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Utilization of Water from Void Pit a Through a Water Treatment Plant for Domestic Water Needs at Mess Rayeuk for the Period of July - August 2025

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ABSTRACT

The availability of clean water is a vital requirement in supporting mining operations, especially for bathing, washing, and toilet (MCK) purposes at Mess Rayeuk. To date, clean water supply is still entirely dependent on drilled wells, which causes problems such as high operational costs, dependence on groundwater, and environmental risks. This study aims to optimize the use of alternative water sources from Void Pit A through the implementation of a Water Treatment Plant (WTP) as an effort to reduce dependence on drilled wells. The research method uses the Quality Control Circle (QCC) approach with the PDCA (Plan–Do–Check–Action) model. Primary data were obtained from daily water usage records, flow meter monitoring results, and water quality tests in the laboratory, while secondary data came from operational cost reports and groundwater extraction permit documents. The results showed that after the WTP was operational, the use of drilled well water decreased by 57.12%, with the total clean water supply from the WTP reaching 1,089,000 liters in 15 days. In terms of costs, the WTP is more efficient, with savings of 22.9% compared to the use of drilled wells, and laboratory test results also ensure that the water processed by WTP meets all quality standard parameters according to Minister of Health Regulation No. 32 of 2017. In conclusion, the implementation of WTP has succeeded in increasing the availability of clean water, reducing operational costs, and reducing groundwater exploitation, so that it not only provides economic and operational benefits but also strengthens the company's commitment to supporting environmental sustainability.

INTRODUCTION

The availability of clean water is a key requirement for smooth mining operations, particularly for domestic needs such as bathing, washing, and toilets (MCK) in the employee mess area (Amin et al., 2024). To date, water needs at Mess Rayeuk have been entirely dependent on drilled wells, which is a common practice in mining sites across Indonesia (Priadi et al., 2024). This dependence has led to several problems, including high operational costs due to pump maintenance, electricity, distribution, and the legal obligation to obtain a groundwater extraction permit (SIPA) (Juridical Analysis, 2024). Furthermore, over-reliance on groundwater has been shown to contribute to declining aquifer capacity and environmental degradation in several Indonesian regions (Taftazani et al., 2022). In addition, the available drilled well capacity has proven insufficient to meet the daily demand, which reaches 427 m³, while the available capacity is only around 120 m³ per day, resulting in a deficit of 71.9% (Amin et al., 2024). Similar cases of groundwater shortages and high operational costs have been reported in other Indonesian mining operations, where clean water consumption per worker often exceeds the standard domestic level (Groundwater Issues and Management in Indonesia, 2024). This situation highlights the urgent need for alternative water supply strategies, regulatory compliance, and improved water management practices in mining operations (Sugiyono & Dewancker, 2020; Hadipuro, 2020).

According to Government Regulation Number 121 of 2015 concerning Water Resources Management, groundwater utilization must be carried out wisely to avoid overexploitation, which can lead to groundwater level decline and environmental damage (Putra et al., 2019). Several studies have also shown that large-scale use of drilled wells has the potential to cause ecological impacts such as seawater intrusion in coastal areas (Fauzi et al., 2020; Rina et al., 2021) and decreased groundwater quality (Khasanah et al., 2018). Overextraction of groundwater has been linked to land subsidence in several Indonesian cities, exacerbating flooding risks and infrastructure damage (Chaussard et al., 2019). Research on aquifer vulnerability also indicates that unregulated drilling worsens contamination risks, particularly from domestic and industrial waste (Yustiani et al., 2020). Furthermore, integrated water resources management is urgently needed to balance economic development and environmental sustainability (Setiawan & Purwanto, 2021). Recent findings also highlight that climate change intensifies groundwater stress in regions already facing overexploitation, demanding stronger policy enforcement and adaptive measures (Wijaya et al., 2022).

On the other hand, there is an alternative water source in the form of Void Pit A, which has not been optimally utilized (Zhe et al., 2023). The water stored in this void has the potential to be treated through a Water Treatment Plant (WTP) system to make it suitable for domestic use. Utilizing this water resource not only reduces dependence on groundwater but also contributes to long-term cost savings, increases operational efficiency, and supports environmental sustainability programs. This aligns with the concept of water reuse, which encourages the reuse of unconventional water resources to reduce pressure on groundwater resources (Rahmawati et al., 2021).

Therefore, through the Quality Control Circle (QCC) activity, an initiative was undertaken to design and implement water utilization from Void Pit A through the WTP as an innovative effort to provide clean water at Mess Rayeuk. This innovation is expected to increase clean water availability sustainably, reduce operational costs, and mitigate the environmental impact of overexploitation of groundwater.

Previous studies have highlighted the challenges and risks associated with groundwater dependence in industrial operations. Sutanto & Rachmawati (2020) examined the ecological impacts of large-scale groundwater extraction, emphasizing issues such as seawater intrusion and declining groundwater quality, particularly in coastal and high-demand areas. Their research underscores the environmental consequences of overexploiting drilled wells but does not explore practical solutions for alternative water sources within operational sites. Another study by Rahmawati et al. (2021) discussed the potential of unconventional water reuse, including the treatment and repurposing of industrial voids or process water for domestic use. While this research supports the sustainability benefits of water reuse, it remains theoretical and lacks detailed implementation frameworks for mining sites, particularly for meeting domestic water demands in employee facilities.

This study addresses these gaps by combining the sustainability insights from Rahmawati et al. (2021) with the practical challenges of groundwater overexploitation identified by Sutanto & Rachmawati (2020). Specifically, it investigates the utilization of water from Void Pit A at Mess Rayeuk, treated via a Water Treatment Plant (WTP), to provide clean water for domestic use. By implementing a Quality Control Circle (QCC) initiative, this research not only evaluates the technical feasibility of water reuse but also measures its impact on reducing operational costs, improving water availability, and mitigating environmental risks, providing a model for sustainable water management in mining operations.

METHOD

This study used an action research approach through the implementation of a Water Treatment Plant (WTP) program to treat water from Void Pit A to make it suitable for domestic use. The WTP program also serves as the primary intervention in a continuous improvement cycle using the Quality Control Circle (QCC) method with the PDCA (Plan–Do–Check–Action) model.

Research stages:

1. Plan: Identify the problem of clean water shortages in Mess Rayeuk, calculate water demand versus availability, and analyze the operational costs of drilled wells.
2. Do: Build and operate the WTP system at Mess Rayeuk, appoint management personnel, and conduct daily monitoring of water usage using flow meters.
3. Check: Evaluate the effectiveness of the WTP program by comparing pre- and post-implementation well water usage data, analyzing cost efficiency, and conducting water quality tests in accordance with Minister of Health Regulation No. 32 of 2017.
4. Action: Standardize the use of the WTP as the primary source of domestic water and formulate a further development plan, including integration with a Sewage Treatment Plant (STP).

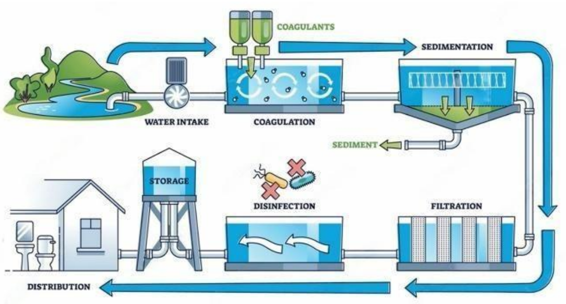

Figure 1. WTP flow process

RESULT AND DISCUSSION

A. Intake Unit

The Intake Unit functions as a system for taking raw water from a water source (such as a river, lake, reservoir, or spring) and then processing it into clean water. The Intake Unit uses a pump to lift water from a source at a lower elevation of approximately 10 meters, and a distance of approximately 750 m.

Figure 2. Intake Unit

B. Raw Water Tank

The raw water tank is a crucial component of a water treatment system. Its function encompasses several key aspects.

Figure 3. raw water tank

C. Process Pump

The process pump in a water treatment system functions to circulate, distribute, and maintain water pressure throughout the various stages of the water treatment process. This pump is crucial for ensuring water flows from one treatment unit to another at the appropriate pressure. Process pumps are a vital component in a water treatment system, functioning to:

Figure 4. process pump

D. pH Adjustment

The function of pH adjustment in a water treatment plant (WTP) is crucial in various stages of water treatment, whether for industrial use, drinking water, or wastewater. Here are some of the main functions of pH adjustment in the water treatment process.

Figure 5. pH adjustment

E. Coagulant

Coagulation is a crucial step in the water treatment process at a Water Treatment Plant (WTP). The primary function of coagulation is to remove suspended and colloidal particles in water by adding a coagulant chemical, which allows small particles to clump together into larger, more easily sedimented particles.

Figure 6. Coagulation

F. Flocculant

Flocculation is a crucial stage in the water treatment process at a Water Treatment Plant (WTP), which increases the efficiency of separating suspended particles from water. This process occurs after coagulation and before sedimentation or filtration. Here are some of the main functions of flocculation in water treatment:

Figure 7. Flocculation

G. Static Mixer

A static mixer is a fluid mixing device that operates without moving parts. This device is designed to efficiently mix chemicals in a water stream moving through pipes. In a Water Treatment Plant (WTP), a static mixer has several main functions, namely:

Figure 8. static mixer

H. Clarifier System

A clarifier is a unit in a Water Treatment Plant (WTP) that functions as a sedimentation system to separate suspended solids from water. This process occurs through the principle of gravity, where heavier particles settle to the bottom of the tank, while clearer water flows to the top for further treatment.

Figure 9. clarifier system

I. Sand & Carbon Filters

Sand and carbon filters play a crucial role in Water Treatment Plants (WTPs) by filtering and removing contaminants from water before it is used or consumed. Here are some of the main functions of sand and carbon filters in the water treatment process:

Figure 10. Sand and carbon filters

J. Clear Water Tank

The Clear Water Tank (CWT) in a Water Treatment Plant (WTP) serves primarily as a temporary storage area for water that has undergone all stages of the treatment process before being distributed to consumers. The following are some of the main functions of a Clear Water Tank.

Table 1. Water Usage (Liters)

Date	Water Usage (Liters)
01/08/2025	200,000
02/08/2025	60,000
03/08/2025	55,000
04/08/2025	30,000
05/08/2025	25,000
06/08/2025	50,000
07/08/2025	25,000
08/08/2025	55,000
09/08/2025	22,000
10/08/2025	137,000
11/08/2025	41,000
12/08/2025	39,000
13/08/2025	55,000
14/08/2025	208,000

15/08/2025	87,000
Total	**1,089,000**

Table 2. Clean Water Usage in August

Date	Amount of Water/Liters (120 L/person)
01/08/2025	53,400
02/08/2025	53,640
03/08/2025	50,400
04/08/2025	50,040
05/08/2025	50,400
06/08/2025	49,920
07/08/2025	49,440
08/08/2025	49,920
09/08/2025	49,920
10/08/2025	49,080
11/08/2025	49,560
12/08/2025	48,960
13/08/2025	50,160
14/08/2025	49,080
15/08/2025	50,280
Total	**754,200**

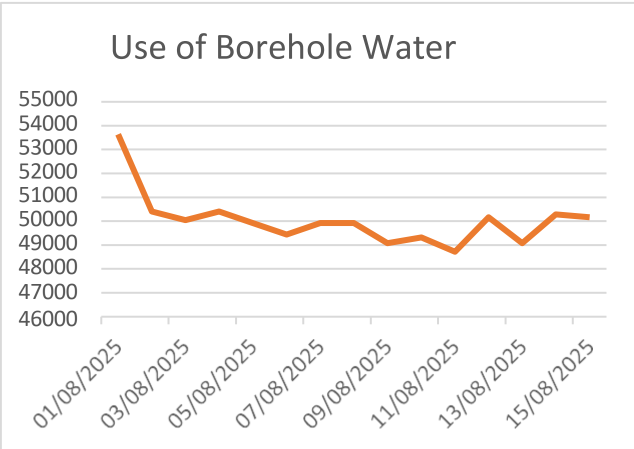

Figure 11. Water Usage

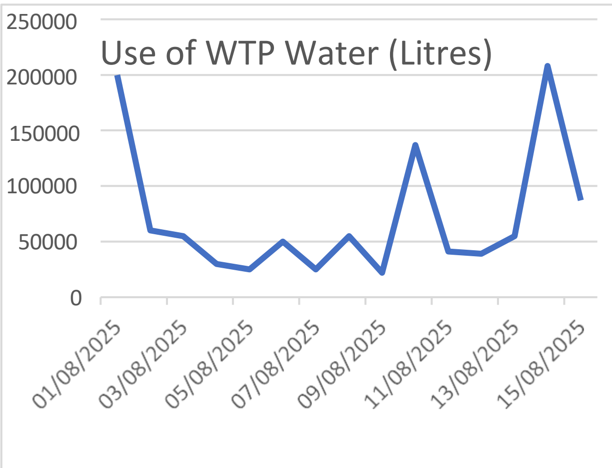

Figure 12. Water Usage

Figure 13. Water Tank

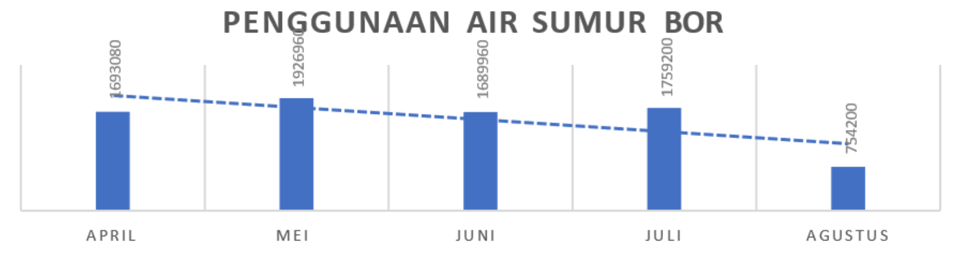

Figure 14. Water Usage

The evaluation of borehole water use showed a significant downward trend after the implementation of the Water Treatment Plant (WTP). From April to July 2025, total borehole water consumption was relatively stable, ranging from 1.68–1.92 million liters per month. However, after the WTP began operating in August 2025, borehole water use decreased dramatically from 1,759,200 liters in July to only 754,200 liters in August, a decrease of 57.12%.

These findings demonstrate that the WTP plays an effective role in reducing dependence on groundwater. Operationally, diverting domestic water supplies from boreholes to the WTP not only increases clean water availability but also supports cost efficiency and environmental conservation. This reduction in groundwater exploitation aligns with the concept of water reuse, which emphasizes the use of unconventional water sources to reduce pressure on groundwater resources and maintain environmental sustainability (Rahmawati et al., 2021).

CONCLUSION

The implementation of a Water Treatment Plant (WTP) using water from Void Pit A at Mess Rayeuk has effectively alleviated domestic water shortages by reducing drilled well water use by 57.12%, thereby lowering groundwater dependence. This initiative achieved approximately 22.9% cost savings compared to relying solely on drilled wells. Laboratory analyses confirmed that treated water complies with all quality standards per Minister of Health Regulation No. 32 of 2017, ensuring safety for toilet and bathing purposes. Environmentally, the WTP reduces excessive groundwater extraction, lowers the risk of subsidence, and aligns with the company's sustainability goals by promoting water conservation and eco-friendly mining practices. Future research could explore scalable optimization of WTP operations and assess long-term environmental impacts across different mining sites to enhance sustainable water management strategies.

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