effort allocation – wise consumption of inputs on which the work is	

[11] Proteus III is an environmental risk analysis package for impacts on the aquatic environment. An environmental damage index, (MSI) is determined on the basis of substance properties, effect limiting measures and the receiving water system. This effect is expressed in the MSI. Experts state that an MSI <0.1 is acceptable. Proteus III is also used to calculate the worst case scenario quantity of substances released to the surface water environment.

		completed Effectiveness – to achieve the objectives – to deliver on time what was expected	
Inputs – what are the set-up and running costs – financial, time and information requirements? What information needs to be inputted? Site, environmental, cost etc Are there any fixed inputs? Are the inputs readily available for other jurisdictions? What can be tailored?	The methodology, (supported by flowcharts) has been produced by consultants on behalf of the Dutch Ministry of Infrastructure and Water Management . The information to input into the model will often be already provided as part of the Dutch permitting and regulatory process. There are limited input requirements. The method uses a combination of fixed and variable inputs. The variable inputs are as follows: type and environmental behaviour of substance, quantity of substance/discharge, capacity of	Economy – Expected low input cost due to limited input requirements of generally readily available information (from permit application). Cost of Proteus III model (for surface water calculation) not known but companies and regulators have access to this pre-existing tool (model and guide are available at https://www.helpdeskwater.nl/onderwerpen/applicaties-modellen/applicaties-per/vergunningverlening/vergunningverlening/proteus/) . Efficiency - Some research of substance classification (according to REACH) and environmental behaviour of substances is likely to be required. Effectiveness – Overall, straightforward and easily applicable, though inputs must be manually documented and the output of	The inputs for the soil and groundwater and waste calculations should be readily available for other jurisdictions. The calculation of costs for water purification and treatment require a risk score generated by a Proteus III analysis. This software package may not be widely used outside of the Netherlands. It is easy to replace the unit remediation costs with a country specific remediation unit cost.

	largest containment system/pit/bund, presence of soil protection measures, proximity to surface water, Environmental Damage Index (as determined by Proteus III). Fixed inputs (inputs that cannot be changed) include calculations and cost of remedial actions	Proteus III reviewed. The method has been successfully tested by the developers.	
Activities – what does the model do with the information inputs? Can the "black box" be seen/understood/amended? Can the model activities be interrogated and tailored to specific	The method estimates the cost for three components: waste, soil and groundwater, surface water. These are then combined (totalled). There is no digital model or spreadsheet as yet; the calculations must be made and recorded manually.	Economy – As a paper based approach the calculations, whilst quick and simple, will take more time than a spreadsheet. Efficiency – The calculations are simple and step by step and easy to check. Positive efficiency and accuracy gains could be expected if the method was supported by a spreadsheet.	The calculation in the model could be tailored to other requirements for example adding other substances, considering multiple containment units (waste) , inclusion of additional steps, multipliers (soil and groundwater contamination). The method can also be used to

requirements?	The concepts and calculations are simple and readily understandable. The calculations are based on consequence, not probability of occurrence.	Effectiveness - The method is transparent, understandable and logical. It is possible to amend the method which gives flexibility but the potential for inconsistency.	calculate the amount of financial provision required to deal with chemicals and wastes which may be left on site in the case of bankruptcy. For jurisdictions which do not have access to Proteus III, a different risk assessment tool could be used to make a decision about risk to surface water and the quantity of water/stream bed to be treated.
Outputs – what are the outputs generated by the model? Are they relevant to other sectors/regulations/jurisdictions?	The output is a combined cost based on a reasonable scenario. There is no formalised reporting mechanism in place as yet.	Economy - The output is generated as a result of the activity. Efficiency - The output is generated as a result of the activity.	The output will be relevant to other jurisdictions/regulations/sectors. However, because the scope is focussed on primary treatment

Can the scope be extended to other sectors/regulations/jurisdictions. Is the aim and target audience relevant to other jurisdictions? —		Effectiveness – It is expected that the inputs and calculations will be documented and justified as part of the process which will make it possible to peer review. The outputs are reported to meet the regulators needs. Whilst not yet in use, the results have been tested by "officials" and found to be a reasonable estimate of expected costs.	of soils, wastes and waters additional costings would be required for scenarios involving 1. complementary and compensatory remediation; 2. restoration of damaged habitats and species; 3. emissions to air.

PART 3 Case Study

<table>
<tr><th colspan="6">General description of the case</th></tr>
<tr><td colspan="6">Description business activities

Storage terminal where shipping and storage of chemicals takes place

Location

Large industrial area directly adjacent to water

Storage facilities

Substances are stored in vertical cylindrical above-ground tanks (PGS 29)

Threshold value

High threshold value</td></tr>
<tr><th colspan="2">Waste treatment</th><th colspan="2">Soil remediation</th><th colspan="2">Water treatment</th></tr>
<tr><td>Volume largest containment system</td><td>22,393 tonnes</td><td>Intrinsic soil threatening substance Y/N</td><td>Yes</td><td>Location directly near surface waters</td><td>No</td></tr>
<tr><td>Volume</td><td>22,393 tonnes</td><td>Does</td><td>Yes</td><td>Intrinsic water</td><td>Yes</td></tr>
</table>

largest containment system		substance penetrate into the soil Y/N		contaminating substance Y/N	
		Soil protecting measures	Yes	Water protecting measures Y/N	No
		Permeability of the soil Y/N	Yes	Characteristics of the substance	Aquatoxic
		Surface largest reception facility	18.976 m2	Type of surface waters	Not applicable
	€ 11.196.500		€ 711.600		€ 425.000
TOTAL	**€ 12.333.100**				

Annex V Ireland

PART 1 How the Irish methodology works

Ireland has published guidance ('Guidance on assessing and costing environmental liabilities') for costing potential liabilities arising from incidents (i.e. unforeseen liabilities).

The first step is a standard risk assessment (based on International Standards Organisation standards) to identify, analyse and evaluate plausible risks for treatment. The guidance provides non-exhaustive lists of risks that typically arise under the headings: fuel storage; bulk storage and handling (chemicals, solvents, milk, etc.); production; waste management; air abatement; waste water treatment; drainage; landfill; fire; weather; traffic; and legacy. The risks are ranked in priority based on the product of their likelihood and consequence scores. Mitigations are then proposed, risk owners assigned and implementation timeframes specified.

The second step is the identification, quantification and costing of the plausible worst-case scenario. This is the potential event that poses the maximum environmental liability (i.e. highest consequence score from above). The plausible worst-case scenario is described in detail in terms of the following:

- types of materials lost
- quantity of materials lost
- pathways involved
- nature and extent of impact
- control and remediation measures required

The costing must cover the environmental aspects of an event, e.g. stopping it, preventing further emissions/pollution, clean-up of emissions/pollution caused. It does not include other costs that, though associated, are non-environmental, e.g. legal fees/penalties and business interruption.

The Irish paper-based methodology has been available since 2014 on the Irish EPA website. This is currently been considered for production in electronic form.

PART 2 Evaluation

Guidance on assessing and costing of Environmental liabilities (2014) Owner – Irish EPA http://www.epa.ie/enforcement/financialprovisionforenvironmentalliabilities/
Description
The Irish Environmental Protection Agency (EPA) methodology comprises of the following guidance documents: 1. Guidance on assessing and costing of Environmental liabilities (2014) 2. Guidance on Financial Provision for Environmental liabilities (2015) These guidance documents are paper based and include tables for risk classification and templates for risk analysis, risk evaluation, risk matrix, statement of measures and quantification and costing. The overall aim is to assist operators to provide accurate and realistic information and in turn quantify the overall risk. The methodology in the Irish guidance identifies the worst case environmental liability. The amount of financial provision for primary, complementary and compensatory type remedial measures for water, soil and air must be costed. The calculations are based on consequence not the probability of occurrence. Once the liability is quantified, operators must put financial provision in place that meet the core principals of secure, sufficient and available when required. The role of the EPA is an important aspect of this methodology in that it is for the EPA to satisfy itself, in some detail, about the operator's submission prior to acceptance. This requires a level of knowledge and skill on behalf of the regulator. The approach has been developed to assist, primarily, operators, in fulfilling the obligations in their environmental authorisation. This has particular relevance to the following permitted operators, Seveso, Extractive Waste Directive, Landfill, Incinerators, Cement plants, hazardous and non-hazardous waste treatment facilities The Irish EPA website hosts a webinar on assessing and costing environmental liabilities. The method is in English. The development and maintenance costs are borne by the Irish EPA. The EPA is considering automating the guidance into an Environmental Liability Risk Assessment excel database (ELRA) along with a user guide

to assist in the calculation of the amount of financial provision for environmental liabilities for unforeseen liabilities. A case study using an early DRAFT version of the ELRA excel has been populated and is provided in Part 3 of this Annex for illustrative purposes.			
Category	**Description**	**Application in Ireland** Economy – reducing the costs of inputs – balance the use of resources to achieve the right goals at a reasonable cost Efficiency – the right effort allocation – wise consumption of inputs on which the work is completed Effectiveness – to achieve the objectives – to deliver on time what was expected	**Potential application in other jurisdictions**
Inputs – what are the set-up and running costs – financial, time and information requirements? What information needs to be inputted? Site, environmental,	The guidance/methodology have been produced in-house by the Irish EPA and has been available since 2014 The EPA has identified the generic risks per sector.	**Economy** - The modest costs associated with development and maintenance of the guidance are off-set by the benefits to	Availability in other jurisdictions of input information The input information would generally be expected to be

cost etc Are there any fixed inputs? Are the inputs readily available for other jurisdictions? What can be tailored?	Operators, - bear no costs associated with producing the guidance/methodology - will incur costs in obtaining the information to input into the methodology, although this information will often be already provided as part of the regulatory process. The methodology uses a combination of fixed inputs, variable inputs and free text. The variable inputs are as follows: - generic history of the site - Site specific risks -consequence rating (1-5) -Likelihood ranking (1-5) -Mitigation measures and responsible person -Remediation tasks, quantities and costs	the operator. In particular, the tables and templates give clarity to the information and data requirements which should bring time and cost benefits. Efficiency - – The templates improves the efficiency and accuracy of the input process – Identification of standard risks – Allows assessment of mitigation measures in place or required Effectiveness – Flexibility to add other inputs (e.g. other species, remedial techniques, mitigation measures and site specific risks) is permitted when justified. The DRAFT ELRA EXCEL would further streamline the input process by providing an	provided as part of the permitting process. Many of the inputs (e.g. Mitigation measures, costs, quantities) are variable which provides the opportunity to be tailored to be relevant to a wide range of types of activity/operations. Unit cost rates are available on the Irish EPA website. Costs may vary from other jurisdictions. Inputs require detailed check /assessment by knowledgeable regulator.

	-Contingency. Fixed inputs (inputs that cannot be changed) include generic risk assessments and risk scoring	electronic, non paper based system. This would bring further benefits in economy, efficiency and effectiveness.	
Activities – what does the model do with the information inputs? Can the “black box” be seen/understood/amended? Can the model activities be interrogated and tailored to specific requirements?	Operator will complete the site risk assessment identifying the site-specific risks and associated controls that are required to mitigate the impact. The output calculates the primary, complementary and compensatory remediation costs for the highest scored plausible environment consequence scenarios The calculations are based on consequence not the probability of occurrence. The risk assessment requires expert review by the regulator.	Economy - The 2014 methodology has been tested and found to be effective, - As a paper based approach the assessment takes time though this is off-set by the benefits of the operator taking the time to evaluate the risks and consider appropriate mitigations. Efficiency - The tables and templates help to make the assessment more efficient. Effectiveness The activity is transparent, understandable and logical and	The guidance and proposed ELRA excel follows a step by step risk based approach that can be readily populated and relevant to all jurisdictions and operators.

		is documented in the guidance The activity in the DRAFT ELRA excel cannnot be modified providing the further benefit of being tamperproof.	
Outputs – what are the metrics generated by the model? Are they relevant to other sectors/regulations/jurisdictions? Can the scope be extended to other sectors/regulations/jurisdictions. Is the aim and target audience relevant to other jurisdictions?	- Plausible worst case environmental scenario identified - A costed scenario. - Identification of the associated controls / mitigation measures in place - Future controls/ mitigation measures and timelines for implementation documented.	Economy - Deliver the expected economic benefits of the output being identified. - Operator benefits through the identification of the scenario and assessment of controls/ mitigation measures. Efficiency - Specific operator scenarios identified - Identification of areas / mitigation / controls requiring action - Cross reference to	The methodology is in English and will be relevant to other jurisdictions, sectors and legislation that take a consequence based approach to calculating financial security. The output needs to be scrutinised by the regulator prior to agreement.

		similar industries and subsequent controls. Effectiveness - Outputs meet the regulators needs - Transparent account of the risk assessment and costs. - Documentation of mitigation /control measures is an aide to routine regulation and environmental protection. The DRAFT ELRA excel would bring further benefits in economy, efficiency and effectiveness because the output would be produced in a standardised format in the course of the assessment.	

PART 3 CASE STUDY

Operator Name	Dairy Foods Ltd	
Operator location	Baile Beag, Ireland	
Background Data		**Detail**
Site operation	Size and nature of the activity	Milk;-Treatment and Processing with a quantity greater than 200 tonnes per day
	Age of the activity and previous site uses	In operation since 1996, greenfield site previously
	Details of licence / authorisation / permit	IPPC License granted in 1996, P0XXX-03
	Overview of site infrastructure	Milk Pasteurisers, Evaporators, Driers, Clean in Place Chemical Store, Waste water treatment plant, storm drain network, utilites, refrigeration units, potable water supply tank, administration building
	Details on storage and handling of fuel and other materials	One fuel tank (50 m^3), raw milk silos, pasteurised milk silos
	Details on the scale and nature of all environmental emissions	*Information found in Schedule C of License*
	Overview of abatement plant	WWTP, Storm drain network
	Overview of the nature and volumes of waste generated	As reported in the 2017 annual environmental report
Operator Performance	Environmental Management Systems	EMS with full ISO 140001 accreditation. - Last audit June 2017
	Compliance history	No environmental complaints in 2017; one in 2016, none in 2015 all related to odour.
	Enforcement history	Refer to EPA site visit report

Environmental Sensitivity	Incident/accident history	Two significant environmental incidents reported since the license was issued, spillage of milk during delivery and spillage of fuel from storage tank. Refer to the electronic incident report EPAINC xxx1 and EPA INC xxx2
	Details on the underlying geology/ hydrogeology coupled with any historic soil or groundwater monitoring or known contamination	Bedrock geology underlying site is Dinitian Limestone, classified as Regionally Important Aquifier. High groundwater vulnerability
	Proximity to identified surface water bodies, their Water Framework Directive status and identification of scheduled or unscheduled discharges to these water bodies from the facility.	The River Abhainn Is adjacent to the eastern boundry, all licensed surface water discharges discharge to River Abhainn. River discharges to Estuary Mór. Both rivers caterogised as good quality;
	Proximity to sensitive human receptors and potential for nuisance or health impacts to these receptors.	Site is located north of the village Baile Beag, nearest properties located 100 m from site
	Details on the nearest EU or National protected site, natural habitat or protected species and potential pathways for the facility to impact these habitats and species.	The estuary is a proposed National Heritage Area, a Special Prtection Area and a Special Area of Conservation. All are located within 1 km of site.

Generic Risks for All Sectors

Sector	Process	Risk ID	Potential Risk
Generic	1.0 Fuel Storage	1.1	Fuel spillage during tanker unloading/delivery operations
Generic	1.0 Fuel Storage	1.2	Loss from above ground tanks/pipelines, discharge to surface water
Generic	1.0 Fuel Storage	1.3	Loss from above ground tanks/pipelines, groundwater and/or soil contamination
Generic	1.0 Fuel Storage	1.4	Loss from above ground tanks/pipelines, discharge to WWTP
Generic	1.0 Fuel Storage	1.5	Loss from underground tanks, groundwater and/or soil contamination
Generic	1.0 Fuel Storage	1.6	Loss from underground pipelines, groundwater and/or soil contamination
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.1	Spillage during tanker unloading/delivery operations
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.2	Loss from bulk storage tanks, discharge to surface water
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.3	Loss from bulk storage tanks, groundwater and/or soil contamination
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.4	Loss from bulk storage tanks, discharge to WWTP
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.5	Loss from pipelines
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.6	Leak from Intermediate Bulk Containers (IBC)/drums during storage or handling
Generic	2.0 Bulk Storage and Handling (chemicals, solvents, milk, etc.)	2.7	Storage of incompatible chemicals
Generic	3.0 Production	3.1	Process explosion leading to discharges to air, water and/or soil
Generic	3.0 Production	3.2	Other spillages from production
Generic	3.0 Production	3.3	Mixing of incompatible chemicals
Generic	4.0 Weather	4.1	Flooding on the site causing uncontrolled discharge
Generic	4.0 Weather	4.2	Impact to process and abatement of extreme cold temperatures
Generic	4.0 Weather	4.3	Power failure
Generic	5.0 Waste Management Practices	5.1	Errors in waste classification/labeling, particularly hazardous waste classification
Generic	5.0 Waste Management Practices	5.2	Leaching from waste storage, impact on surface water, groundwater and/or soils
Generic	5.0 Waste Management Practices	5.3	Spillages/leaks of waste oil in process areas
Generic	5.0 Waste Management Practices	5.4	Breach of waste bund capacity, impact on surface water, groundwater and/or soils
Generic	5.0 Waste Management Practices	5.5	Non-hazardous waste contaminated with hazardous waste
Generic	6.0 Air Abatement Systems	6.1	Emissions due to poor combustion in incinerator
Generic	6.0 Air Abatement Systems	6.2	Burning of unauthorised material in incinerator.
Generic	6.0 Air Abatement Systems	6.3	Losses from incinerator ash storage and handling
Generic	6.0 Air Abatement Systems	6.4	Failure of abatement, release of unabated emissions to atmosphere
Generic	6.0 Air Abatement Systems	6.5	Thermal Oxidiser bypass and emissions to atmosphere
Generic	6.0 Air Abatement Systems	6.6	Failure of the monitoring/control system on the emission point
Generic	7.0 Drainage Network	7.1	Excessive loss of suspended solids to surface water network
Generic	8.0 Water Treatment Systems	8.1	Losses and overflows from above ground tanks and pipelines
Generic	8.0 Water Treatment Systems	8.2	Losses and overflows from underground tanks and pipelines
Generic	8.0 Water Treatment Systems	8.3	Unscheduled or shock load discharge from production disrupting treatment process
Generic	8.0 Water Treatment Systems	8.4	Non-compliant discharge from treatment plant to municipal sewer
Generic	8.0 Water Treatment Systems	8.5	Non-compliant discharge from treatment plant to surface water
Generic	9.0 Fire	9.1	Fire emissions to air, firewater discharge to sewer, surface water or groundwater
Generic	10.0 Traffic	10.1	Loss to environment due to incidents involving vehicles (forklifts, trucks, etc.)
Generic	11.0 Legacy	11.1	PCB containing equipment, potential for leakage
Generic	11.0 Legacy	11.2	Asbestos containing material

Sector	Process	Risk ID	Potential Risk
Generic	11.0 Legacy	11.3	Historical groundwater or soil contamination
Urban Wastewater Treatment Plants	12.0 Discharge	12.1	Failure of inlet works and overloading to receiving waters
Urban Wastewater Treatment Plants	12.0 Discharge	12.2	Failure of aeration tank and discharge of untreated wastewater
Urban Wastewater Treatment Plants	12.0 Discharge	12.3	Failure of clarifier and discharge of elevated solids to receiving waters
Urban Wastewater Treatment Plants	12.0 Discharge	12.4	Failure of effluent monitoring system and uncontrolled discharge
Urban Wastewater Treatment Plants	12.0 Discharge	12.5	Power failure at the WWTP resulting in prolonged and uncontrolled discharge
Dumping at Sea	13.0 Loading Operation	13.1	Major fuel spillage from vessel
Dumping at Sea	13.0 Loading Operation	13.2	Collision leading to discharge to surface water
Dumping at Sea	13.0 Loading Operation	13.3	Uncontrolled or poorly controlled release during loading or plough dredging – impact on marine environment
Dumping at Sea	13.0 Unloading Operation	13.4	Major fuel spillage from vessel
Dumping at Sea	13.0 Unloading Operation	13.5	Collision leading to discharge to surface water
Dumping at Sea	13.0 Unloading Operation	13.6	Unloading carried out at incorrect location
Dumping at Sea	13.0 Unloading Operation	13.7	Uncontrolled or poorly controlled release during unloading – impact on marine environment
Landfill	14.0 Landfill Operations	14.1	Landfill fire at facility causing the release of fugitive air emissions
Landfill	14.0 Landfill Operations	14.2	Landfill fire at facility causing damage to the liner, impact on groundwater and/or soil
Landfill	14.0 Landfill Operations	14.3	Damage to liner during filling of cells, impact on groundwater and/or soil
Landfill	14.0 Landfill Gas Management	14.4	Escape of landfill gas to the atmosphere, failure of the flare/gas control
Landfill	14.0 Landfill Gas Management	14.5	Landfill gas migration and accumulation in structures on/off site
Landfill	14.0 Leachate Management	14.6	Leachate escaping from unlined cells. Contamination of groundwater/soil/surface water from leachate
Landfill	14.0 Leachate Management	14.7	Leachate tanks and lagoons rupturing and entering surface water and groundwater
Landfill	14.0 Leachate Management	14.8	Overflow of leachate from cells
Landfill	14.0 Leachate Management	14.9	Leachate breakout/leakage due to breach in liner
Landfill	14.0 Leachate Management	14.1	Silt clogging pumps resulting in leachate build up and release
Landfill	14.0 Leachate Management	14.11	Traffic accidents within the site during the tankering of leachate, resulting in loss of leachate to groundwater/soil/surface water
Landfill	14.0 Leachate Management	14.12	Traffic accidents during off-site disposal of leachate, resulting in loss of leachate to groundwater/soil/surface water
Landfill	14.0 Leachate Management	14.13	Failure of pipeline connections, joints, tees, etc. resulting in the release of leachate and groundwater/soil/surface water contamination
Landfill	14.0 Leachate Management	14.14	Leachate being unsuitable for treatment at local WWTP
Landfill	14.0 Landfill Capping	14.15	No capping in place and subsequent impact
Landfill	14.0 Landfill Capping	14.16	Degradation of capping
Landfill	14.0 Landfill Capping	14.17	Breach of capping system
Other	15.0 Other		
Other	15.0 Other	15.1	

Risk Assessment Template

Risk ID	Potential Risks	Environmental Effect	Consequence Rating	Basis of Consequence	Likelihood Rating	Basis of Likelihood	Risk Score (Likelihood x Occurrence)
1.1	Fuel spillage during tanker unloading/delivery operations	Surface water, soil and groundwater contamination	3	Tanker Volume is limited, hazardous and persistant material	3	Delivery is in a contained area. SOP and Supervision of delivery	9
1.2	Loss from above ground tanks/pipelines, discharge to surface water	Soil and groundwater contamination	4	Large volume loss. Hazardous and persistant material. Shallow overburden and underlying aquifier is classified as highly vulnerable limestone.	3	Tank is in a bunded location. Tanks, bunds and pipelines infrequently inspected and tested. Previous incident occurred.	12
2.1	Spillage during tanker unloading/delivery operations	Surface water, soil and groundwater contamination	3	Tanker volume may be high. Potential or fish kill. Non hazardous and not persistant.	4	Delivery is in a contained area. SOP and Supervision of delivery. Previous incident occurred	12
2.2	Loss from bulk storage tanks, discharge to surface water	Contamination of surface water	4	Large volume loss. Potential for fish kill. Non hazardous and not persistant	4	Tanks bunded. Tanks, bunds and pipelines infrequently inspected and tested. Level alarms installed. High number of tanks subject to ongoing use.	16
2.6	Leak from Intermediate Bulk Containers (IBC)/drums during storage or handling	Surface water, soil and groundwater contamination	1	Very low volumes. Hazardous but not persistant	3	Forklift driver trained. Storage in bunded areas. High frequency movements	3
3.2	Other spillages from production	Surface water, soil and groundwater contamination	2	Losses would be low volume. Non hazardous and not persistant.	2	Production area contained and all runoff diverted to WWTP	4
4.1	Flooding on the site causing uncontrolled discharge	Surface water, soil and groundwater contamination	4	Large volume loss. Potential for fish kill. Non hazardous and not persistant	1	Site is located in a very low flood risk area	4
5.2	Leaching from waste storage, impact on surface water, groundwater and/or soils	Surface water, soil and groundwater contamination	2	Losses would be low volume. Non hazardous and not persistent.	2	Stored in a covered area. Integrity tested and inspected regularly. Drainage directed to WWTP	4
5.4	Breach of waste bund capacity, impact on surface water, groundwater and/or soils	Surface water, soil and groundwater contamination	3	High volume losses. Non hazardous and not persistant.	2	Storage capacity caters for typically for 1 year sludge production + 20%	6
6.4	Failure of abatement, release of unabated emissions to atmosphere	Air Pollution	2	Elevated stack providing good dispersion.	5	Failure to maintain consistant compliance with air emission values.	10

Risk ID	Potential Risks	Environmental Effect	Consequence Rating	Basis of Consequence	Likelihood Rating	Basis of Likelihood	Risk Score (Likelihood x Occurrence)
7.1	Excessive loss of suspended solids to surface water network	Contamination of surface water	1	Non hazardous and not persistant. Low volume.	3	Interceptors, silt traps and continuous monitors on emission points.	3
8.1	Losses and overflows from above ground tanks and pipelines	Contamination of surface water	3	Large volume loss. Potential for fish kill. Non hazardous and not persistant	3	Tanks and pipelines regularly inspected and tested. Level alarms installed.	9
8.3	Unscheduled or shock load discharge from production disrupting treatment process	Contamination of surface water	3	Potential for fish kill. Non- hazardosu and not persistant.	2	SOP in production area in relation to preventing shock loads. Monitoring and alarms on WWTP inlet. Spare balancing capacity available.	6
8.4	Non-compliant discharge from treatment plant to municipal sewer	Contamination of surface water	3	Potential for fish kill. Non- hazardosu and not persistant.	3	Good compliance history. Good balancing capacity. Standby pumps etc. Continuous monitoring and alarms at outlet. Highly trained staff.	9
9.1	Fire emissions to air, firewater discharge to sewer, surface water or groundwater	Surface water, soil and groundwater contamination	4	Potential large volume loss. Mixed pollutant content. Fish kills and groundwater contamination	3	Low volumes of combustable materials on site. Extensive fire protection measures. Emergency response team in place. No fire water retention capacity.	12
10.1	Loss to environment due to incidents involving vehicles (forklifts, trucks, etc.)	Surface water, soil and groundwater contamination	3	Tanker volumes may be high. Potential for fish kill and contamination of groundwater	4	High traffic frequency and good signage in place.	12
							0
							0

Statement of Measures

Risk ID	Potential Risk	Risk Score	Mitigation Measures to be taken	Outcome	Action	Completion Date	Contact Person
1.1	Fuel spillage during tanker unloading/delivery operations	9	Install level alarms on all fuel tanks.	Reduced potentaial for spillage during unloading operations	Purchase and install level alarms for all fuel tanks	6 months	Facilities Manager
1.2	Loss from above ground tanks/pipelines, discharge to surface water	12	Increase tank and bund integrity testing to annual frequency. Install level alarms in tanks.	Increased tracking of potential faults in tank/ bund structure	Contract structural engineer to carry out works	Immediate	Facilities Manager
2.1	Spillage during tanker unloading/delivery operations	12	Install remote bund around tanker loading area sized for one full tanker and 25% contingency.	Full containment of tanker spill locally reducing potential environmental impact	Commission engineer to design bund and action contractr to spec project	3 months	Production manager
2.2	Loss from bulk storage tanks, discharge to surface water	16	Increase tank and bund integrity testing to annual frequency.	Increased tracking of potential faults in tank/ bund structure	Contract structural engineer to carry out works	Immediate	Facilities Manager
2.6	Leak from Intermediate Bulk Containers (IBC)/drums during storage or handling	3	Revise driver training and awareness programmes	Reduced frequency and impact of spills	Revise training manual and commence revised training programme	3 months	Environmental Manager
3.2	Other spillages from production	4	Increase spill awareness and management training to be provided to all the staff.	Reduced frequency and impact of spills	Revise training manual and commence revised training programme	3 months	Environmental Manager
4.1	Flooding on the site causing uncontrolled discharge	4	Check OPW data on potential for flooding on site	Increased awareness of response procedures and reduced impact	Carry out flood risk assessment and revise ERP accordingly	3 months	Environmental Manager
5.2	Leaching from waste storage, impact on surface water, groundwater and/or soils	4	Existing controls are adequate. Reguar inspections should be undertaken to assess potential for discharge.	Increased awareness of likelihood of event	Commence weekly inspections to determine frequency and nature of spills.	3 months	Environmental Manager
5.4	Breach of waste bund capacity, impact on surface water, groundwater and/or soils	6	Carry out full review of sludge storage capacity and projected volumes. Calculate worst case capacity requirements and revise storage capacity as required.	Reduced potential for storage exceedance	Commission enginner to review existing storage against projected volumes and advise of options as required	9 months	Facilities manager
6.4	Failure of abatement, release of unabated emissions to atmosphere	10	Investiaget alternative abatement options for the relevant stacks Possible use of back up system such as secondary bag filter	Reduced potential for breaches of ELV	Contact abatement supplier and initiate discussions on alternative/ supplimentary abatement options	6 months	Environmental Manager
7.1	Excessive loss of suspended solids to surface water network	3	Regular inspections should be undertaken to assess potential for discharge.	Increased awareness of likelihood of event	Commence weekly inspections to determine frequency and nature of spills. Site cleaning modified as required.	3 months	Environmental Manager
8.1	Losses and overflows from above ground tanks and pipelines	9	Increased tank and pipeline integrity assessment to biannual frequency. Instal level alarms on all tanks	Increased tracking of potential faults in tank/ bund structure	Contract structural engineer to carry out works	6 months	Facilities Manager

Risk ID	Potential Risk	Risk Score	Mitigation Measures to be taken	Outcome	Action	Completion Date	Contact Person
8.3	Unscheduled or shock load discharge from production disrupting treatment process	6	Investigate potential for increase in existing capacity at inlet	Increased attenuation volume fo high-conc. Or high-volume shock loads.	Commision an engineer to review existng balancing capacity against worst case projected volumes and advise of options as required	9 months	Facilities Manager
8.4	Non-compliant discharge from treatment plant to municipal sewer	9	Install automatic shut off valve on discharge point. Trigger values to be set on continuous monitor to initiate valve	Reduced potential for ELV breach	Purchase and install automatic shut off valve on discharge point	6 months	Facilities Manager
9.1	Fire emissions to air, firewater discharge to sewer, surface water or groundwater	12	Review firewater risk assessment. Calculate the retention volumes required for such an event. Cary out cost benefit analysis installation of retention pond	Increased firewater containment capacity if option is progressed	Commision engineer to review fire water risk assessment include cost benefit analysis	3 months	Environmental Manager
10.1	Loss to environment due to incidents involving vehicles (forklifts, trucks, etc.)	12	Reduce speed limit on site to 15 km/h. Include traffic hazard awareness in environmental training	Improved awareness and reduced potential for traffic hazards	Update training manual. Revise signage across site for speed limit.	3 months	Environmental Manager

Scenario Costing

Types of Materials Lost

Material name	Firewater	Oil
Description	Loss of firewater to ground	Loss of oil from storage tank and IBC's
Hazards (H Statements)		
Quantity lost (m3/ tonnes)	50 tonnes	22.5 m^3
Pathway i.e. ground, groundwater, surfacewater, sewer	Ground	Ground
Nature and extent of impact	Results in contamination of 300 tonnes of soil	Generation of 2,400 tonnes contaminated soil

Risk ID	Potential Risk	Consequence Rating	Likelihood Rating	Risk Score
1.2	Loss from above ground tanks/pipelines, discharge to surface water	4	3	12
2.2	Loss from bulk storage tanks, discharge to surface water	4	4	16
4.1	Flooding on the site causing uncontrolled discharge	4	1	4
9.1	Fire emissions to air, firewater discharge to sewer, surface water or groundwater	4	3	12

Costing

Task	Description	Quantity (No)	Measurement Unit	Unit Rate (€)	Cost (€)	Source of Unit Rates
Risk 9.1: Fire in Production Area	Fire fighting	2	Day	20,000	40,000	EPA
	Excavation and construction of temporary fire water contaminant	1	unit	10,000	10,000	EPA
	Transport of firewater	400	Tonne	50	20,000	EPA
	Disposal gate fee for fire water	400	Tonne	25	10,000	EPA
	Excavation of contaminated soil (non-hazardous)	200	m^3	10	2,000	EPA
	Transport of contaminated soil (non-hazardous)	300	Tonne	30	9,000	EPA
	Disposal gate fee for contaminted soil (non-hazardous)	300	Tonne	50	15,000	EPA
	Consultancy costs	20	Day	600	12,000	EPA
	Importation of topsoil	80	Tonne	11	880	EPA
	Landscaping	2	Day	500	1,000	EPA
	Decontamination fo the building	30	Day	1,750	52,500	EPA
	Transport of decontamination wastes	200	Tonne	30	6,000	EPA
	Disposal gate fee of decontaminted waste	200	Tonne	50	10,000	EPA
	Surface water monitoring	40	Sample	130	5,200	EPA
	Groundwater monitoring	200	Sample	150	30,000	EPA
	Air monitoring	20	Sample	200	4,000	EPA
	Ecological monitoring	12	Sample	1,000	12,000	EPA
	Waste monitoring	40	Sample	200	8,000	EPA
Risk 1.2 Loss to ground from above ground fuel tanks, Risk 2.6: Loss from IBC/	Trial pits	20	Pit	100	2,000	EPA
	Boreholes	10	Well	1,700	17,000	EPA
	Soil monitoring	30	Sample	130	3,900	EPA

	drums during handling	Excavation of contaminated soil (hazardous)	400	m3	10	4,000	EPA
		Excavation of contaminated soil (non-hazardous)	1,600	m3	10	16,000	EPA
		Installation of lined holding area	1	unit	26,000	26,000	EPA
		Transport of contaminated soil (hazardous)	600	Tonne	70	42,000	EPA
		Transport of contaminated soil (non-hazardous)	2,400	Tonne	30	72,000	EPA
		Disposal gate fee for contaminted soil (hazardous)	600	Tonne	150	90,000	EPA
		Disposal gate fee for contaminted soil (non hazardous)	2,400	Tonne	50	120,000	EPA
		Installation and operation of pump and treat	1	Year	200,000	200,000	EPA
		Consultancy costs	40	Day	600	24,000	EPA
		Temporary replacement water supply	1	unit	200,000	200,000	EPA
		Importation of topsoil	140	Tonne	11	1,540	EPA
		Landcaping	5	Day	500	2,500	EPA
		Site management	6	months	25,000	25,000	EPA
		Utilities (esb etc)	6	months	1,000	6,000	EPA
		Security	6	months	1,000	6,000	EPA
Total (€)						**1,105,520**	
Contingency (€)			**40%**			**442,208**	
Total Including Contingency (€)						**1,547,728**	

Risk Scoring

Consequence Risk Table

Rating	Category	Description
1	Trivial	No damage or negligible change to the environment.
2	Minor	Minor impact/localised or nuisance
3	Moderate	Moderate impact to environment
4	Major	Severe impact to local environment
5	Massive	Massive impact to a large area, irreversible in medium term

Likelihood Risk Table

Rating	Category	Description
1	Very Low	Very low chance of hazard occurring
2	Low	Low chance of hazard occurring
3	Medium	Medium chance of hazard occurring
4	High	High chance of hazard occurring
5	Very High	Very high chance of hazard occurring

Glossary

GLOSSARY

The IMPEL project uses the following terms as defined:

'Financial provision' is the establishment of a secure source of funding for responsibilities or liabilities under environmental law or an environmental permit, licence or other authorisation. The terms **'financial security'** and **'financial guarantee'** are also used.

'Unforeseen liabilities' are potential environmental liabilities arising from incidents/accidents.

Acronyms

ACRONYMS

BOD	Biochemical Oxygen Demand
BRIG	Better Regulation Interest Group
BRZO	Seveso company
CLP	Classification, Labelling and Packaging Regulation
ELD	Environmental Liability Directive
EMAS	EU Eco-management and audit system Regulation (EC) No 1221/2009
EPA	Environment Protection Agency
EPA Network	European Environment Protection Agencies Network
EU	European Union
EVOA	EC Regulation on Shipment of Waste
FP	Financial Provision
IED	Industrial Emissions Directive
IMPEL	European Union Network for the Implementation and Enforcement of Environmental Law
MS	Member State
NRB	Dutch Soil Protection Directive
SEPA	Scottish Environment Protection Agency
ZZS	Substances of very high concern