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EVALUATION OF TREATMENT DRINKING WATER TREATMENT (IPAM) INSTALLATION OF KESUGIHAN PDAM TIRTA WIJAYA, CILACAP REGENCY

Akbar Maulana Grantaka, Sri Hastutiningrum, Sudarsono
Department of Environmental Engineering, Faculty of Applied Sciences
IST AKPRIND Yogyakarta

ABSTRACT

Water is one of the important factors in fulfilling human needs. The existence of water on earth is very abundant but the quality doesn't meet the standards. The system value of a DWTP can be seen from 3 aspects, quality, quantity, and continuity of water produced. Dry season, increasing population, and the age of DWTP are things that will be faced in maintaining the three aspects of value. Seeing the several conditions experienced by PDAM Tirta Wijaya, it is necessary to conduct an evaluation to determine the performance of each unit, the quality of raw and production water, the fulfillment of water needs, the operation during the dry season and the optimization that needs to be done. The method used is direct observation to DWTP Kesugihan. The results of the evaluation of DWTP Kesugihan are that the flocculation, sedimentation and filtration units is not comply with SNI 2774-2008, the water demand in 2029 is 1170.7 L/second. From this study it can be concluded that the performance of the DWTP unit is categorized as quite good, the quality of raw water is still worthy of consideration, the quality of production water has met the quality standards, DWTP Kesugihan has not been able to fulfill water needs in 2029 as much as 80% coverage, there is no operational standard during the dry season. Optimization of DWTP Kesugihan by increasing the height of the filtration unit to 6.5 m, the nozzle diameter to 0.05 m and the number of nozzles to 500 and making SOPs for the dry season

Keyword : *DWTP, Evaluation, Drinking Water, PDAM Tirta Wijay*

INTRODUCTION

Water is one of the important factors in meeting human needs. The existence of water on earth is very abundant, ranging from springs, rivers, reservoirs, lakes, seas, to the ocean. The water area is larger than the land area. However, not all of them can be used by humans to meet their daily needs. One of them is the need for clean water and drinking water.

Utilization of water as drinking water and clean water, cannot be done directly, but requires a processing process first. Processing is carried out so that the water can meet the standards as clean water and drinking water. According to Slamet (1994), the general parameters of drinking water consist of physical, chemical, biological, and radioactive

PDAM Tirta Wijaya is a company that serves drinking water needs in Cilacap Regency. The Kesugihan Water Treatment Plant (IPA) is one of the IPA units owned by PDAM Tirta Wijaya. The Kesugihan IPA at PDAM Tirta Wijaya is the first IPA owned by PDAM Tirta Wijaya so that it has the oldest age of 34 years.

According to Joko (2010), the value of a system from a WTP can be seen from 3 aspects, namely the quality, quantity, and continuity of the water produced. In order to achieve a certain target, these 3 aspects must be met by maintaining technical and non-technical conditions. In maintaining continuity and quality, PDAM Tirta Wijaya faces annual problems, namely seawater intrusion every dry season at the Kesugihan WTP. The increase in the population and its activities in Cilacap Regency will go hand in hand with the target customers. In order to achieve the quantity aspect, namely the fulfillment of customer needs, PDAM Tirta Wijaya needs to calculate and evaluate the amount of water production compared to population growth. In technical calculations,

Drinking water is water that has been processed or without processing that meets health requirements and can be drunk directly (Permenkes No.492/2010). In Indonesia, the standard that applies to clean water is based on the Regulation of the Minister of Health of the Republic of Indonesia Number 416/Menkes/Per/IX/1990 concerning Requirements and Monitoring of Water Quality and Regulation of the Minister of Health No. 492 of 2010 concerning Drinking Water Quality Requirements.

The formulas used in this study include: (Darmasetiawan, 2004)

Contact Time (Td)

$$Td = \frac{Vol}{Q}$$

with :
Vol = Volume (m^3)
Q = Discharge (m^3/second)

Major Headloss

$$HL_{Major} = f\ \frac{L}{D}\frac{v^2}{2g}$$

with :
f = Darcy friction factor
L = Pipe length (m)
D = Pipe Diameter (m) = Fluid Flow
V = Velocity (m/sec)
g = Gravity (9.81 m/sec^2)

Minor Head Loss

$$HL_{minor} = k \times \frac{v^2}{2g}$$

with :

k = Pipe accessories value
v = flow rate (m/sec)
g = Gravity (9.81 m/sec2)

Speed Gradient

$$G = [\frac{(HL \times g)}{\vartheta \times Td}]^{1/2}$$

with :

HL =Total Head Loss (m)
g = Gravity (9.81 m/sec2)
μ = Viscosity of water (m2/second)
Td = Residence Time (seconds)

Continuity Equation

$$Q = v \times A$$

with :

v = Flow velocity (m/sec)
A = Cross- sectional area (m2)

Fraude Number

$$Fr = \frac{Vo^2}{g \times Rh}$$

with :

vo = Surface Load Tube Settlers(m/sec)
g = Gravity (9.81 m/sec2)
Rh = Hydraulic Radius (m)

Reynolds number

$$Re = \frac{Vo \times Rh}{\vartheta}$$

with :

vo = Surface Load Tube Settlers(m/sec)
Rh = Hydraulic radius (m)
ϑ = Kinematic viscosity of water (m2/second)

Speed Backwash

$$V_{bw} = Vs \times \mathcal{E}^{4,5}$$

with :

vs = Deposition Rate (m/sec)
Ɛ = Media Porosity

Media Expansion

$$L = (1-\varepsilon)L\Sigma \frac{x}{1-\varepsilon_e}$$

with :

Ɛ = Media Porosity
X = Media Faction

Area Percentage Nozzle

$$\%\text{Nozzle} = \frac{\text{Luas } Nozzle}{\text{A}}$$

with :

A = Cross-sectional Area Nozzle(m2)

Population Projection Arithmetic Method (Hartono, 2009)

$$Pn = Po + (Ka.X)$$

$$Ka = \frac{Po-Pt}{t}$$

with :

Pn = Total population in the next n years
Pt = population at the beginning of the data year
Po = Total population at the end of the data year
X = Time lapse
t = Number of data -1
Ka = Average population increase

RESEARCH METHODS

This research was carried out at IPAM Kesugihan and carried out rom March to April 2021. The data were obtained based on direct observation, testing, calculations and secondary data collection from related agencies.

Primary data collection includes raw water quality, work unit dimensions, treated water quality, and interview data observations. Secondary data collection includes raw and processed water quality, information on processing, Cilacap Regency in Figures, Districts in Cilacap Regency in The dimension data of the existing unit will be calculated according to the existing equation and the results will be compared with SNI 6774-2008. The quality of raw water will be compared with PP no 82 of 2001 and the quality of treated water will be compared with PERMENKES 492 of 2010. Population data will be projected and processed into data on total water demand for the next 10 years. Interview data will be used to analyze the management of IPAM operations during the dry season. From all data processing, IPAM optimization can be planned.

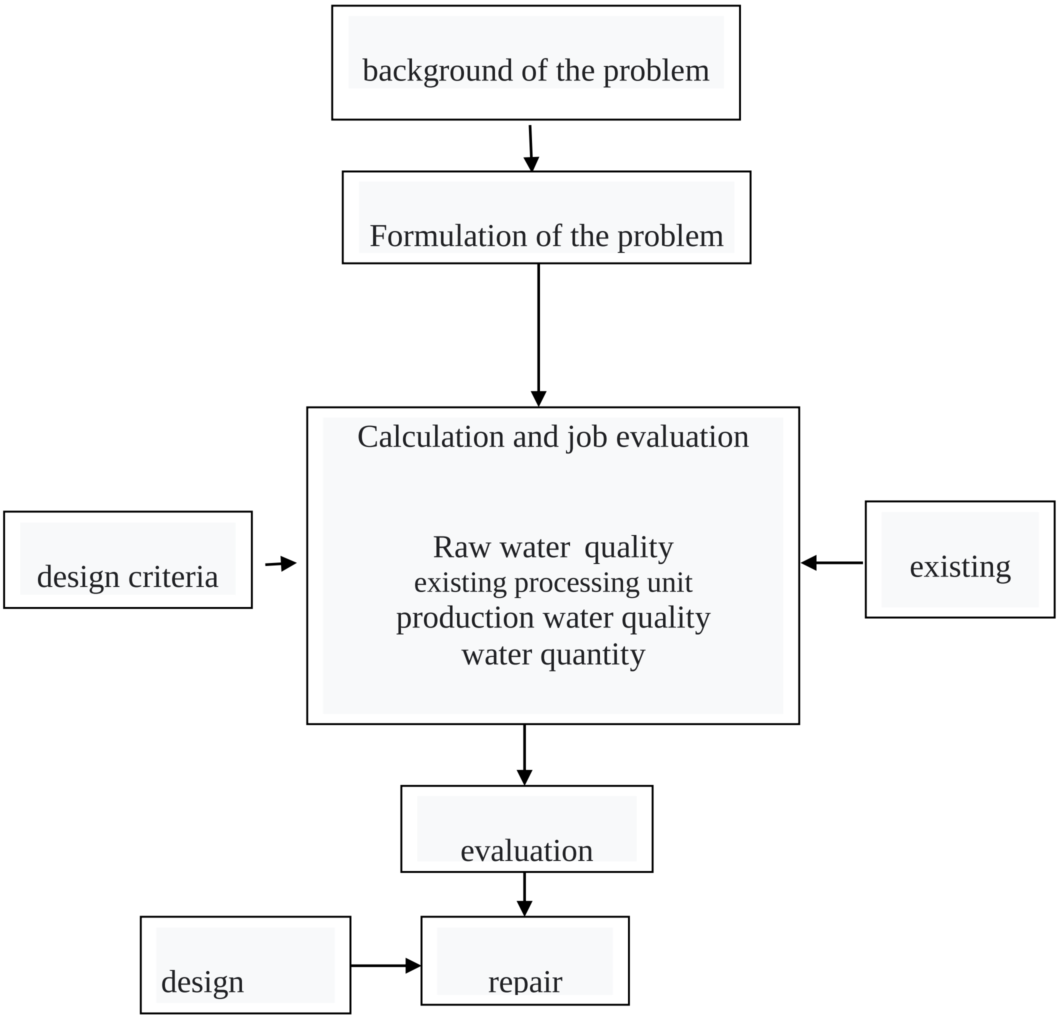

Figure 1. Flowchart and Summary of Accounts

RESULTS AND DISCUSSION

The Production Office which is concurrently with the drinking water treatment installation unit (IPAM) of Kesugihan PDAM Tirta Wijaya, Cilacap Regency is located on Jl. Salakan, Kesugihan, Cilacap, Central Java. This office is the production and distribution office of PDAM Tirta Wijaya, Cilacap Regency.

1. Work Unit

a. Intakes

The Drinking Water Treatment Plant (IPAM) of PDAM TIrta Wijaya has 3 sources of raw water that are used according to priority, namely the Gerak Serayu Weir Irrigation, an artificial reservoir, and the Serayu River. The production process will use a raw water source from the Serayu River which is a last resort if the Gerak Serayu Dam Irrigation and an artificial reservoir cannot be used. Each raw water source has its own intake pump which will be channeled through a transmission pipe to the coagulation unit.

The construction of the intake building and pump housing are made of iron and concrete and are currently in good condition. At the mouth of the tapping channel which is directly connected to the raw water source, it is equipped with a bar screen. Filtering of raw water at the intake is carried out to prevent coarse objects from being carried into the installation.

b. Coagulation

The Kesugihan Drinking Water Treatment Plant uses the hydraulic fast stirring method in the coagulation unit. Hydraulic stirring itself is a mixer that utilizes the turbulence of water caused by the flow of water. (Darmasetiawan, 2004).

Coagulation in IPAM Kesugihan occurs in the spillter tub. The coagulation process starts from the entry of coagulant liquid (Poly Aluminum Chloride) using a dosing pump on the transmission pipe and continues in the dividing tub (Spillter) to 2 clarifier units.

Table 1. Coagulation Calculation Results

Description	Unit	Mark	Standard
Time Stirring (Td)	second	4.76	1-5
Value G/sec	/second	958	> 750

(Source: Researcher Analysis)

In the table it can be seen that in the coagulation unit there are no parameters that are not in accordance with SNI 6774-2008.

c. flocculation

The flocculation unit has the goal of converting microflocs into macroflocs. The Flocculation Unit is insideClarifier which hangs right in the middle Clarifier. The flocculation and sedimentation unit is in a tubular tub consisting of 2 units with a capacity of 200 liters/second each.

The flocculation process at IPAM Kesugihan uses a diffuser pipe as the flocculator where slow stirring is carried out by utilizing the flow of water that enters through the diffuser pipe hole. The process starts by entering the inlet pipe, then goes to zone 1 which flows down with a total of 8 diffusers, zone 2 which flows upwards with a total of 7 diffusers, zone 3 which flows to the side with a total of 12 diffusers, zone 4 which flows downwards with a total of 16 diffusers, the final flow goes to the sedimentation unit

Table 2. Flocculation Calculation Results

Description	Unit	Mark	Standard
Mark G/sec	/second	88.3	100-10
Time Stay (Td)	minute	126	20-200
Speed Max flow	m/sec	1,22	0,5 – 1,5
tall	m	8.75	2-4

(Source: Researche Analysis)

In the table, it can be seen that one of the parameters does not comply with SNI 6774-2008, namely the high parameter.

d. Sedimentation

The Sedimentation Unit at IPAM Kesugihan is located around the Clarifier with a height of 5 meters and a depth of 3.5 meters. After the water passes through the Flocculation Unit zone 4 with a downward flow direction, then the water goes to the Sedimentation Zone with an upward flow direction.

In the Sedimentation Unit there is a plate settler visible on the top surface Clarifierwith an inclination of 60°. The plate settler is used to speed up the sedimentation process

Table 3. Sedimentation Calculation Results

Disciption	Unit	Mark	Standard
Burden surface	m^3/m^2/jam	1,49	0,5-1,5
Dept	m	3,5	0,5-1
Time Stayl (Td)	jam	2,32	2-2,5
Number Reynold	-	23,3	<2000
Number Fraude	-	$1,31.10^{-4}$	$> 10^{-5}$
Speed Precipitation	cm/menit	0,04	<1
Tilt Basic bak	°	56,4	45-60

In the table, it can be seen that the sink does not comply with SNI 6774-2008.

e. Filtration

After the deposition process is carried out in the Clarifier then the water goes to the Filtration Unit. In the IPAM KESUGIHAN Filtration Unit there are 8 filtration tanks.

Table 4 Filtration Calculation Results

Discription	Unit	Mark	Standard
Speed Filtering	m/jam	9,17	6-11
Speed *Backwash*	m/jam	47,7	36-58
Long *Backwash*	menit	5,64	11-15
Expantion	%	30,56-	30-50
Tichk Antrasit	mm	300	300-700
Quartz thickness	mm	600	400-500
Media tickness Buffer	mm	250	80-100
Slot width *Nozel*	mm	0,03	<0,5
Presentage Slot area *Nozel* to filter area	%	1,49	> 4

(Source: Researcher Analysis)

In the table it can be seen that the old parameter backwash, thickness of anthracite, thickness of buffer media and % Nozzle not in accordance with SNI 6774-2008.

f. Disinfection

Water that has passed through the filtration unit will be accommodated in Clear Water Storage or final reservoir for clean water. However, before entering the CWS, the water first gets chlorine injection from the pipe using a dosing pump with a dose of 12 Mg/liter.

Volumetric discharge or discharge of chlorine affixing in the disinfection unit can be determined using the chlorine requirement approach using the following calculations: (DLH PemKOT Surabaya, 2019).

Chlorine Requirement = Chlorine Dose x Operating Discharge
= 12 mg/L x 400 L/sec
= 4800 mg/sec

Affixed debit $= \frac{\text{need for chlorine}}{\text{chlorin density}}$
$= \frac{4800 \text{ mg/sec}}{3{,}124 \text{ g/cm3}}$
= 1350,7 mg/sec
= 5,53 L/hour

2. Raw Water Quality

In accordance with Government Regulation No. 82 of 2001, the source of raw water for drinking water is included in the class I (one) category, where class I water is water designated for drinking water.

Table 1. Raw Water Parameters Not Conforming to Quality Standard

Parameter	Unit	Mark	Raw Quality
Iron	mg/l	0,42	0,3
Manganase	mg/l	0,86	0,1
Copper	mg/l	0,59	0,02
TSS	mg/l	153	50
COD	mg/l	16,4	10
Phopfates as P	mg/l	0,888	0,2
Free Chlorine	mg/l	0,1	0,03

(Source : Researcher Analysis)

In the table above, there are 7 parameters that are not in accordance with the quality standard of PP No. 82 of 2001. The comparison of parameters that do not meet the quality standard is 0.24, based on this comparison and the parameter values are not too far from the quality standard, the raw water deserves to be considered as raw water for IPAM Kesugihan.

3. Production Water Quality

The independent testing and testing conducted by the relevant agencies showed that the quality of the treated water had complied with the PERMENKES 492/2010 quality standard.

4. Meeting Water Needs

a. Calculation of Water Needs

The calculation of water demand is based on population projections in the next 10 years using the arithmetic method. The choice of method is based on the value of r (correlation) and standard deviation (Hartono, 2009).

Table 2. Comparative Results of Correlation Test and Standard Deviation

Metode	Nilai (r)	Standar Deviasi
Arithmetic	1	31737,941
Geometry	0,999548	38000,8748
Least Square	1	34003,843

(Source : Author’s Analysis)

Table 3. Number of Population in Projected Year

Year	Amount Population
2019	462322
2029	567184

(Source : Author's Analysis)

The total need for clean water for the IPAM Kesugihan service area in 2029 which is the sum of domestic water needs, non-domestic water needs, and water losses. The total need for clean water in 2029 is 1064,272 L/second.

b. Fulfillment of water needs

The discharge of water treated by the Drinking Water Treatment Plant (IPAM) is different from the total demand for clean water. Water discharge treated by IPAM must consider the maximum day factor (fmd). Water usage standards based on city category, daily maximum factor (fmd) which is 1.1 (Department of Public Works, 1998), then the need for treated water or processing discharge can be calculated in the following way:

$$
\begin{aligned}
Q_{Production} &= Q_{Total} \times 1.1 \\
&= 1064{,}272 \text{ L/sec} \times 1.1 \\
&= 1170.7 \text{ L/sec}
\end{aligned}
$$

It can be seen that the need for treated water ($Q_{Production}$) which is 1170.7 L/second.

When compared with the availability of water, the shortage of water can be calculated by:

$$
\begin{aligned}
\text{Shortage} &= 1170.7 \text{ L/sec} - 400 \text{L/sec} \\
&= 770.7 \text{ L/sec}
\end{aligned}
$$

So it can be seen that IPAM Kesugihan needs to increase the processing discharge by 770.7 L/second to meet service needs in 2029.

5. Dry Season Operation

The dry season is a season where rain is rare, or rainfall is of low value. The dry season usually lasts from April to September (Badan Meteorology, Climatology and Geophysics, 2014).

Based on the results of interviews conducted, it can be seen that the management of dry season operations is carried out based on incidental actions. The action in question is in the event of seawater intrusion, the pointintake will be moved to intakewhich is further away. However, if the sea water intrusion gets worse and reaches the pointintakeSecond, production activities will be stopped.

6. IPAM optimization

a. Filtration Unit Backwash time

Design Criteria : 10-15 minutes

Design Plan : 10.5 minutes

$$Td = \frac{\text{Vol tub}}{\text{Qbw}}$$

$$10{,}5 \text{ menit} = \frac{\text{Vol tub}}{0{,}202^3/sec}$$

$$\text{Vol tub} = 10{,}5 \text{ minute } \times 60 \frac{\text{sec}}{\text{minute}} \times 0{,}202 \frac{\text{m}^3}{\text{sec}}$$

$$= 127{,}26 \text{ m}^3$$

In the evaluation design, the existing diameter is used because the addition of height makes it more possible in the construction work.

Body Diameter = 5 m

Vol tub = 0.25 x 3.14 x D2x H

$$H = \frac{\text{Vol tub}}{0{,}25 \times 3{,}14 \times \text{D}^2}$$

$$= \frac{127{,}26 \text{ m}^3}{0{,}25 \times 3{,}14 \times 5 \text{ m}^2}$$

$$= \frac{127{,}26}{19{,}625}$$

= 6.48 rounding off 6.5 m

Checking the value of Backwash Time (Td)

vol ba = 0.25x 3.14 x D2x H

= 0.25x 3.14 x (5m)2 x 6.5m

= 127.56 m3

$$Td = \frac{\text{Vol tub}}{\text{Qbw}}$$

$$= \frac{127{,}56^3}{0{,}202 \text{ m}^3 \ /sec}$$

= 631,48 sec or 10,52 minute
(meet quality standard)

% Nozzles

Design Criteria : > 4

Design Plan : 5

$$\%\ Nozzle = \frac{\text{A } Nozzle}{\text{Media area}} \times 100\%$$

$$5 = \frac{\text{A } Nozzle}{19{,}625 \text{ m}^2} \times 100\%$$

$$\text{A } nozzle = \frac{5 \times 19{,}625 \text{ m}^3}{100}$$

$$= 0{,}98125 \text{ m}^2$$

Quantity adjustment nozzle from 600 to 500, then Diameter nozzle :

A nozzle = 0.25 x 3.14 x Dnozz2 x Amount Nozzle

$$D_{nozz}^2 = \frac{A\ Nozzle}{0{,}25 \times 3{,}14 \times 500}$$

$$= \frac{0{,}98125\ m^2}{0{,}25 \times 3{,}14 \times 500}$$

$$= 2{,}5 \times 10^{-3}\ m^2$$

$$D_{nozz} = \sqrt{2{,}5 \times 10^{-3}\ m^2}$$

$$= 0{,}05\ m$$

% value checking nozzle :

A nozzle = 0.25 x 3.14 x Dnozz2 x Amount Nozzle

= 0.25 x 3.14 x (0.05m)2 x 500

= 0.98125 m2

$$\%\ Nozzel = \frac{A\ Nozzle}{\text{Media area}} \times 100\%$$

$$= \frac{0{,}98125}{19{,}625} \times 100\%$$

= 5 (>4) (meets quality standards)

b. Standard Operating Procedure

Standard Operating Procedures for the dry season really need to be developed. This is because the alertness of employees is not always maintained for various reasons. With the applicable SOP, operators donot need to wait for orders from employees who have higher authority so that they can prevent unwanted things from happening.

CONCLUSION

The current performance of IPAM Kesugihan can be categorized as quite good because there are only 3 units that are not in accordance with SNI 6774-2008 and also production water that has complied with PERMENKES RI No.492 of 2010.

IPAM Kesugihan's raw water, which is the Irrigation of the Serayu Gerak Weir, an artificial reservoir, and the Serayu River actually does not meet the class 1 water quality standard as the drinking water quality standard. However, based on the number of parameters that exceed the quality standard, only 7 of the 32 parameters and the parameter values that exceed the quality standard are not too far from PP. 82 of 2001, the raw water can still be considered in accordance with economic considerations.

The production water produced by IPAM Kesugihan has met the quality standards stated in the PERMENKES RI No.492 of 2010.

The current production capacity of IPAM Kesugihan has not been able to meet the water needs of the next 10 years. In 2029, the IPAM Kesugihan service area has a water requirement of 1170 L/second with a population of 567182 people. IPAM Persistence needs increase production capacity by 770.7 L/second to meet customer needs in 2029 with 80% customer coverage.

The operation of the production process is carried out incidentally and based on the direction of the leadership who has the authority. Move pointintake at a further point it is used as a countermeasure against seawater intrusion. Stopping the production process is the next step taken when seawater intrusion has reached the pointintake The second,

IPAM Kesugihan has good production quality, so IPAM optimization is chosen based on the easiest option to implement. IPAM Kesugihan can be optimized by changing the height of the filtration tank to 6.5 meters and changing the holenozzle on the filtration unit to 500 and change the diameter nozzle to 0.05 m. The next optimization is done by adding a Standard Operating Procedure (SOP) for operators during the dry season.

SUGGESTION

- Make improvements to the existing processing unit as suggested in the IPAM optimization.
- It is necessary to schedule and re-check the procurement of reagents in the laboratory so that testing can be carried out optimally.
- Create standard operating procedures for incidental events such as the dry season.
- It is necessary to increase the expertise and knowledge of operators and technicians so that IPAM Kesugihan's performance can be optimal.

BIBLIOGRAPHY

Anonymous, 2015, Regional Drinking Water Company of Cilacap Regency, URL, pdamcilacap.co.id/profile (accessed June 6, 2021)

Anonymous, 2019, Technical Instructions for Management of Liquid Waste Activities Hospitality, Environmental Service PemKOTSurabaya, Surabaya

Hartono, 2009, Geography Explore Earth and Universe 2, Center Books Department of National Education, Jakarta

Joko, Tri. 2010.Raw Water Unit in Drinking Water Supply System, Graha Science, Yogyakarta

Minister of Health Regulation No. 492 in 2010,Water Quality Requirements Drink, Ministry of Health, Jakarta.

Slamet, JS, 1994, Environmental Health. Gadjah Mada University Press, Yogyakarta

Darmasetiawan, Martin, 2004, Water Treatment Plant, Eka Mitra Engineering, Jakarta.

Government Regulation Number 82 of 2001, Dan Water Quality Management Water Pollution Control, Jakarta. SNI 6774 2008 , Procedure for Planning Processing Installation Package Units Water. National Standardization Agency, Jakarta