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Regional Case Study

Wastewater Treatment Plant (WWTP) Bahagia Market on Kuala Dua Village Subdistrict Sungai Raya

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Abstract
Location of Bahagia Market on K.H. Abdurrahman Wahid streets, Kubu Raya regency. Bahagia Market has been operation for two years but doesn't have wastewater treatment, the liquid waste product is discharged directly into the waters. The purpose of this plan is to knowing the discharge of wastewater generated, so the treatment is adjusted to the quality of wastewater and the available land area, as well as calculating cost budget. Planning methods is area survey, data collection, waste inventory, sampling, quality analysis, calculation of wastewater discharge, planning of wastewater treatment, and calculation of cost budget. The planning results are Bahagia market has 11 stalls, 64 loss and 43 tables with 3 drains. The liquid of wastewater come from the washing of vegetables, fish, meats, and poultry. BOD, COD, TSS, and ammonia parameters are above quality standards, while total coliform, fat and oil are below quality standards. Wastewater treatment project for the 5 next years starting from 2023 to 2027 with wastewater effluent is 8640 liters/days. Treatment unit use are sump well, bar screen, rotating biological contactor, settling basins, disinfection tub, and sludge drying bed with a land area of 5 m^2 and a cost budget of Rp. 69,315,479.

Keywords: Market; rotating biological contactor; wastewater; wastewater treatment; WWTP.

1. Introduction
The market has quite a large potential in producing wastewater so wastewater treatment is a problem that must be overcome (Neshart et al, 2021). The resulting liquid waste is directly discharged into a water bodies without going through a processing causing environmental pollution (Kaawoan et al, 2022). Market activities such as washing fish in the form of blood and water contain high levels of carbohydrates, protein, mineral salts and other remnants of materials which have a negative effect on the environment (Marlina et al, 2021). Some of the adverse effects of wastewater that are not managed properly cause health problems, decreased environmental quality, disturbance to the beauty and damage to living things and the environment (Almufid and Permadi, 2020). To prevent river pollution due from liquid waste being disposed of directly, the market must have a wastewater treatment plant (WWTP). Benefits from provides wastewater treatment such as reducing and eliminating the bad effects of liquid waste for humans and the environment, and improve the quality of the environment in processing, disposing and utilizing liquid waste for the benefit of life (Wulandari, 2014).

Wastewater treatment aims to reduce physical, chemical and biological parameters with a certain percentage of degradation. Liquid waste that has been treated at the processing unit should not cause disturbance to the environmental ecosystem when the effluent is discharged into the receiving water body. The following are the objectives of wastewater treatment:

a. Reduces the amount of suspended solids
b. Reduces the amount of floating solids
c. Reduces the amount of organic matter
d. Kills pathogenic bacteria
e. Reduces the amount of dangerous and toxic chemicals
f. Reduce excessive nutritional elements (N and P).
g. Reducing other elements that are considered to have a negative impact on the ecosystem (Moersidik, 2006).

A wastewater treatment plant is a combination of an operating unit and a process unit designed to reduce certain parameters contained in wastewater until it reaches a certain percentage level. The dimensions of each unit are adjusted to the amount of waste water you want to treat. Wastewater treatment plants are divided into several stages, namely preliminary processing (preliminary treatment), primary processing (primary treatment), secondary processing (secondary treatment), and advanced processing (Metcalf and Eddy, 2004). According to Manurung (2019), the research entitled Planning for the Padang Bulan Traditional Market Waste Water Treatment Plant (IPAL) in Medan Baru District, Medan City carried out planning by testing the quality and quantity of waste water by first determining the characteristics of waste such as BOD, COD, TSS, NH3, oil and fat which then become a reference in the construction of waste water treatment plants. The research results showed that the quantity of liquid waste produced was 22.5 m3/day so that the appropriate waste processing technology to be applied was using an activated sludge processing system with other supporting units such as bar screens, fat separator tanks, grit chambers, equalization tank, initial settling tank, aeration tank, final settling tank and disinfectant.

Kuala Dua Village is one of the villages that has many traditional markets, however none of the markets in that area have a good wastewater treatment system that meets standards, because most of the markets built in that area are close to rivers, so the resulting waste water is immediately discharged into the nearest river body. Meanwhile, according to Peraturan Pemerintah Nomor 22 (2021), it is stated that every business and/or activity has an obligation to process waste before it is disposed of into environmental media, and according to Menteri Kesehatan Nomor 519, (2008) also states that liquid waste from each stall/stall in the market must be first market to a waste water treatment plant before being disposed of. Therefore, it is necessary to plan a Wastewater Treatment Plant (WWTP) at Bahagia market. Bahagia Market is a traditional market located on K.H Abdurrahman Wahid streets, Kuala Dua village. The market has a 1,500 m2, with a width of 30 m and a length of 50 m. Bahagia Market has been operating for 2 years from Monday to Sunday at 04.00 a.m to 08.30 a.m. Bahagia Market has have 11 stalls, 62 booths and 42 tables, it selling various like as vegetables, fruits, meat, poultry, fish and other basic necessities. The waste generated by this market comes from 100% water use, the wastewater generated in a day from all market activities amounts to 3,550 liters/day.

This research was important because Bahagia market is one of the most visited markets in the Kuala Dua Village area and the processing system for waste disposal is also not well planned. This is a challenge in itself to plan a WWTP in that market, because Bahagia Market will be the first market in the village that has a waste processing system that meets the specified needs and standards, besides that the location of the market is flanked by residential areas on the left and right so that the land It is empty only behind the market where the WWTP is being built and the river which is the waste disposal site is across the street from the market. The planning of wastewater treatment plant on Bahagia market must carried out with a minimalistic manner and as effective as possible in its operation.

The treatment unit planned to the results from the analysis initial characteristics of the liquid waste from the laboratory so the treatment unit chosen is appropriate and according to local environmental aspects, easy to use and maintain. The units used are sump well, bar screens, rotating biological contactors, sedimentation tank, disinfection tank, and sludge drying bed. The rotating biological contactors is the main biological processing unit used, this unit was chosen because after

analysing the waste water according to the results obtained, the rotating biological contactors unit was easy to use, electricity requirements are relatively smaller, do not require large amounts of air, the sludge produced is relatively small compared to the activated sludge process, and relatively does not cause foam, apart from that because RBC is a biological processing unit that is suitable for use with small waste capacities. In addition, this unit effective for reducing biological oxygen demand (BOD) and chemical oxygen demand (COD) content by up to 80%,

The purpose of this research is to know the discharge of liquid waste produced from Bahagia Market, to know the processing unit and dimensions, to know the area of land required for wastewater treatment plant according to the designed treatment system, as well as the cost budget according to the processing method used.

2. Methods

2.1 Inventory of Wastewater Sources and Sampling

Inventory of pollutant sources is one of the efforts made to control river pollution that occurs. (Ermawati et al, 2017). The inventory of wastewater was carried out at 3 points to the number of channels for the final disposal Bahagia Market. The last waste disposal distance from the river bank is about 100 meters. The location of sampling points in the final wastewater channel is marked using GPS. The sources of wastewater at each sampling point are described below:

- Point 1 with coordinates 0°8'59" S 109°24'59" E waste sources come from vegetables, fish and meat
- Point 2 with coordinates 0°9'1" S 109°25'1" E the source of waste comes from fish and poultry
- Point 3 with coordinates 0°9'1" S 109°25'1" E the source of waste comes from vegetables

The sampling method for wastewater at the Bahagia Market refers to SNI 6989.59.2008 using the integrated sampling method. Sampling selected as many as 3 points on the right, left, and in the middle behind the market. Sampling of wastewater at the Bahagia Market was carried out at 10.00 a.m when the market activities were over and the traders were cleaning their trading places. Five liters of samples were taken and placed in jerry cans. The sampling method used is as follows: 3 medium sized buckets are used to collect liquid waste in the outlet channel. 1 container for homogenizing liquid waste and 1 jerry can to use for liquid waste samples ready to be taken to the laboratory. The container is placed at 3 points where the liquid waste outlet is. 2 liters of waste are taken from each channel point to be homogenized in 3 different containers. the temperature and pH of the water samples collected from the 3 points were measured alternately usingthermometer and pH meter, the measurement results are recorded. Liquid waste samples are homogenized in 1 container by stirring using a stirrer made from a material that does not contaminate the sample. The homogenized sample was put into a 5 liter jerry can and closed tightly. Liquid waste is ready to be taken to the laboratory for analysis.

2.2 Data Analysis and Projection of Water Use

Parameters to be analyzed refer to PerMenLHK Nomor 68 (2016). Sample testing was carried out at PT. Sucofindo Pontianak on Adi Sucipto streets Km 12.9, Sungai Raya, Kubu Raya regency. The results of the analysis of the characteristics wastewater are used as a reference for designing an wastewater treatment plant according to market needs so that the waste output from the design results can meet the quality standard criteria and be safely disposed of into the river.

The use of water in the Bahagia Market is projected for the 5 next years in the wastewater treatment plant, because the use of clean water in the Bahagia Market can produce different amounts when taking into account daily needs, maximum needs and peak needs. The total water usage requirement is assumed for the next 5 years, from each stalls, booths, and tables the number of units and the amount of water demand increase each year. Calculation of total water needs can use the formula (Said et al, 2019):

Total water usage requirement/day = water requirement for all stalls + total water requirement for all booths + total water requirement for all tables

2.3. Planning of Flow Wastewater from Bahagia Market

The design of wastewater flow from Bahagia Market for each stalls and booths is adjusted to the Regulation of Peraturan Gubernur Provinsi Jakarta Nomor 122 (2005) which is 40 liters/day, while each table is adjusted to PerMenKes RI Nomor 17 Tahun 2020 which is 15 liters/day. From these data, the average water usage used in the Bahagia Market is calculated by assuming the wastewater discharge is 100% of water usage. The formula that can be used is (Said et al, 2019):

Qr = (amount of water used/day x number of stalls) + (amount of water used/day x number of booths) + (amount of water used/day x number of tables)

Calculation of peak discharge to calculate the dimensions of the planning unit. The peak factor (fp) reaches 1.2-2. The equation (1) used in calculating the peak discharge is:

$Q_{peak} = f \times Q_r$ .....(1)

$Q_{peak} = 2 \times 4{,}285$ L/days

$Q_{peak} = 2 \times \left(\frac{4{,}285\ L}{86{,}400\ second}\right)$

$Q_{peak} = 2 \times 0.05$ L/second

$Q_{peak} = 0.1$ L/second

Where:

Q_{peak} = peak discharge of wastewater (L/sec)

fp = crest factor (1.2-2), used 2

Q_r = average discharge of wastewater (L/second) = 8,640 L/days = 0.1 L/second

2.3 Calculation of Removal Efficiency and Mass Balance

The parameters to be calculated for removal efficiency are TSS, BOD, and COD. Calculation of the total efficiency of the treatment process is based on the quality of the influent and the quality of the effluent from final treatment, the formula can be used in equation (2) (Duma et al, 2022):

$$\text{Removal efficiency} = \frac{(parameter\ inlet - parameter\ outlet)}{parameter\ outlet} \times 100\% \quad \text{.....(2)}$$

Mass balance calculation for each processing unit is calculated using the following equation (3):

$$\text{Mass Balance} = \text{Debit} \times \frac{constituent\ concentration}{1000} \quad \text{.....(3)}$$

2.4 Units of Wastewater Treatment Plant (WWTP)

The treatment units selected to be designed in the wastewater treatment plant at Bahagia Market are adjusted to the results of laboratory analysis of the characteristics of the initial sample of wastewater taken. The processing units used consist of: sump well, bar screens, rotating biological contactor, sedimentation tank, sludge drying beds, then discharged into water bodies.

2.5 Budget Plan

The volume calculation refers to the technical drawings that have been made. The reference for the RAB calculation is based on PerMen PUPR Nomor 1 Tahun 2022, the concerning guidelines for preparing estimated costs for construction work in the field of public works and public housing. In general, the stages in calculating budget plan can be seen from the following equation. The equation (4) for calculating is (PerMen PUPR Nomor 1 Tahun 2022):

Draft Budget Plan = Volume x Labor Unit Price.....(4)

3. Result and Discussion

3.1 Waste Inventory and In Situ Measurement Results

There are different sources of waste obtained from each point, the waste issued by point 1 is waste from the vegetables, fish and meat; point 2 is waste from fish and poultry; while point 3 the waste is released comes from selling vegetables only. The difference in the source of the liquid waste produced at the 3 sampling points is influenced by the difference in the flow of the channels at each booth and the goods sold by each trader.

In situ measurements for temperature and pH were carried out in order to find out the accurate temperature and pH when the first wastewater was obtained from each sampling point on the last 3 channels of the wastewater. The measurement results are still within the appropriate quality standard, at first point have a temperature of 25°C and a pH of 6.9; second point has a temperature of 27°C and a pH of 6.7; and third point has a temperature of 26.8°C and a pH of 6.6; After taking 3 samples from 3 points, the samples were homogenized into 1 sample and measured so that the temperature was 26°C and the pH was 7.

3.2 Wastewater Quality Test Results of Bahagia Market

Samples taken from wastewater of Bahagia Market were analysed at Sucofindo according of PerMenLHK Nomor 68 Tahun 2016, described in the table below:

Table 1. Results wastewater quality test of bahagia market based on PerMenLHK Nomor 68 Tahun 2016 concerning domestic wastewater quality standards

Parameters	Unit	Quality Standard	Test Result	Quality	Analysis Method
pH on temperature 24,8°C	-	6-9	6.92	Qualify	SNI 6989.11:2019
BOD5 days 20°C	mg/l	30	155	Not eligible	SM.ed.23.Th.2017
COD by K2Cr2O7	mg/l	100	641	Not eligible	SNI 6989.73:2019
TSS	mg/l	30	332	Not eligible	SNI 6989.3:2019
Oil and Fat	mg/l	5	4.70	Qualify	SNI 6989.10:2011
Ammonia	mg/l	10	31	Not eligible	SNI 06-6989.30-2005
Total Coliforms	total/100ml	3000	2801	Qualify	SNI 06-6858-2002

The quality test results obtained show that several parameters are above the quality standard, which means they can pollute the river if they are disposed of directly without processing them first. Parameters that are still above the quality standard are: BOD, COD, TSS, and ammonia. The high BOD and COD values are caused by the large number of organic compounds in the wastewater (Royani et al, 2021). The organic compounds in the wastewater of Bahagia Market came from vegetables residue, washing meat, fish blood and poultry. The high values of BOD and COD have an impact on decreasing dissolved oxygen caused by microorganisms and indicating that these waters have been polluted (Fadzry et al, 2020). High BOD values in wastewater when discharged into water bodies cause aquatic microorganisms to degrade organic matter in wastewater and result in depletion of dissolved oxygen (Munthe et al, 2021). High COD concentrations cause the dissolved oxygen content in water bodies to become low, even depleted, so that oxygen as a source of life for creatures in the water such as aquatic animals and plants cannot be fulfilled, is threatened with death and cannot reproduce properly. The high concentration of TSS when discharged into the waters can affect light penetration which interferes with the photosynthesis process, because turbid water cannot settle and dissolve (Lumunon et al, 2021). High ammonia values result in toxic water conditions. Ammonia levels in the water increase as pH and temperature increase (Said and Sya'bani, 2014).

3.3 Projection of Bahagia Market for the 5 Next Years

Calculation of the results of the additional assumptions for each kiosk, booth and table along with the use of clean water used for the next 5 years from 2023 to 2027 is described in the table below:

Table 2. Units of stalls, booths, and tables along with the total water needs of the Bahagia Market in 2023-2027

Year	Total Population	Stalls	Booths	Tables	Water Requirement (L/days)		
					Stalls	Booths	Tables
2022	31.542	11	64	43	440	2560	645
2023	32.573	12	66	45	480	2640	65
2024	33.639	12	68	46	480	2720	690
2025	34.739	13	71	48	520	2840	720
2026	35.875	13	73	49	520	2920	735
2027	37.048	13	75	51	520	3000	765

3.4 Planning Debit of Wastewater

The amount of water used for each building unit from Bahagia Market in 2022 according to needs is calculated following equation (5):

Qr = (number of stalls x water usage/unit/day) + (number of booths x water usage/unit/day) + (number of tables x water usage/units//day).....(5)

Qr = (11 x 40 liters/unit/day) + (62 x 40 liters/unit/day) + (42 x 15 liters/unit/day) = 3,550 liters/day

The calculation of the waste discharge from the WWTP planning uses assumptions for the next 5 years because it is known that in the next 5 years the Bahagia Market will likely continue to be developed which will lead to an increase in the number of buildings in the market. Planning starts from 2023 to 2027 so that the WWTP that is built is suitable and more effective and can continue for the specified time. The calculation for the 2027 debit is as follows based on the use of clean water in the market which can be calculated using the following formula (Said et al, 2019):

- It is due in installments

Qr = (number of stallss x water usage/unit/day) + (number of boothss x water usage/unit/day) + (number of tables x water usage/unit//day)

Qr = (13 x 40 liter/unit/day) + (75 x 40 liter/unit/day) + (51 x 15 liter/unit/day) = 4,285 liter/day

- Peak discharge

It is known that Qr = 4,285 liters/day: 86,400 seconds = 0.05 liters/second

fp = peak factor (1,2 until 2), using 2.

Qpeak = fp x Qr

Qpeak = 2 x 0.05 liter/second

Qpeak = 0.1 liter/second = 8640 liter/day = 8.64 m^3/day = 0.36 m^3/hour

So, the discharge used for planning unit of wastewater treatment plant is the peak discharge in 2027 which is 8.64 m^3/day.

3.5 Removal Efficiency and Mass Balance of Wastewater Treatment Plant Units

Calculation of the mass balance and removal efficiency of each planned processing unit and it has been known that the reduction effectiveness of each processing unit can be summarized in the flowchart image below:

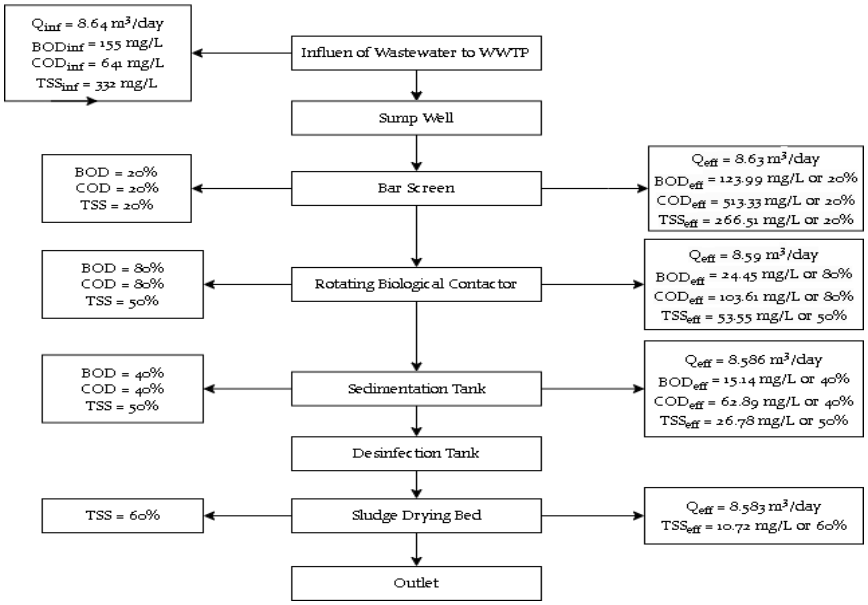

Figure 1. Flowchart of mass balance and processing unit removal efficiency

3.6 Planning of Wastewater Treatment Plant (WWTP)

a. Sump Well

The sump well is an initial holding tank that functions to accommodate liquid waste that will be processed before heading to further processing (Belladona et al, 2020). The result of the calculation of the collecting tank:

Tub size = 0.72 m²
Tank volume = 0.36 m³
Long = 1.2 m
Wide = 0.6 m
Depth = 0.5 m
Detention time = 1 hour
Pump = Shimizu PS 128 BIT
Pipe = 1.25 inch

b. Bar Screen

Bar screen is a pre-processing function to separate large impurities so that they are not carried away by further processing (Sari and Yuniarto, 2016). The results of the bar screen calculation are:

Wide = 0.6 m
Distance between rods = 0.025 m
Bar depth = 0.03 m
Bar width = 0.004 m
Number of rods = 21 pieces
Submerged stem length = 0.06 m
Headloss = 0.028 m/s

c. Rotating Biological Contactor

The working principle of rotating biological contactor is by contacting wastewater containing organic pollutants with microbial films attached to the surface of the media in the reactor (Rizal and Weliyadi, 2014). Waste treatment with rotating biological contactor is affected by biofilms formed, biofilms can degrade organic and inorganic compounds present in wastewater. The thickness of the biofilm on the media depends on the organic load and the rotational speed of the reactor (Laili et al, 2014). The results of calculating the RBC dimensions are as follows:

Surface area = 0.03 m²

Medium spokes = 0.61 m
Dipped fingers = 0.25 m
Undipped fingers = 0.36 m
Number of shafts = 1 unit
Number of discs = 30 disk
Tub length = 1.43 m
Tub width = 1.23 m
Tub depth = 0.6 m
Land area = 1.76 m^2
Detention time = 1 hour
Aerator = 1 unit of surface aerator SFA-02 with a power of 1.49 kWh

d. Sedimentation Tank

The treatment system at the end uses a sedimentation tank which is useful for precipitating the remaining insoluble solids in the wastewater and will then settle to the bottom of the tank (Sirait et al, 2023). The calculation for the sedimentation tank unit is:

Land area = 0.54 m^2
Tub width = 0.52 m
Tub length = 1.04 m
Tub depth = 1 m
Detention time = 2 hour
The shape of the mud room = trapezium
Sludge chamber volume = 0.04 m^3
Sludge collection period = 10 days

e. Disinfection Tank

Functions of disinfection tank is to contact disinfectant compounds with wastewater that can kill pathogenic microorganisms. The determination of chlorine to be used for the chlorination process is determined by the levels of organic matter contained in the waste (Achmad et al, 2021). The dimensional planning for the disinfection tank is:

Chlorine dose = 10 mg/l
Ca(OCl)2 = 0.15 kg/day
Embedding capacity = 500 cc/minute
Chlorine content in solution = 0.0004
Volume tank = 0.15 m^3
Surface area = 0.3 m^2
Tub width = 0.4 m
Tub length = 0.8 m
Tub depth = 0.5 m
contact time = 27 minutes
Land area = 0.32 m^2

f. Sludge Drying Bed

The principle of sludge drying bed processing is to reduce the water content and sludge volume through drying or dewatering (Hu et al, 2017). The calculation for the sludge treatment unit is:

Sludge = 51.11 kg/day
Thick sand = 23 cm
Gravel thickness = 20 cm
Thick mud = 20 cm
Thick bed = 20 cm
Beds = 2 pieces

Bed surface area = 1.3 m²
Drying time = 10 days
Bed width = 1 m
Bed length = 1.3 m

3.7 Design Recapitulation Wastewater Treatment Plant

Design recapitulation for wastewater treatment plant of Bahagia marke is considered on the basis of calculations that have been carried out and each processing unit is adjusted to the waste discharge produced each day, so that the planning is carried out according to needs. The results of the dimensional calculations for each planned processing unit wastewater treatment plant can be seen in the table below:

Table 3. Total area wastewater treatment plant of pasar bahagia

Processing Units	Detention Time	Dimension (m)	Area (m²)
Sump Well	1 hour	l = 1.2 w = 0.6 h = 0.5	0.72
Rotating Biological Contactor	1 hour	l = 1,43 w = 1,23 h = 0,6	1.76
Sedimentation Tank	2 hour	l = 1.04 w = 0.52 h = 1	0.54
Desinfection Tank	27 minutes	l = 0.8 w = 0.4 h = 0.5	0.32
Sludge Drying Bed	10 day	l = 1.3 w = 1 h = 1	1.3
Total			5

3.8 Budget Plan and Stages Work

The budget plan used in wastewater treatment plant for Bahagia market takes into account and is adjusted to needs, where each material used is calculated according to the needs of the unit to be built. The reference for the RAB calculation is based on PerMen PUPR Nomor 1 (2022), the concerning guidelines for preparing estimated costs for construction work in the field of public works and public housing. Meanwhile, the calculation for each price is guided by Peraturan Gubernur Kalimantan Barat Nomor 204 (2021) concerning Basic Unit Prices for West Kalimantan Provincial Government Activities for Fiscal Year 2022. The estimated budget costs for the construction of Pasar Bahagia are for a land area of 5 m² namely IDR 69,315,479.

The stages of IPAL construction work are as follows:

a. Preparatory work
- Clearing and leveling land
- Measurement and benchmarking (*bluepank*)
- Earth excavation work
- Land compaction work

b. WWTP building work
- Construction of IPAL foundation
- WWTP concrete construction with a capacity of 0.1 liter/second

c. Auxiliary unit work

- Pump installation
- Installation of aerators
- Use of chemicals
- Sand and gravel
- Installation of pipes and accessories

4. Conclusions

The conclusions drawn from the results of this planning are the discharge of liquid waste produced by the Bahagia Market is 4,285 liters/day, the calculation for the processing unit uses the peak discharge in 2027 which is 8,640 liters/day. The processing units used in the Bahagia Market WWTP planning are sump well, bar screens, rotating biological contactor, sedimentation tank, disinfection tank, sludge drying bed. The land area used for the construction of the WWTP unit is 5 m^2. The total budget for the development of the Bahagia Market WWTP is Rp. 69,315,479,00.

Based on the existing conclusions, it can be suggested that in this research there are several things that need to be considered, namely as follows: the construction of an IPAL should be realized at Pasar Bahagia so that the waste water produced does not pollute water bodies, there is a need for deeper studies and regular checks regarding the quality of waste water so that the IPAL at Pasar Bahagia can be more efficient and meet needs, the estimated costs for building materials and other requirements needed for the construction of the IPAL are checked to ensure they are more accurate.

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