Inspection guidance book for Landfill inspection

*A practical book with guidance on activities on landfills* (2012)
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 Bruxelles, 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 6th 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 report:
Inspection Guidance book for landfill inspections

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### Executive summary:
During 2011 and 2012 we have been working on the project Reinforcement program on inspections skills according to the landfill directive.


Improving implementation of EU law is a high priority objective of both the European Commission and IMPEL. Recent reports on implementation of EU waste legislation have shown that “implementation and enforcement of EU waste law remain poor particularly regarding the waste framework directive, the landfill directive and the waste shipment regulation”.
The project Landfill inspection started in 2011. The objectives of the project:
- identification of good inspection practices, developing guidance;
- improve cooperation between IMPEL member countries to work towards a consistent regulatory and enforcement regime;
- to give feedback to policy makers on (effectiveness) of the various approaches and practices in the field of permitting and inspection of landfill sites in the IMPEL member countries.

In 2011 an information exchange forum was organised in base camp and a workshop was organised in Sardinia (Italy). The aim of the project in 2012 has been to improve inspections skills for landfills by:
- Two joint inspections in Slovenia and Romania. Guidance and inspection tools that are available from the different EU member states have been used and checklists to be used during the inspections were developed. During a workshop in October 2012 the joint inspections were evaluated and the practicability of guidance’s and tools used was discussed.

As an inspection at a landfill has to cover different subjects, the inspection team decided to choose certain subjects to focus on during the joint inspections. The results of the 2011 workshop and the information exchange forum showed that the activities, on which the project will focus, to begin with, are:
1. Criteria and procedures for the acceptance of waste.
2. Gas control.
3. Protection of soil and water (underground water).
4. Water control and leachate management.

A separate report gives an overview from all activities according to this project.

Disclaimer:
This report is the result of a project within the IMPEL network. The content does not necessarily represent the view of national administrations or the European Commission.
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1. Introduction

1.1 Purpose and context

Landfill directive

Project background
Improving implementation of EU law is a high priority objective of both the European Commission and IMPEL. Recent reports on implementation of EU waste legislation have shown that “implementation and enforcement of EU waste law remain poor particularly regarding the waste framework directive, the landfill directive and the waste shipment regulation”.

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(2) Gas control.
(3) Protection of soil and water (underground water).
(4) Water control and leachate management.

1.2. Structure of the Guidance Book
In this guidance for each specific subject at a landfill a short description is given, including the requirements in the Landfill Directive regarding this activity.

Secondly reference is given to (know) existing guidance and tools in EU member states.
2. Landfills

2.1 Landfill Directive

Council Directive 99/31/EC of 26 April 1999 on the landfill of waste came into force on 16 July 1999. The deadline for implementation of the legislation in the Member States was 16 July 2001. All new and existing landfills had to fully comply with the requirements of Directive 1999/31/EC on the landfill of waste (Landfill Directive) at the latest by 16 July 2009 or as indicated in the accession treaties (for new member states). Detailed description on acceptance criteria and the acceptance process have been set by Council Decision 2003/33/EC. This decision entered into force on 16 July 2004 and the limit values had to be applied in the Member States at the latest by 16 July 2005.

The Directive 1999/31/EC on the landfill of waste and the Decision 2003/33/EC on acceptance criteria set standards for the authorisation, design, operation, closure and aftercare operations at landfills. The objective of the directive is to prevent or reduce as far as possible negative effects on the environment from the landfilling of waste, by introducing stringent technical requirements for waste and landfills. The directive is intended to prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health. It defines the different categories of waste (municipal waste, hazardous waste, non-hazardous waste and inert waste) and applies to all landfills, defined as waste disposal sites for the deposit of waste onto or into land.

Landfills are distinguished into three classes:

- landfills for hazardous waste;
- landfills for non-hazardous waste (these landfills may be used for (i) municipal waste (ii) non-hazardous waste of any origin, which fulfill the criteria for the acceptance of waste at landfill for non-hazardous waste set out in accordance with annex II (and Council decision 2002/33/EC) iii) stable, non-reactive hazardous waste (e.g. solidified, vitrified) with leaching behaviour equivalent to those of the non-hazardous waste referred to in point (ii) which fulfill the relevant acceptance criteria set out in accordance with Annex II (and Council decision 2002/33/EC). These hazardous waste shall not be deposited in cells destined for biodegradable non-hazardous waste);
- landfills for inert waste (waste that does not undergo any significant physical, chemical or biological transformations).

The Landfill Directives excludes the following activities:

- the spreading of sludge's, including sewage sludge's and sludge's resulting from dredging operations and similar matter on soil for the purposes of fertilisation or improvement;
- the use of inert waste which is suitable in redevelopment/ restoration and filling-in work, or for construction purposes in landfills;
- the deposit of non-hazardous dredging sludge's alongside small waterways from where they have been dredged and of non-hazardous sludge's in surface water including the bed and its sub soil;
- the deposit of unpolluted soil or non-hazardous inert waste resulting from prospecting and extraction, treatment and storage of mineral resources as well as from the operation of quarries.

The following types of wastes may not be accepted at a landfill:

- liquid waste;
- flammable waste;
- explosive or oxidising waste;
- hospital and other clinical waste which is infectious;
- used tyres, with certain exceptions;
- any other type of waste which does not meet the acceptance criteria laid down in Annex II of the directive.

The Directive sets up a system of operating permits for landfill sites. Applications for permits must contain the following information:

- the identity of the applicant and, in some cases, of the operator;
- a description of the types and total quantity of waste to be deposited;
- the capacity of the disposal site;
- a description of the site;
- the proposed methods for pollution prevention and abatement;
- the proposed operation, monitoring and control plan;
- the plan for closure and aftercare procedures;
- the applicant's financial security;

Member States must ensure that existing landfill sites may not continue to operate unless they comply with the provisions of the Directive as soon as possible.


2.2 Industrial Emission Directive

Landfills that fall within the scope of Industrial Emission Directive are the following categories of activities in annex 1:

- **5.4** Landfills as defined in Article 2(g) of Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste, receiving more than 10 tonnes of waste per day or with a total capacity exceeding 25 000 tonnes, excluding landfills of inert waste;
- **5.6** Underground storage of hazardous waste with a total capacity exceeding 50 tonnes.

For these landfills both the Landfill Directive and the Industrial Emissions Directive have to be taken into account. This means the following additional requirements for these landfills:

- **Updating of permit conditions**: Article 21 of the Industrial Emission Directive requires competent authorities to periodically reconsider permit conditions and where necessary to ensure compliance with the Directive to update those conditions. New is that within 4 years after publication of decisions on BAT conclusions the competent authority shall ensure that (a) all the permit conditions for the installation concerned are reconsidered and if necessary updated to ensure compliance with the Directive (in particular Article 15(3) and (4) where applicable) (b) the installation complies with those permit conditions. When an installation is not covered by any of the BAT conclusions the permit conditions shall be reconsidered and if necessary updated where developments in the best available techniques allow for significant reduction of emissions. For landfills no BAT conclusions have been developed. (BAT are the conditions of the Landfill directive).

- **Applications for permits**: Article 12 of the Industrial Emission Directive specifies information that must be included in the application for a permit. Much, but not all, of this information is also required under the Landfill Directive (Art. 7). On the other hand, some requirements are specific to the Landfill Directive (see Article 7(i)). It should be noted that the IED requires information on the sources of emissions from the installation as well as the nature and quantities of foreseeable emissions into each medium and identification of significant effects on the environment. An application for an landfill has to comply with both the provisions of Article 12 of the Industrial Emission Directive and Article 7 of the Landfill Directive.

- **Access to information and public participation in the permit procedure**: Article 24 of the Industrial Emissions Directive requires that permit applications for new or substantially changed installations are made available to the public. The public is given the right to comment on them before the competent authority reaches its decision. The decision, a copy of the permit, permit updates and the results of release monitoring must be made available to the public. No corresponding provision exists in the Landfill Directive. Any landfill also covered by the Industrial Emission Directive must be made subject to public participation and information as outlined above.

- **Environmental inspections**: Article 23 of the Industrial Emission Directive requires that member states shall ensure that all installations are covered by an environmental inspection plan at national, regional or local level and shall ensure that this plan is regularly reviewed and where appropriate updated. The period between two site visits shall be based on a systematic appraisal of the environmental risks of the installations concerned and shall not exceed 1 year for the installations posing the highest risk and 3
years for installations posing the lowest risks. Following each visit the competent authority shall prepare a report describing the relevant findings regarding compliance of the installation with the permit conditions and conclusions on whether any further action is necessary. The report shall be notified to the operator concerned within 2 months of the site visit taking place. The report shall be made publicly available by the competent authority in accordance with Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information within 4 months of the site visit taking place.

More information on the Industrial emission directive is available on the website: [The Industrial Emissions Directive - Environment - European Commission](#).


**Directive 2008/98/EC** sets the basic concepts and definitions related to waste management, such as definitions of waste, recycling, recovery. It explains when waste ceases to be waste and becomes a secondary raw material (so called end-of-waste criteria), and how to distinguish between waste and by-products. The Directive lays down some basic waste management principles: it requires that waste be managed without endangering human health and harming the environment, and in particular without risk to water, air, soil, plants or animals, without causing a nuisance through noise or odours, and without adversely affecting the countryside or places of special interest.

3. Major activities

3.1 General description

On the following website an interactive picture and a description of the main activities is given Landfilling —.A.S.A..

Available guidance for overall inspection at a Landfill

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARPA Sardegna</td>
<td>Checklist for inspections at landfills for non-hazardous waste (check-liste per la visita ispettiva in impianti di discarica (in Italian))</td>
<td>Basecamp</td>
</tr>
<tr>
<td>ARPA Lombardia</td>
<td>Verifica di conformità progettuale e autorizzativa per l’avvio delle operazioni di smaltimento e per la chiusura delle discariche (Italian)</td>
<td>Basecamp</td>
</tr>
</tbody>
</table>

3.2 Waste acceptance criteria for landfills

Description of activity
In the process of the acceptance of waste at a landfill a difference can be made between the pre-acceptance and acceptance procedure. Waste treatment sites require information and/or samples to be provided prior to the transport of waste to the site, to enable them to ensure that the waste is within the requirements of the site licence. Pre-acceptance includes (mostly) taking a sample, filling out an identification form, carrying out the analysis and then assessing whether the waste can be accepted at the installation.

This procedure is split into a basic characterization (performed by the producer of the waste) and in a following compliance testing (usually performed by the operator) aiming to determine if the waste complies with the results of the basic characterisation and the relevant acceptance criteria. The analysis of a sample is required for each batch of incoming waste, in case these wastes are not regularly generated in the same process in the same installation and are not part of a well-characterised waste stream. Particular attention has to be paid to mirror code waste, as the analysis has to determine whether the waste is hazardous or not and the relevant hazard properties as well. Relevant information may be found on: Waste Framework Directive - Environment - European Commission

When the waste is accepted at the landfill a unique code is assigned to the waste stream. Each delivery has a unique code. Upon delivery the waste is depending on the kind of waste tested. When waste is accepted the facility signs a declaration and sends a copy of this to the waste producer.

The last activity performed by the operator is the on-site verification: each load of waste delivered to a landfill is visually inspected before and after unloading and the required documentation is checked.
**Sampling of waste**

The more heterogeneous the content of a waste is, the more samples must be taken to ensure that the sample is representing this waste. The size of the particles in the waste and the size of the waste population also affect how many samples must be taken. Many more factors also play an important role in the way a waste should be sampled to give an correct answer to how high the content of pollutants are.

Analytical results not based on a sampling plan cannot be considered reliable representing this waste.

A European Standard has been developed for the purpose of characterization of waste: EN 14899:2005 (approved by CEN 28 October 2005). This European Standard specifies the procedural steps to be taken in the preparation and application of a sampling plan. The sampling plan describes the method of collection of the laboratory sample necessary for meeting the objective of the testing programme. The principles or basic rules outlined in this European Standard provide a framework that can be used by the project manager to:

- produce standardised sampling plans for use in regular or routine circumstances (elaboration of daughter/derived standards dedicated to well defined sampling scenarios);
- incorporate the specific sampling requirements of European and national legislation;
- design and develop a sampling plan for use on a case by case basis.

There may be a need for more than one sampling plan to meet all the requirements of the testing programme. Ultimately the sampling plan provides the sampler with detailed instructions on how sampling should be carried out.

By making a sampling plan the person responsible for sampling has to think through and analyze the sampling problem, which leads to better results and to reduce the probability of incorrect sampling. The sampling plan determines how waste samples should be taken in the waste, to get a representative sample and also to determine the type of test (or total content leaching test) that should be performed. With repeated testing a sampling plan ensures that the sampling will be performed the same way every time. The sampling plan is a valuable system for quality control. If you have not taken out a representative sample, the analysis itself has limited or no value, at worst, the result is directly misleading.

To develop a sampling plan is a process that is carried out in several steps with repeated contacts between stakeholders until a desired level of detail is achieved. A draft of the sampling plan is reviewed by stakeholders so that unrealistic objectives, inaccuracies, etc. can be corrected. A basic principle is that a sampling plan is made specifically for a particular sampling problem, not generally for a particular type of waste.

Important tasks to be defined in a sampling plan can for instance be as follows:

- the purpose of the test
- the target population and sub-populations to be sampled to achieve the purpose
- the extent of characterization used
- wanted guaranty for the selected sampling strategy
Conditions in landfill directive

For landfills detailed rules about standardisation of control, sampling and analysis methods are defined in the Council decision establishing criteria and procedures for the acceptance of waste at landfills pursuant to Article 16 of and Annex II to Directive 1999/31/EC (2003/33/EC). The objective is that landfills only accept waste that is compatible with the protection level required by each landfill class. Member states have implemented these conditions in their national legislation.

Section I of the Annex lays down the procedure to determine the acceptability of waste at landfills.

It contains the following subsections:
1.1.1 Functions of basic characterisation
1.1.2 Fundamental requirements for basic characterisation of waste
1.1.3 Testing
1.1.4 Cases where testing is not required
1.2 Compliance testing
1.3 On site verification

Section II of the Annex lays down the acceptance criteria for each landfill class. Waste may be accepted at a landfill only if it fulfils the acceptance criteria of the relevant landfill class as laid down in section 2 of the Annex.

It contains the following subsections:
2.1 Criteria for landfills of inert waste
   2.1.1 List of wastes acceptable at landfills for inert waste without testing
   2.1.2 Limit values for waste acceptable at landfills for inert waste
       2.1.2.1 Leaching limit values
       2.1.2.2 Limit values for total content of organic parameters
2.2 Criteria for landfills for non-hazardous waste
   2.2.1 Waste acceptable at landfills for non-hazardous waste without testing
   2.2.2 Limit values for non-hazardous waste
   2.2.3 Gypsum waste
2.3 Criteria for hazardous waste acceptable at landfills for non-hazardous waste
   2.3.1 Leaching limit values
   2.3.2 Other criteria
2.3.3 Asbestos waste

2.4 Criteria for waste acceptable at landfills for hazardous waste

2.4.1 Leaching limit values
2.4.2 Other criteria
2.5 Criteria for underground storage

Section III of the Annex list the methods to be used for the sampling and testing of waste.

3. Sampling and test methods

Available guidance/ checklist in English

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
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<tbody>
<tr>
<td>Environmental Agency (UK)</td>
<td>Waste acceptance at landfills 2012</td>
<td>Environment Agency - Landfill guidance</td>
</tr>
<tr>
<td>Sweden</td>
<td>NT Envir004 Nordtest method</td>
<td>base camp</td>
</tr>
<tr>
<td>CEN</td>
<td>EN 14899:2005</td>
<td></td>
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</tbody>
</table>

Checklist Impel project landfill for inspection
For this project we have developed a checklist that has been used during the inspections in Romania and Slovenia. By following the steps in the checklist we received a good view on the way the landfill in each member state accepted the waste. Also the differences of the activity between member states becomes clearer.

In Slovenia we selected one waste stream being (EWC)10.01.01 fly ash of combustion plant for coal (Energy plants). In Romania we selected a waste stream 04.01.08 waste tanned leather. Using the checklist for these selected waste streams all the necessary information was collected to check whether the landfill operator accepts waste according to national legislation (which is an implementation of the Landfill directive).
3.3 Gas control

Photo 2: Torch for landfill gas at Landfill in Slovenia and Romania

**Description of activity**

The treatment and disposal of municipal, industrial and other waste produces significant amounts of methane (CH₄). In addition to CH₄, solid waste disposal sites also produce biogenic carbon dioxide (CO₂) and non-methane volatile organic compounds (NMVOCs) as well as smaller amounts of nitrous oxide (N₂O), nitrogen oxide (NOx) and carbon monoxide (CO). The degradable organic component in waste decays slowly throughout a few decades, during which CH₄ and CO₂ are formed. If conditions are constant the rate of CH₄ production depends solely on the amount of carbon remaining in the waste. As a result emissions of CH₄ from deposited waste are highest in the first few years after deposition, then gradually decline as the degradable carbon in the waste is consumed by the bacteria responsible for the decay.

Design of a Landfill gas winning and flare gas and/or treatment installation.

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¹ 2006 IPPC Guidelines for National Greenhouse Gas Inventories
Clarification of numbers in figure:

1. pipes
2. sources of landfill gas
3. extract installation
4. flare
5. installation for the use of landfill gas

Depending on the quality of the landfill gas it can be used to produce energy or must be flared. Energy can be produced by feeding a gas motor, a furnace or a boiler. Landfill gas also can be cleaned to full fill the quality requirements of natural gas. Landfill gas that can not be used must be flared.

Landfill gas use depends on the minimal quality requirements and flow to guarantee stable performance to keep the system at stable conditions. The process control has to be adjusted periodically. Sources (wells) with a low concentration of methane or high oxygen concentration will have to be closed more and sources (wells) with high methane concentration have to open more. The possibility to open and close underlines the necessity of control valves in the system with which the sources (wells) can be controlled individual. The following control methods can be performed:

- continuous measurement of the amount of landfill gas that is extracted;
- continuous measurement of the oxygen concentration in the gas with an alarm detecting system;
- periodical measurement of the concentration of methane and CO in the landfill gas;
- periodical measurement of the under pressure and of the concentration of methane, oxygen and CO₂ in the sources (wells);
- periodic inspections of the waste that is land filled on indications of gas leaking, as for example cracks in the slope, odour and vegetation damage².
- periodic estimation of pumping system efficiency, by means of periodical measurement of the quality of the air surrounding the landfill and of the monitoring of surface gas emission.

Conditions in landfill directive

In the landfill directive the following articles and annexes contain conditions on gas control in a landfill.

Article 8: requirements of annex should be conditions in the permit.

For gas control these are the conditions in Annex I: section 4: Gas control.

4.1 Appropriate measures shall be taken in order to control the accumulation and migration of landfill gas (Annex III).

In annex III: section 3, third paragraph, gas monitoring must be representative for each section of the landfill. The frequency of sampling and analysis is listed in the following table.

The frequency of sampling could be adapted on the basis of the morphology of the landfill.

Landfill waste (in tumulus, buried etc). This has to be specified in the permit:

2.4 Potential gas emissions and atmospheric pressure (CH$_4$, CO$_2$, O$_2$, H$_2$S, H$_2$ etc) (these measurements are related mainly to the content of the organic material in the waste).
During the operating phase **monthly** (CH$_4$, O$_2$, regularly, other gases as required, according to the composition of the waste deposited, with a view to reflecting its leaching properties). After-care phase every **six months**.

4.2 Landfill gas shall be collected from all landfills receiving biodegradable waste and the landfill gas must be treated and used. If the gas collected can not be used to produce energy, it must be flared.

The collection, treatment and use of landfill gas under paragraph 4.2 shall be carried on in a manner which minimises damage to or deterioration of the environment and risk to human health.

**Available guidance/ checklists in English**

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Guidance on monitoring trace components in landfill gas</td>
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<tr>
<td></td>
<td>Guidance for monitoring enclosed landfill gas flares</td>
<td></td>
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<td></td>
<td>Guidance on gas treatment technologies for landfill gas engines</td>
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<td></td>
<td>Guidance on monitoring landfill gas surface emissions</td>
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<td></td>
<td>Guidance for monitoring landfill gas engine emissions</td>
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<tr>
<td></td>
<td>Guidance on landfill gas flaring</td>
<td></td>
</tr>
<tr>
<td>NL Agency (Ministry of Economic Affairs, basecamp</td>
<td>Handreiking methaanreductie bij stortplaatsen</td>
<td>basecamp</td>
</tr>
</tbody>
</table>
IMPEL Landfill project checklist
For this project we have developed a checklist (see Annex 2) that can be used during an inspection on a landfill site when focussing on this activity. Parts of the checklist were used during the inspections in Romania and in Slovenia.

3.4 Protection of soil and groundwater

Description of activity

The trigger level is the threshold below which remedial action must be taken to restore the previous situation. For each parameter to be analyzed, the trigger level must be identified depending on the depth to groundwater, the site-specific hydro geological formations and groundwater quality. This information, especially in relation to groundwater quality must be obtained by conducting a campaign of at least annual monitoring of groundwater, in order to establish reference values to perform future inspections. This monitoring campaign should be conducted prior to the construction of the landfill, in order to exclude any interaction of the system with the quality of groundwater which you want to determine the characteristics.

In the case where the trigger level should be identified while the landfill is already in operation, or when no data is available about the characteristics of the groundwater prior to landfill operation which would constitute the so-called "level of natural white", it is necessary to drill wells upstream at a sufficient distance from the site to exclude direct influences, in order to achieve representative data of local groundwater characteristics.

In case of reaching the trigger level(s) actions foreseen in an emergency plan have to be applied as a process occurs that can lead to an environmental pollution.

Photo 3: monitoring of groundwater on landfill
### Conditions in Landfill Directive

#### Annex I

3. Protection of soil and water

3.1 A landfill must be situated and designed so as to meet the necessary conditions for preventing pollution of the soil, groundwater or surface water and ensuring efficient collection of leachate as and when required according to section 2. Protection of soil, groundwater and surface water is to be achieved by the combination of a geological barrier and a bottom liner during the operational/active phase and by the combination of a geological barrier and a top liner during the passive phase/post closure.

3.2 The geological barrier is determined by geological and hydro geological conditions below and in the vicinity of a landfill site providing sufficient attenuation capacity to prevent a potential risk to soil and groundwater.

The landfill base and sides shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to the one resulting from the following requirements:

- landfills for hazardous waste: \( K \leq 1.0 \times 10^{-9} \text{ m/s}; \text{ thickness } > 5 \text{ m} \)
- landfills for non-hazardous waste: \( K \leq 1.0 \times 10^{-9} \text{ m/s} >; \text{ thickness } = 1 \text{ m} \)
- landfills for inert waste \( K \leq 1.0 \times 10^{-7} \text{ m/s}; \text{ thickness } \geq 1 \text{ m} \)

\( m/s = \text{ meter/second} \)

Where the geological barrier does not naturally meet the above conditions it can be completed artificially and reinforced by other means giving equivalent protection. An artificially established geological barrier should be no less than 0.5 metres thick.

3.3 In addition to the geological barrier described above a leachate collection and sealing system must be added in accordance with the following principles so as to ensure that leachate accumulation at the base of the landfill is kept to a minimum:

**Leachate collection and bottom sealing**

<table>
<thead>
<tr>
<th>Landfill category</th>
<th>non hazardous</th>
<th>hazardous</th>
</tr>
</thead>
<tbody>
<tr>
<td>artificial sealing liner</td>
<td>required</td>
<td>required</td>
</tr>
<tr>
<td>drainage layer</td>
<td>required</td>
<td>required</td>
</tr>
</tbody>
</table>

Member states may set general or specific requirements for inert waste landfills and for the characteristics of the abovementioned technical means.

If the competent authority after a consideration of the potential hazards to the environment finds that the prevention of leachate formation is necessary, a surface sealing may be prescribed. Recommendations for the surface sealing are as follows:

<table>
<thead>
<tr>
<th>Landfill category</th>
<th>non hazardous</th>
<th>hazardous</th>
</tr>
</thead>
<tbody>
<tr>
<td>gas drainage layer</td>
<td>required</td>
<td>not required</td>
</tr>
<tr>
<td>artificial sealing liner</td>
<td>not required</td>
<td>required</td>
</tr>
<tr>
<td>impermeable mineral layer</td>
<td>required</td>
<td>required</td>
</tr>
<tr>
<td>drainage layer &gt; 0.5 M</td>
<td>required</td>
<td>required</td>
</tr>
<tr>
<td>top soil cover &gt; 1 M</td>
<td>required</td>
<td>required</td>
</tr>
</tbody>
</table>

3.4 If on basis of an assessment of environmental risks taking into account in particular Directive 80/86/EEC (until 22 December 2013 then replaced by Directive 2006/118/EC) the competent authority has decided in accordance with section 2 that collection and treatment of leachate is not necessary or it has been established that the landfill posed no potential hazard to soil, groundwater or surface water the requirements in paragraphs 3.2 and 3.3 above may be reduced accordingly. In the case of landfills for inert waste these requirements may be adapted by national legislation.
3.5 The method to be used for the determination of the permeability coefficient for landfills in the field and for the whole extension of the site is to be developed and approved by the Committee set up under Article 17 of this directive.

**Protection of groundwater**

A. Sampling
The measurements must be such as to provide information on groundwater likely to be affected by the discharging of waste, with at least one measuring point in the groundwater inflow region and two in the outflow region. This number can be increased on the basis of a specific hydro geological survey and the need for an early identification of accidental leachate release in the groundwater.

Sampling must be carried out in at least three locations before the filling operations in order to establish reference values for future sampling.

B. Monitoring
The parameters to be analysed in the samples taken must be derived from the expected composition of the leachate and the groundwater quality in the area. In selecting the parameters for analysis account should be taken of mobility in the groundwater zone. Parameters could include indicator parameters in order to ensure an early recognition of change in water quality

<table>
<thead>
<tr>
<th>Level of groundwater</th>
<th>Operation phase</th>
<th>After-care phase</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>every six months</td>
<td>every six months</td>
</tr>
<tr>
<td>Groundwater composition</td>
<td>site-specific frequency</td>
<td>site-specific frequency</td>
</tr>
</tbody>
</table>

C. Trigger level
Significant adverse environmental effects, as referred to in Articles 12 and 13 of this Directive should be considered to have occurred in the case of groundwater, when an analysis of a groundwater sample shows a significant change in water quality. A trigger level must be determined taking account of the specific hydro geological formations in the location of the landfill and groundwater quality. The trigger level must be laid down in the permit whenever possible.

The observation must be evaluated by means of control charts which with established control rules and levels for each down gradient well. The control levels must be determined from local variations in groundwater quality.

**Available guidance/ checklists in English**

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
</thead>
</table>
Recommendations
Member states have different methods to define trigger levels. For member state that have old and new landfills at the same location, groundwater pollution from old (closed) landfill may cause exceeding of trigger level. It might be interesting to have information about these kinds of situations and the measures that were taken at landfills in member state. In 2012 no information on this activity was received.

Groundwater monitoring is an activity that is difficult to inspect for inspectors. Especially when there is only limited time available to perform inspections. The knowledge of the permit writers (competent authority) and specialists on groundwater is necessary to be able to perform a good inspection.

3.5 Water control and leachate management

Description of activity

Photo 4: lagoon for treated leachate water at Landfill in Romania

Depending on the Member State and on the Competent Authority, leachate recirculation in the landfill body is allowed or not. On the one hand leachate recirculation results in the benefits of a faster stabilization of the landfill, and enhanced gas production as it restores the content of humidity in the waste; on the other hand, the recirculation of excess leachate, where additional leachate no longer provides any benefit, is seen as leachate disposal at a landfill and is not an appropriate option for managing it. The leachate collected can be treated as a liquid waste and can be sent to a waste water treatment plant authorized for the treatment of wastes; a preliminary treatment often is mandatory to reduce the pollutant charge. In case leachate has to be discharged into a superficial water body, the treatment is mandatory.
### Conditions in landfill directive

#### Annex I

2. Water control and leachate management

Appropriate measures shall be taken, with respect to the characteristics of the landfill and the meteorological conditions, in order to:

- control water from precipitations entering into the landfill body,
- prevent surface water and/or groundwater from entering into the land filled waste,
- collect contaminated water and leachate. If an assessment based on consideration of the location of the landfill and the waste to be accepted shows that the landfill poses no potential hazard to the environment, the competent authority may decide that this provision does not apply,

Treat contaminated water and leachate collected from the landfill to the appropriate standard required for their discharge.

#### Annex III

Emission data: water, leachate

Sampling of leachate and surface water if present must be collected at representative points. Sampling and measuring (volume and composition) of leachate must be performed separately at each point at which leachate is discharged from the site.

Monitoring of surface water if present shall be carried out at no less then two points, one upstream from the landfill and one downstream.

For leachate and water, a sample representative of the average composition shall be taken for monitoring.

The frequency of sampling could be adapted on the basis of the morphology of the landfill waste (in tumulus, buried etc). This has to be specified in the permit.

<table>
<thead>
<tr>
<th></th>
<th>Operating phase</th>
<th>After-care phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Leachate volume</td>
<td>monthly</td>
<td>every six months</td>
</tr>
<tr>
<td>2.2 Leachate composition</td>
<td>quarterly</td>
<td>every six months</td>
</tr>
<tr>
<td>2.3. Volume and composition of surface water</td>
<td>quarterly</td>
<td>every six months</td>
</tr>
</tbody>
</table>
### Available guidance/ checklists in English

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
</thead>
</table>
4. INSPECTION PREPARATION

There are different types of inspections to be performed at an installation. i.e.:
- regular, announced on-site inspection;
- regular, not announced inspection (according to an inspection plan)
- inspections in case of accidents, incidents and complaints.

The following parts of the Landfill Directive guarantee that information at the different stages being permit application, control/monitoring and not normal operation should be supplied to the competent authorities. This information should be used to prepare a landfill inspection at a landfill. Within an inspection organisation it must be clear where the necessary information can be obtained.

**Permit (application)**

Article 7, Application for a permit according to the directive a application shall at least contain the following:

(a) the identity of the applicant and of the operator when they are different entities;
(b) the description of the types and total quantity of waste to be deposited
(c) the proposed capacity of the disposal site
(d) the description of the site, including its hydro geological and geological characteristics
(e) the proposed methods for pollution prevention and abatement
(f) the proposed operation, monitoring and control plan
(g) the proposed plan for the closure and after-care procedures
(h) impact assessment 85/337/EEC
(i) financial security by the applicant or any other equivalent provision

**Control and Monitoring programme**

Article 12, control and monitoring procedures in the operational phase

(a) the operator of a landfill shall carry out during the operational phase a control and monitoring programme as specified in Annex III;

Annex III contains conditions about:

2. meteorological data
3. emission data: water, leachate and gas control
4. protection of groundwater
5. topography of the site: data on landfill body
6. specific requirements for metallic mercury
Notification of operator to competent authority of any adverse environmental effects
Article 12 under b
(b) The operator shall notify the competent authority of any significant adverse environmental effects revealed by the control and monitoring procedures.

Report all monitoring results to the competent authorities
Article 12 under b
(b) At a frequency to be determined by the competent authority, and in any event at least once a year, the operator shall report, on the basis of aggregated data, all monitoring results to the competent authorities for the purpose of demonstrating compliance with permit conditions and increasing the knowledge on waste behaviour in the landfills.
5. ON SITE INSPECTION

During the 2011 workshop some member states presented their way to perform landfill inspections.

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Title of document</th>
<th>Link to website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovenia: Inspectorate of the RS for the Environment and spatial planning</td>
<td>Experience with Landfill inspections in Slovenia</td>
<td>basecamp</td>
</tr>
<tr>
<td>Sardenia (ARPAS)</td>
<td>The experience of ARPAS</td>
<td>basecamp</td>
</tr>
<tr>
<td>Sweden: Environmental protection of Administrative board of Kalmar County</td>
<td>Landfill inspections in Sweden</td>
<td>basecamp</td>
</tr>
<tr>
<td>Italy (Sardinia): Sardinian regional Environmental Protection Agency (ARPAS)</td>
<td>The experience of ARPAS</td>
<td>basecamp</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Inspection on landfills in the Netherlands</td>
<td>basecamp</td>
</tr>
</tbody>
</table>

On site inspections could include the following visual controls:
- steepness of slopes;
- content of top layer;
- handling of waste
- storage of waste
- condition of top layer.

During the inspections in Slovenia and Romania, inspector’s attention was drawn to certain subjects (see pictures below).
6. AFTER INSPECTION

After an inspection the following activities can be performed:
- Record inspection in database
- Determine if changes in permit are necessary
- Determine environmental impact
- Written information (to operator).

In case of irregularities detected/identified the following general procedures are possible:
- administrative order;
- administrative ruling in terms of permit conditions, i.e. setting new additional conditions within a permit;
- sanctions, fines and penalties;
- withdrawal of a permit.

Member state legislation has to be consulted to check what kind of procedure is to be applied in case of irregularities and incompliance.

The Industrial Emission Directive (2010/75), article 23, contains conditions on inspections. More information on the conditions of the Industrial Emission Directive and the inspections can be found in the report “IED Inspections”, Guidance for the implementation of the IED in planning and execution of inspections (to be published on IMPEL website).
7. CONCLUSIONS/ RECOMMENDATIONS

The Landfill Project started in 2011 with a workshop in Sardinia followed by two joint inspections in September 2012 (in Slovenia and Romania). The objectives of the project were:

- identification of good inspection practices and developing guidance for inspectors;
- improve cooperation between IMPEL member countries to work towards a more consistent regulatory and enforcement regime;
- to give feedback to policy makers.

During the Utrecht workshop in 2012 the project team evaluated the project findings.

The following conclusions are based on the draft Guidance Book for Landfill inspection and the joint inspections performed:

- More attention should be given to the *sampling of waste* during the waste acceptance process;
- Although the pre-treatment of municipal waste is not within the scope of this project, more knowledge on this activity would give inspectors a better view on the composition of the landfilled waste;
- The identification of waste and the waste code used are an important part of the waste acceptance procedure;
- Special attention should be given to waste codes which can be either hazardous or non-hazardous waste;
- By using the same checklist during the inspections in two different member states, it became clearer how the Landfill Directive has been implemented in the different member states.

The following recommendations on how guidance can be used by inspectors:

- To stimulate that more inspectors in the different member states use the guidance (from this project) as well as guidance from other member states a website (open space) to download these documents would improve an easier access for inspectors...
- In every member state national networks have to stimulate that inspectors receive the information that is developed in IMPEL projects. Workspace tools could be a solution for this.
- A training program for inspectors who need knowledge about specific landfill activities by experienced inspectors. For example the waste acceptance procedure or gas control.
- Translation of useful guidelines existing in member states that might be useful for other member states (in English).

Future joint inspections should focus on the following activities:

- The pre-treatment of waste before land filling.
- How and when to inspect the top and bottom layer of landfills.
- The sampling of waste (and classification).
- Ground water monitoring.

For landfills no Best Reference Document (BREF) was developed as the Landfill Directive is regarded as BAT.
In this project different techniques in different member states were observed, for example, dealing with the steepness of (landfill) slopes. For some of these activities it may be worth a consideration to assess the techniques implemented in the different member states and to develop a system of best available techniques (besides the techniques described in the BREF waste treatment).
ANNEX Checklist

Checklists used during inspections in Slovenia and Romania:
1. WASTE ACCEPTANCE CRITERIA FOR LANDFILLS

<table>
<thead>
<tr>
<th>Kind of landfill</th>
<th>yes</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazardous waste</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Non-hazardous waste
(These landfills may be used for (i) municipal waste (ii) non-hazardous waste of any origin, which fulfill the criteria for the acceptance of waste at landfill for non-hazardous waste set out in accordance with annex II (and Council decision 2002/33/EC) iii) stable, non-reactive hazardous waste (e.g. solidified, vitrified) with leaching behaviour equivalent to those of the non-hazardous waste referred to in point (ii) which fulfill the relevant acceptance criteria set out in accordance with Annex II (and Council decision 2002/33/EC). These hazardous waste shall not be deposited in cells destined for biodegradable non-hazardous waste)

Inert waste

Other........

Method of inspection can be to make a selection of different kind of waste streams that the landfill may accept according to the permit. For the streams selected all the steps in this checklist can be checked to verify if the landfill is in compliance with the acceptance criteria defined.

Waste streams selected:

**Waste code:**

**Name of waste:**

**Description:**
### Period for which records with required information are kept

The operator shall keep records of information required for a period to be defined by the Member State. In your member state this ..(TO BE DEFINED).................... (Regulation in which this is required is .............................................
.................................................................................................................................)

Are the basic characterisation documents kept according to the period determined in your national legislation?

### Data required for basic characterisation of the waste

Do the records contain the following information?

(A) The source and origin of the waste

(B) Information on the process producing the waste (description and characteristics of raw/input materials and products)

(C) Description of the waste treatment applied in compliance with Article 6(a) of the Landfill Directive, or a statement of reasons why such treatment is not considered necessary

*Definition:* treatment: means physical, thermal, chemical or biological processes, including sorting that change the characteristics of the waste in order to reduce its volume or hazardous nature, facilitate its handling or enhance recovery.

(D) Data on the composition of the waste and the leaching behaviour, where relevant (see also questions under 3)
(E) (physical) Appearance of the waste (odour, colour, physical form)

(F) Code according to the European waste list (EWC)

(G) For hazardous waste in case of mirror entries: the relevant hazard properties according to Annex III to Annex III to Directive 2008/98/EC

(H) Information to prove Article 5(3) of the Landfill Directive does not apply on this type of waste

Waste that falls within the scope of article 5 (3) is: (a) liquid waste (b) waste which in conditions of landfills is explosive, corrosive, oxidising, highly flammable or flammable (c) hospital and other clinical wastes arising from medical or veterinary establishments, which are infectious as defined (property H9 in Annex III) by directive 2008/98/EC and waste falling within category 14 (Annex I.A) of that directive (d)whole used tyres (2003) excluding tyres used as engineering material and shredded used tyres (2006) excluding in both instances bicycle tyres and tyres with an outside diameter above 1 400 mm) (e) any other type of waste which does not fulfil the acceptance criteria determined in accordance with Annex II.

(I) If necessary, additional precautions to be taken at the landfill

(J) Check if the waste can be recycled or recovered

(K) Check on location one or several documents from this year to ensure that they comply with the demands.

Testing (1.1.3. Testing)

Waste must be tested to obtain the necessary information for basic characterisation (See D above). In addition to the leaching behaviour, the composition of the waste must be either known or determined by testing. The scope of (basic) characterisation, the extent of laboratory testing required and the relationship between characterisation and compliance testing depends on the type of waste. A differentiation can be made between:

A. Wastes regularly generated in the same process

(individual and consistent wastes regularly generated in the same process, where: the installation and the process generating the waste are well known and the input materials to the process and the process itself are well defined the operator of the installation provides all necessary information and informs the operator of the landfill of changes to the process (especially changes to the input material). The process will often be from a single installation but the waste can also be from different installations, if it can be identified as a single stream with common characteristics within known limits/facilities (e.g. bottom ash from the incineration of municipal waste)

B. Wastes that are not regularly generated

These wastes are not regularly generated in the same process and are not part of a well characterised waste stream. Each batch produced of such waste will need to be characterised. The basic characterisation shall include the fundamental requirements for basic characterisation. As each batch produced
has to be characterised, no compliance testing is needed

(C) Cases where testing is not required

(a) When the waste is on a list of wastes not requiring testing as laid down in section 2 of this Annex being: 10.11.03 (waste glass-based fibrous materials), 15.01.07 (glass packaging glass), 17.01.01 (concrete), 17.01.02 (bricks), 17.01.03 (tiles and ceramics), 17.01.07 (mixtures of concrete, bricks, tiles and ceramics), 17.02.02 (glass), 17.05.04 (soil and stones), 19.12.05 (glass), 20.01.02 (glass), 20.02.02 (soil and stones)

(b) All the necessary information, for the basic characterisation, is known and duly justified to the full satisfaction of the competent authority

(c) Certain waste types where testing is impractical or where appropriate testing procedures and acceptance criteria are unavailable. This must be justified and documented, including the reasons why the waste is deemed acceptable at this landfill class.

1.2. Compliance testing

When a specific waste is qualified for a certain landfill class on the basis of basic characterisation it shall subsequently be subject to compliance testing to determine if its complies with the results of the basic characterisation and the relevant acceptance criteria. The directive makes a difference in:

2.1 criteria for landfills for inert waste
2.2 criteria for landfills for non-hazardous waste
2.3 criteria for hazardous waste acceptable at landfills for non-hazardous waste pursuant article 6(c)iii
2.4 criteria for waste acceptable at landfills for hazardous waste
2.5 criteria for underground storage)
The member states shall determine which of the test methods and corresponding limit values in the table should be used. Your national legislation in which this is implemented is:

<table>
<thead>
<tr>
<th>in compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>yes</td>
</tr>
</tbody>
</table>

For the selected waste streams has compliance testing been performed?
selected waste stream :
(1)........................
(2)........................
(3)........................
(4)........................
(5)........................
(6)........................

Are all the tests of the compliance testing in line with the ones used in the basic characterisation procedure?

Is a *batch leaching test* done in line with the sampling and testing methods (section 3).

Do the results of the analysis test show that the waste meets the limit values for critical parameters and may the waste be accepted at this landfill?
<table>
<thead>
<tr>
<th><strong>Is the frequency of compliance testing in agreement with the frequency of basic characterisation?</strong></th>
</tr>
</thead>
</table>

If not how often is the compliance test performed?

<table>
<thead>
<tr>
<th><strong>Records (data) of the analytical results shall be kept for a period that will be determined by the Member States legislation; are the records kept for the time required?</strong></th>
</tr>
</thead>
</table>

1.3. **On-site verification**

Each load (batch) of waste delivered to a landfill shall be visually inspected before and after unloading. The documentation required shall be checked. During a landfill inspection focus should be laid on the way waste is checked visually and who is responsible for control.

Is there physical space to perform an inspection of a waste delivery?

<table>
<thead>
<tr>
<th><strong>The waste may be accepted at the landfill, if it has the same composition as is the waste that has been subject to the basic characterisation procedure and the compliance testing and the descriptions in the accompanying documents. If this is not the case, the waste must not be accepted.</strong></th>
</tr>
</thead>
</table>

Are records (data) kept of waste that has not been accepted at the landfill?

<table>
<thead>
<tr>
<th><strong>Member States shall determine the testing requirements for on-site verification, including where rapid test methods where appropriate.</strong></th>
</tr>
</thead>
</table>
What kind of legislation exist on this subject in your member state:

Is this part of the acceptance procedure in compliance with this legislation

Upon delivery, samples shall be taken periodically. The samples taken shall be kept after acceptance of the waste for a period that will be determined by the Member State (see Article 11(b) of the Landfill Directive not less than one month).

Period that sample shall be kept according to legislation is:

<table>
<thead>
<tr>
<th>3. Sampling and test methods</th>
<th>in compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes or No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Sampling and testing for basic characterisation and compliance testing shall be carried out by independent and qualified persons and institutions. Laboratories shall have proven experience in waste testing and analysis and have an efficient quality assurance system.

Member States may decide that:

1. the sampling maybe carried out by producers of waste or landfill operators under the condition that sufficient supervision of independent and qualified persons or institutions ensures that the objectives as set out in this Decision are achieved;
2. the testing of the waste maybe carried out by producers of waste or operators if they have set up an appropriate quality assurance system including periodic independent checking.

In your member state what is the regulation in regard to this subject?:

For sampling
For analysis
## 2. GAS CONTROL

<table>
<thead>
<tr>
<th>Topic</th>
<th>What has been observed during the inspection?</th>
<th>What information needs to be checked in the administration of the installation owner</th>
<th>In compliance?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas extraction system</strong></td>
<td>(conditions in permit and description in permit application are important to be checked before the inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gas flaring torch</strong></td>
<td>(conditions in permit and description in permit application are important to be checked before the inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gas trigger level</strong></td>
<td>(conditions in permit and description in permit application are important to be checked before the inspection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Gas samples</strong></td>
<td>How often are samples taken?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Is this in line with the permit conditions?</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Which parameters are measured?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Answer 1</td>
<td>Answer 2</td>
<td>Answer 3</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>Is this in line with the permit conditions?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observation during inspections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you observe indications of gas leaking (for example cracks in landfill slopes) odour or vegetation damage?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>