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ESTIMATION OF POST-MINING GUARANTEES FOR PT. X'S MINERAL ROCK MINING OPERATIONS IN MANOKWARI REGENCY

ESTIMASI JAMINAN PASCATAMBANG USAHA PERTAMBANGAN MINERAL BATUAN PT. X DI KABUPATEN MANOKWARI

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ABSTRACT

PT. X is one of the companies in Manokwari that is engaged in rock mining. Currently, the company has conducted a feasibility study and has progressed to the production operation stage. Any company that aims to upgrade its license from an Exploration Mining Business License (IUP) to a Production Operation License is required to prepare a post-mining plan document, which includes post-mining financing. The amount of this financing will be deposited in a bank as a post-mining guarantee to the government. This study aims to estimate the amount of the post-mining guarantee that will be deposited on behalf of the government. To achieve this objective, the study employs an applied research method by referring to the Minister of Energy and Mineral Resources Decree No. 1827 K/30/MEM/2018. The results of this study show that the post-mining guarantee consists of direct costs amounting to IDR 92,750,110 and indirect costs amounting to IDR 15,303,768, resulting in a total post-mining cost of IDR 108,053,878 to be deposited. Based on these findings, the post-mining guarantee will not be fully paid at once, but will be divided into three installments: in the first year, IDR 55,242,545 will be deposited, followed by IDR 33,891,302 in the second year, and IDR 23,102,571 in the third year.

Keywords: post-mining guarantee, production operations, direct and indirect costs.

ABSTRAK

PT. X merupakan salah satu perusahaan di Manokwari yang bergerak di bidang usaha pertambangan batuan. Saat ini, perusahaan telah melakukan studi kelayakan dan melanjutkan ke tahap operasi produksi. Setiap perusahaan yang akan meningkatkan perizinannya dari Izin Usaha Pertambangan (IUP) Eksplorasi ke Izin Usaha Pertambangan Operasi Produksi diwajibkan untuk mempersiapkan dokumen rencana pascatambang yang mencakup pembiayaan pascatambang. Besaran biaya tersebut akan didepositokan ke bank sebagai jaminan pascatambang kepada pemerintah. Penelitian ini bertujuan untuk memperkirakan besaran jaminan pascatambang yang akan didepositokan atas nama pemerintah. Untuk mencapai tujuan tersebut, penelitian ini menggunakan metode penelitian terapan dengan mengacu pada Keputusan Menteri ESDM No. 1827 K/30/MEM/2018. Hasil penelitian ini menunjukkan bahwa jaminan pascatambang terdiri dari biaya langsung sebesar Rp 92.750.110 dan biaya tidak langsung sebesar Rp 15.303.768, sehingga jumlah total biaya pascatambang yang akan didepositokan adalah Rp 108.053.878. Berdasarkan hasil tersebut, jaminan pascatambang tidak akan dibayarkan sekaligus, melainkan dilakukan dalam tiga tahap. Pada tahun pertama, akan didepositokan sebesar Rp 55.242.545, pada tahun kedua sebesar Rp 33.891.302, dan pada tahun ketiga sebesar Rp 23.102.571.

Kata kunci: jaminan pascatambang, operasi produksi, biaya langsung dan tidak langsung.

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INTRODUCTION

Indonesia possesses non-renewable natural resources, such as minerals and coal. The mining sector is one of the key contributors to economic growth. For decades, mining has played a crucial role in economic development, providing employment, infrastructure, and essential raw materials for society (Worlanyo and Jiangfeng, 2021). Mining is a key industry for the Indonesian government, contributing to foreign exchange earnings and expanding employment opportunities (Thalib *et al.*, 2020). Therefore, management of mineral and coal resources can be carried out through mining businesses. Mining of natural resources is still a common practice in various countries to stimulate economic growth (Pambudi *et al.*, 2023). This mining business generates a multiplier effect that drives economic activity in a region. However, it can have negative environmental impacts (Umar and Hijriani, 2020). Some of the adverse environmental effects caused by post-mining land include water pollution, air pollution, and land degradation (Hayatuzzahra and Yolanda, 2023).

Mining companies have social and environmental responsibilities according to Law No. 40 of 2007, Article 74, which requires companies managing natural resources to fulfill these responsibilities. It clarifies that environmental management by mining companies is not limited to when the company is in production but continues up to the post-mining stage (Rizki and Firmansyah, 2021).

When a company's mining production operations come to an end, several issues may arise, such as environmental degradation, a decline in economic development, and a decrease in social quality and public health (Setiawan *et al.*, 2022). This mining activity can cause damage to the soil, such as the loss of desired mineral materials and the degradation of soil texture, which affects vegetation and leads to land degradation (Buta *et al.*, 2019). This reclamation program aims to restore land that disturbed by mining, ensuring it can be restored and utilized as intended. Based on this explanation, post-mining land management should be focused on appropriate land use and effective spatial planning (Nadar *et al.*, 2018). Post-mining land can be repurposed for agriculture, housing, industrial sites, community facilities, wildlife habitats, and recreational areas (Mert, 2019). Therefore, mine reclamation is a multifaceted process aimed at restoring post-mining areas to a state of ecological and social well-being (Basu and Mishra, 2024).

PT. X is a company engaged in mining activities in Manokwari Regency, West Papua Province, focusing on mineral extraction, specifically river rock. According to Article 1 of Law Number 3 of 2020, mining includes all or part of the stages involved in the exploration, management, and exploitation of minerals or coal. These stages cover general investigations, exploration, feasibility studies, construction, mining, processing and refining, development and utilization, transportation, sales, and post-mining activities. To operate a mining business, obtaining a business permit is required, one of which is the Mining Business Permit (IUP). The Mining Business Permit (IUP) consists of two stages of activities—exploration and production operations—as outlined in Article 36, Paragraph 1 of Law No. 3 of 2020.

The company obtained an Exploration IUP to conduct general investigation activities, exploration, and feasibility studies. After completing several of these activities, the company is authorized to conduct production operations, as stipulated in Article 46, Paragraph 1 of Law No. 3 of 2020. Based on this, the company wants to upgrade from Exploration IUP to Production Operation IUP. The Production Operation IUP obtained will have a maximum lifespan of 5 years, which can be extended twice for 5 years each by Law no. 3 of 2020 article 47 letter d. However, the company must meet several requirements to obtain an IUP for production operations. Some of the conditions that the company must fulfil are the preparation of reclamation and post-mining documents. Post-mining refers to planned, systematic, and continuous activities carried out after the completion of all or part of mining operations, aimed at restoring natural environmental and social functions according to local conditions throughout the mining area. According to the Decree of the Minister of Energy and Mineral Resources Number 1827 K/30/MEM/2018 in the preparation of the Post-mining Plan for IUP Production Operations for Non-Metal Mineral Commodities and Rocks which have a mine life of less than or equal to 5 years, the reclamation plan for the production operation stage included in the post-mining

plan. In Article 100 of Law No. 3 of 2020, in addition to reclamation and post-mining documents, IUP holders must provide and place reclamation and post-mining guarantee funds. The guarantee amount will later be explained regarding direct and indirect costs from reclamation and post-mining activities.

Reclamation is essential to realizing environmentally sound development, so it must be guided by the principles of Good Mining Practice (GMP). Reclamation focuses on restoring land and/or infrastructure to a condition where it can be utilized for economic, environmental, or societal purposes (Keenan and Holcombe, 2021). It is regulated under the Minister of Energy and Mineral Resources Regulation Number 26 of 2018, which mandates mining companies holding IUPs to conduct reclamation and post-mining activities systematically and in a planned manner (Putri, Nila Trisna and Dara Quthni Effida, 2023). Based on this, land reclamation activities require labour and costs, so they need economic analysis (Kowalska *et al.*, 2020).

Based on the explanations above, for PT. X, who wants to obtain a Production Operation IUP, requires reclamation guarantee funds and post-mining guarantees, which the company must deposit with the government. Based on this, the research aims to estimate the amount of reclamation and post-mining guarantees that the company will deposit through the government.

METHODS

Research is a scientific way to obtain data with specific purposes and uses (Sugiyono, 2021). According to the objectives to be achieved in this research, this research is included in applied research. Applied research aims to apply, test and evaluate a theory's ability to solve practical problems (Abubakar, 2021). Theory is interweaving facts according to a meaningful framework (Syahza, 2021). The Kamus Besar Bahasa Indonesia (KBBI) explains that theory is the general principles and laws that form the basis of art or science. Based on this explanation, several bases are used, namely Ministerial Decree 1827 K/30/MEM/2018. The cost plan for reclamation and post-mining, according to Ministerial Decree 1827 K/30/MEM/2018, explains that the costs in question consist of 2, namely

1. Direct costs
   Direct costs are costs that arise as a result of activities that are directly related to the production process (Mukiat and Asof, 2023). These costs consist of:
   1) Ex-mining site costs include dismantling mining facilities and reclamation of land used for mining facilities.
   2) Costs for processing facilities include dismantling processing facilities and reclamation of land used by processing facilities.
   3) Maintenance costs used to maintain ex-mining sites, former processing facility land, and former supporting facility land.
   4) Monitoring costs used t o implement programs and procedures per environmental documents.

2. Indirect costs
   Indirect costs are spending money caused by activities unrelated to production (Mukiat and Asof, 2023). These costs consist of:
   1) Equipment mobilization and demobilization costs can be budgeted at 2.5% or based on your calculations.
   2) Administrative costs and profits of third parties as post-mining implementers are budgeted at 3% to 14% of direct costs.

The total direct and indirect costs for reclamation and post-mining activities are based on the current currency value as of 2023. However, to account for the value of money over the next five years, equations 1 and 2 are used . The reason is that the value of money can change over time. This change is the decreasing purchasing power of money caused by inflation or what is better known as the concept of equality. The idea of equivalence states that a certain amount of money at a particular time equals a different amount at an additional time if a specific discount rate is given. The concept of equivalence can be applied to assess reclamation and post-mining plans.

$$F = P \times (1+i)^n \quad \text{.....(1)}$$

$$A = P \times \frac{i(1+i)^n}{(1+i)^n-1} \quad \text{.....(2)}$$

Information:
F : Future value of money (Rp.)
A : Value of money each year (Rp.)
P : Current value of money (Rp.)
i : Discount rate can be inflation deposit interest, or loan interest rate (%)
n : Period

RESULTS AND DISCUSSION

PT. X will carry out revegetation on the right, or east side, of the Maruni River, where mining activities have taken place, during the post-mining phase. On the west, or left side of the mining site (Figure 1), only land arrangement will be conducted as slope stabilization. Based on Figure 1, the costs planned by the company refer to Ministerial Decree no. 1827 K/MEM/2018, as explained below.

Costs on Ex-Mining Sites

This fee is used for dismantling mining facilities, such as dismantling and reclamation of mine roads, reclamation of surface mines (pits and waste dumps), reclamation of land for settling ponds, and securing all ex-mining land. Based on this explanation, the only activities done post-mining at the former mining site are the dismantling and reclamation of the mine road on the east side, and slope stabilization on the west side. The total budgeted costs are Rp. 59,691,743 in 2023 (period 0). The fees used for the former mining site consist of several expenses, namely:

1. Land Use
   Land use management is an effort to plan and regulate land use in an integrated manner to meet human needs while maintaining environmental sustainability. Based on this, several activities will be conducted, namely:
   1) Land arrangement
      The activity stage before revegetation is conducted on the east side of the former mining road. Land management cleans the land before spreading the rooting zone. The area of land that was cleared is 3,900.26 m², or 0.390026 hectares. If the production rate of tools for land arrangement is 1.18 hectares per hour, then the time required to complete the arrangement is 0.33 hours. The production value and the time required for land reclamation above are obtained using equations 3 and 4.

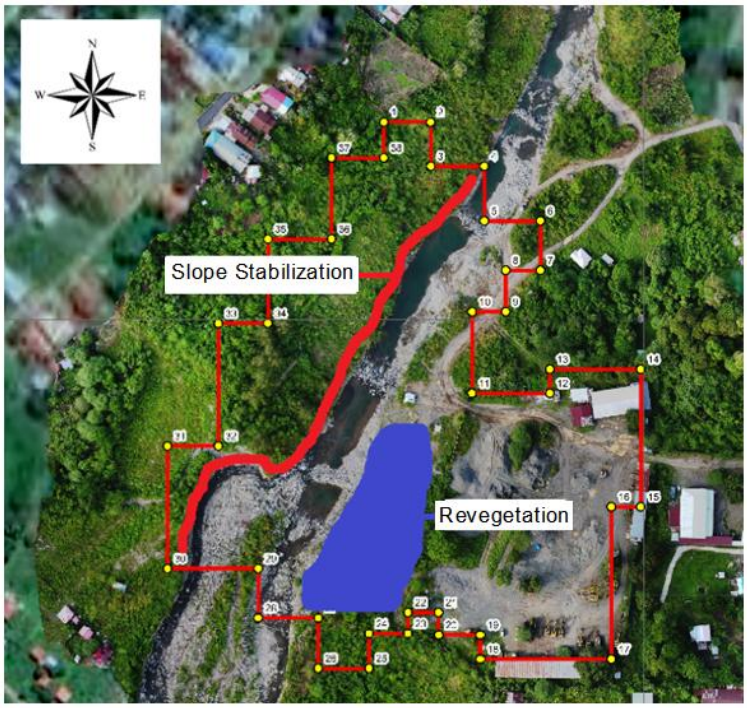

Figure 1. Location of PT. X mining business license area.

$$P = \frac{LB \times F \times E}{10{,}000\ m^2/Ha} \quad \text{..... (3)}$$

$$T = \frac{A}{P} \quad \text{.....(4)}$$

Information:
P : Production (ha/hour)
F : Forward Speed (km/hour)
E : Work Efficiency
LB : Blade or Bucket Width (m)
T : Time required for land reclamation (hours)
A : Area to be reclaimed (ha)

The heavy equipment used for land reclamation is the WA 380-3 Loader, with specifications including a forward speed of 6 km/h, a minimum work efficiency of 67%, and a bucket width of 2,925 mm (Komatsu Ltd., 2019). Therefore, the values of these specifications are converted to units of 6,000 m/hour for speed and 2,925 meters for the bucket width. Based on the data, the production of the heavy equipment and the time required are as follows:

$$P = \frac{2{,}925\ m \times 0.67 \times 6{,}000\ m/hour}{10{,}000\ m^2/Ha}$$

P = 1.18 ha/hour.

$$T = \frac{0.390026\ ha}{1.18\ ha/hour}$$

T = 0.33 hour

Based on this, the cost required for landscaping on the east side for revegetation is Rp. 786,125 (Appendix 1).

a. In addition to land arrangement activities on the former mining road, landform arrangement activities are conducted on the west side of the Maruni River. This is necessary because the mining site features a steep slope on the riverbank, with an angle of approximately 90°, as shown in Figure 2. Such a steep slope can pose dangers both during and after the production operation phase. To minimize or prevent landslides caused by erosion, the company reshapes the slopes to make them less steep and safer.

Figure 2. Slope to be repaired.

This sloping process is called slope improvement or shape adjustment (Figure 3). The aim of regulating the shape of the slope is to reduce the speed of runoff water, erosion, sedimentation and landslides. Therefore, the shape and design of the hill must be flat to gentle, with a ratio of 1:4 or a maximum gradient of 25% (Heriansyah *et al.*, 2019). This is done in cases where a geotechnical study has not been conducted.

There is a way to increase slope stability known as the geometric method. This slope improvement method works by changing the geometry of the slope by cutting it so that it is not steep (Imran, Afriani and Zakaria, 2020). Based on this, the slope which initially had a slope of 90° will be excavated to become 14°. This slope will have a height of approximately 3 meters with a horizontal distance of 12 meters. The slope was excavated at 300 m. Based on this, the production volume that must be moved is 5,400 m^3. The volume is obtained by multiplying the cross-sectional area of 18 m^2 by the excavation length of 300 m, as shown in Figure 3. The operating costs required to repair a slope of 5,400 m^3 are Rp. 19,788,181. (Appendix 2).

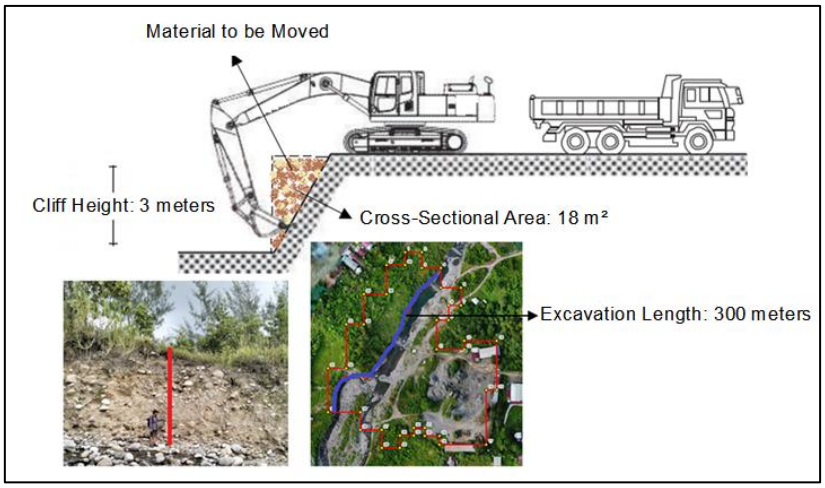

Figure 3. The area where land planning will be carried out.

b. Spreading the Rooting Zone Soil
Root zone soil is a layer of soil that contains nutrients that function as a planting medium. Based on this explanation, one of the reclamation plans is to plant mangoes. Based on this, before planting mangoes, rooting zone soil is needed. Therefore, before planting mangoes, the first dig a hole with an area measuring 1 x 1 meter and a depth of 1 meter. The excavated soil is mixed with manure in 2 cans of kerosene per hole (equivalent to 10 liters or 0.001 m^3), then returned to the spot (Broto *et al.*, 1994). The need for trees to be planted is 44 trees. This number represents the total mango trees to be planted in the former mining site, as shown in Appendix 3. Determining this amount refers to the area to be produced and the spacing between mango trees. Conventionally, the mango planting distance is 10 x 10 m (Nuraini *et al.*, 2022). Based on this explanation, the required volume of soil rooting zone is 0.22 m^3 for 1 tree, so for 44 trees, a rooting zone of 9.05 m^3 is needed. The manure required is 0.44 m^3. Based on the explanations above, this work involves a fee of Rp. 3,034,437., with details of costs in Table 1.

2) Erosion and Sedimentation Control
Erosion and sedimentation control is an effort to prevent or reduce soil loss (erosion) and the accumulation of solid material (sediment) in various environments. Soil erosion can occur due to factors such as rain, wind, or human activities, including deforestation, which significantly reduces or removes forest cover, and unsustainable agricultural practices. Sediment transported by water flows can pollute rivers, lakes, and other

Table 1. The cost for the soil rooting zone

No.	Description	Cost per unit		Volume		Total Cost
1	Digging of holes for rooting zone	Rp. 466,275	per hour	0.346	hour	Rp. 161,237
2	Cost of fertilizer requirements for the rooting zone per hole					
	- Manure (Rp. 15,000 per 5 kg)	Rp. 3,000	per kg	20	kg	Rp. 60,000
	- NPK Fertilizer	Rp. 28,000	per kg	0.10	kg	Rp. 2,800
	- Dolomite Lime Fertilizer	Rp. 10,000	per kg	0.25	kg	Rp. 2,500
	Total fertilizer cost for the rooting zone					Rp. 65,300
3	The number of holes to be planted is 44 holes					
4	Total fertilizer cost for the rooting zone x 44 holes					Rp. 2,873,200
	Total Cost = (1 + 4)					Rp. 3,034,437

water areas, harming the environment and infrastructure. There are two types of erosion control, namely:

a. Wind erosion control
   Wind erosion usually occurs at the beginning of reclamation, land arrangement, and before planting, as well as on mine roads. The main impact of wind erosion is a decrease in land productivity, flying dust, and dust deposits in ditches on the sides of roads, fences, and buildings. However, if revegetation has been implemented and plants grow to cover the soil, wind erosion will be significantly reduced (Heriansyah *et al.*, 2019). One method to mitigate this issue is by applying water to maintain soil moisture. Accordingly, the necessary tools for performing these activities are detailed in Table 2.

Table 2. Cost for wind erosion control

No.	Description	Cost per unit (Rp per unit)	Volume		Total Cost (Rp)
1	Bucket	163,000	2	Unit	326,000
2	Dipper	11,000	2	Unit	22,000
Total cost					348,000

b. Control of water erosion and sedimentation
   Controlling erosion and sedimentation is closely related to the land structuring process, especially in planning landforms that will be created when land structuring begins (Heriansyah *et al.*, 2019). Therefore, the form of Control directs the water flow away from the slope, as seen in Figure 4. This form of control is implemented on the slopes located to the west of the site, near the mining area along the Maruni River. Meanwhile, other erosion control measures on the eastern side of the mining site involve vegetation. Control techniques using plants will be explained further in the revegetation section. The costs required are included in the land arrangement in the land arrangement section for slope stabilization.

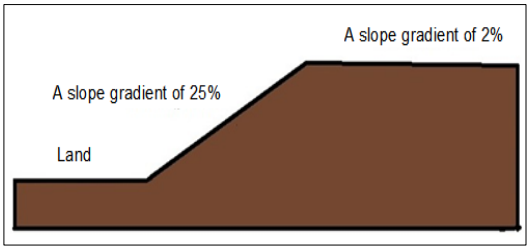

Figure 4. A Form of controlling water erosion and sedimentation.

c. Revegetation Costs
   Revegetation is conducted on the eastern side of the post-mining land. The plant that will be planted is mango. The reason for selecting mango is that it is a local plant that naturally grows in the vicinity of the permit area. Based on this, several costs will be budgeted, namely:
   1) Soil Quality Analysis.
      This work requires a fee of Rp. 4,381,000, with details that can be seen in Table 3.
   2) Fertilization.
      Fertilization is applying fertilizer to soil or plants to increase the availability of nutrients needed by plants. Fertilizer requirements for mango plants differ for each type, as seen in Table 6 (Broto *et al.*, 1994). The costs required for fertilization are Rp. 26,776,200, with details in Table 6.
   3) Procurement of Seeds.
      The cost required to procure mango seeds is Rp. 88,000 per seedling (Regent of Manokwari, 2022). The need for seeds is 44 trees, so the cost is Rp. 3,872,000.
   4) Planting.
      For planting mangoes, you need about 25 grams of furadan. Furadan is an insecticide and nematicide-type pesticide used to eradicate pests. The planting hole, as explained in the land preparation with the application of fertilizer, is dug again, and subsequently, the mango tree seed is placed. Based on this explanation, the required cost for this activity is Rp. 196,800, with details in Table 4.

5) Plant Maintenance.
The activities that will be carried out for plant maintenance include replanting, watering, and weeding. Replanting involves replacing dead seedlings, for which tools such as a hoe and a shovel are used. For watering, the necessary tools include a hand sprayer (typically used for pesticides) and a watering can, which serves as a tool for watering plants. For weeding yourself, the tools required are a shovel and a hoe. Based on the explanation above, the cost needed to purchase this tool is IDR. 509,000, as in Table 5.

Based on the explanations provided, the total direct costs required by the company to execute the reclamation amount to Rp. 59,691,743. This value is the current value, which is a reference for the costs of the ex-mining site.

Table 3. Cost required for soil quality analysis

No.	Description	Cost per unit		Volume		Total Cost
1	Soil Sampling					
	Land Drilling 1 package	Rp. 200,000	per day	1	Day	Rp. 200,000
	Hoe	Rp. 122,000	per unit	1	Unit	Rp. 122,000
	Shovel	Rp. 163,000	per unit	1	Unit	Rp. 163,000
	Sample Bags	Rp. 100,000	per pack	1	Pack	Rp. 100,000
	Label Paper	Rp. 40,000	per roll	1	Roll	Rp. 40,000
	Markers	Rp. 8,000	per piece	2	Pieces	Rp. 16,000
	Soil Sample Information Sheet	Rp. 50,000	per piece	1	Piece	Rp. 50,000
	Labor (3 people per day a Rp. 300,000 per person)	Rp. 900,000	Per day	1	Day	Rp. 900,000
					Total Sampling Cost	Rp. 1,591,000
2	Complete Soil Analysis (UNIPA)	Rp. 930,000	per sample	3	Sample	Rp. 2,790,000
	The Need for Sampling In The Field and Soil Quality Testing in The Lab.					Rp. 4,381,000

Table 4. Required cost for planting mangoes

No.	Description	Cost per unit	Volume	Total Cost
1	Furadan - 25 g requirement per tree - Price Rp. 68,000 per kg (Rp. 68 per g) - 44 mango trees will be planted	- -	- -	-
	Furadan requirement = 25 g x Rp. 68 per g x 44 trees			Rp. 74,800
2	Hoe	Rp. 122,000 per unit	1 unit	Rp. 122,000
			Total Cost	Rp. 196,800

Table 5. Tools needed for plant maintenance

No.	Description	Cost per unit	Volume	Total Cost
1	Shovel	Rp. 163,000 per unit	1 unit	Rp. 163,000
2	Hoe (already in the previous Table 4.)	-		-
3	Hand sprayer	Rp. 271,000 per unit	1 unit	Rp. 271,000
4	Gembor or Emrat	Rp. 75,000 per unit	1 unit	Rp. 75,000
			Total Cost	Rp. 509,000

Table 6. Required costs for fertilization in revegetation

Plant Ages Years)	Fertilizer rate per tree per year										
	Fertili-zer	Prices (Rp)									
Manure Requirements											
1	40 kg	15,000	5	kg	3,000	per kg	120,000	Rp per tree	44	Tree	5,280,000
2	40 kg	15,000	5	kg	3,000	per kg	120,000	Rp per tree	44	Tree	5,280,000
3	60 kg	15,000	5	kg	3,000	per kg	180,000	Rp per tree	44	Tree	7,920,000
4	-	-	-				-		-		-
Before Flowering	-	-	-				-		-		-
After harvest	-	-	-				-		-		-
Cost of Manure Requirements											18,480,000
Need for Urea Fertilizer											
1	100 g	10,000	1,000	g	10	Rp Per gram	1,000	Rp Per tree	44	Tree	44,000
2	125 g	10,000	1,000	g	10	Rp Per gram	1,250	Rp Per tree	44	Tree	55,000
3	150 g	10,000	1,000	g	10	Rp Per gram	1,500	Rp Per tree	44	Tree	66,000
4	-	-	-				-		-		-
Before Flowering	1,600	10,000	1,000	g	10	Rp Per gram	16,000	Rp Per tree	44	Tree	704,000
After Harvest	2,000	10,000	1,000	g	10	Rp Per gram	20,000	Rp Per tree	44	Tree	880,000
Cost of Urea Fertilizer Requirements											1,749,000
TSP Fertilizer Requirement											
1	175 g	28,000	1,000	g	28	Rp Per gram	4,900	Rp Per tree	44	Tree	215,600
2	200 g	28,000	1,000	g	28	Rp Per gram	5,600	Rp Per tree	44	Tree	246,400
3	250 g	28,000	1,000	g	28	Rp Per gram	7,000	Rp Per tree	44	Tree	308,000
4	-	-	-				-		-		-
Before Flowering	1,000	28,000	1,000	g	28	Rp Per gram	28,000	Rp Per tree	44	Tree	1,232,000
After Harvest	2,000	28,000	1,000	g	28	Rp Per gram	56,000	Rp Per tree	44	Tree	2,464,000
Cost of TSP Fertilizer Requirements											4,466,000
KCl Fertilizer Requirement											
1	75	11,000	1,000	g	11	Rp Per gram	825	Rp Per tree	44	Tree	36,300
2	100	11,000	1,000	g	11	Rp Per gram	1,100	Rp Per tree	44	Tree	48,400
3	125	11,000	1,000	g	11	Rp Per gram	1,375	Rp Per tree	44	Tree	60,500
4											
Before Flowering	2,000	11,000	1,000	g	11	Rp Per gram	22,000	Rp Per tree	44	Tree	968,000
After Harvest	2,000	11,000	1,000	g	11	Rp Per gram	22,000	Rp Per tree	44	Tree	968,000
Cost of KCl Fertilizer Requirements											2,081,200
Total Costs Required for Fertilization											26,776,200

Costs at Processing Facilities

In the processing area, neither processing nor other supporting facilities are dismantled, and reclamation is not carried out. This is because the current processing location is private land owned by PT. X, which has been purchased and is not leased from forest land. Furthermore, the land containing the processing facilities will continue to be used as a parking area for heavy equipment and mining business activities.

Maintenance

Based on the explanation of revegetation, maintenance activities are carried out in the reclamation section of the former mining site. The required costs are the same as those for revegetation in the maintenance section. To avoid double expenses, the cost applied to post-mining is zero rupiah.

Monitoring

Monitoring reclamation and post-mining activities consists of several activities, namely:

1. Slope Shape Settings. After adjusting the shape of the slope, the next effort is to monitor the slope whose geometry has been changed. Forming a gentle slope will require higher stripping overburden costs, even though the slope is more stable. The straighter the slope, the lower the safety factor (Sukhyar, 2014). Based on this explanation, the arranged slopes have a stable shape. It refers to the shape and design of the slope, which should be flat to gently sloping, with a ratio of 1:4 or a maximum slope of 25%. This is done in cases where a geotechnical study is not conducted, ensuring the slope remains stable (Heriansyah *et al.*, 2019).

The basic principle of monitoring slope instability is measuring the movement of unstable slopes. At the same time, the intensity of data collection refers to the stability and activity of mining operations in the area at the foot of the slope. Monitoring is conducted during both the mining and post-mining stages. However, it is advisable to plan the monitoring program from the outset. Based on this, monitoring of slope improvements to ensure stability and prevent landslides involves measuring the slope geometry. The tool utilized is a theodolite, and this is performed once a month at the conclusion of mining activities in the fifth year, typically during the rainy season. Based on both explanations, monitoring was conducted for a duration of six months. Even though the slope remains stable after modification, the company continues to conduct monitoring. The cost required for monitoring is Rp. 1,845,000 per month. Consequently, over a period of six months, the total expenses amount to Rp. 11,070,000.

2. The second monitoring is monitoring the water quality of the Maruni River. It refers to the PT UKL-UPL Document. PT. X conducts monitoring twice every six months in the fifth year. Therefore, monitoring is conducted twice during this period. The cost for each monitoring activity amounts to Rp. 10,994,184. Based on this, the total costs required are Rp. 10,994,184 x 2 = Rp. 21,988,367.
3. For monitoring mango cultivation, monitoring is incorporated into maintenance costs. To prevent double financing, the costs to be incurred are assumed to be IDR 0.

Based on these three points, the total cost required for monitoring activities is IDR 33,058,367.

Indirect Costs

In the implementation of post-mining activities, there are indirect costs that must be budgeted by the company, to be subsequently outsourced to third parties, while considering the future value of money. The future value of money refers to predictions or projections of inflation that may occur. The highest inflation ever recorded in Manokwari was 2.25%, based on data from the Central Statistics Agency. This figure represents the highest inflation rate observed in Manokwari Regency. The inflation data is derived from the last five years (2018–2022), with the peak occurrence in 2019. These indirect costs consist of:

1. Equipment mobilization and demobilization costs.
   This fee is established in accordance with Ministerial Decree No. 1827 K/MEM/2018 and represents 2.5% of the direct costs. Based on this regulation, the budgeted amount for these costs is as follows:
   Mob Cost. & De. = 2.5% x Rp. 92,750,110
   = Rp. 2,318,753.
2. Administrative costs and profits of third parties as implementers of reclamation during the production operations stage.
   This fee is set at 3% to 14% of direct costs. The percentage selection refers to Englemen's Heavy Construction Cost Chart. In this graph, the minimum value used as a reference is 10,000 US dollars, which, when converted, amounts to Rp. 150,000,000, assuming the lowest exchange rate of 1 USD = Rp. 15,000 at an Indonesian bank.

However, the projected direct costs amount to Rp. 92,750,110. That explains that the value does not reach the minimum value stated in the Englemen's Heavy Construction Cost Chart. Therefore, it was decided to choose a large percentage, namely 14%. This choice is because Englemen's Heavy Construction Cost Chart explains that the smaller the direct costs incurred, the greater the percentage given. Based on this, this cost is budgeted at 14% of Rp. 92,750,110, so the result is:

Administration charge & profit
14% x Rp. 92,750,110 = Rp. 12,985,015.

The total indirect costs from points 1 and 2 amount to Rp. 15,303,768.
The total post-mining costs budgeted by the company is IDR. 108,053,878, with details in Table 7. This value represents the value at period 0, or the calculation is performed as of the current period.

Given that PT. X mines a rock mineral, the maximum allowable lifespan is five years. The company will select this option, with post-mining guarantees allocated as per Ministerial Decree 1827 K/MEM/2018: 50% in the first year, 30% in the second year, and 20% in the third year. Consequently, the company will make payments of Rp. 55,242,545 in the first year, Rp. 33,891,302

in the second year, and Rp. 23,102,571 in the third year, as detailed in Table 8.

Based on Table 8, the option that companies can choose in placing post-mining collateral is to deposit the collateral in a government bank, as seen in Table 9. Based on Table 9, the recommended bank choice is one with a high deposit interest percentage. The company will gain more profits, as seen in Table 10.

Tabel 7. Total post mining cost

No.	Description	Cost (Rp.)
Direct Cost		
1	Cost on ex-mining sites	
	1) Demolition of mining facilities	0
	2) Reclamation of land used by mining facilities	59,691,743
	Total Cost on Ex-Mining Site	59,691,743
2	Costs at processing facilities	
	1) Dismantling of processing facilities	0
	2) Reclamation of land used by processing facilities	0
	Total Costs at Processing Facilities	0
3	Maintenance cost	0
4	Monitoring Fees	33,058,367
Total Direct Costs		92,750,110
Indirect Costs		
1	Equipment mobilization and demobilization costs (2.5%)	2,318,753
2	Administrative costs and profits of third parties as post-mining implementers (3%-14%)	12,985,015
Total Indirect Costs		15,303,768
Total direct & indirect costs		108,053,878

Table 8. Placement of post-mining collateral for IUP rock commodity production operations PT. X

Mine Age	0th Year	1st Year	2nd Year	3rd Year	4th Year	5th Year
1	Rp. 108,053,878	Rp. 110,485,091	-	-	-	-
2	Rp. 108,053,878	Rp. 110,485,091	-	-	-	-
3	Rp. 108,053,878	Rp. 110,485,091	-	-	-	-
4	Rp. 108,053,878	Rp. 55,857,110	Rp. 55,857,110	-	-	-
5	Rp. 108,053,878	Rp. 55,242,545	Rp. 33,891,302	Rp. 23,102,571	-	-

Table 9. The company's choice of depositing post-mining guarantees with government banks

Government Bank	Deposit Interest	1st Year	2nd Year	3rd Year
		12 bulan	24 bulan	36 bulan
Bank BRI	3,00%	Rp. 55,647,747	Rp. 34,390,308	Rp. 23,614,678
Bank BNI	3,00%	Rp. 55,647,747	Rp. 34,390,308	Rp. 23,614,678
Bank Mandiri	2,50%	Rp. 55,377,613	Rp. 34,057,232	Rp. 23,272,442
Bank Danamon	4,75%	Rp. 56,593,219	Rp. 35,568,838	Rp. 24,838,905
Bank BTN	3,05%	Rp. 55,674,761	Rp. 34,423,705	Rp. 23,649,085

Table 10. The profit option that the company will obtain for placing post-mining collateral with government banks

Keuntungan yang didapatkan PT. X	Bunga Deposito	Tahun ke 1	Tahun ke 2	Tahun ke 3
		12 bulan	24 bulan	36 bulan
Bank BRI	3,00%	Rp. 405,202	Rp. 499,006	Rp. 512,108
Bank BNI	3,00%	Rp. 405,202	Rp. 499,006	Rp. 512,108
Bank Mandiri	2,50%	Rp. 135,067	Rp. 165,930	Rp. 169,871
Bank Danamon	4,75%	Rp. 1,350,673	Rp. 1,677,536	Rp. 1,736,335
Bank BTN	3,05%	Rp. 432,216	Rp. 532,403	Rp. 546,515

CONCLUSION AND SUGGESTION

Based on the plan outlined above, the post-mining guarantee for the 5-year period is as follows:

1. In the first year: Rp. 55,242,545.
2. In the second year: Rp. 33,891,302.
3. In the third year: Rp. 23,102,571.

The company can deposit the collateral in a government bank offering the highest deposit interest rate of 4.75%, resulting in a profit, as this percentage exceeds the inflation rate.

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APPENDIX 1

HEAVY EQUIPMENT PRODUCTION COSTS REFERENCING THE MINISTER OF PUBLIC WORKS AND HOUSING REGULATION NUMBER 8 OF 2023

Type of equipment: Whell Loader WA 380-3

No.	Description	Code	Value
1	Fixed Costs per year:	P	Rp. 187,842,341
	- Equipment Price in Manokwari	N	Rp. 750,000,000
	- Installment Factor (Capital Recovery)	D	0.250
	- Bank Interest (Bank Mandiri, BRI, and BNI Loans)	i	8%
	- Economic Lifespan of Standard Factory Equipment (Years)	A	5
	Fixed Costs per Hour	HS	Rp. 90,309
	Total Fixed Costs for 7 working hours		Rp. 632,162
2	Operational Costs		
	- Fuel Costs (OC = H x Diesel Fuel Price)	FC	Rp. 194,820
	Fuel consumption per hour (liters)	H	28.65
	H = (12.5% s/d 15% x HP (Horse Power)		
	- 12.5% for light-duty equipment		
	- 15% for heavy-duty equipment		
	- Diesel Fuel Price (Rp per liter) in Manokwari		Rp. 6,800
	- Horse Power		191
	- Lubricant Costs (LC = I x Lubricant Price)	LC	Rp. 148,980
	Lubricant consumption per hour (liters)	I	6
	I = (2.5% s/d 3%) x HP (Horse Power)		
	- 2.5% for light-duty equipment		
	- 3% for heavy-duty equipment		
	- Lubricant Price (Rp per liter)		Rp. 26,000
	- Horse Power		191
	- Workshop Costs	J	31,550
	J = (6.25% s/d 8.75%) x (B/W)		
	- 6.25 % for light-duty equipment		
	- 8.75 % for heavy-duty equipment		
	- Price of heavy equipment (Rp)	B	Rp. 750,000,000
	- Total working hours in one year in hour (Hour)	W	2,080
	- Maintenance & Repair Costs	K	Rp. 63,101
	K = (12,5% s/d 17,5%) x (B/W)		
	- 12.5% for light-duty equipment		
	- 17.5% for heavy-duty equipment		
	- Price of heavy equipment (Rp)		Rp. 750,000,000
	- Total working hours in one year in hour (Hour)		2,080
	- Operator Wage per Hour	OW	Rp. 25,714
	OW = SOW / 7 Hour/day		
	Skilled Operator Wage per Day (Manokwari Regency) — 7 hours/day	SOW	Rp. 180,000
	Total Heavy Equipment Operating Cost (Rp per Hour) **=** (FC + LC + J + K + OW)		Rp. 464,166
	Total Heavy Equipment Operating Cost for 0.33 Hours of Operation		Rp. 153,964
	Total Fixed and Operating Costs for Land Preparation per hour (1 + 2)		Rp. 786,125

Note: In the planning process, the researcher selects higher values to avoid shortages during project execution.

APPENDIX 2

HEAVY EQUIPMENT PRODUCTION COSTS REFERENCING THE MINISTER OF PUBLIC WORKS AND HOUSING REGULATION NUMBER 8 OF 2023

Type of equipment: Hidraulic Excavator Komatsu PC 200

No.	Uraian	Kode	Nilai
1	Fixed Costs per year:	P	Rp. 187,842,341
	- Equipment Price in Manokwari	N	Rp. 750,000,000
	- Installment Factor (Capital Recovery)	D	0.250
	- Bank Interest (Bank Mandiri, BRI, and BNI Loans)	I	8%
	- Economic Lifespan of Standard Factory Equipment (Years)	A	5
	Fixed Costs per Hour	HS	Rp. 90,309
	Total Fixed Costs for 43 working hours		Rp. 3,832,607
2	Operational Costs		
	- Fuel Costs (OC = H x Diesel Fuel Price)	OC	Rp. 144,840
	Fuel consumption per hour (liters)	H	21
	H = (12.5% s/d 15% x HP (Horse Power)		
	- 12.5% for light-duty equipment		
	- 15% for heavy-duty equipment		
	- Diesel Fuel Price (Rp per liter) in Manokwari		Rp. 6,800
	- Horse Power		142
	- Lubricant Costs (LC = I x Lubricant Price)	LC	Rp. 110,760
	Lubricant consumption per hour (liters)	I	4
	I = (2.5% s/d 3%) x HP (Horse Power)		
	- 2.5% for light-duty equipment		
	- 3% for heavy-duty equipment		
	- Lubricant Price (Rp per liter)		Rp. 26,000
	- Horse Power		142
	- Workshop Costs	J	Rp. 31,550
	J = (6.25% s/d 8.75%) x (B/W)		
	- 6.25 % for light-duty equipment		
	- 8.75 % for heavy-duty equipment		
	- Price of heavy equipment (Rp)		Rp. 750,000,000
	- Total working hours in one year in hour (Hour)		2,080
	- Maintenance & Repair Costs	K	Rp. 63,101
	K = (12.5% s/d 17.5%) x (B/W)		
	- 12.5% for light-duty equipment		
	- 17.5% for heavy-duty equipment		
	- Price of heavy equipment (Rp)		Rp. 750,000,000
	- Total working hours in one year in hour (Hour)		2,080
	- Operator Wage per Hour	OW	Rp. 25,714
	OW = SOW / 7 Hour/day		
	Skilled Operator Wage per Day (Manokwari Regency) — 7 hours/day		Rp. 180,000
	Total Heavy Equipment Operating Cost (Rp per Hour) **=** (FC + LC + J + K + OW)		Rp. 375,966
	Total Heavy Equipment Operating Cost for 43 Hours of Operation		Rp. 15,955,574
	Total Fixed Costs and Operating Costs for 43 Hours of Work		Rp. 19,788,181

Note: In the planning process, the researcher selects higher values to avoid shortages during project execution.

APPENDIX 3

THE NUMBER OF MANGO TREES TO BE PLANTED IN THE POST-MINING AREA PT. X