Original Research Article

Feasibility of Water Quality from Treated Domestic Wastewater Effluent in IPAL Bojongsoang, Bandung District for Fish Farming

.

ABSTRACT

IPAL Bojongsoang is a place for processing wastewater in domestic activities in Bandung City before being released into the aquatic environment. This study aims to determine the feasibility of water quality from domestic wastewater treatment for fish farming activities at the IPAL Bojongsoang in January - June 2023. The method used was a survey method with purposive sampling technique and conducted at five research stations with two replicates. The efficiency of reducing sewage treatment at the IPAL Bojongsoang is able to reduce the BOD5 value by 73%, reduce ammonia by 66%, reduce TSS by 38%, increase DO by 75% and the temperature and pH parameters are stable as expected. The results of testing six water quality parameters from processed domestic wastewater at the IPAL Bojongsoang, some ponds are at high levels and exceed water quality standards. So that it is not suitable if it is used as a fish farming pond that will be consumed or traded. The performance of each WWTP treatment pond is not yet optimal in accordance with the aims and objectives of wastewater treatment (WWTP), namely to reduce (eliminate) polluting substances so that they can be used for agricultural and fishery needs.

Keywords: IPAL Bojongsoang, water quality, appropriateness, cultivation

1. INTRODUCTION

In the current era, the state of the water sector is increasingly threatened by various activities such as household activities, industry, and other activities that produce waste and can ultimately provide pollutant loads into water bodies. Overcoming problems related to pollutant loads is certainly necessary, namely by carrying out management activities for the waste before it is finally discharged into the waters. The destruction of the aquatic environment will have a major impact on the balance of nature and will disrupt the stability of life of living things in a very large scope. With poor water conditions due to wastewater contamination, many things are disturbed, both the impact on humans and the impact on biota in waters, especially fish commodities.

Based on data from the Bandung City Statistics Agency (BPS), the population of Bandung City increased by around 0.68% from 2021 - 2023. This has increased the pollutant load of domestic liquid waste and resulted in Bandung City experiencing considerable urgency towards the preservation of its water ecology, including in terms of controlling domestic liquid waste from every resident living in the Bandung City area.

Fish is one of the animals whose main habitat is in the water. Fish breeding activities require water sources that meet the requirements of both in physical and chemical parameters (Siegers et al. 2019). Fish life is very dependent on the condition of the aquatic environment. Fish that live in polluted waters and have habitats that cannot provide the appropriate carrying capacity for fish survival will certainly interfere with the growth of the fish itself. This makes it necessary to manage the wastewater to reduce the impact on fish breeding activities.

The Wastewater Treatment Plant (WWTP) in Bojongsoang is one of the institutions engaged in wastewater treatment that operates under the auspices of PDAM Bandung City. This WWTP is a place for processing wastewater in household activities (domestic) before being released into the aquatic environment which applies a conventional wastewater treatment system. This installation is engaged in wastewater treatment, producing water for reuse in agricultural and fishery activities (Budi 2012). The treatment process at the IPAL Bojongsoang uses a treatment pond as the processing stage. Currently, in the treatment pond at the IPAL Bojongsoang, there are fish that grow because they are born during floods, including catfish, gabus fish, tilapia, and goldfish. Fish that live in the treatment pond can be used as an indicator of the feasibility of processed wastewater treatment results for aquatic biota, but these fish are instead utilized by local residents for consumption and trading. Based on research conducted by Siregar (2004), it is stated that the performance of the treatment pond at the IPAL Bojongsoang is not optimal in accordance with the aims and objectives of wastewater treatment, namely to reduce the levels of polluting substances so that they can be used for fisheries and agricultural activities, which are eventually returned to the receiving water body (river).

The various problems above are the reasons for the importance of domestic waste management for the sake of maintaining the aquatic environment in Bandung City and by knowing that there are fish living in the treatment pond, so research is needed on the feasibility of water quality in the treatment pond for aquaculture activities.

2. MATERIAL AND METHODS

2.1 Period and Research Area

This research is located at the IPAL Bojongsoang, Bandung Regency, West Java with data collection and data processing time from January - June 2023 with details of data collection starting from January - March 2023 making observations and surveys to the research location. April - May 2023 conducting water sampling and data processing starting from May to June 2023. Samples were taken with 2 replicates in a 14-day sampling time span. Sampling is carried out at 08.00 am because at that time, the input of domestic wastewater discharge to the WWTP is the highest. Water quality measurements were conducted in situ and Ex-situ. In-situ measurements include temperature, pH, and DO measurements. Exitu measurements include measurements of BOD5 (Biochemical Oxygen Demand), and NH3 (Ammonia) at the Aquatic Resources Laboratory of the Faculty of Fisheries and Marine Sciences, Padjadjaran University and TSS (Total Suspended Solids) at the Central Laboratory of Padjadjaran University.

2.2Research Method

The method used in this research is purposive sampling. The purposive sampling method is one of the non-random sampling techniques where the researcher will determine sampling by determining specific characteristics that are in accordance with the objectives of the research so that it is expected to answer the problems of the research. Sampling refers to SNI No. 6989-59-2008 Water and Wastewater - Part 59 on wastewater sampling methods.

Determination of sampling points is based on locations that represent the condition of each pond and pay attention to the source of water input into the IPAL Bojongsoang. Of the several problems at the IPAL Bojongsoang, the most dominant is in the treatment pond which has the most dominant function to improve water quality parameters. An overview of the location map of the IPAL Bojongsoang and its stations is in Fig 1.

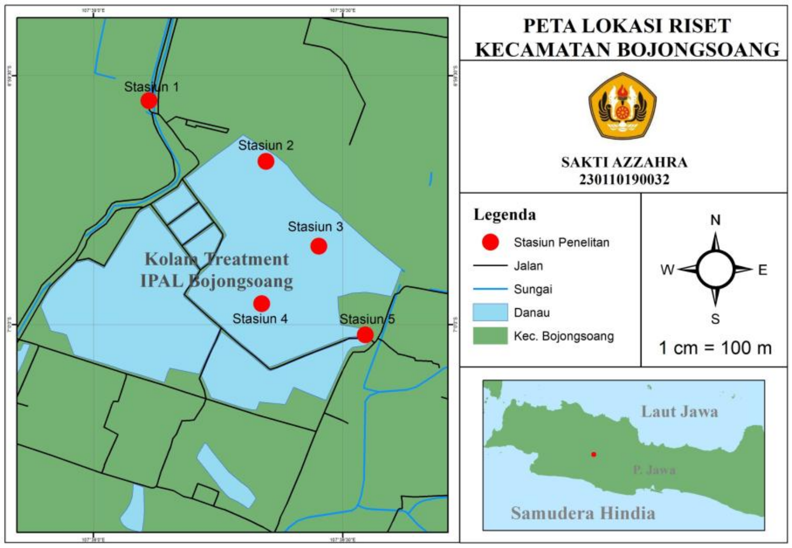

Fig 1. Research location map and data collection location at IPAL Bojongsoang

The locations of the research stations are as follows:

- Station 1: IPAL Bojongsoang inlet area
- Station 2: Anaerobic Pond 1 Set A outlet area
- Station 3: Facultative Pond outlet area 1 Set A
- Station 4: Maturation Pond outlet area 1 Set A
- Station 5: IPAL Bojongsoang set A outlet area

2.3Observation Parameters

The water quality parameters observed and the method of analysis in Table 1.

Table 1. Water quality parameters

Parameter	Unit	Analysis Method	Observation Location
		Water Quality	
		Physical	
Suhu	°C	Potensiometrik	IPAL Bojongsoang
TSS	mg/L	Gravimetrik	Laboratory
		Chemical	
pH		Potensiometrik	IPAL Bojongsoang
DO	mg/L	Potensiometrik	IPAL Bojongsoang
BOD$_5$	mg/L	Titrasiiodometrik	Laboratory
Ammonia	mg/L	spektofotometrik	Laboratory

2.4 Data Analysis

Analysis of water quality data which includes physical and chemical parameters of water is carried out descriptively comparative, namely by comparing the measurement results with the Domestic Liquid Waste Quality Standard Criteria according to PerMen LHK Number 68 of 2016 for parts of Station 1 and Station 5. Government Regulation No. 22 of 2021 concerning "Implementation of Environmental Protection and Management" class 2 and 3 for all stations. Analysis is also carried out by comparing the quality of incoming water with outgoing water to see the effectiveness of wastewater treatment at the IPAL Bojongsoang. The expected results are follows to:

Table 2. Expected parameter value comparison results at Inlet and Outlet

Parameters	Value
Biochemical Oxygen Demand (BOD$_5$)	Decreasing
Dissolved Oxygen (DO)	Increasing
Amonia (NH_3)	Decreasing
Total Suspended Oxygen (TSS)	Decreasing
Suhu	Stable

pH	Stable

3. RESULTS AND DISCUSSION

3.1 Physical and Chemical Parameters of Water

Physical water quality parameters measured during the research included temperature, and TSS. Chemical parameters in this research include BOD, DO, pH, and ammonia. The results of physical parameter water quality measurements are presented in Table 3 and the results of the chemical parameter measurements are presented in Table 4.

Table 3. Physical Parameters in the IPAL Bojongsoang

Parameter (unit)		Station					PerMen LHK No. 68 Tahun 2016	Baku Mutu PP No. 22 Tahun 2021	
		1	2	3	4	5		Grade II	Grade III
Temperature (°C)	Average	25-25,5	26,3-26,5	26,5-27,3	26-27	26,8-27	-	Deviasi 3*	Deviasi 3*
	Range	25,25	26,4	26,5	26,5	26,9	-		
TSS (mg/L)	Average	165,25-172,25	157-177,3	144.37-158,35	119	96,5-111,8	30	50	100
	Range	168,75	167,15	151,36	119	104,16			

Table 4. Chemical Parameters in the IPAL Bojongsoang

Parameter (unit)		Station					PerMen LHK No. 68 Tahun 2016	Baku Mutu PP No. 22 Tahun 2021	
		1	2	3	4	5		Grade II	Grade III
BOD (mg/L)	Average	78,92-82,9	61,76-69,97	50,94-54,48	33,36-45,3	19,76-23,6	30	3	6
	Range	80,91	65,87	52,71	39,33	21,68			
DO (mg/L)	Average	1,9-2,2	4,6-4,9	5,2-7,3	7,5-8,5	8,1-8,5	-	4	3
	Range	2,05	4,75	6,25	8	8,3			
pH	Average	7,81-8,15	6,12-7	6,04-6,73	6,95-7,14	6,56-7,24	6-9	6-9	6-9
	Range	7,98	6,56	6,4	7,05	6,9			
Amonia (mg/L)	Average	2,3-2,82	1.35-3.45	1,65-2,09	1,67-1,88	0,77-0,95	10	0,2	0,5
	Range	2,56	2,4	1,87	1,78	0,86			

3.1.1 Temperature

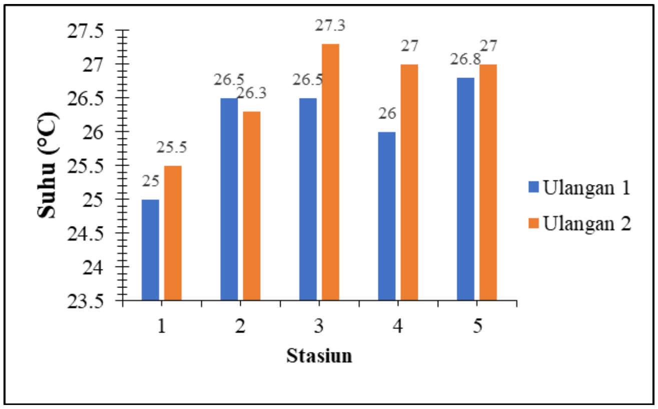

Fig 2. Temprature in IPAL Bojongsoang

The results of temperature measurements at the IPAL Bojongsoang starting from station 1 to 5 sequentially tend to be stable. The water temperature at station 1 at the IPAL Bojongsoang is lower than the other stations. The measurement results at all stations are still within the threshold of water quality standards based on Government Regulation No. 22 of 2021. Water quality standards for temperature in grade 2 and 3 have a requirement that the water temperature is normal with a deviation of 3 from the natural normal temperature conditions in the local environment.

According to Suprastini et al. (2014) that water temperatures ranging from 26-27 °C affect fish life activities such as breathing, reproduction, and growth. Direct effects are in the form of organism activities such as growth, reproduction, and metabolism, while indirect effects include increasing the accumulation power of various chemicals and reducing oxygen levels in water. The process of decomposition of organic matter in wastewater is strongly influenced by water temperature because the activity of microorganisms is higher at increasing temperatures (Ramadani et al. 2021).

3.1.2 Total Suspended Solid (TSS)

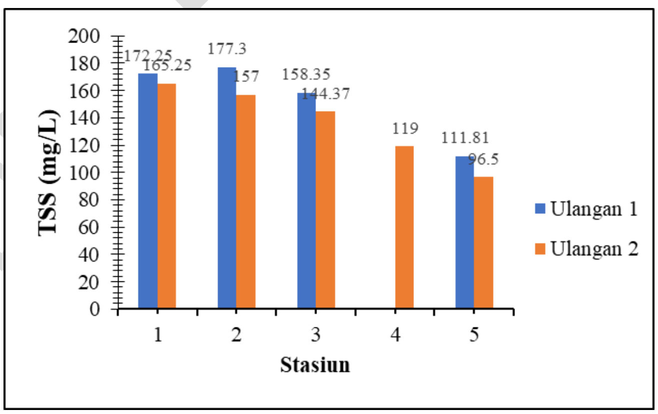

Fig 3. TSS in IPAL Bojongsoang

The measured TSS content values tend to decrease sequentially from station 1 to station 5 in accordance with the purpose of the WWTP itself. The highest average was found at station 1 with a value of 168.75 mg/L and the lowest value was found at station 5 with a value of 104.16 mg/L. The high TSS value at station 1 is because it is the inlet of the IPAL Bojongsoang which receives the highest input load. Station 2 replicate 2 has a higher value than station 1 because this station is an anaerobic pond that has sediment that is high enough to be visible from the surface, the outlet condition of station 2 also has a lot of garbage and sediment that is lifted and accumulated from the pond. At station 3, namely in the facultative pond, the TSS value decreased because this pond is designed to create slow or almost silent flow conditions and reduce pollutant levels aerobically and anaerobically with anaerobic bacteria and microalgae.

The decrease in TSS at station 3 is not too high, station 3 should be able to reduce TSS levels to around 20% (Siregar 2004).

The TSS test results at the outlet are considered not to meet the wastewater quality standards according to PerMen LHK No.68 of 2016. The concentration of total suspended solids at station 5 has not met the quality standard set at 30 mg/L. The results of the TSS value at the IPAL Bojongsoang at almost every station do not meet the quality standards of classes 2 and 3 of Government Regulation No. 22 of 2021, namely 50 mg/L and 100 mg/L. According to Harmilia (2017) TSS values of 25-80 mg/L have little effect on fisheries interests such as fish farming, so 81-400 mg/L is not good for fisheries interests. This shows that the waters in the IPAL Bojongsoang pond are inadequate for use as a fish farming pond.

3.1.3Biochemical Oxygen Demand (BOD_5)

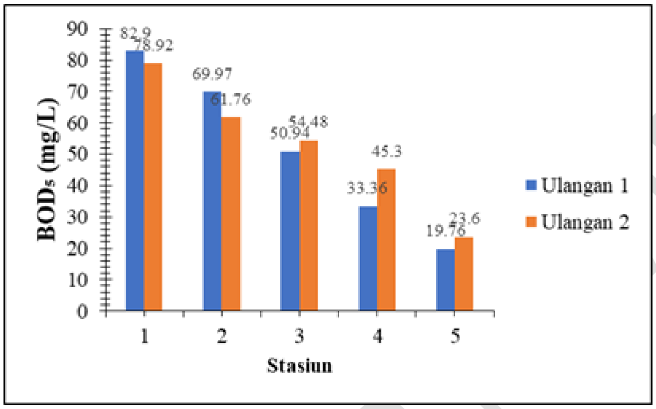

Fig 4. BOD_5 in IPAL Bojongsoang

Station 1 has the highest average BOD5 value of 80.91 mg/L with a range of 82.9-78.92 mg/L. The station with the lowest average value is station 5, which is 21.68 mg/L with a range of 19.76 - 23.6 mg/L. This result is in accordance with the objective of the IPAL Bojongsoang, which is to reduce the pollutant load because station 5 is the outlet of the IPAL Bojongsoang unit set A, which is the end point of domestic wastewater treatment before it is finally discharged into the Citarum River. The BOD5 test results at the outlet of the WWTP are considered to have met the domestic wastewater quality standards, namely PerMen LHK No. 68 of 2016 at the outlet with a range of 19.76-23.6 mg/L.

3.1.4 Dissolved Oxygen (DO)

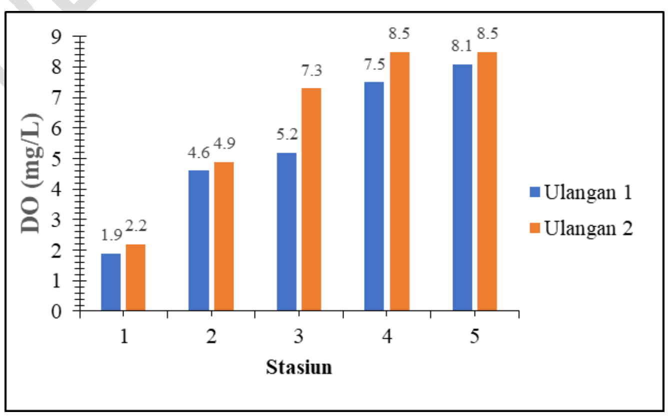

Fig 5. DO in IPAL Bojongsoang

The station that has the lowest DO value is station 1 with a range of 1.9-2.2 mg/L. The low DO at station 1 is because this station is the inlet of the WWTP which receives the first waste input load. Supported by several previous parameters that have high values so that dissolved oxygen in the waters is utilized to decompose organic compounds contained in the waters. The more organic matter in a body of water, the less residual oxygen dissolved in it.

The station with the largest average DO is station 5 which is 8.3 mg/L with a range of 8.5-8.1 mg/L. The high DO at station 5 occurs because this station is the last point of domestic wastewater treatment at the IPAL Bojongsoang so that the amount of organic matter entering the waters is not as much as at other stations. The concentration of dissolved oxygen in natural waters is generally less than 10 mg/L (Effendi 2003).The station with the largest average DO is station 5 which is 8.3 mg/L with a range of 8.5-8.1 mg/L. The high DO at station 5 occurs because this station is the last point of domestic wastewater treatment at the IPAL Bojongsoang so that the amount of organic matter entering the waters is not as much as at other stations. The concentration of dissolved oxygen in natural waters is generally less than 10 mg/L (Effendi 2003).

When compared to the water quality standards of Government Regulation No. 22 of 2021, the value of dissolved oxygen at station 2, station 3, station 4 and station 5 is in good condition for the survival of aquatic organisms because it has a value of more than 3 mg/L, this value is the minimum value for fisheries activities which means that dissolved oxygen should not be less than 4 mg/L in class 2 and should not be less than 3 mg/L in class 3. The main source of dissolved oxygen in waters is the photosynthesis process of phytoplankton and direct absorption/binding of oxygen from the air through contact between the water surface and the air (Darmawan, et al. 2018).

3.1.5 Ammonia

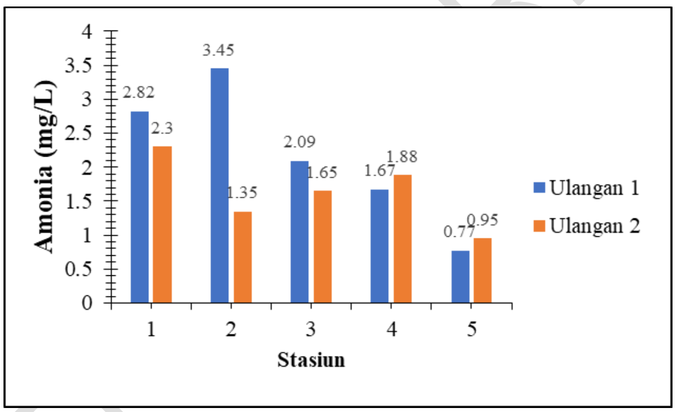

Fig 6. Ammonia in IPAL Bojongsoang

The highest ammonia concentration was at station 2, which is an anaerobic pond. High ammonia concentrations in anaerobic ponds can occur due to lack of nitrification, so that the conversion of ammonia into nitrite and nitrate does not take place effectively. Ammonia that has a high concentration in the water can cause a decrease in dissolved oxygen which can lead to disturbances in physiological and metabolic functions such as respiration (Zhang et al. 2013). The lowest concentration is at station 5, which is the outlet of the WWTP because ammonia levels have been treated in several previous stages.

A comparison of ammonia test results at the IPAL Bojongsoang at all stations is considered to have met the effluent quality standards of PerMen LHK No. 68 of 2016, which is 10 mg/L. So the performance of the IPAL Bojongsoang in reducing ammonia levels is in accordance with the waste quality standards. Comparison results of testing ammonia levels at the IPAL Bojongsoang. When compared with PP No. 22 of 2021, no ammonia levels meet water quality standards. So the water is not yet suitable for release into water bodies. Fish cannot tolerate free ammonia levels that are too high because it can interfere with the oxygen-binding process in the blood and can eventually cause suffocation (Effendi 2003). High ammonia levels will make the gills swell so that the tissue will be damaged and its function as a respiratory device will be disrupted (Kordi and Andi 2010).

3.1.6 power of Hydrogen (pH)

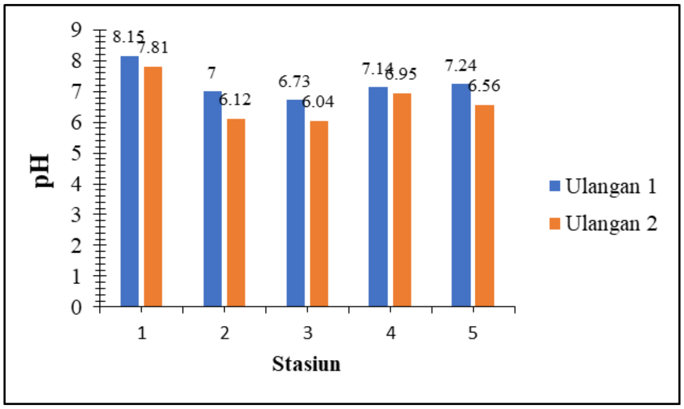

Fig 7. pH in IPAL Bojongsoang

The power of Hydrogen (pH) is still in the normal pH range of 6-9 because some gases that cause water to become acidic such as hydrogen sulfide are neutralized by the alkaline detergent content in the waste. This is supported by research by Sari et al., (2015) which states that the presence of residual detergents, shampoos, soaps and other alkaline cleaning agents in wastewater results in a low pH of low waste to a neutral pH again.

According to the quality standards of PerMen LHK 68 of 2016 pH has a quality standard with a value of 6 -9. The results of this measurement show that in the outlet section the pH has met the quality standards with a stable value. The results of the comparison with PP No. 22 of 2021 also for all stations have met the range of numbers 6-9 quality standard values for classes 2 and 3. This indicates that the condition of the pond at the IPAL Bojongsoang is in a fairly good condition in its pH parameter.

Water conditions that are very alkaline or very acidic will endanger the survival of organisms because they will interfere with metabolic processes and respiration (Hamuna et al. 2018). Very low pH levels cause greater solubility of metals in water which are toxic to aquatic organisms, conversely high pH can increase the concentration of ammonia in water which is also toxic to aquatic organisms (Tatangindatu et al. 2013).

3.2 Water Quality Parameters Feasibility

Feasibility data of test results at stations 1 (WWTP inlet) and 5 (WWTP outlet) with wastewater treatment quality standards can be seen in Table 5.
Table 5 -wastewater treatment quality standard.

Parameter	Average test result (April-May)		Effectiveness percentage	Average test result LPKL		PerMen LHK No.68 Tahun 2016
	St 1 (inlet)	St 5 (outlet)		Inlet Quarterly II	Outlet Quarterly II	
BOD_5 (mg/L)	80,91	21,68	73%	39,21	16,25	30
DO (mg/L)	2,05	8,3	75%	-	-	-
Ammonia (mg/L)	2,56	0,86	66%	2,78	5,67	10
pH	7,98	6,9	0%*	8,76	7,40	6-9
Suhu (°C)	25,25	26,9	0%*	-	-	-
TSS (mg/L)	168,75	104,155	38%	76,00	25,33	30

Description: - st = station
- * temperature and ph are effective because they are stable/constant and in accordance with quality standards.
- red box indicates effluent exceeds quality standards

Based on the test results of six parameters, there are only four parameters listed in the minister of environment and forestry regulation no. 68 of 2016, namely bod5, ammonia, ph, and tss. There is one parameter that exceeds the quality standards for wastewater treatment. That parameter is tss. According to firdaus (2014) the high tss at station 5 (wwtp outlet) is caused by the processing pond before heading to the outlet being utilized by residents as a fish farming pond which is thought to affect the water quality in the pond so that the treatment system is less than optimal.

The effectiveness of domestic wastewater treatment at the wwtp in this study can be seen through several water quality parameters in accordance with the wastewater quality standards. The level of effectiveness of waste treatment is different, the effectiveness of bod treatment ranges from 73%, ammonia, and tss 38%. The process of processing parameters such as bod, ammonia, and ph of the wwtp runs effectively. The temperature of the wwtp wastewater is still in accordance with quality standards and is quite high compared to normal water temperature because the dissolved oxygen level in the waste is lower than the dissolved oxygen level in normal water. In addition, the ponds in the wwtp are exposed to direct sunlight without any cover, so that the wastewater becomes hotter and the temperature rises. The increase in temperature can also be caused by low dissolved oxygen contained in wastewater, this is supported by pratiwi and ernawati (2016) who state that the higher the temperature of the waters, it will be inversely proportional to the dissolved oxygen (do) levels in the waters. The effectiveness of bod treatment occurs because the process of decomposition of organic matter (substrate) contained in domestic wastewater takes place continuously from both aerobic and anaerobic processes (romayanto et al. 2006).

Testing conducted by the pdam at lpkl is carried out every month with data recap per 3 months (quarterly). The test results in the second quarter showed that all parameters met the quality standards but the data were quite different from the test results. Although taken in the same month, this could be due to different data collection times, the pdam may conduct monitoring and data collection regularly and periodically according to a specific schedule or need.

Seeing the fact in the field that the treatment pond is used as a means of fish farming by residents, it is also necessary to compare it with its water quality standards according to pp no. 22 of 2021 class 2 and class 3 for fisheries activities. The feasibility data of the test results at all stations with water quality standards can be seen in the table below.

Table 6The feasibility data of the test results at all stations with water quality standards

Parameter (satuan)	Repetition 1					Repitition 2					PP No. 22 Tahun 2021	
	St 1	St 2	St 3	St 4	St 5	St1	St 2	St 3	St 4	St 5	Grade 2	Grade 3
BOD_5 (mg/L)	82,9	69,97	50,94	33,36	19,76	78,92	61,76	54,48	45,3	23,6	3	6
DO (mg/L)	1,9	4,6	5,2	7,5	8,1	2,2	4,9	7,3	8,5	8,5	4	3
Ammonia (mg/L)	2,82	3,45	2,09	1,67	0,77	2,3	1,35	1,65	1,88	0,95	0,2	0,5
pH	8,15	7	6,73	7,14	7,24	7,81	6,12	6,04	6,95	6,56	6-9	6-9
Suhu (°C)	25	26,5	26,5	26	26,8	25,5	26,3	27,3	27	27	Dev 3	Dev 3
TSS (mg/L)	172,25	177,3	158,35	-	111,81	165,25	157	144,37	119	96,5	50	100

Description: - st = station
- * temperature and ph are effective because they are stable/constant and in accordance with quality standards.
- red box indicates effluent exceeds quality standards

Based on the comparison results with class 2 and 3 water quality standards, there are several parameters that still do not meet water quality standards for fisheries activities. There are two parameters whose water quality still exceeds the quality standard limit, namely bod5 and tss. Poor water quality can cause changes in the aquatic ecosystem. Unfit water conditions can damage natural habitats, such as coral reef ecosystems, mangroves, or fishing grounds, which in turn can affect the sustainability of fisheries.

According to febrita and roosmini (2022), the outlet of the IPAL Bojongsoang contains cr, zn, cu, and ni. This indicates that the processing stage in the treatment pond contains heavy metals. Heavy metals in waters have a negative impact on aquatic organisms that can damage their tissues and organs. Fish cultivated in treatment ponds are likely to contain heavy metals, so if consumed in excessive amounts, it will cause health problems .

4. Conclusion

The efficiency of sewage treatment after going through three ponds, there are several parameters that meet the quality standards and some that do not meet the quality standards. The efficiency of reducing sewage treatment at the IPAL Bojongsoang is able to reduce the BOD_5 value by 73%, reduce ammonia by 66%, reduce TSS by 38%, increase DO by 75% and the temperature and pH parameters are stable as expected.

The results of testing six water quality parameters from processed domestic wastewater at the IPAL Bojongsoang, some ponds are at high levels and exceed water quality standards. So that it is not suitable if it is used as a fish farming pond that will be consumed or traded.

The performance results of each WWTP treatment pond are not yet optimal in accordance with the aims and objectives of wastewater treatment (WWTP), namely to reduce (eliminate) polluting substances so that they can be used for agricultural and fishery needs.

REFERENCES

1. Central Bureau of Statistics (BPS). Interim Population Projection Results 2020-2023 (Mid Year/June). Accessed from https://bandungkota.bps.go.id/indicator/12/1620/1/besar-penresiden-hasil-produksi-interim-menrut-jen-kelamin-di-kota-bandung.html. On July 25, 2023.
2. Budi, D. S. 2012. Fieldtrip Report of the Bojongsoang Wastewater Treatment Plant (WWTP), Bandung. Bogor.
3. Darmawan, A., B. Sulardiono, and Haeruddin. 2018. Water Fertility Analysis of Phytoplankton, Nitrate and Phosphate Abundance in the Waters of the Solo River, Surakarta City. Management of Aquatic Resources Journal (MAQUARES) 7(1):1–8.
4. Effendi, Hefni. 2003. Study of Water Quality: For Management of Water Resources and Environment. Yogyakarta: Kanisius.
5. Febrita, Joana, and DwinaRoosmini. 2022. "Analysis of Industrial Heavy Metal Pollutant Loads on the Quality of the Upper Citarum River." Journal of Civil and Environmental Engineering 7(1):77–88. doi: 10.29244/jsil.7.1.77-88.
6. Firdaus, M. I., S. K. Saptomo, and J. Febrita. 2018. Performance Evaluation of the Bandung Bojongsoang Wastewater Treatment Installation Unit. Journal of Civil and Environmental Engineering 3(1):35–48. doi: 10.29244/jsil.3.1.35-48.
7. Harmilia. E. D, and E. Dharyati. 2017. Preliminary Study of Physical-Chemical Water Quality of the Ogan River, Indralaya District, Ogan Ilir Regency, South Sumatra. Fiseries 7(1):7–11.
8. Kordi, M.G.H, Andi, B.T. 2009. Water Quality Management in Aquaculture. PT Rineka Cipta. Jakarta.

9. Regulation of the Minister of Environment and Forestry of the Republic of Indonesia. Number 68 of 2016 concerning Domestic Wastewater Quality Standards. Jakarta. Appendix I.
10. Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning Implementation of Environmental Protection and Management. Jakarta.attachment vi.
11. Pratiwi, M.A, & N.M. Ernawati. 2016. Analysis of water quality and density of molluscs in the mangrove ecosystem area, Nusa Lembongan. J. of Marine and Aquatic Sciences, 2(2): 67-72. https://doi.org/10.24843/jmas.2016.v2.i02.67-72
12. Ramadani, R., S. Samsunar, and M. Utami. 2021. Analysis of Temperature, Degree of Acidity (PH), Chemical Oxygen Demand (COD), and Biological Oxygen Demand (BOD) in Domestic Wastewater at the Sukoharjo Environmental Service. Indonesian Journal of Chemical Research 12–22. doi: 10.20885/ijcr.vol6.iss1.art2.
13. Romayanto, M.E., Wiryanto, W., and Sajidan. 2006. Domestic waste treatment with aeration and the addition of Pseudomonas putida bacteria. Biotechnology. 3 : 42-49
14. Siegers, W. H., Yudi. Prayitno, and Annita. Sari. 2019. The Effect of Water Quality on the Growth of Tilapia Nirwana (Oreochromis Sp.) in Brackish Ponds.” The Journal of Fisheries Development 3(2):95–104.
15. Siregar, S. 2004. Study of the Operation and Maintenance (O&M) System for Waste Water Treatment Plants (IPAL) (Case Study of Bojongsoang IPAL) Bandung City. Diponegoro University, Semarang.
16. Suprastini, E. R. Ardli, and A. Nuryanto. 2014. Diversity and Distribution of Fish in Segara Anakan Cilacap. Scripta Biological 1(2):147. doi: 10.20884/1.sb.2014.1.2.441.
17. Tatangindatu, Frits, OckstanKalesaran, and Robert Rompas. 2013. Study on Water Physical-Chemical Parameters around Fish Culture Areas in Lake Tondano, Paleloan Village, Minahasa Regency. Vol. 1.