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Analysis of Decision Making on Wastewater Use Technology in the Universitas Pertamina Area

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Abstract

Wastewater available through the sewerage system can be reused as a daily need. With a sewer system, the Universitas Pertamina Area can utilize water according to Government Regulation of the Republic of Indonesia Number 82 of 2001 Class 4. Reuse of wastewater within this scope can improve sustainable development goals. This study aims to analyze the decision-making of sewerage water treatment so that it can be reused according to the class 4 quality standard. The first alternative consists of a collection tank, bar screen, pre-sedimentation, rapid sand filter (RSF), and disinfection. The second alternative consists of a collection tank, bar screen, horizontal roughing filter (HRF), RSF, and disinfection. The two alternatives provided have met the required quality standards. However, the area of land required in alternative one is too large compared to the second alternative. This causes the second alternative to be more appropriate to be applied in the Universitas Pertamina Area. Analysis of decision-making on the use of RSF media is carried out using the Analytical Hierarchy Process (AHP). The alternative media for RSF are sand, granular active carbon (GAC), and zeolite. The criteria for BOD removal, total coliform removal, cost, headloss, and replacement period of the most appropriate zeolite media for use in the RSF unit process.

Keywords: wastewater, reuse, treatment, sewerage, AHP

INTRODUCTION

The current condition at the Universitas Pertamina area is that greywater is channelled into a grease trap, then mixed with yellow water from the urinal and rainwater before being discharged through the drainage channel without further processing. Wastewater that will blend with rainwater in sewerage system has the potential to cause pollution (Khansa *et al*., 2020; Apritama *et al*., 2020). Urine or yellow water can cause eutrophication and pharmaceutical pollution. According to Udert (2002), human urine is an essential source of nutrients causing eutrophication with a contribution of 80% nitrogen and 60% phosphorus in domestic wastewater. Pharmaceutical pollutants can enter the environment through the urine due to the human excretory system. Their presence in the water cycle is harmful to the environment and human health (Udert, 2002). As much as 70% of the drugs consumed by humans excreted through urine, and the other 30% is through feces (Abdel-Shafy & Mohammed-Mansour, 2013).

Wastewater in the form of greywater that disposed of without going through processing also can contain pollutants. Untreated wastewater impacts water quality and public health through its high bacterial load, nutrient discharge, and high organic content (EPA, 2019; Sofiyah *et al*., 2021). In one study conducted by Oteng-Peprah *et al*. (2018), data collected that greywater contains turbidity of 619 NTU, 518 mg/l of biological oxygen demand (BOD_5), 2000 mg/l of chemical oxygen demand (COD), 98 mg/l of NO_3, 511 mg/l of suspended solids (TSS) (Al-Mughalles *et al*., 2012), 573 mg/l of dissolved solids (TDS) (Parjane & Sane, 2011), 4 mg/l of total phosphate (Jokerst *et al*., 2011), as well as a surfactant as methylene blue active substances (MBAS) of 5.4 mg/l (Wiel-Shafran *et al*., 2006).

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Sustainable development is a global endeavor, and the Government of Indonesia has committed to taking action toward this goal. One of Indonesia's critical targets in achieving sustainability is preventing, reducing, recycling, and reusing waste to minimize waste production (International NGO Forum on Indonesian Development, 2017, Suryawan & Lee, 2023). The potential for implementing the recycling concept in the Universitas Pertamina Area is significant (Hasnaningrum *et al.*, 2021). Specifically, domestic wastewater holds promise as a valuable resource for reuse in watering plants and flushing toilets, provided it meets the class IV water quality classification standard outlined in Government Regulation of the Republic of Indonesia Number 82 of 2001 concerning Water Quality Management and Water Pollution Control. The class IV standard is intended for water used in irrigation and other similar purposes with the exact water quality requirements. Thus, choosing an appropriate wastewater treatment process becomes crucial. The Analytic Hierarchy Process (AHP) offers a method for identifying a suitable wastewater recycling process.

AHP is a versatile theory of measurement that facilitates the determination of ratio scales, whether through discrete or continuous pairwise comparisons. The AHP system breaks down complex multi-factor or multi-criteria problems into a hierarchy, allowing a comprehensive and structured analysis. A complex problem can be systematically organized into groups and subgroups by determining this hierarchy. Utilizing AHP, this study seeks to identify the most fitting wastewater treatment process through decision analysis. The primary objective of this study is to assess the decision-making process for sewerage water treatment, ensuring that the treated water meets the class IV water quality standard for reuse. By employing the AHP method, the researchers aim to evaluate various processing options and prioritize the one that aligns with the class IV quality requirements.

MATERIAL AND METHOD

Based on Davis (2010), the factors determining the design criteria are the characteristics of raw water, regulatory and environmental standards, system reliability, limitations on facilities, design life, and costs. The factors of raw water include composition, variation in composition, water availability at different times, rainwater intrusion, and contributions from industrial and commercial activities.

The Wastewater Treatment Plant for sewerage in the Universitas Pertamina Area is designed based on considerations that include the quality and flow of water in the sewerage channel, the condition of the land in the Universitas Pertamina Area, and the design criteria for the WWTP unit. The rainy and dry seasons can affect drainage water's discharge and quality. On the other hand, with less rain, the drainage water quality will worsen with high pollutant concentrations in the dry season. The parameters that are the focus in the design of the WWTP are the parameters BOD_5, COD, TDS, TSS, pH, $NO\text{-}_3$ as N, Surfactant, Total Phosphate as P, and Total Coliform. The land condition in the Universitas Pertamina area will affect the availability of land used for WWTP design considerations.

There are alternative options in the study and conceptual design process. One of the methods in the selection of alternatives is the Analytical Hierarchy Process (AHP). Pavithra and Lokesh (2014) used this method for the selection of wastewater treatment processes. The steps for working on AHP based on Taherdoost (2017) are as follows problem definition and objectives., create a hierarchical structure from the top level to the bottom level, create a comparison matrix and assessment between criteria and alternatives based on a scaled review, the weighting of the lower-level eigenvectors based on the weight of the criteria and the total eigenvectors of the upper level, and calculation of consistency ratio (CR).

RESULT AND DISCISSION

Alternative Wastewater Treatment Plant Process

The selection of WWTP units carried out by considering the available land area, wastewater discharge, and wastewater quality. The WWTP series has two alternative options with a granular filtration unit in RSF as the primary unit that will treat the non-biodegradable waste. The Rapid

Sand Filter (RSF) filtration unit used because it requires less land than the Slow Sand Filter (SSF).

The preferred processing unit determined by adjusting the needs influenced by the type of parameters that require processing, the extent to which the parameters exceed the existing quality standards, and the efficiency of each processing technology. The type of processing will be affected by the BOD_5/COD ratio. If the ratio indicates that the wastewater is non-biodegradable, which is <0.3 (Srivinas, 2008; Suryawan *et al.*, 2021), the treatment will be physical, such as sedimentation and filtration. The BOD/COD ratio in the existing condition, which is 0.25, indicates that wastewater has non-biodegradable properties. Wastewater properties can be caused by slow to non-biodegradable greywater (Bakare *et al.*, 2017). This can be caused by detergents or non-biodegradable surfactants (Morel & Diener, 2006).A variety of media applied if the wastewater adequately treated by granular filtration. However, if membrane filtration is required, the type of filtration can be a variant. Consideration of technology selection can see from processing efficiency, head loss, if any, cost, and ease of operation and maintenance. If the Total Coliform parameter exceeds the quality standard, the disinfection unit will be involved as an additional treatment.

The first alternative is to use a collection tank, bar screen, sedimentation unit, RSF unit, and disinfection unit, treating a total discharge of 222,019,5 m^3/day. The sedimentation unit is used as an initial treatment to minimize blockages in the filtration unit (Albalawneh & Chang, 2015). Before being treated with a sedimentation unit and RSF, wastewater is first collected in a collection tank and then passed through a bar screen to set aside waste. A disinfection unit was added as a post-treatment, aiming to remove the high Total Coliform content in the wastewater. Before being used as water for irrigation, clean water will be stored in the reservoir. The sludge produced by the sedimentation unit will be held in a sludge collection tank before being handed over to a 3rd party for processing. The following is a unit diagram in alternative design WWTP showed in Figure 1.

Alternative two proposed because the available land for the designed WWTP is limited, namely on a volleyball court no longer in use. The field has an area of 40.9 m x 38 m or the equivalent of 1554.2 m^2. This alternative made to anticipate the shortage of land in the first alternative with a large enough discharge. In this alternative, the release used is 9,850 m^3/day, or 114 L/second, with a wastewater content of 62.8% and rainwater of 37.2%. The units used in alternative two are the collection tank, bar screen, HRF, RSF, and disinfection. HRF will replace the function of the pra-sedimentation unit, which reduces turbidity to prevent blockages. The following is a unit diagram for the second alternative design WWTP shown in Figure 2. The existing ground tank has an area of

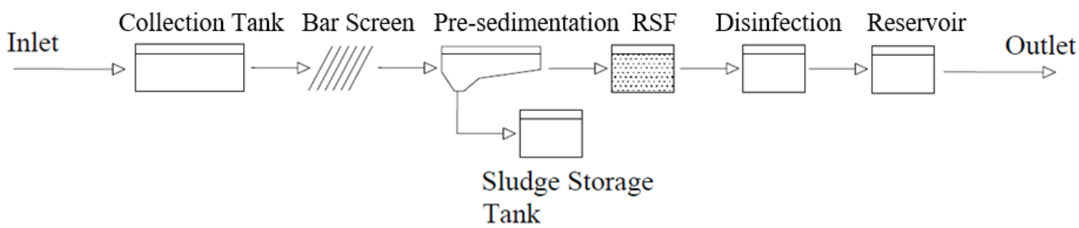

Figure 1. Alternative One WWTP Unit for Water Reuse in Universitas Pertamina Area

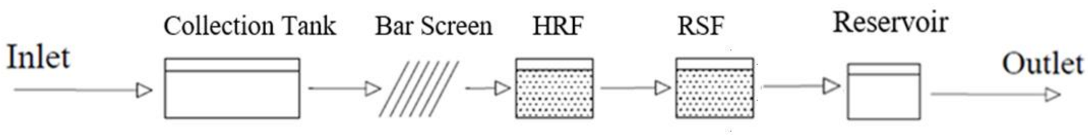

Figure 2. Alternative Two WWTP Unit for Water Reuse in Universitas Pertamina Area

273 m^2. The ground tank has a depth of 3 m and is pumped every 2 hours. So, if the ground tank volume for one pump is 819 m^3, then the total volume for one day is 9,829 m^3/day, rounded up to 9,850 m^3/day, or 114 L/second. The selection of the WWTP circuit will be based on a comparison between the calculation of mass balance and preliminary sizing.

Effluent Quality Estimation

This stage aims to determine the effectiveness of the design WWTP in treating the removal of pollutants in wastewater. The effluent quality is calculated based on the wastewater quality and efficiency removal results for alternative one and alternative two, shown in Table 1 and Table 2. The largest concentration in each parameter will be used as the influent concentration of the WWTP. It aims to determine the ability of each unit to treat the lowest quality waste to meet the class IV water quality classification standards in Government Regulation 82 of 2001. The collection tank and bar screen units are not counted in measuring the estimated quality of the effluent. This is because the collection tank unit is only used as a collector without processing. The bar screen unit, which is treated debris (solid waste), is not included in wastewater quality.

Table 1. Estimation of Effluent for Each Processing Unit in Alternative 1

Parameter	Influent	Pre-sedimentation		RSF		Disinfection		Standar[d)]
		% [a)]	Effluent	% [b)]	Effluent	% [c)]	Effluent	
TDS (mg/L)	278	0.50%	276.61	-	276.61	-	276.61	2.000
TSS (mg/L)	56	66.60%	18.704	96.57%	0.642	-	0.642	400
Turbidity (NTU)	22	66.15%	7.447	95.00%	0.372	-	0.372	-
BOD_5 (mg/L)	25	65.20%	8.7	94.50%	0.479	-	0.479	12
COD (mg/L)	91	60.30%	36.127	80.00%	7.225	-	7.225	100
PO_4 (mg/L)	3	25.00%	2.25	55.91%	0.992	-	0.992	5
NO_3^-N (mg/L)	0.1	-	0.1	-	0.1	-	0.1	20
Detergent (MBAS)(mg/L)	0.7	56.00%	0.308	-	0.308	-	0.308	-
Total Coliform (MPN/100mL)	92,000	-	92,000	95.00%	4.600	100%	0	10.000

[a)] Meshram *et al.*, 2015; [b)] Khezri *et al.*, 2017; [c)] Wegelin, 1996 [e)] PP 82 2001

Table 2. Estimation of Effluent for Each Processing Unit in Alternative 2

Parameter	Influent	Pre-sedimentation		RSF		Disinfection		Standar[d)]
		% [a)]	Effluent	% [b)]	Effluent	% [c)]	Effluent	
TDS (mg/L)	278	-	278	-	278	-	278	2.000
TSS (mg/L)	56	32.20%	37.968	96.57%	1.302	-	1.302	400
Turbidity (NTU)	22	85.00%	3.3	95.00%	0.165	-	0.165	-
BOD_5 (mg/L)	25	54.00%	11.5	94.50%	0.633	-	0.633	12
COD (mg/L)	91	66.40%	30.576	80.00%	6.115	-	6.115	100
PO_4 (mg/L)	3	28.21%	2.154	55.91%	0.950	-	0.950	5
NO_3^-N (mg/L)	0.1	34%	0.066	-	0.066	-	0.066	20
Detergent (MBAS)(mg/L)	0.7	-	0.7	-	0.7	-	0.7	-
Total Coliform (MPN/100mL)	92,000	-	92,000	95.00%	4.600	98%	100	10.000

[a)] Abdel-shafy *et al.*, 2014; [b)] Khezri *et al.*, 2017; [c)] Wegelin, 1996 [d)] PP 82 2001

Preliminary Sizing

This stage aims to determine the estimated area required by the design WWTP by calculating each unit according to the design criteria. The results of the calculation will be compared with the available land area. If it does not meet the available land area, then the alternative cannot be implemented. The total space required for the first alternative is 5,507.5 m^2. The second alternative involves land with a total area of 1,263.35 m^2. Calculation of the detailed preliminary sizing for each alternative is as follows Table 3. The land area available for processing is 8505.7 m^2. Because alternative 1 requires a land area close to the available land area value, this alternative cannot be used as an alternative in processing. In addition, alternative ones also require land for the collection of sludge collected in the pre-sedimentation unit. As for the second alternative, it requires much less land than the first alternative.

Decision Analysis

RSF can use several alternative media. Based on literature studies, media in the sand and granular active carbon (GAC) are often used to treat greywater (Amin *et al.*, 2015). According to Ang *et al.* (2007), zeolites may be used in water and wastewater treatment because of their adsorption and ion exchange capabilities. The type of zeolite used as an alternative is synthetic zeolite. Media selection was carried out using the AHP adapted from the wastewater treatment process carried out by Pavithra & S. (2014). The criteria consist of media efficiency in processing BOD_5 and Total Coliform, headloss at the beginning of backwash, media price, and replacement of media selection. The removal efficiency of BOD_5 and Total Coliform became the selection criteria because these parameters are parameters that exceed the quality standard. Headloss is directly proportional to the energy required in media treatment. Price represents the cost that must be incurred to buy media. In addition to maintenance, media replacement will affect the cost and waste generated. Figure 3 shows a diagram of the AHP hierarchical structure.

The five criteria are then analyzed by assessing the requirements based on importance or priority, as shown in Table 5. BOD_5 efficiency is slightly more critical than Total Coliform efficiency because Total Coliform can be further set aside in the disinfection unit to give a value of 3. Total Coliform efficiency is essential when compared to headloss, so it has a value of 7. Compared to the price and frequency of replacement, Total Coliform efficiency is slightly more important because it will focus on the disinfection unit. Price is a little more critical when compared to headloss. The frequency of replacement is slightly more significant than the price and more essential when compared to headloss. Then, an assessment carried out on each alternative and criteria. The first criterion is BOD_5 efficiency. According to Hamoda *et al.* (2004), the efficiency of BOD_5 removal from sand media is 54%. Meanwhile, the BOD_5 removal of GAC and Zeolite media was 57.6% (Shegokar *et al.*, 2015) and 94.5% (Reyes *et al.*, 1997). The GAC value is two because it has a difference of below 10% with sand media, which is 3.2%. Zeolite media has a value of 6 and 5 compared to sand and GAC because the difference with each medium is 40.5% and 37.9%. Total Coliform efficiency for sand, GAC, and zeolite media was 63%, 53.3% (Amin *et al.*, 2015), and 90-96% (Reyes *et al.*, 1997).

The total efficiency of Coliform sand media is 9.7% greater, so it has a value of 2 because <10%. The total efficiency of zeolite coliform media is more significant than sand and GAC with a difference of 27% and 37%, respectively, so that it has a value of 4 and 5. GAC media has a smaller headloss than other media, with a difference of 0.48 m to sand media and 0.084 m to zeolite media. GAC media has a value of 6 for sand and 2 for zeolite. Meanwhile, zeolite has a value of 5 against the sand with a difference of 0.4 m. The following criterion is the price of each filtration medium. The market prices for sand, GAC, and zeolite media are IDR 25,000, IDR 17,500, and IDR 28,500, respectively. GAC media has the lowest price and has a difference of IDR 7,500 with sand media and IDR 11,000 with zeolite media. GAC media has values of 5 and 7 when compared to sand and zeolite. Meanwhile, sand media has a value of 3 because it has a price difference of IDR 3,500 with zeolite media.

The last criterion is the frequency of media replacement. Each sand, GAC, and zeolite medium has a replacement frequency of every 5-7 years

(Inyo Pools, 2014), every year (O'Connor, O'Connor, & Twait, 2009), and every 4-6 years (Onga Pantera Sand Filters, 2016). Zeolite has the best replacement frequency among other media, with a value of 2 for sand and 5 for GAC. Zeolite media itself has a difference of 1 year against sand media and five years against GAC. Meanwhile, sand media has a value of 7 because it has a difference of 6 years from GAC media. The following is Table 4, which compares alternatives for each criterion.

Table 3. Calculation of the detailed preliminary sizing for alternative

Unit	Preliminary Sizing Alternative 1	Preliminary Sizing Alternative 2
Flow rate influent	222,019.5 m^3/day	9,850 m^3/day
Collection tank	Number of units = 4 Detention time = 8 minute (<10 menit; Direktorat Jenderal Cipta Karya (2018) Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{2{,}57\ \text{m}^3/\text{s}}{4}$ = 0.642 m^3/s Volume = $\text{Q} \times \text{td}$ = $0{,}642\,\frac{\text{m}^3}{\text{s}} \times$ 480 s =308.36 m^3 Area (A) = $\frac{\text{Vol}}{\text{H}}$ = $\frac{308{,}36\ \text{m}^3}{8\ \text{m}}$ = 38.545 m^2 W = $\sqrt{\frac{\text{A}}{2}}$ = $\sqrt{\frac{38{,}545\ \text{m}^2}{2}}$= 4.39 m ≈ 4.5 m L = 2 x W =2 x 4.39 = 8.73 m ≈ 9 m Required area = (Number of units + Redundancy) (L x W) = (4+1) (4.5 m * 9m) = 202.5 m^2	Number of units = 4 Detention time = 5 minute (<10 menit; Direktorat Jenderal Cipta Karya (2018) Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{0{,}114\ \text{m}^3/\text{s}}{2}$ = 0,057 m^3/s Volume = $\text{Q} \times \text{td}$ = $0{,}057\,\frac{\text{m}^3}{\text{s}} \times 300\ \text{s}$ = 17,1 m^3 A = $\frac{\text{Vol}}{\text{H}}$ = $\frac{17{,}1\ \text{m}^3}{3\ \text{m}}$ = 5.7 m^2 W = $\sqrt{\frac{\text{A}}{2}}$ = $\sqrt{\frac{5{,}7\ \text{m}^2}{2}}$ = 1.7 m ≈ 2 m L = 2 x W =2 x 1.7m = 3.4 m ≈ 3.5 m Required area = (Number of units + Redundancy) (L x W) = $(2+1)(3{,}5\ \text{m} \times 2\ \text{m})$= 21 m^2
Bar Screen	Number of Bar Screen = 4 Velocity through bars (v)= 0,6 m/s (≤0,9 m/s; Davis, (2010)) Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{2{,}57\ \text{m}^3/\text{s}}{4}$ = 0,642 m^3/s A-Cross = $\frac{\text{Q}}{\text{v}}$ = $\frac{0{,}642\ \text{m}^3/\text{s}}{0{,}6\ \text{m/s}}$ = 1,07 m^2 W = $\sqrt{\frac{\text{Across}}{3}}$ = $\sqrt{\frac{1{,}07\ \text{m}^2}{3}}$ = 0,59 m ≈ 1 m H = 3 x W = 3 x 0.59 m = 1,79 m ≈ 1,5 m Velocity check = $\frac{\text{Q}}{\text{H}\times\text{L}}$ = $\frac{0{,}642\ \text{m}^3/\text{s}}{1{,}5\ \text{m} \times 1\ \text{m}}$ = 0,42 m/s Required area = (Number of units + Redundancy) (L x W) = $(4+1)(2\ \text{m} \times 1\ \text{m})$ = 10 m^2	Number of Bar Screen = 4 Velocity through bars (v)= 0,6 m/s (≤0,9 m/s; Davis, (2010)) Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{0{,}114\ \text{m}^3/\text{s}}{1}$ = 0,114 m^3/s A-Cross = $\frac{\text{Q}}{\text{v}}$ = $\frac{0{,}114/\text{s}}{0{,}6\ \text{m/s}}$ = 0.19 m^2 L = $\sqrt{\frac{\text{Across}}{3}}$ = $\sqrt{\frac{2\times 0{,}19\ \text{m}^2}{3}}$ = 0.35 m ≈ 0.4 m H = $\frac{3}{2} \times \text{L}$ = $\frac{3}{2} \times 0{,}35\ \text{m}$ = 0.53 m ≈ 0.6 m Velocity check = $\frac{\text{Q}}{\text{H}\times\text{L}}$ = $\frac{0{,}114\ \text{m}^3/\text{s}}{0{,}4\ \text{m} \times 0{,}6\ \text{m}}$ = 0.47 m/s Required area = (Number of units + Redundancy) (L x W) = $(1+1)(2\ \text{m} \times 0{,}6\ \text{m})$= 1.6 m^2
Pra-sedimentation (alternative 1) HRF (alternative 2)	Number of units = 8 *Overflow rate* (OFR) = 70 m^3/d. m^2 (40-70 m^3/d. m^2; Davis (2010)); Length (L): Width (W) = 1:4 (4:1 - 6:1; Davis (2010)) Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{2{,}57\ \text{m}^3/\text{s}}{8}$ = 0,321 m^3/s A = $\frac{\text{Q}}{\text{OFR}}$ = $\frac{27.752{,}4\ \text{m}^3/\text{d}}{70\ \text{m}^3/\text{d.m}^2}$ = 396,463 m^2	Filtration velocity (vf) =3 m/h (0.5-4 m/jam; Hadi (2012)) Width (W) = 5 m (2-4 m; Hadi (2012)) Depth (H)= 1,5 m (1-1,5 m; Hadi (2012)) Length column 1 (P1) = 5 m (4,5-6 m; Hadi (2012)) Length column 2 (P2) = 4 m (3-4 m; Hadi (2012))

Unit	Preliminary Sizing Alternative 1	Preliminary Sizing Alternative 2
	W = $\sqrt{\frac{A}{4}}$ = $\sqrt{\frac{396,463\ m^2}{4}}$ = 9.956 m ≈ 10 m L = 4 x W = 3 x 9.956 m = 39.822 m ≈ 40 m Required area = (Number of units + Redundancy) (L x W) = $(8+1)(40\ m \times 10\ m)$ = 3600 m^2	Length column 3 (P3) = 1,5 m (1.5-2 m; Hadi (2012)) Redundancy = 3 Discharge = 0,114 m^3/s = 410 m^3/h Discharge each unit= vf x W x H= 22,5 m^3/jam Number of units = = $\frac{410\ m^3/jam}{22,5\ m^3/jam}$ = 18.2 ≈ 19 P = P1 + P2 + P3 = 5 m + 4 m + 1.5 m= 10.5 m Required area = (Number of units + Redundancy) (L x W) = 1155 m^2
RSF	Filtration velocity (vf) = 10 m/h (6-11 m/h; SNI 6774:2008) Number of units = $12Q^{0,5}$ = $12(2,57\ m^3/s)^{0,5}$ = 19.2 ≈ 20 Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{2,57\ m^3/s}{20}$ = 0.133 m^3/s A = $\frac{Q}{Vf}$ = $\frac{0.133\ m3/s}{10\ m/h}$ = 48 m^2 W = $\sqrt{\frac{A}{2}}$ = $\sqrt{\frac{48\ m^2}{2}}$= 4,9 m ≈ 5 m L = 2 x W = 2 × 4,9 m= 9,8 m ≈ 10 m Required area = (Number of units + Redundancy) (L x W) = $(20+2)(10\ m \times 5\ m)$ = 1100 m^2	Filtration velocity (vf) = 10 m/h (6-11 m/h; SNI 6774:2008) $12Q^{0,5}$ = 12× $(0,114\ m^3/s)^{0,5}$ = 4,05 ≈ 5 Discharge each unit=$\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{0,114\ m^3/s}{5}$ = 0,028 m^3/s A = $\frac{Q}{Vf}$= $\frac{102,06\ m^3/jam}{10\ m/jam}$ = 10.1 m^2 W= $\sqrt{\frac{A}{2}}$ = $\sqrt{\frac{10,1\ m^2}{2}}$ = 3.18 m ≈ 3.5 m L = 2 x W = 1 × 3,18 m = 3.18 m ≈ 3.5 m Required area = (Number of units + Redundancy) (L x W) =$(5+2)(3,5\ m \times 3,5\ m)$ = 85.75 m^2
Desinfection	Number of units = 4 Detention time (td) = 15 minute = 900 secon (Mines(2010)) Length (L): Width (W) = 10:1 (10:1 s.d. 40:1; Mines(2010)) Depth (H) = 5 m Discharge = $\frac{\text{Flow rate}}{\text{Number of unit}}$ = $\frac{2,57\ m^3/s}{4}$ = 0,642 m^3/s Volume = $Q \times td$ = $0,642\frac{m^3}{s} \times 900\ s$ =578.18 m^3 A= $\frac{Vol}{H}$ = $\frac{578,176\ m^3}{5\ m}$ = 115,635 m^2 W = $\sqrt{\frac{Across}{10}}$ = $\sqrt{\frac{115,635\ m^2}{10}}$ = 3,4 m ≈ 3,5 m L= $10 \times L = 10 \times 3,4\ m$ = 34 m Required area = (Number of units + Redundancy) (L x W) = $(4+1)(34\ m \times 3,4\ m)$ = 595 m^2	-
Total required area	5,507.5 m^2	1,263.35 m^2

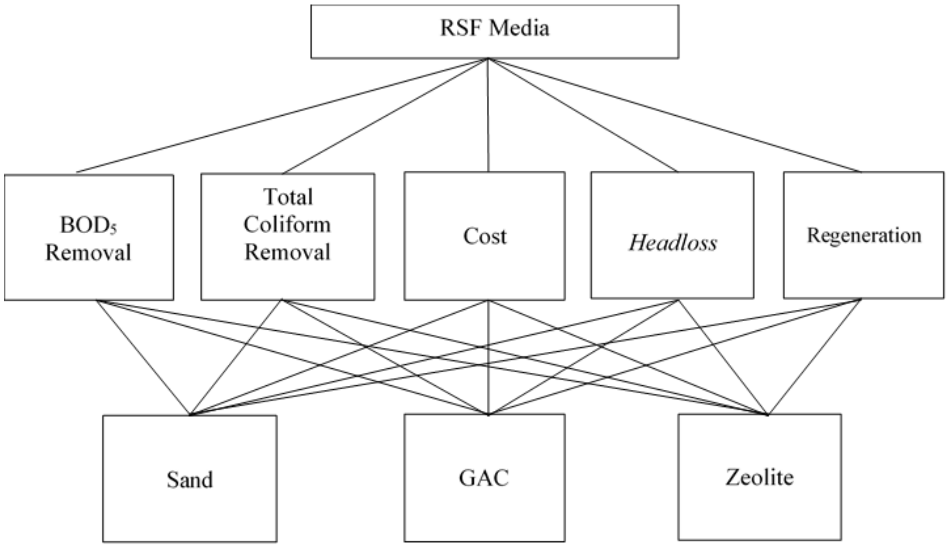

Figure 3. The RSF Media Selection Matrix

Table 4. Matrix of Comparison of Levels of Interest for Each Criterion

	BOD removal	Total Coliform removal	Headloss	Cost	Replacement period	Total
BOD removal	0.498	0.624	0.304	0.405	0.398	2.229
Total Coliform removal	0.166	0.208	0.304	0.243	0.398	1.319
Headloss	0.071	0.029	0.043	0.027	0.027	0.198
Cost	0.099	0.069	0.130	0.081	0.044	0.425
Replacement period	0.166	0.069	0.217	0.243	0.133	0.829

Each analysis is tested for consistency by calculating the consistency ratio (CR) with a random index value (Table5). Studies are considered consistent if they have a CR value of 0.1 (Rimantho *et al.*, 2016). The following is a table of calculation results. It can be seen in the table, the BOD5 efficiency criterion has the highest value and indicates that this criterion is the most important. They were followed by Total Coliform efficiency, replacement frequency, price, then headloss at the start of backwash. Zeolite media ranks first on the criteria of BOD5 efficiency, Total Coliform efficiency, and replacement frequency with the most significant value.

The best media is zeolite media, with the highest value compared with another alternative (Table 6). GAC media became the second-best media with a value of 0.202 and followed by sand media with a value of 0.177. Thus, zeolite media will be used in the design of the RSF unit as the primary medium. Geotextiles can be used as media because geotextiles can be applied as a separator between media (Morel & Diener, 2006). In addition, the use of geotextiles can increase the efficiency of the filtration unit. According to Ochoa *et al.* (2015), the application of geotextiles in greywater treatment with intermittent sand filtration can increase the efficiency of SS removal from 25% to 85% and COD removal from 3% to 30%.

The results of preliminary sizing, mass balance, and AHP show that the series of units to be implemented is an alternative series 2 with RSF media in the form of zeolite media. The WWTP for water reuse in Universitas Pertamina consisting of a collection tank, bar screen, HRF, RSF, and disinfection.

Tabel 5. Matrix of Comparison of Levels of Interest for Each RSF Media Alternative

BOD removal				Eigen Value				
	Sand	GAC	Zeolite	Sand	GAC	Zeolite	Total	Average
Sand	1	0.500	0.143	0.1	0.077	0.106	0.283	0.094
GAC	2	1	0.200	0.2	0.154	0.149	0.503	0.167
Zeolite	7	5	1	0.7	0.769	0.745	2.213	0.738
Total	10	6.5	1.343	CR = 0.021 (≤0.1)				
Total Coliform removal				Eigen Value				
	Sand	GAC	Zeolite	Sand	GAC	Zeolite	Total	Average
Sand	1	2	0.25	0.182	0.250	0.172	0.604	0.201
GAC	0.5	1	0.2	0.091	0.125	0.138	0.354	0.118
Zeolite	4	5	1	0.727	0.625	0.690	2.042	0.681
Total	5.5	8	1.45	0.033 (≤0.1)				
Headloss				Eigen Value				
	Sand	GAC	Zeolite	Sand	GAC	Zeolite	Total	Average
Sand	1	0.167	0.2	0.083	0.100	0.063	0.246	0.082
GAC	6	1	2	0.500	0.600	0.625	1.725	0.575
Zeolite	5	0.5	1	0.417	0.300	0.313	1.029	0.343
Total	12	1.667	3.2	CR = 0.034 (≤0.1)				
Cost				Eigen Value				
	Sand	GAC	Zeolite	Sand	GAC	Zeolite	Total	Average
Sand	1	0.200	3	0.158	0.149	0.273	0.580	0.193
GAC	5	1	7	0.789	0.745	0.636	2.171	0.724
Zeolite	0.333	0.143	1	0.053	0.106	0.091	0.250	0.083
Total	6.333	1.343	11	CR = 0.096 (≤0.1)				
Replacement period				Eigen Value				
	Sand	GAC	Zeolite	Sand	GAC	Zeolite	Total	Average
Sand	1	7	0.500	0.318	0.500	0.300	1.118	0.373
GAC	0.143	1	0.167	0.045	0.071	0.100	0.217	0.072
Zeolite	2	6	1	0.636	0.429	0.600	1.665	0.555
Total	3.143	14	1.667	CR = 0.093 (≤0.1)				

Table 6. Matrix of Final Result Value of Each Alternative Against RSF Media Media Criteria

Criteria	BOD removal	Total Coliform removal	Headloss	Cost	Replacement period
Score	0.446	0.264	0.039	0.085	0.166
Sand	0.094	0.201	0.082	0.193	0.373
GAC	0.168	0.118	0.575	0.724	0.072

CONCLUSION

Water conservation and pollution reduction in the MU complex can be effectively accomplished by implementing a plan to recycle wastewater from drainage channels for plant irrigation. To reuse this wastewater for irrigation purposes, a Wastewater Treatment Plant (WWTP) capable of treating the collected wastewater must meet the water quality standards outlined in Government Regulation 82 of 2001, corresponding to water quality classification class IV. The proposed configuration for the WWTP unit that can effectively treat wastewater from the drainage channels in the Universitas Pertamina Area consists of several key components. These components include a collection tank, Horizontal Roughing Filter (HRF), Rapid Sand Filtration (RSF), a reservoir, and a disinfection process. By adopting this wastewater recycling and treatment approach, the MU complex can significantly contribute to conserving water resources and minimizing potential pollution in the surrounding environment. Implementing a WWTP capable of meeting water quality standards ensures that the recycled wastewater is safe for irrigation purposes and aligns with sustainable water management practices. This not only supports the goals of water conservation but also promotes environmentally-friendly practices within the Universitas Pertamina Area.

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