https://doi.org/10.48047/AFJBS.6.15.2024.10092-10099

African Journal of Biological Sciences
Journal homepage: http://www.afjbs.com
Research Paper Open Access

FEASIBILITY STUDY OF WASTEWATER FROM PT. WUTAMA TRI MAKMUR MARBLE MINING SITE IN KALABIRANG VILLAGE, MINASATE'NE DISTRICT, PANGKEP REGENCY FOR USE BY THE COMMUNITY AROUND THE MINE

Didik Eka Saputra[1], Hazairin Zubair [2], Meutia Farida[3]

[1]Magister Program of Environmental Management Study Program, Postgraduate School, Hasanuddin University, Makassar, 90245, Indonesia
[2]Department of Soil Conservation, Faculty of Agriculture, Hasanuddin University, Makassar, 90245, Indonesia
[3]Faculty of Geological Engineering, Hasanuddin University, Makassar, 90245, Indonesia

Volume 6, Issue 15, Oct 2024

Received: 15 Sep 2024

Accepted: 05 Oct 2024

Published: 25 Oct 2024

doi: 10.48047/AFJBS.6.15.2024.10092-10099

Abstract

Pangkep Regency, precisely in Minasate'ne District, has a fairly rich potential for natural resources, both physical and non-physical potential. One type of activity to utilize existing natural resources is marble mining activities in Minasate'ne District, Pangkep Regency. However, this mining activity also has an impact on environmental conditions, one of which is hydrology and groundwater problems. Currently, the condition of groundwater around the mining area is quite disturbed, especially the condition of the residents' wells which is quite concerning, especially in the dry season where the wells of the community around the mining site have experienced a decrease in the groundwater level at an alarming level. The results of geoelectric measurements for deep groundwater for the Kalabirang Village Area are in the depths of 10.7 – 17.2 meters. Meanwhile, for the area around Bontoa Village, the groundwater position is at a depth of 3.76 – 6.3 meters. The existence of deep groundwater that appears on the mining front of PT. Wutama Tri Makmur has ± 161 Liters / Second but from a physical, chemical and biological perspective it can be concluded that the water at the mining site, absorption ponds and community wells is still at the water quality standard threshold where the pH ranges from 7 -7,8 and TDS 65 - 1292 mg/l.

Keywords: Hidrogeology, Marble mining, Groundwater, Pangkep Regency

1. Introduction

The mining industry is one of the sectors that has a major contribution to the rapid growth of market capitalization in Indonesia. The total contribution to the growth of the domestic product (GDP) of the mining industry averages 7.2% (Estefania, 2021). One of the commodities that is cultivated is marble that is sold in the form of chunks or that has been processed first with a local and export market share. The characteristics of marble can be influenced by the differences in the metamorphism processes that occur and can give special characteristics to the rock yield both from physical properties and chemical compounds (Fatoye and Gideon, 2013; Hadyan, et al., 2015).

Marble is one of the natural resources that are quite abundant in the world, marble stones are often found as home decoration stones, as stones used for floors, walls, not furniture such as tables, benches and so on. Marble stone has a fairly high economic value so that with the existence of mining in Minasate'ne District, Pangkep Regency, it is hoped that it can improve the socio-economic improvement of the community around marble mining.

Although it provides economic benefits, there is one main problem of this marble mining activity, namely environmental problems, one of which is the influence of this mining activity on the condition of groundwater around the mining site. The result of this mining activity, especially if the mining digs down to cut the aquifer layer, is the deeper the groundwater table or the pollution of groundwater.

Due to mining activities, the water that comes out of the mining site as wastewater becomes cloudy and seems unsuitable for use. Seeing this, research was conducted on this wastewater to find out whether it is suitable for use or not. Based on the above background, the research "Feasibility study of wastewater from PT. Wutama Tri Makmur marble mining site in Kalabirang Village, Minasate'ne District, Pangkep Regency for use by the community around the mine".

2. Materials And Methods

The tools used during the study were: global positioning system (GPS) and compass used to determine the location of the sampling point, rool meter, sample bottle, piece of paralon pipe, ice box, latex gloves, filter paper, cool box, sample bag, enough label paper, lup used at the time of identification. The temperature is measured using a thermometer on a scale of 0 – 100°C, the degree of acidity is measured with a pH-meter. Geoelectric data using the Naniura NRD 300 HF. The materials used include water samples, sediment samples, and test equipment in the laboratory.

The data analysis of this study used is a descriptive analysis method by presenting the results of conditions in the field. The chemical physical conditions measured were temperature, suspended solids (TSS), pH, dissolved oxygen (DO), BOD, and COD. All data is processed using Microsoft Excel for Windows software, the results are displayed in the form of graphs. Water quality is analyzed by comparing the water quality of the measurements with the water quality classification as mentioned in Government Regulation Number 22 of 2021 in Appendix VI: National Water Quality and South Sulawesi Governor Regulation No. 69 of 2010 concerning Water Quality Standards and Liquid Waste. For the depth data of residents' wells and geoelectric data at the research site, it is processed with software and overlayed using ArcGIS software to determine the location and make a map so that later it can be known which areas are affected or influenced by using intervals and color ranges on the map.

3. Results And Discussion

Surface Water (Shallow Ground Water)

The initial cycle of shallow groundwater level in the area around the mining and processing site of PT. Wutama Tri Makmur will experience a gradual decrease in shallow groundwater level in the dry season, but before reaching dry conditions, the rainy season arrives so that the shallow groundwater level rises again, resulting in the community's wells around the mining site never being in a dry condition.

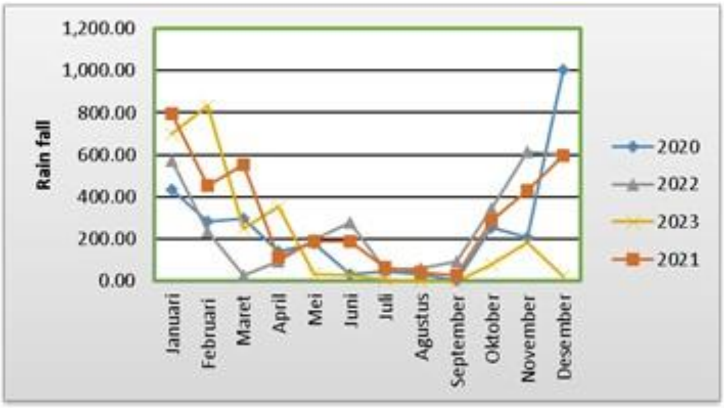

Figure 1. Rainfall Graph for the Last 4 Years in Minasate'ne District

Based on rainfall data from Minasate'ne station for the last 4 years, the highest rainfall was in December 2020 with rainfall reaching 1005.41 mm with 25 rainy days during December 2020. Meanwhile, the lowest rainfall or longest dry season occurred in September to October 2023 when there was no rain.

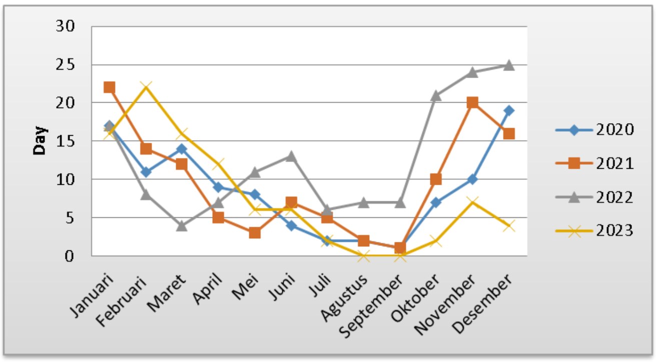

Figure 2. Rainy Days Graph for the Last 4 Years in Minasate'ne District

From the results of a study comparing shallow groundwater level data, data was obtained that the height in the air surface (shallow groundwater) is influenced by rainfall factors, height and depth of wells of residents around the mining location. This is proven by the monitoring results of all wells that were previously dry and filled again with surface air, except for the well 07 observation location which was still dry. This is because the depth of the well is 6 meters with an elevation of 12 meters above sea level, almost the same as the initial mining elevation. If the depth of the well is increased, it is likely that you will find fine soil that is relatively stable.

PT. Mining Location Wutama Tri Makmur is located in a valley area where in the eastern and southern parts there are rows of limestone hills so that the direction of surface air when entering the rainy season will be towards the current mining location.

PT. Wutama Tri Makmur which is towards the bottom of the surface (elevation -14 meters from the initial condition) will of course have an impact on reducing the level of penetrating ground water because some of the ground air is towards the front of PT's mining. Wutama Tri Makmur. This of course has an impact on several community wells that use shallow groundwater experiencing drought. However, some other residents use deep ground ater so it doesn't have much of an impact, especially during the dry season.

Another factor that also plays a role in the dry condition of several residents' wells is the presence of many fracture structures in the limestone in the Kalabbirang and Bontoa areas and their surroundings. These fractures are directed relatively northeast - southwest, thus accelerating the process of lowering the shallow ground water level towards the mine opening location. whose elevation is lower.

Residents' wells in the north and south do not experience drought conditions during the dry season because the shallow groundwater source comes from springs at the Lamsang tourist attraction. This is proven by data from field measurements showing different conditions between the surface water at the PT mining location. Wutama Tri Makmur and residents' wells located in the western part of the PT Wutama Tri Makmur mining location. Apart from that, there is also a thick layer of limestone that separates the two locations.

Deep Groundwater Condition

The lithology of the data collection area is examined using regional geological maps. So with this reference, we can estimate the possible layering model from the interpretation of geoelectrical data in the form of the resistivity values of the rocks. According to Suyono, the resistivity values of the rocks above can be grouped as follows:

- sandstone with a resistivity of 50-500 ohm meters,
- groundwater with a resistivity of 30-100 ohm meters,
- conglomerate rock with a resistivity of 100-500 ohm meters,
- andesite group with a resistivity of 100-2000 ohm meters,
- granite group with a resistivity of 1,000 - 10,000 ohm meters,
- tuff with a resistivity of 20-200 ohm meters (Suyono,1978).

Limestone according to Loke (2006) has a resistivity value of 50-400 ohm meters, and clay according to Roy E. Hunt (1984) has a resistivity value of 3-15 ohm meters, as well as a list of resistivity according to Halide (1984). After interpreting the data, it was carried out using the curve matching method with a model of the
layer of the earth below the surface..

The measurement results at all measurement points have a pH value of 7 – 7,8. This is because groundwater originating from limestone with a chemical structure in the form of calcium carbonate ($CaCO_3$) dissolves with water (H_2O), then a chemical process occurs where the Ca^{2+} element binds OH- to become $Ca(OH)_2$. A pH value of 7 -7,8 is within the required range, namely 6.5–9 for BMA clean water standards.

From all locations where observations were made, it was found that the average temperature of well water was still within the maximum allowable temperature range (28–35.8 ^{o}C) and the average was classified as a normal water temperature, so that from this parameter there were no indications of water pollution.

Figure 3. The appearance of wastewater from the mine site

The measurement results on groundwater samples and well water samples had a TDS content of between 65 – 1292 mg/l. The measurement and test results are still below the maximum threshold for clean water quality with a maximum TDS limit of 1500 mg/l. The increase in TDS values in several locations was caused by the influence of the rainy season so that surface runoff water seeped into the ground. Apart from that, there are also ponds that collect water from groundwater at mining sites as groundwater infiltration that seeps into the ground mixed with shallow groundwater. So it has a high TDS content but is not cloudy, this shows that the level of light intensity in the water is still stable due to the high TDS content.

Organic Chemistry

From the results of laboratory tests on shallow and deep groundwater samples around the PT mining site. Wutama Tri Makmur obtained the following chemical analysis results:

- The free chlorine (Cl2) content of the sample analysis results has a value of <0.02 mg/l which is still below the maximum threshold allowed, which is ≤ 1 mg/l for clean water.
- The test results show that the nitrite content at the study location is 0.003 - 0.0045 mg/l. This value is below the maximum threshold required for clean water. Nitrite compounds in certain amounts (<1 mg/l) are very useful for body growth, especially for aquatic plant life.
- The Nitrate content in the sample is 0.03 - 0.04 mg/l, below the maximum threshold required, which is ≤ 15 mg/l for the BMA (Water Quality Standard) standard which is intended for clean water.
- The Sulfide (H2S) content is ≤ 0.012 mg/l. All samples are below the maximum threshold allowed for clean water (≤ 0.05 mg/l).
- Detergent content (MBAS) from the test results is ≤ 0.05 mg/l. All samples are below the maximum threshold allowed for drinking water (≤ 5 mg/l).

Metal Parameter

From the results of laboratory tests on shallow and deep groundwater samples around the mining location of PT. Wutama Tri Makmur obtained the following chemical analysis results:

- The Zinc (Zn) content of the sample analysis results has a value of <0.022 mg/l which is still below the maximum threshold allowed, which is ≤ 4 mg/l for clean water quality.
- The test results show that the Iron (Fe) content at the study location is <0.03 mg/l. This value is below the maximum threshold required for clean water, which is ≤ 5 mg/l.
- The Manganese (Mn) content in the two samples is <0.08 mg/l, below the maximum threshold required for clean water, which is ≤ 2 mg/l.
- The Copper (Cu) content is ≤ 0.010 mg/l. All samples are below the maximum threshold allowed for clean water (≤ 1.5 mg/l).

- The Lead (Pb) content from the test results is ≤ 0.02 mg/l. All samples were below the maximum threshold allowed for clean water (≤ 0.1 mg/l).

For marble processing locations, the processing activities require a large amount of water as a rinse aid for cutting and polishing machines. Water from cutting and polishing activities contains a lot of fine material so that it is channeled to the sedimentation pond. Analysis carried out on wastewater from the final sedimentation pond (Pond 3), the results of wastewater sample tests are still below the threshold for quality standards for residential areas, offices, restaurants and businesses based on South Sulawesi Governor Regulation No. 69 of 2010 concerning Quality Standards and Environmental Damage Criteria. The irrigation channels in Bontoa and Kalabirang Villages are water flows originating PT. Wutama Tri Makmur's wastewater processing, so that the level of pollution will affect the economic conditions of the community, some of whom work as farmers and use irrigation channels for agricultural activities.

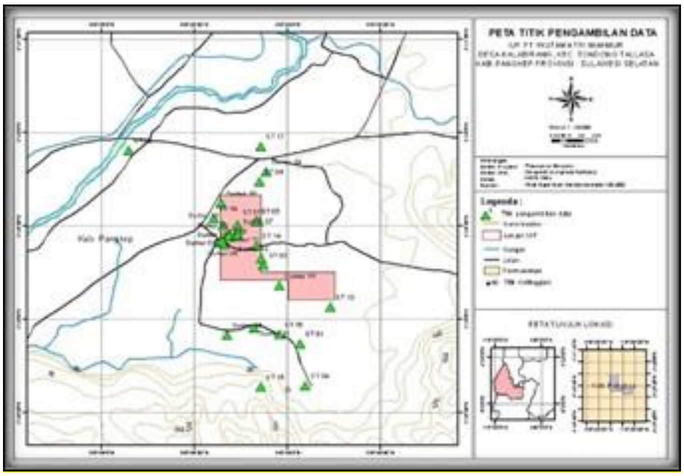

Figure 4. Map of data collection points

Table 1. Water Quality Standards Result of Sample Analysis

No	TEST RESULTS		WATER QUALITY STANDARD RESULTS
	PARAMETERS	ELEMENTAL	
1	Physical	Temperature	Below BMA of clean water
2		Odor	Below BMA of clean water
3		TDS	Below BMA of clean water
4		Flavors	Mostly incompatible with BMA clean water
5		pH	Below BMA of clean water
6	Organic Chemistry	Chloride	Below BMA of clean water
7		Nitrates (NO_3)	Below BMA of clean water
8		Nitrite (NO_2)	Below BMA of clean water
9		Sulfate (SO_4)	Below BMA of clean water
10		Sulfide (H_2S)	Below BMA of clean water
11		Detergent (MBAS)	Below BMA of clean water
12	Metal	Zinc (Zn)	Below BMA of clean water
13		Iron (Fe)	Below BMA of clean water
14		Manganese (Mn)	Below BMA of clean water
15		Cadmium (Cd)	Above BMA of clean water
16		Copper (Cu)	Below BMA of clean water
17		Lead (Pb)	Below BMA of clean water
18	Microbiology	Total Coli	Below BMA of clean water
19	Waste	Below the quality standard threshold for residential areas, offices, restaurants and commerce	

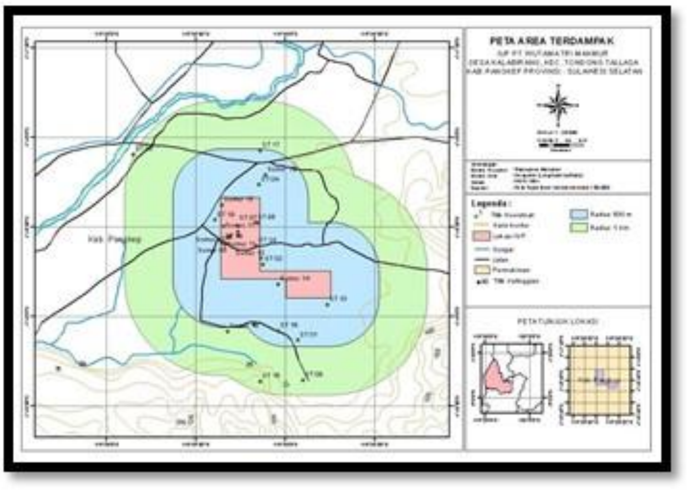

Figure 5. Map of the affected areas of the research area

4. Conclusion

The results of geoelectric measurements for deep ground water for the Kalabirang Village area are within 10.7 – 17.2 meters. Meanwhile, for the area around Bontoa Village, the groundwater is at a depth of 3.76 – 6.3 meters. The presence of deep groundwater that appears at the mining front of PT. Wutama Tri Makmur has a discharge of > 161 Liters / Second. Results of field measurements and laboratory tests on water around the mining area of PT. From a physical, chemical and biological perspective, Wutama Tri Makmur can conclude that the water at the mining site, absorption ponds and community wells is still at the threshold of water quality standards.

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