



European Commission

DG Environment

**Establishment of guidelines for the inspection of
mining waste facilities, inventory and rehabilitation of
abandoned facilities and review of the BREF document**

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**Final Report
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1. Introduction

The European Commission, DG Environment, has retained DHI (Denmark) and its co-operation partners, Cantab Consulting Ltd (United Kingdom), University of Tartu (Estonia), Mecsek-Öko (Hungary), Miskolc University (Hungary) and VTT (Finland) to undertake the study “Establishment of guidelines for the inspection of the mining waste facilities and review of the reference document on the best available techniques”, study contract no. 070307/2010/576108/ETU/C2. The study took place during the period 9 November 2010 to 9 February 2012.

The main objective of the study has been to support the Commission in implementing the specific aspects of Directive 2006/21/EC on the management of waste from extractive industries (the “mining waste directive” or the “MWD”) by:

1. providing the necessary technical information in order to prepare the technical guidance document on inspection as required under Article 22 (d) of the Directive;
2. reviewing the methodologies relating to the rehabilitation of closed and abandoned facilities in order to develop a supporting document for the Member States;
3. reviewing the BREF document on mining waste and assessing the opportunity to launch a revision of the BREF.

This Final Report presents the results of the project

2. Approach and results

The project work has been carried out during the period from November 2010 to December 2011. An Inception Report was prepared by the project group on the basis of the Technical Description in the Study Contract, the project proposal and the discussions between Commission and the project team at the kick-off meeting on 9 December 2010 and the inception meeting on 26 January 2011, both held in Brussels. A status or interim report was submitted in May 2011, and a draft final report was submitted on 9 December 2011 and resubmitted on 22 March 2012.

In order to gather the relevant information and discuss work in progress, stakeholders have been consulted, questionnaires have been sent to members of the TAC Mining Waste from EU-27, and two workshops have been organised. Two separate documents have been prepared:

1. Guidelines for the inspection of mining waste facilities, and
2. Supporting document on closure methodologies for closed and abandoned mining waste facilities.

These documents are included in this report as Annexes.

The questionnaires requested information on Member State inspection practices for mining waste facilities (national legislation, statutory instruments/regulation, defined inspections in terms of frequency, defined protocols, qualifications of inspector, statutory appointment, and reporting process, extent of inspection in terms of site visit, investigation and sampling, review of inspection and monitoring data, review of operating data, reporting process, recommendations, time table for any remedial actions, and inspection report in the public domain, and facilities in terms of divergence from the above for ponds, heaps, underground disposal, and in pit disposal.

They further requested information on types and numbers of extractive activities (commodities divided into 18 metals, 72 types of industrial minerals including 12 types of clay and 40 types of stone/aggregates, 8 types of mineral fuels including uranium) in each Member State. For each com-

modity information was requested on type of extractive activity (open pit/quarry, underground, in-situ leaching, sub-aqueous, and others), on the type of waste facilities (tailings pond, tailings heap, waste rock dumps/heaps, in-pit disposal, underground disposal, and others), the classification of facilities (Class A facilities, Seveso II facilities), the main environmental issues (physical damage, contaminant leaching, acid rock drainage (ARD), fugitive dust, land use, and others), and risk of trans-boundary effects. This information was requested for operating facilities and facilities under care and maintenance, for closed/abandoned facilities, and for planned facilities.

Finally the Member States were asked about their views on a revision of the BAT document (BREF, 2009).

The questionnaires for all 27 EU Member States were filled out in part by the project team and submitted to the members of the TAC Mining Waste for review and completion. It was believed that the fact that the questionnaires were prepared like this would facilitate the responding process. However, despite reminders, only a few questionnaires were filled out and returned, and little additional information was obtained in this way. Instead the project team received considerable contributions from several Member States in the form of national regulations, reports, papers and comments to the documents produced. The 27 questionnaires filled out by the project team and in a few cases completed/verified by the TAC members (Belgium, Czech Republic, Ireland, Portugal, Slovakia, Romania, United Kingdom) are available from the following sharepoint web-site:

<http://mwf-info.team.dk.dhigroup.com> , user name: "TACMW", password: "TAC".

This site will stay open for some time (well beyond May 2012 where more complete information will be available from the reporting on the Member States to Commission on the implementation of the Mining Waste Directive) but the Commission may want to move the files to its own website.

3. The workshops

Two workshops were organised as part of the project.

The first workshop was a one-day meeting held in Brussels at the premises of EU Commission on 30 June 2011. 30 participants attended the meeting, representing stakeholders including Member State authorities (legislators, regulators, and inspectors), the EU Commission and the extractive industry. At the workshop the first outline of the Guidelines for the inspection of mining waste facilities was discussed and commented, and the need for a revision of the BREF/BAT document was discussed. Several participants submitted written comments to the project team after the workshop.

The second workshop was three-day meeting held in Lisbon on 21 to 23 September 2011 and hosted by Empresa de Desenvolvimento Mineiro (EDM, Mining Development Enterprise). The 37 participants were again stakeholders representing Member State authorities (legislators, regulators, and inspectors), the EU Commission and the extractive industry. The first day was dedicated to a detailed discussion of the second draft of Guidelines for the inspection of mining waste facilities as well as a second discussion of the need for a revision of the BREF/BAT document. On the second day, several of the participants gave presentations on the subject of closure abandoned mining waste facilities and mines, and a first annotated outline of the Supporting document on closure methodologies for closed and abandoned mining waste facilities was discussed and commented. On the third day, the Portuguese hosts had organised a field trip to operating and abandoned mining waste facilities relevant to the subject of the workshop. After the workshop several of the participants sent written comments on the Guideline on for the inspection of mining waste facilities and the Supporting document on closure methodologies for closed and abandoned mining waste facilities. Some Member State representatives also sent supplementary information on these issues.

The programmes and the minutes of the two workshops as well as lists of participants are included as Annex 1.

4. Main types of facilities and associated environmental risks

The types of mining operations occurring in the EU-27 include metals (e.g. iron, zinc, copper, lead, gold, silver, manganese, bauxite, nickel, chromium, molybdenum, tungsten, etc.), industrial minerals (e.g. calcium carbonate, dolomite, limestone, rock salt, potash, bentonite, ceramic clay, granite, marble, etc.) and mineral fuels (e.g. anthracite, bituminous coal, brown coal, lignite, peat, oil shale, uranium, etc.). For further details, e.g. estimates of numbers of operating sites in Member States, please refer to the above mentioned questionnaires on the sharepoint web-site.

Table 4.1 provides an overview of the most commonly occurring waste facilities for the different main categories of extractive operations and waste types and some of the associated potential environmental issues. More details can be found in Annex 2.

Table 4.1 Extractive operations, waste and disposal sites and potential environmental issues.

Extractive operation	Overburden	Waste rock	Tailings/silt	Potential environmental issues
Aggregates	Tipped in heaps	Tipped in heaps	Tipped in heaps	Dust from exposed facilities
Construction materials	Backfilled into void	Backfilled into void	Deposited in lagoons or TMFs	Contaminated seepages
Dimension stones				Occasional ARD Tip/slope failure Failure of containment structures
Industrial minerals	Tipped into heaps Backfilled into voids	Tipped in heaps Backfilled into voids	Tipped in heaps Deposited in lagoons or TMFs	Dust from exposed facilities Contaminated seepages Leaching of process chemicals Tip/slope failure Failure of containment structures
Salt/potash		Managed in heaps	Underground backfill Deep well disposal	Salinity of run-off
Metals	Tipped in heaps Backfilled into voids Construction use	Tipped into heaps Backfilled into void Underground backfill Construction use	Deposited in TMFs Used to backfill voids Underground backfill	Dust from exposed facilities Contaminated seepages Leaching of process chemicals Tip/slope failures Failure of containment structures ARD of both waste rock and tailings
Energy minerals Coal/lignite/uranium	Tipped in heaps Backfilled into voids	Tipped in heaps Backfilled into voids	Tipped in heaps Deposited in TMFs	Dust from exposed facilities Contaminated seepages Leaching of process chemicals Tip/slope failures Failure of containment structures ARD of both waste rock and tailings Reactive waste Spontaneous ignition

The main types of mining waste facilities in Europe, including both operating and closed or abandoned sites, are shown and described in table 4.2 which also shows some examples of sub-categories of sites. The table also provides an indication of the main potential impacts or problems associated with the different categories of facilities. This will influence the strategies for inspection of facilities and for rehabilitation of closed/abandoned facilities, particularly when, prioritisation of the use of the resources available for inspection and rehabilitation is necessary. In both cases, mining waste facilities that are classified as Category A facilities according to the MWD and Commission Decision 2009/337/EC on the criteria for classification of waste facilities in accordance with Annex III in the MWD or as Seveso II facilities to Directive 2003/105/EC should always have highest priority and no exemption from inspection should be possible for such facilities. Table 4.3 shows the criteria to be evaluated when classifying a facility as Category A or not Category A and lists in generic terms the potential source, pathways and receptors associated with the risk (or consequence) assessment. Table 4.4 further show some examples of incorrect operation of facilities as well as the potential consequences that may result from this. These issues may be subject to particular attention during inspections.

Table 4.2 Main categories of mining waste facilities and associated potential impacts/problems.

Main categories of facilities	Subcategories (examples)	Main associated potential impacts/problems
Ponds/lagoons Constructed for the disposal of waste in slurry or paste form which normally involves some kind of confining structure on top or below surrounding ground level. Different variations exist depending on location (valley type, paddock type, etc.), different dam construction methods (centre line, up-stream or down-stream methods, etc.), dam construction material (clay, moraine, tailings, etc.), deposition method for the tailings (under water deposition, beach deposition, etc.).	Tailings management facilities (TMFs) Silt lagoons Sludge ponds from sedimentation and deposition of sludge from water treatment	See tables 4.3 and 4.4
Heaps Constructed for disposal of solid waste. Containing structures are normally not necessary.	Spent ore heap - waste from heap leaching. Normal leaching chemicals are cyanide or acids. Waste-rock heap - waste from accessing the mineral resource. Spoil heap - waste from sorting of ore. Fine waste-rock dump - waste rock from sorting of ore by mechanical (e.g., gravity), optical or magnetic means.	See tables 4.3 and 4.4
Lake disposal facilities	From disposal of extractive waste in lakes	Contaminated sediments, contaminated water, unstable bottoms and relocation by waves and currents, loss of land and restrictions on land use
Sea disposal facilities	From disposal of extractive waste in the sea	Contaminated sediments, contaminated water, unstable bottoms and relocation by waves and currents, loss of land and restrictions on land use
Riverine disposal facilities	From disposal of extractive waste in rivers	Contaminated sediments, contaminated water, unstable bottoms and relocation by waves and currents, loss of land and restrictions on land use, trans-border effects

Table 4.3 The potential risks that are assessed during classification of mining waste facilities as Category A or not Category A.

Potential risk	Potential source	Potential pathway	Potential receptor
Loss of structural integrity	Physical movement of waste, water and confining structures	Movement over land, and transport by surface water bodies, groundwater and air (fugitive dust)	Humans and the downstream environment (terrestrial and aquatic environment, groundwater, surface water)
Incorrect operation or closure	May lead to physical or chemical instability of the facility and the waste. See also table 4.4	Air, soil, groundwater, surface water, sediments	Humans, the environment and facility structures
Contains hazardous waste	The waste itself (direct exposure and fugitive dust), leachate from the waste	Air, soil, groundwater, surface water, sediments	Humans and the environment, in particular surface water, groundwater and sediments
Contains dangerous substances/preparations	The aqueous phase of the waste in a tailings pond	Soil, groundwater, surface water, sediments	Humans and the environment (in particular surface water, groundwater and sediments),

Table 4.4. Some examples of potential consequences of incorrect operation of various environmental protection measures as part of mining waste facilities.

Environmental protection measure	Purpose of measure	Potential consequences of incorrect operation
Bottom liners, drainage and leachate collection (ditches or wells) and treatment systems Most relevant to the operation period	Leachate collected and treated before discharged	All leachate leaks to the environment – or the leachate is not treated before discharge (long-term situation)
Dry top cover to reduce the rate of infiltration Most relevant to the after-closure period	Reduces the flux of contaminants but prolongs the leaching period	Does not function and allows up to 100 % of general infiltration, depending on the conditions
Dry top cover to minimise influx of oxygen Most relevant to the after-closure period	Prevents/reduces oxidation of potentially ARD generating waste and other reactive waste (also used to prevent self-ignition)	Does not function/is disrupted and allows oxidation of potentially ARD generating waste and other reactive waste
Wet covers (under water storage) to prevent oxidation Relevant both to the operation and the after-closure period	Prevents/reduces oxidation of potentially ARD generating waste and other reactive waste	Does not function – dries out or is diverted and allows oxidation of potentially ARD generating waste and other reactive waste
Selective management (e.g. segregation of different (incompatible) types of waste) Relevant both to the operation and the after-closure period	Prevents/reduces undesired waste/waste interactions (e.g. acidification of non-acidic waste from ARD producing waste)	Incompatible types of waste are mixed/landfilled together and causes an increased level of contamination
Compaction Relevant both to the operation and the aftercare period	Minimise oxygen transport into potentially ARD generating waste or self-igniting waste	Compaction does not have the intended effect and does not reduce oxygen transport to the desired levels
Treatment of leachate or waste Most relevant to the operation period	Minimise contaminant release in discharged water from the facility	Treatment is interrupted and discharge contain elevated levels of contaminants
Back-pumping Most relevant to the operation period	Leakage/drainage from the facility is back-pumped to the facility to minimise contaminant transport to the environment	Back-pumping is in-effective or interrupted

Some of the potential impacts on the environment or humans that may occur from malfunctioning of operating or abandoned mining waste facilities are instant or quick and the resulting impacts on the environment may only remain for a short period of time due to remedial actions or due to their nature (e.g. sudden releases of acid- or cyanide-containing liquids into a river system) or they may constitute problems that may remain over a longer period of time (e.g. release of large masses of ARD-producing tailings into water bodies or onto land). Other potential impacts may occur from sources that develop and remain over very long periods of time and in some cases many years after closure or abandonment of the waste facility (this is often the case for problems involving production and release of acid seepage from facilities containing ARD-producing/sulphidic mining waste). Inspection procedures should therefore be tailored to the time-scale of the relevant potential issues and also take measures to avoid or minimise potential long term problems into account. The same is true for rehabilitation measures to be taken for closed or abandoned facilities.

For larger facilities, in particular TMFs containing ARD-producing waste or other hazardous wastes and systems containing cyanide or red mud, located near a river or waterway that passes a (downstream) border to another Member State or similar facilities located near the border to another Member State, there may be a risk of trans-boundary contamination. In those cases, which in principle may involve both operating and abandoned facilities, a communication system should be set up between the Competent Authorities in both Member States to ensure that the neighbouring MS receives all relevant information and results from the inspections.

5. The Guidelines on inspection of mining waste facilities

The Guidelines on inspection of mining waste facilities are included as Annex 2. Some of the background information for the document has been addressed in chapters 2, 3 and 4. Some information on the required resources can be found in the document in Annex 2.

The Guidelines are intended to provide a framework for inspections for all extractive waste facilities across the EU and to facilitate compliance with the Mining Waste Directive, MWD (Directive 2006/21/EC on the management of waste from extractive industries and amending Directive 2004/35/EC). In particular, the document is intended to give guidance on inspections by the Competent Authority according to Article 17 of the MWD. In order to optimise the resources and efforts applied by the Competent Authority, it is important for the Competent Authority to fully understand, appreciate and be able to evaluate the monitoring and inspections performed by the operator. Thus, significant effort has been spent on describing and summarising the monitoring and inspection regime of the operator according to legal obligations (Article 11.2 of the MWD), BAT, and best practice as well as corporate policies. Independent Experts are used by operators to inspect the facilities on a regular basis. The option for the Competent Authority or Competent Authorities (in most Member States inspections will involve more than one public institution) to use Independent Experts in inspections of extractive waste facilities is highlighted and recommended, specifically if the Competent Authority does not have the required experience in-house. The aim of this guidance is to support the Member States in ensuring that the inspection strategies and plans for all types of mine waste facilities comply with best practice and to be accord with Article 22 of the MWD.

The document presents non-prescriptive guidance for all Competent Authorities and for other stakeholders who may not be as familiar with technical or procedural aspects of the inspection of extractive waste facilities and the requirements of the MWD. It presents guidance which is based on the generally accepted principles for the inspection and monitoring of extractive waste facilities which enable compliance with best practice. The guidance presents an outline for inspections which can be used to develop site-specific regimes where none currently exist or, where there is a fully developed system, to reinforce or update existing inspection regimes.

Competent Authorities are obliged to carry out regular **inspections** to assure the compliance of the facility in comparison to the control referential (i.e. the permit and applicable legislation). The inspection also covers the operating conditions.

The application of **monitoring and inspection procedures** is in general in the **responsibility of the operator**. However, the monitoring and inspection plan has to be prepared according to the legislation, the permit as well as BAT and in close cooperation with the competent authority. The operator is also obliged to **report** on the results of the monitoring and inspection program on request and on a regular basis.

The **operator** use **Independent Experts** to perform inspections on a regular basis and to supervise, improve and audit the management of the facility according to relevant legislation, BAT, best practice and company policy. The **Competent Authority** may also appoint Independent Experts to perform inspections or to validate monitoring and inspection reports from the operator.

The guidance recognises the site specific nature of extractive waste, the containment facility and thus the inspection and monitoring requirements. However, the document recognises that there are minimum standards for inspection and monitoring and thus provides recommendation for the minimum requirements for those facilities which pose a significant risk. **In order to guarantee that minimum standards on inspections of extractive waste facilities are implemented throughout the EU27 it is recommended to develop a Commission Decision on Minimum inspection requirements for extractive waste facilities, which should be approved by the Technical Adaptation Committee (TAC) in agreement with article 23 of the MWD. The minimum inspection requirements should focus particularly but not exclusively on Category A facilities.**

The Guideline presents in Section 2 the legislative background to the requirement for inspections of extractive waste facilities focusing on the inspections by the Competent Authority. Section 3 addresses the inspections to be undertaken by the Competent Authority and its role as required in Article 17 of the MWD. In order to facilitate the inspections by the Competent Authority, the guideline recognises the Operators need for adopting the requirements of Article 4 (general requirement regarding application of BAT) and Article 11.2 of the MWD and the importance to the inspection of a Competent Authority. The competence of the Competent Authorities' inspection procedures is therefore reliant on the assumption that there is an existing inspection and monitoring regime as required in Article 11.2 (c) and in BREF (2009). Furthermore, Article 11 requires operators to report all monitoring results in an aggregated format to the Competent Authority on a frequency decided by the Competent Authority or at least once a year for the purposes of demonstrating compliance with permit conditions and increasing knowledge of waste and waste facility behaviour. On the basis of this report the Competent Authority may decide that validation by an Independent Expert is necessary.

The Guideline assumes that all operating facilities to which Article 11 of the MWD and BAT (BREF, 2009) is applicable are in the hands of a Competent Person and subject to monitoring and inspections by Operators who use Independent Experts on a regular basis for inspection of the facility (Section 4 and 5), and that aggregated reports from these inspections and the associated monitoring data form the basis for the Competent Authorities' own inspection and reporting. Sections 4 and 5 are therefore mainly intended as background information to assist the Competent Authority in planning inspections, optimising resources and to assure implementation of best practice and support compliance with the MWD in the case of operating facilities.

However, if for any reason the management of a facility does not fall under or comply with Article 11 of the MWD and there is no existing monitoring and inspection regime at a facility, which may be the case for closed and abandoned facilities, the Competent Authority would need to require that satisfactory and suitable monitoring and inspection protocols be put in place. In an extreme case, where no such regime exists, if there is no responsible Operator or if the Operator is unwilling to initiate one, the Competent Authority itself should undertake all activities outlined in Sections 4 and 5, if necessary assisted by Independent Experts. Such a system of monitoring & inspection should be in place at all facilities on the register unless they have been adequately closed and the effectiveness of the closure has been validated.

It is important to recognise that, without the required and appropriate levels of monitoring & inspection of all extractive waste facilities by persons with the correct competence and the implementation of the associated recommendations, the risks of failure and of danger to life and the environment are increased.

An annotated outline of the Guidelines were distributed to the participants of workshop 1 and presented at the workshop. Numerous comments were received during and after the workshop (see Annex 1), and partly based on that a new draft version of the guidelines were distributed to the participants and presented at workshop 2. A considerable number of valuable comments were again received during and after the workshop. Comments made during the workshop are documented in Annex 1 and comments received after the workshop are listed in Annex 4. Because of the number of comments and since the Guidelines have been restructured substantially and further developed since the workshops, a detailed account of how each comment has been addressed is not considered useful. Much of the advice given has been incorporated into the final version of the Guidelines, and many of the practical and editorial issues (e.g. the use of consistent terminology reflecting the terminology of the MWD, inclusions of terms and definitions, etc.) have been attended to. There were differing views between the stakeholders (including the Commission) on several issues. In particular the degree of detail to which “check-lists” should be elaborated gave rise to disagreement between those who were afraid that a detailed list of issues to be inspected would tempt unqualified persons to perform insufficient inspections, and others who would welcome a “cook-book” to help authorities with little or no experience to get started on required inspections. In the Guidelines it has been attempted to find a reasonable balance between these views, i.e. to produce a document which can be useful while at the same time emphasising that only persons with proper qualifications must carry out inspections. Other issues that caused diverging opinions were the interpretation of parts of the legal background for inspections and the degree of prescriptiveness. The Guideline is not a legal document, and it is meant to provide the best possible advice, but the implementation of the inspection requirements is still in the hands of the Competent Authorities in the Member States. Member States that have well-functioning inspection routines in place are not required to change them to follow the Guidelines, but may still find useful information there. The same is true for operators of mining waste facilities.

6. The Supporting document on closure methodologies for closed and abandoned mining waste facilities

The Supporting document on closure methodologies for closed and abandoned mining waste facilities is included as Annex 3. Some of the background information for the document has been addressed in chapters 2, 3 and 4.

In the introduction, the supporting document discusses the legal background and the mandate (Article 20 and Article 21 of the MWD), i.e. that MSs are required to draw up an inventory of potentially problematic closed or abandoned mining waste facilities and to take measures (Article 4) to protect human health and the environment against harmful impacts from such facilities, and that the Commission is required to ensure an appropriate exchange of information between MSs on the rehabilitation of closed mining waste facilities. A screening document for the inventory has been produced by the TAC

and the Commission (Stanley et al., 2011). The supporting document summarises the international experience of addressing closed and abandoned facilities and refers to large programmes in the USA and Canada. In addition, some recent guidelines on mine closure, which are also relevant to closed and abandoned mining waste facilities, are mentioned. Based on this background a general framework or strategy for closure and remediation of closed and abandoned facilities is proposed, consisting of the following sequential steps: Screening, development of an inventory, prioritisation + listing + estimation of cost, performance of detailed investigations, consideration of remedial options and costing, detailed design and implementation, follow-up and feedback, and long-term stewardship. Finally the document provides some guidance on remedial options, mostly referring to major guidelines specific issues, an indicative list on remedial options for common problems, and an indicative list of the costs related to remediation of facilities. As an external appendix to the supporting document, a report produced by the Portuguese institutions, Empresa de Desenvolvimento Mineiro (EDM) and Direção Geral de Energia e Geologia, "The legacy of abandoned mines" from 2011 is attached.

A draft version of the document was distributed prior to and discussed during workshop 2. Several comments were received during and after the workshop and incorporated into the draft final version submitted to the Commission on 9 December 2011. Only minor changes have been made to the draft final version in the preparation of this final version of the supporting document. A list of the written comments received and how they were addressed is included as Annex 5.

7. Assessment of the need to revise the BREF/BAT document

7.1 Objective

The objectives of this note are to support the Commission in reviewing the BREF document on mining waste and assessing the opportunity to launch a revision of the BREFs. As part of this assessment DHI has reviewed:

- fundamental changes since the development of the BREF
- the main expected developments in the EU mining sector for the coming 10 years and to identify future mining projects within the EU.
- recent technological developments in the mining sector and compared the result to the content of the BREF.
- whether a review of the BREF document for specific sectors should be recommended, with specific emphasis on the sectors for which new developments have occurred or are expected in the EU.

Views and comments have been received from several stakeholders during two workshops held in Brussels and Lisbon, respectively, in 2011.

7.2 Fundamental changes since the development of the BREF

The BREF document on the Management of Tailings and Waste-rock in Mining Activities was developed during the years 2001-2004, i.e., approximately 10 years ago. To a large extent the BREF document was developed in parallel with the MWD 2004/35/EC and then amended by 2006/21/EC. However, the BREF document was completed before the directive and in particular, before the implementation work related to the directive was developed. This has led to the fact that the scope of the BREF-document and the MWD directive do not coincide. In particular, the scope of the MWD is much wider and not limited to the 14 metals, 10 industrial minerals and to some extent coal. An example of this is manifested in the Commission Staff working paper (SEC(2011) 340 final) on the situation concerning

uranium mine and mill tailings in the European union, where it is clearly stated that uranium mining will be included in the reference document for best available techniques during the next revision of the document.

Since the BREF-document was produced EU 15 has developed into EU 27. This means that 12 member states have not participated in the information exchange related to the BREF-document.

Numerous new "best practice" and "guidelines" have been developed worldwide since the BREF-document was developed (e.g., the GARD-Guide, ICOLD bulletins on Tailings Dams Safety as well as the bulletin on Sustainable design and post-closure performance of tailings ponds, the MAC 2011 guideline on audits) and within the EU (e.g., Mining RIDAS 2010, Finnish best practice guidance on extractive waste management 2011).

In addition, various decisions have been developed in relation to the implementation of, and according, to the MWD:

[Commission Decision 2009/337/EC on the Criteria for the classification of waste facilities in accordance with Annex III,](#)

[Commission Decision 2009/335/EC on the Technical guidelines for the establishment of the financial guarantee,](#)

[Commission Decision 2009/360/EC completing the technical requirements for waste characterisation,](#)

[Commission Decision 2009/359/EC on the Definition of inert waste in implementation of Article 22 \(1\)\(f\), Commission Decision 2009/358/EC on the Harmonisation, the regular transmission of the information and the questionnaire referred to in Articles 22\(1\) \(a\) and 18,](#)

Furthermore, significant guidance has been and is being developed to support the implementation of the MWD such as four guideline documents (technical reports, TR), one technical specification (TS) document and one standard developed by CEN/TC292/WG8:

- Overall Guidance for characterising waste from the extractive industry (TR);
- Sampling Guidelines (TR);
- Kinetic testing guidelines (TR); and
- Sampling and Analysis of Cyanides (WAD) in tailings ponds (TS)
- Standard (EN15875) for static determination of acid and neutralisation potential of sulphidic waste (Acid Base Accounting).

Guidelines are being developed on inspections of extractive waste facilities and supporting documents are being developed on closure of closed and abandoned facilities.

All in all this means that the current BREF on management of tailings and waste-rock from the extractive industry does not reflect the scope of the MWD and is not coherent with the status of many of the technical best practice developed over recent years.

There has also been an evolution of the BREFs under the new Industrial Emission Directive IED (2010/75/EU) where the new BREFs developed under IED include BAT conclusions that contain emission level values based on BAT. The competent authorities shall set emission limit values that ensure that, under normal operating conditions, emissions do not exceed the emission level values associated with the best available techniques as laid down in the decisions on BAT conclusions.

7.3 Likely developments in the EU mining sector for the coming 10 years

As well summarised by the communication from the Commission to the European Parliament tackling the challenges in commodity markets and on raw materials (COM(2011) 25 final), the global metal and mineral markets generally follow a cyclical pattern based on supply and demand. However, the period 2002-2008 was marked by a major rise in demand for raw materials driven by strong global economic growth, in particular in emerging countries. This was reflected in unprecedentedly high price levels. Recent trends indicate that demand for raw materials will be driven once more by the future development of emerging economies and by the rapid diffusion of key enabling technologies.

This development led to that the fundamental conditions for the European mining industry changed remarkably over the last 10 years, from being an industry struggling to survive and turning into an industry with a positive view of the future. The political stability in the EU27 attracts investors and the public opinion is becoming more positive towards mining, which is also reflected in strategic initiatives on EU-level such as the European Raw Materials Initiative. Furthermore, prices are currently, despite of the economic crisis, reasonable for most commodities as a consequence of the high demand from emerging economies. This has resulted in an increased exploration activity throughout Europe, expansion and increased production at existing mining operations and increased efforts to permit new mining projects.

In addition, despite the recent incidents in Japan, a global change in the attitude towards nuclear energy production has led to renewed interests in uranium mining. Currently uranium prices are kept back as uranium generated by reprocessing of dismantled nuclear weapons (mainly Russian) is supplied to the market, but prices are expected to rise in the medium-term.

Throughout the mining industry there is, and there will be, a general trend towards obtaining more value from each ton ore extracted, by extracting additional value minerals (e.g., Rare Earth Metals - REM) or by producing higher quality concentrates or pure metals/minerals, and towards extracting more difficult ores (in the sense of processing). This will lead to "new" beneficiation processes being implemented often based on leaching technology which in turn will produce extractive waste (sludges and leached materials) with other material characteristics than considered in the BAT-document. Such "new" types of waste may/will require different types of waste disposal methodologies than commonly applied until date within the extractive industry. Heap-leach operations are likely to become more common as lower grade ores will be extracted and processed.

Gold extraction using cyanide is likely to increase significantly within EU27 unless the cyanide ban within the mining sector becomes effective. New gold mines and re-opened gold mines will come into production over the next coming years. In addition, many base metal mines are looking at introducing leaching of the tailings which in many cases contain residual gold. Most sites consider tank leaching. Cyanide destruction is an integral part of the process design, however, internal cyanide re-cycling, is getting more attention. On the one hand it reduces costs for process chemicals (in processing and in destruction) and on the other hand cyanide re-cycling reduces the resulting nitrogen concentration in the discharge to the recipient.

Almost 15 years has now passed since the Aznalcóllar accident in year 1998 which together with the Baia Mare accident in year 2000 (see Figure 1) triggered an intensified development and evolution within waste management and dam safety management in Europe and worldwide. These unfortunate accidents have led to significant changes in extractive waste management procedures and methodology. To some extent this has led to changes in waste deposition technology and facility constructions technology. This is a process that will continue over time and facilities designed and operated according to old practice will be adapted or substituted for facilities that comply with the conditions of the MWD and to BAT. It is expected that this trend will continue within the European mining industry in the

future and that unfortunate accidents, like the red mud accident in Kolontar in Hungary in October 2010, will cease to occur.

The improved economic situation, increased environmental awareness and recent legal developments (e.g., the WFD) has led to, and will to, increased efforts in relation to minimising emissions. It is expected that this trend will continue over the next coming 10 years.

With increasing energy prices, shale gas and shale oil extraction is obtaining new attention. Shale oil extraction is mainly performed in Estonia, but may become economically viable in other parts of Europe.

In summary, the extractive industry in Europe is expected to develop significantly over the next-coming 10 years. Old mines will be re-opened and old mining waste may become reprocessed (which is an opportunity to address old liabilities), existing mines will be expanded and new mines will be opened. An increased amount of commodities will be produced, in new mines and from extracting additional commodities from ores that are already being extracted. This will result in new processing techniques which in turn will generate extractive waste with different characteristics compared to what we are currently managing. The trend in implementing more sophisticated waste management procedures will continue and also be implemented on more sectors of the industry.



Figure 1 The failed TMF at Baia Mare in February year 2000.

7.4 Recent technological developments in the mining sector

The main areas in which significant developments and changes have been accomplished over recent years within the mining sector include:

- Processing techniques: New commodities, re-processing of old extractive waste and the development of more difficult ores is resulting in implementation of more leaching based processing technology. This includes heap-leaching and tank leaching, bio-leaching, leaching at modified temperature and/or pressure. Extracting additional commodities from the extracted ores may imply, apart from additional processing techniques, additional re-grinding resulting in finer tailings as the end waste product and it may also change the environmental characteristics of the tailings. Leaching processes often result in increased production of sludges which may require selective handling.

Sludge management is not adequately addressed in the current version of the BREF. Leached out heap-leach facilities may require close out measures that are not addressed in the BREF. The scope should be expanded, and if possible, not excluding any commodities, but as a minimum include all commodities extracted with EU27, e.g., waste from uranium mining, shale gas and shale oil extraction needs to be within the scope.

- Deposition methods: Over recent years dry tailings disposal, paste tailings and thickened tailings disposal have become used technologies also for potentially acid generating tailings. Even in already operating mines, paste disposal has been introduced and the the TMF converted into a paste tailings facility. Di-pyritisation and selective management of high-sulphide tailings is being implemented at various sites as a valid method for minimising environmental liabilities and closure costs. Much focus has been devoted to minimise dust emissions developing the disposal method using spigotting or paste, but also by binder materials, temporary covers on exposed areas and by competence building. Paste disposal of potentially acid generating tailings has not been sufficiently addressed in the BREF nor has the effect of different disposal techniques on dust emissions. Marine tailings management was treated in a superficial way in the BAT-document due to lack of information. Marine tailings management in the form of Deep Sea Tailings Placement (DSTP) (>100m) and Sea Tailings Placement (STP) (<100 m) is allowed in Norway. The OSPAR Convention, Annex II, Article3, 2(b) states that "inert material of natural origin, that is solid, chemically unprocessed geological material the chemical constituents of which are unlikely to be released into the marine environment" are exempt from the ban on placement in Norwegian fjords. Currently there are 6 STPs in operation in Norway (with discharges from 300 000 to 4 million tons/year), and 17 fjord- or near-coastal sites in Norway where mining tailings have been deposited in the past. In the pending project at Engebøfjellet in Førdefjorden, the application asks for 7 million tons/year to be deposited over 40 years.
- Construction and performance of facilities: There are mainly three trends developing with regard to the construction and performance of facilities. For conventional tailings slurry disposal the upstream method using the coarse fraction of the tailings as the construction material has become much more common. This is a safe and resource-effective construction method, however it also has potential drawbacks such as accumulation of sulphide rich materials in the area in and next to the dams (with implications for both the operational and the long-term phase), limitations in the possible increase rate and monitoring requirements. On the other hand the use of liners, especially bottom liners, is becoming more commonly required. The performance, potential advantages, limitations and the risks related to the use of liners needs to be better addressed in the BREF. Finally, facilities are now becoming planned using sustainable long-term design and full-out life cycle planning. The methodologies for sustainable long-term design of facilities have developed significantly and are not sufficiently addressed in the BREF.
- Management procedures: All facilities permitted under the MWD should comply with the requirements of the directive by May 2012. Amongst other requirements, a waste management plan needs to be in place. Having developed waste management plans all these facilities in Europe should have led to a large knowledge basis that could be compiled and summarised in the BREF for all member states to benefit from. In addition, significant progress has been obtained in relation to management procedures, e.g., the development of Mining-RIDAS (2010) and the guideline on Inspections being developed by the Commission, which is only partly addressed in the BREF. Monitoring and follow-up of performance of facilities need to be better addressed in the BREF.
- Waste characterisation: The [Commission Decision 2009/360/EC completing the technical requirements for waste characterisation](#) has outlined how waste characterisation needs to be performed in order to fulfil the requirements of the MWD. Significant guidance has been, and is being, developed to support the implementation of the MWD such as the four guideline documents (technical reports, TR), one technical specification (TS) document and one standard developed by CEN292-WG8. These new developments should be reflected in the BREF.

- Minimisation of emissions: Stricter environmental legislation and increased awareness is leading to further reduced emissions. In particular, developments in minimising emissions to water and emissions to air (dust) are being implemented. Focus is now being placed on “new” contaminants such as thiosalts (which are not completely oxidised sulphur compounds that are generated when processing ores containing sulphides), see Figure 2, and on nitrogen compounds (originating mainly from the explosives used in the ore extraction and from cyanide destruction processes where applicable) and treatment technologies have been developed or adapted to the circumstances related to these particular types of wastewater. Process developments and environmental aspects are making cyanide recovery processes more economically viable/necessary, especially if N-treatment may be required before discharging water from facilities. These developments need to be reflected in the BREF.



Figure 2 Treatment facility under construction for treating thiosalts using the Fenton-process at the Hötjäm TMF in northern Sweden.

7.5 Consultation process

The issue of a possible review of the BREF has been discussed at two stakeholder workshops organised by the Commission during year 2011 (Brussels 30 June and Lisbon 21-23 September). The position of the various stakeholders has been summarised in the minutes from the workshops (Annex 1). In summary, the opinions are to some extent contradictory. Most stakeholders agree on that a review and actualisation of the BREF is necessary. Some stakeholders request a review and urgent review and one member state (Finland) has actually developed their own series of up-dated BREFs as they found the need so urgent in the light of the rapid development and boom with in the mining sector in Finland. Other stakeholders do not see the need, or propose that it would be more appropriate to amend the BREF rather than reviewing the entire document.

In addition, Member states were asked to fill out questions regarding the potential to review the BREF in a questionnaire. However, there was very little response to then questionnaire, maybe because the Member States had already expressed their opinions at the workshops. Nevertheless, it is worth mentioning that Portugal requests a review of the BREF regarding paste tailings disposal and in particular the applicability of the method for potentially acid generating tailings.

7.6 Conclusions and recommendations on the revision of the BREF

In the light of the MWD, the recent decisions, the new definition of BAT and the new approach taken for the BREF's in line with the Directive on Industrial emissions, recent guidance documents and having reviewed the current situation in the European mining industry and the outlook for the coming 10 years, where demand for natural resources including new sources of energy like shale gas and oil will be governed by the growth in developing economies, it can be concluded that the scope of the BREF needs to be expanded to cover the scope of the MWD, i.e., not excluding any commodities by limiting the scope to a few metals and minerals and fully addressing the developments that the new guidance documents imply.

DHI recommends a review of the BREF to be initiated, where a starting point could be the areas of development described in this study.

8. References

BREF (2009): The Reference Document on Best Available Techniques for Management of Tailings and Waste Rock in Mining Activities, European Commission, JRC, Institute for Prospective Technological Studies, Seville, Spain. Produced in 2004 but formally adopted by the EU Commission as 2009/C81/06 on 7 January 2009.

Stanley, G., Jordan, G., Hamór, T. (2011): Guidance document for a risk-based pre-selection protocol for the inventory of closed waste facilities as required by Article 20 of Directive 2006/21/EC. Inventory of Closed Waste Facilities Ad-Hoc Group, A Sub-Committee of the Technical Adaptation Committee for Directive 2006/21/EC. Can be downloaded from the EU Commission web-site.

Separate reference lists are provided in the guidance document on inspection (Annex 2) and the supporting document on closure methodologies for closed and abandoned mining waste facilities (Annex 3).