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Analysis of Water Quality in Wells Around the Pelangan Sekotong Gold Mine in Lombok, Indonesia

Yuni Mirayanti[1*], Lalu Ahmad Didik Meiliyadi[1,2], Ilham[3], Irwan[4], Isniwana Damayanti[2,5]

[1,2,3,4]Departement of Physics Education, Faculty of Education and Teacher Training, Universitas Islam Negeri Mataram, Jln. Gajah Mada 100, Jempong Baru, Mataram, Indonesia
[2]Advance Science and Integration Research Group, Universitas Islam Negeri Mataram, Jln. Gajah Mada 100, Jempong Baru, Mataram, Indonesia
[5]Departement of Natural Science Education, Faculty of Education and Teacher Training, Universitas Mataram, Mataram, Indonesia

*e-mail: 2101080214.student@uinmataram.ac.id

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Abstract. This study was conducted around the Pelangan Sekotong gold mine, Sekotong District, West Lombok Regency. The location was chosen because of the potential for water pollution that could affect the quality of life of the surrounding community. The method used in this study was quantitative with an experimental approach, where well water samples were taken from three points around the mining area. The parameters analyzed included physical aspects (TDS and conductivity) and chemical aspects (mercury, iron, and pH). The results of the study revealed that well water around the Pelangan Sekotong gold mine was contaminated, especially by mercury, which posed a risk to the health of the community. This study provides important information about water quality and potential pollution, which is expected to raise public awareness about the importance of preserving the environment and health. The conclusion of this study is that water pollution around the Pelangan Sekotong gold mine requires serious handling to ensure the sustainability of the ecosystem and public health. This study is also expected to be a reference for students and the community in understanding the impact of mining activities on water quality.

Keywords: Water Source Quality, Physical Parameters, Chemical Parameters, Gold Mining

INTRODUCTION

Indonesia is known as a country with abundant natural resources, including minerals and other agricultural products (Sumardi et al., 2022). One natural resource with high economic value is gold mining. In West Nusa Tenggara Province (NTB), the mining sector contributes significantly to gross domestic product, making it an important sector in supporting the national economy. The Sekotong sub-district, located in West Lombok Regency, is an area with considerable gold mining potential, with activities dominated by the local community. Therefore, it is certain that there is potential for the distribution of mineral resources in the mining sector.

Small-scale gold mining in Sekotong Subdistrict generally uses simple processing methods, such as amalgamation and cyanidation. The amalgamation method can be described as a process of extracting gold by mixing gold ore with mercury (Hg), commonly known as quicksilver. Meanwhile, cyanidation is a shortcut in the gold ore processing method in smaller-scale gold mining to replace amalgamation. Although both methods are very effective on a small scale, their use often neglects environmental safety and health aspects. One of the negative impacts of mining is damage to the environment the environment at mining sites and surrounding areas. This also occurs not only in Indonesia but also in other countries (Sudarningsih, 2021; Toyoda et al., 2022).

The damage can also take the form of water pollution caused by the use of chemicals (hazardous and toxic substances such as mercury) and chemical exposure through mining materials that then contaminate water sources (Nurhidayati et al., 2021). One form of mercury-related water pollution has been proven to cause neurological disorders, such as motor function impairment and learning difficulties in children in Minamata, Japan, which experienced a similar pollution tragedy. In Pelangan, the local community is highly dependent on well water, but this dependence increases the risk of serious illness due to mercury accumulation.

In Sekotong Subdistrict, gold mine waste disposal sites are often located close to wells that are frequently used by the community to meet their daily needs, based on observations that the distance between mine waste disposal sites and community wells ranges from 2 to 5 meters. This increases the potential for well water contamination by mercury and other heavy metals, which can endanger the long-term health of the community (Syuzita et al., 2022).

The quality of water in wells is assessed based on Environmental Health Quality Standards for water used in hygiene and sanitation, covering physical and chemical parameters. These parameters are divided into two types: mandatory parameters and additional parameters (Meiliyadi et al., 2024b). Mandatory parameters are those that must be monitored regularly in accordance with the provisions set forth in applicable laws and regulations. Meanwhile, additional parameters only need to be monitored if geohydrological conditions indicate potential pollution related to these parameters. Well water used for hygiene and sanitation purposes serves to maintain personal hygiene, such as bathing, brushing teeth, and washing, and can also be used as raw water for drinking (Meiliyadi & Syuzita, 2022). In the Environmental Health Quality Standards for water used in hygiene and sanitation, the physical parameters that must be considered include turbidity, color, maximum dissolved solids content, temperature, and ensuring that the water is odorless and tasteless (Ezzeddine et al., 2021).

Various studies have shown that gold mining activities have a significant impact on the quality of surrounding water. However, to date, there has been no study that specifically focuses on the quality of well water around the Pelangan Gold Mine in Sekotong. This is a particular concern, given that the community in the area is highly dependent on well water to meet their daily needs, such as bathing, cooking, washing, and various other household activities. Well water is the main source of clean water for them, so its quality directly affects the health and lives of the community. Therefore, this research is urgent and important, especially to identify whether the well water in the area has been contaminated by hazardous chemicals such as mercury, arsenic, and various other heavy metals that may be produced by gold mining activities. This identification not only aims to provide an overview of the safety level of well water for the local community, but also serves as a first step in formulating better mitigation and environmental management strategies to protect the health of the community and the ecosystem in the area. Through this research, it is hoped that a comprehensive picture of the quality of well water around the Pelangan gold mine can be obtained. The results of this study can also serve as a basis for policy-making for better environmental management and provide protection for the health of communities around the mining area.

RESEARCH METHODS

In this study, the population studied was all wells around the Pelangan Sekotong mine. The sample was well water around the Pelangan Sekotong gold mine located in Sekotong District, West Lombok Regency, with three well water points around the Pelangan Sekotong gold mine (Figure 1). Referring to SNI 06-6989.58-2008 concerning methods for sampling well water, the sampling point for well water must take into account the flow pattern of the well water. Samples can be taken from free (unpressurized) well water and pressurized well water. In this study, well water samples were taken from free (unpressurized) well water, which could come from dug wells or drilled wells. The research flow diagram is shown in Figure 2.

Figure 1. Sample Collection Location

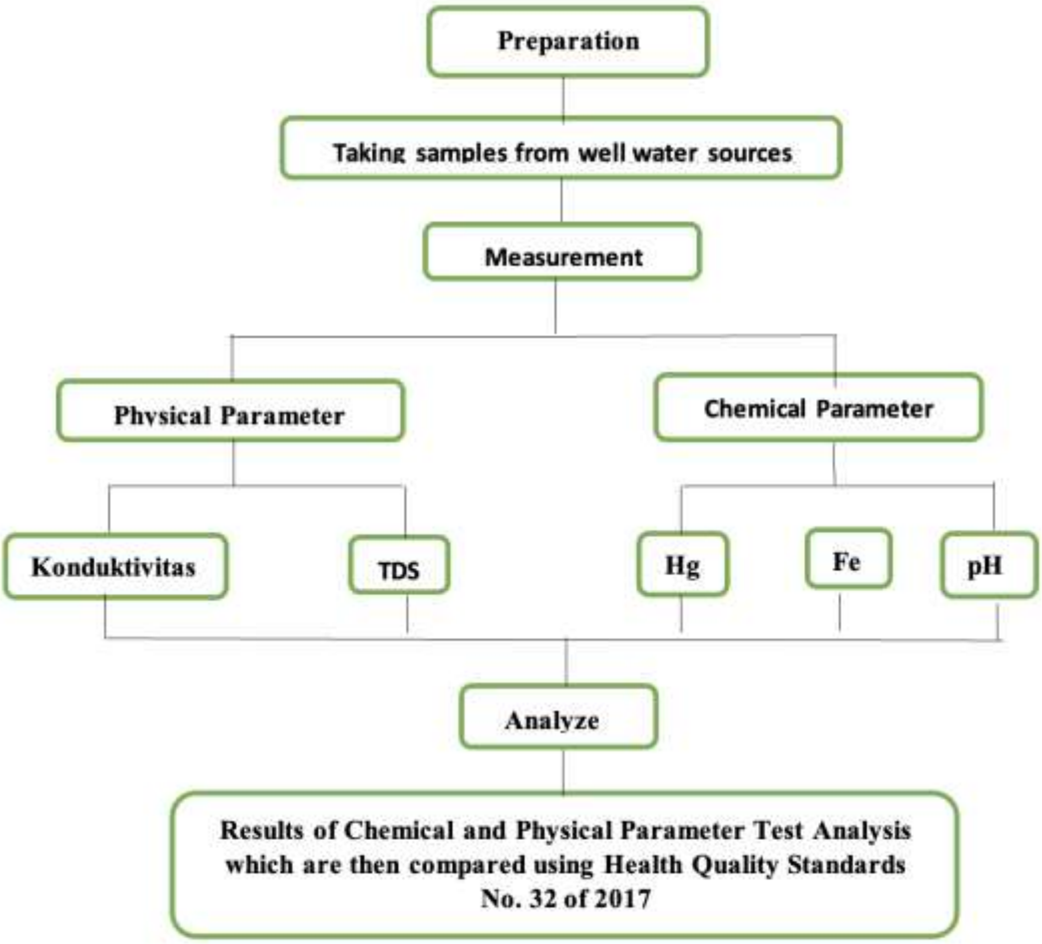

Figure 2. Research Flow Diagram

Physical parameter analysis was performed using a TDS meter, including conductivity and total dissolved solids (TDS) (Nurhidayati et al., 2021). Physical parameter analysis included Hg and Fe content measured using Atomic Absorption Spectroscopy (AAS) and well water acidity (pH) measured using a pH meter (Syuzita et al., 2022). The data produced then compared with the standard water quality values based on Indonesian Minister of Health Regulation No. 32 of 2017. The measurements were taken twice. The following are the formulas for determining the average value of each sample and the standard deviation formula as shown in equation 1 and equation 2 (Asri et al., 2021; Didik et al., 2020; Ningsih; et al., 2019).

$$\bar{x} = \frac{\sum_i^n x_i}{n} = \frac{x_1 + x_2 + x_3 + \cdots x_n}{n} \qquad \text{............ (1)}$$

$$s_d = \sqrt{\frac{\sum_{i=1}^n (x_i - x)^2}{n-1}} \qquad \text{............ (2)}$$

RESULTS AND DISCUSSION

Measurement of Physical Parameters

The results of the Total Dissolved Solids (TDS) measurement showed significant variations at three different sampling points, as shown in Table 1. Sampling point A, located at 8 logs, showed an average TDS value of 2095 mg/L with a standard deviation of 7.071. This value clearly exceeds the established threshold of 1000 mg/L, indicating a fairly high level of dissolved substance contamination at that location. This may indicate potential pollution or poor water quality in the area.

Table 1. TDS Measurement Results

No.	Point Sampling	Experiment I	Experiment II	Average	Standard Deviation	Description
1	A (8 logs)	2090	2100	2095,0	7,071	Exceeding the threshold
2	B (6 logs)	578	569	573,5	6,370	Below the threshold
3	C (4 Logs)	570	563	566,5	4,949	Below the threshold
Threshold limit				1000 mg/L		

On the other hand, sampling point B at 6 logs and sampling point C at 4 logs showed lower results. Point B had an average TDS value of 573.5 mg/L with a standard deviation of 6.370, while point C showed an average of 566.5 mg/L with a standard deviation of 4.949. Both points have TDS values that are still below the specified threshold of 1000 mg/L, which indicates better water quality compared to point A. Although there is a slight difference in the average TDS value between the two points, both still show a relatively low level of solubility, which means that the water at these two points is likely to be cleaner or not contaminated with excessive levels of dissolved substances.

Overall, the significant differences between point A and points B and C indicate variations in water quality that require further attention, especially at point A, which exceeds the permissible TDS limit. This requires monitoring or intervention to ensure that water quality is maintained and meets standards that are safe for the environment and health.

Figure 3 shows the TDS graph for well water around the Sekotong gold mine. Total Dissolved Solids (TDS) are compounds and chemicals dissolved in water. Based on the Minister of Health's Regulation No. 32 of 2017 on Water Quality Standards, the TDS value for water quality is 1000 mg/L. Based on the TDS measurement data for sample A with 8 dredges, the value obtained was (2095 mg/L. Then, in sample B, which had 6 water wheels, the TDS value obtained was (573.5-6.37) mg/L. And in sample C, which had 4 water wheels, the TDS value obtained was (566.5-4.949) mg/L. The maximum TDS value was in sample A, and the minimum TDS value was in sample C.

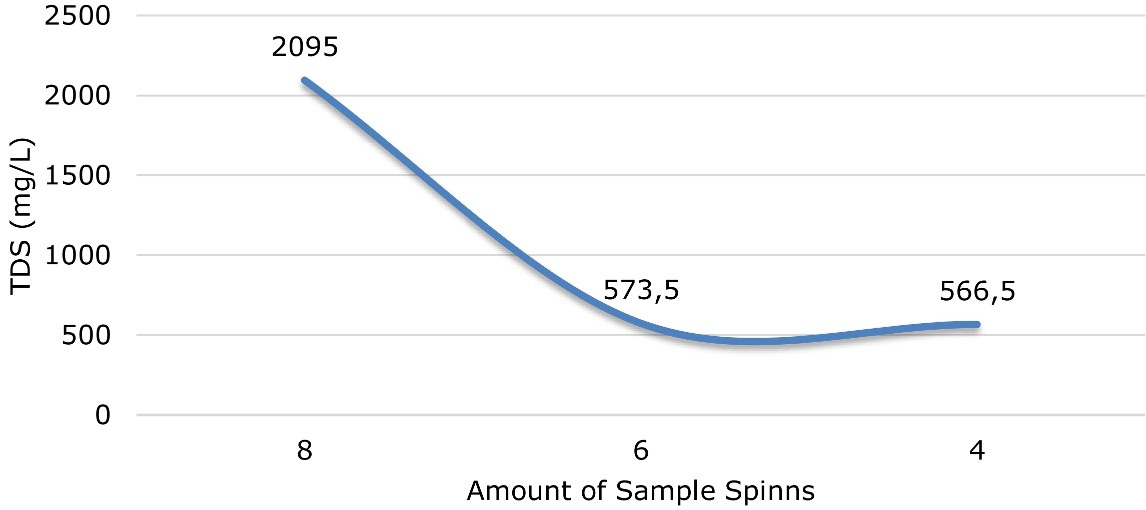

Figure 3. TDS Graph For Well Water Around The Sekotong Gold Mine

Theoretically, TDS content will increase if contaminated by household, agricultural, and industrial waste (Irwan et al., 2016). Rocks and air containing calcium, bicarbonate, phosphorus, and other minerals can also cause TDS (Sari & Huljana, 2019). Referring to Dwi Rani's research, the TDS level in the study area did not exceed the threshold limit due to the existence of gold mining far from the river flow and sedimentation in the Batanghari River.

In the research results, only one TDS value exceeded the threshold, namely sample A, while samples B and C were still below the threshold. Therefore, it can be concluded that the level of contamination in well water by TDS around the Pelangan Sekotong gold mine is still within safe limits for consumption.

Table 2. Conductivity Measurement Results

No	Point Sampling	Experiment I	Experiment II	Average	Standard Deviation	Description
1	A (8 Logs)	4220	4120	4170	70,71	Exceeding the threshold
2	B (6 Logs)	1127	1137	1132	7,07	Exceeding the threshold
3	C (4 Logs)	1126	1092	1109	24,04	Exceeding the threshold
Threshold limit			42-500 $\mu S/cm$			

The conductivity measurement results show that all samples measured exceeded the established threshold, which is between 42 and 500 μS/cm, as shown in Table 2. Sampling point A, located at 8 logs, recorded an average conductivity value of 4170 μS/cm with a standard deviation of 70.71. This conductivity value greatly exceeds the permissible threshold, indicating a very high level of solubility of dissolved substances. This may indicate pollution or accumulation of chemicals that can affect water quality at that location.

Meanwhile, sampling point B at 6 logs and sampling point C at 4 logs, although still exceeding the threshold, showed lower values than point A. Point B recorded an average conductivity of 1132 μS/cm with a standard deviation of 7.07, while point C had an average conductivity of 1109 μS/cm with a standard deviation of 24.04. Although the conductivity values of these two points are lower than point A, both are still above the specified threshold. This indicates that there are dissolved substances in the water that have the potential to affect its quality, although not as much as at point A.

Overall, the conductivity measurement results show that the water quality at the three sampling points has experienced a significant increase in the solubility of dissolved substances, especially at point A, which has a much higher value. This needs serious attention, especially regarding its impact on the ecosystem and health if water quality is not immediately improved.

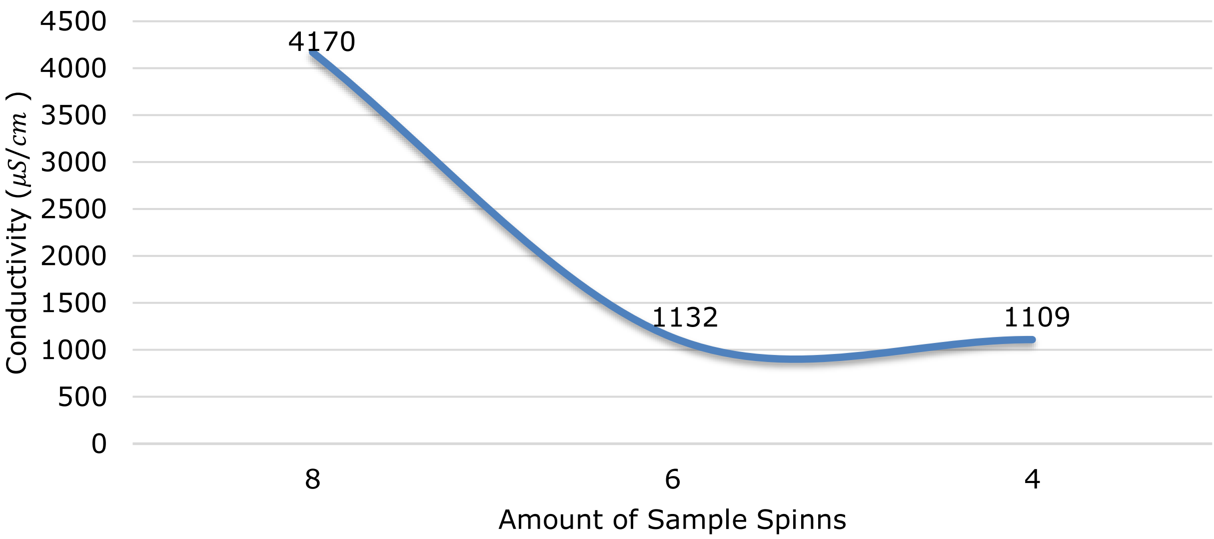

Figure 4. Conductivity Graph Of Well Water Around The Sekotong Gold Mine

Figure 4 shows several factors that affect sampling from gold mine waste disposal sites, including well water flow. If well water flows from the final disposal site to the measurement point (sample), the conductivity value is likely to be high because it is close to the source of contamination, and will decrease as the sampling distance increases. Other influencing factors are the movement of well water or the depth of the water table, which can affect the movement of water in the soil, as well as seasonal and hydrogeological conditions such as rain and drought, and the type and structure of the soil around the gold mining disposal site.

TDS (Total Dissolved Solids) and water conductivity are closely related (Meiliyadi et al., 2024a). Conductivity measures the ability of water to conduct electricity, which depends on the amount of ions dissolved in it. The higher the TDS, which reflects the total amount of dissolved solids, the higher the conductivity. In other words, the more ions dissolved in water, the greater the water's ability to conduct electricity, so the conductivity value also increases as TDS increases (Meiliyadi et al., 2025). This is in line with Indah's research, which states that water with low conductivity is safer for consumption. This is because the amount of dissolved solids is also low.

Chemical Parameter Measurement

Water quality analysis using chemical parameters involves testing the content of certain organic and inorganic elements in water, which must not exceed specified thresholds (Cui et al., 2022). A common problem found in the use of well water is the heavy metal content in the water. Heavy metals are usually found in dissolved water in the form of compounds or bicarbonate salts, sulfate salts, hydroxides, or combinations of organic compounds (Liosis et al., 2021).

These heavy metals contain many hazardous substances, therefore it is necessary to check all well water that is consumed directly without any treatment (Sebayang et al., 2018). Well water is often contaminated by heavy metals because the location of the well is close to long-term gold mining waste disposal sites (Tarigan et al., 2025). Therefore, in this study, the distance limit used is 3-10 meters. This is because a close distance reduces the influence of external variables and allows for quick and accurate identification of changes in water quality (Nishad et al., 2025). The quality of well water around the Pelangan Sekotong gold mine can be seen from the indicators Hg, Fe, and pH.

Table 3. Results of Hg Content Analysis

No	Point Sampling	Hg content	Description
1	A (8 Logs)	0,063	Exceeding the threshold
2	B (6 Logs	0,044	Exceeding the threshold
3	C (4 Logs)	0,003	Exceeding the threshold
Threshold limit		0,001 mg/L	

Based on Table 3, it appears that the results of mercury (Hg) content analysis at all sampling points show contamination exceeding the established threshold limit of 0.001 mg/L. Sampling point A, located at 8 logs, shows a significant mercury content of 0.063 mg/L. This value far exceeds the safe threshold, indicating a fairly high level of mercury contamination that is potentially harmful to the ecosystem and human health. The presence of mercury at such high levels can contaminate water and affect the quality of life of organisms that depend on these water sources.

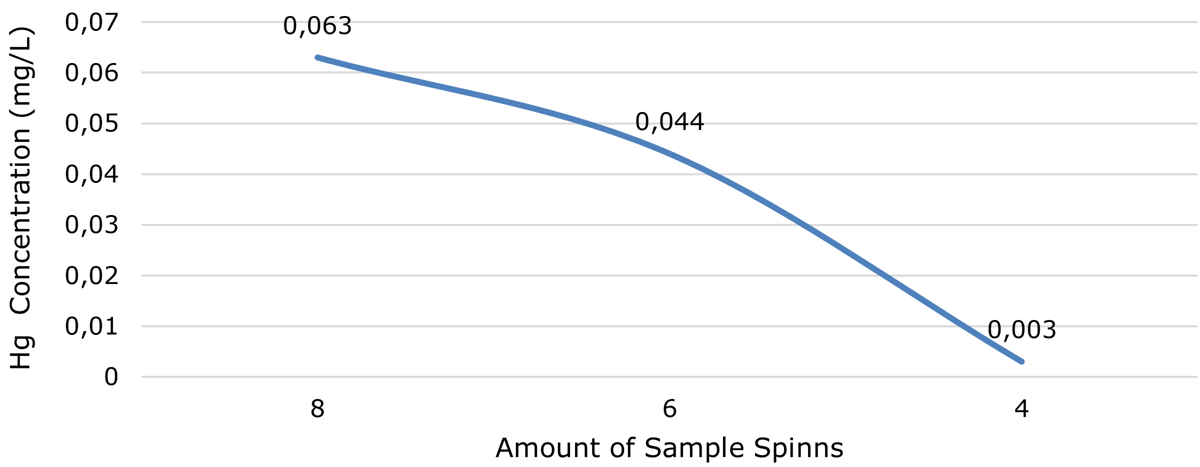

Figure 5. Graph Of Hg In Well Water Around Sekotong Gold Mining

Sampling point B, located at 6 logs, recorded a mercury content of 0.044 mg/L. Although this value is lower than that of point A, it is still far above the permissible threshold, indicating the presence of mercury pollution that needs to be addressed. Similarly, sampling point C at 4 logs showed a mercury content of 0.003 mg/L, which is also above the safe threshold. These two points, although having lower mercury levels than point A, still indicate pollution that can affect water quality.

Overall, the analysis results show that all three sampling points experienced mercury pollution that exceeded safe limits. This mercury pollution can have adverse effects on the health of humans, animals, and plants that depend on this water (Yahdi et al., 2025). Therefore, it is important to take preventive or remedial measures so that the mercury content in the water can be reduced and water quality can be maintained in accordance with established standards (Ezzeddine et al., 2021).

Figure 5 shows that there is a very close relationship between the number of dredges and the mercury (Hg) content. The more gold mining dredges there are, the higher the mercury content. Another factor that affects water quality is the type of well. The source of dug wells is a layer of soil at a relatively shallow depth, making it easily contaminated by foreign substances such as human or animal waste and domestic activities that can seep into it.

Based on the results of the study, it can be seen that the three samples have exceeded the established threshold. Referring to the research by Andrie et al., the mercury (Hg) content does not exceed the river water quality standards, but the results show that there is mercury discharge from gold mining activities in the river. Meanwhile, in this study, the mercury content exceeds the specified threshold.

Table 4. Results of Fe Content Analysis

No.	Point Sampling	Hg content	
		Results	Description
1	A (8 Logs)	0,001	Below the threshold
2	B (6 Logs	0,005	Below the threshold
3	C (4 Logs)	0,008	Below the threshold
Threshold limit		1 mg/L	
Description		1 ppm = 1 mg/L	

The results of iron (Fe) content measurements at the three sampling points show values that are still below the specified threshold limit of 1 mg/L, as shown in Table 4. Sampling point A, located at 8 logs, recorded an iron content of 0.001 mg/L, which is much lower than the threshold limit. This value indicates that the iron content at point A is very low and does not show significant potential for contamination. Sampling point B at 6 logs showed an iron content of 0.005 mg/L, which is also well below the permitted threshold. Although slightly higher than point A, the iron content at point B is still within safe limits and does not indicate any serious water quality issues related to iron content.

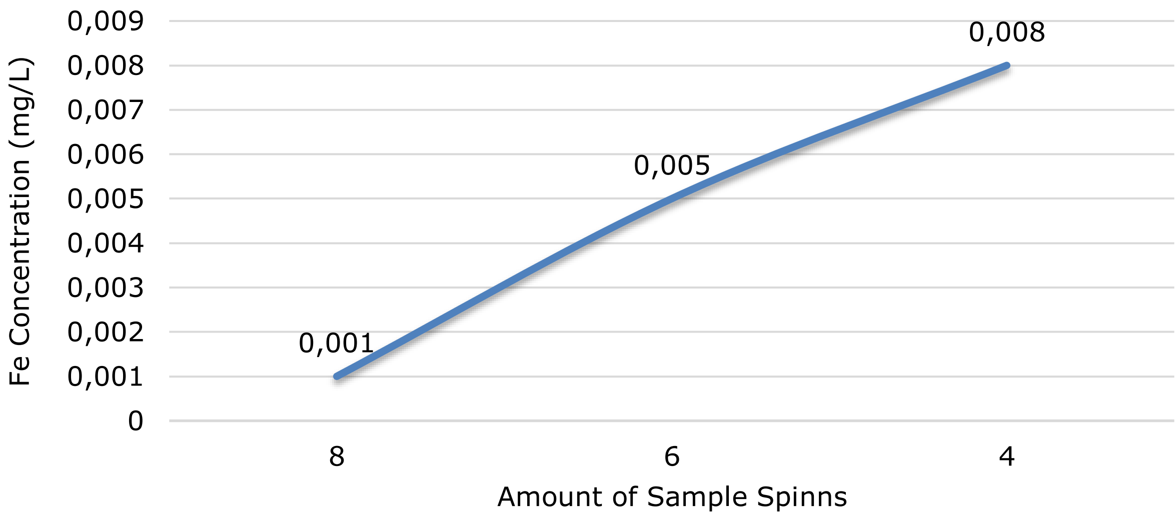

Figure 6. Graph Showing Fe Content In Well Water Around The Sekotong Gold Mine

Sampling point C at 4 logs recorded an iron content of 0.008 mg/L, which is also below the threshold limit. This value indicates a low iron content, which means that the water quality at point C is relatively good in terms of iron content. Overall, the results of iron content measurements at the three sampling points show that the iron content in the water is still within a safe range, which is below the threshold limit of 1 mg/L. Thus, there is no indication of significant iron contamination at these three locations, and the water quality can be considered good in terms of iron content.

Based on Figure 6, it can be seen that there is a close relationship between the number of dredges and iron (Fe) content. The more gold mining dredges there are, the lower the iron content. This is also influenced by geographical factors. As can be seen in Figure 3.1, sample A is closer to the coast/beach, while samples B and C are located in the middle of the mainland. Thus, well water on the mainland has a lower oxygen content, so that iron is more stable in the ferro ($Fe2+$) form. Meanwhile, well water near the coast/beach can reduce iron content due to the oxidation process.

Table 5. Result of pH measurement

No.	Point Sampling	Experiment I	Experiment II	Average	Standard Deviation	Description
1	A (8 Logs)	7,43	7,38	7,41	0,036	Below the threshold
2	B (6 Logs)	7,32	7,33	7,32	0,01	Below the threshold
3	C (4 Logs)	7,26	7,11	7,19	0,104	Below the threshold
Threshold				6,5-8,5		

The results of water pH analysis around the mining area show that the water pH quality is within a safe range, namely between 6.5 and 8.5, which is the generally accepted pH range for maintaining the stability of aquatic ecosystems, as shown in Table 5. Sampling point A, located at 8 logs, recorded an average pH of 7.41 with a standard deviation of 0.036. This value is in the middle of the safe pH range, indicating that the water at this point is neutral to slightly alkaline, which does not have the potential to damage the surrounding ecosystem. Sampling point B, located at 6 logs, had an average pH of 7.32 with a standard deviation of 0.01. This pH value is slightly lower than point A, but it is still within the safe pH range and does not indicate any significant changes ( ) that could negatively affect water quality. Although there is a slight variation at this point, the water quality at point B still meets the established quality standards.

Sampling point C at 4 logs recorded an average pH of 7.19 with a standard deviation of 0.104, indicating a stable pH value within the safe range. This pH value is lower than points A and B, so it remains within normal limits and does not indicate any adverse chemical changes in the water at this point. Overall, all sampling points showed water pH levels that met quality standards, which are in the range of 6.5 to 8.5. Thus, the pH quality of the water around the mine can be considered good and does not indicate any potential problems that could disrupt the balance of the water ecosystem.

pH is one of the organic chemical parameters used to determine the level of acidity or alkalinity in groundwater. According to health quality standards for hygiene and sanitation purposes, water pH ranges from 6.5 to 8.5. Groundwater is considered acidic if its pH value exceeds 8.5, in which case the water is alkaline.

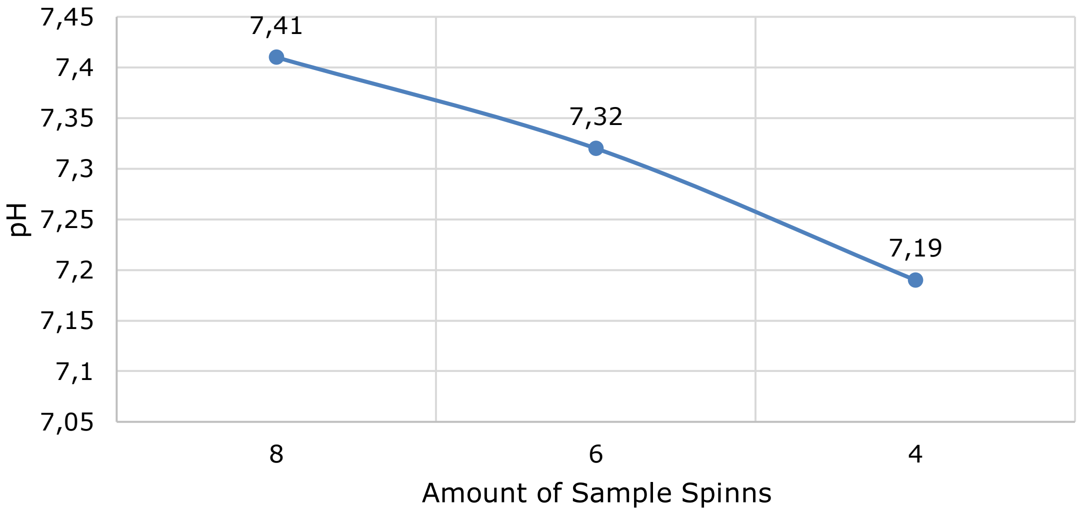

Figure 7. pH Chart Of Well Water Around The Sekotong Gold Mine

The results of measurements taken show that the pH values of well water around the Pelangan Sekotong gold mine in this study also vary, as shown in Figure 7. In the first measurement with 8 pump machines, the value obtained was (7.41 0.036). In sample B with 6 drilling machines, the pH value was (7.32 0.01). Then, in sample C with 4 drilling machines, the value obtained was (7.19 0.104).

There are several factors that influence the fluctuation of pH values in wells around the Pelangan Sekotong gold mine. One of these is the distance from the sampling location. When wells are close to the mine, they are likely to contain various chemicals, including organic and inorganic acids that can lower the pH of the well water. As a result, the pH of the water tends to approach neutral in accordance with the established threshold.

CONCLUSION

The results of the study show that measurements of water physics parameters, such as Total Dissolved Solids (TDS) and conductivity, show several values that are unstable. Although the TDS value shows fluctuations, the level is still below the threshold set by the quality standards regulations. This indicates that the concentration of dissolved solids in well water ( ) is still in the safe category according to water quality standards. However, unlike TDS, the results of conductivity measurements of well water around the Pelangan Sekotong gold mining area show alarming results. All samples tested showed conductivity values that exceeded the threshold determined by quality standards. This indicates that the well water in the area has been contaminated, most likely due to mining activities that produce waste containing high concentrations of metal ions or dissolved substances. This finding indicates that the well water in the area no longer meets the physical standards for water quality suitable for use.

The measurement of chemical parameters in this study included analysis of heavy metal content of mercury (Hg), iron (Fe), and acidity level (pH) in well water samples around the Pelangan Sekotong gold mine. The analysis results show that the mercury (Hg) content in well water has exceeded the maximum threshold value set by the quality standards. This indicates that the water has been contaminated with mercury in dangerous concentrations, making it unsafe for consumption or daily use. This contamination is most likely caused by the use of mercury in the gold amalgamation process in the area. Meanwhile, tests for iron (Fe) content and acidity (pH) showed more positive results. The iron (Fe) content in the well water samples was still below the permissible threshold, indicating that this metal had not reached levels that could be harmful to health or the environment. Similarly, the pH of the water is within the safe range according to quality standards, indicating that the acidity or alkalinity of the well water is still suitable for daily use. Nevertheless, mercury pollution is a major concern that needs to be addressed immediately to protect public health and environmental sustainability in the area.

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