**Factsheet & checklist**

**Sector: Quarries & mines**

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**List of Acronyms**

|  |  |
| --- | --- |
| ARD | Acid rock drainage |
| BATs | Best Available Techniques |
| BAT-AEL | Emission Levels Associated with the Best Available Techniques |
| BREFs | Best Available Techniques Reference Document |
| CWW BREF | Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW BREF) |
| DTH | Down the hole |
| EC | European Commission |
| EFS BREF | Reference Document on Best Available Techniques on Emissions from Storage |
| ELV | Emission Limit Values |
| EMS | Environmental Management System |
| ENE BREF | Reference Document on Best Available Techniques for Energy Efficiency |
| E-PRTR | European Pollutant Release and Transfer Register |
| ETS | Emissions Trading System |
| EWC | European Waste Catalogue |
| IED | Industrial Emissions Directive 2010/75/EU |
| IMPEL | European Union network for the implementation and enforcement of environmental law |
| IPPC | Integrated Pollution Prevention and Control |
| IPPC A/B permit | A/B integrated environmental permit (as defined in LoE) |
| MoEPP | Ministry for Environment and Physical Planning |
| LCP | Large Combustion Plant |
| MTWR BREF | Reference Document on Best Available Techniques for Management of Tailings and Waste-Rock in Mining Activities |
| NFM BREF | Best Available Techniques (BAT) Reference Document for the Non-Ferrous Metals |
| PRTR | Pollutant Release and Transfer Register |
| RMCEI | Recommendation 2001/331/EC of the European Parliament and the Council providing for minimum criteria for environmental inspections in the Member States |
| SEA | Strategic Environmental Assessment |
| SEI | State Environmental Inspectorate |
| TMF | Tailings Management Facilities |
| WT-BREF | Reference Document on Best Available Techniques for the Waste Treatments Industries |
| WRMF | Waste-Rock Management Facilities |

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# Introduction

This factsheet for quarries and mines contains a short description of this sector as it exists and operates in the Republic of Macedonia. It will be necessary to update this document if the situation in the sector evolves substantially.

To prepare and execute well the environmental inspection of facilities within this sector, this document provides information for inspectors about how this industry works, what are its main environmental impact and pollution mitigation measures, and what are the key points for the inspection of these facilities, complemented by a practical inspection checklist. The goal is to facilitate the work of inspectors, ensuring a more uniform inspection approach and quality, and a level playing field for the operators.

Detailed information about production processes and Best Available Techniques (BATs) relevant for this sector can be found in the reference links and documents in Annex 1. This document provides a first introduction and is intended to be a practical tool for inspectors, and for that sake is kept brief.

# What are mines and quarries?

Mines and quarries are the sites in which the activities known as quarrying and mining are carried out.

Mining is the extraction of minerals from the earth which starts with the exploration and discovery of mineral deposits, continues with their exploitation, including the ore extraction and processing, and finishes with the closure and rehabilitation of work-out sites. This factsheet covers only the processing of minerals in mines and quarries.

For the purpose of their exploitation, minerals are classified as shown in Table 1:

Table 1: Classification of minerals

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Minerals | | | | | |
| Metals | | | Industrial minerals | Energy minerals | Construction minerals |
| Ferrous | Non-ferrous | Precious |
| Iron | Alumina  Cadmium  Chromium  Copper  Lead  Manganese  Mercury  Nickel  Tin  Tungsten  Zinc | Gold  Silver | Barytes  Borates  Feldspar  Fluorspar  Kaolin  Limestone1  Phosphate  Potash  Strontianite  Talc  Clay 2 | Hard coal 3  Lignite 4  Oil shale 5 | - Dimension stone: used for structural6 or decorative purposes 7:   * Marble * Granite * Slate * Limestone * Sandstone * Travertine * Alabaster * Soapstone * Serpentine   - Aggregates in a range of particle sizes (sand & gravel) + crushed rocks (e.g. chalk, limestone, sandstone, slate)  - Clay and shale used in earthworks, earthmoving and specialised engineering applications  - Gypsum |
| 1 Used as calcium carbonate and in the cement and lime industry  2 Used in the manufacture of ceramic products (in particular roofing tiles, bricks, refractory bricks, tiles, stoneware or porcelain)  3 Also termed ‘rock coal’ or ‘black coal’  4 Also termed ‘brown coal’  5 Relevant only in Estonia in Europe  6 Dimension stone for structural purposes is termed ‘structural stone’  7 Dimension stone for decorative purposes is termed ‘decorative stone’ | | | | | |

In this factsheet only mining of solids is covered, excluding thus oil and gas extraction.

Regarding the technique to extract the minerals, mining can be classified in surface mining and underground mining. Surface mining is the excavation of minerals to extract minerals which are closer to the surface and it implies the removal of the topsoil and the rock covering the mineral deposits, which is called the overburden. Underground mining happens when the minerals lie deep under the surface, and shafts and tunnels must be dug into the earth to extract the minerals. In underground mining only a small portion of the topsoil and the overburden is removed just in the opening of shafts and tunnels.

Quarries involve surface mining in which construction minerals are extracted. The extraction of construction minerals and aggregates in particular, represents the largest sub-sector of non-energy mining in the EU in terms of value and volume.



## Production process

In the mines and quarries the production process includes the following stages:

* Exploration
* Exploitation
* Closure and rehabilitation

### 2.1.1. Exploration

In the exploration stage the location, the extent and value of the mineral ore is determined in order to find out if the quantity and grade of mineral deposits is sufficient for a feasible exploitation project. This requires carrying out geological, geotechnical and geophysical as well as geochemical surveys, including soil and rock analyses.

For that purpose, the exploration stage may include the following operations:

* Land clearance
* Drilling and trenching
* Access road/trail construction for drilling/trenching equipment

In the Republic of Macedonia deep drillings carried out in the the exploratory stage of a mining project are included in the Annex II of the Decree for determining the projects and criteria for determining the need to conduct an environmental impact assessment (Official Gazette of Republic of Macedonia no. 74/05) (see Section 4.1.1), and as such, screening is required to determine if an Environmental Impact Assessment is necessary. Exploratory projects which include deep drillings may therefore be subjected to a separate Environmental Impact Assessment (EIA) procedure because impacts in this stage can be significant and because the project may not proceed when the quantities of high-grade deposits are not sufficient.

### 2.1.2. Exploitation

The exploitation stage includes the site preparation operations, the extraction and processing of minerals.

#### 2.1.2.1. Site preparation operations

Before the extraction actually starts some previous actions are carried out:

* Infrastructure and installations development:
  + Land clearance and earthworks for infrastructure and installations development
  + Construction of roads, power lines, conveyor belts, buildings (for staff, equipment, equipment maintenance, raw materials storage, hazardous substances and process chemicals storage, non-extractive hazardous waste storage), drainage system and other infrastructure (e.g. infrastructure for monitoring such as a network of water boreholes for groundwater sampling or wastewater sampling manholes and catch basins)
  + Construction of mineral processing installations
* Site preparation for the disposal of topsoil
* Site preparation for:
  + Ore storage
  + Overburden disposal, Overburden is the layer of surface material below the topsoil and on top of the ore body (or mineral deposit). In surface mining it has to be removed prior to ore extraction but not in underground mining
  + Waste-rock management facilities (WRMF), including facilities for disposal. Waste-rock (discard, dirt or spoil) is the part of the ore body, without or low grades of ore, which cannot be extracted and processed profitably. The ore body is a naturally occurring geological structure consisting of an accumulation of a desired mineral and waste-rock. Waste-rock management facilities include waste-rock heaps, and facilities for recycling (e.g. to produce construction aggregates).
  + Tailings management facilities, including facilities for disposal. Tailings are the discard that remains after the treatment of minerals by separation processes to remove the valuable minerals from less valuable rock. Tailings consist mainly of gangue (the non-desirable part of an ore) and may include process water, process chemicals and portions of the unrecovered minerals. The coarser and dryer fraction of the tailings are also called coarse discard as compared with fine discard, the finer and wetter fraction of the tailings, produced from the thickened or flocculated suspended solids in the wash water used to process and separate the desired product from the coarse discard by washing or floatation of the extracted minerals. Tailings management facilities (TMF) include:
    - Tailings dams/ponds
    - Tailings heaps
    - Facilities for backfilling
    - Facilities for recycling (e.g. to produce construction aggregates)
    - Facilities for reprocessing (extract the content of the ore by new better processing methods)
* Disruption of water courses

#### 2.1.2.2. Extraction

##### 2.1.2.2.1. Surface mining

When the ore lies near the surface and can be extracted by removing of layers of topsoil and waste-rock surface mining methods are used. Surface mining methods are currently prevalent due to their lower costs.

Those methods can be divided as follows:

* Mechanical excavation methods. Mechanical processes are employed in a dry environment to recover minerals. They include the following:
  + Open pit mining
    - Quarrying
  + Strip mining
  + Other methods (terrace mining)

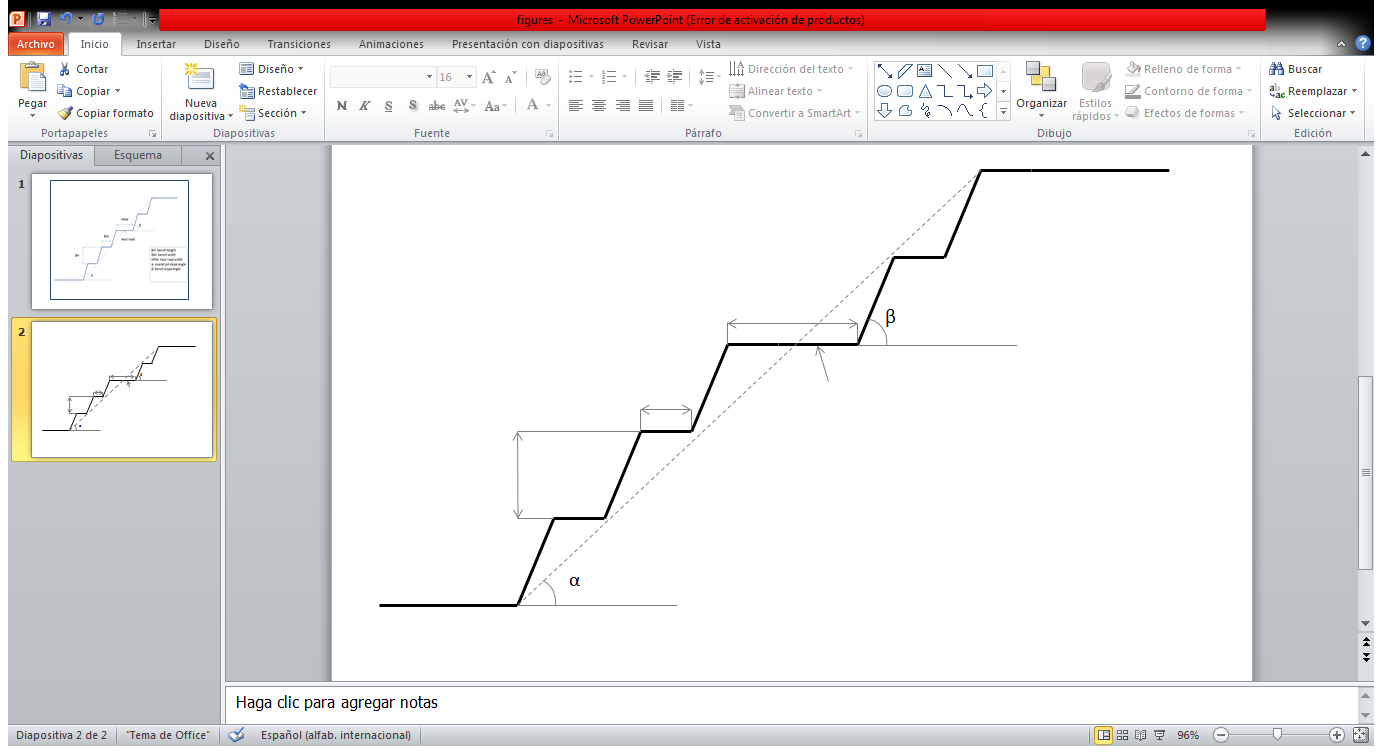
Aqueous methods. In most cases involves the use of water or a liquid solvent (e.g. diluted sulphuric acid, weak cyanide solution or ammonium carbonate) to flush minerals from underground deposits either by hydraulic disintegration or physicochemical dissolution. They include the following techniques:

* + Placer mining. Includes a set of techniques used to exploit loosely consolidated deposits (alluvial or placer deposits) like common sand and gravels containing metals such as gold, tin, diamonds, platinum, titanium or gems. Placer mining projects may, release large quantities of sediment that can impact surface water for several miles downstream of the placer mine. The following techniques are placer mining techniques:
    - Hydraulic mining: It is used for weakly cemented near-surface ore deposits against which a high-pressure stream of water (hydraulic jet) is directed, under-cutting it, and causing its removal by the erosive action of the water. A typical case is the hydraulic mining of a gold placer deposit.
    - Dredging mining: It is generally used for mineral-sands and some near-shore alluvial diamond mining operations, often to bring up underwater deposits. When performed from floating vessels, accomplishes the extraction of the minerals mechanically or hydraulically (in this case using suction dredges).
    - Sluicing: Itimplies the use of the sluice box in a stream of water to separate gold from gravel. A sluice box is a channel designed to flow water through it with riffles and other devices to catch the gold.
    - Panning: It is a form of traditional, small-scale example of placer mining that extracts gold from a placer deposit using a pan which is submerged in water and shaken, sorting the gold from the gravel and other material. As gold is much denser than rock, it quickly settles to the bottom of the pan.
  + Solution mining. Techniques employed to extract soluble or fusible minerals by dissolving them in a liquid (water or a leaching agent) and siphoning them out. Used to extract salts, lithium, boron, bromine, potash, copper and uranium. Includes the following techniques:
    - Heap leaching. Although heap leaching is included in different classifications of extraction techniques it is actually a mineral processing technique and as such it will be addressed in the corresponding section of this factsheet (see )Section 2.1.2.3).
    - In-situ leaching (ISL). The solution is pumped in the ore body from a series of injection wells, and is then pumped out, together with salts dissolved, from a series of extraction wells. It is used commonly on evaporite (e.g. salt and potash) and sediment-hosted uranium deposits, and to a lesser degree to recover copper from low-grade oxidized ore.

This factsheet will focus on the relevant methods used in the Republic of Macedonia:

**Open pit mining**, also called open cast or open cut mining, is an excavation, usually conical in shape, in which alternative layers of waste-rock and ore are extracted. Both are extracted in horizontal benches ranging in height from 4 m to more than 30 m. The bench forms a single level of operation above which mineral or waste-rock are mined from the bench face. Unless geological conditions dictate otherwise, all benches should be the same height. A thin deposit may require one or few benches but a thick deposit needs more benches. The expansion of the mining front is carried out in the working benches. During the life of the pit a haul road must be maintained for access, arranged spirally along the perimeter walls of the pit or in a switch back system (zigzag pattern on one side of the pit). Design parameters of an open pit mine include the ultimate pit depth and overall pit slope, bench height, width, slope and length and haul road width and slope. These design parameters are decided based both in economic and technical reasons.. In some cases open pit mining is used to extract mineral deposits that are at a substantial depth, reaching below the groundwater table. In those cases, water has to be pumped out of the pit. In other cases, as in many quarries in which the excavation is shallow, benches are not used and there is not any need to pump water. Open pit mining is the extraction technique which produces the largest environmental impacts.

Figure 1 shows different design parameters of an open pit mine.



Haul road

HRW

BW

BH

BH: bench height

BW: bench width

HRW: haul road width

α: overall pit slope angle

β: bench slope angle

Figure 1: design parameters of an open pit mine

The general extraction operations in open pit mining include the following:

* Drilling, Holes are drilled that are around 30 cm in diameter and 12- 15 m deep. Usually rotary and down the hole (DTH, basically a hammer driven by pneumatic of hydraulic systems) drills are used for drilling. Holes are filled with explosives. Drill hole location and spacing depends on the type of minerals extracted and the overall mine plan. The depth of the hole will determine the height of the bench in the pit.
* Blasting. Explosives in the drill holes are detonated, breaking up the mineral into smaller pieces that can be hauled for further processing.
* Loading and hauling.
  + Shovel-dumper systems. They are the prevalent loading and hauling system in open pit mining. In these systems, after blasting the rock, loading is made by hydraulic shovels, rope shovels, wheel loaders, front end loaders or by draglines. Trucks and dumpers haul the ore to the storage facilities or to the installations for the processing of minerals. Nowadays large haul dumpers are used, carrying up to 200 t per load. They are usually loaded by three or four shovel cycles. Haul dumpers also transport waste-rock out of the pit to waste-rock management facilities. A haul road and access ramps must be constructed and maintained for shovel-dumper systems.
  + In pit crushing and conveying systems. As pits get deeper, so does hauling distance. In order to keep shovels at maximum operating rates truck fleet size must be increased. For distances exceeding 1000 m conveyor systems, made up of conveying belts, may be more economical. Conveyor hauling requires a size reduction of the ore as well as of the overburden and waste-rock, which represents an extra cost. While some ores may be processed directly without crushing by leaching, most minerals processed conventionally generally require crushing. It makes therefore sense to locate the primary crusher in the pit in order to carry out the first stage of the mineral processing in it for conveyor hauling. It implies the crushing of the ore to pieces less than 30 cm in the primary crusher. Ore is hauled to primary crushers in trucks. From the crusher, ore or alternatively waste-rock is conducted into the conveying belts.

**Quarries are** a form of open pit mines in which construction minerals are extracted. Quarrying is the form of open pit mining in quarries, usually at shallower depths, and as such, they have usually smaller and more vertical benches. Some of them do not have any bench at all while others can have a high wall up to 300 m. As mentioned above (see page 6), construction minerals include dimension stone, aggregates, clays and shale and gypsum. General aspects regarding quarrying of dimension stone and aggregates include the following:

* + Dimension stone: The first step in dimension stone quarrying is to extract the primary blocks. In marble and granite quarries, the primary blocks are cubic or rectangular and measure from a few hundred to 4000 cubic metres. Sandstone, slate and limestone primary blocks are usually much smaller. To extract the primary blocks from the rock face primary cuts are made with different techniques. Where present, natural fractures may be used as natural limitations of the primary blocks. After the extraction of the primary blocks, they are divided into slices, which in turn are subdivided in commercial blocks. This operation is called squaring. The squaring is done by sawing, blasting or wedging, depending on the properties of the rock. The key issue is to extract whole pieces of rock with as little damage as possible. Natural stone is a kind of dimension stone used both for structural and decorative purposes which is not cut and polished.

Figure 2 shows the principle of block extraction from primary blocks to smaller sized slices, which will be further divided to commercial blocks.

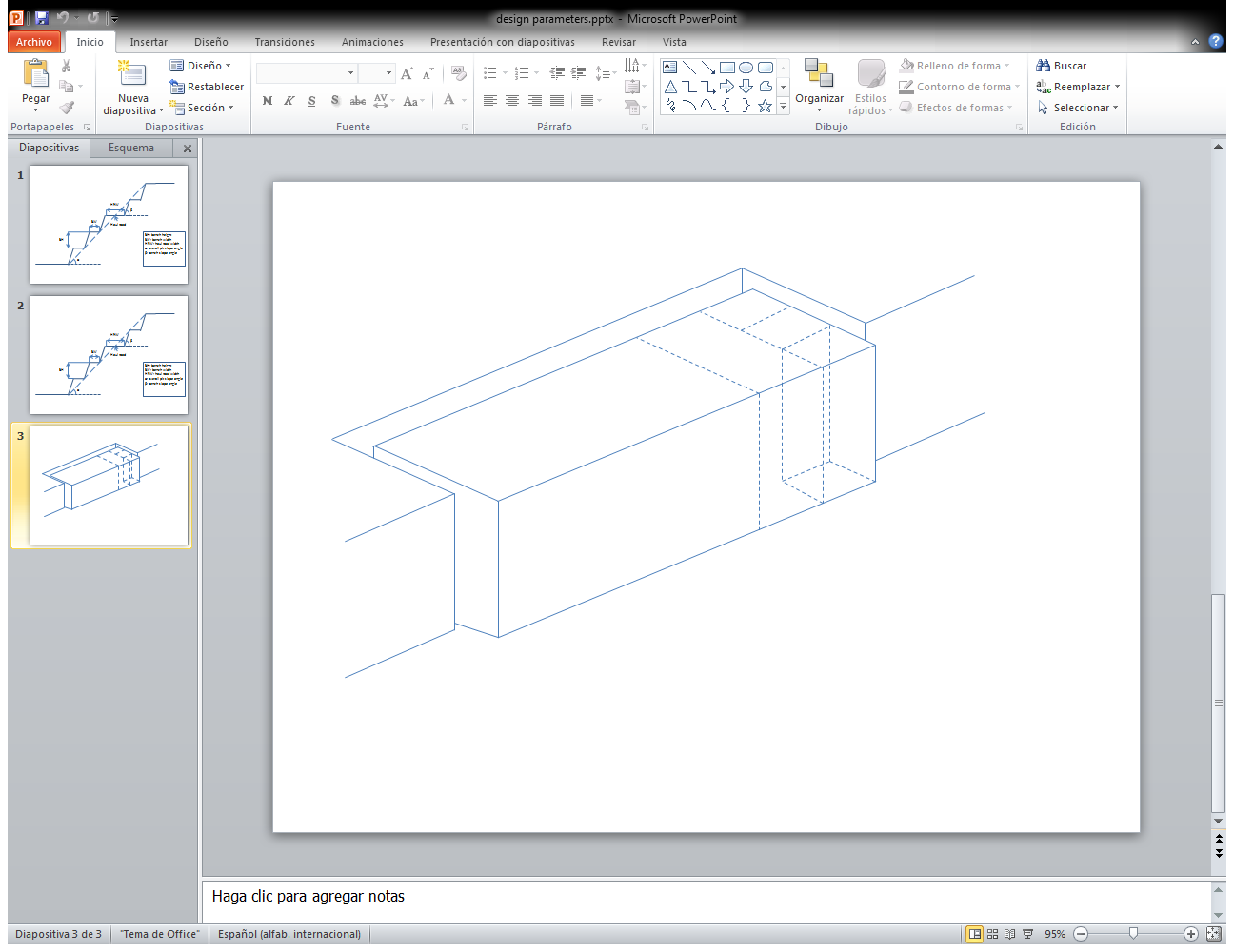


Figure 2: block extraction from primary blocks to smaller sized slices

* + Aggregates which are produced by crushing rocks after extraction such as chalk, limestone, sandstone, slate, include as first step the extraction of primary blocks and the subsequent subdivision to manageable sizes for crushing. Aggregates such as sand and gravel usually don’t need extracting blocks of rock, except to remove more consolidated overburden or waste-rock and they are not crushed. Aggregates are the most mined materials in the world.

* Beside the common features of open pit mining, the following specific techniques are identified for mineral extraction in quarries:

1. Splitting: Involves the generation of fractures, preferably planar, for extracting rock. This may be done using several techniques such as drilling and blasting, slow splitting (using expanding mortar placed in drill holes), wedging (using wedges or the so called plug-and-feather to create fractures; previously holes are drilled in the rock and wedges are driven into the holes; sometimes a combination of blasting and wedging may be used to split rocks into more manageable-sized piece) or using a combination of explosives and compressed air/water. In aggregates produced from crushed rocks, fragmentation on blasting is designed to produce material suitable for primary crushing and more powerful explosives such as dynamite are used. In the process, significant quarry fines may also be produced. In dimension stone the extraction requires more precise techniques such as selective precise blasting using weak types of explosives, such as lighter gunpowder, to avoid damage or weakening of the stone. Although splitting techniques may be applied on most rock types, it works better on hard igneous and metamorphic rocks with well-defined preferred splitting directions.
2. Channelling: Channelling involves cutting long and narrow channels into the rock to free up a slice from the large rocks for dimension stone extraction. Special machines called channellers are used. The cut in the stone is used to guide the fracture of the rock. In most cases channelling is combined with other methods such as wedging and sawing. Using a saw involves the production of vertical or horizontal cuts in the rock itself. When using wedges the cut in the stone carried out by the channelers is deep enough to allow wedges to be inserted down into the rock until it is split, Expansion mortars and other non-explosives are also used to split the rock. The use of channelling is extensive in soft rocks quarries such as those containing limestone, marble and sandstone for dimension stone.
   * Sawing: Sawing is applied in the majority of European ornamental dimension stone quarries. It involves the execution of cuts using saws. Different types of saws are used:
     + Wire saws: diamond wire saws are the most common option
     + Chain saws
     + Diamond belt saws
     + Disc saws

In sand and gravel quarries operations such as splitting and channelling are rare, except to remove more consolidated overburden or waste-rock.

In quarries, loading and hauling is carried out as described in the general open pit mining case, using shovel-dumper systems, using front loading shovels or, in the case of aggregates, in pit crushing-conveying systems

**Strip mining** is used when the mineral deposits are near the surface and it consists of the removal of a long strip of overburden and the extraction of the mineral in long narrow strips up to 50 m wide x 1 Km long using some of the largest heavy machines on earth such as bucket-wheel excavators which can move as much as 12,000 cubic meters of earth per hour. When the ore in one strip is extracted, the extraction of the next one starts. The waste-rock taken off of the active strip is stored in the next strip. Strip mining is most commonly used to extract hard coal and lignite, as well as oil impregnated sands. Mine rehabilitation can be carried out progressively at the same rate as mining. Similarly to open pit mining, strip mining includes drilling, blasting, loading and hauling as main operations.

##### 2.1.2.2.2. Underground mining

Underground mining methods are employed when the depth of deposit and/or the waste to ore ratio are too great to apply surface mining methods. The extraction of the minerals in underground mining requires the opening of tunnels (horizontal, or near-horizontal, underground passage, entry, or haulageway, that is open to the surface at both ends) and shafts (vertical or near vertical tunnels for hoisting) to gain access to the ore. Shafts and drifts (horizontal or sub horizontal development openings) are constructed from which the ore can be extracted more selectively. Areas of waste-rock and low grade ore can be mostly left out and therefore the amount of waste-rock produced is smaller than in surface mining. On the other hand, the waste-rock usually remains underground.

The economic value of the ore and grade distribution within de deposit are key when selecting the most appropriate mining method. Additionally, while surface mining may be applied to almost any ore configuration, a large number of underground mining methods have been developed primarily in response to the requirements of differing spatial and geometric characteristics of the deposit concerned (shape, size, thickness, plunge and depth), as well as to the strength of the hanging wall, footwall and ore body.

The major distinction between the different underground mining methods is whether the mined out areas remain supported after mining, or if they are allowed to collapse. They are also differentiated by the type of wall and roof supports used, the configuration and size of production openings, and the direction in which mining operations progress.

The most commonly used underground mining methods are classified in three groups:

* Methods producing openings naturally supporting or requiring minimum artificial support (**Unsupported methods**): Those methods are used to extract deposits in which the rock is essentially self-supporting and for which no major artificial support (artificially placed pillars or fill) is necessary to assist in the support the load of overlying rock in the openings. However, generous amounts of roof bolting and localized support measures are often used. They include the following methods:
  + Room and pillar (R & P): This is an old method used in flat or nearly horizontal tabular deposits (horizontal veins), usually of coal but also of other minerals. Pillars of original bedrock are left to support rock pressures and for safety. Coal ore bodies are generally large in scale and relatively uniform and therefore, openings are driven orthogonally and at regular intervals in a deposit to leave rectangular or square pillars for natural support. In non-coal mining, pillars may be irregularly shaped, sized and randomly placed, usually in areas of low-grade ore or waste-rock. Pillars may be left un-extracted, partially extracted or extracted while retreating
  + Shrinkage stoping: This method is used in vertical or steeply dipping ore bodies. The ore is mined in horizontal slices from bottom to top. The broken ore remains in the stope (exploitation opening) as temporary support to the walls and to provide a vertical platform for the miners. Some of the blasted ore must be removed to provide space for the next ore slice. Once the top of the stope is reached, all the ore is removed from the stope. Thus the stope operates as the centre for production. The stope may be backfilled or left empty. This method is relatively infrequent today, due to its labour intensity.
  + Sublevel stoping: This method is used also in vertical or steeply dipping hard rock ore bodies which are of tabular in shape (veins). A large open stope is created into the vein-type orebody. In this method the stope doesn’t operate as centre for production. The open stope is not to be occupied by the miners, and therefore all drilling, blasting and mining are carried out at different levels in the ore block.
* Methods requiring substantial artificial support (**Supported methods**). These methods require substantial amounts of artificial support to maintain stability in the stopes to prevent caving or surface subsidence. Supported methods when the two other categories of methods (unsupported and caving) are not applicable. They have been in decline because cut and fill stoping is the only methods which allows mechanization. The most applied forms of artificial support are backfilling/stowing, timber/stulls, cribs/packs and hydraulic/frictional props. There are 3 methods included in this class:
  + Cut and fill stoping: This method is suited to high grade irregular steeply dipping ore bodies. The ore is extracted in horizontal slices from bottom to top. As each horizontal slice is extracted, the voids (opens) are backfilled with a variety of materials to support the walls: waste-rock, tailings, cemented tailings or other suitable materials. The backfill serves both to support the stope walls and provide a working platform for equipment when the next horizontal slice is mined.
  + Stull stoping:, In this method timbers are used to provide the support and placed between the foot wall and the and hanging walls. Due to its high labour intensity and low productivity, as well as to a scarcity of skilled labour is relatively infrequent today
  + Square set stoping: This method is used when the ore is weak and the walls are not strong enough to support themselves. In this method a small block of ore is removed and replaced by a ‘set’ or cubic frame of timber which is immediately set into place. The timber sets are filled with broken waste-rock or sand. The value of the ore must be relatively high because the method is slow and expensive and requires skilled miners. It is relatively infrequent today as is stull stoping.
* **Caving methods**. Those methods are associated with induced, controlled, massive caving of the ore body, the overlying rock or both and the exploitation workings are therefore designed to collapse. There are 3 methods included in this class:
  + Longwall mining: Is a mining method used in flat-lying, relatively thin, tabular deposits (mainly coal) in which a long wall of mineral is mined in a single slice. Is one of the main methods for mining coal. The basic idea is to remove all the coal from a broad coal face and allow the roof and overlying rock to collapse into the void behind, while maintaining a safe working space along the face for the miners.
  + Sublevel caving: Is used to extract large ore bodies with steep dip tabular or massive deposits. In this method the ore is extracted via sublevels which are developed in the ore body at regular vertical spacing. Each sublevel has a systematic layout of parallel drifts, along or across the ore body. Sublevel caving recovers the ore from open stopes separated by access drifts each connected to a ramp
  + Block caving: Is used generally for steeply dipping ores, and thick sub-horizontal seams of ore. It has application in sulfide deposits and underground kimberlite (diamond) mining. Is a large-scale or bulk mining method in which a grid of tunnels is driven under the ore body and then the rock mass undercut by blasting. The rock will break under its own weight and the broken ore is then taken out.

As in surface mining, all methods involve different operations:

* Drilling
* Blasting
* Digging out the mineral
* Loading and hauling the mineral to the surface
* Backfilling of overburden, waste-rock and tailings into underground voids is usually carried in underground mining.
* Underground mining also requires the construction and installation of a ventilation system and of a pumping system to pump out the water from the shafts, tunnels and drifts.

In some places, dimension stone is mined underground, mostly regarding marble and limestone deposits. The most frequent method involved is room and pillar (e.g. in massive limestone and marble deposits). Sawing is the most frequently used technique, with a combination of chainsaw and diamond wire. To mine siliceous rocks such as granite underground is too expensive since only waterjet technology combined with diamond wire is applicable.

Underground mining of limestone is also carried out for aggregate production in different sites in the world.

#### 2.1.2.3. The processing of minerals

The processing of minerals, also called beneficiation includes the following 3 steps:

1. Crushing. It is the first stage of processing. It is usually a dry operation which involves breaking down the ore. This process step prepares the ore for further size reduction (grinding) or for feeding directly to the classification and/or concentration separation stages. Tailings are usually not generated in this process step.
2. Grinding comes after crushing. If possible, grinding is performed ‘wet’ as this requires less energy, allowing energy savings of up to 30 % compared to dry grinding. In grinding, the particles are usually reduced by a combination of impact and abrasion of the ore by the free motion of grinding bodies such as steel rods, balls or pebbles in the mill. Small quantities of valuable mineral particles are separated from the non-valuable part of the ore which become tailings.
3. Beneficiation may include physical and/or chemical separation techniques such as screening, classification (e.g. by hydrocyclones), gravity concentration, flotation, conditioning, aeration, magnetic separation, electrostatic separation, sorting, leaching, dewatering, electrowinning, precipitation, and amalgamation (often involving the use of mercury). Wastes from these processes include waste rock dumps, tailings, heap leach materials (for gold and silver operations), and dump leach materials (for copper leach operations).

Flotation is a technique used in copper, lead and zinc mines in the RM. It is a technique used to separate large flocs or floating particles like plastic parts from the effluent by bringing them to the surface of the suspension. Flotation can be achieved by dissolved air flotation. Air is dissolved in the suspending medium under pressure and leaves the solution when the pressure is released as minute air bubbles attached to suspended particles. This causes the particles to float to the surface and the flocs can then easily be taken away from the surface of the liquid.

Leaching involving the use of cyanide is a kind of beneficiation process, usually used with gold, silver, and copper ores, that merits separate attention because of the serious environmental and public safety impacts. With leaching, finely ground ore is deposited in a large heap (called a ‘leach heap’) on top of an impermeable pad, in order to protect the surface and ground waters and the soil. A solution containing cyanide is sprayed on top of the heap. The cyanide solution dissolves the desired metals and the ‘pregnant’ solution containing the metal is collected from the bottom of the heap using a system of pipes.

The beneficiation process generates high-volume of tailings. If a mining project involves the extraction of a few hundred million metric tons of mineral ore, then the mine project will generate a similar quantity of tailings. How a mining company disposes of this high-volume waste material which may include hazardous substances, is one of the central questions that will determine whether a proposed mining project is environmentally acceptable. The key long-term goal of tailings disposal and management is to prevent the mobilization and release into the environment of pollutant constituents of the tailings. The most commonly used option to achieve this is the use of a tailings pond and dams although other options, such as tailings heaps, could be a more preferable option from the environmental point of view.

When beneficiation includes different steps such, crushing, grinding, gravity concentration, flotation and leaching, as it is the case in the mineral ore processing in gold mines, separated tailings ponds must be constructed for instance for tailings resulting from flotation and leaching.

The products of the mining industry, processed as shown above, are sometimes used directly, but often are subjected to further processing , e.g. refining, smelting, roasting (e.g for metals such as copper, lead, zinc and precious metals) and calcination (e.g. to produce cement from limestone). Whereas the processing steps described in this section (e.g. crushing, grinding, flotation and leaching) are usually carried out in on-mine installations, further processing, e.g. in smelters, is carried out in specific installations in off-mine installations.

In this factsheet only processing in on-mine installations is addressed. Further processing in specific installations such as smelters is not included.

**Regarding quarries**, the processing of construction minerals extracted in them involves the following operations:

a. Aggregates:

* + Hard rock aggregates processing operations can be divided in three main stages:
    - Primary crushing stage: Primary crushers reduce the ore from anything as large as 1.5 m down to 100 to 200 mm. Machines such as jaw and gyratory crushers apply a fracture force to the large particles, breaking the ore by compression.
    - Secondary crushing stage: Secondary crushing reduces the particle size down to 5 to 20 mm. Cone crushers, roll crushers and impact crushers (e.g. hammer mills) are examples of the equipment used.
    - Screening: After crushing and grinding, the products are usually separated simply according to their size. The primary purpose is to produce appropriately sized feed material for further treatment. Oversize material is recycled for further reduction. Screening is generally applied to fairly coarse material. It may also be used to produce a reasonably uniform feed size for a subsequent operation where this is required. The grizzly and the trammel are the equipment used for screening.
    - Washing: In some cases, aggregates are washed to upgrade the quality of scalpings (the material left over from crushing operations) and fines

These processes generate waste water and quarry fines settled out in ponds; dust is emitted into air in crushing operation, along with noise.

* + Gravel and sand: Production of sand and gravel involves washing and scrubbing to remove clay, separation of the sand fraction by screening, grading of the gravel, sand classification and dewatering, and crushing of any oversize gravel to produce a saleable product. Washing removes silt and clay which are settled out in ponds, from which process water is recovered.

b. Dimension stone:

Usually a processing facility is built near the quarry. The main role of the processing facility is to cut and polish the rock. Large amount of wastes are generated in processing, so it is required to plan for some storage/dump space for the cuttings. Large amounts of dust are also released into the air, along with noise emissions.

### 2.1.3. Closure and rehabilitation

When active mining ceases, mine facilities are closed down and the site must be rehabilitated. After-closure procedures are also laid down, as well as procedures on monitoring upon cessation of the activity. The goal of mine site rehabilitation is the return of disturbed land to a safe, stable, non-polluting landform in an ecologically sustainable manner that is productive and/or self-sustaining consistent with the agreed post-mining land use.

Mines that are notorious for their immense impact on the environment often made impacts only during the closure phase, when active mining operations ceased. These impacts can persist for decades and even centuries. Therefore, the EIA for every proposed mining project must include a detailed discussion of the mine Closure and Rehabilitation Plan offered by the mining proponent. Additionally, the Law on Mineral Resources (Official Gazette of Republic of Macedonia no. 136/12, 25/13, 93/13, 44/14 and 160/14) includes a provision in its Article 87 by which the drawing up of a waste management plan is compulsory. It shall include at least the proposed plan for closure, including rehabilitation, after-closure procedures and monitoring, in compliance with the Article 94 of this Law.

#### 2.1.3.1. Principles of closure planning

* From the project approval stage throughout mine life, the Mine Closure and Rehabilitation Plan should demonstrate that ecologically sustainable mine closure can be achieved consistent with agreed post-mining outcomes and land uses, and without unacceptable liability to the State.
* Closure planning should be risk-based, taking into account results of materials characterisation, data on the local environmental and climatic conditions, and consideration of potential impacts through contaminant pathways (including but not limited to site activities or infrastructure) and environmental receptors.
* Planning for mine closure should be fully integrated in the life of mine planning, and should start as early as possible and continue through to final closure and relinquishment. For new projects, closure planning should start in the project feasibility stage (before project approvals).

#### 2.1.3.2. Identification of impacts and goals of the Closure and Rehabilitation Plan

The plan should include identify the following items:

* The predicted impacts of the project on the surrounding ecosystems.
* A description of how the impacts will be mitigated and what the residual impacts will be
* A general overview on how the site will be decommissioned (i.e. buildings removed; pits filled in, etc.).
* The final rehabilitation objective, which will in part be based on the residual impacts of the projectSpecific goals of mine site rehabilitation include the prevention of surface water, groundwater and soil contamination and sedimentation, the restoration of wildlife habitat and ecosystem health, and of the landscape. Specific rehabilitation objectives must be established for each feature of the mine (buildings, infrastructure and equipment; over burden and waste-rock; open pits; tailings ponds and dams; tailings heaps and other TMFs).
* Stakeholders. Stakeholder engagement and consultation must be part of the plan.

#### 2.1.3.3. Operations of rehabilitation

The closure and rehabilitation plan should include the following aspects:

* A schedule of when closure and rehabilitation operations will start and when will be finished.
* Provisions for progressive rehabilitation and post-closure.
* Operations regarding decommissioning of buildings, infrastructure and equipment.
* Operations regarding overburden and waste-rock:

Overburden and waste rock are materials that should be considered returning to open pits as backfill, to prevent pit lake formation. If a Closure and Rehabilitation Plan calls for return of overburden and waste rock, then closure and rehabilitation of these areas would simply require revegetation of these former waste disposal sites.

However, if the Closure and Rehabilitation Plan calls for leaving piles of overburden and waste rock in place after mining ceases, then the plan must provide detailed information about the final conditions of these waste piles. Most importantly, measures must be put in place to prevent any potentially acid-generating materials in piles of overburden and waste rock from becoming acidic (acid rock drainage or ARD). These measures might include the construction of runoff diversion structures and the placement of caps of low-permeability material over the piles, to prevent water from infiltrating the waste piles.

After measures for the prevention of acid mine drainage at any piles of overburden and waste rock are left in place, the Closure and Rehabilitation Plan should specify the manner in which such piles would be contoured and revegetated to control erosion and restore the site’s natural condition.

* Operations regarding open pits:

Open pits should normally be backfilled, recontoured, and revegetated to create a final surface that is consistent with the original topography of the area. The Closure and Rehabilitation Plan should not allow for the formation of a pit lake. If the plan allows for the formation of a pit lake, it should include a detailed discussion of the efficacy and feasibility of all possible options for the prevention of acid mine drainage within the pit lake, the potential characteristics of pit lake effluent, and its impact on groundwater and adjoining surface waters.

* Operations regarding tailings ponds and dams:

Dewatering of tailings and their use as backfill (dry tailings disposal) is the environmentally preferable option for tailings disposal. If the EIA calls for the creation of tailing ponds and dams at mine closure, they must be drained and then subject to the following closure and rehabilitation measures: placement of a cover over the tailings; recontouring of the tailings to prevent ponding, erosion, and runoff; the maintenance of leachate collection and removal systems; and the performance of monitoring tests to prevent and detect groundwater contamination.

* Operations regarding tailings heaps and other tailings management facilities (TMF):

As explained further in this factsheet, tailing heaps may produce ARD. As in the case of overburden and waste-rock, measures must be put in place to prevent ARD. After active mining ceases, huge piles of waste nearly always contain excessive levels of a variety of contaminants (salts, metals, cyanide) that require detoxification to prevent ARD. Mining projects that involve cyanide heap leaching or copper dump leaching leave behind mine waste heaps (leach heaps) that require special consideration. Rinsing the heaps with fresh water (which must be itself treated) until the accepted pH range and cyanide and other pollutants levels are reached is one of the approaches in leach heaps decommissioning.

* Operations regarding revegetation and ecosystem and landscape restoration:

Revegetation is an essential and oft-promised element of mine Closure and Rehabilitation Plans. Actual revegetation is easy to describe on paper, but very difficult to accomplish in practice. It requires attention to details such as maintenance of topsoil stockpiles, selection of native species, and preparation of soil for the growth of planted species. To assure the establishment of a diverse and long-lasting vegetative cover, appropriate techniques of site preparation and protection, soil amendments and fertilization as well as irrigation, if needed, must be applied. Ecosystem and landscape restoration implies recreating the original ecosystems and landscape by reassembling its original features that once were present at the site. The Plan must establish specific operations to meet the goals regarding this issue.

The plan shall also include financial assurances for closure and rehabilitation.

#### 2.1.3.4. Post-closure maintenance and monitoring

The Closure and Rehabilitation Plan must include appropriate detail on closure performance monitoring and maintenance framework during progressive rehabilitation and post closure, including the methodology, quality control system and remedial strategy. A preliminary plan for closure monitoring and maintenance may be acceptable in the early stages of the project. As the operations approach closure, the Mines Authority should require the operator to submit a detailed Post-Closure Monitoring and Maintenance Program to be included in the Closure and Rehabilitation Plan. The Programme should include the type and frequency of monitoring against relevant completion criteria. The Programme should be submitted to the Environment Authority (for approval if it is provided in the national legislation).

Operators are responsible for carrying out all monitoring and maintenance operations during the period of time established in the EIA statement and until the established rehabilitation goals and environmental indicators have been met. The provision by which the performance monitoring reports must be submitted both to the Mines Authority and the Environment Authority should be established in the EIA statement. The reports should document progress in view of the established rehabilitation goals. Provisions should be established by the authorities involved for an adequate period of post-closure monitoring and maintenance, including provision for remedial work if monitoring shows completion criteria are not being met.

The Monitoring and Maintenance programme should include provisions regarding at least the following items:

* Groundwater monitoring: The setting of a network of monitoring boreholes shall be provided in the EIA statement. The network shall be kept in operation during post-closure monitoring period established. Regular maintenance operations shall be carried out
* Surface waters. Regular maintenance operations of rain water collection networks shall be carried out
* Rehabilitated areas stability, specifically waste-rock, overburden and TMF stability
* Revegetation and ecosystem & landscape restoration, including performance of natural habitat types and wildlife species with a focus on species included in the lists of endangered species

### 2.1.4. Mining and quarrying techniques relevant in the Republic of Macedonia

In the Republic of Macedonia there are deposits containing economic grades of lignite, copper, iron, lead, zinc and precious metals such as silver and gold. In addition, industrial minerals such as bentonite, feldspar, and quarry based minerals for construction such as gypsum, sand and gravel, dimension stone, cement and aggregates from crushed minerals were produced, mainly for export.

#### 2.1.4.1. Surface mining.

The Suvodol Coal Mine is a lignite mine located in Bitola. The mine has coal reserves amounting to 175 million tonnes of [lignite](https://en.wikipedia.org/wiki/Coke_(fuel)), one of the largest coal reserves in [Europe](https://en.wikipedia.org/wiki/Europe) and the world and has an annual production of 6.5 million tonnes of lignite which supplies the LCP of Bitola, located nearby. The exploitation is carried out by **strip mining**. This method is described in Section 2.1.2.2.1. A system of conveyor belts is in place for the hauling. Other important lignite mine is Oslomej mine in Kičevo, where strip mining is performed. It supplies LCP of Oslomej with lignite as fuel.

Bučim Radoviš in Radoviš is the only copper mine of the RM. It is an **open pit mine** producing flotation concentrate which contains copper, gold and silver. The ore contains 0,2-0,3 % of copper and 0,2-0,3 g/T of gold. Regarding copper, the end product is transported and delivered to copper smelters in Serbia and Bulgaria. The extraction technique of an open pit is described in Section 2.1.2.2.1. The processing of the ore includes crushing, grinding, conditioning, aeration, flotation and dewatering. The processing of minerals is described in Section 2.1.2.3. Main environmental issue are the tailings management facilities. Another **open pit mine** is the Ržanovo mine located in Kavadarci which provides nickel to the FENI-Kavadarci ferronickel plant. The ore is conveyed from the mine into the plant by a conveyor belt 36.5 km long, which is considered to be one of the longest conveyor belts in the world.

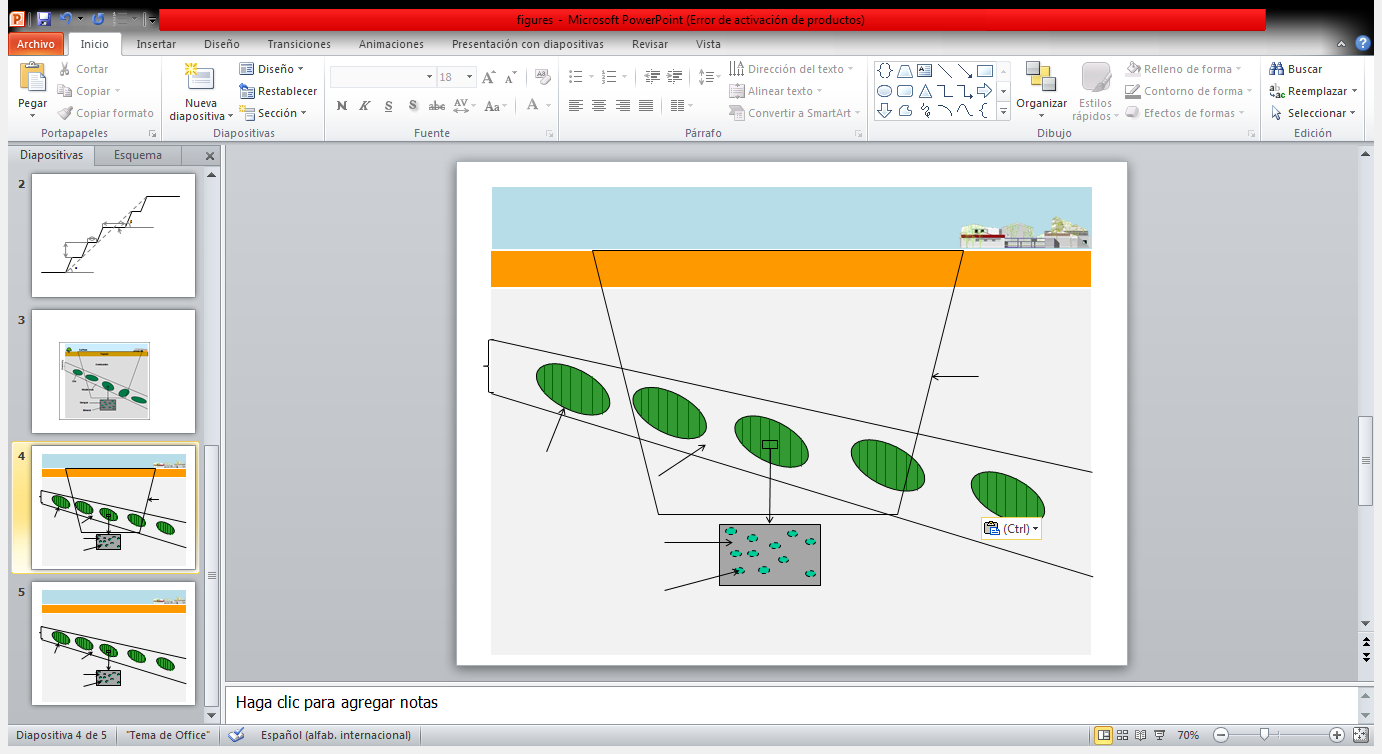
Regarding dimension stone quarries, white marble (Sivec, Prilep), grey granite, slate, travertine, limestone, sandstone and alabaster quarries are present in the RM. Aggregate quarries are also an important activity.

#### 2.1.4.2. Underground mining.

Zletovo Mine in Probištip is a lead and zinc underground mine. The country’s smelter and refinery for the production of zinc, lead and associated metals was located at Veles, but is now closed. Other lead and zinc underground mines are the Sasa Mine in Makedonska Kamenica and the Toranica Mine in Kriva Palanka. The processing of the ore in the three mines includes crushing, grinding, conditioning, aeration, flotation and dewatering. Different underground mining techniques are described in Section 2.1.2.2.2. In Zletovo, the cut and fill stoping and sublevel stoping methods are used. In the case of the Sasa Mine, the sublevel caving method is applied for the deeper parts of its ore deposits. The processing of minerals is described in Section 2.1.2.3. Main environmental issue are the tailings management facilities (dams and heaps). In 1975 the tailing dam at Zletovo failed and the pond discharged, flooding villages and agricultural land down-stream.

## Production scheme

**Extraction scheme for and open pit:**

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Mineral

Gangue

Orebody

Pit boundaries

Waste rock

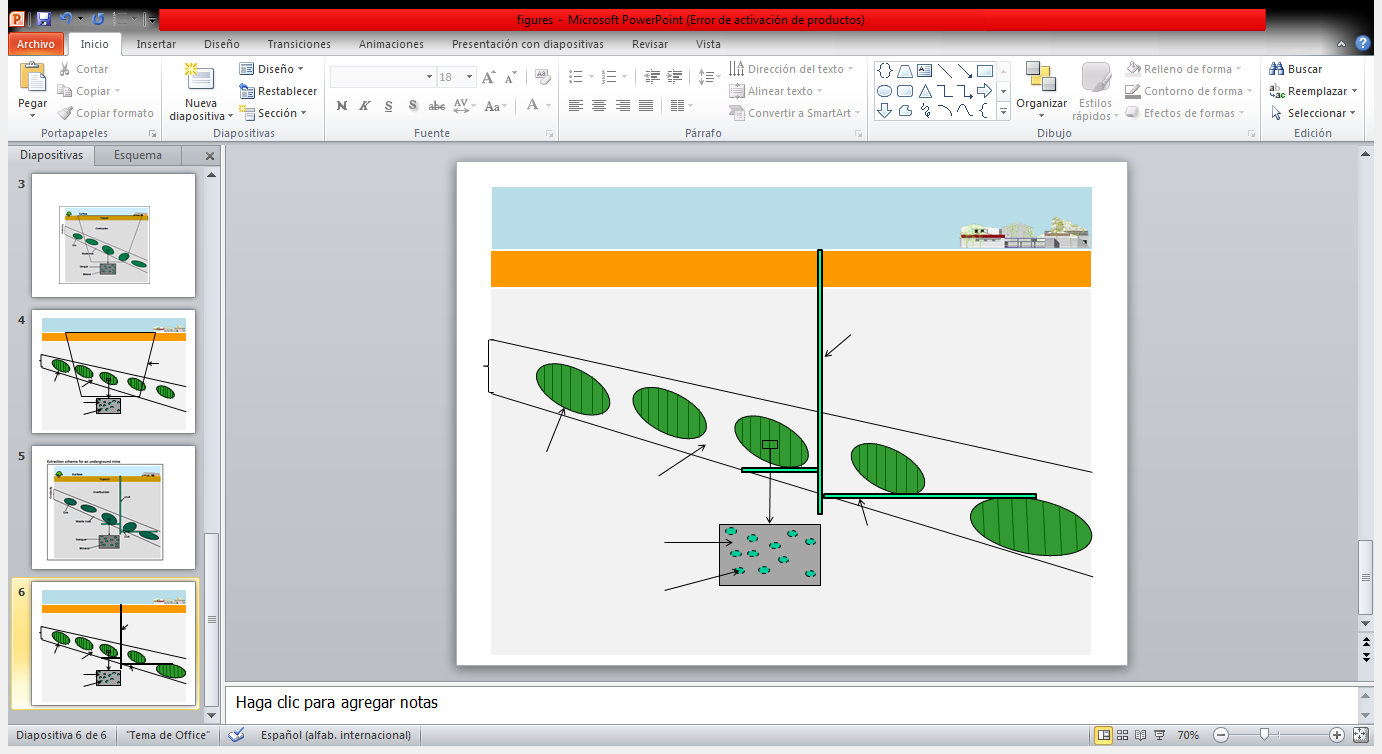
Surface

Overburden

Topsoil

Ore

**Extraction scheme for an underground mine:**

****

Drift

Shaft

Waste rock

Ore

Gangue

Mineral

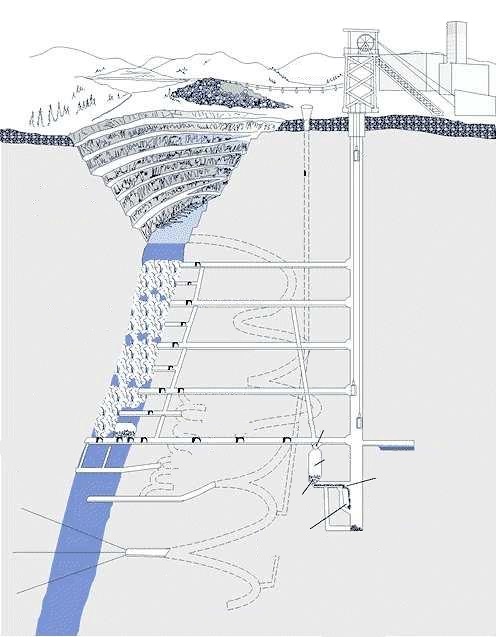
Orebody

Surface

Overburden

Topsoil

**Extraction scheme: transition from open pit to underground mining:**



**Production plant**

**Headframe**

**Tailings**

**Tailings pond**

**Open pit**

**(mined out)**

**Ventilation shaft**

**Main shaft**

**Mined out and backfilled**

**Production stopes**

**Development of stopes**

**Exploration**

**Drilling**

**Decline**

**Abandoned level**

**Sublevel**

**Ore**

**pass**

**Main level**

**Haulage level**

**Ore**

**Crusher**

**Conveyor belt**

**Internal**

**ramp**

**Water basin**

**Pump station**

**Skip**

**Cage**

**Measuring pocket**

**Sump**

**Skip filling**

**station**

**Ore bin**

**Lead and zinc ore mining and processing by flotation. Flow chart:**

**Underground mining**

Vertical shaft construction

Waste-rock

Acid rock drainage

Drilling

Engine fumes

Dust and noise

Blasting

Suspended solids

Loading

and hauling

Zinc

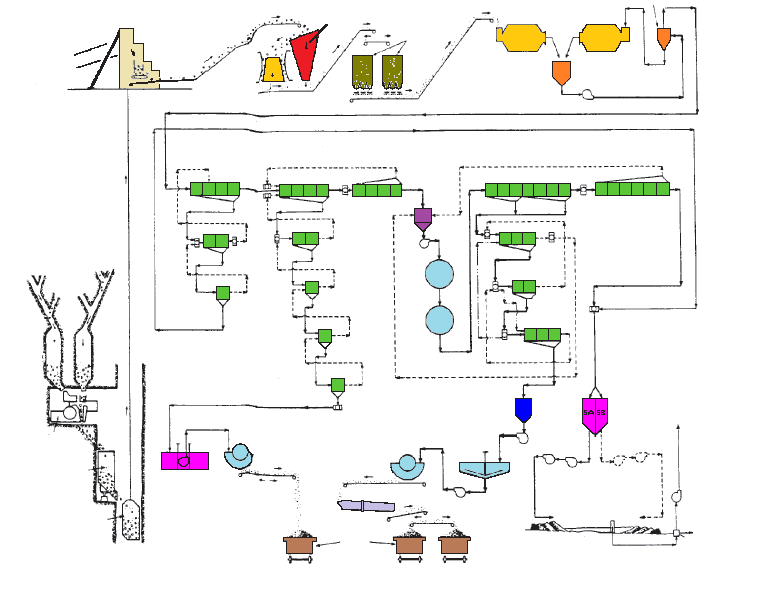
flotation

Lead flotation

Crushing and grinding

**Cyclone classifiers**

**Headframe**



**3rd stage**

**cleaning**

**Reclaim water to mill**

**Final tailings pump**

**3rd stage**

**cleaning**

**2nd stage**

**cleaning**

**1st stage**

**cleaning**

**2nd stage**

**cleaning**

**1st stage**

**cleaning**

**4th stage**

**cleaning**

**Conditio-ning tank**

**Conditio-ning tank**

**1st stage**

**cleaning**

**2nd stage**

**cleaning**

**Cyclone**

**feed pump**

**Rod mill**

**Mill storage**

**Skip**

**Measuring pocket**

**Waste-rock pocket**

**Zinc**

**feed**

**pump**

**TALC PREFLOAT**

**ZINC FLOTATION**

**LEAD FLOTATION**

**Talc**

**roughers**

**Zinc conc. pump**

**Zinc**

**conc.**

**pump**

**Decant tower**

**Tailings pond**

**Gondola**

**cars**

**Filter**

**Zinc**

**thickener**

**Lead roughers**

**Lead scavengers**

**Zinc roughers**

**Zinc scavengers**

**Lead storage tank**

**Ball mill**

**Filter**

**Dryer**

**Ore pocket**

**Jaw crusher**

**Screen**

**Crusher**

**Effluent**

# Sector description in the Republic of Macedonia



## Mining in the country

The Republic of Macedonia produces a number of metals, including ferroalloys, steel, and mine output of lead and zinc, as well as industrial minerals and lignite. Petroleum is imported and processed at the country’s sole domestic refinery. Production of mineral products is not significant on either a world or regional scale, but metal commodities are a relatively important source of export revenue for Macedonia.

Macedonia’s real gross domestic product (GDP) increased by 3.0% compared with the GDP in 2010. In 2010 (the latest year for which data were available), manufacturing made up 12.6% of the GDP and mining and quarrying made up only 1.5%. In 2010, mineral fuels, lubricants, and related materials made up about 21% of the value of Macedonian imports and 8% of the value of exports. Macedonia’s State Statistical Office listed ferronickel, flat-rolled steel products, and petroleum products as three of the country’s five most significant export items.

Production of ferrosilicon increased by 87%; silicomanganese, by 38%; crude steel and steel semimanufactures, by 32% each; cement, ferronickel, and lignite, by 20% each; marl, by 15%; gypsum, by 14%; clay and sintered dolomite, by 13% each; and agglomerated dolomite, by 11%. Output of sand and gravel decreased by 97%; talc, by 58%; pumice and related materials, by 49%; crushed and broken stone, by 20%; and dimension stone and petroleum refinery products, by 18% each. No ferromanganese was produced from 2009 through 2011 because Skopski Leguri DOOEL halted production owing to market conditions. Production may restart in the future if market conditions improve. Solway Group developed a $15 million solvent extraction-electrowinning (SX-EW) operation at its Bucim Mine and was thought to have begun refined copper production in 2011. A small amount of production was estimated for 2011, but the company reported that the new SX-EW facility would be able to produce up to 3,500 metric tons per year (t/yr) of copper when full capacity is reached (Metal Bulletin, 2012; Solway Group, 2012).

Republic of Macedonia has deposits containing economic grades of copper, iron, lead, precious metals such as silver and gold, and zinc.

In the second half of the 20th century an extensive processing and manufacturing infrastructure was also established allowing production not only of these metals and their alloys, but also of ferro-alloys such as ferrochromium, ferromanganese and ferronickel, and aluminium. In addition, industrial minerals such as bentonite, feldspar, gypsum, sand and gravel, stone (carbonate and silicate), cement and other quarry-based construction materials were produced, mainly for export.

Bucim Radovis in Radovis was the country’s only producer of copper ore with capacity to produce about 4 million t/yr of ore, 50 000 t/yr concentrates, 8 000 t/yr copper cathode and 3 000 t/yr copper alloys. The company also produced gold and silver bars and granules as by-products.

Macedonia operated two ferro-alloy plants at Tetovo and Kavadarci. The Jugohrom SILMAK Jegunovce ferro-alloy plant at Tetovo was established in 1952 to produce mainly such chromite-related products as ferrochromium, ferro-silicochromium and sodium dichromate.

Power was supplied by nearby hydroelectric plants and used water from Lake Mavrovsko Ezero. Originally chromite was supplied by the nearby Radusa mine. Ferro-alloy capacity at the plant was about 70 000 t/yr. The FENI-Kavadarci (FENI) ferronickel plant at Kavadarci started operation in 1982 with an installed capacity of about 12 000 t/yr using nickel or feedstock from the Rzanovo Mine. Skopje also has a cold-rolling steel mill with 600.000 t/yr capacity and a 100.000 t/yr galvanizing line, now also under foreign ownership.

According to the Ministry of Environment and Physical Planning at least 150 million t of mine waste (principally tailings containing Pb, Cd, Zn, Cu, and organic flotation reagents) are held on mine sites, of which smelters have produced at least 6 million t of metallurgical slag and cinder. The two largest mining-power generation complexes have so far produced about 330 million t of waste (mine spoil/tailings, cinder and ash).

The privatization process is of key importance to the status of sites and their potential for ongoing operation and rehabilitation, or closure.

## Applicable legislation

On the ‘Legislation’ section of the website of the State Environmental Inspection (SEI) (<http://www.sei.gov.mk/page_en.asp?ID=2>) there is relevant legislation available.

The relevant legislation includes the following main laws:

* Law on Environment
* Law on Inspection Supervision
* Law on Waters
* Law on Nature Protection
* Law on Protection from Environmental Noise
* Law on Ambient Air Quality
* Law on Waste Management
* Law on Management of Batteries and Accumulators and Waste Batteries and Accumulators
* Law on Management of Packaging and Packaging Waste
* Law on Management of Electrical and Electronic Equipment and Waste Electrical and Electronic Equipment
* Law on Genetically Modified Organisms
* Law on Control of Emissions of Volatile Organic Compounds Resulting from Use of Petrol
* Law on Administrative Procedure
* Law on Misdemeanor
* Criminal Code Law on Criminal Procedure
* Law establishing a State Commission for decisions in the second instance in the area of the inspection supervision and misdemeanor procedures

Additionally, on the website of the Ministry of Environment and Physical Planning (<http://www.moepp.gov.mk>) there are also links to relevant primary and secondary legislation provided. Information about secondary legislation like Rulebooks is available on the website of the Official Gazette ([www.slvesnik.com.mk](http://www.slvesnik.com.mk)).

Finally, legislation of the sector has to be taken into account as well, e.g. the Law on Mineral Resources.

# Key environmental issues of the sector

## Preliminary information about MTWR BREF & applicable BATs

### IPPC A - IPPC B – Elaborates. Enforceability of BATs. EIA.

IPPC-A or not IPPC-A?

Core extraction activities, and therefore mines and quarries are not covered by the IED. However, processing of gold ore by leaching, as undertaken in some installations such as in the Baia Mare gold mine (Romania) or proposed but not authorized in Corcoesto (Municipalities of Cabana de Bergantiños, Coristanco and Ponteceso in the region of Galicia (Spain)) are inside the scope of the IED. In the epigraph 2.5 of the Annex I of IED are listed the following activities:

2.5. Processing of non-ferrous metals:

1. Production of non-ferrous crude metals from ore, concentrates or secondary raw materials by metallurgical, chemical or electrolytic processes;

This activity is also included in the epigraph 2.5.(a) of Annex 1 (IPPC-A activities) of the Ordinance on determining the activities of the installations requiring an integrated environmental permit, i.e., adjustment permit with an adjustment plan and time schedule for submission of application of adjustment permit with an adjustment plans (Official Gazette of Republic of Macedonia no. 89/05). These installations shall therefore hold an integrated environmental permit and implement the Best Available Techniques (BAT) included in the BAT Reference document (BREF document) for Non-ferrous metal industries (NFM BREF) (see Annex 1 for more information on this document).

EIA

In the Republic of Macedonia, according to the Decree for determining the projects and criteria for determining the need to conduct an environmental impact assessment (EIA) (Official Gazette of Republic of Macedonia no. 74/05), the following activities are subjected to a mandatory EIA procedure (Annex I) or to screening for determining if a EIA procedure is required (Annex II):

Activities included in Annex I (projects with mandatory EIA):

5. Installations for the extraction of asbestos

16. Quarries and surface mining where the surface of the site exceeds 10 ha.

Activities included in Annex II (projects for which MoEPP has to decide if EIA is required or not) :

2. Exploitation of mineral resources:

(A) Quarries, all kinds of quarries not included in Annex I;

(B) Underground mines;

(C) exploitation of minerals from the beds and banks of surface bodies

(D) Deep drillings, in particular:

* geothermal drilling,
* drilling for the storage of radioactive waste
* drilling for public water supply, with the exception of drillings for investigating the stability of the soil (geotechnical drilling)

(E) Surface industrial installations for the extraction of coal, ore,and oil shale.

In the case of a project under the scope of Annex II, if MoEPP decides that it does not need to follow an EIA procedure, then the project will need to follow the procedure for Elaborates.

Elaborate

If a project in Annex II of the EIA Ordinance finally does not need to follow an EIA procedure, or if a project does not belong to neither Annex I nor Annex II of the EIA Ordinance, but belongs to one of the categories described in one of the 2 Ordinances defining operations requiring an Elaborate[[1]](#footnote-1), it will need to follow the procedure for Elaborates (Official Gazette No. 44/13, 111/14) and obtain an Elaborate.

Mining and quarrying activities fall under the scope of the Regulation on Elaborates issued by the Administration for Environment. Some processing activities (cutting, shaping and finishing of dimension stone; breaking and crushing of gravel) fall under the scope of the Regulation on Elaborates issued by the LSGUs.

### MTWR BREF

The Law on Mineral Resources requires in any case that mining and quarry operators take all measures necessary to prevent or reduce any adverse environmental or human health effects related to the management of extractive waste. The first BREF on the Management of Tailings and Waste-Rock in mining activities (MTWR BREF) was published in 2009. Recently the European Commission launched the process of reviewing and adapting the MTWR BREF, expected to finish in 2017.

It must be emphasized that, contrary to other BREF documents, managed by the European IPPC Bureau , the MTWR BREF is not subject to the IED.

The BREF document is available on the following link: <http://eippcb.jrc.ec.europa.eu/reference/BREF/mmr_adopted_0109.pdf>

The underlying theme of the document covers mineral processing, tailings and the waste-rock management of ores that have the potential for a strong environmental impact or that can be considered as examples of “good practice”. The document does not cover the ore extraction but it does provide a basic approach to mining techniques because the subsequent mineral processing techniques and tailings and waste-rock management are highly dependent of on the mining technique. The document, in its **Chapter 5**, presents the **techniques and the emission and consumption levels** that are considered **compatible with BAT** in a general sense. Previously, in Chapter 3 data and information are provided concerning the techniques applied and current emission and consumption levels. In Chapter 4 a description is given in more detail of emission and risk reduction and other techniques that are considered to be most relevant for determining BAT and BAT based measures. However, the document does not propose emission limit values.

### Key environmental issues regarding mines and quarries

This factsheet will cover the management of tailings and waste-rock as the result of mineral extraction.

The key environmental issues regarding mines and quarries are the following:

* Land and water use;
* Waste Management;
* Chemicals and pollutants;
* Tailings disposal;
* Human health risks; and potential environmental risks and
* The plans to mitigate these risks.

While the MTWR BREF does not set legally binding standards, it is meant to give information for the guidance of industry, Member States of the EU and the public on achievable performances, emissions, and consumption levels when using specified techniques.The BATs given in Chapter 5 have not therefore the legally binding nature as have the BAT in IED legislation

In the following subsections a brief description is done of the different impacts caused by these activities, and of the techniques available to mitigate them, as mentioned in the MTWR BREF.



## Air

The main issue regarding emission into air is the release of dust in surface mining operations and by crushing and grinding operations during mineral processing.

### Dust

Dust can consist of materials such as quartz or any other components found in rocks and minerals, including metals. Fugitive emissions of dust are produced basically in the extraction operations of surface mining due to drilling, blasting, loading, hauling and transporting (including dump truck and heavy machinery traffic). Hauling and transporting to the processing facilities in underground mining also give rise to dust emissions. In the processing operations channelled dust emissions are produced basically in the crushing, grinding (dry), and screening and classification operations. Extraction and abatement systems are used and the collected dusts are returned to the process. Tailings and waste-rock management facilities give also rise to dust emissions. To a lesser degree, on a temporary basis, dust is also released from fugitive sources in the previous operations to the extraction, during the construction of networks of access roads and other infrastructure such as mineral processing installation and the associated installations.

In Section **5.2 ’Generic’** of the MTWR BREF to prevent dusting is included as BAT (page 429). The corresponding BAT takes into account the following items with the corresponding measures:

* Dams and heaps: wind breaks, water spraying, application of binding material
* Tailings beaches: water spraying
* Slopes of tailings dams: cover with coarsely crushed waste-rock
* Transport
  + Conveyor belts: covering, use minimum discharge heights
  + Trucks: watering the roads, speed limit of 30 km/h, water spraying the shovel of the loader and the bucket of the truck

### Odour

Usually the odour is of not a concern unless there is residential housing near waste water treatment plants. In this case odour control measures shall be implemented.

There are no BATs included in the MTWR BREF regarding odour.

In Section 4.5.5 of the Best Available Techniques (BAT) Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW BREF) prescribes BATs regarding odour emissions. BAT 20 is to set up, implement and regularly review an odour management plan, as part of the environmental management system (EMS) (BAT 1) in order to prevent or to reduce odour emissions. BAT 21 is to use one or a combination of the techniques given with the same purpose as in BAT 20.The associated monitoring is in BAT 6. The techniques included are the following:

* Minimize residence times of waste water and sludge in collection and storage systems
* Chemical treatment (use chemicals to destroy or to reduce the formation of odorous compounds)
* Optimise aerobic treatment (controlling oxygen content;frequent maintenance of the aeration system; use of pure oxygen;removal of scum in tanks)
* Enclose or cover facilities for collecting the waste water and sludge
* End of pipe treatments (biological treatment using biofiltration, bioscrubbing, biotrickling or moving-bed trickling filter; thermal oxidation)

### Pollutant substances

Main sources of air pollutant substances in mining activities include the following:

* Particulate matter (PM10) transported by the wind as a result of blasting, transportation of materials and tailings and waste-rock management facilities. Exhaust gas emissions from mobile sources (trucks, heavy machinery) contribute also to the particulate matter emissions.
* Gas emissions (NOX, CO, SO2) of combustion of fuels in stationary and mobile sources (trucks, heavy machinery)
* Heavy metals (especially arsenic, lead and cadmium) SO2 and NOx are released in the mineral processing, for instance in the process called smelting of copper and other non-ferrous metals, in which the ore is heated to separate it from the gangue.

There are no BATs included in the MTWR BREF regarding pollutant substances emitted into the air other than dust.

### Greenhouse gases

Greenhouse gases released in mining include methane (CH4), carbon dioxide (CO2) and nitrous oxide (N2O).

CH4 emissions arise from underground mining operations, especially in coal mines. CH4 is generated during the formation of coal through the process called ‘coalification’ process of vegetal matter and it is released into the air in the extraction operations.

CO2 is released in the combustion of fuels for energy use in stationary and mobile sources (cars, trucks, heavy machinery).

N2O emissions are mentioned in the literature in the context of soil reclamation after decommissioning in which organic amendments such as bio-solids, manure, composted manure and industrial by-products are used to restore soil productivity. These amendments may also give rise to CO2 emissions, but research has shown that the impact of both N2O and CO2 is very short-lived.

The emissions of greenhouse gases are not regulated in IED but in other relevant European policy instruments like the Emission Trading System (ETS), and therefore BREFs do not include BATs for the prevention or reduction of these emissions.

In the Reference Document on Best Available Techniques for Energy Efficiency (ENE BREF) the following BATs related to energy efficiency are included, which contribute to the reduction of emissions of greenhouse gases:

* BAT n.3-4: Identify the aspects of an installation that influence energy efficiency by carrying out an audit
* BAT n.8: Establish energy efficiency indicators
* BAT n.15: Carry out maintenance at installations to optimise energy efficiency

## Noise and vibrations

Noise is produced basically in the extraction operations of surface mining due to drilling, blasting, loading, hauling and transporting (including dump truck and heavy machinery traffic, as well as conveyor belts). Hauling and transporting to the processing facilities in underground mining also give rise to noise emissions. In the processing operations dust is produced basically in the crushing, grinding (dry), screening and classification operations. In a lesser degree, in a temporary basis, noise emissions arise in the previous operations to the extraction, during the construction of networks of access roads and other infrastructure such as mineral processing installation and the associated installations. Noise can be also an important source of disturbance for protected wild life species.

Noise nuisance from trucks, conveyor belts and heavy machinery can be reduced by shielding the operations from housing areas with noise barriers

Vibrations are produced during the drilling and blasting operations. They may affect the stability of nearby infrastructures, buildings, and homes.

In Section **5.2 ’Generic’** of the MTWR BREF BAT, regarding noise emission, the following measures are considered to be BAT (page 430): .

* Use continuous working systems (e.g. conveyor belts, pipelines)
* Encapsulate belt drives in areas where noise is a local issue
* First create the outer slope of a heap, and then transfer ramps and working benches into the heap’s inner area as far as possible.

## Waste water

Potential sources of water pollution from mining include drainage from surface and underground mines, wastewater from beneficiation, and surface run-off from the surface mines including all infrastructures, installations as well as storage facilities and tailings and waste-rock management facilities. Main environmental issues regarding waste water emissions are the following:

* Waste water from mineral extraction.
  + Acid rock drainage (ARD). Is considered one of the main serious threats to water resources arising from mining. It happens when mineral ore containing sulphides such as nickel, copper, iron, copper, gold, zinc, cadmium, lead and coal (if pyrites are present) are extracted. These operations may produce acidic, high in sulphate and metal rich solutions resulting from the natural oxidation of the sulphides through exposure to air and water. The combination of acids and metals can have severe effects on the ecology of local watercourses. Acid mine water can be a problem for drainage from both underground and surface workings, as well as drainage from tailings and waste-rock deposits. It can occur while the mine is operating and long after the mine closure. ARD may generated in sulphide-bearing pit walls and underground mines as a consequence of extraction operations but also in tailings and waste-rock management facilities.
  + Other pollution. Leaching of toxic constituents, such as arsenic, selenium, and metals, can occur even if acidic conditions are not present. Elevated levels of cyanide and nitrogen compounds (ammonia, nitrate, and nitrite) can also be found in waters at mine sites, from heap leaching and blasting.
  + Suspended solids. Much mine wastewater contains large amounts of suspended solids (ranging from colloidal to materials that settle) originating from the ore itself, from tailings and waste-rock stock piles and from surface installations due to sediment laden surface runoff.
* Waste water from mineral processing.
  + Hazardous substances used as reagents in the mineral processing. Mineral separation processes that make use of hazardous chemicals such as sulphuric acid or cyanide, in the case of gold mining (e.g. leaching), or organic reagents (e.g. flotation) can be serious sources of pollutions of surface waters if appropriate control systems are not in place. Other pollutants such as xanthates, acid and bases depending on pH, solid metals or metalliferous compounds, dissolved salts, radioactivity (in coal tailings/waste-rock heaps), chloride (coals) can also be included.
  + Suspended solids. Mineral processing operations such as grinding can give raise also to large amounts of suspended solids.

In Section **5.2 ’Generic’** of the MTWR BREF, regarding emissions to water, the following measures are considered to be BAT (page 429): .

* Re-use process water
* Mix process water with other effluents containing dissolved metals
* Install sedimentation ponds to capture eroded fines
* Remove suspended solids and dissolved metals prior to discharge of the effluent to receiving watercourses
* Neutralise alkaline effluents with sulphuric acid or carbon dioxide
* Remove arsenic from mining effluents by the addition of ferric salts

In Section **5.2 ’Generic’** of the MTWR BREF the following additional BATs are included regarding dam operation (page 431), which relate to waste water:

* Provide for diversion of any discharge into the pond away from the pond in the event of difficulties
* Provide alternative discharge facilities, possibly into another impoundment
* Provide second decant facilities (e.g. emergency overflow) and/or standby pump barges for emergencies, if the level of the free water in the pond reaches the predetermined minimum freeboard
* Measure ground movements with deep inclometers and have a knowledge of the pore pressure conditions
* Provide adequate drainage

In Section **5.2 ’Generic’** of the MTWR BREF additional BATs are included regarding removal of free water from the pond (page 431) which relate to waste water:

* Use a spillway in natural ground for valley site and off valley site ponds
* Use a decant tower:
  + In cold climates with a positive water balance
  + For paddock-style ponds
* Use a decant well:
  + In warm climates with a negative water balance
  + For paddock-style ponds
  + If a high operating freeboard is maintained.

## Soil and groundwater

The main environmental issues regarding soil and groundwater are the following:

* Acidification due to ARD
* Pollution with heavy metals due to ARD
* Leaching of pollutants such as arsenic, selenium and metals, cyanide and nitrogen compound (ammonia, nitrate and nitrite)
* Deposition of polluting substances from air emissions such as heavy metals.

In Section **5.2 ’Generic’** of the MTWR BREF the following good practicesare included regarding seepage management which relate to soil and groundwater protection (page 429):

* Preferably the location of a tailings or waste-rock management facility will be chosen in a way that a liner is not necessary.
* If this is not possible and the seepage quality is detrimental and/or the seepage flowrate is high, then seepage needs to be prevented, reduced or controlled using the following techniques:
  + Use a liner system (e.g.clay or other sealing material) to prevent and reduce seepage
  + Use seepage barriers (e.g. cut-off trenches, slurry walls, grout curtains) or return systems (e.g. collector ditches, collector wells) to control seepage

Often a combination of these measures is applied.

## Waste

### Extractive waste

In most countries, waste from mining activity is not covered by the common regulation on waste and there is specific regulation on the issue. At the EU level, as mentioned above, there is a specific Directive, the Directive on the management of waste from extractive industries 2006/21/EC (the so-called "Mining Waste Directive”), transposed in the case of the Republic of Macedonia through the Law on Mineral Resources, which includes a provision in its Article 87 by which the drawing up of a waste management plan is compulsory. It shall include at least the proposed plan for closure, including rehabilitation, after-closure procedures and monitoring, in compliance with the Article 94 of this Law.

Tailings and waste-rock may be the result of mineral excavation (metalliferous and non-metalliferous) and also of the physical and chemical processing of metalliferous and non-metalliferous minerals. Drilling muds and other drilling wastes are also produced both in the exploration (or prospective) and exploitation stages. All these types of wastes belong to the generic chapter *01 ‘Waste resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals’* of the Waste Catalogue, which includes both hazardous and non-hazardous substances. According to article 25 of the Law on Waste Management, they belong to the generic chapter 11 ‘Residues from raw materials extraction and processing (e.g. mining residues etc.)’ of the List of Wastes.

The management of tailings and waste-rock is the main environmental issue regarding waste production and management, due to the huge quantities produced and to its potential polluting capacity. There are many options for managing tailings and waste-rock. The most common methods are:

* Discarding slurried tailings into ponds
* Backfilling tailings or waste-rock into underground mines or open pits or using them for the construction of tailings dams
* Dumping more or less dry tailings or waste-rock onto heaps or hill sides
* Using the tailings and waste-rock as a product for land use, e.g. As aggregates, or for restoration
* Dry-stacking of thickened tailings
* Discarding tailings into surface water (e.g. sea, lake, river) or groundwater

Tailings and waste-rock management facilities vary vastly in size, e.g. from swimming-pool sized tailings ponds to ponds of over 1000 hectares, and from small tailings or waste-rock piles to waste-rock areas of several hundred hectares or tailings heaps over 200 m high.

The choice of the applied tailings and/or waste-rock management method depends mainly on an evaluation of three factors, namely:

* Cost
* Environmental performance
* Risk of failure

The key environmental issues regarding tailings and waste-rock management facilities are impacts associated with the site location and relative land take as well as the potential emissions of dust and effluents during operation or in the after mine closure, as mentioned in sections 4.1.1 ‘Dust’ and 4.3 ‘Waste water’. Furthermore, bursts or collapses of tailings and/or waste-rock management facilities can cause severe environmental damage and even loss of human life.

The bases for the successful management of tailings and waste-rock are a proper material characterisation, including an accurate prediction of their long-term behaviour, and a good choice of site location.

As provided in article 87 of the Law on Mineral Resources, it shall be ensured that the operator draws up a waste management plan for the minimisation, treatment, recovery and disposal of extractive waste, taking into account the principle of sustainable development.

In Section **5.2 ’Generic’** of the MTWR BREF the following good practices regarding ARD management (page 429) which refer to the characterization of tailings and waste-rock are included:

* Tailings characterisation including the general description of physical and chemical characteristics, such as:
  + daily/yearly throughput and total quantity
  + size distribution
  + solid or slurried tailings, pulp density (% solids)
  + density of solids
  + stability/plasticity
  + liquid phase chemistry
  + acid generating potential
  + geochemical characteristics (metal content, leaching behaviour)
  + pore water
  + consolidation behaviour
  + kinetic testing
  + mineralogy
  + hydrological properties

In Section **5.2 ’Generic’** of the MTWR BREF, regarding ARD management BAT is to firstly prevent the generation of ARD and if the generation of ARD cannot to be prevented, to control ARD impact or to apply treatment options (page 429) are included regarding seepage management which relate to soil and groundwater protection.

In Section **5.2 ’Generic’** of the MTWR BREF BAT is considered to use the following techniques regarding tailings and waste-rock facility operation (page 432):

* Divert natural external run-off
* Manage tailings or waste-rock in pits. In this case heap/dam slope stability is not an issue
* Apply a safety factor of at least 1.3 to all heaps and dams during operation
* Carry out progressive restoration/revegetation

In Section **5.2 ’Generic’** of the MTWR BREF BAT is considered the application of the following techniques regarding dewatering of tailings (page 431) :

* Dry tailings management
* Thickened tailings management
* Slurried tailings management

In Section **5.2 ’Generic’** of the MTWR BREF BAT is considered the application of the following techniques regarding the reduction of footprint (page 433):

* If possible, prevent and/or reduce the generation of tailings/waste-rock
* Backfill tailings
* Backfill tailings in the form of paste fill
* Backfill waste-rock,
* Investigate possible uses of tailings and waste-rock

### Non-extractive hazardous and non-hazardous waste

Waste which is not the direct result of prospecting, extraction and treatment of mineral resources and the working of quarries may include hazardous waste (waste oil, oil filters, brake pads containing asbestos, batteries, chemicals and package containing hazardous substances etc., depending on the maintenance of vehicles and equipment carried out on site) and non-hazardous waste (waste assimilable to domestic waste generated in staff housing and offices, package not containing hazardous substances etc.) Duty of care relates to everyone who handles waste, from the person producing the waste to the person who finally disposes of or recovers it. Waste must be kept secure so it does not leak, spill, or blow away and can only be given to an authorised person (e.g. a registered waste carrier) and be transferred with the release of signed transfer notes. Treatment of waste should follow the waste hierarchy framework (reduction, reuse, recovery, disposal) and it applies principles of proximity (treatment of waste as close as possible) and of precaution (immediate application of cost-effective measures to prevent environmental degradation).

Hazardous wastes must be collected and stored separately and shall not be mixed among them or with non-hazardous waste or other substances and materials. They must be kept secure so they do not leak, spill, or blow away and with compliance with the regulations. They must be transferred, accompanied by the supporting documents to an authorised waste management company.

There are no BATs included in the MTWR BREF regarding non-extractive waste.

## Storage of hazardous substances

Regarding the management of tailings ponds containing dangerous substances, see next subsection 4.8.

Storage of reagents for the mineral processing: in mineral separation processes hazardous chemicals substances are used in significant quantities, such as sulphuric acid or cyanide, in the case of gold mining (e.g. leaching), or organic reagents (e.g. flotation). If quantities equal to or exceeding the qualifyng quantities set out in Part 1 or Part 2 of Annex I of the Seveso-III Directive (2012/18/EU) on the control of major-accident hazards involving dangerous substances are present, the activity is covered by the Directive, which lays down obligations for the States and operators.

In the Republic of Macedonia the Seveso-II Directive (1996/82/EC) has been transposed so far, mainly through Chapter XV of the Law on Environment and corresponding secondary legislation.

## Safety

Major accidents in mining involving the release of dangerous substances were due to the collapse or burst of tailing dams, as it was the case in the Aznalcóllar (Spain) and Baia Mare and Baia Borsa (Romania) accidents. Therefore, tailing pond and tailing dam management are keys to prevent accidents. The exploitation, namely the exploration, extraction and processing, of minerals in mines and quarries, including by mines of boreholes is not covered by the Seveso-III Directive. As mentioned in the previous Section (4.7), in the Republic of Macedonia only the Seveso-II Directive (1996/82/EC) has been transposed so far. However, it covers operational tailings disposal facilities, including tailings ponds or dams, containing dangerous substances in quantities equal to or exceeding the qualifyng quantities set out in Part 1 or Part 2 of Annex I of the Directive.

Although the focus has been put on tailing ponds and dams, severe environmental damage can be also caused by the collapse of tailings and waste-rock heaps.

Regarding safety, in Section **5.2 ’Generic’** of the MTWR BREF BATs are included regarding:

* **Dam design:**

In addition to the measures described in Section 4.1 and Section 4.2, during the design phase (Section 4.2.1) of a tailings dam

* **Dam construction**

In addition to the measures described in Section 4.1 and Section 4.2, during the construction

phase (Section 4.2.2) of a tailings dam.

* **Raising dams**

In addition to the measures in Section 4.1 and Section 4.2, during the constructional and operational phases (Sections 4.2.2 and 4.2.3) of a tailings dam.

* **Dam operation**

In addition to the measures in Section 4.1 and Section 4.2, during the operational phase (Section 4.2.3) of a tailings dam

* **Mitigation of accidents**

## Administrative organisation / Internal control

### Environmental management system

Regarding environmental management, in Section 5.7 Environmental management’ of the MTWR BREF a number of environmental techniques are determined as BAT.

The scope (e.g. level of detail) and nature of the EMS (e.g. standardised or non-standardised) will generally be related to the nature, scale and complexity of the installation, and the range of environmental impacts it may have.

BAT is to implement and adhere to an Environmental Management System (EMS) that incorporates, as appropriate to individual circumstances, the features listed in Section 5.7 of the MTWR BREF.

Specifically for the management of tailings and waste-rock, BAT is to apply an integrated risk/safety and environmental management system. Therefore environmental management has to be developed and carried out jointly with the risk assessment/management described in Section 4.2.1 of the MTWR BREF and the operation, supervision and maintenance management described in Section 4.2.3.1.

### Self-monitoring and reporting

In Section **5.2 ’Generic’** of the MTWR BREF BATs are included regarding monitoring stability of the tailings ponds and dams and heaps. An additional BAT referred to in this section is the monitoring of groundwater around all tailings and waste-rock areas (Section 4.3.12)

In Section **5.7 ’Environmental management’** of the MTWR BREF BAT is considered to adhere to an EMS that incorporates the checking of performance and taking of corrective actions, paying particular attention to monitoring and measurement

Additional self-monitoring and reporting obligations must be fulfilled as set in waste water discharge permits issued based on legislation on Waters and Water Quality. This is the case as well when other obligations must be fulfilled regarding emissions into air, groundwater and soil, noise emissions and vibrations and waste production as set in permits or in the specific regulation. Additionally, the decision of the Competent Authority on the EIA may include additional monitoring and reporting conditions, specifically regarding the frequency of the measurements.

## Specific mineral processing

## Gold leaching using cyanide

In Section **5.3 ’Gold leaching using cyanide’** of the MTWR BREF BATs are included, in addition to the generic measures in Section 5.2, for all sites applying gold leaching using cyanide.

## Aluminium

In Section **5.4 ’Aluminium’** of the MTWR BREF BATs are included, in addition to the generic measures of Section 5.2, for all allumina refineries.

## Potash

In Section **5.5 ’Potash’** of the MTWR BREF BATs are included, in addition to the generic measures of Section 5.2, for all potash sites.

## Coal

In Section **5.6 ’Coal’** of the MTWR BREF BATs are included, in addition to the generic measures of Section 5.2, for all coal sites.

## Other environmental issues

### Raw materials and energy consumption and efficiency

There are no BATs included in the MTWR BREF regarding energy consumption and efficiency. General principles on energy consumption reduction and efficiency apply.

In Section **5.2 ’Generic’** of the MTWR BREF BAT is included which is defined as ’reduce reagent consumption’ which refers to techniques described in Section 4.3.2 ’Techinques to reduce reagent consumption’ of the document.

### Natural resources management

As well as causing water pollution, excavations can also influence the hydrology around the excavated area. Excavations may lead to more rapid seepage into the groundwater, causing nearby streams or wells to become dry. Underground works may cut across aquifers and bring otherwise separate bodies of water together.

Additionally a water balance must be carried out in order to develop a water management plan by the operator.

In Section **5.2 ’Generic’** of the MTWR BREF BATs are included regarding the necessity to carry out a water balance (Section 4.3.7) and the use of the results to develop a water management plan (Section 4.2.1.3), as well as to apply free water management.

### Reduction of footprint, and closure and after-care

The reduction of footprint focuses mainly in the prevention and reduction of tailings and waste-rock.

In Section **5.2 ’Generic’** of the MTWR BREF BATs are included regarding the reduction of footprint which refer to the prevention and/or reduction of the generation of tailings/waste-rock (Section 4.1). In this context BAT is also to backfill tailings under certain conditions (Section 4.5.1), to backfill waste-rock under certain conditions (Section 4.5.2) and to investigate the possible uses of tailings and waste-rock (Section 4.5.3).

As impacts of mining are long term, closure must be carried out under control and after-care measures must be applied.

In Section 5.2 ’Generic’ of the MTWR BREF BATs are included regarding the closure and after-care in addition to the measures described in Section 4.1 and Section 4.2, during the closure and after-care phase (Section 4.2.4) of any tailings and waste-rock management facilities.

For the closure and after-care phase of tailings ponds, BAT is to construct the dams so that they stay stable in the long term if a water cover solution is chosen for the closure (Section 4.2.4.2).

### Impact of quarries and mines in the natural habitats and wildlife, landscape and the cultural heritage

Quarries and mines may produce significant impacts on the natural habitats and on the wildlife, including:

* Habitat loss
* Habitat degradation
* Habitat fragmentation
* Alteration of soil and subsoil
* Barrier effect (linear infrastructure)
* Trap effect (drainage, ponds etc.) on certain species of animals which are sensitive to this impact such as the amphibians
* Disturbance due to noise emissions
* Disturbance due to vibrations

Additionally, due to the significant earthworks carried out, especially in surface mining, impacts in the landscape and cultural heritage may also be significant.

Conditions laid down in the decision on the EIA regarding natural habitats, wildlife (with a focus on endangered and protected species, protected sites under the nature conservation legislation, landscape and cultural heritage shall be complied with. The permitting authority must be consulted and all the information available be requested from them.

# The inspection



## Preparation before inspection

### Decide on type of inspection, staff and equipment

The inspection team shall decide on the type of inspection and on the resources, including staff and equipment, which will be assigned to the task. Examples of inspection types can be routine inspection of all production processes or targeted inspection of problematic areas on the basis of complaints or in case that there are indications that critical emission limit values (ELV) cannot be met.

The following aspects should be taken into account:

* Complexity and duration of the installation - the more complex it is the more inspectors that may be needed
* Time of inspection - for safety reasons it is recommended that at night two inspectors should conduct inspection;
* For non-routine inspection, especially conducted upon a complaint and problematic situation, it is advisable to direct two inspectors to it;
* Weather condition as well as the time of a year - some additional equipment might be needed (e.g. torches, protective clothes, etc.).
* The resources needed (man-power/equipment, safety precautions)
* In relation to the previous point, it is recommended to have a check-list of the equipment needed (including safety gear, sampling equipment in case sample taking is required, laptop if available and convenient…).

### Desk study

The collection and evaluation of existing information about the installation is critical for the success of the inspection since it allows the easier formulation of targeted questions for the interview of the operator and the concrete investigation of those unit operations which show the highest potential for not complying with the conditions set in the decision on the EIA or surpassing the set ELV in the environmental permit, if the processing of mineral is an activity included in the paragraph 2.5 of the Annex I of the IED. **Examples of** **information to be collected** are listed below:

1. Reports of previous inspections of the site
2. Maps
3. Environmental Impact Assessment (decision, study, monitoring plan, monitoring reports)
4. Application for the permit
5. Environmental permit/s
6. Environmental reports submitted by operators, including monitoring reports
7. Complaints received about the installation
8. MTWR BREF document
9. NFM BREF document on non-ferrous metals if applicable
10. PRTR and other registers such as register of polluting substances into air, register of waste producers and managers
11. Information on installation to be inspected received from other competent authorities
12. Information available on the website of the operator

On the basis of the evaluation of the collected information **the following has to be prepared**:

* A comprehensive questionnaire which will be used for the operator’s interview
* A **check list** to facilitate the inspection (see next subsection).
* An outline of the “critical” ELV (i.e. those parameters which significantly contribute to the pollution load coming out of the installation)
* The list of BATs (according to the issued permit) which the operator should have installed and operated
* The list of documentation to be provided by the operator (e.g. self-monitoring records, annual reports submitted to the authorities)
* The inspection minutes and report templates (tailor-made for the installation) to be filled in at the end of the inspection
* **Agenda of the inspection** (see next subsection).

### Templates for agenda of the inspection and checklist

**You can use** as starting, **partially completed, checklist template** the one **in Annex 4**, which is **tailored to this sector**.

A **short agenda** can be a **very useful** tool that will help to conduct an inspection. Providing an operator with it in advance may result in more smooth coordination of the inspection from his/her side, simply because the operator will be aware of how many resources and people they will have to allocate to the inspection. Preparing such a document before an inspection is not time-consuming, you can **use the template of inspection agenda in Annex 2**.

### Prior operator notification

* Routine inspections. The operator shall be previously notified of routine inspections as provided in the Law on Inspection Supervision.
* Non-routine inspections. There is not an obligation to notify operators of non-routine inspections. Therefore, in case of inspections carried out to verify if the operator is in line with environmental regulations, as a consequence of complaints by citizens or for other reasons, it is not recommended to notify operators previously.

## On-site inspection

### General considerations to take into account

The aim of the inspection will be to **check compliance** of the operator **with** the operating/environmental conditions set in the issued **permit**.

1. Identify yourself. Clearly introduce yourself and show your identification card at the beginning of each inspection.
2. Explain purpose of visit.
3. The operating/environmental conditions set in the issued **permit will be the „guidance”** throughout the inspection.
4. If necessary take **samples**, and/or define the samples that should be taken by a certified laboratory. Seepage, surface and groundwater sampling (from bore holes for monitoring) should be the main focus.
5. **Always record your inspection with photographs and/or videos**, they are fundamental as a proof in Court.

#### Best Available Techniques (BATs)

It must be checked that all BATs that are prescribed in the permit are present and that the corresponding Emission Limit Values are met. For installations falling under the scope of the IED, if a necessary BAT-Associated Emission Level (BAT-AEL) is not in the permit it must be checked if there is an explanation as prescribed by the article 15.4 in the IED[[2]](#footnote-2). If there is no (good) explanation, feedback to the permit writer and the operator must be given. If a BAT prescribed in the permit is present, works properly but the ELV is not met, possible alternatives can be discussed with the permit writer and the operator.

### Main questions for inspection

The major points of interest for inspection for the activities related to mines and quarries are the following:

* Dust and particulate matter emissions. See Sections 4.2.1 and 4.2.3 (for particulate matter)
* Polluting substances emissions into air (NOx, SO2, heavy metals). See 4.2.3
* Odour emissions. See Section 4.2.2
* Noise emissions into air and vibrations. See section 4.3
* Waste water management. See Section 4.4
  + ARD management. See Section 4.4
* Soil and groundwater. See Section 4.5
* Waste:
  + Extractive waste: tailings and waste-rock heaps and ponds. See Section 4.6.1
  + Non-extractive hazardous waste. See Section 4.6.2
  + Check compliance with BATs set in the permit.
* Surface water. See Section 4.4 and 4.6.1
* Sampling should focus on seepage, surface and groundwater sampling (from bore holes for monitoring)

### Obstruction by the operator

It may happen sometimes that an operator does not want to have an inspector in his/her factory and closes the door for him/her. If this is the case you are entitled to call a state administration body for assistance/police.

But this is not the only way an operator can obstruct your job. Other ways may include such things as:

* Not providing information explaining at the same time that all is confidential
* Trying to ask you for giving them a few additional days for preparation of information that is needed
* Trying to discourage inspectors from visiting "difficult" places such as for example areas where waste is improperly stored.

It must be kept in mind that an obstruction by an operator is considered to be a misdemeanour.

## After the inspection

### Inspection reporting

After the inspection, according to EU best practices, the inspector has to draft a final inspection report. A template for such report has been delivered within this Twinning project and is available at SEI’s website (see Annex 1 for more information). The main contents of such a report are the following:

1. Baseline of the inspection

* Inspection basis (permit, legal regulations)
* Competent inspection authority, cooperating inspection authorities
* Kind of installation (e. g. quarry, underground mine, surface mine (open cut, open cast, open pit; processing of minerals if present))
* Operator (Name of the company)
* Address
* Date of inspection
* Length of inspection time
* Scope of the inspection (e. g. integrated inspection, media that were inspected, parts of the installation that were inspected)
* Kind of inspection (regular, extraordinary, control)

1. Inspection’s results

* No or only minor non-compliances
* Significant or relevant non-compliances
* Serious or important non-compliances

1. Recommended corrective measures

* Minor corrective measures
* Significant or major corrective measures
* Serious or important corrective measures

### Inspection recording

The inspection report and any other additional material used for the preparation of the inspection should be stored and made accessible to any relevant authorities for their information.

# Annex 1: Useful references & links

Website of the State Environmental Inspectorate, with useful materials, including inspection manual, factsheets and checklists:

[www.sei.gov.mk](http://www.sei.gov.mk)

BREF Document for Management of Tailings and Waste-Rock in Mining Activities

<http://eippcb.jrc.ec.europa.eu/reference/BREF/mmr_adopted_0109.pdf>

Guidance document: Non-energy mineral extraction and Natura 2000. European Commission

<http://ec.europa.eu/environment/nature/natura2000/management/docs/neei_n2000_guidance.pdf>

BREF Document for the Non-Ferrous Metal Industries

<http://eippcb.jrc.ec.europa.eu/reference/BREF/NFM_Final_Draft_10_2014.pdf>

Reference Document on Best Available Techniques for Emissions from Storage (EFS BREF)

<http://eippcb.jrc.ec.europa.eu/reference/BREF/esb_bref_0706.pdf>

Reference Document on Best Available Techniques for Waste Treatments Installations (WT BREF):

<http://eippcb.jrc.ec.europa.eu/reference/BREF/wt_bref_0806.pdf>

Reference Document for Common Waste Water and Waste Gas Treatment/Management Systems in the Chemical Sector (CWW BREF):

<http://eippcb.jrc.ec.europa.eu/reference/BREF/CWW_Final_Draft_07_2014.pdf>

Reference Document on Best Available Techniques for Energy Efficiency (ENE BREF):

<http://eippcb.jrc.ec.europa.eu/reference/BREF/ENE_Adopted_02-2009.pdf>

Flotation tailing dams in the Republic of Macedonia (in Macedonian). Conference paper. Blagoj Golomeov et al. Goce Delčev University. Štip:

<https://www.researchgate.net/publication/232725351_Flotation_tailing_dams_in_Republic_of_Macedonia>

***Videos***

Surface mining: an example of open pit coal mining and processing:

https://www.youtube.com/watch?v=8F6SHwNv\_YU&index=35&list=PLIkde6iIhwypJqWHxEIJE5oaLmMMCALOn

Surface mining: in-pit crushing and conveying systems:

https://www.youtube.com/watch?v=doNcVs-APvY

Surface mining: limestone quarrying and road construction aggregate quarrying in England:

https://www.youtube.com/watch?v=sWgaLikMPfc

Surface mining: natural stone (dimension stone) quarrying in U.S.A.:

https://www.youtube.com/watch?v=qUQVQAQaUXc

Surface mining: dimension stone quarrying by splitting and sawing

https://www.youtube.com/watch?v=Sa0Z0m4UmYo&list=PLDRmp-K9I8WR17uEr70Quk3sTXxZMtPrx

Underground mining. Room and pillar technique:

https://www.youtube.com/watch?v=5aPoX3\_P1GQ&list=PLF7F0E3B58229BF99&index=3

Underground mining. Cut and fill stoping:

<https://www.youtube.com/watch?v=XhI0IPZmniY>

Underground mining. Longwall mining:

<https://www.youtube.com/watch?v=xTnEGu5UQog>

<https://www.youtube.com/watch?v=r0bgRe_kBQ8>

Types of tailings embankments: upstream, downstream and centreline construction methods:

https://www.youtube.com/watch?v=1wm1XR6z-QE

# Annex 2: Template for an inspection agenda

**AGENDA FOR THE INSPECTION**

*Name of the company*

*Data of the inspection*

*n. of IPPC A/B permit*

This Agenda for the inspection defines and plans the in situ activities; it defines the type of investigations to be performed (identification of key environmental issues) and how to investigate the defined topics (administrative or technical check by means of direct inspection on the plant). The Agenda is delivered to members of the inspection team and the operator during the preliminary meeting .

***Composition of Inspection Group***

The Inspection Group (IG) is composed of the following technical officials :

*Name – Administration* (Leader of the IG)

*Name – Administration*

xxx

xxx

**Timing and execution of the inspection**

The inspection will be conducted according to the following program:

***Day/month/year***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Subject** | | **Activities** | **Time** | **Who / Staff needed** |
| Step 1 | Opening meeting | | Presentation of the Agenda and the inspection team  Presentation and current status of the plant (production capacity and planimetry to check differences with the authorized layout) by the Operator | 9.00 | IG Leader  Legal responsible of the plant  Representative of the plant in charge of environmental issues |
| Step 2 | Administrative inspection | | *xxxxx* | 11.00 | *xxx* |
| Step 3 | Site visit | | Check BAT Application | 12.00 | Representative of the plant in charge of environmental issues |
| Lunch 13.30 -14.30 | |
| Step 4 | Site visit | | Waste storage | 14.30 | Representative of the plant in charge of environmental issues |
| Step 5 | Site visit | | Water treatment plant | 15.00 | Representative of the plant in charge of environmental issues |
| *Step xxx* | *xxx* | | *xxx* | *xxx* | *xxx* |
| Step xx | Minutes of the inspection | | Drafting and projecting the minutes of the inspection. | 16.00 | Legal responsible of the plant |
| Step xx | Conclusive meeting | | Conclusions | 17.30 | Legal responsible of the plant  Representative of the plant in charge of environmental issues |

***Documents to be prepared by the operator***

* Updated planimetry of the plant, indicating:
* Water discharge points
* Air emissions points
* Waste storage areas
* *xxxxxx;*
* Environmental Management System certificate.
* Analysis certificate provided by certified laboratory of last monitoring analysis.
* Communication to Competent Authority related to Incidents.
* *xxxxx.*

# Annex 3: Sector terminology

**Backfill**

Reinsertion of materials in extracted part(s) of the orebody. Materials used for backfilling can be waste-rock or tailings from the mineral processing plant. In most cases backfill is used to refill mined-out areas.

**Cone crusher**

A machine for reducing the size of materials by means of a truncated cone revolving on its vertical axis within an outer chamber, the annular space between the outer chamber and cone being tapered.

**Dewatering**

Process of removing water from an underground mine or open pit, or from the surrounding rock or non-lithified area. The term is also commonly used for the reduction of water content in concentrates, tailings and treatment sludges.

**Diversion structures**

Relatively small interceptor ditches that collect run-off from the contributing watershed and divert it downstream beyond the TMF.

**Drift**

A near-horizontal passageway in a mine, following the bed (of coal, for instance) or vein of ore. A drift may or may not intersect the ground surface

**Gangue**

The part of an ore that is not economically desirable but cannot be avoided in mining.

**Grade**

Dimensionless proportion of any constituent in an ore, expressed often as a percentage, grams per tonne (g/t) or parts per million (ppm).

**Gyratory crusher**

A primary crusher consisting of a vertical spindle, the foot of which is mounted in an eccentric bearing within a conical shell. The top carries a conical crushing head revolving eccentrically in a conical maw.

**Hauling**

The horizontal transport of ore, supplies and waste. The vertical transport of the same is called hoisting.

**Impact crusher**

In impact crushers, material comminution is accomplished primarily through the impact action of beaters, which hit the pieces of rock freefalling through the crusher chamber and throw them against stationary surfaces at high speed.

**Jaw crusher**

A machine for reducing the size of materials by impact or crushing between a fixed plate and an oscillating plate.

**Ore**

Mineral or variety of accumulated minerals (including coal) of sufficient value as to quality and quantity that it/they may be mined at a profit. Most ores are mixtures of extractable minerals and extraneous rocky material described as gangue.

**Orebody (mineral deposit)**

Naturally occurring geological structure consisting of an accumulation of a desired mineral and waste-rock, from which the mineral can be extracted, at a profit, or with a reasonable expectation thereof.

**Paddock-style pond**

Tailings pond build on flat land.

**Recovery**

Proportion, expressed as a percentage, of a constituent pertaining to the concentrate (or for coal final tonnage) as compared to the total amount of that mineral initially present in the feed prior to mineral processing. A measure of mining, extraction and processing efficiency.

**Roll crusher**

A type of secondary crusher consisting of a heavy frame on which two rolls are mounted. These are driven so that they rotate toward one another. Rock fed in from above is nipped between the moving rolls, crushed, and discharged at the bottom.

**Screening**

Separating material into size fractions.

**Seam**

Stratiform mineralization (typical for coal and some types of salt deposits). Due to tectonic overprint, seams may also be folded or steep lying.

**Shaft**

Primary vertical or inclined opening through mine strata used for ventilation or drainage and/or for hoisting of personnel or materials (e.g. ore, waste-rock); connects the surface with underground workings).

**Slurried tailings**

Tailings consisting of a suspension of liquids and solids.

**Thickening**

Liquid-solid separation process to increase the concentration of a suspension by sedimentation, accompanied by the formation of a clear solid.

**Vein**

Thin complex structure of ore accumulations surrounded by gangue.

**Waste-rock management facilities (WRMF)**

Facility where waste-rock is discarded, stored and in some cases treated, including waste-rock heap leaches.

# Annex 4: Inspection checklist for quarries & mines

1. • Ordinance on the operations and activities that must prepare an elaborate which is to be approved by the Administration for Environment (Official Gazette of Republic of Macedonia No. 80/09 and 36/12).

   • Ordinance on the operations and activities that must prepare an elaborate which is to be approved by the mayor of LSGUs, the mayor of the City of Skopje and the mayors of the LSGUs within the City of Skopje (Official Gazette of Republic of Macedonia No. 80/09 and 32/12). [↑](#footnote-ref-1)
2. Art.15.4 of the IED states the following:

   The competent authority may, in specific cases, set less strict emission limit values than BAT-AELs. Such a derogation may apply only where an assessment shows that the achievement of emission levels associated with the BATs as described in BAT conclusions would lead to disproportionately higher costs compared to the environmental benefits due to:

   (a) the geographical location or the local environmental conditions of the installation concerned; or

   (b) the technical characteristics of the installation concerned.

   The competent authority shall document in an annex to the permit conditions the reasons for the application of the derogation including the result of the assessment and the justification for the conditions imposed.

   The ELVs set in accordance with the derogation shall, however, not exceed the ELVs set out in the Annexes to the IED, where applicable.

   The competent authority shall in any case ensure that no significant pollution is caused and that a high level of protection of the environment as a whole is achieved.

   The competent authority shall re-assess the application of the derogation as part of each reconsideration of the permit conditions pursuant to Article 21 of the IED. [↑](#footnote-ref-2)