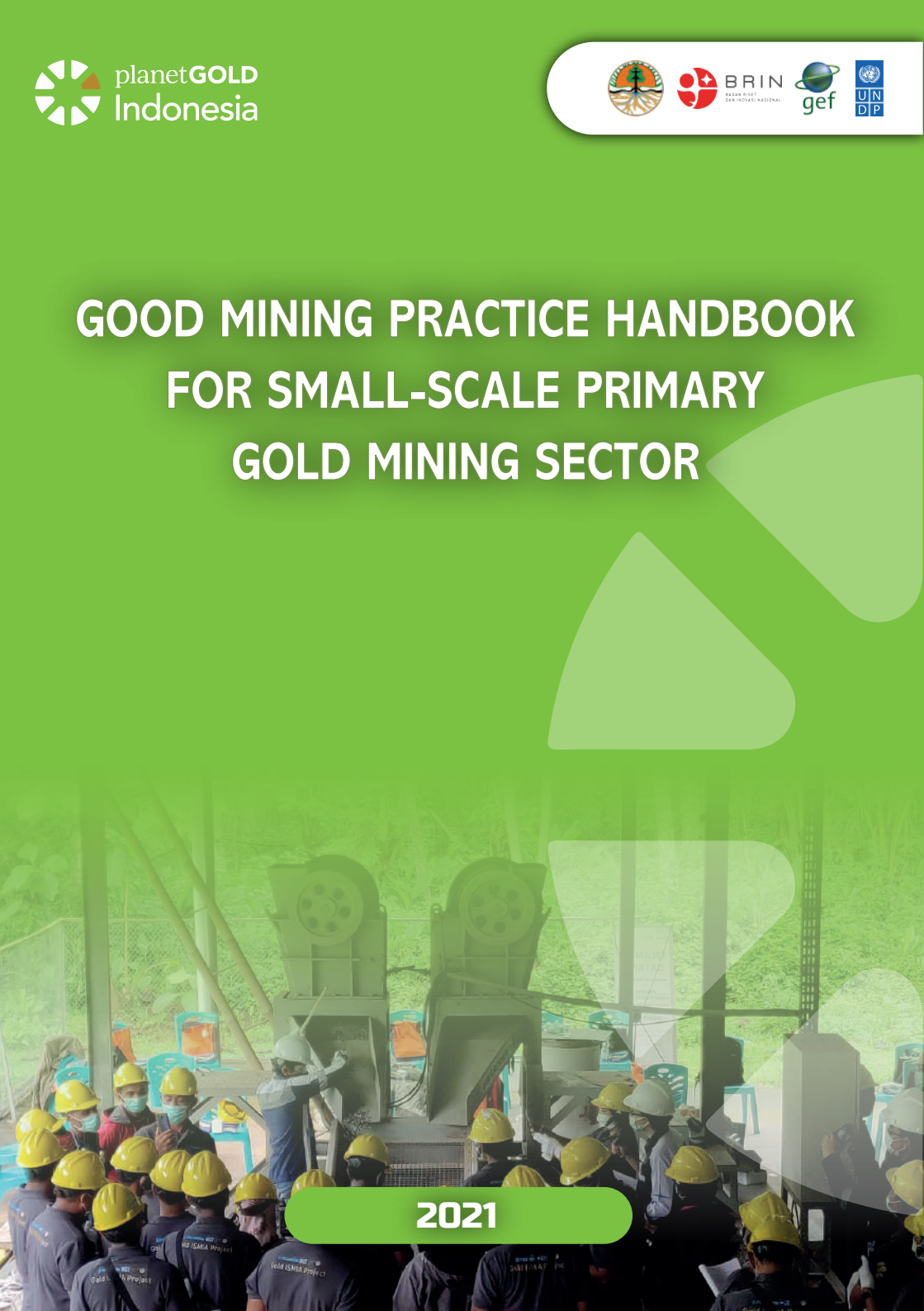


GOOD MINING PRACTICE HANDBOOK FOR SMALL-SCALE PRIMARY GOLD MINING SECTOR



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Good Mining Practice Handbook for Small-Scale Primary Gold Mining Sector

Budi Sulistijo

Bandung, November 2021

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I. INTRODUCTION

A. Background

Artisanal gold mining activities from the primary rocks have seen many benefits for the remote areas. However, small-scale gold mining activities if not managed properly or illegally will cause the loss of many people as well as environmental damage.

In Mining Law No. 3 of 2020 (UU No. 3/2020) Amendments to Law No. 4 of 2009 concerning Mineral and Coal Mining Article 1 states that Artisanal Mining Permit (IPR) is a permit to carry out mining business in artisanal mining area within **a limited mine area and investment**.

In implementing artisanal mining in Indonesia, there are various requirements to carry out mining activities. As a first step, stakeholders are required to know in detail about the regulations which are applied. This handbook provides additional recommendations for stakeholders to implement good mining practice. This handbook aims to provide an overview of good practices in primary gold mining with that these procedures can be further improved and as implementation progress increases.

The contents of this book are based on the conditions of small-scale primary gold mining in Indonesia. This handbook applies only for small-scale gold mining and does not suitable for alluvial gold mining activities which normally require suction pumps and sluice boxes. The technical expert responsible for developing this handbook is Budi Sulistijo, PhD from the Bandung Institute of Technology (ITB).

This handbook focuses on the technical level of mining safety and environmental management. The benefits of this handbook should be seen as complementary to other national and international initiatives supporting small-scale mining in Indonesia. There are several pilot projects underway in Indonesia, including aspects such as safe gold processing.

► *See Appendix I for GOLD-ISMIA activities in small-scale primary gold mining sector*

The development of this handbook was inspired by discussions with Indonesian stakeholders and also by the examples provided by the Frugal Rehabilitation Methodology developed for small-scale mining in Mongolia specifically for reclamation (The Asia Foundation, 2016). The technical information contained in this handbook is something need to know about people-based mining activities. This information is useful for stakeholders in the small-scale primary gold mining sector - small-scale mining operators, local governments, as well as mine regulators and supervisors. The

handbook also provides information for communities living close to small-scale primary gold mining areas and students dealing with small-scale primary gold mining questions.

B. Regulations

In Law Number 3 of 2020 as Amendments to Law Number 4 of 2009 concerning Mineral and Coal Mining (UU No. 3/2020) Article 1 states that Artisanal Mining Permit (IPR) is a permit to carry out mining business in artisanal mining with **a limited area and investment**. In Article 70 paragraph b, small-scale mining actors comply with laws and regulations in the field of mining safety, environmental management, and comply with applicable standards. In the regulation of the Minister of Energy and Mineral Resources No. 1827 K/30/MEM/2018, every IPR must have a Class IV Head of Technical Mine (KTT).

► *See Appendix II for a summary of become a KTT*

Then Government Regulation No. 96 of 2021 Article 66 paragraph 2 regulates, among other things: not using explosives, not mining using the underground mining method for individual IPR holders.

The purpose of the regulation is to provide safety for small-scale primary gold mining actors, reduce environmental damage, restore and improve the quality of the environment and ecosystem, and restore land functions in accordance with the mine closure planning.

The small-scale primary gold mining is a dangerous for both the miners and the surrounding community, so it is very important to manage work safety and environmental management. Land management needs to consider sustainable of gold yield productivity, safety, and social balance.

C. Responsibilities of Small-Scale Primary Gold Miners

Small-scale primary gold mining actors are required to have artisanal Mining Permit (IPR) that occupies an Area of Artisanal Mining (WPR). The holders of artisanal mining permits have primary responsibility for mining safety and environmental management as well as implementing applicable standards. In addition to managing the environment, they are required to pay artisanal mining fees (Ipera) but exempt from fixed fees and production fees (royalty) and submit reports on the implementation of artisanal mining activities periodically.

D. Small-Scale Primary Gold Mining

Primary gold is gold that is found in metallic form (native) found in quartz rock cracks and in minerals which are formed due to magmatism or concentration processes at the surface. Some deposits are formed due to contact metasomatism and hydrothermal

activities, which form ore bodies with the main content of silica. Primary gold deposits have a distribution in the form of gold vein in igneous rocks (Figure 1.1). The small-scale primary gold mining usually uses underground mines and only few uses open-pit mines at the beginning of excavation, and then turns into underground mining.

Small-scale primary gold mining usually uses chisels and hammers, crowbars, Jack Hammers to make access or rock excavation. Almost never uses tools like jack leg to break the rock. Barren rock that do not contain gold are separated from ore that contain gold. Stones that do not contain gold are usually discarded around the openings. Stone containing gold is usually processed at a site near the excavation or is often processed elsewhere. The process of taking gold and disposing of processing waste is often neglected, that it causes pollution.

The mining methods of small-scale primary gold mining are generally relatively simple. Equipments commonly used are chisel and hammer, crowbar, jack hammer, shovel for picking up broken rocks, water pump for dewatering, air pump for ventilation and head lamps for lighting. Depending on the processing techniques used, mining and processing can cause a variety of obvious environmental impacts such as changes in landscape, subsidence, landslides but also impacts that cannot be seen directly, such as changes in ground water level, turbidity, etc.

Various elements of the mining process, such as waste, tailings, and open pit morphology and underground space and their impact on the environment need to be managed. As the scale of this impact differs from place to place, mining costs and yields can also show significant differences between different locations. Mining in areas of soft rock, fractured rock, rock containing clay requiring special treatment which will require more expensive costs. Therefore, all mining and processing costs need to be budgeted properly according to the specific situation of the area. Mining and processing budgets should consider underground pit maintenance activities and processing methods.

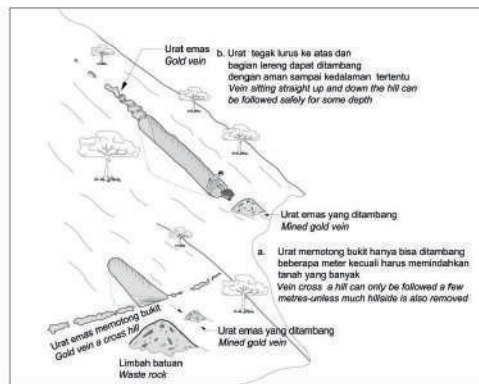
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a. Gold veins a cross the hill



b. Gold vein straight up and down the Hill



c. (Blowers, 1988)

Figure 1.1 Typical Primary Gold Vein

Area of small-scale primary gold mining operation range from small (<1 Ha) to 5 Ha for individuals and 10 Ha for cooperatives with a term of 10 years and can be extended to 2 times of 5 years each (Law No 3/2020, Article 68). Therefore, it is necessary to plan which areas will be mined because of the ease or the presence of high grade deposit.

Primary gold ore is a natural resource that is quite abundant in Indonesia, so it is very easy to exploit with small-scale mining (Map 1.1). Therefore, small-scale mining can fulfill important economic functions for the local communities. Small-scale mining activities must be carried out by having an IPR. In this case, the IPR concession holder will be responsible for the mining safety and the environmental management. However, in some cases, the small-scale mining activities occur without permits, outside of formal mining concessions. These unlicensed mining do not pay mining fee, royalties environmental guarantee so that the environmental damage they cause today is a sustainable challenge for the community (Photo 1.1).

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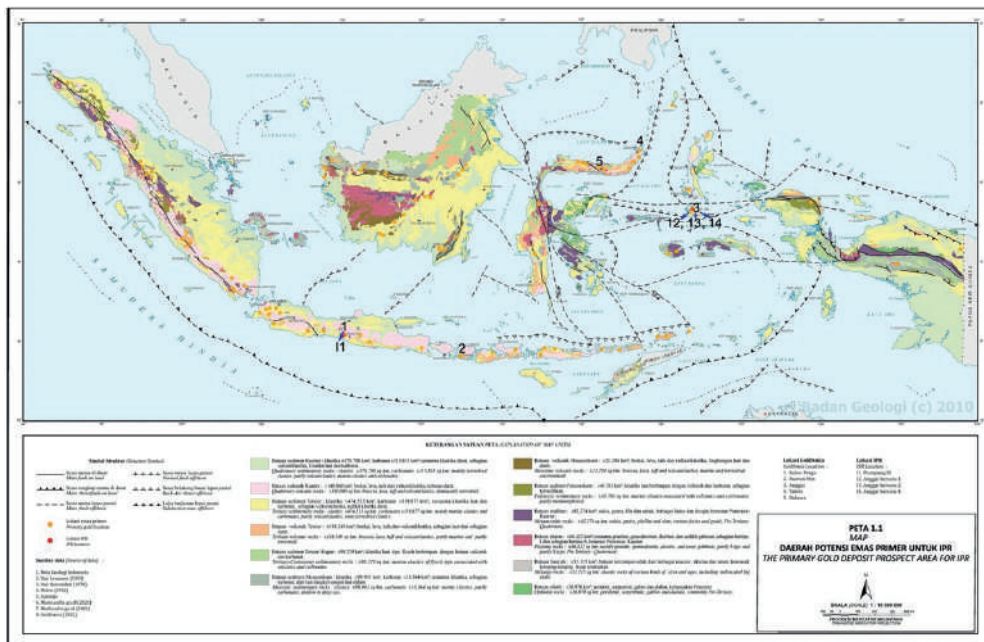




Photo 1.1 Small-Scale Primary Gold Mining Area Close to Productive Rice Fields and Rural Area

In addition, small-scale miners tend to maximize the profitability rather than the maximizing gold extraction when carrying out mining and processing operations, so combined with geological factors, relatively low of gold recovery in some mining operations, as a result, the waste rock and tailings still contain a significant gold. This can cause the abandoned mine or closed mines to become targets for re-mining without permission by the local people when gold prices are high, even this also happens at mines that have previously been reclaimed and rehabilitated in accordance with the regulations. Thus, the risk for re-mining activities is a challenge to the sustainability of environmental management.

E. Short-Term Versus Long-Term Perspectives on Small-Scale Mining

Small-scale Primary Gold Mining has existed in Indonesia for a long time, either as a permanent livelihood or to fill time while waiting for the harvest. Many areas in Indonesia have shown severe environmental damage from previous small-scale primary gold

mining activities. There are high expectations among economically disadvantaged local communities in areas with potential for primary gold mining to be able to work in peace in small-scale gold mining which creates economic benefits for local communities and raises current incomes that are insufficient. However, even though the economic benefits to the community are very important, it is unlikely that this target can be easily achieved in the short term and on a large scale, unless there is a new breakthrough in the law that protects small-scale mining businesses.

Minimally, small-scale primary gold mining is able to take advantage of gold veins that have not been used so far, so that they become economically useful for the community. Because the volume of rock excavated is very large compared to the gold produced, the waste rock that is piled up around the opening is very large and this makes it prone to landslides. Likewise, tailings from processing are usually piled up around the processing site so that they can pollute the surrounding environment. Extensive deposit of mine waste and tailings creates problematic conditions for crop growth, even for cover crops, which are needed to reduce the risk of erosion and flooding (Photo 1.2).



**Photo 1.2 Primary Gold Mining Waste a) Low Grade Rock/Waste
b) Remaining Heap Leach Processed Rock.**

Therefore, assuming that miners' financial availability is limited, the short-term target for mining safety and environmental management is to focus on increasing miners' awareness of safety and environmental management. This can be achieved by implementing a system that involves safe, inexpensive mining control measures and increases the gold recovery of small-scale gold mines. This is a process that takes a considerable amount of time to show significant progress. During this period, local communities will receive little economic benefit from the affected area. They may therefore need other forms of support as part of a larger socio-economic concept that also includes capacity building for small-scale mining communities.

In the long term, after increasing awareness it is progressively transformed into another form of individual or group into a cooperative. This conversion can ultimately lead to increased economic benefits for local communities.

II. GOOD MINING CONCEPT AND GUIDELINES FOR SMALL SCALE PRIMARY GOLD MINING

A. Initial Mining Evaluation and Miners Capabilities

The plan of mining and processing efforts are carried out long before to start of the small-scale primary gold mining. Ideally, the mining should be carried out in stages following exploration activities. This chapter provides the background information on some basic evaluations that can help to ensure the cost-effective and sustainable primary gold mining.

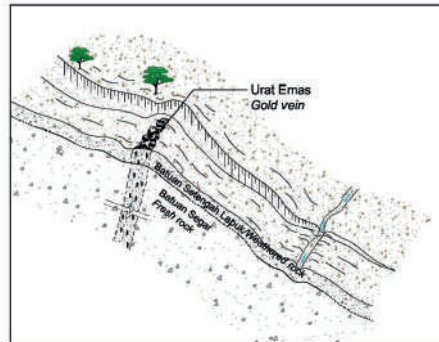
A.1. Planning and Risk Assessment

A number of parameters and risks affect the prospects for the continued success of small-scale primary gold mining in certain areas. Adequate evaluation of these parameters and risks by adjusting the mining plan requires a collection of baseline data. Chapter IV provides detailed information on these factors. Important risks and parameters to be evaluated include:

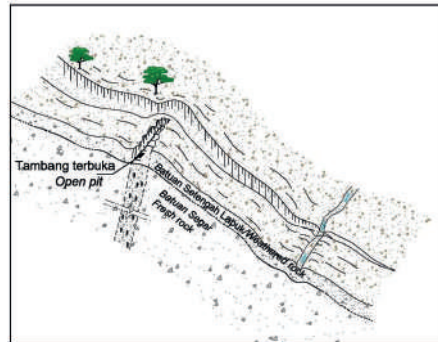
1. Deposit form

Mining risk is strongly influenced by the form of gold line deposits. Primary gold deposits can be in the form of deposits that cut perpendicular to hills or cut along hills. There are generally veins that contain gold in contrast to the surrounding rocks that do not contain gold. Rocks containing gold are usually more resistant to the weathering condition than adjacent rocks but often these rocks do not extend to the surface. In these rock conditions, excavation usually begins along the veins that are still profitable. Excavations are only carried out along the gold veins without moving barren rock or low grade gold to surface. If at the top of the gold vein is not continuous or has a small grade then proceed with making tunnels and shaft along the gold vein (Figure 2.1).

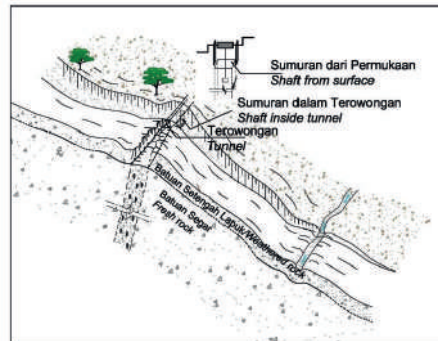
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Gold veins cut through the surface



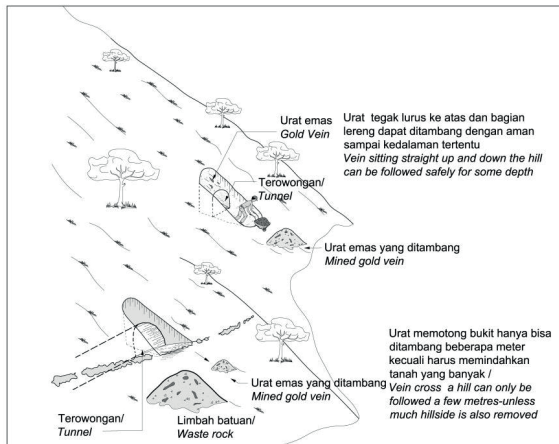
Rock excavation by applying narrow open pit



Rock Excavation by using tunnel and vertical shaft

Figure 2.1 Excavation Process in the Veins that Cut Up the Hill

Under certain conditions, gold veins break through the hills and gold veins are found exposed along the hills. The gold veins that are exposed are because rocks containing gold are usually more resistant to weathering condition than the surrounding rocks. To take the gold veins, it is necessary to remove the side rocks that do not contain gold with a volume that is large enough compared to the volume of the gold veins taken. If open-pit mining is no longer profitable, then proceed with underground mining by making tunnels and shaft along the vein (Figure 2.2).



Tunnel Shape

**Figure 2.2 Vein Morphology Affecting Excavation Method
(Base Map from Blowers,1988)**

2. Risks of landslide/subsidence/collapse

Mining risk, either underground and open pit, is affected by the position of the gold vein and its surrounding rock conditions. During the tunnel openings usually encounter soft rocks and steep cliffs so that reinforcement is needed at the portal tunnel (Photo 2.1a) or when the slopes are very steep during excavation in order to reduce cost of soil disposal so there is a risk of slope collapse (Photo 2.1b).

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a



b

Photo 2.1 Landslide Risk a) At Tunnel Opening b) At Open Pit

- See chapter IV D.4.1. for support in the tunnel
- See chapter IV D.4.2. for shaft support method
- See chapter IV D.4.3. for support method in open pit

3. Air ventilation, dewatering and lighting

Availability of adequate fresh air, dry working area and adequate lighting will increase work productivity (Photo 2.2).



a



b

Photo 2.2 Good Environment of Working Conditions a) In Tunnels b) Vertical Shaft

- See chapter IV F for ventilation, lighting and communication

4. Risk of processing method

The right processing method is in accordance with the existing condition of the gold veins, safety for workers and the environment

- See chapter III.E for waste handling method

5. Socio-economic factors where the mining community is not valued as a good profession and there is no long-term community development business model. This further includes questions about licensing status

► *See appendix IV for permitting the artisanal mine permit*

A.2. Involvement of Miners, Community and Industry in Good Mining Practice

The socio-economic situation of the local community is one of the most important factors determining the success and sustainability of a small-scale primary gold mining program. This situation is related to individual demographic conditions, education level, social structure, job availability, and business opportunities as determinants of the wealth of people living near locations near potential primary gold mining. The community can play a positive role in the small-scale mining process and its processing to improve the economy based on small-scale gold mining. If they can be involved as stakeholders, investors or landowners of ex-mining land, they can act as supporters of long-term legal gold trading targets and reduce the risk of illegal gold trade and environmental damage.

The socio-economic situation of local communities and their potential role in developing the concept of primary gold mining may differ from place to place. Therefore, there is no standard "one size fits all" approach. It is important to understand individual situation of the local community in sufficient detail before carrying out gold mining.

Gaining an adequate understanding of the dynamics and capacities of local communities can be achieved through a community baseline assessment. As part of this process, appropriate mechanisms should be developed to facilitate continuous communication between communities and organizations responsible for small-scale gold mining.

Some of the relevant questions and considerations related to understanding and involving communities in reclamation programs include the following - these can be considered when planning community baseline assessments or similar activities.

What is the level of awareness and willingness of different members of the local community (especially youth, low-educated and underemployed people, formal and informal leaders, and local entrepreneurs and women) to engage in small-scale primary gold mining programs and possible models related business? What are their individual expectations for small-scale primary gold mining and can this be taken into account for planning their welfare improvement targets with respect to the environment?

Whenever possible, it is recommended to strengthen the organizational capacity of community business activities. This can be achieved by involving rural

economic institutions such as cooperatives or village-owned enterprises, namely BUMDES. The progressive creation and professionalization of these organizations should be supported. Government support options for access to required credit or microfinance options should be clarified. Ideally, the organization (perhaps with external support) should have the capacity to develop a business plan related to the gold mining and processing process.

If community organizations or rural economic institutions are new, they may not have the capacity to be responsible for all but only some aspects of the mining and processing process. They may also have limited financial resources and management capacity, for example, to work as workers. In these cases, it is helpful to discuss individual and specific business models within the overall mining program with the community, for example, setting up a BUMDES or cooperative business unit to provide mining extension services (e.g. providing wind pumps, generators, hydroelectric power plants, supporting equipment) and processing (e.g. chemicals, activated carbon, processing equipment etc.).

The involvement of local communities must be carried out on a formal and appropriate legal basis, for example, through an agreement between mining communities, land owners and mining concession holders even though this agreement has never been written. Any possible conflicts over land ownership, community access to land and the risks (eg encroachment by third parties) must be addressed.

If the land owner is known, an agreement with the community should be made about their involvement in developing the area. If there are no registered land owners, communities should be encouraged to claim land for themselves by following appropriate regulatory procedures. To develop a mutually balanced agreement and communities claim land in a sustainable manner, it is recommended that the village (Village Head/Kampung Head and BPD/Village Consultative Body) and the Local Government support the community.

Mining and processing activities require certain technical skills in the community. This should be evaluated through a capacity assessment. In some cases, local people can be trained to acquire the necessary skills. Possible examples include:

Experience in agriculture. This allows community involvement in the following activities:

- Opening the tunnel and shaft
- Transport of wall rock to the surface or to the disposal site
- Transport of gold-bearing rock to processing and sizing processes.

Experience in woodworking. This enables the person providing support services for operation of tunnel or pit reinforcement.

Experience in blacksmithing. This enables the provision of support services in machining processes and the manufacture of equipment for processing.

Experience in business planning and management. Any community enterprise or cooperative requires adequate business planning and management skills in order to function properly and become an efficient business partner. For example, community members need to understand the condition of world gold prices and determine quality in order to obtain the best selling price. Therefore, community capacity building should be supported regarding these skills. This further covers the decision-making structure within the cooperative or BUMDES as well as the marketing skills to sell the product.

B. Preparation of Gold Mining Techniques for Small-scale Mining

B.1. Mine Design (Entrance, Tunnel and Shaft)

For the purpose of developing plans of underground and open pit mining small-scale primary gold deposit, it is necessary to check the land status and land cover conditions and prepare a base map of the area.

Check the land status of the mine plan by referring to the land status map and the Regional Spatial Plan (RTRW). Is it a forest or an Area for Other Uses (APL)? These maps can be obtained from the Provincial and District Office of the Development Planning, Research and Development Agency (Bappelitbangda) Offices.

Obtain a topographic map at a scale that can adequately describe the micro-topographic conditions of the area. These maps may not be available at sufficient resolution. In that case, a new map can be created, for example using a plane table, passing compass or with T₀ if there is equipment available.

The size of an IPR is often less than 5 Ha for individuals and 10 Ha for cooperatives. Topographic maps covering the area are generally available on a scale of 1: 50,000 or 1: 25,000 which are not useful for interpreting the condition of land plans with an area of less than 10 Ha. Therefore, another way that might be applied is to use a plan table, passing compass or drone to produce aerial photos (Photo 2.3), or use satellite data.

Determine the design of the opening direction by combining maps of vein distribution, land status, land cover, and topographic information derived from maps or satellite/drone images (or digital elevation models).

Clarify the size of the opening in accordance with the thickness of the gold-carrying veins and rock conditions. This process requires experience and a

detailed evaluation of the risk of collapse (Photo 2.4). A landslide risk management is required after the opening hole is formed.



Photo 2.3 Example of Aerial Photography from Drone

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**Photo 2.4 Collapse in a Tunnel**

► See chapter IV D.4.1 for support in the tunnel

After the excavation is carried out for sampling the gold veins, take rock samples with dowsing, sampling (Photo 2.5a) and panning (Photo 2.5b). Adjust the opening area plan according to the condition of the gold veins and rock conditions found in the area.

**a****b****Photo 2.5 a) Gold Vein Sampling b) Gold Content Checking**

► See chapter IV E for excavation and hauling method

Consultation with primary gold miners and if possible with existing mine expert from education institution or agencies related to appropriate rock reinforcement (Photo 2.6) and processing methods (mandate of Mining Law No. 3/2020).

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a



b

**Photo 2.6 a) Safe due to the Rock Strength and the Tunnel Shape
b) Safe Due to Supporting System**

Adjust the design of the mining plan to the conditions of the vein distribution and grade because this will determine the detailed land preparation plan, reinforcement method, the need for wood for reinforcement, the number of blowers, water pumps and electricity requirements for mining (Photo 2.7).



a



b

Photo 2.7 Selection of Entry Access a) Forming a Tunnel b) Forming a Vertical Shaft

Consider the integration of required supporting infrastructures, such as mine site buildings, drainage and drying systems, chemical storage facilities (cyanide, zinc dust, urea, lime, activated carbon etc.).



a



b (Bapak Panca)

Photo 2.8 Supporting Facilities a) Miners Accommodation b) Pump System

► See chapter IV. G for mine dewatering system

B.2. Management of Mine and Processing Waste

Small-scale primary gold mining activities produce a waste rock from the wall rock and the waste of gold processing, with the significant differences in size, height, volume and quality (Photo 2.9). This activity has the potential to reduce the quality of the environment due to the pollution and or the environmental damage.

For the waste rock, based on the existing topographical conditions, determine the location of mining waste disposal. If it is too high and dangerous, slope formation must be reshaped where the slope is not more than the natural slope of the embankment material (the angle of repose), this slope angle varies according to the moisture content and grain size distribution of the material.

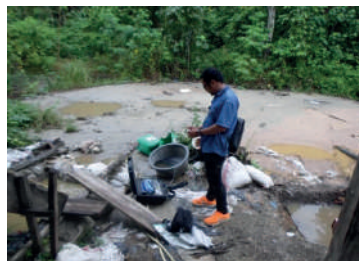
► See chapter V for reclamation and post-mining

Mining waste must be drained into a collecting pond to keep it from the leaving the activities area, if it must be released to the environment it must meet the quality standard requirements (Figure 2.3). For soils that are easily excavated, a settling pond can be made of plastic with a protective covering around it (Figure 2.4a). The used settling pond in clear water conditions can be used to keep fish (Photo 2.10). If the surrounding soil is difficult to excavate, it can be made as shown in Figure 2.4b). If pond 2.4b is to be applied, the position of the water outlet hole from the mine is higher than the pond so that water can flow itself to the location of the reservoir.

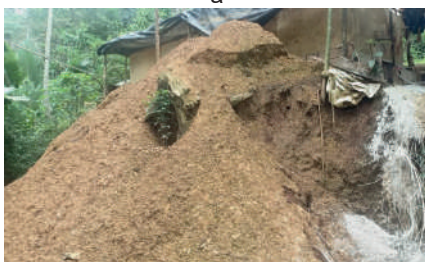
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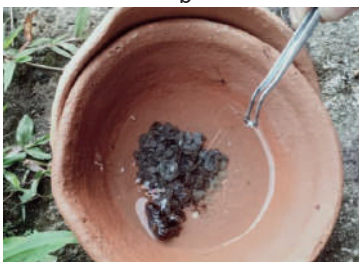
a



b



c



d

Photo 2.9 Waste from Mining Process a) Well and Tunnel Waste, Waste from Cyanide Processing b) With Tanks c) With Heap Leach d) Slug from Bullion

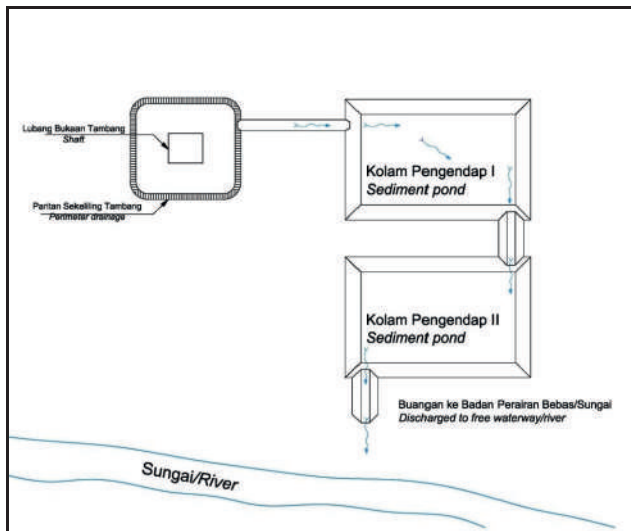


Figure 2.3 Construction of Settling Ponds (Kepmen LH No. 23/2008)

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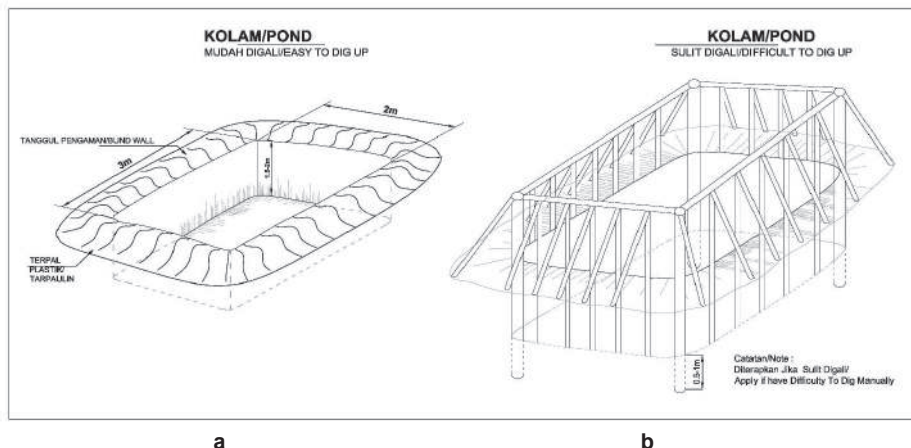


**Figure 2.4 How to Build a Pond a) in an Area that is Easy to Dig up
b) in an Area that is Difficult to Dig up**



Photo 2.10 Used Sedimentation Pond

The wastewater quality standards for gold and or copper ore mining activities are shown in Table 2.1.

Table 2.1
The Wastewater Quality Standards for Gold and or Copper Ore Mining Activities

Parameters	Units	Maximum Concentration	Analysis Methods **
pH		6-9	SNI 06-6989-11-2004
TSS	mg/L	200	SNI 06-6989-3-2004
Cu*	mg/L	2	SNI 06-6989-6-2004
Cd*	mg/L	0.1	SNI 06-6989-18-2004
Zn*	mg/L	5	SNI 06-6989-7-2004
Pb*	mg/L	1	SNI 06-6989-8-2004
As*	mg/L	0.5	SNI 06-2913-1992
Ni*	mg/L	0.5	SNI 06-6989-22-2004
Cr*	mg/L	1	SNI 06-6989-22-2004
Hg*	mg/L	0.005	SNI 06-2462-1991

* Source: Decree of the Minister of State for the Environment Number 202 of 2004

Notes:

- * = As the concentration of dissolved metal ions
- ** = If there is an updated version, use the latest version
- If in the natural state the pH of the water in the water body is below or above the water quality standard, then with the recommendation of the Minister, the Provincial Government may determine the maximum level for the pH parameter in accordance with the natural conditions of the environment.
- To meet the quality standards of wastewater, it is not allowed to achieve the level of wastewater parameters by dilution with water directly taken from the water source.

B.3. Supporting

Based on the shape of the deposit and the ease to mine then determine the mining type, open pit or underground mine.

For Open Pit Mine:

1. Determine the angle of the slope, the height of the bench, and the width of bench by taking into account the rock strength.
2. Try to drain water by gravitation so pump is not required.
3. Determine the soil disposal location, as well as the haulage system.

► See chapter IV.D.4.3 for support method in open pit

For Underground Mine (Photo 2.11)

1. Determine the approximate entrance by using tunnel (Photo 2.11a) or vertical shaft (Photo 2.11b)
2. Determine the opening area and available reinforcing materials
3. Lighting and ventilation sources
4. Ground water conditions
5. How to transport waste and gold ore



a



b (Photo: Mr. Panca)

Photo 2.11 a) Design of Tunnel b) Design of Vertical Shaft

► See chapter IV.D.4.1 for support in the tunnel

► See chapter IV.D.4.2 for shaft support method

B.4. Ventilation System

Ventilation is very necessary for underground mining work, in order to work efficiently, miners require sufficient fresh air with minimum dust content. This equipment requires electricity to move it and requires a long access (usually made of plastic) for air flow into the working area (Photo 2.12). In order to be efficient, it must be known from the beginning:

Size of the opening

Source of electricity (from the generator or PLN) if the generator will be used as power how to transport the generator and fuel to the location)

Air supply equipment



Photo 2.12 Ventilation System with Blower from Above

► See chapter IV.F.1 for ventilation

B.5. Lighting

Lighting is indispensable for underground mining work. In order to work efficiently, miners need lighting to the work site even though many miners only rely on headlights. Lighting both along the tunnel (Photo 2.13a) and the head lamp) (Photo 2.13b) requires a power source. For this reason, it must be known from the beginning the power source that will be used.



a Lighting in tunnel (Photo: Mr. Adang)



b Head lamp for Miners (Photo: Mr. Panca)

Photo 2.13 Lighting and Electrical System

► See chapter IV.F.2 for lighting

B.6. Mine Plan

In the excavation plan there is one general rule, and a good procedure to follow, is to obtain one ton of gold ore of the desired grade for every mined material in order to achieve mining sustainability. The basis of the purpose of excavation there are two, namely:

1. Determine the size, shape, boundary of the gold rock, grade, mineralogy and wall rock properties (Figure 2.5)
2. Prepare the deposit to be mined so that the mining period can be determined

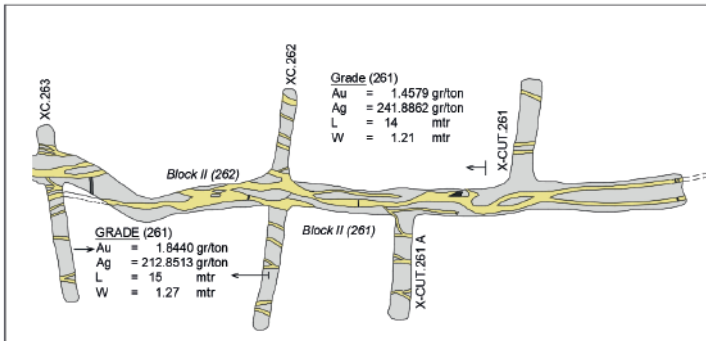


Figure 2.5 Examples of Vein Areas for Determining Rock Reserves

► See chapter IV.B for position and underground mapping

B.7. Location of Facilities and Infrastructures (Road, Shelters, and Processing Facilities)

In order to achieve efficient, safe, environmentally friendly mining, the following must be done:

1. Determine a safe (non-slippery) road with a handrail and steps when passing through a steep slope
2. The location of the openings is safe from natural disaster and from rock pile
3. Mark the excavated pits with clear marks so that no one will fall into
4. Determine the location of the gold processing plant and its waste site. This location must be safe from landslides and processing waste does not spread
5. Determine the location of chemical storage and gold refining away from housing

C. Mining Activities Towards Veins

To facilitate the implementation, maintenance and transportation of materials required for excavation and mining products, access roads should be constructed. Usually access roads are built directly through gold veins either by tunnels or vertical shaft. Under certain conditions, the excavation of veins is carried out by open-pit mining.

1. Construct roads with possible dimensions to facilitate the transportation of tools, equipment, support materials and other necessities (air pipes, water pipes and electrical cables, etc.)
2. The road must be safe from debris and flooding
3. Road construction design should consider adequate drainage facilities to protect against flooding. Roads and associated drainage facilities require regular maintenance.

C.1. Rock Strength

The strength of rock wall and ore will affect the safe slope of the open pit and rock fall in the tunnel. In hard rocks usually do not need reinforcement (Photo 2.14a). In weathered rock, fractured rock or contain a lot of clay, reinforcement is needed (Photo 2.14b).



a



b

Photo 2.14 Rock Strength a) Strong Rock b) Weak Rock

► See chapter IV.C for rock strength

C.2. How to Excavate

The method of excavation is generally carried out manually, namely chisels and hammers and crowbars. In certain conditions if the gold veins are large enough and the capital can support excavation with a Jack Hammer or Jack Leg (2.15). What needs to be done is:

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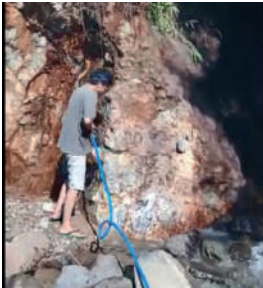
1. The chisel must be in accordance with the rock conditions and always in a sharp condition. Try to sharpen it with a grinder or other sharpening tool.
2. Use goggles, head protection (project helmet), gloves as protection and earplugs.



a



b (Photo: Mr. Panca)



c (Photo: Mr. Panca)



d

Photo 2.15 a) Excavation with Hammer and Chisel b) Electric Hammer Jack
c) Pneumatic Handheld d) Use of Leg Jack to Speed Up Production
in Wide Vein

► See chapter IV.E for excavation and hauling method

C.3. Supporting Methods

C.3.1. For Horizontal Access

In soft rock or many fractures, wood and/or bamboo are very commonly used to support rock in small-scale gold mining because of their ease of discovery and ease of installation. The shape of the opening for soft rock is usually in the form of a rectangle. The distance between the supports is usually between 1-1.5 m. Between the supports, the boards are usually installed either on the roof or on the left and right side of the road (Photo 2.16a).

For hard rocks usually no support is required (Photo 2.16b). The roof is shaped like a horseshoe.



a



b

Photo 2.16 a) With Wooden Support b) No Support with a Horseshoe Shape Roof

► See chapter IV.D.4 for support method

C.3.2. For Vertical Shaft

If vertical shaft is chosen, then should carry out followings:

1. Provide the wooden support
2. Create a framework that is strong enough to withstand the weight of waste rock material and gold ore to be lifted up (Photo 2.17a and b).
3. Make the wall of the hole straight by attaching the plumb bob to keep the wall straight.



a



b

**Photo 2.17 Reinforcement in Vertical Shaft a) Upper Support Section
b) Strengthening Along the Tunnel**

► See chapter IV.D.4 for support method

C.4. Ventilation Preparation

Fresh air is urgently needed in underground mining operations. Fresh air is pumped into the hole through a blower installed outside (Photo 2.18):

- Ensure that the incoming air is free of fumes that may occur around the mine
- Blower power can reach the end of the working area
- No leaky air ducts
- Air duct material can be rubber or plastic



a



b

Photo 2.18 Ventilation System a) Horizontal b) Upright

► See chapter IV.F.1 for ventilation

C.5. Lighting

Lighting in mine inlets is very important though often ignored (Photo 2.19a). Lighting generally relies on lights in the head (Photo 2.19b). For safety and convenience and reduce costs, do the following:

1. Use LED lights throughout the tunnel.
2. Use DC Current.
3. The connection must be waterproof.



a (Photo: Mr. Adang)



b (Photo: Mr. Panca)

Photo 2.19 Lighting in a Tunnel a) Small-scale Mine b) Artisanal Mine

► See chapter IV.F.2 for lighting

C.6. Lorry, Pulley or Similar (How to Transport Waste or Gold Veins)

One of the things that is often forgotten in tunnel construction is the construction of rails (the rails here are not only iron rails (Photo 2.20a) but also rails made of wood structures that form the rails (Photo 2.20b). Indeed, at the beginning the construction of this rail wasted time but had a higher production rate in transporting rock from the mine to the surface. Some aspects that have to be considered are:

1. Check the slope down towards the entrance
2. Fasteners with bearings must be firmly maintained
3. Always checked regularly to keep it in a good condition



a



b

**Photo 2.20 a) Intermediate Scale Mine Level with Iron Rails
b) Simple Lorry System with Wooden Rails**

► See chapter IV.E.4 for underground haulage system

D. Mine the Gold Veins

Mining in veins is very important to ensure the extracted stone contains a favorable grade of gold and maintains continuity.

Check for veins containing irregularly branched gold, if the veins are getting smaller the possibility of running out. If the veins are enlarged, it is likely to continue (Figure 2.6).

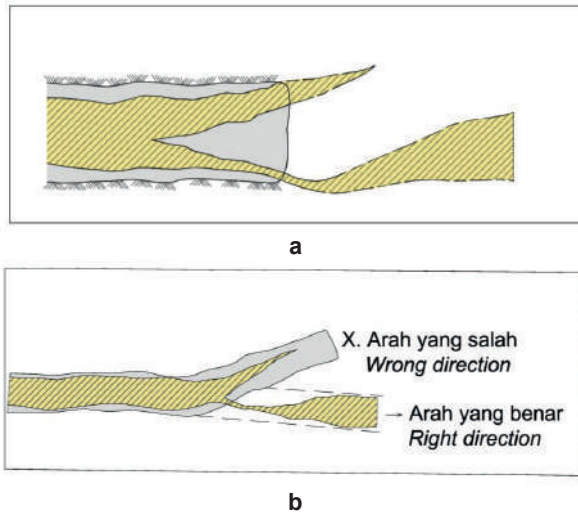


**Figure 2.6 How to Chase the Gold Vein a) Towards Thick or Thin
b) Thick Vein does not Guarantee Continuity Compared to Thinner**

- If the gold veins disappear because of the fault do as follows (Figure 2.7):
 - o Carry out advanced digging
 - o Make a vertical hole
 - o Find the continuity of gold veins
 - o Direct the excavation towards the golden veins

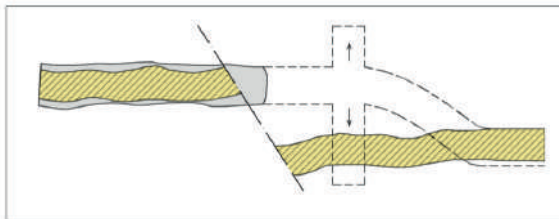


Figure 2.7 How to Chase the Gold Veins that Suddenly Disappear

Disappearing of gold veins due to wedge. The gold veins are sometimes found become thinner such as they have disappeared. Continue to dig until it reaches a certain length until you see the veins enlarge again (Figure 2.8).

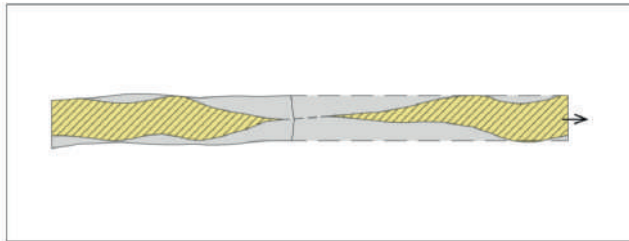


Figure 2.8 How to Ensure Veins Continuation

But if the shrinking veins are disappearing, it can be ascertained that the veins are no longer continuous (Figure 2.9).

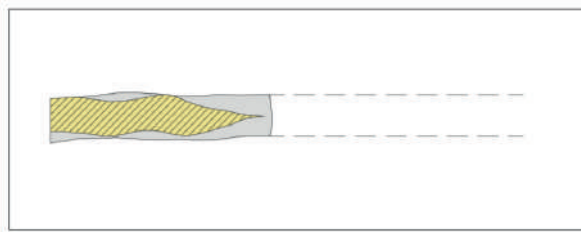


Figure 2.9 Indication of the End of Gold Vein

D.1. Veins Selection

Not all veins contain gold with sufficient levels to generate profits. Only rocks containing profitable gold are taken. For that do:

If the color of the side rock is similar to the vein of rock containing gold, use tools such as "dowsing" (Photo 2.21a)

Sampling of rocks that have the same physical properties in the horizontal direction (Figure 2.2b)

If there are veins that have different physical properties, separate them

Collect the samples and grind them

Weigh the rock and do the pan with a mini pan

Observe the presence or absence of gold, separate gold and rock

If the gold content is very fine:

- take more samples
- do more grinding

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- do panning and make sure the pan is washed with detergent soap so that it is free from oil
- separate the fine gold grains from iron minerals by using a magnet
- Mix the granules gold with borax in the cup and heat with the right mixture of oxygen and LPG and added charcoal to increase the temperature.
- Observe the gold yield in crucible

Determine which part has sufficient grade for you.



a



b

Photo 2.21 a) Quick Sampling with "Dowsing" b) Direct Sampling

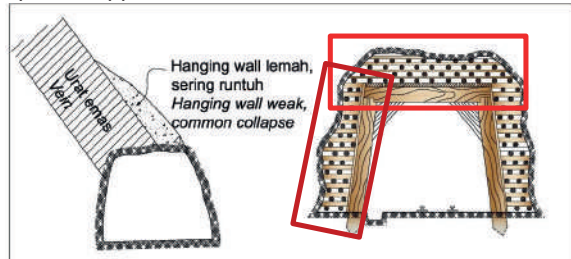
D.2. Supporting System

For weak rocks, a pair of wood is required to withstand the forces from the top (roof) and from side of tunnel, for that do:

1. Make sure there are no voids between the roof and the side rock with support, fill it up as quickly as possible so that the rock will support itself (Figure 2.10). This condition will reduce the required support load.



a



b

Figure 2.10 Load Reduction Techniques on Supporting System
a) Field Conditions b) In Plan

2. If soft rock is found from above and from the side, use a spilling (Figure 2.11). Do it little by little with the material that is between the wall or roof with the support and compact it.

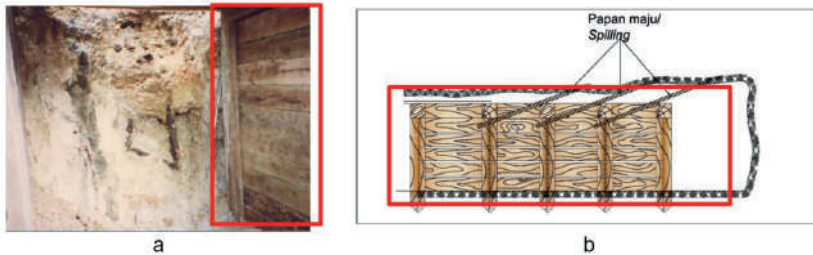


Figure 2.11 Installation of Spilling a) Field Conditions b) In Plan

► See chapter IV.D.4.1 for support in the tunnel

D.3. Haulage

Things that required to be considered of rocks hauling either waste rock or gold rock in a tunnel are:

1. Rails installation, distance between the connection and installation of the connectors and distance between the rails must be precisely so that the lorry (usually from a box equipped with wheels) does not fall or roll over (Photo 2.22)
2. Clean the gravel that is on the rail so that the lorry does not roll over
3. A routine equipment maintenance and inspection

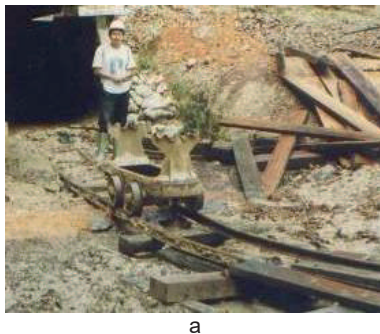


Photo 2.22 Installation of Rails and Bearings a) Steel b) Wood

Meanwhile, for a vertical shaft after passing through the tunnel, it is carried up by a pulled rope:

1. Make sure the swivel mount is strong enough and check regularly
2. Make sure the rope used is in accordance with the weight of the stone/ore being pulled
3. Make sure the handle of basket and the basket is strong enough

► See Chapter IV.E.4 for underground haulage system

E. Hauling to Temporary Stacking or Processing Site

Hauling cost from the mine entry to the processing site affects whether a mine site is economically mined or not. Therefore, make sure:

1. Road facilities from the mine site to stockpile or processing locations
2. Transportation costs per kg or per unit weight (Photo 2.23)
3. Time required for one time haulage



a



b

**Photo 2.23 Gold Rocks Haulage a) Carried by Man with Weight of 25 kg
b) Modified Motor to Accommodate Additional Loads**

► See Chapter IV.E.4 for underground haulage system

F. Work Safety

The IPR holder needs to provide all equipment, supplies, facilities, and personal protective equipment that are given free of charge to workers according to the type, nature, and danger of the work they are doing and for everyone who enters a mining or processing and/or refining business place.

The most basic thing that must be provided by the IPR holder is the Occupational Health and Safety (K3) Box which must be available according to the number of workers involved (Table 2.2).

Table 2.2 Occupational Health and Safety K3 Box that Must Be Available

No	Content (Unit)	Workgroup		
		Type A (less than or equal to 25 Workers)	Type B (26 -50 Workers)	Type C (51 - 100 Workers)
1	Wrapped sterile gauze (wrap)	20	40	40
2	Bandage (5 cm wide) (roll)	2	4	6
3	Bandage (10 cm wide) (roll)	2	4	6
4	Plaster (width)	2	4	6
5	Quick pads	10	15	20
6	Cotton (25 gram)	1	2	3
7	Mittela (Sheet)	2	4	6
8	Scissors (unit)	1	1	1
9	Pins (unit)	12	12	12
10	Disposable gloves (pair)	2	3	4
11	Masker (unit)	1	1	1
12	Masks for cardiopulmonary resuscitation (unit)	1	1	1
13	Clean plastic bag (unit)	1	1	1
14	Aquades (100 ml Saliner solution)	1	1	1
15	First aid guide at work	1	1	1
16	Table of contents notebook	1	1	1

It is very important to pay attention to the safety of underground mining workers so that no miners are left in the underground area in certain work shifts. Each person who represents or is in charge is obliged to record how many people enter the underground area and record how many people leave the underground area after their shift. The work schedule must be posted at the entrance (Photo 2.24). For that make sure:

1. Everyone is registered/registered at the entrance of the tunnel/shaft at the time of entering the tunnel by placing a clear identity card, do not use sandals, or any object that does not show the identity of entering the tunnel/shaft
2. Everyone is required to take an identity card when exiting the tunnel/shaft
3. If within a certain time in accordance with the usual working hours, the identity card is still stuck in its place, the person in charge or the person assigned to take absent must look for the identity card owner that is still left behind

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4. Workers in shift work are prohibited from entering until the identity card owner left behind is found



a



b

Photo 2.24 a) Work Schedule at the Entrance b) Example of Placement of Identity Card

III. GOOD CONCEPT AND GUIDELINES FOR PROCESSING OF PRIMARY GOLD

The processing of ore containing gold into pure gold or precious metal will go through several processes starting from the reduction of ore containing gold to the remaining processing results (waste).

A. Rock Reduction

Ore containing gold in the size of boulder, reduced in size. This reduction process is highly dependent on the size of the existing gold ore (Figure 3.1). The purpose of ore reduction is so that gold can be free from ore that does not contain gold so that the gravitational (physical) and chemical processing can be carried out to get the maximum gold possible in the shortest possible time, so that the right size for processing varies from one location to another varies depending on the size of the gold in the ore sources.

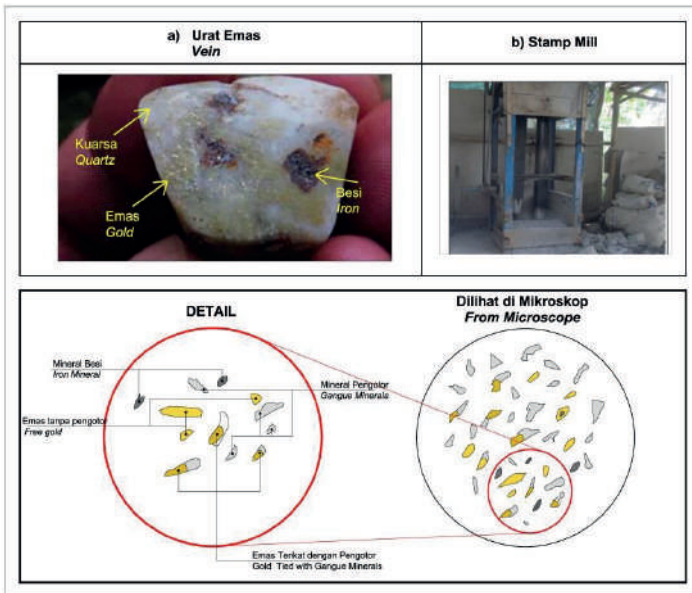


Figure 3.1 a) Rocks Containing Gold Before Size Reduction b) Rocks is reduced in Ball Mill etc. c) Rocks After Size Reduction d) Details on Gold Condition after Fully Liberated

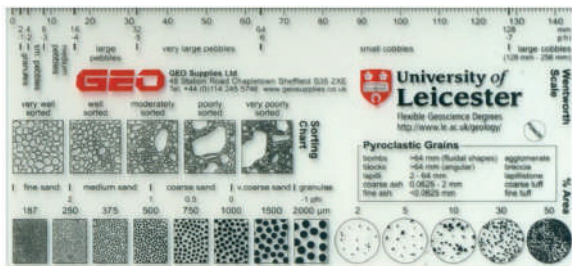
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The gold veins from mines have various sizes. The gold is often covered by the host rock making it very difficult to separate it out. In order for gold to come into contact with and react with materials that can dissolve gold or can be separated without chemical processing, the veins containing gold must be reduced to a point where almost all of the gold can react with the solvent if the separation is carried out chemically. If the separation is done in a non-chemical way, the purpose of separating gold from the parent rock that does not contain gold is so that there is a difference in specific gravity so that it can be separated between gold and rocks that do not contain gold.

The size used in small-scale primary gold processing is mesh. Mesh is a measure of the number of holes in a net or gauze in an area of 1 square inch of net/gauze that can be passed by solid materials. Mesh 40 means that there are 40 holes in the 1 inch area of the net/gauze, mesh 6 means that there are 6 holes in the 1 inch area of the net/gauze, and so on (Table 3.1).

Table 3.1
Conversion of Mesh to Other Units

Inci	Millimeter	Mikron	Mesh
0.255	6.73	6730	3
0.187	4.76	4760	4
0.157	4	4000	5
0.132	3.36	3360	6
0.111	2.83	2830	7
0.0937	2.38	2380	8
0.0787	2	2000	10
0.0661	1.68	1680	12
0.0555	1.41	1410	14
0.0469	1.19	1190	16
0.0394	1	1000	18
0.0331	0.841	841	20
0.028	0.707	707	25
0.0238	0.7	700	28
0.0232	0.595	595	30
0.0197	0.5	500	35
0.0165	0.42	420	40
0.0138	0.354	354	45
0.0117	0.297	297	50
0.0098	0.25	250	60
0.0083	0.21	210	70
0.007	0.177	177	80
0.0059	0.149	149	100
0.0049	0.125	125	120
0.0041	0.105	105	140
0.0035	0.088	88	170
0.0029	0.074	74	200
0.0024	0.063	63	230
0.0021	0.053	53	270
0.0017	0.044	44	325
0.0015	0.037	37	400
0.00099	0.025	25	550
0.00079	0.02	20	625
0.0005	0.012	12	1200
0.000394	0.01	10	1250
0.000197	0.005	5	2500
0.000118	0.003	3	4800
0.000099	0.0025	2.5	5000
0.0000394	0.001	1	12000



<https://andythonceianus.wixsite.com/andythonceianus/single-post/2018/02/14/mesh-micron-sizes>

The reduction method is carried out in stages starting from boulder sizes which are from the mine to appropriate size. This is according to the size of the liberation degree of gold in the rock veins. The reduction process is carried out as follows:

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If done manually, use rubber or bamboo in a circle with a handle. Use a hammer that weighs according to the strength of rock to be more effective (Photo 3.1a). Use goggles to prevent splashes of stones in your eyes and gloves

If using a jaw crusher or hammer mill, pay attention to the size of the filter iron so that the stone is not squeezed so that it interferes with productivity (Photo 3.1b). The results from manual process and jaw crusher are suitable for the heap leach process and zinc dust

If using a stamp mill, make sure that whenever there is space in the stamp mill container, fill it with gold ore (Photo 3.1c). It should be noted that the stamp mill casing made of iron will interfere with the cyanidation process

Use a trommel or ball mill to produce a fine size that is used for the cyanidation process carried out in the drum (Photo 3.1d).



a (Do not imitate because without glasses and gloves)



b (Do not imitate because without glasses, masks and gloves)



c



d

Photo 3.1 Size Reduction Process With a) Manual with Hammer b) Hammer Mill c) Stamp Mill d) Trommel

► See chapter IV.H.1 for crushing

B. Gold Extraction Process

B.1 Gold Leaching Process

The gold extraction process is a very important stage in primary gold processing. Gold cyanidation is the most common leaching process used for gold extraction. The gold cyanidation process is a hydrometallurgical technique for extracting gold from ores by converting gold into water-soluble complex ions. The gold-rich solution is adsorbed by activated carbon or precipitated using zinc dust.

In an effort to support government policies and increase the acquisition of gold at an affordable cost so that the net results from small-scale miners are several gold processing techniques as follows:

1. The Heap Leach method uses carbon to capture gold:

- Create a roof shield so that it is not exposed to direct sunlight and rain
- Ensure that the sink and cyanide holding pool containing gold are not leaking
- Ensure that there is sufficient space between the bottom of the tub and the ore for smooth circulation
- Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12
- Cover the surroundings with plastic so that splashes from the sprinkler do not come out polluting the environment (Photo 3.2)



Photo 3.2 a) Small Scale Heap Leach Process b) Cyanide Containing Gold Captured With Activated Carbon

► See chapter IV.H.2.2 for gold ore leaching method using sprinkling/heap Leach and carbon

2. Cyanidation method using submergence for gold recovery

Create a roof shield to prevent direct sunlight and rain (Photo 3.3)

Ensure that the sink and cyanide pool containing gold are not leaking

Ensure that there is sufficient space between the bottom of the sink and the ore so that it can be used for draining

Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12



Photo 3.3 Submergence Process

► See chapter IV. H.2.3 for the gold ore leaching method using immersion and carbon

3. Cyanidation method using carbon for gold recovery:

Create a roof shield to prevent direct sunlight and rain

Make sure the drum holder is strong enough to withstand the load when filled with material, water and lime

There is sufficient supply of water and air

Make sure before the fine ore are poured into the drum, the material has decomposed well, it is better to prepare a stirrer that can go directly into the barrel (Photo 3.4a)

Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12

Make sure that no material from which the gold will be extracted settles to the bottom



a



b

Photo 3.4 a) Material Decomposition Process b) Simple Cyanide Tong Construction

► See chapter IV. H.2.1 for the gold ore leaching method using tanks and carbon to extract the gold

4. Cyanidation method using zinc dust

Create a roof shield to prevent direct sunlight and rain (Photo 3.5)

Ensure that the sink and cyanide pool containing gold are not leaking.

Make sure there is enough space between the bottom of the drum and the ore for smooth circulation.

Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12



Photo 3.5 Cyanidation Process Using Zinc Ash

► See chapter IV.H.2.4 for gold ore leaching method using zinc dust

B.2 Refining and Borax Methods for Capturing Gold

This method with borax is a process of separating gold in ore without using cyanide. The ore from the mine is enriched by using a pan or other concentration tool after which it is mixed with borax and burned. The process carried out is as follows:

1. Choose ore with gold
2. Reduce rock size according to the liberation degree of gold in veins to obtain optimum results
3. Do the panning to separate the gold, the gold that is still attached to the ore (concentrate) and the ore that do not contain gold (tailing)
4. Put in crucible, add borax and charcoal as materials to increase the combustion temperature
5. Heat up slowly with torching technique (combination of LPG and oxygen) until it becomes liquid
6. Look for the “eyes” on the bottom of the crucible that indicate bullion
7. Gently separate liquid that does not contain gold with bullion by pouring it into a container filled with water (Photo 3.6b)
8. Take the bullion then put into water and clean it up



a



b

Photo 3.6 a) Concentrate Mixed with Borax and Charcoal b) Separation between Slug with Bullion

► *See chapter IV.H.3 for the gold processing method into bullion without cyanide and mercury (borax method)*

C. Process of Becoming Bullion (Adsorption and Melting)

In the process of gold recovery by using cyanide process with the addition of zinc dust do:

Collect black mud

Wash with water to remove cyanide

Add nitric acid to dissolve anything in the black mud except gold grains

Heat it until bullion produced (Photo 3.7)

In the process of extracting gold from activated carbon (Figure 3.2) using the cyanide process, make sure:

Attention to the wind direction, because the produced vapor still contains high cyanide

The carbon is air-dried before pouring to the chamber

Use wood chips on the part of the igniter for the first ignition

Adjust the incoming air so that dust does not fly, but the fire not too small to keep it on

Check if all activated carbon has turned to ash

Filter the ash through a filter if there is still carbon that has not been completely ashed, collect it and re-ash it

Mix ash with borax then burn with the concept of torching/welding using oxygen and LPG

Separate gold from waste

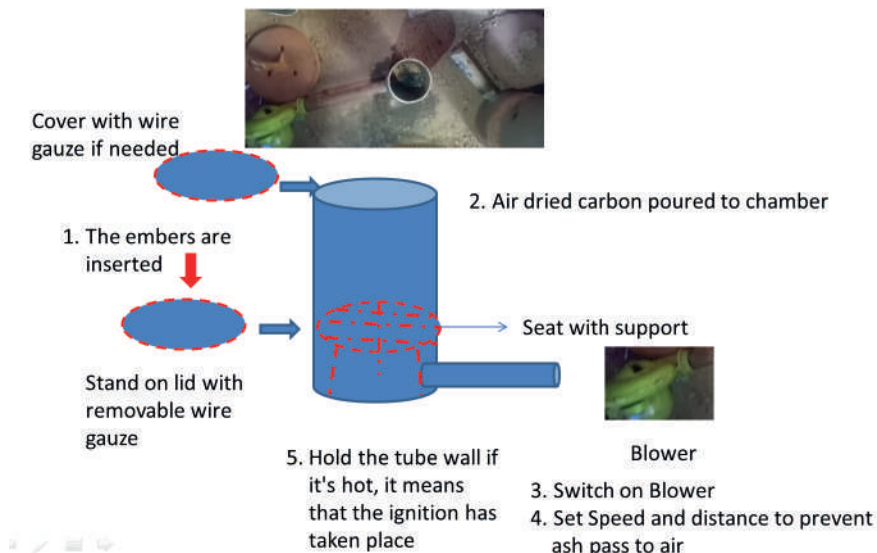


Figure 3.2 Activated Carbon Combustion Equipment



Photo 3.7 Bullion from Torching

► See chapter IV. H.4 for processing charcoal into ash

D. Gold Purifying Process

The resulting bullion is not pure yet still contains silver and other metals. To increase the added value, gold should be sold in the form after being cukim so as to produce local gold with levels above 99%. This process usually produces a strong odor so that often only a few miners sell in the form of cukim. Cukim design and equipment are shown in Photo 3.8.



a



b



c

Photo 3.8 a) Simple Cukim Equipment (For Individuals) b) Small Scale Cukim (Photo: Mr Panca H.W.) c) Pure Gold Using Cukim Technique

► See chapter IV. H.6 for the processing of bullion into local gold (cukim)

► See chapter IV.H.7 for assay calculation

E. Waste Handling Method

When processing gold with cyanide, the combustion of activated carbon and smelting will produce gases that may be inhaled by workers or surrounding community (Photo 3.9). For that make sure:

The location of processing plant should be far from settlements by considering of wind direction and land contours so that air pollution can be minimized

Make sure that the location of activated carbon combustion and smelting is in an open space or if it is in a closed room, it is equipped with good ventilation and good natural lighting

Ensure that when activated carbon ashing and smelting are equipped with an air chimney or work with your back to the wind

All processing workers must be equipped with a mask.

Waste from gold processing is generally in the form of solid and liquid waste, then ensure:

1. Solid waste is placed in area that will not be flooded during rainy season, no landslides and must meet environmental requirements (Figure 3.3).
2. Liquid waste before is discharged into river must placed in sediment ponds for sedimentation, and if possible the waste can be processed prior discharging in

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order to meet the quality standard (Figure 3.3). The wastewater quality standards for gold and or copper processing are shown in Table 3.2.



a



b

Photo 3.9 Concentration of CN in the Air a) 1.5 m From Active Heap Leach Reaches 2 ppm b) 1 m From Active Carbon Ashing Reach 7.1 ppm

**Table 3.2
Wastewater Quality Standards for Gold and/or Copper Ore Processing Activities**

Parameter	Unit	Maximum Content	Method of Analysis **
pH		6-9	SNI 06-6989-11-2004
TSS	mg/L	200	SNI 06-6989-3-2004
Cu*	mg/L	2	SNI 06-6989-6-2004
Cd*	mg/L	0.1	SNI 06-6989-18-2004
Zn*	mg/L	5	SNI 06-6989-7-2004
Pb*	mg/L	1	SNI 06-6989-8-2004
As*	mg/L	0.5	SNI 06-2913-1992
Ni*	mg/L	0.5	SNI 06-6989-22-2004
Cr*	mg/L	1	SNI 06-6989-14-2004
CN**	mg/L	0.5	SNI 19-1504-1989
Hg*	mg/L	0.005	SNI 06-2462-1991

**Source: Decree of the Minister of State for the Environment Number 202 of 2004*

Information:

- * = As the concentration of dissolved metal ions
- ** = Specific parameters for gold ore processing using Cyanidation process CN in the form of free CN.

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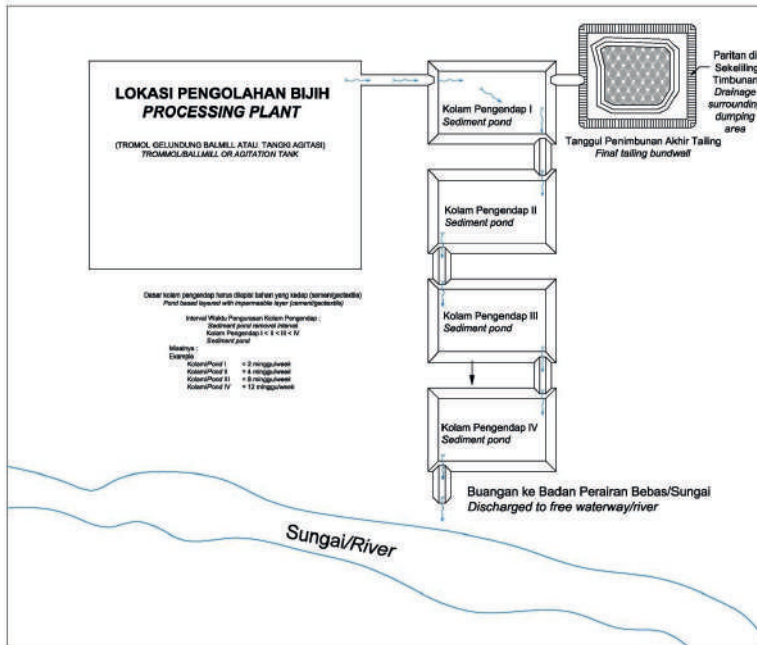


Figure 3.3 Construction of Tailings and Sedimentation Ponds
(Kepmen LH No 23/2008)

IV. DETAILS OF MINING AND PROCESSING APPLICATION TECHNIQUES

A. Primary Gold Mining and Processing

The mining and processing of small-scale primary gold is different compared to alluvial gold. In general, small-scale primary gold mining is carried out by making shafts, tunnels or a combination of tunnels and shafts. The primary gold mining system requires more complex technical knowledge to run a primary gold mine.

Likewise, the processing of small-scale primary gold needs special treatment compared to alluvial gold. The processing of small-scale primary gold mines mostly use chemical techniques to capture gold so the process of it is more complicated than alluvial gold.

In small-scale primary gold mining, mine safety and environmental management comply with applicable standards and payment of contributions is mandatory. So that one of them is the need for easy and accountable daily records as a benchmark for safety as shown in Table 4.1.

Table 4.1 Daily Record Example

Lokasi :
Location
Pemilik :
Owner

Tanggal/ Date	Kegiatan/Activities	Keterangan/Remark	Orang yang terlibat/ Involved Workers
9	Pembenahan Bedeng		
10	Penggalian + listrik	2,8 m belum stek	10
11	Penggalian dan perapian base camp	3,785 belum stek	
12	Pemasangan blower	1 Hari persiapan	
	Instalasi penggalian		
13	Langsir Kayu stek	Dari Penjual ke lokasi	
	Pembuatan stek		
14	Pembuatan stek		
	pemasangan Stek		
15	Penggalian	6,33 m	
		tembus lubang lama	
16	Perapian posisi sumur	Setting dududkan stek gantung	
		Perencanaan terowongan belok kanan	

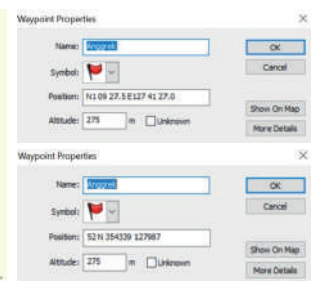
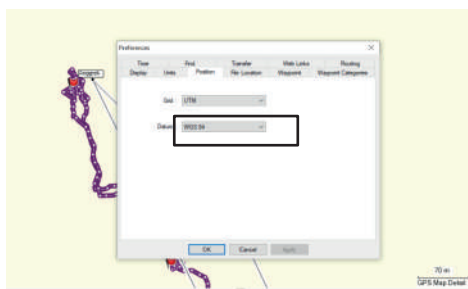
B. Positioning and Underground Mapping

The location of the tunnel and shaft entry points can be determined using GPS or a mobile phone that is already equipped with map application software.

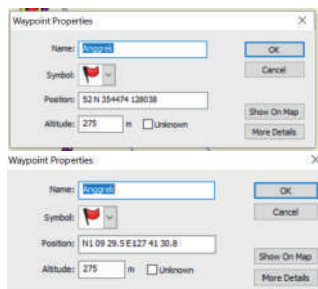
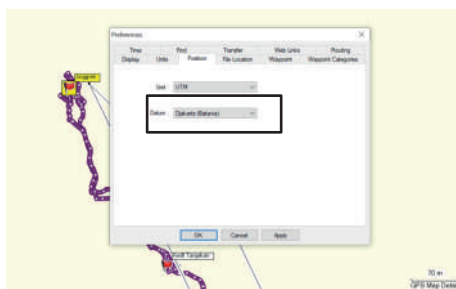
1. Make sure that the datum system (e.g. WGS84 (Figure 4.1a) or Djakarta (Batavia) (Figure 4.1b)) because it will produce the different coordinates result (UTM/Longitude-Latitude) even though in the same location. For example: Anggrek location with different datum systems (can be seen in Table 4.2) that will produce different coordinates result even though in the same location.

Table 4.2 Example of Different Datum System Will Produce Different Coordinate

System	Datum Djakarta (Batavia)		Datum WGS 84	
Latitude-Longitude	N1° 09' 29,5"	E127 ° 41' 30,8"	N1° 09' 27,5'	E127° 41' 27,0"
UTM	52 N 354 474	128038	52 N 354 339	127987



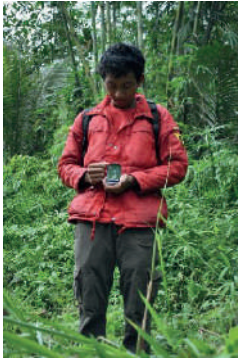
a



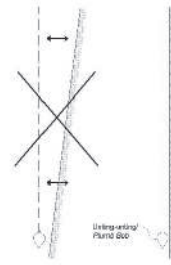
b

Figure 4.1 Datum Systems a) WGS 84 b) Djakarta/Batavia Produce Different Coordinate

2. Use a compass/theodolite (Figure 4.2a) to determine the tunnel direction or use plumb bob (Figure 4.2b) to determine the shaft alignment.



a



b

Figure 4.2 a) Compass to Determine Tunnel Direction and b) Plumb Bob to Determine Shaft Alignment

3. Use a fixed point from a nail on the wall or roof portal and use a tape measurement to measure the length of the progress of a tunnel or shaft to provide mining progress information (Photo 4.1).



a Insert the "looping" into the reference nail



b The tape measurement is pulled tight until it binds the reference nail

Photo 4.1 The Measurement of Tunnel or Shaft Progress using Reference Nail and Tape Measurement

4. Create a tunnel progress map using compass, tape measurement, and nails as fixed points along the tunnel/shaft progress. It is drawn as a reference and equipped with a scale and North direction (Figure 4.3).

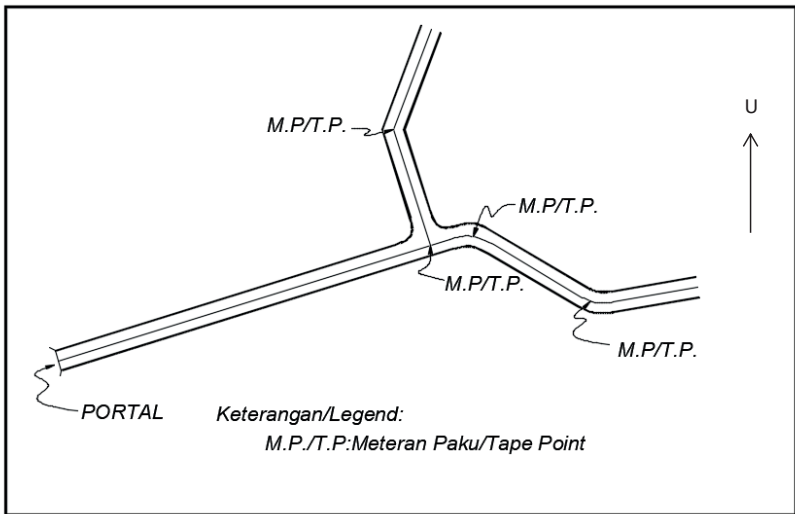


Figure 4.3 Tunnel Progress Measurement

5. Draw gold bearing vein distribution at the end of tunnel when tunnel is developed (Photo 4.2) so the direction of gold bearing vein distribution can be estimated as shown in Figure 4.4.



Photo 4.2 Gold Bearing Vein in The Tunnel

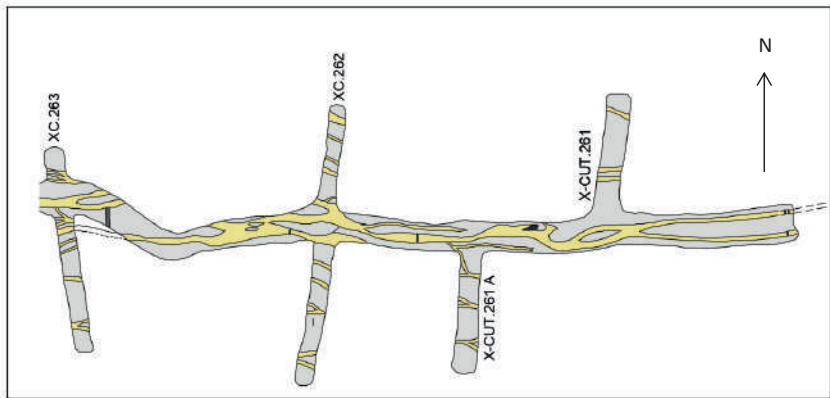


Figure 4.4 Vein Distribution Map in The Tunnel

C. Rock Strength

In making tunnels, there are problems that will become obstacles in progress, where these obstacles come from the state of the rock, one of them.

C.1. Rock Type

Primary gold mine are usually dominated by igneous rock of "andesite" inside, weathered rock near surface, and clay (alteration) near the gold bearing vein. Rock fractures are often found in hard rocks so it will change the rock strength from strong to weak when excavated. The following figure shows rock conditions based on the weathering level, see Figure 4.5 and Photo 4.2 for field conditions.

C.2. Rock Strength

The strength of a rock can easily be measured using simple tools such as thumb, pen knife, and hammer. Table 4.2 provide guideline to calculate rock strength.

D. Tunnel Support

D.1. Location

The appropriate location must be selected in order to facilitate safe entry access and close to the ore body containing gold. The selected location must consider the following factors:

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The tunnel location must avoid landslide area, falling rocks, floods and allows to facilitate the workplaces outside the tunnel, disposal, transportation of mine equipments, and other facilities.

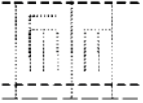
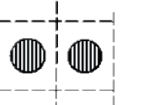
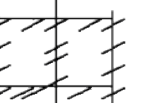
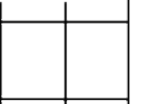
Term	Description	Illustration
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structures is still largely intact	
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discoloured rock is present either as discontinuous framework or as core stones	
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discoloured rock is present either as continuous framework or as cores	
Slightly weathered	Discolouration indicates weathering rock material and discontinuity surfaces. All the rock material may be discoloured by weathering and may be somewhat weaker externally than in its fresh condition	
Fresh	No visible sign of rock material weathering; perhaps slight discolouration on mayor discontinuity surfaces	

Figure 4.5 Rock Weathering Level

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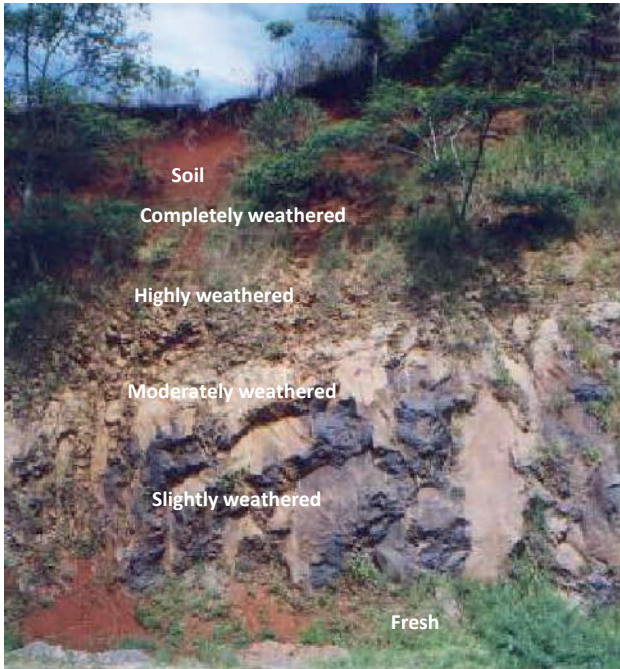


Photo 4.3 Rock Weathering Condition in The Field

Table 4.3 Simple Rock Strength Determination

Term	Field Test	UCS (MPa)
Extremely weak rock	Indented by thumbnail	0.25 – 1.0
Very weak rock	Crumbles under firm blows with point of a geological hammer. Can be peeled by pocket knife	1.0 - 5.0
Weak rock	Can be peeled by pocket knife with difficulty Shallow indentation with firm blow with point of geological hammer	5.0 - 25
Medium strong rock	Cannot be scraped or peeled by pocked knife Specimen can be fractured with a single firm blow a geological hammer	25 - 50
Strong rock	Specimen requires more than one blow of a geological hammer to fracture it	50 - 100
Very strong rock	Specimen requires many blows of a geological hammer to fracture it	100 - 250
Extremely strong	Specimen can only be chipped with a with a geological hammer	> 250

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a) Unsafe tunnel entry point



b) Safe tunnel entry point



c) Unsafe shafts



d) Safe Shaft

Photo 4.4 Tunnel/Shaft Entry Point a, c) Unsafe b, d) Safe

The water drainage must be built above of the tunnel so the rainwater will be directed to the left and right side of the tunnel

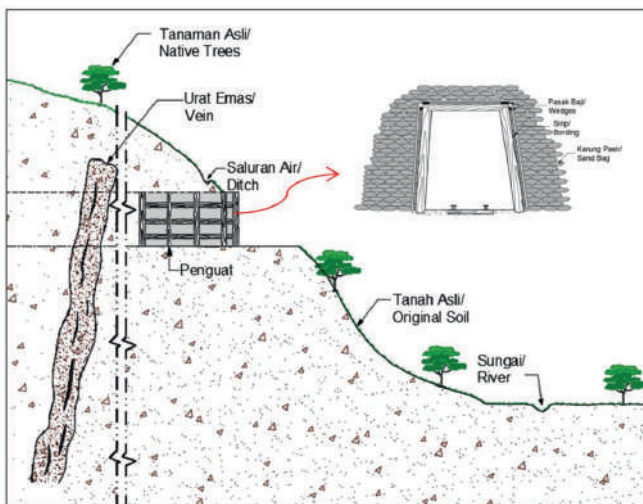


Figure 4.6 The Location of Water Drainage System and River to The Tunnel

The tunnel and shaft entrances are provided with a protective roof so the rainwater cannot enter into the tunnel/shaft

There is a safe access road for both walking and two-wheeled or four-wheeled. Roads built around dirt/waste stones are usually soft when exposed to water so road access may be more difficult during the rainy season so the road must be made of wood for comfortable walking or if climbing must be given stairs and given a handrail on the side of the ravine

The tunnel location must consider mine drainage facilities that collect mine waste water. The roads and associated drainage facilities require regular maintenance

Involve all miners in the location, especially shared facilities

D.2. Portal/Shaft Collapse

The collapse in portal or shaft area is a significant risk in small-scale primary gold mining due to it is close to weathered area. Collapse can occur at the portal and shaft area due to the weak support system, the heavy rainfall that increases the load on the soil/rocks, and the additional load as the result of the flow of water carrying rocks or landslides that hit the portal or shaft.

The soil/rock contains small quantities of water during dry season but it becomes saturated during the rainy season. The water must be directed as far away as possible from portal and shaft.

Make roofs/houses to protect the tunnel/shaft from the rain and the sun which can reduce the binding force between the grains.

Ask local community members about their experiences with collapse and flooding events: which areas that have high risk and how many times it occurs? Consider this information for portal collapse mitigation.

D.3. Tunnel/Shaft Dimension

The tunnels and shaft dimension must be made in the appropriate size for the workers in order to provide safe workplace, comfort workplace, and work effectiveness.

For tunnels : the dimension of the tunnel must comply with the height of worker and width of comfort access (including the support dimension) for worker and equipment. The tunnel must have space for ventilation and lighting.

For shaft : the shaft dimension (not including the left and right side support) must comply with the worker width who can go down using the ladder. The tunnel must have space for ventilation and lighting.

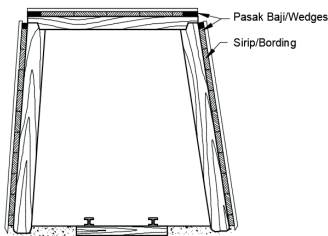
The shaft access for gold bearing vein transportation should be separated with people access

D.4. Support Method

D.4.1 Support in the Tunnel

Almost all tunnels requires support to prevent a collapse that will cause accident or disturb the mine operation. The support materials usually are made of the processed wood such as timber and lumber, sometimes inlaid with bamboo if available. The tunnel support pattern is different among mine locations so it requires special skills to install the support. The basic knowledge of tunnel supports as follows:

- Create standards or working drawings according to the potential rock collapse
 - Portal design (Figure 4.7a)
 - Work procedures (Figure 4.7c)
 - Supports installation
 - Fill the gap between flank and rock wall using waste rock until compact in shape to prevent rock movement
 - Support installation (Figure 4.7d)



a Portal design



b Field condition



c. Installation



d. Installed support

Figure 4.7 Portal Support Planning and Installation

Tunnel support. It is necessary to inform the support types that must be carried out such as:

- Stull: this method is used to maintain the opening in the hanging wall or gold bearing vein that easily collapse. Usually this method is combined with wedges in place on the top of the stull (Photo 4.5).

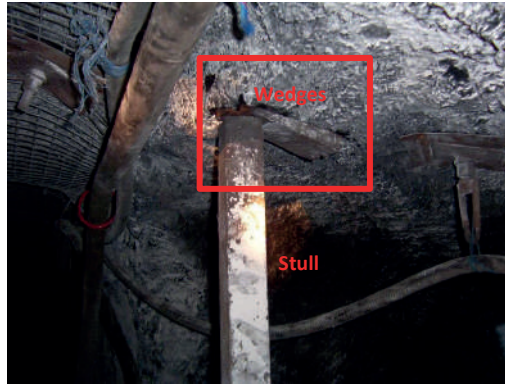


Photo 4.5 Wedges and Its Installation

- Supports for weak veins that have strong wall (Figure 4.8a)
- Supports for weak veins and weak hanging walls that have strong footwall (Figure 4.8b)
- Supports for wall and veins that easily collapse if no supports are installed as quickly as possible (Figure 4.8c)
- The small mines usually use logs as shown in Figure 4.8d

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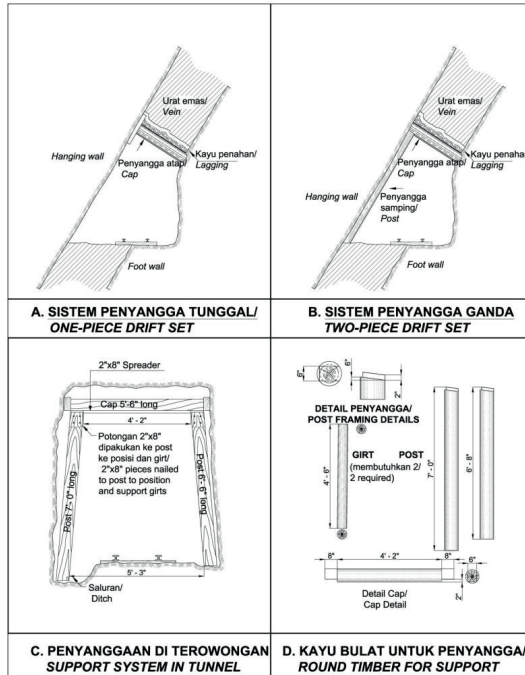


Figure 4.8 Support Planning (Stout, 1989)

When excavating the soft rock, the problem is the fall which which hinders the excavation (Photo 4.6). The boring should be installed to solve this problem. The installation of boring as follows :



Photo 4.6 Collapse in Tunnel That Must Be Handled using Boring

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- Make stop and false frame (Figure 4.9a)
- Through the false frame, pushed them into the fall using a hammer until it penetrates the rock (Figure 4.9b)
- Open the stop and remove the fall. If the fall is a vein, then move it to stockpile area/processing area. If it is barren rock, move it to disposal area
- After all the rock is clean, fill the cavity with wood until all the rock is in contact with the filler wood. If necessary, hit until full contact with the original rock (Figure 4.9c)
- If the wall rock tends to collapse, install the lagging (Figure 4.9d)

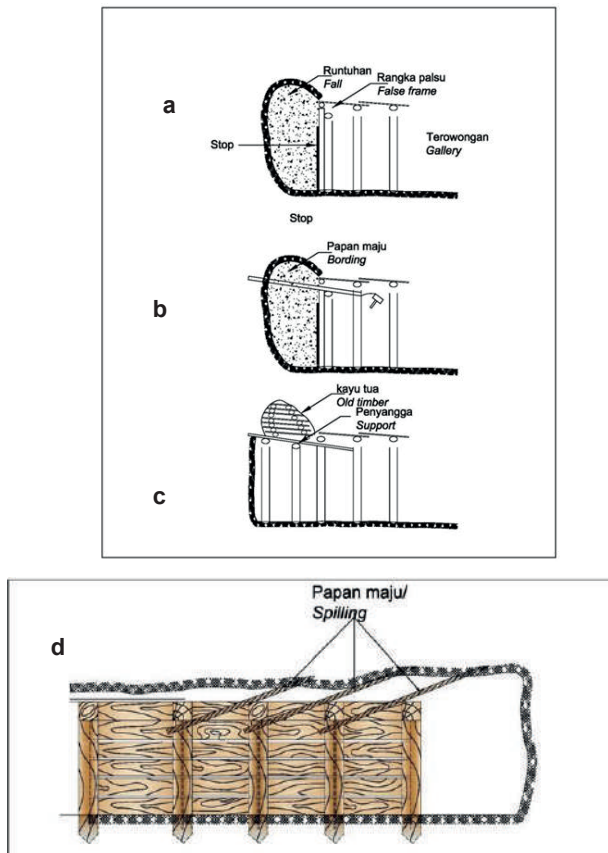


Figure 4.9 Bording Installation (1,2,3 Chaussier,1987)

D.4.2 Shaft Support Method

Almost all shafts requires support to prevent a collapse that will cause accident or disturb the mine operation. The support materials usually are made of the processed wood such as timber and lumber, sometimes inlaid with bamboo if available. The shaft support pattern is different among mine locations so it requires special skills to install the support.

Create standards or working drawings according to the potential rock collapse (Figure 4.10):

- Shaft design
- Work procedures

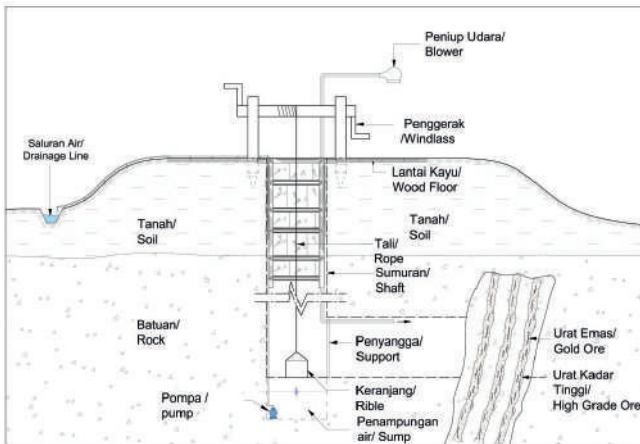


Figure 4.10 The Shaft Support Method

D.4.3 Support Method in Open Pit

Small-scale primary gold mining with open-pit mines is almost never done in Indonesia when referring to Law No. 3/2020 where IPR is granted with a limited area and investment. Excavations in open pits will form slopes. Usually the ratio of the vertical and horizontal axes in soil slopes is 1:2 and in rocks 1:1 (Figure 4.11d). From Figure 4.11d, it can be seen that to be able to carry out good mining for small-scale primary gold mining using an open pit mining system is difficult to carry out to deep elevations because it will be unprofitable. To move side rock which is quite a lot requires investment and extracting ore requires a larger investment.

If the open pit mine will be applied for the primary gold deposit with small scale mine, following steps must be carried out:

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Create standards or drawings according to the potential failures:

- Design open pit in weak rock/soil (Figure 4.11a)
- Excavation design for open pit (Figure 4.11d)

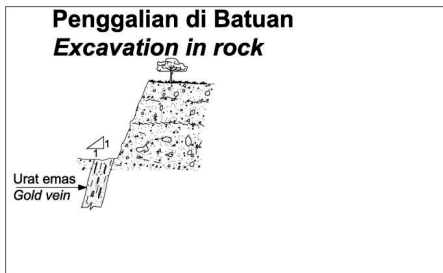
The factor of safety criteria of open pit mine based on The Ministerial Decree of Energy and Mineral Resources of The Republic Indonesia Number 1827 K/30/MEM /2018.



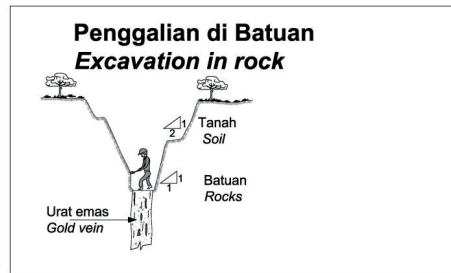
a Soil/Soft rock mine plan



b Gold bearing vein condition



c Rock mining



d Open pit

Figure 4.11 The Slope Design of Primary Gold Open Pit Mine

The factor of safety criteria of open pit mine based on The Ministerial Decree of Energy and Mineral Resources of The Republic Indonesia Number 1827 K / 30 / MEM / 2018. The factor of safety criteria (static and dynamic), probability of failure, and consequences of failure according to The Ministerial Decree of Energy and Mineral Resources of The Republic Indonesia Number 1827 K / 30 / MEM / 2018 are shown in Table 4.4.

Table 4.4 The Factor of Safety and Probability of Failure of Slope Mine

Type of Slope	Consequences of Failure	Acceptability Criteria		
		Static Factor of Safety (FoS) (min)	Dynamic Factor of Safety (FoS) (min)	Probability of Failure (max) PoF (FoS<1)
Single Slope	Low to high	1.1	-	25-50%
Inter-ramp	Low	1.15-1.2	1.0	25%
	Medium	1.2-1.3	1.0	20%
	High	1.2-1.3	1.1	10%
Overall Slope	Low	1.2-1.3	1.0	15-20%
	Medium	1.3	1.05	10%
	High	1.3-1.5	1.1	5%

The consequences of failure criteria based on The Ministerial Decree of Energy and Mineral Resources of The Republic Indonesia Number 1827 K/30/ MEM/2018 consist of low, medium, and high. Based on the assessment of B Sulistijo, PhD, this severity criterion can be applied to small-scale primary gold mining. The consequences of failure criteria are as follows:

- a. High; if there are consequences for:
 - (i) human death;
 - (ii) over-three-people serious injury;
 - (iii) over 50% mining facilities and infrastructure damages;
 - (iv) over 24 hours stoppage time of production;
 - (v) lost and unmineable reserves; and/or
 - (vi) the impact of environmental damages are widespread outside the mining permit (IUP) area including settlements;
- b. Medium; if there are consequences for:
 - (i) people serious injury;
 - (ii) 25% - 50% mining facilities and infrastructure damages
 - (iii) 12 - 24 hours stoppage time of production
 - (iv) reserves are buried but still mineable; and/or the impacts of environmental damage inside mining permit (IUP) area
- c. Low; if there are consequences for:
 - (i) people unserious injury;
 - (ii) under 25 % mining facilities and infrastructure damages; and/or under 12 hours stoppage time of production

E. Excavation and Hauling Method

The rock breaking process in small scale mining can be excavated using manual method (chisel, hammer, and picks), Jack Hammer, and Jack Leg (rare conditions). When the excavation is started, ensure following procedures:

1. Ensure to write the daily record (Table 4.5)

Table 4.5. Daily Record Example

Lokasi/Location :

Tanggal/Date	Nomer/No.	Keterangan/Remark	Sketsa/Sketch
3	1	Lebar urat 30 cm	
		<i>Wide of vein 30 cm</i>	
		Dilakukan sampling ada indikasi emas	
		<i>Sampled with gold indication</i>	
	2	Arah kemajuan terowongan N10°E	
		<i>Direction of tunnel N10° E</i>	
4	1	Kondisi 5 m dari patok batuan sampling warna hitam lunak. Kuarsa putih sedikit abu-abu	
		<i>The condition is 5 m from the side rock peg, soft black color. White quartz slightly gray</i>	

1. Plot the tunnel development in map. Some small-scale miners have conducted the method in limited plotting map (Figure 4.12). The tunnel development map (if possible) can provide information not only the gold bearing vein but also the support location, faults, shaft locations, rock types, and geological structures (Figure 4.13)
2. Plot of the sampling position/vein progress taken and the gold yield obtained (Figure 4.14). Mention in the form of bullion or after purification (cukim -Ciok Kim/local gold). If faults are found (see Figures 2.7, 2.8 and 2.9 for pursuing gold vein forwarding) plots on the map as well as bedding should be plotted to estimate the direction and grade conditions of gold veins.

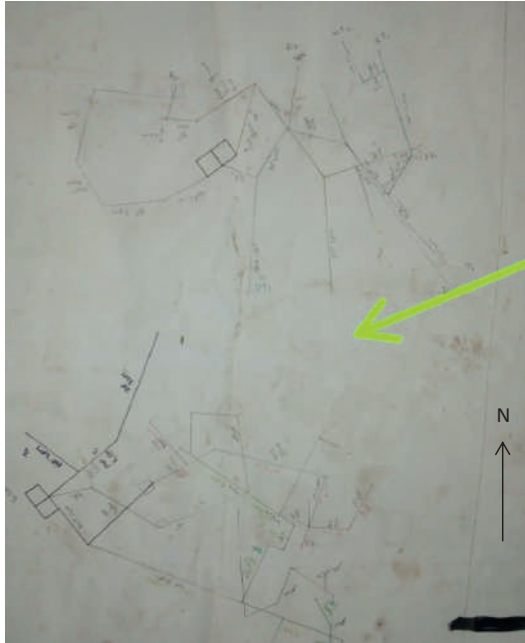


Figure 4.12 Plotting Map Example at Small Scale Mine

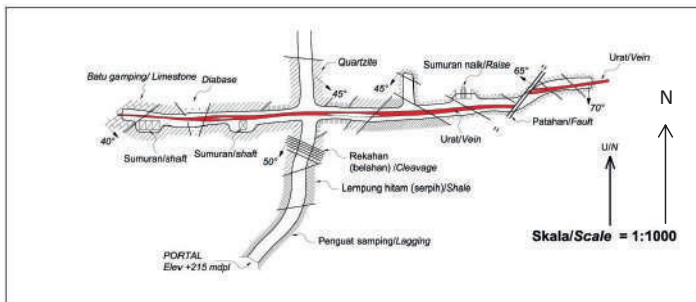
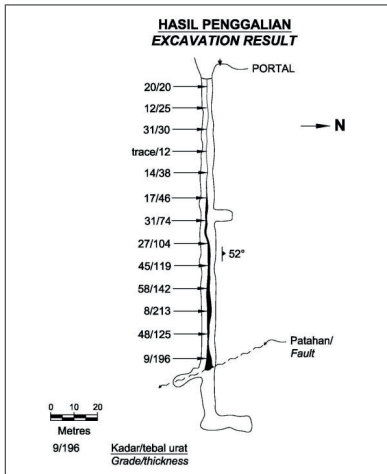


Figure 4.13 Tunnel Detail Mapping
(Forrester, 1955 modified by Sulistijo)



a) Assay plotting result



b) Strike and dip measurement

Figure 4.14 Analysis Result Plotting Method

E.1. Manual Excavation

To facilitate manual excavation (Photo 4.7), the openings and the size of the equipment must be adjusted to the work holes and carry out the following steps:



Photo 4.7 Manual Excavation (Do Not Try Without Personal Protective Equipment)

Keep the chisel sharp and protected with safety rubber to prevent it from being hit by a hammer when it misses

Always wear a safety helmet, shoes, gloves, and goggles to avoid splashing stones into the eyes

Provide a container (dustpan, plastic sack, etc.) that make it easier to transport the loose stones from the mining face to the surface

Sacks must be separated between containing gold bearing vein or not containing gold bearing vein

Pay attention for lithology changing to identify the gold or the rock strength for support

Pay attention to the needed support

► See chapter IV.D.4 for support method

E.2. Jack Hammer

To facilitate manual excavation with a Jack Hammer (Photo 4.8) the minimum size of the working hole must be adjusted to the equipment used. The things that must be considered in excavation activities using a Jack Hammer are:

Ensure the sufficient electricity supply

Inspect that the cable is not chipped

Always wear a safety helmet, shoes, gloves, and goggles to avoid splashing stones into the eyes

Place a container at the bottom of the surface (dustpan, plastic sack, etc.) to make it easier to bring loose stones from mining area to the surface

Sacks must be separated between containing gold bearing vein or barren rock

Pay attention for lithology changing to identify the gold or the rock strength for support



Photo 4.8 Jack Hammer

E.3. Jack Leg

To facilitate manual excavation with Jack Legs (Photo 4.9) the minimum size of the working area must be adjusted to the equipment used. Things that must be considered in excavation activities using Jack Legs are:

Provide compressed air pipe

Always wear a safety helmet, shoes, gloves, and goggles to avoid splashing stones into the eyes

Place a container at the bottom of the surface (dustpan, plastic sack, etc.) to make it easier to bring loose stones from mining area to the surface

Sacks must be separated between containing gold bearing vein or barren rock

Pay attention for lithology changing to identify the gold or the rock strength for support



Photo 4.9 Jack Leg Equipment

E.4. Underground Haulage System

The underground haulage types from the mining face to surface are conducted based on the haulage direction.

1. On horizontal direction (adit or tunnel) (Photo 4.10) do as follows :

If the mine opening is wide enough, the rails and rail pads can be made from wood

The wagon size must comply with the tunnel width, tunnel condition, and the miners ability to push the wagon.

Ensure to lubricate the wheels or rail pads neither with oil or grease for free spinning.

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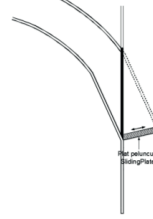
a



b



c



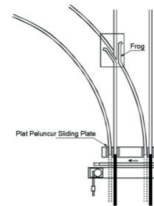
d

Photo 4.10 a) Simple Railway Arrangement b) Wagon c) Railway Setup d) Railway Junction Construction Diagram (Stout, 1988)

- ii. For a larger scale can use iron rails and wagons (Photo 4.11) that can be shed from the side. If using iron rails and wagons, the principle of making the junction is the same as that of a simple junction.



a



b

Photo 4.11 a) Railway Junction Arrangement b) Railway Junction Construction Diagram (Stout, 1988)

2. On vertical direction (shaft) do as follows :
 Create threaded wheels axle to prevent threads wrapping around the wheel axle (Figure 4.15.1)
 Prepare a strong storage container, make sure it does not scrap the wall to avoid wear and tear when it is lifted to the surface

Inspect the rope to keep it in good condition

Adjust the strength of the rope and the storage container with the filling rock in the storage container

Lubricate the axle and rope grooves (Figure 4.15.2)

Ensure the axle wheel is strong enough/not broken and install a safety equipment or the miners must work together to avoid the storage container fell back suddenly

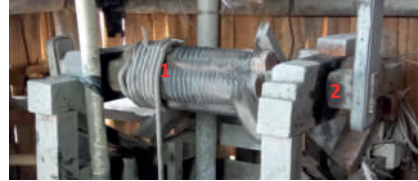
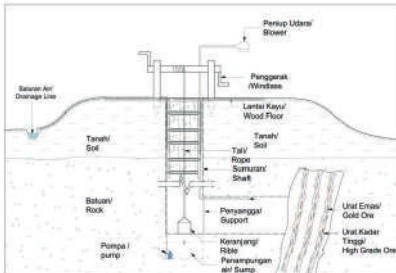


Figure 4.15 The Tunnel Haulage Equipment

F. Ventilation, Lighting, and Communication

F.1. Ventilation

The mechanical ventilation system is needed when the tunnel development, raise, and shaft are located far from the surface. It is not enough only to rely on natural ventilation.

1. Choose a blower or suction air pump that is suitable with the length of the tunnel or shaft. A blowing fan for ventilation is commonly used.
2. Put the blowing fan in a safe and clean position to ensure air intake (Photo 4.12)
3. Choose a delivery pipe that is suitable with the tunnel development.
PVC
Plastic
4. Be sure that the wind speed at the end of the ventilation system at least 7 m/minute.
5. Be sure the minimum oxygen volume is 19.5%, the air temperature in the underground mine must be maintained from 18°C to 20°C with a maximum relative humidity of 85%
6. In order to work for 8 hours, the carbon monoxide (CO) volume is 0.005% (50 ppm) and the maximum hydrogen sulfide (H₂S) volume is 0.001% (10 ppm)
7. Prepare a measuring tool for temperature, humidity, gas and wind speed

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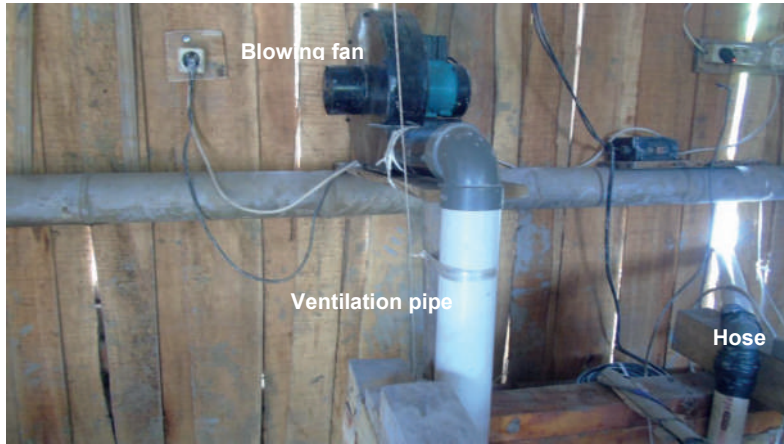


Photo 4.12 Blowing Fan Position



Figure 4.16 a) Simple Temperature and Humidity Measuring Tool (Tokopedia) b) H₂S, CO, O₂ Detector and Exploding Gas c) Wind Speed Measuring Tool

The advance ventilation plan must be designed better than the conventional one if the underground mine will be scaled up as shown in Figure 4.17. The mine air flow is adjusted by installed the doors that that can be opened and closed in accordance with the direction of air flow.

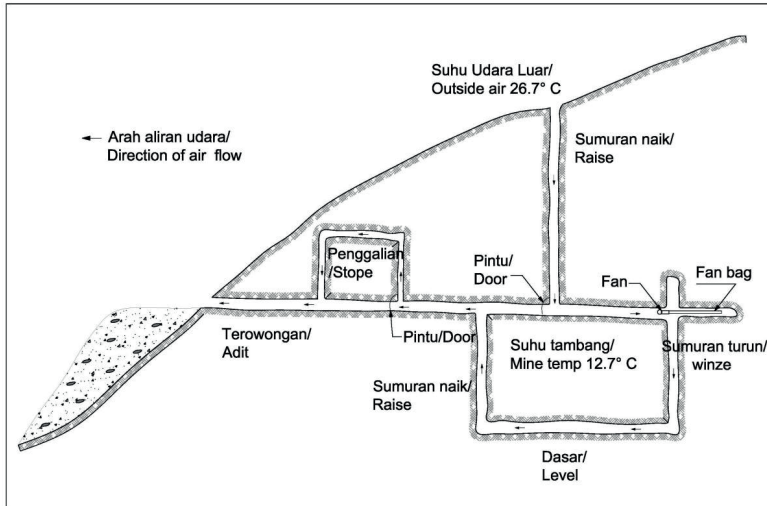
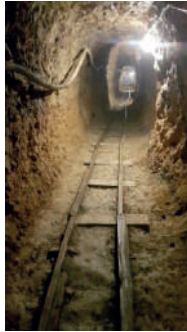


Figure 4.17 A Typical Ventilation System of The Advance Small Scale Mine (Stout, 1988)

F.2. Lighting

The mining locations, such as workplace and mine opening, require lighting. The lighting in the mine opening is needed to increase efficiency so it will increase production. In many small-scale mining locations, lighting relies on a head lamp for each mine worker. It will effects the production if there is a problem with the head lamp. Some aspects that need to be considered in mining lighting are as follows:

1. Electricity from the independent generator or State Electricity Company/PLN (if the mine area close to the residential area)
2. Inspect that the cable conductor is not chipped
3. Use separate fuses according to the field conditions. It will not shut off power in the entire area due to the short circuit
4. Choose a moisture-resistant cable
5. Use LED lights to save money



a



b

Photo 4.13 Lighting a) Tunnel b) Shaft

F.3. Communication

The communication in underground mines is very important aspect to achieve efficient work. The telephone or one-way communication equipment should ideally be installed. The ventilation tubes can be used as the communication system if there are no standard telecommunication equipment to avoid communication problems. There is a part of the blower that can be opened and closed (Photo 4.14) so it can be used as a one-way communication tool where one person talks and the other person listens and vice versa. It is an effective communication tool in underground mining.

**Photo 4.14 Simple Communication Tool using Ventilation Tube**

G. Mine Dewatering System

The tunnel or shaft often develops through both of the water bearing layer and the terrain condition that is not suitable for gravity drainage, so it requires water pump to drain it. This pump requires full 24-hour supervision so the pump can be operated whenever needed. If the pump unit is in trouble/not working properly, it is possible that

the tunnel will be submerged and interfere the production/exploration process. The stages that must be carried out are as follows:

1. Intake flow rate determination :

Flow rate measurement :

i. Using V-Notch weir

1. Install V-notch in the selected channel
2. The gap between the tool and the channel is clogged with clay
3. Be sure there are no seepages in the gap
4. Watch the rise of water at V-notch until it shows steady condition
5. Measure the head
6. Calculate flow rate using equation below :

$$Q = 1.39 H^{5/2} \text{ m}^3/\text{second}$$



Where:

Q = flow rate m^3/second

H = m

*V-Notch angle = 90°

iii. By calculating the volume of water in a period time :

1. Determine the area (A) filled with water (m^2)
2. Provide measurement tape and stand it on one side
3. Record water level (H_1) at T_1
4. Record water level (H_2) at T_2
5. Flow rate = $A \times (H_2 - H_1) / (T_2 - T_1)$ (m^3/second)

2. Determine the maximum flow rate to be pumped, $O_{\max} = 1.2Q$
3. Determine the maximum suction (H_s)
4. Determine head of the water discharge from the fixed groundwater (H_p)
5. Determine the effective pump head, $H_e = 1.2(H_p + H_s)$ (Figure 4.18. No.1)

6. Determine how long it will take to dry so the flow rate that must be pumped every second can be calculated (Figure 4.18 No. 2)
7. Select the pump capacity according to discharge at the intended head (Figure 4.18. No.3) and the type of water that can be pumped

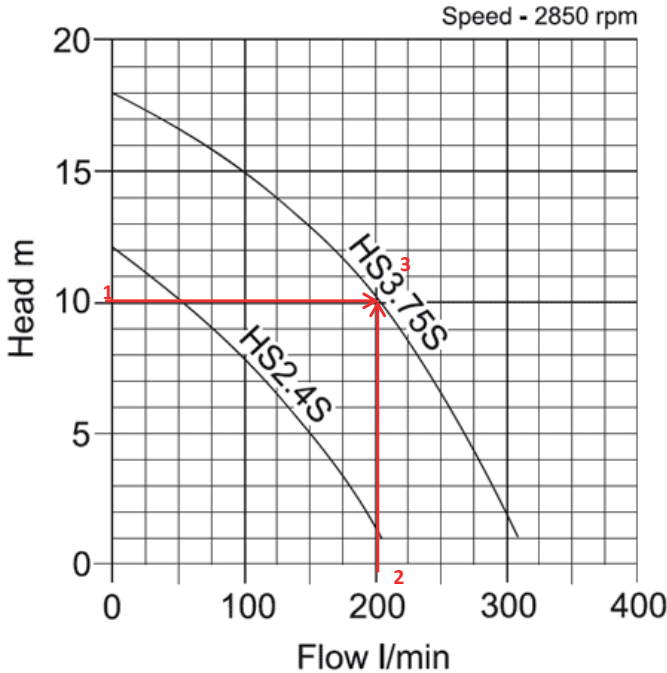


Figure 4.18 The Example of The Flow rate, Head, and Pump Type Relationship (Tsurumi Chart)

H. Processing

H.1 Crushing

The rocks containing gold, in boulder size, are reduced into smaller size. The reduced size depends on the gold extraction method, permeability, and the free gold condition. The hard rock with no voids and ore covered with quartz veins need to be reduced until the contact between the gold and the solution is visible. The greater contact between gold and solution, the higher gold recovery will be. The finer the ore size in vein, the finer the rock containing gold must be crushed. The procedure for ore reduction is as follows:

Check the weathering, strength, voids, and ore condition using a loupe
Crush the ore into fine size and see liberates gold particles using magnifying glass / loupe and record its size

Select the gold processing method used and then determine the equipment used:

- Heap leach : Manually with 1-3 cm size
Jaw crusher
- Immersion : Hammer mill
- Tank : Manual (hammer)- Trommel
Stamp mill-trommel
Jaw Crusher- Ball mill
Jaw Crusher-trommel
- Borax : Ball mill, trommel

H.2. Gold Ore Leaching

The Gold ore leaching process consists of two important steps, namely the dissolution process and the process of separating gold from the solution. The solvent most often used is NaCN, because it is able to dissolve gold better than other solvents. In the second stage, the separation of gold metal from the solution is carried out using activated carbon or zinc dust or other methods.

H.2.1. The Gold Ore Leaching Method Using Tanks and Carbon to Extract the Gold

The steps that must be carried out for leaching gold ore with leaching tanks equipment and activated carbon media to capture gold to the maximum are as follows:

1. Choose the base leaching tank system to be installed. There are two types of base leaching tank systems and each of it will affect the installed equipment :
 - a. Tank with flat base system (Photo 4.15)
The advantage of the leaching tank with flat base system is that the equipment can be built directly without supports and it is suitable for large capacities. The disadvantage of the system is that the system required mixing equipment and design properly along the walls of the leaching tank to prevent precipitate at the bottom of the leaching tank.

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Leaching tank with flat base system



Mixing axle system

Photo 4.15 Leaching Tank with Flat Base System

b. Leaching tank with conical base system (Photo 4.16)

The advantage of leaching tank with conical base system is that the equipment does not need a stirrer in the middle of the leaching tanks to prevent precipitate of fine ore. The disadvantage of this system is that support structure and compressor must be built to prevent precipitate of ore.



Tank with conical case system



Truss system of tank with conical base

Photo 4.16 Leaching Tank with Conical Base System

2. Prepare a pH meter (paper or digital probe) and other measuring equipment such as temperature, TDS, EC, ORP and DO measuring devices (Photo 4.17)

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A Paper pH Indicator



Digital probe pH, TSD, EC, ORP, Density

Photo 4.17 Cyanidation Testing Kit

3. Prepare a mixer (Photo 4.18a), and turn it on then add the fine rock containing gold with water then put it in a tank (Photo 4.18b)



a Feeding Mixer System



b Feeding

Photo 4.18 Ore Mixer

4. Add the ore material and turn on the compressor simultaneously to generate the stirring process
5. Add the required chemicals according to the capacity and common utilization or according to Indonesian National Standard (SNI).
6. Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12
7. Keep a daily log every hour to find out the effectiveness of the processing as shown in Table 4.6
8. After the process finished, separate the carbon with impurities using a panning or sieve according to the capacity of the tank
9. Do ashing.

► See chapter IV.H.4 for processing charcoal into ash

10. Do bullion processing.

► See chapter IV. H.5 for the smelting process

Table 4.6 Example of Daily Log Processing Data

Lokasi/location :
Tanggal/Date :
Pemilik/Owner :
Berat Material /Weight : 1.415 ton
Berat Jenis Campuran/ :
Density
Volume air/Water Vol.

Tanggal/Date	Jam/Hour	Keterangan/Remark		pH	DO	ORP	EC	TDS	Suhu
20	09.00	Masukan kapur		7.18					
	11.00	H ₂ O ₂ 5 lt		11.7					
	12.00	H ₂ O ₂ 10 lt		6.58					
	14.00	H ₂ O ₂ 10 lt+ Kapur		11.85					
21	07.30	Masukan CN 1kg		11.82					
	19.30	NaCN 2 kg		11.7					
22	09.30	Masukan 6 kg karbon dan 1kg CN		11.72					
	18.30	Masukan Carbon 6 Kg		11.73					
23	08.30	Panen							
		Bulion	414.9 gram						
		Au	8.32 gram						
		Ag	352.4 gram						
		Kadar/Grade	5.879859 gram/ton						

H.2.2. Gold Ore Leaching Method Using Sprinkling/Heap Leach and Carbon

The steps that must be carried out for leaching gold ore with watering and activated carbon media to capture gold to the maximum are as follows:

1. Make sure there is no leak in the sink and cyanide tank containing gold. Make a double layer, if necessary, if there is a leak then the gold will seep into the ground (Photo 4.19a)
2. Make sure there is sufficient space between the bottom of the tank and the ore for better circulation
3. Crush the rock into 1-3 cm in size and spread it carefully after it is mixed with lime
4. Cover the surroundings with plastic so that splashes from the shower do not pollute the environment (Photo 4.19b)



a Before filling process



b After filling process

Photo 4.19 Preparation and Processing

5. Prepare a pH meter (paper or digital probe) and other measuring equipment such as temperature, TDS, EC, ORP and DO measuring devices (Photo 4.17)
6. Add the required chemicals according to the capacity and common utilization or according to Indonesian National Standard (SNI)
7. Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12
8. Keep a daily log every hour to find out the effectiveness of the processing as shown in Table 4.6
9. After finished, dry the carbon in the air
10. Do ashing

► See chapter IV.H.4 for processing charcoal into ash

11. Do bullion processing

► See chapter IV. H.5 for the smelting process

H.2.3. The Gold Ore Leaching Method Using Immersion and Carbon

The steps that must be carried out for leaching gold ore by immersion and activated carbon media (Photo 4.20) to capture gold to the maximum are as follows:

1. Make sure there is no leak in the sink and cyanide tank containing gold. Make a double layer, if necessary, if there is a leak then the gold will seep into the ground

2. Make sure there is sufficient space between the bottom of the tank and the ore for better circulation.
3. Crush the rock into fine size and spread it carefully after it is mixed with lime



Photo 4.20 Immersion Method

4. Prepare a pH meter (paper or digital probe) and other measuring equipment such as temperature, TDS, EC, ORP and DO measuring devices (Photo 4.17)
 5. Add the required chemicals according to the capacity and common utilization or according to Indonesian National Standard (SNI)
 6. Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12
 7. Keep a daily log every hour to find out the effectiveness of the processing as shown in Table 4.6
 8. After finished, dry the carbon in the air
 9. Do ashing
- ▶ See chapter IV.H.4 for processing charcoal into ash
10. Do bullion processing

▶ See chapter IV. H.5 for the smelting process

H.2.4 Gold Ore Leaching Method Using Zinc Dust

The steps that must be carried out for leaching gold ore by immersion and zinc dust (Photo 4.21) media to capture gold to the maximum are as follows:

1. Make sure there is no leak in the sink and cyanide tank containing gold. Make a double layer, if necessary, if there is a leak then the gold will seep into the ground
2. Make sure there is sufficient space between the bottom of the tank and the ore for better circulation.
3. Crush the rock into fine size and spread it carefully after it is mixed with lime



Photo 4.21 The Immersion Method using Zinc Powder

4. Prepare a pH meter (paper or digital probe) and other measuring equipment such as temperature, TDS, EC, ORP and DO measuring devices (Photo 4.17)
5. Add the required chemicals according to the capacity and common utilization or according to Indonesian National Standard (SNI)
6. Maintain the pH above 10 so that the cyanide does not evaporate and the maximum limit is pH 12
7. Keep a daily log every hour to find out the effectiveness of the processing as shown in Table 4.6
8. After it finished, separate the concentrated solids using chemical process

H.3. The Gold Processing Method into Bullion without Cyanide and Mercury (Borax Method)

With the ban on the use of 100% mercury in small-scale gold mining by 2025 (Presidential Decree No. 21/2019) and strict requirements for the use of cyanide and the handling of processing waste using cyanide, this alternative borax method can be utilized. This method is relatively fast and inexpensive. This method can use the existing refining equipment except the cyanidation process.

The process can be explained as follows:

1. Choose ore that contain gold
2. Observe using a magnifying glass / loupe the mesh size that is suitable to liberate gold from rocks
3. Reduce the size using manual (hammer), stamp mill, jaw crusher
4. Reduce the size according to the degree of freedom of ores to get optimum results using a trommel, hammer mill, rood mill, etc.
5. Processing the gold separation with impurities by :
 - a. In small amount, do panning method to separate gold particles and gangue minerals particles. Collect gold and gold particles in one container

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- b. In large amount, use a gravity concentration separator to separate gold particles and gangue minerals particles. Collect gold and gold particles in one container.

Note: The separation of gold particles can be processed again into fine size to make the melting process faster.

6. Put it on the crucible bowl, add borax in a ratio of 1:1 and charcoal as a material to increase the ignition temperature
7. Warm up slowly using burner with LPG and Oxygen combination as fuel or other smelting equipment until it melted

► See chapter IV.H.5 for the smelting process

8. Look into the eyes on the bottom of the crucible bowl that indicate bullion
9. Gently separate the solution that does not contain gold and bullion by pouring it into a container filled with water. The bullion dissolves easily with the liquid slug (Photo 4.22c)
10. Take the bullion (eye) (Photo 4.22d), put it in the water and clean it



a



b



c



d

Photo 4.22 a) The Concentrate Mixed with Borax and Charcoal b) Separation Between Slug and Bullion c) Dissolved Bullion in Slug d) Eyes that Indicates Bullion

H.4 Processing Charcoal into Ash

The activated carbon as the product of cyanidation process contains gold, other dissolved metals, cyanide, and other sulfides. The following steps must be conducted to obtain the workers healthy, good environmental condition, and optimum results:

Pay attention to the wind direction, because the carbon steam still contains high CN

It is recommended using air dried / natural aerated method to handle the activated carbon, containing gold and other metals

The equipment for ashing of activated carbon can be seen in Figure 4.19. The tube capacity depends on combustion requirements

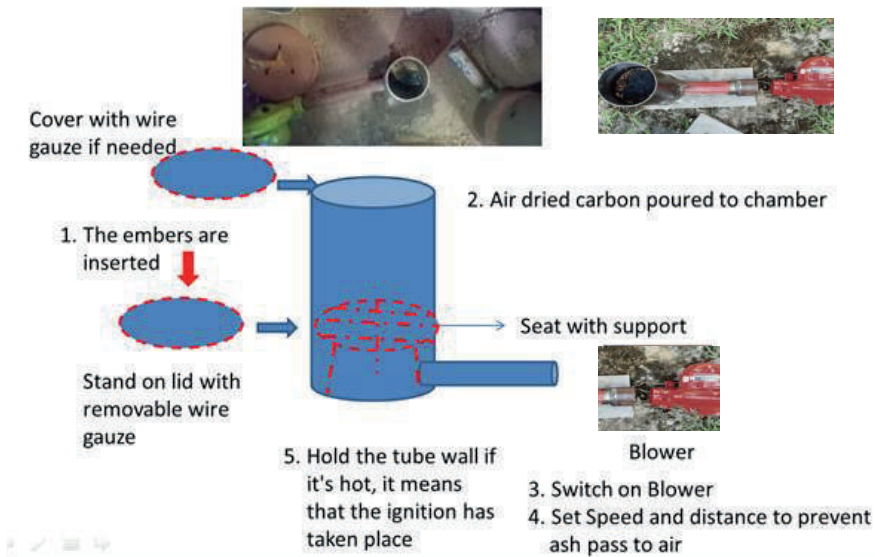


Figure 4.19 The Equipment for Ashing of Activated Carbon

Use a wood chip on the part of the igniter for the first combustion. Once the fire have formed, add enough activated carbon (Photo 4.23) and wait until the fire have formed then add the activated carbon to be processed.

If possible check the content of cyanide (CN), H_2S , O_2 , and H_2S that are exposed on human, especially places with lots human activities.

Adjust the incoming air so it will not make the dust fly. Be sure not adjust the incoming air too small that will lead to stop the fire. Cover the top with gauze to catch the dust. Prevent the dust spread out of the tank because it contains gold and other precious metals.

Do continuous observations by adjusting the air flow from the blower so the fire of activated carbon do not stop.

Check the process until all activated carbon has completely turned ash.

Sieve the ash with a ash sieve. If there is still carbon that has not been completely turned ash, then puree it and sieve it again. Collect the remaining activated carbon that has not been turned ash and do ashing process if the amount is sufficient.



a



b

Photo 4.23 a) Activated Carbon b) Ash Containing Gold and Other Precious Metal Ready to be Processed into Bullion

Ash containing gold and other metals is ready to be processed using burner with LPG and Oxygen combination as fuel or furnish.

► *See chapter IV.H.5 for the smelting process*

The process of removing gold with cyanide and the additional zinc dust, do following steps:

Collect black mud

Rinse it with water to remove cyanide

Add nitric acid to dissolve anything in the black mud except gold

Sieve with filter paper, drain the retained solids on the filter paper

The filter paper containing solid gold, put it on the meting crucible bowl and do using burner with LPG and Oxygen combination as fuel until the bullion remains

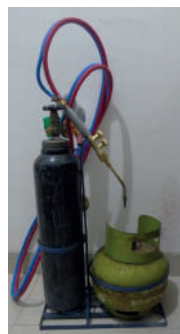
► *See chapter IV.H.5 for the smelting process*

H.5 The Smelting Process

The ash as the product of the activated carbon ashing process, the solid as the product of chemical separation processes, and gold concentrate as the product of other processes must be melted down to obtain bullion. This process can be conducted using a ready-made smelting furnace (Photo 4.24a) or the traditional one using LPG and oxygen combination as fuel (Photo 4.24b).



a



b

**Photo 4.24 Smelting Equipment a) Standard Melting Furnace (Tokopedia)
b) Traditional Melting Method**

The smelting process using burner with LPG and Oxygen combination as fuel as follows:

1. If the crucible bowl is being used for the first time, sprinkle the borax all over the surface and start melting the borax, shaking it slowly until spreads all the crucible bowl surface.
2. Add and mix the ash and gold concentrate with borax in a ratio of 1:1 (Photo 4.25a). Add charcoal (if needed) to raise the temperature and put it on the crucible bowl.
3. Add a little water to prevent ash flies when it is melted with a mixture of oxygen and LPG
4. Adjusting the fire until it reaches the optimum temperature by adjusting the composition of oxygen and LPG bullion add borax if needed (Photo 4.25b)
5. Do it slowly until all the mixture becomes a molten gold
6. At the same time, stirring it until the rounded molten gold and the rounded liquid (eyes) in the crucible bowl are collected. The eye indicates bullion (Photo 4.25d)
7. If there are still red spots, add borax while continuing to heat until the spots disappear, indicating that the process is complete

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8. Pour the slug into the liquid slowly while the fire keeps on burning to maintain the slug in a liquid condition (Photo 4.25b). Be careful to maintain the eye dissolves in the slug (Photo 4.25c)
9. After the eye is visible (Photo 4.25d) and the liquid has reduced, take the eye and put it in water. Cleaning after the temperature is cool. Bullion ready to be refined or sold

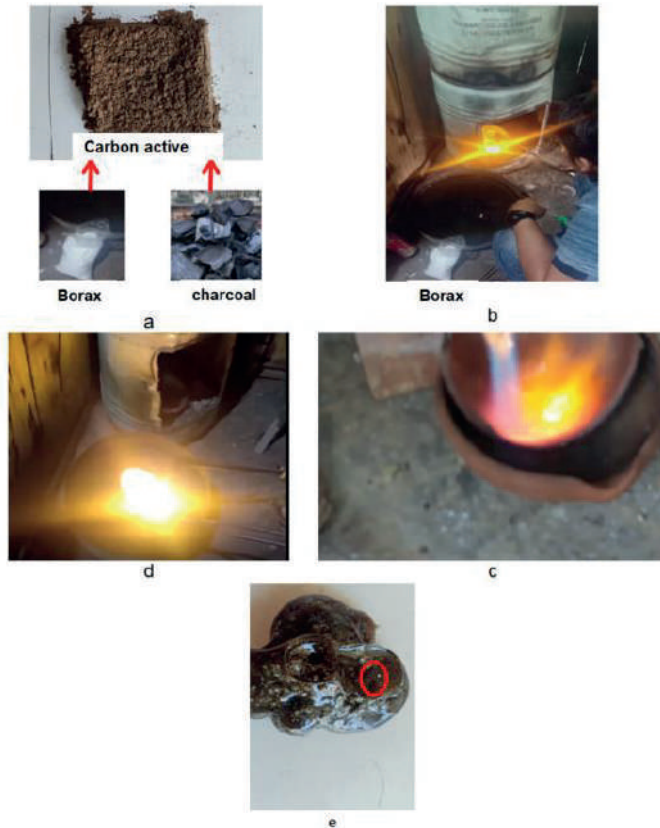


Photo 4.25 a) Concentrate Mixed with Borax and Charcoal b) Separation Between Slug with Bullion c) Dissolved Bullion in Slug d) Eyes Indicating Bullion e) Bullion in slug

- See Chapter IV.H.6 for the processing of bullion into local gold (cukim)
- See Chapter IV. H.7 for assay calculation

H.6 The Processing of Bullion into Local Gold (Cukim)

The processing of bullion into local gold using the cukim concept is suitable for low grades (less than 30% and the optimum grade is 5-10%). Environmentally cukim (Ciok Kim) design and equipments are shown in Figure 4.20.

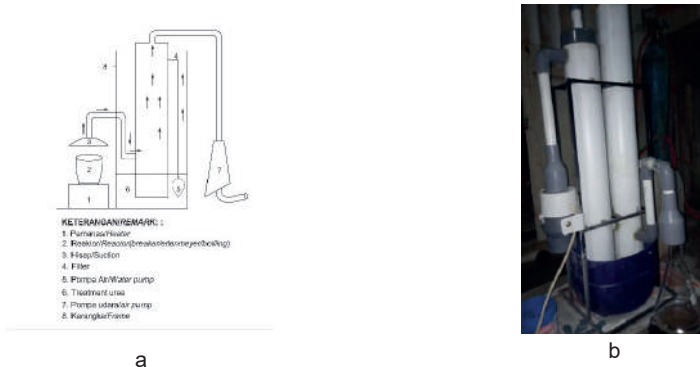


Figure 4.20 The Environmentally Cukim Equipment a) Design b) Equipment

The process as follows:

Maximum bullion grade is 25%, if bullion grade is high then mix with Ag/Au

If the equipment is number 4, then fill number 6 with water and urea in a ratio of 10 water: 1 urea

Use nitric acid (technically HNO_3) with a concentration of 68%

The bullion is crushed (cut into small pieces) so the contact is bigger

Insert the bullion into the reactor, soak it into the water and the water level is ± 1 cm below the surface

Add HNO_3 until it reacted (if the assay is less than 10% use the ratio of HNO_3 : H_2O = 1:10 and if the assay is 10-25% use the ratio of HNO_3 : H_2O = 1:1)

Put in the heating pot (1)

Turn on the water pump (5)

Turn on vacuum cleaner (7)

Wait the reaction until the brown/yellow smoke turns into white, which means the reaction is complete, then replace with concentrated HNO_3

Continue stirring until the reaction is stopped and forms a solid in the bottom like coffee

Rinse it until the water runs clear (collect the rinse water for the Ag removal process)

Boil it with pure H_2O , after boiling then leave it to cool. The filtration is performed by pouring it into filter paper. Collect the solid form on the filter paper. Gold in the

mud, brownish lumps. These lumps are ready to be melted down. The silver, lead and copper will dissolve. Collect the rinse water to obtain Ag.

► See chapter IV.H.5 for the smelting process

The solution that are passing through the filter paper contain AgNO_3 and other metals. Add industrial salt or 10% HCl slowly until a white precipitate on the bottom is no longer formed.

Filter the solution with filter paper and rinse it under running water. The filtered solution must be dried in the sun until the solid turns from white to black. Add caustic soda and a little water, then stir it well. Filter the solution with filter paper and rinse it with water.

Add black silver flour then the filter paper ready to be melted

► See chapter IV.H.5 for the smelting process

H.7 Assay Calculation

The price both of gold bullion and local gold (cukim gold) are determined based on the gold content in each weight. There are several methods to calculate gold content for buying and selling purposes. The methods that have been widely used by the community in small-scale primary gold mining:

1. Use sledge hammer to shape the gold bullion or cukim gold into solid and have similar thickness, length and width
2. Prepare a digital scale with 0.01 gram or 0.001 gram accuracy. The maximum capacity of a scale must be comply with gold sample purposes
3. Prepare a glass container and fill it with pure water, if necessary, measure the temperature and density of the water
4. Prepare a strong small string (thread) that does not absorb water
5. Turn on the scale and be sure to zero out the scale (0.00 gram position) (Photo 4.26a)
6. Weigh the gold (Photo 4.26b)
7. Place the container filled with water on the scale and set the scale to 0.00 grams (Photo 4.26 c)
8. Take the measurement of the hanging gold on a thread in a container filled with water on a scale (Photo 4.26d)

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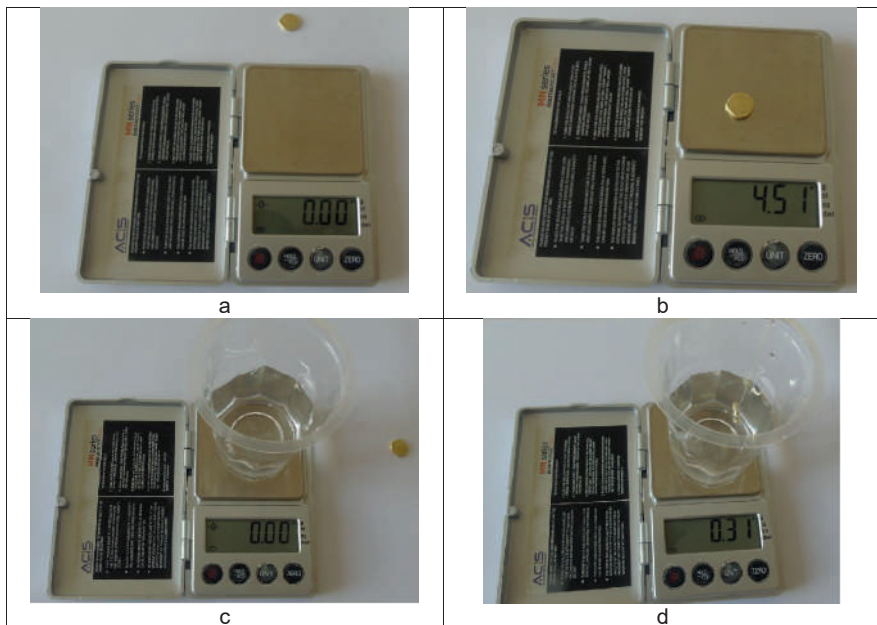


Photo 4.26 Weighing Method to Determine Assay

Calculate the ratio of the bullion weight to its weight in water (Table 4.7)

**Table 4.7
Assay Determination Method**

Tanggal/Date :
Pemilik/Owner :
Merek :
Timbangan/ :
Weighing Brand :
Satuan/Unit :

No	Berat Emas (A) Gold Weight (A)	Berat di air (B) Weight in Water	C=A/B
1	4.510	0.310	14.548

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Use the assay calculation table, usually in unwritten buying and selling Cu=0% and Ag=100% (rightmost column). The assay calculation method is shown in Figure 4.21.

Refer to the table : the gold weight (A) divided by the weight of gold hanging in water (B) is C of 14.55.

Point the C along the horizontal line to the rightmost column where Cu = 0% and Ag = 100% and the assay is 60.99%

S.G	Cu = 100	Cu = 90	Cu = 80	Cu = 70	Cu = 60	Cu = 50	Cu = 40	Cu = 30	Cu = 20	Cu = 10	Cu = 0
BJ	Ag = 0	Ag = 10	Ag = 20	Ag = 30	Ag = 40	Ag = 50	Ag = 60	Ag = 70	Ag = 80	Ag = 90	Ag = 100
14.65	72.76%	71.84%	70.89%	69.91%	68.90%	67.85%	66.77%	65.65%	64.50%	63.30%	62.05%
14.64	72.68%	71.76%	70.81%	69.82%	68.81%	67.76%	66.68%	65.58%	64.40%	63.19%	61.95%
14.63	72.61%	71.68%	70.72%	69.74%	68.72%	67.67%	66.58%	65.45%	64.30%	63.09%	61.84%
14.62	72.53%	71.60%	70.64%	69.65%	68.63%	67.58%	66.48%	65.36%	64.20%	62.99%	61.74%
14.61	72.45%	71.52%	70.56%	69.57%	68.53%	67.49%	66.40%	65.28%	64.10%	62.88%	61.63%
14.60	72.37%	71.44%	70.48%	69.48%	68.40%	67.40%	66.30%	65.17%	64.00%	62.78%	61.52%
14.59	72.30%	71.36%	70.40%	69.40%	68.37%	67.31%	66.21%	65.07%	63.89%	62.68%	61.42%
14.58	72.22%	71.28%	70.31%	69.31%	68.28%	67.22%	66.11%	64.97%	63.79%	62.57%	61.31%
14.57	72.14%	71.20%	70.23%	69.23%	68.19%	67.12%	66.02%	64.88%	63.69%	62.47%	61.20%
14.56	72.07%	71.12%	70.15%	69.14%	68.11%	67.03%	65.92%	64.78%	63.59%	62.37%	61.09%
14.55	71.99%	71.04%	70.07%	69.06%	68.02%	66.94%	65.83%	64.68%	63.49%	62.26%	60.99%
14.54	71.91%	70.96%	69.98%	68.97%	67.93%	66.85%	65.74%	64.58%	63.39%	62.16%	60.88%
14.53	71.83%	70.88%	69.90%	68.89%	67.84%	66.76%	65.64%	64.49%	63.29%	62.05%	60.77%
14.52	71.76%	70.80%	69.82%	68.80%	67.75%	66.67%	65.55%	64.39%	63.19%	61.95%	60.66%
14.51	71.69%	70.72%	69.73%	68.71%	67.66%	66.57%	65.45%	64.29%	63.09%	61.84%	60.55%
14.50	71.60%	70.64%	69.65%	68.63%	67.57%	66.48%	65.36%	64.19%	62.99%	61.74%	60.44%
14.49	71.52%	70.56%	69.57%	68.54%	67.48%	66.39%	65.25%	64.09%	62.88%	61.63%	60.33%
14.48	71.44%	70.48%	69.48%	68.46%	67.39%	66.30%	65.17%	63.99%	62.78%	61.53%	60.23%
14.47	71.37%	70.40%	69.40%	68.37%	67.30%	66.21%	65.07%	63.90%	62.68%	61.42%	60.12%
14.46	71.29%	70.32%	69.32%	68.28%	67.22%	66.11%	64.97%	63.80%	62.58%	61.32%	60.01%
14.45	71.21%	70.24%	69.23%	68.20%	67.13%	66.02%	64.88%	63.70%	62.48%	61.21%	59.90%
14.44	71.13%	70.15%	69.15%	68.11%	67.04%	65.93%	64.78%	63.60%	62.37%	61.10%	59.79%
14.43	71.05%	70.07%	69.06%	68.02%	66.98%	65.84%	64.69%	63.50%	62.27%	61.00%	59.68%
14.42	70.97%	69.99%	69.98%	67.98%	66.88%	65.74%	64.59%	63.40%	62.17%	60.89%	59.57%
14.41	70.89%	69.91%	69.89%	67.85%	66.77%	65.65%	64.49%	63.30%	62.06%	60.78%	59.46%
14.40	70.81%	69.83%	68.81%	67.76%	66.68%	65.56%	64.40%	63.20%	61.96%	60.68%	59.35%
14.39	70.74%	69.75%	68.73%	67.67%	66.59%	65.45%	64.30%	63.10%	61.86%	60.57%	59.24%
14.38	70.66%	69.66%	68.64%	67.58%	66.46%	65.37%	64.20%	63.00%	61.76%	60.47%	59.13%
14.37	70.59%	69.59%	68.56%	67.50%	66.40%	65.27%	64.11%	62.90%	61.66%	60.36%	59.02%
14.36	70.50%	69.50%	68.47%	67.41%	66.31%	65.18%	64.01%	62.80%	61.55%	60.25%	58.91%
14.35	70.42%	69.42%	68.39%	67.32%	66.22%	65.09%	63.91%	62.70%	61.44%	60.14%	58.80%

Figure 4.21 Assay Determination using Table Method

H.8. Gold Quality Checking

The gold quality can be determined quickly using several methods:

- One of the simplest method to determine the presence of gold by using touchstone and nitric acid solution
 - Prepare gold and acid test stones and materials to be tested (Photo 4.27a).
 - Scratch the material on the touchstone, see the mark color on the touchstone (Photo 4.27b).

- c. Rub it with nitric acid solution, if the color disappears that indicates it is not gold, if the color is not disappeared that indicates gold (Photo 4.27c)
- d. If the color gradually disappears, it means that the material has lower assay than the material with the slow-gradual color or unchanging color

*** Be careful when using acid because anything that comes into contact with acid, including our skin, will be destroyed**

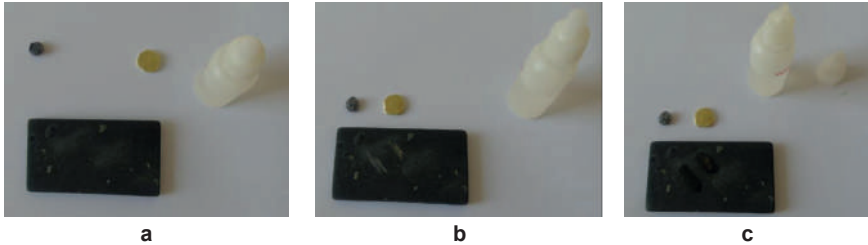


Photo 4.27 The Gold Qualitative Method

2. Another accurately method is by using gold small needle. Each small needle has a different assay for example 50,60,70,80 and 90%. If this equipment is not available, it can be made by taking a small amount of gold that the assay is known. Other equipment is a dark touchstone, flat, and has a slightly rough surface so when a sample of material is scratched, it will leave a mark.

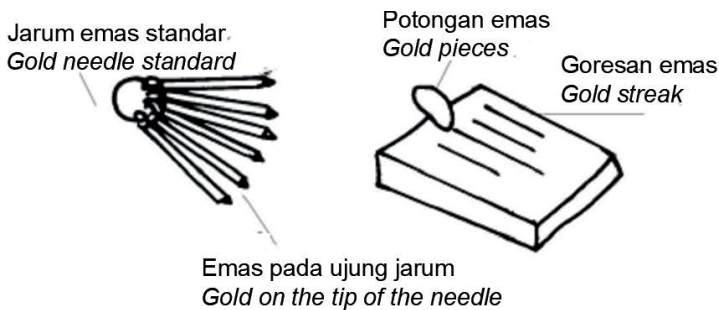


Figure 4.22 Touchstone and Standard Gold Needle for Gold Assay Test (Blower, 1988)

The procedure of touchstone method:

- a. Scratch gold needles on the touchstone
- b. Scratch sample gold on the touchstone
- c. The color that most closely to a standard gold needle indicates the assay of the sample gold

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- d. If the color of the sample gold shows the color between the standard gold needle color, then the assay lies between the standard gold needle
- e. If there is any doubt about the assay material result that has the same color, aqua regia can be used to obtain more accurate assay
- f. Place a drop of acid on the suspicious scratch, observe the scratch, the scratch color that earlier disappear shows lower assay than either the late one or the unchanged color scratch one

I. Bookkeeping

The average cost in small scale mining is very difficult to determine because the cost of exploration and mining costs in the small scale mining industry must include many variable and unexpected costs. However, small-scale primary gold miners must estimate the price and production.

The owners of small-scale primary gold mines have to lease or purchase land which is mostly paid by the owner's profit sharing minus the operational costs. The weaknesses of the community miners are the miners did not have any reserves information in their location and the miners did not have mine planning method because they conducted trial and error method in the initial excavation and they only followed the gold bearing vein which are found.

The small-scale gold miners should make a simple bookkeeping, for financial transparency reason, that records income and expenses, as well as their accountability. Table 4.8 shows an example of income and expenses records in a small-scale mining group.

Table 4.8 Simple Bookkeeping

Lokasi/Location :
Pemilik/Owner :

No	Tanggal/Date	Keterangan/Remark	Pemasukan/Debet	Pengeluaran/Credit	Saldo	Tanda bukti/Evidence
1	3	Kabel+instalasi set		930,000	2,409,500	Nota 10
		Cable+instalation				Note 10
		Head lamp		106,000	2,303,500	Toko kuitansi/Receipt
2	4	Kable PLN		1,320,000	983,500	Nota 11
		PLN Cable				Note 11
		Jasa Instalasi		250,000	733,500	marsono
		Installation cost				
3	5	Papan paku		192,000	541,500	nota 12
		Nail Board				Note 12
4	6	Dari Pak		4,000,000	4,541,500	
		From Mr. x				
5	7	Bambu 4 ikat		200,000	4,341,500	
		Bambo 4 ties				

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The gold miners and people who work in gold processing only get profit sharing, most of them did not get the fixed salary. The financial transaction (buying/expenses and selling/income record) of gold/bullion is very important aspect due to the profit sharing system. The profit sharing is obtained from the income (selling) minus expenses (buying) then divided by the community agreement sharing. The land owner and capital owner get higher profit sharing than the mining workers. The additional profit sharing will be given to the land owner and capital owners if they work in gold mine. According to The Law of Republic Indonesia Number 3 of 2020 Concerning Mineral and Coal Mining, the mining workers must set aside income to pay the production royalties, reclamation and post mining expenses.

V. RECLAMATION AND POST-MINING

According to the Mineral and Coal Mining Law No. 3/2020, reclamation is an activity that applies to all stages of mining, with the aim of managing, restoring, and improving the quality of the environment and ecosystem so that it can function again according to its designation. Post-mining activities, hereinafter referred to as post-mining, are planned, systematic, and continuing activities after part or all of the mining business activities to restore the natural environment and social functions according to local conditions throughout the mining area. Reclamation efforts require planning, management, implementation, maintenance and monitoring, all supported by an adequate budget as defined in the proposed reclamation and mine closure planning document. Where according to Article 73 paragraph 2 the Minister is responsible for the implementation of technical rules in the IPR for environmental management including reclamation and post-mining.

A. Reclamation

Ideally, reclamation in ex-mining and processing zones should be carried out in stages following mining activities and ongoing processes. Considering the maximum of IPR area for individuals is only 5 Ha and cooperatives is 10 Ha and the nature of gold distribution in primary deposits which mostly in form of veins where there is one dimension that is much longer than other dimensions, then the reclamation locations are mostly around the openings.

Because almost all of the primary gold mining activities are carried out by underground mining, erosion generally occurs in the waste dump areas where the waste rock has no economic value to be mined. Waste rock is dumped around the entrance of the tunnel or shaft. The discarded rock is generally poor in nutrients, forming slopes with a slope angle equal to the natural angle of the waste rock so that it is prone to landslides and erosion because there are no plants at the disposal site.

Erosion control is important, both during mining and post-mining. Erosion effects may require repair work on site by means of reclamation. Inadequate erosion control can lead to decreased water quality downstream. The main objective of the programmed, is to establish adequate vegetation cover to stabilize the waste dump area and prevent or control erosion to natural levels.

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Ex-mining land should be planted with local annual plants such as cloves, cocoa, cashew, lemongrass, coconut, teak so that the yields can be used every year and local perennials such as mahogany, jackfruit, kemuning, etc.

Prior of planting activities, then do below:

Ensure embankment slopes do not slide

If the pile is rock make a pot add topsoil from the surroundings (Figure 5.1)

Make planting holes

Distance between planting holes is 2 x 3 m

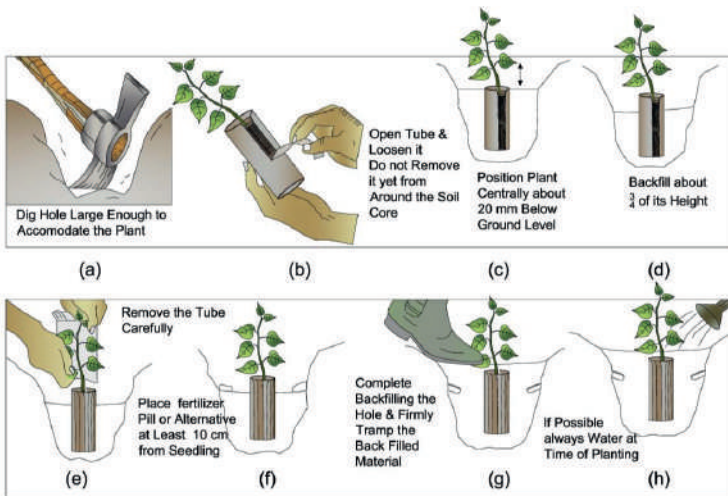
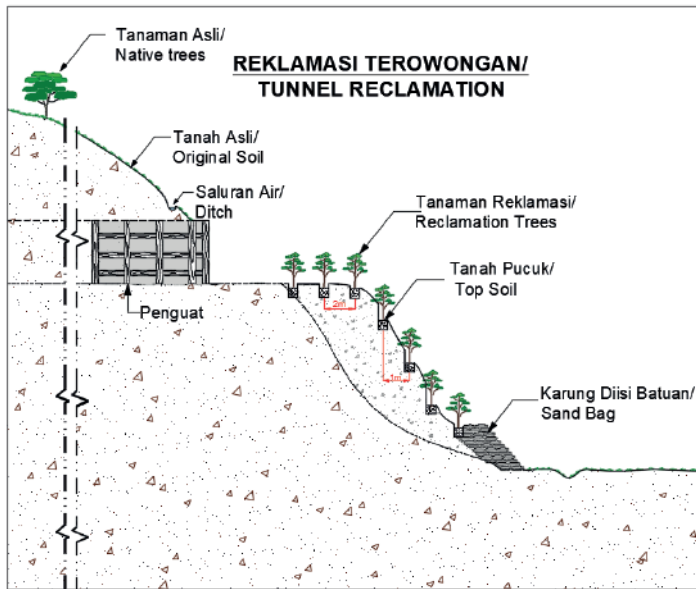


Figure 5.1 Plant Trees Technique (Mine Rehabilitation Handbook, 1988)

The reclamation process is distinguished by the waste dump from tunnels and the waste dump from shaft.

1. The reclamation method for the area around the tunnel is as follows (Figure 5.2):
 - a. In areas that have not disturbed, make holes with a flat distance of 1 m with a size of 30 x 30 x 30 cm
 - b. If possible set the angle with the ratio between horizontal to vertical 2:1
 - c. Fill the plant holes with topsoil (see procedure in Figure 5.1)



Design



Before reclamation



After reclamation

Figure 5.2 Illustration of Reclamation Around the Tunnel

2. Reclamation for area around vertical shaft, as follows:

- Set the embankment to a maximum height of 1.5 m
- Try to make an angle with a horizontal and vertical ratio 1:2
- Make a width slope 1 m wide before piling with waste rock
- At an undisturbed area, make planting holes with a size of 30 x 30 x 30 cm. The distance between the holes on the width slope is 2 m while on the pile of non-slope mining waste the distance between the plants is 2 x 3 m. Procedure for making holes and filling them see Figure 5.1

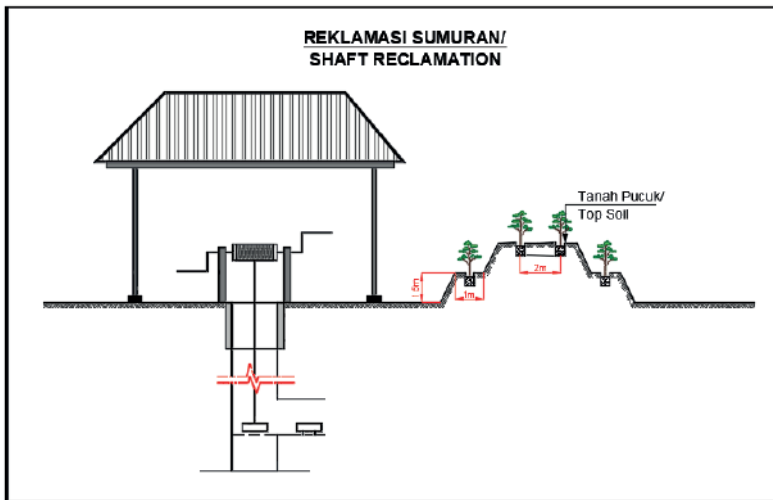


Figure 5.3 Illustration of Reclamation Around Shaft

B. Post-Mining

Post-mining activities are activities that are planned, systematic, and sustainable after the end of part or all of the mining business activities to restore the functions of the natural environment and social functions according to local conditions throughout the mining area. Planning and implementation of sustainable and environmentally sound of post-mining will accelerate environmental recovery according to its designation, and prevent damage to the social functions of communities around abandoned mining areas (Photo 5.1).



a



b

Photo 5.1 Post Mining Impacts a) Tunnel Construction b) Shaft Construction

When mining activities are end, two important things should ideally remain, those are a safe environment and conducive social conditions. Small-scale primary gold mining activities with open pit mines will change the landscape, such as changes in slope, hydrological patterns, loss of some topsoil, decreased soil fertility, and loss of vegetation. Therefore, a post-mining program is required so that abandoned mining land can be reused according to its designation in the future.

According to Government Regulation No. 78 of 2010 concerning Reclamation and Post-mining, Article 44 letter i District/city governments before issuing IPR in small-scale mining areas, are obliged to prepare reclamation and post-mining plans for each small-scale mining area, and Decree of the Minister of State for Energy and Mineral Resources Number 1827 K/30/MEM/2018 concerning Guidelines for the Implementation of Good Mining Rules and Mining Law No. 3 of 2020 article 70 letters b and c, namely b) comply with laws and regulations in the field of mining safety, environmental management, and comply with applicable standards and c) manage the environment with the Minister.

The substance of this document is to provide information on a sustainable post-mining management system. Thus, in the post-mining period, a chain of regional development activities and community development that is sustainable and environmentally sound will sustain. Post-mining activities for small-scale primary gold mining are carried out mainly by securing ex-mining holes so as not to endanger people, animals, or the environment. For that must be carried out:

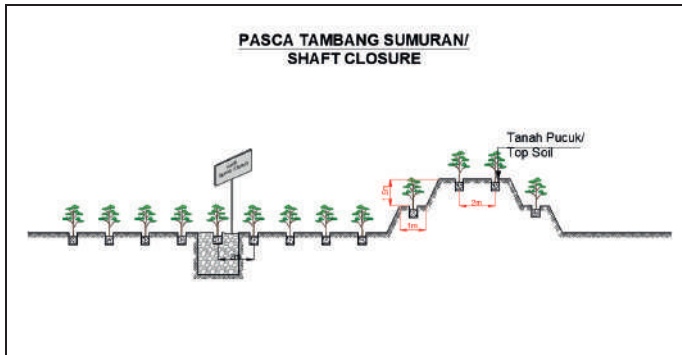
1. Completion of reclamation at the time the mine will be closed

2. Fill up the mine area (tunnel or shaft) as much as possible (Figures 5.4 and 5.5)
3. Provide a sign indicating the area is a former mine
4. If in the future it will be used again or used for other purposes (as access to water sources in the shaft and others) the tunnel opening is given a strong door and locked (Photo 5.2)
5. Planting annual trees around openings with high density so that it functions as a natural barrier
6. Fertilizing and maintaining plants so that plants thrive on land that initially contains limited nutrients.
7. Clean the mine site from building materials and mining equipment when not in use anymore.
8. Planting the former tailings area with hard trees from local species that are easy to grow



Figure 5.4 Post-Mining Illustration Around the Tunnel

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Design



Initial conditions



Illustration after post-mining

Figure 5.5 Post-Mining Illustration Around the Shaft



a



b

Photo 5.2 Example of Non-Permanent Closing of Tunnels a) Rigid b) Not Permanent

C. Alternative Use of Former Mines Area

C.1. Water Resources

Under certain conditions, if the tunnels and shafts produce a lot of water with quality that can be used for daily needs as well as for fisheries (Photo 5.3) and agriculture, it should not be permanently closed, but simply given a door so that water can be utilized by gravity or pumping. What needs attention if you are going to use the water, it must be checked for quality standards so that it is feasible according to its designation.



Photo 5.3 Water Utilization from Small-Scale Primary Gold Mine Shaft for Fishery

Based on Government Regulation no. 22/2021 Appendix VI, river water quality standards and divided into 4 classes:

Class I, water whose designation can be used for raw drinking water, and or other designations that require the same water quality as that use;

Class II, water whose designation can be used for water recreation infrastructure/facilities, freshwater fish farming, animal husbandry, irrigating crops, and or other designations that require the same water quality as those uses.;

Class III, water whose designation can be used for freshwater fish cultivation, animal husbandry, irrigating crops, and or other designations that require the same water quality as those uses;

Class IV, water whose designation can be used to irrigate crops and or other uses that require the same water quality as that use.

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Table 5.1: Surface Water Quality Standards based on Government Regulation No.22/2021

Parameters	Units	Classes			
		I	II	III	IV
Temperature	°C	Deviation 3	Deviation 3	Deviation 3	Deviation 5
TDS(<i>total dissolved solids</i>)	mg/L	1,000	1,000	1,000	2,000
TSS (<i>total suspended solids</i>)	mg/L	40	50	100	400
Colour	PT-CoUNIT	15	50	100	-
pH		6-9	6-9	6-9	6-9
BOD	mg/L	2	3	6	12
COD	mg/L	10	25	40	80
DO	mg/L	6	4	3	1
Sulfate (SO ₄ ²⁻)	mg/L	300	300	300	400
Chloride	mg/L	300	300	300	600
N-NO ₃	mg/L	10	10	20	20
Nitrite	mg/L	0.06	0.06	0.06	(-)
Ammonia	mg/L	0.1	0.2	0.5	(-)
Total Nitrogen	mg/L	15	15	25	(-)
Total Phosphate (P)	mg/L	0.2	0.2	1.0	(-)
Fluoride	mg/L	0.5	1.5	1.5	(-)
Sulfur	mg/L	0.002	0.002	0.002	(-)
Cyanide	mg/L	0.02	0.02	0.02	(-)
Free chlorine	mg/L	0.03	0.03	0.03	(-)
Barium	mg/L	1	(-)	(-)	(-)
Boron	mg/L	1	1	1	1
Mercury	mg/L	0.001	0.002	0.002	0.005
Arsenic	mg/L	0.05	0.05	0.05	0.1
Selenium	mg/L	0.01	0.05	0.05	0.05
Iron	mg/L	0.3	(-)	(-)	(-)
Cadmium	mg/L	0.01	0.01	0.01	0.01
Cobalt	mg/L	0.2	0.2	0.2	0.2
Mangan	mg/L	0.1	(-)	(-)	(-)
Dissolved nickel (Ni)	mg/L	0.05	0.05	0.05	1
Dissolved Zinc (Zn)	mg/L	0.05	0.05	0.05	2
Dissolved Copper (Cu)	mg/L	0.02	0.02	0.02	0.2
Dissolved Lead (Pb)	mg/L	0.03	0.03	0.03	1
Chromium (VI)	mg/L	0.05	0.05	0.05	1
Oil and fat	mg/L	1	1	1	10
Total detergent	mg/L	0.2	0.2	0.2	(-)
Phenol	mg/L	0.002	0.005	0.01	0.02
Aldrin/Dieldrin	µg/L	17	(-)	(-)	(-)
BHC	µg/L	210	210	210	(-)
Chlordane	µg/L	3	(-)	(-)	(-)
DDT	µg/L	2	2	2	2
Endrin	µg/L	1	4	4	(-)
Heptachlor	µg/L	18	(-)	(-)	(-)
Lindane	µg/L	56	(-)	(-)	(-)
Methoxychlor	µg/L	35	(-)	(-)	(-)
Toxaphene	µg/L	5	(-)	(-)	(-)
Fecal Coliform	MPN/100L	100	1,000	2,000	2,000
Total Coliform	MPN/100L	1,000	5,000	10,000	10,000
Waste		nil	nil	nil	nil
Radioactivity Gross-A	Bq/L	0.1	0.1	0.1	0.1
Radioactivity Gross-B	Bq/L	1	1	1	1

Based on Government Regulation No. 22/2021, water used for the purpose of cultivating freshwater fish, animal husbandry and irrigating crops is included in Class III. The water quality parameters of this class that are easiest to check in the field are acidity (pH); The pH value of water is usually measured using pH paper. The standard criteria for water pH quality for freshwater fisheries and irrigation are 6-9. How to measure the pH of water: a) take a strip of pH paper, b) dip it into a water sample, c) then compare the color change of the pH paper strip with the reference color on the most appropriate pH paper packaging that shows the pH value of the water measured or measured directly with a pH meter (Photo 5.4).

In addition to pH, water quality can also be indicated by its color and turbidity. Clear, turquoise-blue water usually indicates a high level of acidity or has a low pH. Acidic water like this cannot be used for irrigation purposes.



Photo. 5.4 pH Measurement with pH Paper and pH Meter

C.2. Mining Education and Tourism

In tunnels made through hard rock and without artificial supports, the site of the former mining tunnel can be used for education or tourism. Before turning the location of the former tunnel into a place for education or tourism, make sure the tunnel is safe and there are no falling rocks. When entering the tunnel it must be ensured to wear a safety hat and head lamp if there is no permanent lighting in tunnel (Photo 5.5).



Photo 5.5 Locations of Former Small-Scale Primary Gold Mines Used for Education

VI. SUGGESTIONS AND FEEDBACK

One of the main barriers to the development of a good small-scale primary gold mining sector is access to finance. Financial entities including banks, microfinance institutions, and other lenders are unwilling to provide loans/credits/financing to the small-scale primary gold mining sector because the risks are often deemed too high. Another reason is that lenders do not have the expertise and experience to review small-scale primary gold mining loan applications or develop financial products tailored to the small-scale primary gold mining sector. On the other hand, cooperative and organizational miners do not have much experience in recording and reporting or preparing loan applications that could increase their access to conventional financing and other options.

To overcome the challenges above, in accordance with the mandate of the Minister of Energy and Mineral Resources Number 7 of 2020 article 74 (IUPK OP for transportation and sales) and the Minister of Energy and Mineral Resources Number 26 of 2018 article 58, IUJP and IUP OP owners can help through:

1. Establish partnerships with financial entities/banks to build their capacity and understanding to develop financial products that will adapt to the small-scale primary gold mining sector and better assess loan applications from IPR holders,
2. Work with IPR owners, both individuals and cooperatives, to build their capacity to develop loan/investment applications for mining equipment/investments (mercury-free mining and processing) and then apply for loans or investments.

A. Preparation for Industry Engagement

Convincing financial entities by the mining industry that small-scale primary gold mining has good prospects so as to increase the small-scale primary gold mining community's access to financing to enable the procurement of efficient mining and processing technology to increase added value. Improving the economy of people who have mining potential through IPR owners by providing:

- a. Technical support
- b. Technology transfer
- c. Formation of private partnership
- d. Access to financing facilities for the purchase of safe and mercury-free mining and processing equipment

For this reason, all financial sectors should support the establishment of long-term financial loan arrangements to provide affordable and accessible loans to smallholder miners/mining cooperatives holding IPRs to purchase more efficient mining and processing equipment.

B. Rewards for Industries Assisting Small-Scale Primary Gold Mining with IPR

In order to attract the mining industry to help small-scale gold mining that has an IPR, several alternatives can be done, including:

1. Can accommodate the production of gold and stone containing gold/ore from primary gold mining locations that have an IPR that has been assisted both in technical and capital terms by the IUP holder. Special production operations for transportation and sales
2. CSR allocation funds can be used to assist IPR in the field of environmental improvement because it is in accordance with the breath of CSR, one of which is in the environmental field.

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A. Abbreviations and Glossary

A.1. Abbreviations

Term	Definition
AMDAL	Environmental Impact Assessment (Analisis Mengenai Dampak Lingkungan)
APL	Area for other usage (Area Penggunaan Lain)
BKPM	Capital Investment Coordinating Board Badan Koordinasi Penanaman Modal
Bappelitbangda	Regional Development Planning, Research and Development Agency (Badan Perencanaan Pembangunan, Penelitian dan Pengembangan Daerah)
CSR	Corporate Social Responsibility (Adalah bentuk tanggung jawab sosial perusahaan kepada masyarakat dan lingkungan sekitar)
BUMDES	Village-owned enterprise (Badan Usaha Milik Desa)
ESDM	Ministry of Energy and Mineral Resources (Kementerian Energi dan Sumber Daya Mineral)
GPS	Global Positioning System
GOLD-ISMIA	Global Opportunities for Long-Term Development – Integrated Sound Management of Mercury in Indonesia's Artisanal and Small-Scale Gold Mining
HP	Hand Phone
IPR	Artisanal Mining Permit (Izin Pertambangan Rakyat)
IT	Mine Inspector (Inspektur Tambang)
IUJP	Mining Services Business Permit Izin Usaha Jasa Pertambangan
IUP	Mining permit (Izin Usaha Pertambangan)
IUPK	Special Mining Permit (Izin Usaha Pertambangan Khusus)
K3	Occupational Health and Safety (Keselamatan dan Kesehatan Kerja)
KTBT	Chief of Underground Mine (Kepala Tambang Bawah Tanah)
KTT	Head of technical Mine (Kepala Teknik Tambang)
KTP	ID card (Kartu Tanda Penduduk)
LGVA	Low Grant Value Agreement
LPG	Liquid Petroleum Gas
NIB	Business Registration Number (Nomor Induk Berusaha)
NPWP	Tax File Number (Nomer Pendaftaran Wajib Pajak)
PESK	Small Scale Mine (Pertambangan Emas Skala Kecil)

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PLN	State Electricity Company (Perusahaan Listrik Negara)
PJO	Operational Responsible (Penanggung Jawab Operasional)
PNBP	Non-tax revenue (Penerimaan Negara Bukan Pajak)
PTL	Responsible for Engineering and Environment (Penanggung Jawab Teknik dan Lingkungan)
RKAB	Rencana Kerja Anggaran dan Biaya
RKL	Environmental Management Plan (Rencana Pengelolaan Lingkungan)
RPL	Environmental Monitoring Plan (Rencana Pemantauan Lingkungan)
RTRW	Spatial Plan (Rencana Tata Ruang dan Wilayah)
SDA	Natural Resources (Sumber Daya Alam)
UKL	Environmental Management Efforts (Upaya Pengelolaan Lingkungan)
UPL	Environmental Monitoring Efforts (Upaya Pemantauan Lingkungan)
UTM	Universal Transverse Mercator (merupakan Metode grid berbasis menentukan lokasi di permukaan bumi yang merupakan aplikasi praktis dari 2 dimensi)
SOP	Standard Operational Procedures (Prosedur Operasi Baku)
SNI	National Standard of Indonesia (Standard Nasional Indonesia)
UNDP	United National Development Program
UU	Laws (Undang-Undang)
WGS 84	World Geodetic System yang merupakan koordinat sistem referensi yang digunakan oleh Global Positioning System.
WIUP	Mining Business Permit Area (Wilayah Izin Usaha Pertambangan)

A.2. Glossary

Term	Definition
Alluvial gold	Deposits form over time where a river runs, or has previously run through ground which is rich in gold.
Datum	Reference
Foot wall	The lower underlying wall of a vein, ore deposit,
Hanging wall	The upper or overhanging wall of an inclined vein, fault, or other geologic structure
Hard crop	Is a perennial plant that has woody stems with a hard texture (hard tree species), has a useful life of up to 20 years or more
Ore	Gold deposits formed by ordinary sedimentary processes that deposit or concentrate heavy minerals
pH	A logarithmic scale from 0-14 that explains the degree of acidity or alkalinity of

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	the water or soil; neutral water has a pH of 7.
Portal	Access to tunnel
Primary gold	Gold formed at the same time as the rock formation process
Pump head	The maximum height that the pump can achieve pumping against gravity
Seedling	A plant that has recently germinated and expanded its seed leaves
Top soil	The uppermost layer of unconsolidated material on the Earth's surface. In this case, this refers to actual soil (with organic material) rather than sterile media such as sand tailings without any plant growth.
Tailings	Mined material rejected after processing when gold concentrate has been extracted; depending on the recovery rate of the processing techniques, the tailings may still contain residual gold ore at low grades.
Wall rock	Rocks devoid of valuable (low grade) minerals surrounding the ore body
Yearly crop	It is a plant that lives all year round, so it can be harvested all year round

APPENDIX I

GOLD-ISMIA ACTIVITIES IN SMALL-SCALE PRIMARY GOLD MINING SECTOR

I.1. Awareness Raising Campaign on the Hazards of Mercury and How to Reduce Its Use in the Small Scale Mine Sector

Stakeholders

The project is managed by the Ministry of Environment and Forestry, BPPT, gef, planetGOLD Indonesia, UNDP

Contact: Ms. Baiq Dewi Krisnayanti (Coordinator of Gold-ISMIA/baiq.krisnayanti@undp.org), Mr. B. Sulistijo (Artisanal Gold Mine Specialist, bsulistijo@yahoo.com)

Key Features

Implementation period: 2019-2020

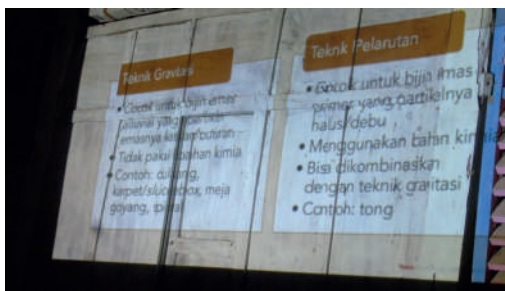
Location: Kalirejo and Hargorejo Village, Kulon Progo District, Special Region of Yogyakarta

Activities:

- Explanation of the mercury hazard program using videos, posters and brochures.
- In-depth discussion on community awareness and mercury use
- Field visit



a



b

a) Socialization atmosphere in Sengon 2 Village and b) Materials and Implementation of Socialization

I.2. LGVA Grants from UNDP and GOLD-ISMIA

Stakeholders

The project is managed by the Ministry of Environment and Forestry, BPPT, gef, planetGOLD Indonesia, UNDP

Contact: Ms Baiq Dewi Krisnayanti (Gold-ISMIA

Coordinator/baiq.krisnayanti@undp.org), Ms, Ria Camelia (Field Assistant Gold ISMIA), Mr Tukiman (Head of miner group of Plampang III)

Key features

Implementation Period: 2019-2022

Location: Plampang III and Kalirejo Village, Kapanewon Kokap, Kulon Progo District, Special Region of Yogyakarta

Activities: Provide guidance to Precious Metal Mineral Producers Cooperatives with No. AHU-001235.AH.01.26. year 2019 in order to maintain gold processing without using mercury but with a pyro metallurgical system



a



b



c



d

a) Metal Mineral Producers Cooperative Started as a Cooperative Assisted by the Gold-ISMIA Project b) Planned Processing Site c) Location of IPR No 545/04630/PZ/2020 Place for Collecting Gold Veins d) Piles of Gold Veins Left Lying

I.3. Mercury Free Gold Processing Pilot Project and Waste Management for Small-Scale Gold Mining in Kulonprogo

Stakeholders

This project is managed by BPPT, Ministry of Environment and Forestry, Gold-Ismia project UNDP
Contact: Mr. Haswi P. Soewoto and Mr. Ridha Cindra

Key factures

Built with APBN funds by BPPT

Implementation period: 2018-2019

Location: Sengon 1, Desa Kalirejo Village, Kulon Progo District, Special Region of Yogyakarta

Activities: as gold mining development research and training for small-scale miners / gold mining



a



a



c

a) Mercury Free Treatment Building Facilities managed by BPPT b) 2 Units of Jaw Crusher Equipment and c) Waste Collection and Treatment (Photo c: Mr. Haswi)

APPENDIX II

Decree of the Minister of Energy and Mineral Resources No. 1827 K/30/MEM/2018, 7 May 2018

Issuance of Endorsement

- a. KalT/Head of Service on behalf of KalT issues a letter
- b. Ratification of the KTT
- c. The applicant receives the KTT ratification letter

Administrative Requirements for Application for KTT Ratification consists of:

- a. Company application letter
- b. A copy of the mining business permit
- c. A stamped statement letter signed by the Company's Supreme Leader, stating that he supports all activities programs of the KTT candidates
- d. Curriculum vitae of KTT candidates
- e. Mandatory competency certificate for KTT candidates who have been registered at the Directorate General of Mineral and Coal or a qualification certificate recognized by KalT
- f. Company organizational structure describing the position of the Candidate for the KTT signed by the company leader and given the company's wet stamp
- g. A copy of the ratification of the KTT candidates if they have previously been ratified as KTT
- h. A stamped statement letter regarding the validity of the document signed by the applicant; and
- i. Softcopy of documents as referred to in letter a to letter h

The duties and responsibilities of KTT consist of:

- a. Make the company's internal regulations regarding the application of good mining engineering principles
- b. Appoint operational supervisors and technical supervisors
- c. Ensure that all mining service companies operating under it fulfill their obligations in accordance with statutory provisions
- d. Apply standards in accordance with statutory provisions; submit a report on mining services activities to the KalT in accordance with statutory provisions
- e. Have competent mining technical personnel in accordance with statutory provisions

- f. Carry out risk management in every business process and sub-process of mining activities
- g. Implementing a mining safety management system and supervising the implementation of a mining safety management system implemented by mining service companies working in their areas of responsibility
- h. Report on the application of good mining engineering principles to the Head Office, either periodic, final, and/or special reports in accordance with the provisions of the legislation
- i. Report the implementation of environmental management and monitoring activities periodically in accordance with the established form
- j. Report the number of procurement, use, storage, and inventory of hazardous and toxic materials and waste periodically every 6 (six) months
- k. Report any symptoms that have the potential to cause environmental pollution and/or damage.
- l. Submit environmental case reports no later than 1 x 24 (one time twenty-four) hours after the occurrence of environmental cases along with efforts to overcome them
- m. Deliver early notification and report accidents, dangerous events, occurrences due to labor diseases, and occupational diseases
- n. Submit an internal audit report on the implementation of the mineral and coal mining safety management system
- o. Stipulate standard procedures for overcoming environmental pollution and/or damage in places that have the potential to cause environmental damage and pollution
- p. Establish standard procedures for the application of good mining engineering principles; carry out conservation of mineral and coal resources; and
- q. The Summit stipulates standard procedures for technical management of mineral and coal mining activities

KTTC Class IV

The Class IV Full fill the following criteria:

- a. For holders of People's Mining Permits (IPR); and
- b. Have a qualification certificate recognized by KalT or have attended education or technical guidance related to the application of good mining engineering principles

APPENDIX III

Decree of the Director General of Mineral and Coal of the Ministry of Energy and Mineral Resources No. 185.K/37.04/DJB/2019 concerning Technical Guidelines for the Implementation of the Assessment and Reporting of the Mineral and Coal Mining Safety Management System.

A. General requirements

Holders of IUP, IUPK, Production Operation IUP specifically for Processing and/or Purification, and IPR need to provide all equipment, supplies, facilities, and personal protective equipment that are given free of charge to Workers in accordance with the type, nature and danger of the work they are doing, and for everyone who enters a mining or processing and/or refining business place.

e. Mining Safety Administration

1) Mining Book

The Mining book includes:

- a) IT prohibitions, orders, instructions to be followed up by KTT and
- b) information, follow-up, and notification from KTT on Mining business activities.

The form and procedure for filling out the mining book refers to Indonesian national standards.

KTT and PTL implement, record, and report on the implementation of prohibitions, orders, and instructions in the mining book, and its contents can be read and studied by Workers.

2) Book of Mining Accident Register:

Holders of IUP, IUPK, Production Operation IUP specifically for Processing and/or Purification, and IPR must have a Mining Accident register book in accordance with the size and shape applied by the Head of Office.

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The Mining Accident book contains notes on Mining Accidents resulting in minor, serious, or death injuries which are filled out by KTT and verified by IT.

KTT evaluates the recording of the accident register, at least including: the tendency or pattern of accidents as material for the preparation of accident prevention programs.

- 3) Documentation of Hazardous Events, Occurrences Due to Labor Diseases, and Occupational Diseases.

Hazardous Events Recapitulation

Number of Dangerous Events	Time, Day, Date	Location	Dangerous Events Chronology	Consequences of Dangerous Events	Reported to KalT/Kadis on behalf of KalT	Notes

Recapitulation of Occurrence Due to Labor Disease

Number of Occurrence Due to Labor Disease	Time, Day, Date	Location	Department, Position, Length of Work	Chronology of Occurrence Due to Labor Disease	Effects of Occurrence Due to Labor Disease	Reported to KalT/Kadis on behalf of KalT	Notes

Recapitulation of Labor Diseases

Sequence number of occupational diseases	Time, Day, Date	Location	Department, Position, Length of Work	Company Doctor's Diagnostic Results	Occupational Disease Cases	Reported to KalT/Kadis on behalf of KalT	Notes

The K3 box must contain:

No	Contents (Unit)	Group of Labor		
		Type A (less than or equal to 25 Workers)	Type B (26 to 50 workers)	Type C (51 to 100 workers)
1	Wrapped sterile gauze (wrap)	20	40	40
2	Bandage (5 cm wide) (rolls)	2	4	6
3	Bandage (10 cm wide) (rolls)	2	4	6
4	Bandage (wide) (rolls)	2	4	6
5	Quick pads	10	15	20
6	Cotton (25 gram)	1	2	3
7	Triangle/Mittela Fabric (Sheets)	2	4	6
8	Scissors (units)	1	1	1
9	Pin (units)	12	12	12
10	Disposable gloves (pairs)	2	3	4
11	Mask (units)	1	1	1
12	Masks for cardiopulmonary resuscitation (units)	1	1	1
13	Clean plastic bag (units)	1	1	1
14	Aquades (100 ml of Saline Solution)	1	1	1
15	First aid guide at work	1	1	1
16	Table of contents notebook	1	1	1

B. Obligation

The work safety obligations that must be carried out in people's mining areas in accordance with the Kepdirjen Minerba No.185.K/37.04/DJB/2019 are as follows:

B.1. KTT as the highest organization must

1. Stipulate internal regulations related to mining operations
2. Conduct the hazard and risk management system in workplace
3. Conduct the health and skill of workers management
4. Responsible for appropriate equipment
5. Record and report of mining safety management

6. Supervise mining activities, supported by operational supervisor and technical supervisor
7. If there are more than one underground mining pits and large areas of the underground mining activity, then the person in charge of the area may be appointed. The underground mine map must show the boundaries of the area and shall be kept in the mine office.
8. Appoint supervisor and convey in writing to the appointed supervisor about the duties and responsibilities based on region and time. The supervisor's name is recorded in the mining book.
9. Ensure a good record of the number of people entering in underground mining each shift
10. Ensure the supply and distribution of goods to support underground mining activities so the work runs safely and smoothly
11. Inspect all administration and underground mines at least once in 3 months
12. Provide evacuation procedures using one way out in case other exit route cannot accessible.
13. Provide additional equipment and supporting tools if the equipment that normally used is either broken or jammed.
14. Practice adequate and effective simulation how to use the equipment and ensure that these guidelines are known and followed to by all underground mining workers. The guidelines copy must available at the mine office. The simulation must be carried out at least 1 (one) time a year.

B.2. Performing underground mine inspections as follows:

1. Conduct inspections of equipment, tools, machinery, electricity and activities in underground mining in accordance with the supervisor duties.
2. Supervisor of each shift at least must carry out:
 - a. inspect every workplace where any activities are carried out, the workers routes
 - b. check the access and the ladder that will be used by the worker. The operational supervisor is allowed to fix any deviations.

B.3. Provide awareness that the duties and obligations of underground miners at least include:

- a. Underground mining workers do not prohibited to carry out any activities in underground mines when either KTT (head of mine) or the represented person are not in the mining area
- b. Cooperate and obey the instructions which is given by the supervisor or person in charge of an activity

- c. Cooperate and obey the instructions given by the supervisor or person in charge of an activity; do not carry out any activities that will cause other people will unable to work
- d. Do not move or destroy the security fences, enclosures, barriers, warning signs or other infrastructures that are installed for safety purposes
- e. Ensure walking to workplaces, vice versa, through designated road
- f. Do not sleep in the underground mine; and
- g. Do not force the locked door open and enter the engine room or control room without the authorization from the supervisor

B.4. Providing a tunnel inspection record with the following provisions:

- a. The head of mine (KTT) provides an inspection book for each tunnel, shaft, and sloping road which contains the inspection records. The inspection book must be signed by the person who maintains the tunnel.
- b. The inspection results of each tunnel are reported and signed by the supervisor who is responsible for maintaining the tunnel at least once a week.
- c. The inspection results of the dangerous conditions and the condition that have been repaired are recorded and signed by the supervisor who is responsible for maintaining the tunnel.
- d. The inspection book of tunnel, shaft, and sloping road are always available. The supervisor name who conducting the inspection must be registered in the mining book.

APPENDIX IV

PERMITTING THE ARTISANAL MINE PERMIT

<https://www.minerba.esdm.go.id>

Application for the Artisanal Mine Permit (IPR)

- a) IPR Requirements
- b) Application Form
- c) The Licensing Process is submitted through link <https://perizinan.esdm.go.id/minerba/>

REQUIREMENTS FOR APPLICATION FOR ARTISANAL MINING PERMIT

NO	DESCRIPTION	REMARK
1.	Application Form	Signed by the management of the cooperative according to the profile of the cooperative, if the application by an individual is signed by the individual concerned
2.	Copy of Business Registration Number 9SNIB)	Including for individual applicants - the electronic mail (e-mail) address in the form and submission of the application must be the same as that stated in the SNIB
3.	List of regional coordinates proposed by IPR in the form of latitude and longitude according to the nationally applicable geographic information system	
4.	Copy of ID card (KTP) and Tax File Number (NPWP)	For cooperatives, attach the KTP and NPWP of the management and supervisor of the cooperative according to the articles of association
5.	Certificate from the local kampong/village stating that all cooperative management or individual applicants are local residents	
6.	A statement letter stating: -Individual: comply with the provisions of laws and regulations in the field of environment and mining safety. -For Cooperatives: environmental management capability and mining safety.	Signed on stamp duty by the chairman of the cooperative or individual applicant
7.	Proof of PNBPN payment for WIUP map printing in accordance with statutory provisions	
8.	Complete digital data of application documents	In pdf form., for each requirement in the order in the checklist including the letter and form (not combined in one pdf file.)

(COMPANY LETTERHEAD)

**APPLICATION ATTACHMENT FILLING FORM (for all applications)
PROFILE PT/Cooperative/CV/Firm**

1. Name :
2. Address/Domicile :
3. Phone Number :
4. Facsimile :
5. Website :
6. E-mail :
7. Capital status :

a. National

Use with (V)

b. Foreign Investment

8. Tax file number :
9. NIB :
10. Company list : * Mention if any
Mining and/or Services
In one group
11. Company management structure

No	Name	Position	Nationality	Tax File Number/ID Tax
1.				
2.				
3.				
Etc.				

12. Composition of Shareholders (as stated in the last deed)

No	Shareholder	Nationality	Number of share	Share Value (Rp.)	%	Tax File Number/ID Tax
1.						
2.						
Etc.						

13. *) Share Ownership Chart to Beneficial Ownership
(Attached separately)

* Number 13 does not need to be included for an IPR application

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I, the undersigned, act for and on behalf of PT/CV/Cooperative, hereby declare that all information submitted and the document attachments are correct. When it is known there is a statement or document that we convey is not true, then we are willing to have our company blacklisted and processed legally in accordance with statutory provisions.

City, Date/Month/Year

Stamp Duty

Name
Position

IPR application form

(COMPANY LETTERHEAD)

For individual applicants there is no need for letterhead

Number : City, Date/Month/Year
Attachment : One file

To:
Head of BKPM RI
JI, Gatot Subroto No. 44
DKI Jakarta 12190

Subject: Application for Artisanal Mining Permit (IPR)

We hereby submit an application to obtain the Artisanal Mining Permit (IPR) commodities... *) which are located in the region Kelurahan/Village ...**), District ... **), Regency ...**) Province**) as list of area coordinates is attached.

For consideration, attached documents are attached requirements as requirement for evaluation of the application.

For your attention, Mr. Head, we thank you

Best Regards

Company Stamp

Name and sign applicant
(Position in cooperative management)

