

## Study on Digging and Loading Equipment Requirement for the Reclamation Plan in the Coal Mining Area of PT. Timah in Paku Village, Payung District, South Bangka Regency, Province of Bangka Belitung Islands

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### ARTICLE INFO

### ABSTRACT

**Keywords:** compaction, embankment, diversion channel, hydrogeology, material properties

Reclamation activity is one of the activities carried out in mining planning. This reclamation activity needs to be well planned. One of the reclamation activities is land arrangement. This land arrangement activity can be carried out by backfilling in ex-mining holes. This back filling activity is carried out by PT. Timah in carrying out reclamations related to land management. Former mining pit at PT. Timah will be back-filled in 2026 or the third year in the life of the mine. The back filling that will be carried out starts from RL 10 to RL 59. RL 59 is the target because the altitude is the same as the surrounding conditions. To carry out back filling on the plan, a material volume of 2,623,400 m<sup>3</sup> is required. The age of the mine is only until 2029, so with the material requirements divided by 4 years of reclamation, 655,850 m<sup>3</sup> per year is obtained. The equipment used to meet annual needs is 1 Dozer Komatsu D85 A, 1 Excavator CAT 320 D, and 5 dump trucks Scania P410.

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## INTRODUCTION

Tin is one of the natural resources found in Indonesia. The tin reserves in Indonesia cover the islands of Karimun, Singkep, and parts of the mainland of Sumatra (Bangkinang) in the north and south, namely the islands of Bangka and Belitung. The region that produces the largest tin is the island of Bangka. PT. Timah Tbk is one of the companies that carry out tin mining activities on the island of Bangka. Mining activities carried out by PT. Timah Tbk using the open pit mining method. It consists of several stages, namely starting from prospecting. Each stage in mining activities has its own function and can have an impact on the environment. Therefore the company is expected to be able to carry out supervision of mining activities in order to minimize the impact that occurs while still having economic value.

One of the impacts that can occur from mining activities using the open pit mining method is the emergence of a former mine opening. The impact of the formation of the former opening hole needs special handling. One form of handling the negative impacts of mining activities is carrying out planned

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reclamation. Reclamation is an integral part of mining activities. This reclamation activity is intended to return ex-mining land to its designation. This research was conducted at PT Timah. Tbk which is located in Paku Village, Payung District, South Bangka Regency, Bangka Belitung Islands Province. The area of PT Timah.Tbk's Mining Business Permit (IUP) which is planned for mining from the 2024-2029 period is 5,199 hectares.

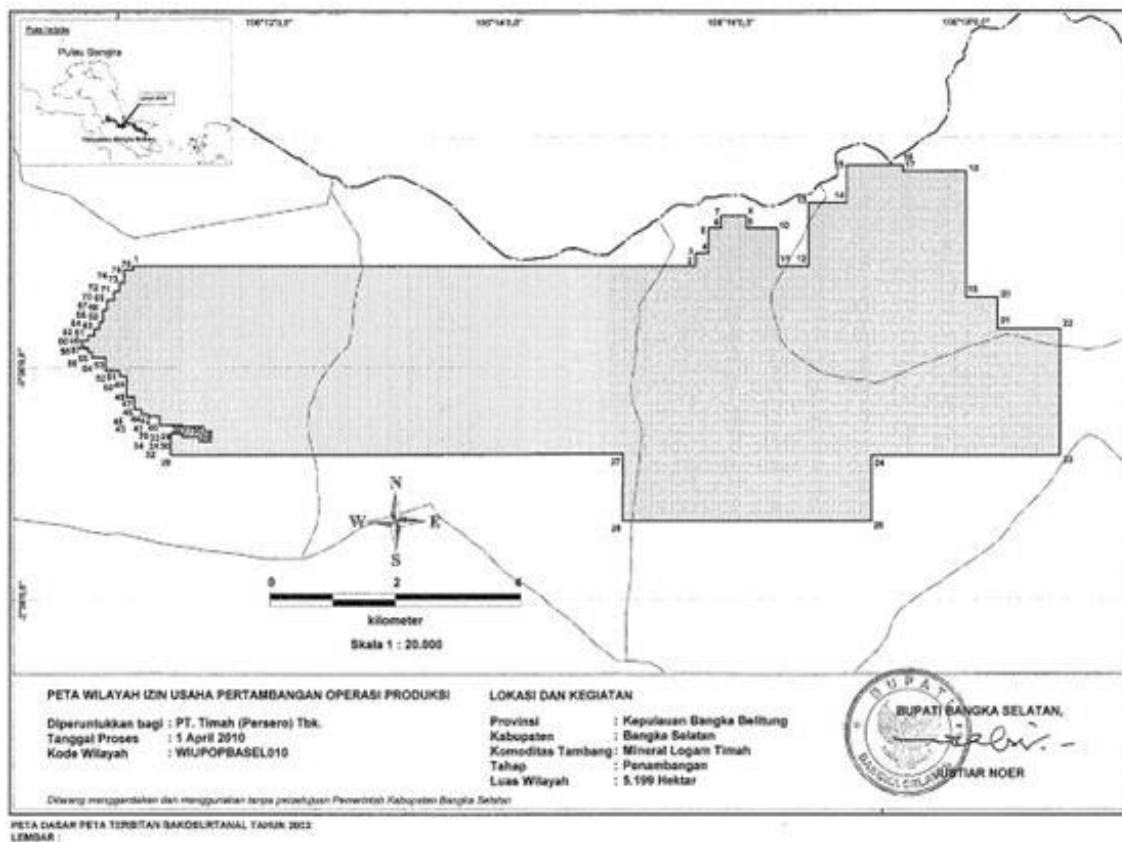


Figure 1. (a) Map of PT. Timah.Tbk. Mining Business Permit (IUP) Area

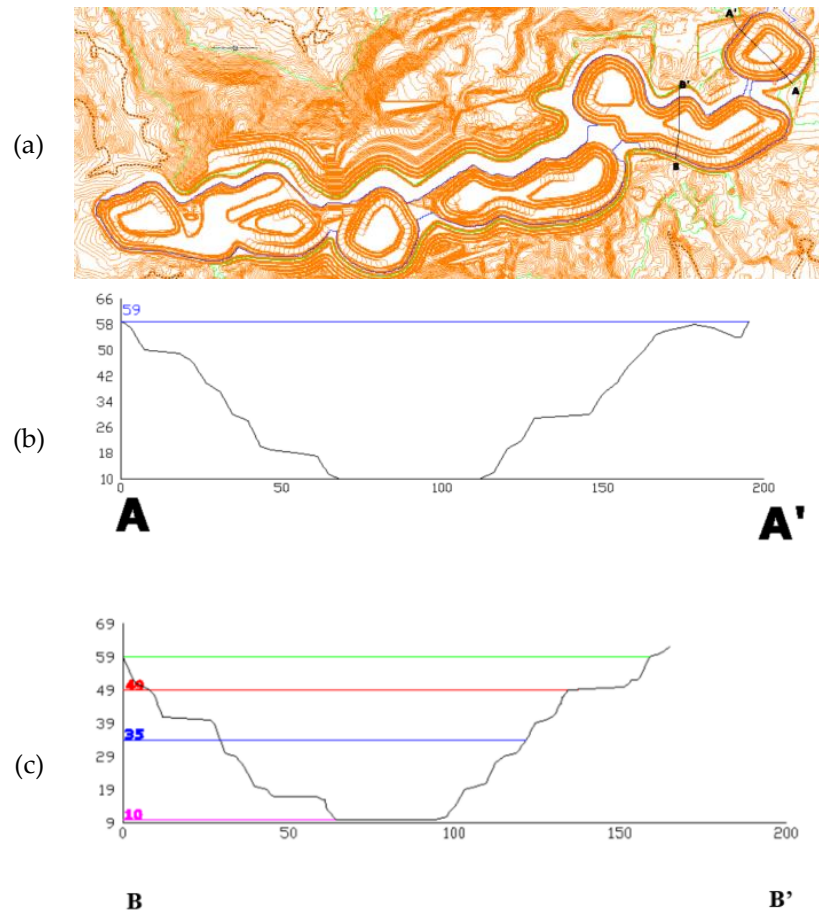
## METHODOLOGY

Minister of Energy and Mineral Resources regulation no 1827 of 2018 states that every IUP holder must carry out reclamation. Reclamation activities are activities carried out to restore land according to its designation. Reclamation activities need to do reclamation planning. Reclamation activities include land use management activities, land clearing plans, reclamation programs for disturbed land which includes temporary and/or permanent ex-mining land and non-ex-mining land. In planning, it is necessary to calculate costs for reclamation activities. This fee will be used for reclamation guarantees. Reclamation guarantees can later be taken by companies whose amount is calculated based on success criteria. Success criteria include success standards for land management, revegetation, civil works, and final completion.

The cost of carrying out the reclamation consists of two parts, namely direct costs and indirect costs. Direct costs consist of land use stewardship, revegetation, prevention and control of acid mine drainage, civil works according to land use, & management and utilization of ex-mining pits. Indirect costs consist of equipment mobilization and demobilization, reclamation planning, administration and benefits of third parties as executors of reclamation at the production operation stage, and supervision. In the research conducted by case study, the calculation of the cost of implementing the reclamation plan was carried out.

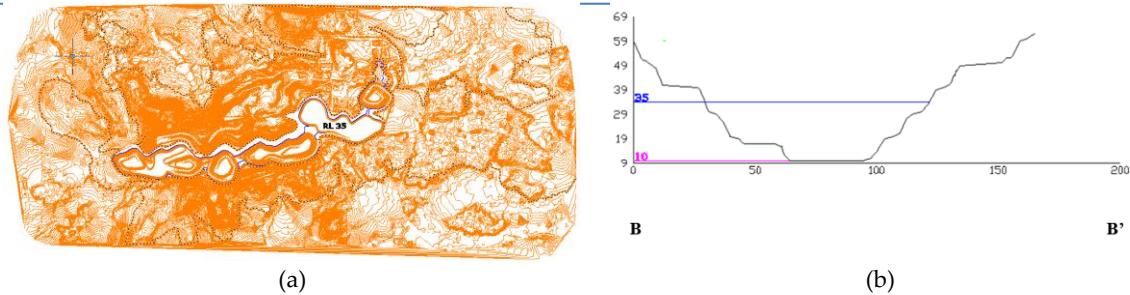
## RESULT

Land reclamation for mining activities at TB Paku PT. Timah. Tbk during the period from 2026 to 2029. Reclamation activities carried out are land structuring by backfilling in ex-mining pits. The ex-mining openings/pits that are being carried out are the east pit (pit A) and the middle east pit (pit B) which are pits that will no longer be active in 2026. (Figure 1). From the picture above, incision A is made in pit A and incision B is in pit B. The side view of the incision will be drawn so that you can get an idea of how much material will be backfilled in the pit. From the incision it appears that the ground floor of the mine is at RL 10 and back filling activities are carried out up to RL 59. At RL 59 is the target height to be achieved adjusted to the surrounding altitude (Figure 2).



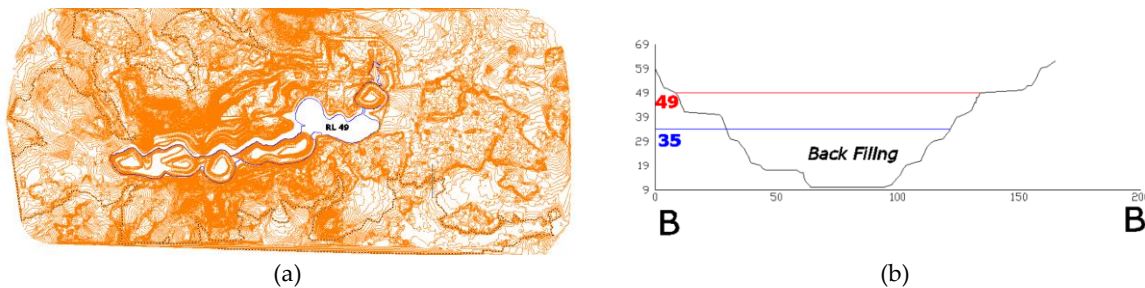
**Figure 2.** Pit TB Paku PT Timah. Tbk Topographic map (a) showing locations of section A - A' (b) and B - B' (c)

From the sections A and B, a total volume of 2,623,400 m<sup>3</sup> was obtained for backfilling with an area of 100,584 m<sup>2</sup> or 10 ha of land being stockpiled. The reclamation plan is planned for 4 years so that the volume to be stockpiled per year is 655,850 m<sup>3</sup>. Stage 1 reclamation will be carried out in 2026 in the former mining area B. According to the productivity target of 655,850 m<sup>3</sup> per year, then backfilling will be carried out from RL 10 to RL 35 with a land area of 4.3 ha. This phase one activity is carried out in 2026 because it is waiting for the Middle East pit or pit B to be inactive (Figure 3).



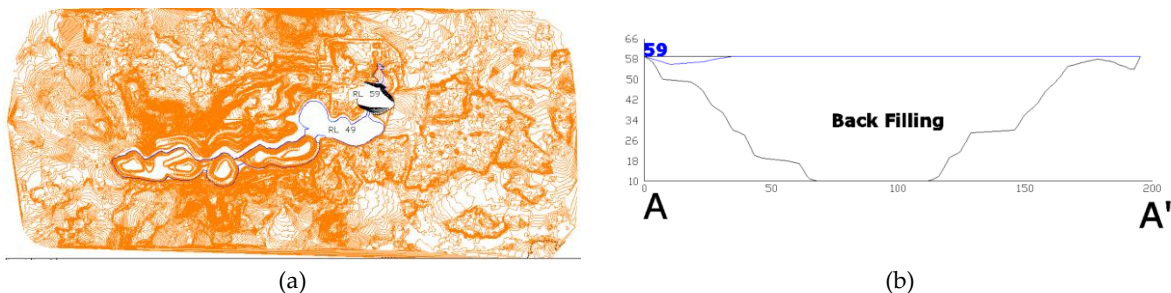
**Figure 3.** Location of Line and Section B of the Reclamation Phase 1

The second stage will be carried out in 2027 by continuing to carry out back filling at the same location from RL 35 to RL 49. Elevation 49 makes the pit level with the mine road to the west pit. With the average elevation of the location, it will be easier to do back filling in the pit at the east end which has not been done back filling. The area of the second stage of reclamation is 5.73 ha and has a volume of 706,776 m<sup>3</sup> for stockpiling. (Figure 4).



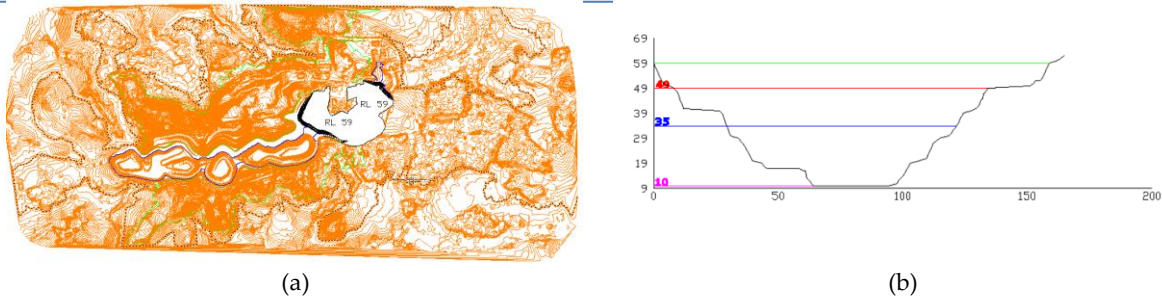
**Figure 4.** Location of Line and Section B of Reclamation Phase 2

The third stage will be carried out in 2028 by backfilling the pit at the east end (Pit A) from RL 10 to RL 59. At RL 59 the pit has the same elevation as the surrounding conditions. The area of the second stage of reclamation is 2.5 ha and has a volume of 548420 m<sup>3</sup> for stockpiling. (Figure 5).



**Figure 5.** Location of Line and Section B of Reclamation Phase 3.

The fourth stage will be carried out in 2029 by back filling the pit which is in the middle east continuing from RL 49 to RL 59. At RL 59 the pit has the same elevation as the position of the surrounding conditions, especially with the back filling pit at the east end. The area of the second phase of the reclamation is 7.8 ha and has a volume to stockpile of 679545 m<sup>3</sup>. (Figure 6).



**Figure 6.** Location of Line and Section B of Reclamation Phase 4

The fourth stage is the last stage in the reclamation process at PT. Timah Tbk because 2029 is the last year of PT. Timah.tbk performs production operations according to the age of the mine. After all mining activities have been completed PT. Timah will also carry out backfilling of ex-mining mines in the middle and west as a post-mining activity. Considering the safety factor in stockpiling overburden based on Minister of Energy and Mineral Resources Regulation No. 1827 of 2018, slopes are made with a horizontal: vertical ratio of 2: 1. The position and dimensions of the slopes can be seen in Figure 7. Meanwhile, to minimize erosion, a cover crop is planted on the embankment surface. This revegetation or replanting activity is carried out on piles of waste in former mine openings that have been backfilled. After arranging the area, it is filled with topsoil and sprinkled with cover crops, namely: the legume family or legume cover crop (LCC).



**Figure 7.** Situation (a) and dimension of disposal area (b)

To carry out back filling activities, it is necessary to carry out calculations to find out the number of loading and transport equipment needed. The equipment used is the same as the equipment used for mining activities. The planned annual stockpiling volume target is obtained from the total volume of the pits to be filled divided by the reclamation time. The total volume to be stockpiled is 2,623,400 m<sup>3</sup> divided by the planned duration of the reclamation activity for 4 years. So the target volume of landfilling per year is 655,849 m<sup>3</sup>. This data can be used as a basis for determining the amount of equipment used. The types of equipment used are Dozers, Excavators, and Dump trucks. The types of equipment used are the Komatsu D85 A Dozer, the CAT 320 D Excavator, and the Scania P410 dump truk.

### Dozer Productivity & Unit Requirement

The dozer used is Komatsu D85A (Figure 8 a) with the required specifications. Heavy Equipment Brand : Komatsu D85 A; Blade Capacity : 3.4 m<sup>3</sup>; Blade width (L) : 4.26 meters; Blade height (H): 1.74 meters; Working distance: 100 meters; Forward speed (F): 113 m/min; Reverse speed (R): 143 m/min; Time to change gears (z) : 0.05 minutes; Angle factor (a) : 0.7; Override distance ( D ) : 100 m; Work efficiency (E): 0.71.

**Dozer Productivity (Q)**

$$\begin{aligned}
 Q &= q \times 60/\text{cm} \times E \\
 &= 9,02 \times 60/1,63 \times 0,71 \\
 &= 235,737 \text{ m}^3/\text{jam} \\
 &= 1.332.730 \text{ m}^3/\text{tahun}
 \end{aligned}$$

$$\begin{aligned}
 q &= L \times H^2 \times a \\
 &= 4,26 \times (1,74)^2 \times 0,7 \\
 &= 9,02
 \end{aligned}$$

$$\begin{aligned}
 C_m &= D/F + D/R + Z \\
 &= 100/113 + 100/143 + 0,05 \\
 &= 1,63
 \end{aligned}$$

Number of dozers = (Production Target)/(Dozer Productivity) = 655,850/(1,332,730 ) = 0.49 ~ 1 unit



(a)



(b)

**Figure 7.** Dozer Komatsu D85 A (a) and Excavator CAT 320 D (b)

**Excavator Productivity & Unit Requirement**

The excavator used is CAT 320 D (Figure 8 b) with the required specifications. Heavy Equipment Brand: CAT 320D; Bucket Capacity : 1.19 m<sup>3</sup>; Bucket Fill Factor : 0.08; Track Length: 4450 mm; Machine type : Net Power ISO-9249 117 KW; Working weight: 22,000 kg; Tank capacity: 345 liters; Work efficiency (E): 0.71; Digging time: 14 seconds; Payload swing time: 7 seconds; Dumping time: 6 seconds; Empty swing time: 7 seconds

Production target = amount of material to be back filled per year = 655,850 m<sup>3</sup>

Working time = 5,663 hours/ year

Total circulation time = 34 seconds

$$\begin{aligned}
 q &= 1.9 \text{ m}^3 \times 0.80 \\
 &= 1.52 \text{ m}^3
 \end{aligned}$$

$$\begin{aligned}
 Q &= (1.52 \times 3600 \times 71.2)/34 \\
 &= 120.70 \text{ m}^3/\text{hour}
 \end{aligned}$$

$$\begin{aligned}
 Q \text{ per year} &= 120.70 \text{ m}^3/\text{hour} \times 5663 \text{ hours/year} \\
 &= 683,524.1 \text{ m}^3/\text{year}
 \end{aligned}$$

$$\begin{aligned}
 \text{Need for excavators} &= \frac{\text{Annual Production Target}}{\text{Annual excavator productivity}} \\
 &= \frac{655.850}{683.524,1} = 0.95 \sim 1 \text{ excavator / year.}
 \end{aligned}$$

## Dump Truck Productivity & Unit Requirement

The dump truck used is Scania P410 with the following specifications. Vessel Capacity : 20 m<sup>3</sup>; Vessel Length : 6 m; Vessel Width : 2.5 m; Vessel Height : 1.5 m; Working time : 5663 hours/year; Work efficiency (E): 0.71.

Dump truck productivity (Q)

$$\begin{aligned} Q &= ((C \times 60 \times E))/CM \\ &= ((20 \times 60 \times 0,71))/28,64 \\ &= 29,74 \text{ m}^3/\text{ hour} \\ &= 168.428,517 \text{ m}^3/\text{ year} \end{aligned}$$

C : Average dump truck capacity (m<sup>3</sup>)

Cm : Distribution time

E : Work Efficiency

$$\begin{aligned} CM &= n \times cms \times D/V1 \times D/V2 \times t1 \times t2 \\ &= 13,15 \times 0,56 \times 1540/333,33 \times 1540/666,66 \times 1,2 \times 0,3 \\ &= 28,64 \end{aligned}$$

$$\begin{aligned} n &= c/((q' \times k)) \\ &= 20/((1,9 \times 0,8)) \\ &= 13,15 \end{aligned}$$

n : the number of cycles required by the loader to load the truck

c : average dump truck capacity (m<sup>3</sup>)

q' : loading bucket capacity (loader / excavator, minutes) (m<sup>3</sup>)

k : bucket fill factor

Cms : Load cycle

D : Dump truck hauling distance

v1 : average speed of loaded dump trucks (m/min)

V2 : average speed of empty dump truck (m/min)

T1 : dump time, standby until discharge start (minutes)

T2 : time for filling and loading positions to start filling (minutes)

Number of dump trucks needed = (yearly production target)/(dump truck productivity) = (655,850) / (168,428,517) = 3.89 ~ 4.

## CONCLUSION

PT Timah Tbk in the implementation of reclamation is carried out for 4 years from 2026 - 2029. In implementing this reclamation, one of the activities carried out is to backfill the ex-mining pits. The total material to be used for backfilling is 2,623,400 m<sup>3</sup>. The required equipment used for backfilling the material is 1 Dozer type Komatsu D85A, 1 type excavator CAT 320, and 4 dump trucks type scania P410.

## ACKNOWLEDGMENTS

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