Horizon 2020 Initiative to de-pollute the Mediterranean by the year 2020

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in collaboration with UNEP/MAP

Training on mercury management and remediation of contaminated sites

"Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites"

Almadén, Spain, 18-19 November 2015

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Minas de Almadén y Arrayanes, S.A.

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Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites

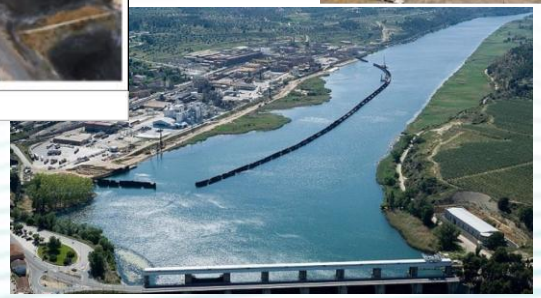
MEDPOL

Regional Activity Centre for Sustainable Consumption and Production


Aerial view, 1970


ESCOMBRERA CERCO SAN TEODORO 2005


ESCOMBRERA CERCO SAN TEODORO 2008



National Technological Center for Mercury Decontamination

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Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites

Objectives

The main objective of this document is to provide an easy-to-consult guide on the definition of mercury-contaminated sites and the best practices for their rational environmental management

Stakeholders

The technical staff of the relevant environmental authorities responsible of the analysis, delimitation and assessment of contaminated sites, as well as a general summary of the most appropriate remediation and reclamation techniques, in accordance with the land use objectives

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Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites

REMEDIATION OF A MERCURY-CONTAMINATED SITE, IS A CORRECTIVE MEASURE TO MITIGATE OR ELIMINATE THE POLLUTION

Steps:

- Examine **the origin, extent, type and amount of existing contamination**
- How and to what extent humans and other affected environmental components have suffered or may suffer from the effect of the contamination.
- Corrective measures should be proposed and adopted to remediate the environmental damage and limit or eliminate the risk of the contamination to the environment

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

IDENTIFICATION OF MERCURY-CONTAMINATED SITES

The potentially contaminated site should be identified, as should its boundaries and the environmental compartments that are affected.

The size of the descriptive study is directly proportional to the complexity of the problem

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

IDENTIFICATION OF MERCURY-CONTAMINATED SITES

IDENTIFICATION OF THE ENVIRONMENTAL IMPACTS

As mercury is mobile, environmental impacts should be assessed in all environmental compartments to determine all risks

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

IDENTIFICATION OF MERCURY-CONTAMINATED SITES

IDENTIFICATION OF THE ENVIRONMENTAL IMPACTS

ENVIRONMENTAL CHARACTERIZATION OF MERCURY-CONTAMINATED SITES

The selection of the environmental compartments (surface and groundwater, soils, air and food) that should be sampled will depend on the characteristics of the contaminated site or location.

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

- IDENTIFICATION OF MERCURY-CONTAMINATED SITES
- IDENTIFICATION OF THE ENVIRONMENTAL IMPACTS
- ENVIRONMENTAL CHARACTERIZATION OF MERCURY-CONTAMINATED SITES
- RISK ASSESSMENT FOR MERCURY-CONTAMINATED SITES

Data derived from the environmental characterization enable the identification of soil or site contamination, and of potential receptors of the toxic substances. The data can then be used to inform decisions on which measures are required to avoid affections on human health or natural elements

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

- IDENTIFICATION OF MERCURY-CONTAMINATED SITES
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- RISK ASSESSMENT FOR MERCURY-CONTAMINATED SITES
- REMEDIATION OF MERCURY-CONTAMINATED SITES

One or more remediation technologies can be considered, taking into account the results of the site study, the target clean-up levels, the capacity of the available remediation technologies, and the intended future use of the site

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Starting Points

- IDENTIFICATION OF MERCURY-CONTAMINATED SITES
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- RISK ASSESSMENT FOR MERCURY-CONTAMINATED SITES
- REMEDIATION OF MERCURY-CONTAMINATED SITES
- MONITORING AND CONTROL

The design and implementation of a monitoring plan (MP) is highly specific to the type of remediation carried out and the contaminated site. Monitoring should be accompanied by assessment of the indicators, to verify whether or not progress has been made in the various activities that form part of the system or project under evaluation

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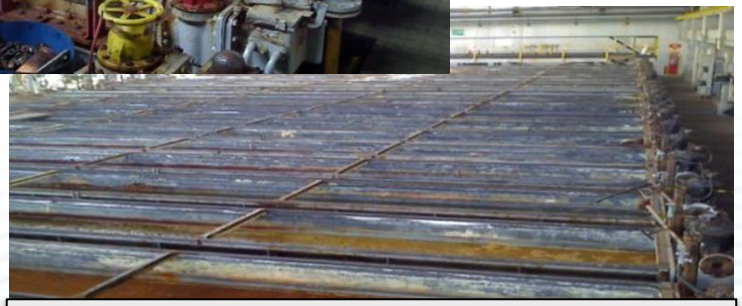
Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

SAFE DECOMMISSIONING OF A MERCURY CELL CHLOR-ALKALI PLANT

First stage of operations



End of first dismantling stage

RECONDITIONING OF THE CERCO DE SAN TEODORO SLAG HEAP. MINAS DE ALMADÉN

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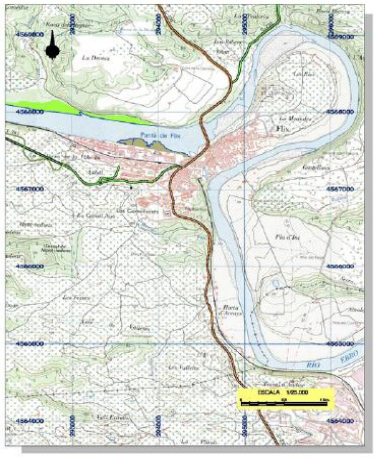
DECONTAMINATION OF THE FLIX DAM IN THE EBRO RIVER (Tarragona, Spain)



The Flix dam, located in the lower stretch of the Ebro, retains in its basin some six hundred thousands cubic meters of sludge mainly dumped by a chemical plant located on the right bank. This sludge was the residual product of the plant's operations, and is composed of both chemicals and inert components.

There are three main groups of contaminants: **organochlorines** (with persistent organic pollutants such as DDT and PCBs), **heavy metals (mainly mercury) and radionuclides**

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Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

DECONTAMINATION OF THE FLIX DAM IN THE EBRO RIVER (Tarragona, Spain)

The production of chemical products on the banks of the river began in the late 19th century.

- The kind of substances produced have been large and varied, accordance with technological advances and demand.
- The initial process: chlorine and caustic soda production, obtained from the salt, through an electrolytic process using mercury.
- Production of hydrocarbons as insecticides, solvents, pesticides and others.
- Apatite to produce di-calcium phosphate. This apatite naturally contains radionuclides.
- Others from the natural drag occurring upstream of the factory.

Aerial view, 1970

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

DECONTAMINATION OF THE FLIX DAM IN THE EBRO RIVER (Tarragona, Spain)

SOLUTIONS CONSIDERED

Studies carried out have established that possible solutions can be classified into two groups depending on whether the waste is finally kept in the reservoir (in-situ solutions) or, conversely, collected and placed at another point (ex-situ solutions).

The key elements that define the optimal solution within each group are:

- In-situ solution: the creation of a working area, making up of waste, waste treatment and protection from river erosion.
- Ex-situ solution: **creating a working site, removal of waste, treatment, transport to a dumping area and the dumping area itself**.

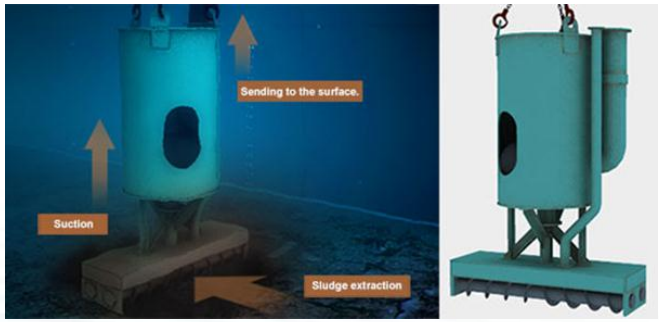
Dredging activities inside the sheet piling

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

DECONTAMINATION OF THE FLIX DAM IN THE EBRO RIVER (Tarragona, Spain)

The Monitoring Commission formed by various government bodies after studying all the responses received from more than 80 organizations consulted to study the alternatives, including that of 'no action', **decided that the ex-situ solution was the more environmentally friendly alternative, since it reduced the level of pollutants and provided more guarantees.**

PRELIMINARY WORKS



PRODUCTION WORKS

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

STABILIZATION OF SOILS CONTAMINATED WITH HEAVY METALS USING LOW-GRADE MAGNESIUM OXIDE

The stabilization treatment with a pH-buffering chemical is an option to consider when the best alternative considered is to remove a contaminated soil with heavy metals from its emplacement, without a process of decontamination, and move it to a suitable landfill or safety cell.

This process of chemical stabilization minimizes heavy metals solubility. Lime or a mix of cement and lime are the usual buffering agent for many kinds of waste, but with the high pH values obtained with lime - a strong alkali - , the leachate water collected in the landfill may contain high concentrations of heavy metals, due to the redissolving of the previously formed metal hydroxides.
The most common heavy metal hydroxides reach their minimum solubility at a pH between 8 and 10. In the chemical stabilization of soils polluted with heavy metals it should be used an alkaline product with solubility equilibrium at that pH interval, and with a competitive price compared to lime.

Guidelines on Best Environmental Practices for the environmental sound management of mercury contaminated sites. Real Cases of Remediation

STABILIZATION OF SOILS CONTAMINATED WITH HEAVY METALS USING LOW-GRADE MAGNESIUM OXIDE

If mercury is present in the soil, it has to be carefully considered the possibility of formation of methylmercury, or its complexation with organic matter, such as humic acid. In this case, the stabilizing agent wouldn't be effective

Inabonos S.A. (a Roullier Group company) undertook the cleaning and decontamination of a 74,408m2 plot in a former emplacement in Lodosa (Navarra, Spain), by moving contaminated soil to a safety cell, with the objective to build a new housing development.

On a Spanish coastal city, a pre-pilot study was undertaken of in-situ stabilization with magnesium oxide of soil contaminated by the uncontrolled dumping of a former fertiliser factory. The area treated covered 200 m2 and was 2 m deep.

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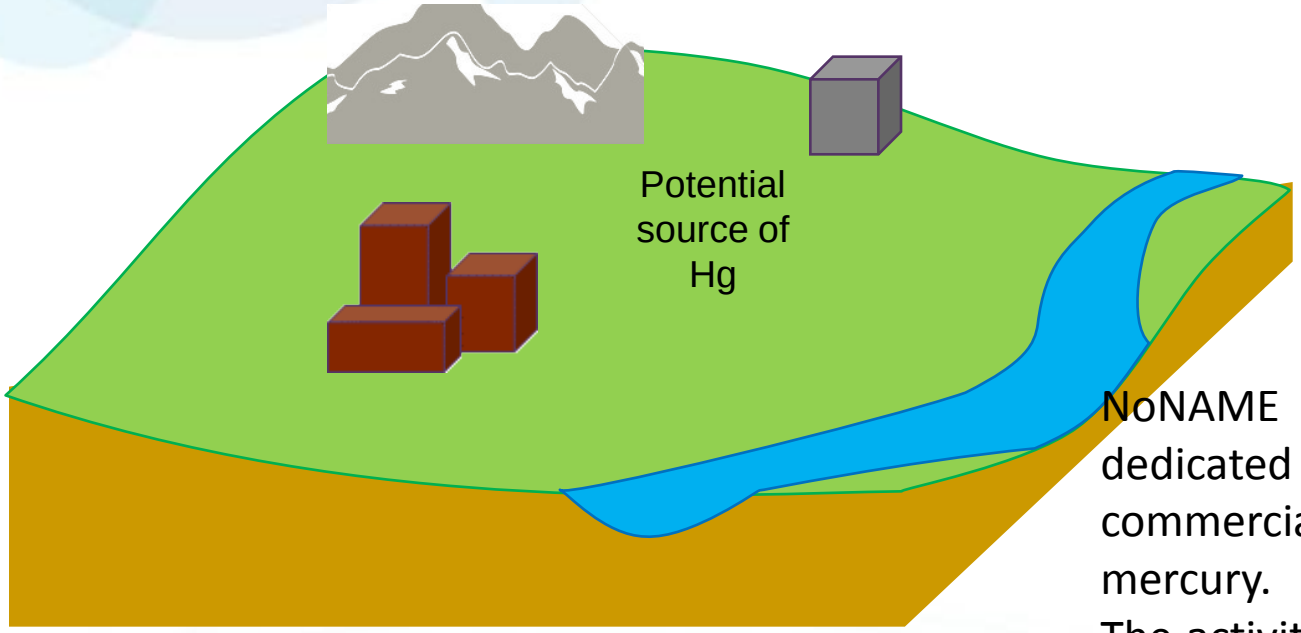

Hypothetical case of mercury-contaminated site.
"NoNAME Company"

NoNAME Company was a company dedicated to the production and commercialization products of mercury.

The activity was done since the 1970s until year 2000, when the activity was stopped. When the activity stopped, any labor of cleaning of the factory was not made.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

IDENTIFICATION OF THE SITE CONTAMINATED WITH MERCRUY

STAGE I. Preliminary report of the situation. (1)

STAGE II. Additional Report.(2)

The potentially contaminated site should be identified, as should **its size and limits and the environmental compartments that are affected**.

A contaminated site must be described in detail before a sound management policy can be applied.

The contaminant/s and the potential receptors of the toxic substance must be identified also. The information that is obtained will help in decisions about which measures to implement to prevent affections to human health and elements of nature.

The extent of the descriptive study is directly proportional to the complexity of the problem at the site that is being assessed.

Descriptive studies should generally involve two stages.

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Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

IDENTIFICATION OF THE SITE CONTAMINATED WITH MERCRUY

STAGE I. Preliminary report of the situation. (1)

The preliminary report should contain a theoretical model of the mercury-contaminated site that draws on all of the previously known information. Data on the following aspects will be gathered during this stage:

- The location, surface area, and details of the physiographic region of the site.
- Historical records of the site and the surrounding area
- Past, current and future uses of the place.
- Analytical data from previous studies.
- A survey of the site and the nearby area

STAGE II. Additional Report.(2)

Additional report. This report will contain the information required to draw conclusions and determine whether or not a more in-depth analysis is needed.
It is advisable to carry out a brief site inspection to meet three specific objectives:

- describe the site,
- examine the type of contamination produced by the mercury and
- define the mechanisms of mercury mobility and the points of exposure.

If detailed studies of the site are required, the environmental characterization stage will be carried out

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Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REPORT OF THE SITUATION OF *"NoNAME COMPANY"*

DATE _____

AUTHORS _____

1. IDENTIFICATION OF THE SITE
1.1 INTRODUCTION
1.2 HISTORICAL DATA
1.3 USES OF THE SITE
1.4 ANALITYCAL DATA

STAGE I. Preliminary report of the situation. (1)

2. SITE ANALYSIS
2.1 LOCALITATION
2.2 CLIMATOLOGY
2.3 GEOLOGY
2.4 HIDROLOGY
2.5 EDAFOLOGY
2.6 SOCIOECONOMIC ASPECTS

STAGE II. Additional Report.(2)

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

➢ Type of contamination

It is an area with more than 30 years of operation, where mercury has been used in a wide range of applications.

The level of mercury in the air is high in several points of the complex and its area.

The storage has a lot of pollution. It has observed containers with rest of mercury and broken containers with mercury. On the floor there are drops of mercury.

Outside the storage building there are lots of waste containing mercury.

The processing facility is contaminated, building, structures, equipment.

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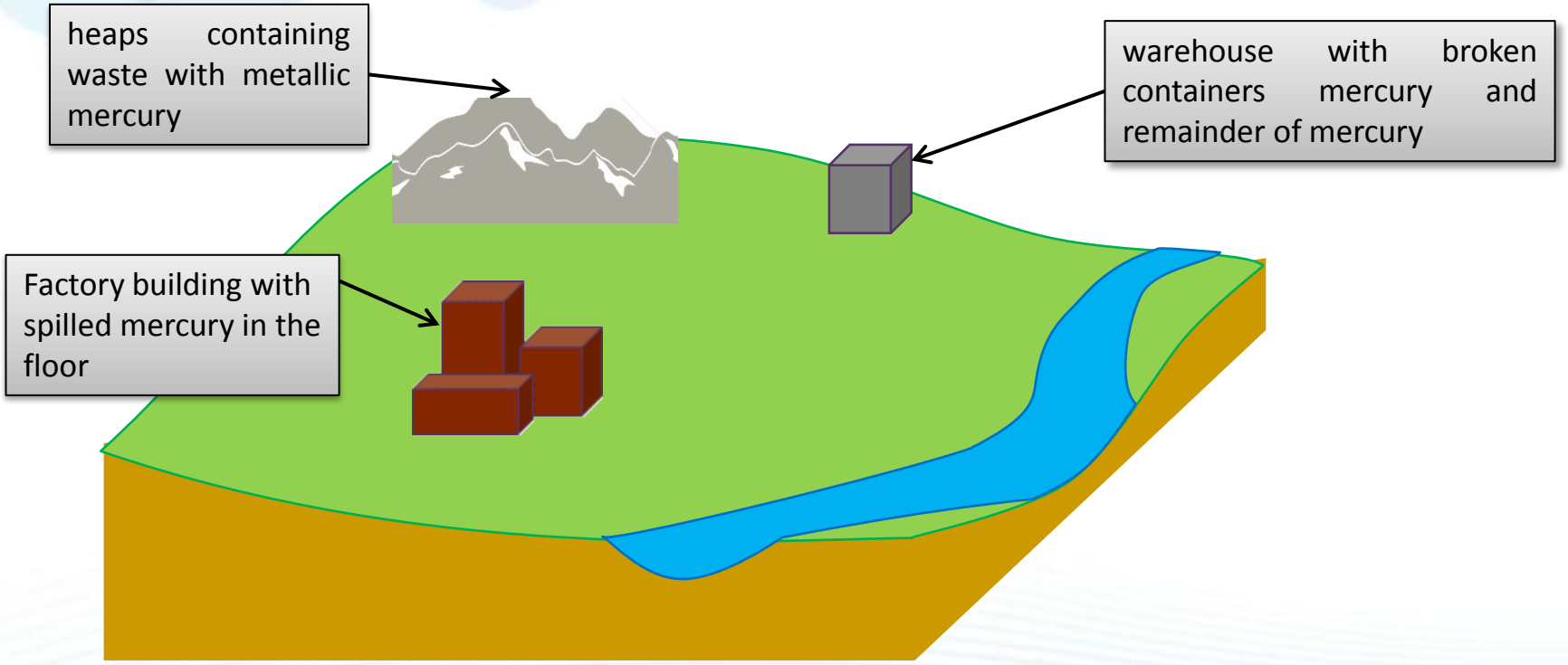


Hypothetical case of mercury-contaminated site.
"NoNAME Company"

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

- Hydrological risk: Alterations in natural surface drainage and contamination of river beds due to runoff and leachate from the contaminated site.

- Atmospheric risks: Resuspension or reemission of particles of dust from the mercury-contaminated site that are carried by the winds. Regasification and release of mercury present in piled up or contaminated materials, due to seasonal changes in temperature.

IDENTIFICATION OF THE ENVIRONMENTAL IMPACTS

- Changes in soils. Occupancy by accumulation of materials. Nearby soil affection by dispersion of materials from the contaminated site, the deposition of dust or the runoff of rainwater.

- Morphology and landscape. Visual impact on the main basins in the natural landscape due to the effect of piling up of material, lack of vegetation or color changes.

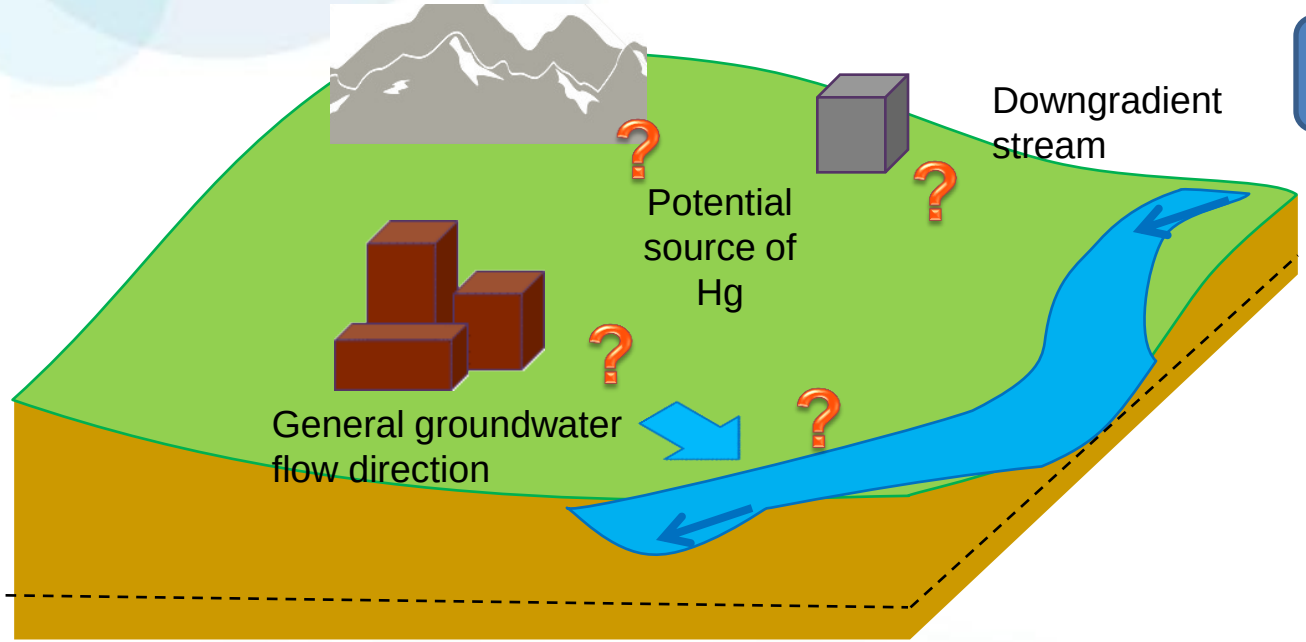
- Impact on vegetation and wildlife. Affection of plant species from the area and movement of wildlife to adjacent habitats.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

- The selection of the environmental compartments sampled depends on the characteristics of the contaminated site or location.
- Each site is different, so criteria that apply to one, might not be applicable to another.
- In some places, surface water and sediments should be sampled; in others, a soil sampling may be sufficient; and in others, emissions should be measured and soil, surface water and groundwater should be sampled

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites



ENVIRONMETAL CHARACTERIZATION

Site Background:

- Mercury in soil and overburden groundwater which is known, but is not characterized.
- Possible surface water contamination
- Air quality concerns in the nearest indoor area
- The Site has a potential source , occupied buildings and downgradient stream

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

SURFACE WATER AND GROUNDWATER

Water may act as a pathway for the dispersal of contamination by leaching from the site.

Unfiltered samples are generally used to analyze surface water. In addition, sampling must be carried out in all of the seasons, that is, in periods of rain and drought.

The document provides general information on methods for the sampling and analysis in the Chapter 5. Environmental characterization of mercury-contaminated sites.

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ENVIRONMETAL CHARACTERIZATION

SURFACE WATER

Sampling campaign should be designed for liquids and solids (sediments)

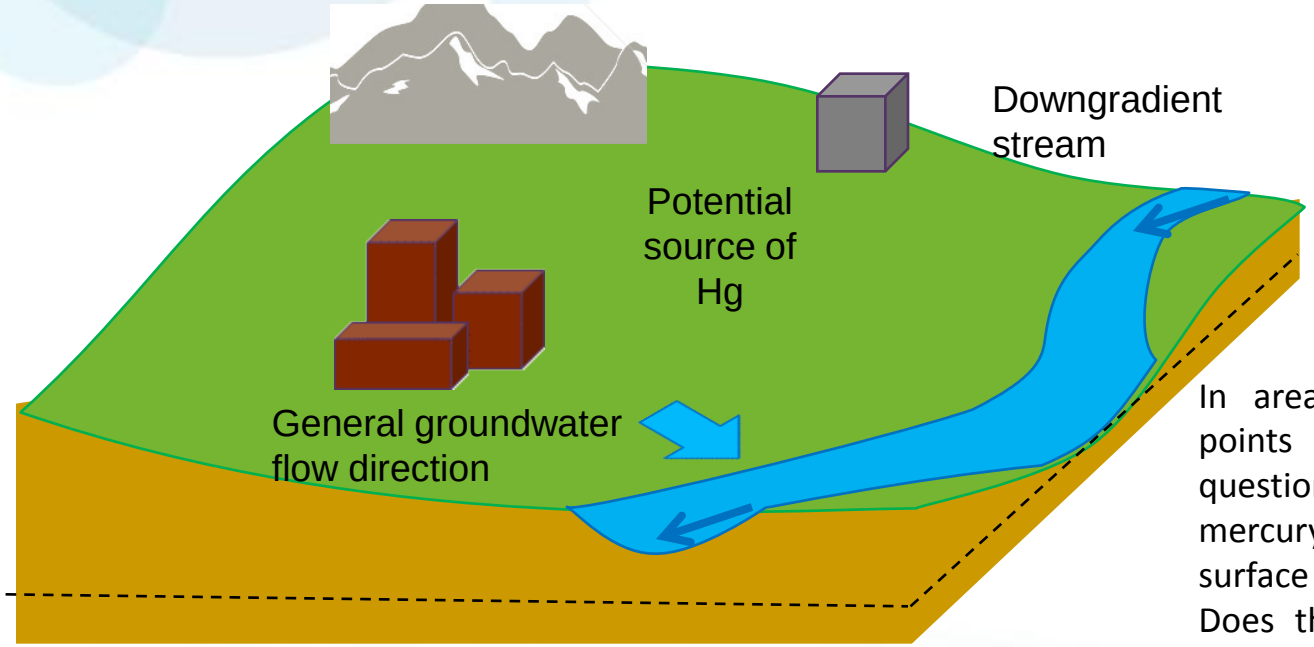
Aim: to know the water quality in the area surrounding the site, the sediment quality in stream beds in the area; and whether sediments are affected

Tasks :

- Inventory of surface water points.
- Field survey of all the types of water points.
- Selection of sampling points and the period for carrying out the sampling
- Establishment of background mercury levels in the area. Sampling points should be selected upstream of the study area.

If mercury levels in surface water are above the limits established for water for human consumption (1 µg/l), we must look for the source.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites



Hypothetical case of mercury-contaminated site.
"NoNAME Company"

In areas where there are potential points of human exposure, two questions should be asked when mercury contamination is found in the surface waters:

Does the surrounding population eat aquatic fauna from the site or not?

If the answer to the above question is yes,

what type of aquatic fauna does the surrounding population eat (to assess potential effects of bioconcentration) and biomagnification

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

GROUNDWATER

Hydrogeological studies.

The design of a preliminary scheme for hydrogeological conditions,

Inventory of water points (water catchment points and springs)

Field survey of all the water points.

Selection of sampling points and the periods for carrying out the sampling, at least three times a year.

The analyzed samples must not be filtered.

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ENVIRONMETAL CHARACTERIZATION

GROUNDWATER

Additional information in complex situations:

- **Test drilling** around the site through structures and formations of hydrogeological or hydrochemical interest.
- **Hydraulic characterization** tests in areas not investigated by the test drilling, to determine the permeability
- of the main structures
- **Hydrochemical sampling** along the test drill holes to reveal the chemical characteristics of the underground flow at different depths of water upstream and downstream of the pollution point source

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

CHARACTERIZATION OF SOIL

ENVIRONMETAL CHARACTERIZATION

And Soils.
Soils in the area surrounding the site should be characterized on the basis of the data collected in the additional report on road infrastructure (entrances, paths, roads in general) and land uses (agriculture and livestock or residential

CEMESMER

CARACTERIZACIÓN SUELOS DEL ENTORNO

CARACTERIZACIÓN RESIDUOS DE CLOROCAÚSTICA

CARACTERIZACIÓN PRODUCTO FINAL

CARACTERIZACIÓN LIXIVIADO PRODUCTO FINAL

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ENVIRONMETAL CHARACTERIZATION

SOILS

A site survey before the soil sampling campaign:

- **Geomorphology** of the site.
- **Topographical and geological characteristics**, land uses, slopes, steeply sloping hillsides, instability, etc.
- **Accessibility** of the site and sampling areas.
- Identification of **areas of natural ground** and areas formed by **backfill** due to the movement of deposited materials.

Contamination is mainly **dispersed by wind** and by **surface water.**

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

SOILS

THREE LEVELS OF SOILS SAMPLES

SIMPLE SOIL SAMPLES: 0 to 5 cm

DEEP SOIL SAMPLES: 0.5 m

ROCK SAMPLES FROM DRILLHOLES

ENVIRONMETAL CHARACTERIZATION

The soil samples should be taken at three levels

The simple surface from zero to 5 cm, at a depth of 0.5 m, and from rock samples obtained during test drill holes.

The aim of sampling at the first two levels is to discover potential variance between surface and deep soils due to mercury enrichment caused by migration from soil and concentration in the contact surface with the bedrock.

The deep soil samples can be taken at half the points of network and alternately.

The hydrogeological test drill holes can be used for sampling, which should be of continuous recovery of core

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

AIR

The mercury concentration in air is a rapid way to confirm the presence of the metal.

Mercury is quickly dispersed in air, but does not remain

Limits in the ambient air:

Air Quality Guidelines for Europe World Health Organization:

1000 ng/m3 as an annual average for mercury

United States Environmental Protection Agency (EPA)

300 ng/m3 for exposure in residential areas

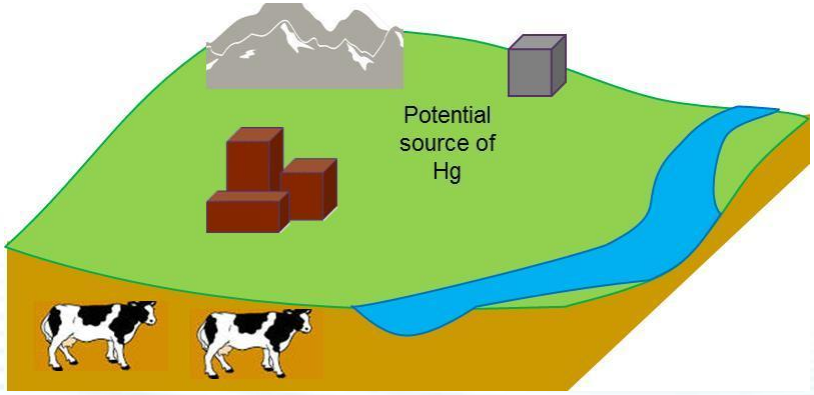
Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

1. SURFACE WATER AND GROUNDWATER
2. SOILS
3. **AIR AND FOOD**

Regarding Characterization of air and food. Mercury levels in ambient air should be considered because of the high dispersion and evaporation of this contaminant.

And in the Food. The mercury content should be determined in plant and animal samples of the food produced in the area and other food that is frequently consumed by the population.



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ENVIRONMETAL CHARACTERIZATION

FOOD

People particularly vulnerable to the effects of mercury:

- FOETUSES, by maternal consumption of fish or seafood
- CHRONIC EXPOSURE PEOPLE (High exposure)

Foetuses: Its exposure to methyl mercury due to maternal consumption of fish or seafood may damage a baby's brain and nervous (nervous) system and people with chronic exposure to high levels of mercury. This group includes people who practice subsistence fishing or those who are occupational exposed.

To ensure that the health of the surrounding population is protected Access to affected foods could be restricted and even regulate the use of the land or types of crops.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

ENVIRONMETAL CHARACTERIZATION

FOOD

According to the principle of precaution, the intake levels described in World Health Organization (WHO) recommendations should not be surpassed.

In 2008, WHO published a guidance document

http://www.who.int/ipcs/assessment/public_health/mercury/en/
to provide information on the potential impact of mercury exposure and to help, as much as possible, to identify at-risk populations.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

Risk assessment is a process that assigns magnitudes and probabilities to the adverse effects of contamination.

Consequently, it is an instrument that can be used to define whether or not environmental measures should be implemented at a contaminated site.

Risk assessment can establish whether the degree of contamination present at a site will have harmful effects.

The greater the risk of the contamination affecting living beings, the greater is the need to implement restoration programmes.

RISK ASSESSMENT FOR HEALT AND ENVIRONMENT

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

RISK ASSESSMENT FOR HEALT AND ENVIRONMENT

ERA constitutes a tool for deciding whether to carry out corrective actions at the contaminated site and for setting the final remediation objective, thus selecting the best clean-up strategies.

The establishment of a target clean-up level on the basis of a risk assessment means that the contamination will be reduced to its maximum accepted level, which may be not necessarily zero, at the end point, the residual concentration of the contaminant will not constitute a risk to the human population and biota.

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RISK ASSESSMENT FOR HEALT AND ENVIRONMENT

Risk assessment can be carried out in four clearly defined stages with specific objectives:

1.Identification and characterization of what is at risk.
2.Analysis of the hazard level and toxicity.
3.Analysis of exposure.
4.Analysis of risks.

Other contaminants besides mercury may have an impact. Therefore, if there is evidence that other contaminants are present at the site, the responsible of the process must take the decision to include them in the study and assessment.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

Remediation measures for mercury-contaminated sites depend on various factors associated with the location itself and with the potential impact on the environment and health.

One or more remediation technologies can be considered, taking into account the results of the site study, the target clean-up levels, the capacity of the available remediation technologies, and the intended future use of the site.

The main factors that influence the selection of an initial set of treatment technologies are:

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

- Receptors (surface water and / or groundwater, soil, air, biota, human..)
- The (potential) mobility of mercury in the hydrological system.
- The possibility of leaching of mercury from soil or sediments.
- The pollution point source.
- Mercury concentrations in human, animal and plant receptors, which indicate
- The chemical states of mercury at the contaminated site.
- Bioavailability to the aquatic biota, invertebrates and edible plants.
- The amount of mercury released during the operations.
- The possibility of mercury methylation.
- Background mercury contamination, regional atmospheric deposition of mercury that is not associated with local sources.
- The local/national clean-up regulations for water, soils/sediments and air.
- In the case of mining operations, it is important to know precisely the geological formations that led to mercury extraction in order to not to include them as polluted soil due to the mining activities.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

The Guidelines provides some treatments options for mercury-contaminated media. These techniques can be used alone or in combination in the remediation of a mercury contaminated site.

TREATMENT SPECIFICALLY GROUNDWATER AND SURFACE WATER REMEDIATION

Precipitation
Adsorption
Ion exchange
Oxidation-Reduction
Others

TREATMENT OF MERCURY-CONTAMINATED SOLID WASTE

Thermal treatments (retorting or roasting, among others)
Solidification/Stabilization (including amalgamation)
Vitrification
Washing/Acid extraction

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

In addition the Guidelines provides a tables presents a summary of the pros and cons of the most usual strategies and treatments for a mercury contaminated site

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

Technology	Principle	Key advantages	Key disadvantages	Targeted mercury	Status
Source removal with excavation	Excavation of the polluted materials the whole contaminated are specifically on the spots where the mercury masses concentrated		Could be expensive due to health and		
In situ containment with vertical barriers and capping	Isolation of existi contaminated are the subsurface fr the surrounding uncontaminated environment				

Technology	Principle	Key advantages	Key disadvantages	Targeted mercury	Status
Soil-washing with pre processing (mechanical separation)	Ex situ technique where soils and polluted materials are washed, generally with water and/or oxidative acid solutions. Wash water and wash solutions can be treated and recycled	Possible reuse of treated			
On-site immobilisation: stabilisation & solidification, amalgamation with on-site or off-site disposal	Chemical reaction (stabilization) and physically encapsulation (solidification) to reduce the hazard potential of a contaminated material by converting the contaminant into less soluble, less volatile, less mobile, and/or less toxic forms On-site or off-site disposal in special engineered landfill licensed to receive mercury wastes.				

Technology	Princi
In situ thermal desorption (ISTD)	In situ heating contaminated causing direct volatilisation - removal of vo products throu vapour extrac
Ex situ Thermal Desorption (ESTD)	Ex situ therm desorption is continuous pr normally cond rotary kilns (o equivalent)

Technology	Principle	Key advantages	Key disadvantages	Targeted mercury	Status
Batch retorting	Ex situ process where contaminated soils are heated in a controlled manner – volatizing contaminants (e.g. mercury) which is then recovered from off-gases.	-Thermal desorption under controlled conditions -Recovery of mercury and separation from material that could be reused for filling on site -High abatement efficiency	-excavation and temporary storage required -limited to treatment capacities of the order of one to five tons per day -expensive, high energy requirements, require vapour treatment, and significant handling effort and long treatment times (1 to ten years based on the capacity of 5 tons per day)	Hg° and inorganic mercury	It has been demonstrated commercially at full scale for small volume of highly polluted materials
In situ Vitrification (ISV)	High temperature process that immobilizes contaminants by incorporating them into a vitrified matrix which is durable and leach resistant	-High abatement efficiency, -No excavation required	-Operation and maintenance would likely be technically difficult and expensive -Required site-specific testing at pilot scale prior to full-scale application -Required dense combined borehole networks for both soil vapour extraction + heating - Mercury captured in the vapour treatment system must be managed Fugitive emissions of mercury vapour must be controlled -Secondary treatment of wastewater streams from condensed water would be complex -Large energy consumption -the long term stability of in situ immobilized media is uncertain or has not been assessed (metastability of glassy material)	All forms and combination of mercury	One application reported at full scale with ex-site treatment in the USA for mercury wastes.

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REMEDIATION OF MERCURY-CONTAMINATED SITES

In some case the remediation of a mercury contaminated site required restrict use of the contaminated area and limit access to it, at least until work can be started on recovery of the site.

Other alternative of treatment is that the site can be contained by making it impermeable using natural materials such as clay or geosynthetic materials such as high density polythene sheets to prevent the evaporation and leaching of mercury.

In addition, waste can be transported for safe storage in landfills engineered for this purpose.

In any case each contaminated site required different treatments for each area or product in a mercury contaminated site.

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REMEDIATION OF MERCURY-CONTAMINATED SITES

According to publications

Technical guidelines on the environmentally sound management of wastes consisting of, containing or contaminated with mercury or mercury compounds

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REMEDIATION OF MERCURY-CONTAMINATED SITES

Moreover in the remediation of mercury contaminated site, the wastes that are removed from the production site:

"Transportation
Mercury wastes should be transported in an environmentally sound manner in order to avoid accidental spills and to track their transportation and ultimate destination appropriately. Prior to transportation, contingency plans should be prepared in order to minimize environmental impacts associated with spills, fires and other emergencies that might occur. During transportation, such wastes should be identified, packaged and transported in accordance with the "United Nations Recommendations on the Transport of Dangerous Goods: Model Regulations (Orange Book)".

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

REMEDIATION OF MERCURY-CONTAMINATED SITES

Moreover in the remediation of mercury contaminated site, the wastes that are removed from the production site:

Collection of waste consisting of mercury or mercury compounds

135. Wastes consisting of mercury or mercury compounds (e.g. from a closing chlor-alkali facility) are different from other mercury wastes in terms of the hazards they may pose if mishandled. These may also be generated in high volumes, making their safe collection more difficult. Mercury in bulk form must be carefully packaged in appropriate containers before shipping to designated storage or disposal facilities.

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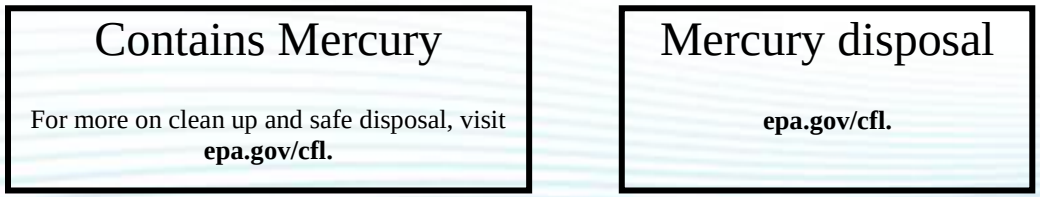
REMEDIATION OF MERCURY-CONTAMINATED SITES

"Packaging of Wastes Containing Mercury. Wastes containing mercury are transported in appropriate packages (such as original boxes or closed containers) that prevents them from breaking and releasing mercury."

"Packaging of Wastes Contaminated with Mercury. Liquid wastes contaminated with mercury are packed in appropriate containers which are placed in containment trays or a curved and leak- proof area. Solid wastes contaminated with mercury are stored in sealed containers, steel waste containers or specially constructed containers."

"Labelling: Appropriate labelling is also important, among others to help with the separation of mercury wastes from other wastes and ensure that the hazards of the waste are clearly communicated during transport"

Figure 1: Example of Product Labelling (Fluorescent Lamp, left for packaging, right for product)



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Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

MONITORING AND CONTROL

Once the option of remediation has been selected, a monitoring plan should be designed, implemented and run.

This plan will determine the times and places at which monitoring will be carried out to assess the progress of the remediation actions and confirm that the targets have been met and that the site is not a risk to human health or the environment.

Monitoring should be accompanied by assessment of the indicators, to verify whether or not progress has been made in the various activities that form part of the system or project under evaluation.

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

MONITORING AND CONTROL

At least the following indicators should be evaluated during the period established by the relevant authority:

Meteorological data

- Volume of precipitation (daily and monthly values)
- Minimum and maximum temperature (monthly average)
- Direction and strength of the prevailing wind
- Evaporation (daily and monthly values)
- Atmospheric humidity (monthly average

Emission data

- Monitoring of surface water at representative points
- Monitoring of groundwater
- Monitoring of mercury vapor emissions and particulates with mercury content

Soil sample survey

Application of Guidelines on Best Environmental Practices (BEPs) for the Environmentally Sound Management (ESM) of Mercury contaminated sites

MONITORING AND CONTROL

The duration of the MP and the sampling and data collection frequency generally depends on the environmental authority.

The following table shows some of the main parameters to include in a MP for a remediation project at a mercury-contaminated site, during implementation of the remediation activities and once the project is finished.

MONITORING PLAN			
MONITORED MEDIUM	MONITORING FREQUENCY	LOCATION	MONITORING PARAMETERS
Surface water	Monthly, first two years	Water upstream of the immediate surroundings of the site to be remediated	Temperature pH Conductivity Dissolved oxygen Oxide-reduction potential (Eh) Nitrites COD Ammoniac Mercury
		Water downstream of the immediate surroundings of the site to be remediated	
	Six-monthly, remaining years	Water upstream of the area near the site to be remediated	Temperature pH Conductivity Heavy metals: mercury.
		Water downstream of the area near the site to be remediated	Temperature pH Conductivity Heavy metals: mercury
	Annual	Water upstream of an area further from the site to be remediated	Temperature pH Conductivity Mercury
		Water downstream of an area further from the site to be remediated	
Groundwater	Monthly, first 2 years	Drilling around the site to be remediated	Mercury
	Six-monthly, remaining years	Drilling around the site to be remediated	Mercury
	Annual	Wells and springs around the site to be remediated	pH, conductivity, HCO3-, SO4=,Cl-, Ca++, Mg++, Na++, NO3-, NO2-, NH4+, Heavy metals: mercury
Monitoring of meteorological data	Monthly	Site and surroundings	Direction, speed and frequency of prevailing wind
Monitoring of the mercury level in air	Monthly, first 2 years Quarterly, remaining years	Site and surroundings	Level of mercury in the air
Monitoring of the mercury level in suspended matter	Monthly, first 2 years Quarterly, remaining years	Site and surroundings	Level of mercury in particles in suspension

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TO DE-POLLUTE THE MEDITERRANEAN BY THE YEAR 2020

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THANK YOU!

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