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Mine Development and Operation (MDO) Planning Study of Temporary Ore Stockpile (TOS) at Laterite Nickel Mining Central Halmahera Regency North Maluku Province

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Abstract. Mine development and operation (MDO) is a construction process in the development and operation of mines to provide areas for the construction of facilities and infrastructure such as road construction, Temporary Ore Stockpile (TOS) sites, Permanent Ore Stockpile (POS) locations, etc. The purpose of this research is to manage the mine out area in the MDO TOS planning so that it can increase nickel production at the CUU site at PT. IWIP, which is located in Central Halmahera Regency, North Maluku Province. MDO TOS planning is carried out for 2 weeks. The basic design considerations refer to the data provided by the company, such as the MDO TOS area design, topographical survey, cut and fill, laminating. Processing of MDO TOS planning data in this study used Surpac Gemcom 6.3 software. From the results of data processing, the cut volume was 14,382 BCM, the fill volume was 8,599 BCM, and the laminating volume was 20,303 BCM.

Keywords: Nickel Laterite, Mine Development and Operation, Temporary Ore Stockpile (TOS)

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1. Introduction

Central Halmahera is an area that has nickel laterite potential managed by PT. Weda Bay Nickel (PT. WBN), as the owner of the Mining Business License (IUP) for production operations and the largest nickel processing industry in Eastern Indonesia, namely PT. IWIP. [1]

PT. IWIP was established on August 30 2018 and will be the first integrated industrial area in the world that will process mineral resources from the mine mouth into final products in the form of electric vehicle batteries and steel.[2]

The mining industry is a series of activities that have a long period of time and a lot of costs. A series of industrial activities, namely digging, loading and hauling. In this activity, of course, the role of Mine Development and Operation (MDO) is very much needed, because from the above activities ore must require a place to store it, so that its quality and grade can be maintained. Mine Development and Operation (MDO) is the development and operation of a mine where the Temporary Ore Stockpile (TOS) is used as a temporary ore storage facility. In planning MDO TOS, it must require a well-thought-out plan both in terms of the ability to accommodate ore and the durability of the floor, because the small capacity to accommodate it will affect the production process.

The purpose of this research is expected can find out in detail about the MDO TOS- 8 planning process for the management of the mine out area s as a temporary ore stockpiling place so as to increase nickel production at the CUU site at PT. IWIP, Central Halmahera Regency. The objective from this activity: Get to know how the world works in mining companies, especially in PT RIM, Central Halmahera, make a planning location plan MDO (Mine Development and Operation) TOS (Temporary Ore Stockpiles), calculating the volume of cut and fill and laminating planning MDO (Mine Development And Operation) TOS (Temporary Ore Stockpile).

2. Literature Review

Nickel laterite deposits are the result of further weathering of ultramafic rocks bearing Ni-Silicate. Generally found in areas with tropical to subtropical climates. The influence of the tropical climate in Indonesia results in an intensive weathering process, so that several areas in Indonesia have a thick profile of laterite - the products of weathering and make Indonesia one of the main laterite nickel producing countries. The process of nickel concentration in laterite nickel deposits is controlled by several factors, namely, bedrock, climate, topography, groundwater, mineral stability, elemental mobility, and environmental conditions that affect the level of mineral solubility. [3]

In nickel mining, if the excavated material has found bedrock , the area is mined out and used as MDO TOS, POS, etc. planning.

Mine Development and Operation (MDO) is a

planning project for the management of the mine out area as a temporary ore stockpile in order to increase daily nickel production. Explanation from KMC (2020) that Mine Development and Operations (MDO) is a development and operation of a mine in the process of preparing an area for the construction of a mining facility.

In the MDO planning, it is determined based on the area that has been mined out, seen from the mine out map made by the Mine Planning Department with a mine out area of 36.3 Ha. (Figure 1). However, if conditions are at the start of mining and there is no temporary ore stockpiling place, then you can use an area where ore is still available for a while. Mine out is an area where mining deposits or mining materials have been taken where there is no material at the bottom. [4]

The first step for MDO TOS planning is to make a design based on the mine out map, so that in determining the design for the planning area it is adjusted to the needs of the existing reserves. Then a topographic survey was carried out to determine the original condition of the field before the cut and fill process was carried out . The topography survey can be in the form of land topography that has not been disturbed by humans, such as forests. [5]

After the topographic survey stage is completed, the cut and fill stage is the process of digging and then stockpiling material to create the same elevation. According to Fajrin et al., (2019) cut and fill is one of the terms in construction which is known as digging and filling an area with a specified elevation. Erianda also explained (2022) that the cut and fill process is carried out to facilitate earthworks, namely by processing data on sloping land so that it becomes flat land, not only that the cut and fill process also produces a calculation of the volume of soil so that the soil that is removed and the land that is stockpiled is in accordance with the rules so that it does not become eroded and even landslides. [8] Added by Ali and Nasrudin (2017) that the purpose of cut and fill is to change the geometry of the slope, both the angle of the slope, the height of the slope and changing the shape of the slope to a terraced one. [6]

After the cut and fill process is complete, then proceed to the laminating process to coat the TOS base with rock material to create a strong floor. Laminating base using rock to harden the mining area so that the terrain conditions are not easily muddy during the rainy season. [7]

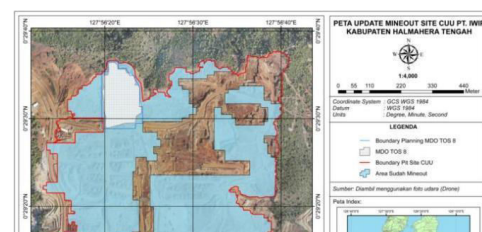


Fig. 1 CUU Mine Out Site Map

3. Research Methods

Technical and operational planning aims to map the layout of the planned mine out area as the MDO TOS site. From this planning, it can be carried out using a quantitative method because an operational analysis is carried out by taking field data related to the coordinates and elevation of the TOS area by carrying out topographical mapping (original, cut and fill and laminating) to calculate the volume MDO TOS using surpac gemcom 6.3 and qualitative methods in the form of observation and direct observation in the field and technical documentation.

4. Results and Discussions

1.1 Results of the MDO Planning Topographic Survey TOS-8

Topographical measurements were carried out using an RTK (Real Time Kinematic) tool to describe the appropriate terrain conditions in the field at various altitudes. The data is used as a reference in the cut and fill process because the highest elevation will be excavated and the lowest elevation will be backfilled. The MDO planning area is 23,293 m² (Figure 2).



Fig. 2 CUU Mine Out Site Map

Survey activities are also used to determine terrain configurations such as crest, toe and base measurements. It is important to determine the direction and boundaries that will be carried out by the process of digging and stockpiling according to a predetermined plan.

1.2 Crest Measurement

Crest is measured using a Real Time Kinematic (RTK) tool to describe the head of the slope/ level, according to SOP using strings of 2 blue lines with 15 data, measured randomly consisting of strings, X coordinates, Y coordinates and survey date. (Figure 3).



Fig. 3 Crest Measurement

1.3 Toe Measurement

Toe is measured using a Real Time Kinematic (RTK) tool to describe the foot part of the slope / level, according to the SOP using a string of 3 green dotted lines with 16 data, measured randomly consisting of a string, X coordinates, Y coordinates and survey date. (Figure 4) and (Table 1).



Fig. 4 Toe Measurement

1.4 Base Measurement

Base is measured using the Real Time Kinematic (RTK) tool to describe the bottom of the mine floor which refers to the floor or bottom of the soil mass that forms the mining site. In accordance with the SOP using a string of 500 yellow dots with 17 data, measured randomly consisting of strings, X coordinates, Y coordinates and survey date . (Figure 5)



Fig. 5 Base Measurement

1.5 Topographic Survey Data

The data from the topographic survey results were taken on December 14, 2022 and then processed using the Surpac Gemcom 6.3 software with the str format with a random distribution pattern of points which can be seen in (1) (Figure 6). The results of the string data modeling are then DTMed so that they can be seen in 3D which illustrates that the topographic survey areas still have various heights with the highest elevation being 191 masl and the lowest elevation being 186 masl (2) (Figure 6).

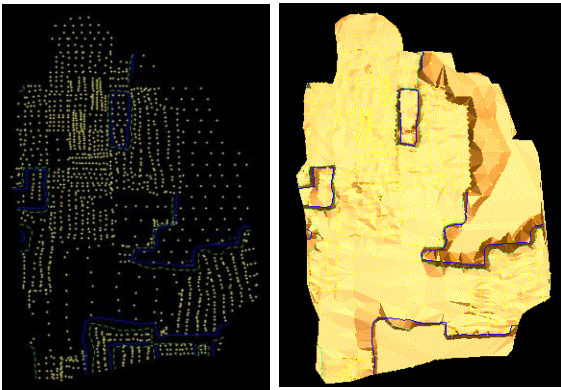


Fig. 6 Topographic Survey Processing Results

1.6 Volume Cut and Fill MDO TOS-8

This process is used when the situation's topography is uneven or sloping, and the desired construction requires a flat surface. The process of digging and filling involves digging up soil from high areas and using it to fill in low areas. This process can be carried out with the help of heavy equipment such as bulldozers and excavators (Figure 7). To calculate the volume of cut and fill soil, topography measurements can be carried out using a Real Time Kinematic (RTK) measurement tool (Figure 8).



Fig. 7 Cut and Fill Process



Fig. 8 Cut and Fill Topography Measurement

The data obtained from the cut and fill topography results are string data, Y coordinates, X coordinates, elevation (Z) and survey dates. In accordance with the SOP, cut and fill topographic modeling uses a string of 400 purple dots, because the terrain already looks flat, so only one string is used with 39 data taken. Then the data is processed using surpac gemcom 6.3 and then DTMed so that it can see the field conditions in 3D (Figure 9).

The data from the topographic survey results above were taken on December 22, 2022 and then processed using the Surpac Gemcom 6.3 software with the str format with a random distribution pattern of points which can be seen in (1) (Figure 9). The results of the string data modeling are then DTMed so that they can be seen in 3D which depicts the topographical survey results area which has the same elevation as 190 meters above sea level (2) (Figure 9).

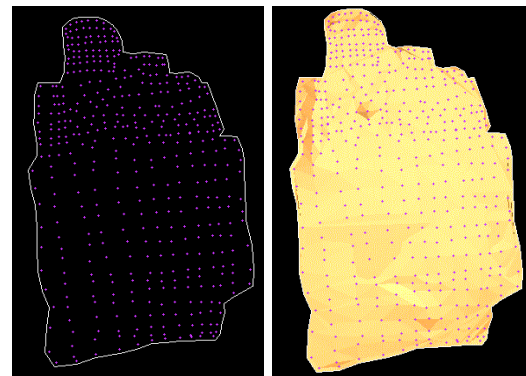
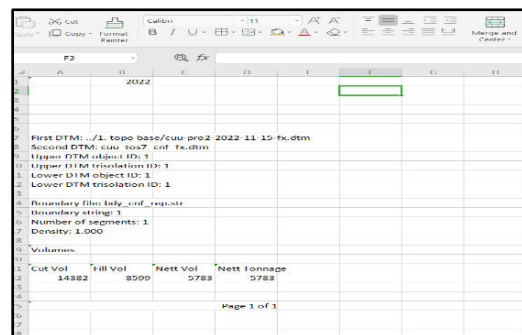


Fig. 9 Cut and Fill Topographic Processing Result



| Volumes | | | |
|---------|----------|----------|--------------|
| Cut Vol | Fill Vol | Nett Vol | Nett Tonnage |
| 14382 | 8509 | 5783 | 5783 |

Fig. 10 Cut and Fill Topographic Processing Result

From Figure 10. above the results of the volume *cut report* are 14.382 BCM and a *Fill* of 8.599 BCM.

1.7 MDO TOS-8 Laminating Volume

Laminating is done to keep the durability of the floor hard and strong to accommodate a number of ore - nickel which will be hauled from loading and of course so that the TOS area is resistant to collapse when it rains. This process can be carried out with the help of heavy equipment such as bulldozers and compactors (Figure 11). The provision for laminating material is in the form of stone dominant waste material with a thickness of ≥ 1 meter. Calculation of cut and fill soil volume can be carried out by measuring topography using a measuring tool in the form of RTK (Real Time Kinematic) (Figure 12).



Fig. 11 MDO TOS 8 Laminating Process



Fig. 12 MDO Laminating Topography Measurement TOS-8

The data obtained from the cut and fill topography is data string , Y coordinate, X coordinate, elevation (Z) and survey date. In accordance with the SOP, laminating topography modeling uses a string of 700 green dots, because the terrain looks flat or level so only one string is used with 40 data taken. Then the data is processed using surpac gemcom 6.3 and then DTMed so that you can see the terrain conditions in 3D in (Figure 13).

The results of the cut and fill topography above were taken on December 30 and then processed using the Surpac Gemcom 6.3 software with the str format with a random dot distribution pattern as shown in (Figure 13). The results of the string data modeling are then DTMed so that they can be seen in 3D which depicts the topographical survey results area which has the same elevation as 190 meters above sea level (Figure 13).

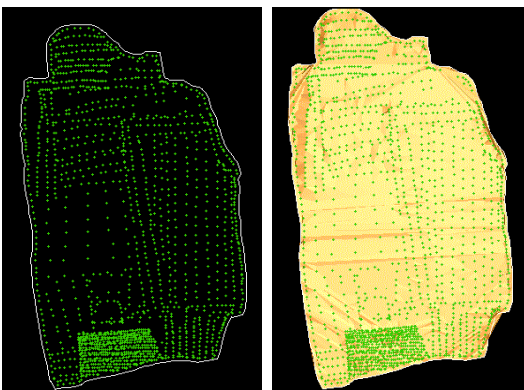
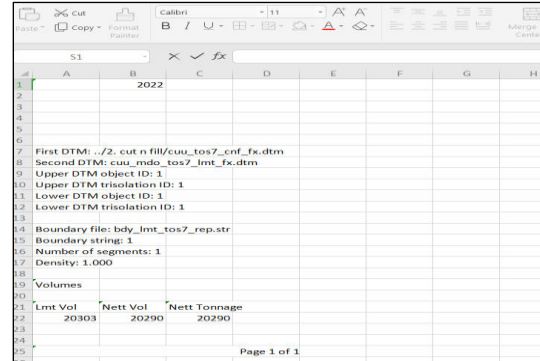


Fig. 13 Cut and Fill Topographic Processing Results



| Volumes | | |
|---------|----------|--------------|
| Lmt Vol | Nett Vol | Nett Tonnage |
| 20303 | 20290 | 20290 |

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Fig. 14 Results Report Volume Laminating

From (Figure 14) above the report results of the laminating volume of 20.303 BCM. The information obtained after processing the data on the Surpac Gemcom 6.3 software is in the form of topographical survey results, cut and fill volumes and laminating volumes. After obtaining information from these results, it can be seen how much volume of material was cut and filled as well as how much volume of material was used when laminating in the MDO TOS 8 planning process. The cut volume was 14.382 BCM, the fill was 8.599 BCM and the laminating was 20.303 BCM. From the results of the volume calculation above, it can be analyzed that the cut and fill volumes have a difference of 5,783 BCM, because based on the survey results of the mine out area , there is still ore that has economic value to mine (Figure 15).

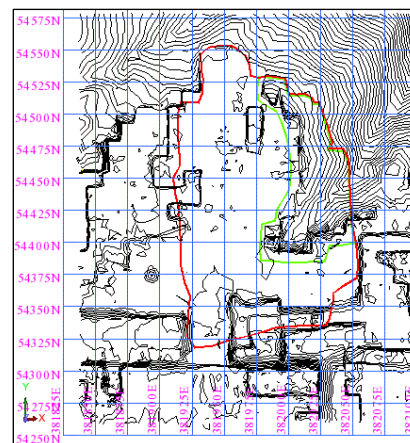


Fig. 15 The Topography of The MDO TOS-8 Area

It can be explained in (Figure 15) above that, the green border with slightly wavy topography can be indicated that there is still ore that has economic value which has a COG content of 1.2% of 0.9% to be mined using the selective mining method , so that in the calculation of cut and fill volume there is a difference. And for the laminating volume it is obtained to increase, because in the MDO TOS process the addition of rock material from outside is used as much as 20.303 BCM.

5. Conclusion

Based on the results, it can be concluded that the data on the results of the MDO TOS- 8 planning are as follows: Volume Cut of 14.382 BCM, The Fill Volume is 8.599 BCM, Laminating volume of 20.303 BCM

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