



PERFORMANCE EVALUATION OF FAECAL SLUDGE TREATMENT PLANT (CASE STUDY: IPLT SIDOKUMPUL LAMONGAN)

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ABSTRACT:

Local Domestic Wastewater Management System (SPALD-S) is widely used in Indonesia, septic tank is one of the components of SPALD-S that treats fecal sludge on-site. Furthermore, fecal sludge from septic tanks needs to be treated in the Fecal Sludge Treatment Plant (IPLT). IPLT Sidokumpul is the only IPLT in Lamongan Regency. It is known that the sludge influent has not fulfilled the planning design capacity of 20 m³ / day. The results of laboratory analysis on the quality of wastewater from IPLT, show that some parameters have not met the quality standards based on the PERMENLHK Number 68 of 2016. This study aims to assess the performance of IPLT Sidokumpul so that the effluent meets quality standards and review the strategy so that the volume of fecal sludge influent meets the planned design capacity. This study was held to evaluate the technical aspects including the production of fecal sludge in the service area, characterization of fecal sludge, service analysis, and the performance of the IPLT Sidokumpul unit processes. To evaluate, the authors use a questionnaire, primary data, and secondary data. The temporary results of evaluating the technical aspects of sludge production are still 0.31 liters/person/day, which is still below the planning design, which is 0.5 liters/person/day. The fecal sludge characteristic is still in the typical fecal sludge range. The service performance is planned to be 60% of the service area but based on existing conditions it is only 5%. Furthermore, it is found that the efficiency of the facultative pond needs to be optimized since it is the one with the lowest removal efficiency and the range of each pollutant removal is below the typical.

Keywords: IPLT Sidokumpul, wastewater treatment unit processes, evaluation of technical aspects.

INTRODUCTION

Domestic waste is waste water generated from household activities. Some of the waste comes from toilets, bathrooms, washing clothes, and washing kitchen equipment that contains food leftovers. Domestic waste has a high organic content and can have a negative impact if it is disposed of directly into the environment (Dhokkikah, 2006) (Marliani, 2015) .

One of the ways to treat domestic waste in Indonesia is regulated in the Regulation of the Minister of Public Works and Public Housing Number 04 of 2017 concerning the Implementation of a Domestic Wastewater Management System (SPALD). In this regulation SPALD in Indonesia is divided into Local SPALD (SPALD-S) and centralized SPALD (SPALD-T). The majority of Indonesia's population still uses SPALD-S, such as using a septic tank to treat sewage sludge. Sludge that is in the septic tank needs to be drained and treated before being discharged into the environment. Disposal of fecal sludge directly onto the ground will result in soil contamination, disrupt plant growth, and become disease vectors for animals and humans (Al Kholif, 2020). Septic tanks used as sludge collection and treatment sites have a limited capacity. Drainage of sludge that has settled at the bottom of the septic tank must be carried out periodically (2-5 years) once according to conditions (Sudarmadji & Hamdi, 2013) .

As an effort to improve the quality of the residential environment and public health, Lamongan Regency built sanitation facilities and infrastructure in the form of a Fecal Sludge Treatment Plant (IPLT) known as Sidokumpul IPLT. This IPLT is located in Sidokumpul Village, Lamongan District. Sidokumpul IPLT is the only IPLT facility in Lamongan Regency with services covering 40 sub-districts/villages located around the Lamongan City District area and adjacent to the IPLT location. Sidokumpul IPLT construction began in 2016 and began operating in 2017 with operational planning up to 2036.

The construction of IPLT is planned to be carried out in 3 stages, the processing capacity of the first stage is 20 m³ / day. Furthermore, the construction of the second phase is planned to be carried out in 2021 with an additional processing capacity of 20 m³ / day and the total capacity will be 40 m³ / day. The third phase of construction is planned for 2026 with a planned total processing capacity of 60 m³ / day. The IPLT service target until 2036 is 200,614 people or 60% of the total population included in the 40 sub-districts/villages targeted for services.

Based on the planning design, the influent of sludge treated at the Sidokumpul IPLT in 2022 or the current second phase of the construction period is 40 m³ / day. However, the results of observations in the field indicate that the second phase of IPLT construction has not been carried out and

there has been no additional capacity. This is because the initial discharge capacity of 20 m³ / day has not been fulfilled. In addition, the results of laboratory tests on the pollutant content in the effluent showed that there were several pollutant parameters that still exceeded the domestic wastewater quality standards, referring to the Regulation of the Minister of Environment and Forestry No. 68 of 2016. Based on these conditions, it is necessary to evaluate the performance of Sidokumpul IPLT so that the effluent from sludge treatment can meet quality standards (Dirga & Lestari, 2023) . In addition, strategies and operational management policies for Sidokumpul IPLT are also needed so that the sludge influent meets the planned design capacity.

RESEARCH METHODS

The methods used in this research are measurements, calculations, and direct surveys in the field. The stages of implementing this research include the data collection stage and the data analysis stage.

Collection Data

1. Data Primary

Data primary Which needed as following :

- a. Wastewater quality laboratory tests (TSS, BOD, COD, Oil & Grease, Ammonia, pH, and *Total Coliform*) at SSC unit *outlets* , anaerobic pond unit *outlets* , *facultative pond outlets* , and maturation pond *outlets as the basis for*

evaluation on technical aspects.

- b. Interviews and observations of operators and operational activities IPLT Sidokumpul Lamongan about operating suitability IPLT with SOPs.
- c. Questionnaire results related to draining septic tanks for residents in the IPLT Sidokumpul Lamongan service area.

2. Secondary Data

Collection data secondary covers :

- a. Data planning IPLT Sidokumpul Lamongan in the form of:
 - condition physique form dimensions each units processing onIPLT Sidokumpul.
 - Condition exist form completeness And damage Which There is onunits processing IPLT Sidokumpul At the moment.
 - Amount truck Which enter to IPLT per day For know debit of sludge that goes into IPLT per day .
- b. Number of employees operational IPLT
- c. Data on the number of residents in the service area
- d. Organizational structure and duties and functions of UPTD IPLT Sidokumpul
- e. Regulations related to domestic waste management
- f. Data of fecal trucks disposing of sludge to IPLT

Data Analysis and Evaluation

After collecting primary and secondary data, next analysis is carried out. The results of data analysis are used to evaluate by comparing the results of primary data or monitoring and secondary data with standards, guidelines, manuals and SNI, both of which are technical and non-technical.

Evaluation of the technical aspects of IPLT Sidokumpul Lamongan includes a comparison of the calculation design criteria results according to the Regulation of the Minister of Public Works and Public Housing Number 4 year2017 Appendix II, 2017 with the existing conditions of each processing unitis in IPLT Sidokumpul Lamongan namely in the SSC unit, the pool anaerobic, facultative ponds, maturation ponds, and sun-drying structures. Where to designThe criteria used have been discussed in the previous chapter, which follows will given recommendations/suggestions in accordance with results Which obtained from evaluation this technical aspect. The steps for carrying out the technical evaluation are as follows:

- a. Identify the existing conditions of sludge production from resident septic tanks. Identification of existing conditions is carried out by calculating the sludge production rate for each resident's septic tank and the average sludge production rate for all septic tanks.

- Calculating the production rate of sludge for each resident's septic tank

$$q_{ts} = \frac{V_{ts}}{p.N} \dots \dots \dots (3.1)$$

- Calculate the average sludge production rate for all septic tanks

$$q_{ts} = \frac{\sum_{1-n} q_{ts}}{n} \dots \dots \dots (3.2)$$

Information:

q_{ts} : Sludge production rate per septic tank (m³ / person/year)

q_{ts} : Average sludge production rate of all septic tanks (m³ / person/year)

Volume: each septic tank (m³)

N : Septic tank drain interval (years)

p : Number of septic tank users/dwelling house occupants (people)

n : The number of samples in the calculation

- b. Calculation of the quantity of sludge based on the real need for the quantity of sludge in the field.
- c. Determining the number of respondents for a survey in the service area uses the Slovin formula and as a comparison, it will also be calculated using the sampling formula referring to Regulation of the Minister of Public

Works No. 18 of 2007 concerning Implementation of Development of Drinking Water Supply Systems. Calculation of the number of respondents using the Slovin formula is as follows:

$$n = \frac{N}{(1+Ne^2)} \dots\dots\dots (3.1)$$

Information :

- n : number of samples
- N : total population
- e : error tolerance limit (*error tolerance*)

Meanwhile, based on Permen PU No.18 of 2007 the number of respondents required can also be calculated using the following formula:

$$n = \frac{Np(1-p)}{D^2 - 1 + p(1-p)}$$

$D = \frac{t}{2}$

Information:

- n : number of respondents
- N : number of households
- p : the ratio of elements in the sample that have the desired property (=0.5 coin probability)
- B : *Bound of error* (error rate of each sample)
- t : the level of confidence that is correlated with the degree of fluency

The total number of people served in 2023 is estimated to be 165765 people

spread across 40 villages/kelurahans within the Sidokumpul IPLT service area.

- d. The IPLT service level can be determined based on a comparison between the quantity of sludge based on real needs and the IPLT capacity.
- e. Make an analysis of the IPLT capacity fulfillment by planning an activity program that can be carried out so that the IPLT processing capacity can be fulfilled in accordance with the design capacity.

RESULTS AND DISCUSSION

Evaluation of the technical aspects is carried out by calculating the rate of sludge generation, analyzing the characteristics of the sludge, comparing the results of calculations from the dimensions of the existing treatment unit with the design criteria, analyzing the effluent of sludge produced by the treatment at the outlet of the maturation pond, and calculating the treatment efficiency in each *treatment* unit . These steps are carried out to be used as a reference for making recommendations for optimizing IPLT performance so that the effluent from sludge treatment meets the required quality standards.

Sludge Production Rate

The rate of sludge production can be calculated by knowing the intervals for draining the septic tank, the number of house occupants/the number of septic tank users, and the volume of the septic tank

obtained from the results of a survey of respondents who have drained septic tanks. An example of calculating the rate of sludge production can be seen in the equation below:

$$q_n = \frac{V}{p \times N} \dots\dots\dots 4.1$$

Information:

- q_n : sludge production rate (liters/person/day)
- V : volume of septic tank (m^3)
- p : number of septic tank users (people)
- N : septic tank drain interval (years)

For example, a respondent drains a septic tank every 7 years, the number of occupants/users of the septic tank is 5 people and the volume of the septic tank is 4 m^3 (2 meters long, 1 meter wide and 2 meters deep). The calculation results show that the respondent's sludge production is 0.31 liters/person/day. This figure is smaller

than the initial IPLT design design of 0.5 liters/person/day.

The number of respondents who had drained the septic tank was 23 out of a total of 100 people. The results of the calculation of all the respondents' septic tanks that carried out the dewatering can be seen in Appendix 4. From the calculations, it was found that the average production of the respondent's sludge was 0.38 liters/person/day. Septic tank drain interval. As many as 35% of respondents drain their septic tanks at intervals of more than 10 years, 30% drain their septic tanks for more than 5 years, and the remaining 35% drain them at intervals of five years and less than 5 years. Based on these results, it is known that only 35% of respondents who have drained septic tanks meet the SNI 2398: 2017 drainage standards with draining intervals every 2-5 years. Furthermore, the distribution of sludge production based on the generation of respondents who have drained the septic tank can be seen in Table 1.

Table 1
Production rate of sludge from septic tanks in the survey area

Fecal sludge production rate (liters/life/day)	Frequency	Percentage
0.10-0.24	4	17.4%
0.25-0.50	12	52.2%
>0.5	7	30.4%
Amount	23	100%

As much as 17.4% of the sludge production rate is below 0.25 L/person/day, which is below the minimum criteria of PUPR Ministerial Regulation No. 4 of 2017. Meanwhile, the fecal sludge rate is within the fecal sludge discharge interval criteria according to PUPR Ministerial Regulation No. 4 of 2017, namely 0.25 liters/person/day – 0.5 L/person/day by 52.5%, and the remaining 30.4% is more than 0.5 liters/person/day. From these results, it is known that the production of fecal sludge in the IPLT Sidokumpul service area is mostly in accordance with the interval discharge generation criteria. However, based on the survey results the number of respondents who drained the septic tank was 23%, this caused the influent of fecal sludge that entered was still less than planned.

Sludge Characterization

Analysis of the characteristics of the sludge was carried out by taking samples of the sludge in the influent SSC IPLT Sidokumpul Lamongan unit. The sample taken is sludge that is flowed into the SAP unit from a fecal truck. Parameters used for characteristic measurement are pH, TSS, COD, BOD, Ammonia, oil & grease, and total coliform. Characteristic analysis of fecal sludge was carried out at the Environmental Quality Management Laboratory, ITS Environmental Engineering Department. Table 2 below shows the results of laboratory tests on the characteristics of fecal sludge compared to typical characteristics.

Table 2
Results of Analysis of Sludge Characteristics

No	Parameter	Unit	Typical Characteristics ^a	Results
1	pH	-	-	7,77
2	TSS	mg/L	4000-100000	40125
3	COD	mg/L O ₂	5000-80000	59000
4	BOD	mg/L O ₂	2000-30000	31576
5	Ammonia	mg/L NH ₃ -N	-	548
6	Oils & Fats	mg/L	-	6386.56
7	Total Coliform	CFU/100 mL	5.6-8.03 x 10 ⁷	1.662 x 10 ¹³

^a : Metcalf and Eddy, 1991

Based on the data shown in the table above, it can be seen that the total coliform

and BOD levels in the sludge that enters the Sidokumpul IPLT exceeds the typical Asian Journal of Engineering, Social and Health

characteristics. While the values of other parameters such as TSS and COD are at the upper limit of the typical characteristic range. Ammonia and oil & grease parameters have high levels, although the average value of typical fecal sludge characteristics is not known, this value is much higher when compared to domestic wastewater quality standards. This shows that the sludge that is discharged into the Sidokumpul IPLT must be treated to reduce the pollutant load. The results of the processing of fecal sludge through the ponds of the processing unit, before being discharged into the environment, must comply with the Regulation of the Minister

of Environment Number 68 of 2016 concerning Domestic Wastewater Quality Standards.

Sidokumpul IPLT Service Level Analysis

Sidokumpul IPLT services can be analyzed by collecting data on fecal trucks that enter and dispose of fecal sludge to IPLT. Based on field observations, it is known that in addition to the sewage trucks owned by the Lamongan Regency government, there are also private company trucks that dispose of the sewage sludge to the IPLT. The total frequency of desludging by government and private companies' sludge trucks in 2022 can be seen in Table 3 below.

Table 3
Overall Average Sludge Desludging Frequency

No	Month	Private Stool Truck	Government Stool Truck	Amount
1	January	10	9	19
2	February	15	4	19
3	March	13	14	27
4	April	9	9	18
5	May	11	11	22
6	June	17	14	31
7	July	12	15	27
8	August	16	18	34
9	September	14	11	25
10	October	16	7	23
11	November	16	7	23
12	December	17	9	26

Performance Evaluation of Faecal Sludge Treatment Plant
(Case Study: IPLT Sidokumpul Lamongan)

No	Month	Private Stool Truck	Government Stool Truck	Amount
	Frequency in 1 year	166	128	294
	Average per month	14	11	25

A total of 294 feces trucks dispose of the desludging results at Sidokumpul IPLT, this number is divided into 166 private feces trucks and 128 government feces trucks. On average, there are 25 trucks per month, with details of 14 private trucks and 11 government trucks. Based on data on the volume of sludge removed, it is known that the average volume of sludge sucked up from each septic tank is 2 m³ to 3 m³. Thus, the quantity of sludge produced by residents of Lamongan City can be calculated based on the frequency of emptying the septic tank by 25 desludging times x 2.5 m³ = 62.5 m³ / month or 2 m³ / day. Sidokumpul IPLT service level is determined by comparing the quantity of fecal sludge and the planning capacity of 20 m³ /day. The calculation of IPLT service levels can be seen below:

desludging in the service area can be seen in Table 4 below.

$$\begin{aligned}
 \text{IPLT service level} &= \frac{2 \frac{m^3}{\text{hari}}}{20 \frac{m^3}{\text{hari}}} \times 100\% \\
 &= 10\%
 \end{aligned}$$

The service level target in IPLT planning is 60%, but this value is still far from being compared to the existing condition of 10%.

In addition, the 10% service level is an overall calculation and does not only cover the IPLT service area. Data on the frequency of

Table 4
Average Frequency of Sludge Collection in Service Areas

No	Month	Private Stool Truck	Government Stool Truck	Amount
1	January	9	8	17
2	February	6	4	10
3	March	4	7	11
4	April	4	8	12
5	May	6	9	15
6	June	7	6	13
7	July	2	7	9
8	August	6	7	13
9	September	9	5	14
10	October	4	6	10
11	November	6	7	13
12	December	12	2	14
Frequency in 1 year		75	76	151
Average per month		6	6	12

The data in table 4 shows that the total number of fecal trucks from the service area that dispose of sludge to IPLT is 151 trucks, with details of 75 private trucks and 76 government trucks. The average monthly volume is 6 private feces trucks and 6 government feces trucks. Based on data on the volume of sludge removed, it is known that the average volume of sludge aspirated from each septic tank is 2 m^3 to 3 m^3 . Thus, the quantity of sludge produced by residents

of Lamongan City can be calculated based on the frequency of emptying the septic tank by $12 \text{ desludging times} \times 2.5 \text{ m}^3 = 30 \text{ m}^3 / \text{month}$ or $1 \text{ m}^3 / \text{day}$. Sidokumpul IPLT service level is ^{determined} by comparing the quantity of fecal sludge and the planning capacity of $20 \text{ m}^3 / \text{day}$. The results of the calculation of the IPLT service level with fecal sludge sources from the service area are known to be 5%.

Thus the service level of IPLT Sidokumpul Lamongan until 2023 is still far from the plan, namely 60% of the total generation of fecal sludge in the service area. Meanwhile, the number of septic tanks drained within 1 year can be calculated based on the quantity of existing sludge as follows:

$$\text{Jumlah tangki septik dikuras} = \frac{N}{V} \times 365 \text{ hari} \dots\dots\dots(4.2)$$

$$\text{Number of septic tanks drained} = \frac{1 \frac{m^3}{\text{hari}}}{2,5m^3} \times 365 \text{ hari}$$

$$\text{Number of septic tanks drained by} = 146 \text{ septic tanks/year}$$

Where:

N : quantity of existing faecal sludge

V : The average volume of sludge aspirated from 1 septic tank

It is assumed that in this study the calculation of the number of septic tanks that

carry out drainage is the same septic tank and the draining interval is carried out every 3 years, then the number of septic tanks that carry out drainage can be calculated as follows:

$$= \frac{\text{jumlah tangki septik dikuras per tahun} \times 3 \text{ tahun}}$$

$$= 146 \text{ septic tanks/year} \times 3 \text{ years}$$

$$= 438 \text{ septic tanks}$$

$$= 438 \text{ houses}$$

The number of septic tanks carrying out this dewatering which can be considered as standard septic tanks, is 438 septic tanks. Because 1 house usually has 1 septic tank, the number of houses that have septic tanks according to the standard is 438 houses. Based on the calculation results above, the percentage of IPLT services for residents in the service area can be calculated as follows:

$$= \frac{\text{jumlah rumah} \times \text{jumlah jiwa/rumah}}{\text{Jumlah penduduk}} \times 100\% \dots\dots\dots(4.3)$$

$$= \frac{438 \text{ rumah} \times 5 \text{ jiwa/rumah}}{165765} \times 100\%$$

$$= 1.3 \%$$

The calculation above shows that the capacity of IPLT Sidokumpul Lamongan in terms of service coverage to the population is still low, namely only 1.3% served. The scope of these services can still be increased by means of dissemination and outreach regarding standard septic tank construction and the importance of draining septic tanks.

The low level of service is influenced by several factors, including:

- a. Draining of the septic tank is generally carried out only when the septic tank is saturated and overflows.
- b. The construction of the septic tank is not according to standards and is not

impermeable, resulting in seepage into the ground through the bottom and walls of the septic tank which results in reduced water content of the sludge.

- c. The groundwater level in most of Lamongan Regency, especially in the service area, is below the average depth of the population's septic tank, so it is considered that there is no infiltration and pollution.

IPLT Processing Unit Evaluation

Evaluation of the processing units in IPLT is carried out to determine the processing capacity and efficiency of each unit for further comparison with the design criteria, so that it can be determined whether the operation of the processing unit is optimal. The results of the evaluation are also expected to provide an overview of what actions can be taken to optimize the performance of the processing unit. with processing requirements.

The initial stage in evaluating the performance of the treatment unit begins with testing the treated wastewater samples. Five samples were taken from the SSC unit *inlet*, SSC unit *outlet*, anaerobic unit *outlet*, *facultative unit outlet*, and maturation unit *outlet*. Sampling was carried out 2 times at each point. The sampling locations can be seen in the figure in Appendix 2 point E. The results of laboratory tests on wastewater samples at IPLT Sidokumpul Lamongan can be seen in Table 5.

Table 5

Results of Wastewater Analysis Test Result from Sidokumpul IPLT Processing

Parameter	Test results					
	SSC inlets	SSC outlets	Anaerobic Outlet	Facultative Outlet	Maturation Outlet	Quality standards*
pH	7,8	8.0	7,9	8,2	8,5	6-9
TSS (mg/L)	40125	544	122	85	87	30
COD (mg/L O ₂)	59000	940	190	179	141	100
BOD (mg/L O ₂)	31576	503	91	86.5	67	30
Ammonia (mg/L NH ₃ -N)	548	22.5	14	18.5	12.5	5
Oils & Fats (mg/L)	6386.6	270,2	169.7	190.0	158.5	10
Total Coliform (MPN/100 mL)	1.7 x 10 ¹³	6.5 x 10 ⁶	2.4 x 10 ⁶	1.4 x 10 ⁶	4.5 x 10 ⁵	3000

*Domestic Wastewater Quality Standard Regulation of the Minister of Environment and Forestry Number 68 of 2016

Based on the data from the wastewater analysis test results, it can be seen that the pollutant content in each processing unit is decreasing in concentration. However, the pollutant concentration at the maturation *outlet* still does not meet the domestic wastewater quality standards. This shows that processing is still not running optimally even

though the influent discharge is below the planned design capacity.

The next step is to analyze the suitability of the wastewater treatment unit building with the design criteria. This aims to find out which units are still not optimal so that optimization can be done. The treatment units in Sidokumpul Lamongan IPLT are SSC units, anaerobic pond units,

facultative pond units, and maturation pond units.

A. SSC Units

SSC is an alternative concentration unit. The working principle is very simple because it only relies on physical processes for the separation of fecal sludge. Sludge that is spread evenly over the SSC media will experience separation between the solids at the bottom and the liquid at the

top. Part of the liquid can be separated from the fecal sludge through an infiltration process in SSC media, then the separated liquid is further processed in the stabilization unit contained in the IPLT. Meanwhile, the solids that have undergone draining are further dried in the sludge drying unit. SSC planning can be implemented using the design criteria in Table 6.

Table 6
SSC Unit Design Criteria and Existing Conditions

Parameter	Design Criteria*	Existing Conditions	Unit
Time dryer cakes (T)	5 - 12	14	day
Time taking cake ripe (T)	1	1-2	day
Thickness cake (HC)	10 - 30	30-40	cm
Thick layer gravel (Hk)	20 - 30	30	cm
Thick layer sand (HP)	20 - 30	22.5	cm
Rate water (P)	20	-	%
Rate solids (Pi)	80	-	%

*Ministry of PUPR Regulation No. 04 of 2017

According to (Mega & Herumurti, 2016) , SSC units can remove including: 40% BOD, 40% COD, and 90% TSS. Data from laboratory tests on pollutant concentrations from the SSC inlet and SSC outlet decreased significantly. The decrease in BOD was 98.4%, from 31,576 mg/LO₂ to 503 mg/LO₂ . COD also decreased by 98.4% where the COD level at the SSC inlet was 59000 mg/LO₂ and reduced to 940 mg/LO₂ at the SSC outlet. The TSS parameter experienced the highest decrease of 98.6% from 40125 mg/L to 544 mg/L. Apart from these three parameters, other parameters such as ammonia decreased by 96%, oil & grease decreased by 95.8%, and total coliform decreased by 99.4%. When viewed from the

results of a comparison of the condition of the existing unit with the design criteria and the reduction in levels of pollutant produced by processing, the SSC unit is considered to be able to operate optimally.

B. Anaerobic Pool Unit

Anaerobic ponds have the ability to reduce organic matter content by the decomposition process of anaerobic microorganisms. The Sidokumpul IPLT anaerobic pond has dimensions of 11 meters in length, 8 meters in width and 4 meters in depth. Meanwhile, the detention time based on the planning design was 17 days. Evaluation of the design of the anaerobic pond at Sidokumpul IPLT showed that the

length and width measurements, as well as the detention time were still inadequate when compared to the design criteria. The

design criteria for anaerobic ponds from several literatures can be seen on Table 7 below.

Table 7 Anaerobic Pond Design Criteria

Parameter	Symbol	range	Reference
Time detention based on temperature (day)			
15 - 20 °C	θ _a	2 - 3	Candy Public Works Number 4 year 2017
20 - 25 °C		1 - 2	
25 - 30 °C		1 - 2	
Warm climate		1 - 5	(D. Mara, 1976)
Cold climate		5-7	(Meiring et al., 1968)
ns		2.5-9.5	(Pearson et al., 1996)
Depth (m)	D _a	2 - 5	Candy Public Works Number 4 year 2017
		2-5	Ramadan and Ponce (accessed 13/06/2023)
		3,1	Paing, et al (2000)
Length ratio And wide	P : L	(2-4) : 1	Candy Public Works Number 4 year 2017
		(3-4):1	Australian Pork Limited (2015) (McCormack et al., 2021)
Gap ratio		1 : 3	Candy Public Works Number 4 year 2017
Sludge dewatering period		1-3 years	Mara (2004) and Peña, 2002

*ns: no specification

The pollutant parameter test results in Table 5 show that the average BOD content from the outlet of the SSC unit is 503 mg/L or equivalent to 503 g/m³. Typical BOD pollutant load in anaerobic ponds in areas with warm and hot climates is 400 g/m³ (DD Mara, 1975), 100-400 (Meiring et al., 1968)

. The BOD load in the Sidokumpul IPLT anaerobic pond is higher than the typical BOD load, this affects the efficiency of waste treatment.

The efficiency of anaerobic treatment for BOD pollutant parameters is 60% (Abdullahi et al., 2014), 50-70%, 50% COD, and 44-70%

TSS (Peña-Varon, 2002). Based on the results of laboratory tests, the levels of BOD contaminants decreased by 81.9%, while the levels of COD and TSS decreased by 79.8% and 77.6%, respectively. Other parameters such as ammonia, fatty oils and total coliform also decreased by 37.8%, 37.2% and 63.1%. The level of ammonia removal parameters based on Ramadan and Ponce, accessed 2023) will be very low in anaerobic ponds and will generally increase, this is due to the hydrolysis process of nitrogen which turns into ammonia. However, in some cases the ammonia level will decrease if the waste storage period is very long so that when it enters the anaerobic pond it has turned into urea. This condition corresponds to fecal waste that has been stored for a long time in a septic tank.

Based on the planning design, the detention time in the Sidokumpul IPLT

anaerobic pond was 17 days, this period was much longer than the typical detention time and design criteria. In addition, sludge drainage has not been carried out in accordance with the recommendations, which is once every 1-3 years. However, although several factors are not in accordance with the recommendations and design criteria, the efficiency of wastewater treatment in anaerobic ponds is still high.

C. Facultative Pool Unit

The process of wastewater treatment in facultative ponds occurs aerobically and anaerobically. The facultative pond decomposes and degrades organic matter from treated wastewater in the anaerobic pond. The facultative pond design criteria from several literatures can be seen in Table 8 below.

Table 8
Facultative Pond Design Criteria

Parameter	Symbol	Design Criteria	Reference
Time retention minimum (days)			
T > 20 °C	θ_f	4	Candy Public Works Number 4 year 2017
-		4-8	Peña -Varon (202 1)
Warm-hot climate		4-5	(D.Mara, 2013)
Efficiency decline BOD %	Mobile phone	70 - 90	Candy Public Works Number 4 year 2017
		40 - 56	Peña -Varon (202 1)
		50 - 90	(Valero, 2008)
Depth pond (m)	D	1.5- 2,5	Candy Public Works Number 4 year 2017
		1 - 2	Ramadan and Ponce (accessed 13/06/2023)

Parameter	Symbol	Design Criteria	Reference
Ratio long And wide	P : L	(2-4) : 1	Candy Public Works Number 4 year 2017
		1:2 – 1:3	Peña -Varon (202 1)
Period drain		5 - 10	Candy Public Works Number 4 year 2017

Typical pollutant reduction efficiency for facultative ponds according to (Peña-Varon, 2002) is 40-56% BOD, 34% COD, 27% TSS, and 44% ammonia. In contrast to the processing results in the SSC unit and anaerobic ponds where the efficiency of the treatment meets and even exceeds typical efficiency, in this facultative pond there is a decrease in treatment efficiency. Ammonia and oil & grease levels have increased from the previous unit. Meanwhile, the levels of BOD and COD only decreased by 4.9% and 5.8%, respectively. The concentration of TSS and total coliform was still quite good, which decreased by 30.3% and 41.7%.

Based on the calculation results, the surface organic load in facultative ponds is 15 kg/ha/day, which is within the range of a typical surface organic load of 15-80 kg/ha/day (US EPA, 2002) (Andiese, 2011). The existing condition of the facultative pond unit at IPLT Sidokumpul has a depth of 1.8 meters, a length of 12 meters and a width of 10 meters with a detention time of 7 days. When compared with the design

criteria, the existing design of the facultative pond unit does not match the dimensions of the ratio of length to width and detention time. This is suspected to be one of the causes of the decrease in processing efficiency. Apart from that, the condition of the pond which has never been drained since it started operating in 2017 also causes the processing to not run optimally.

D. Maturation Pool Unit

The final stage of sewage sludge treatment is to reduce the number of pathogenic organisms contained in the treated water. Maturation ponds function to let microorganisms die by themselves due to lack of organic matter as a source of life energy. The death of microorganisms in the maturation tanks will occur because the amount of organic matter that enters the maturation tanks is low enough, while the number of populations of microorganisms is still high, resulting in starvation which in turn causes the death of microorganisms. The design criteria for the maturation pond from several literatures can be seen in Table 9.

Table 9
Maturation Pond Design Criteria

Parameter	Symbol	Design Criteria	Reference
Time detention	Td	5 - 15	Candy Public Works Number 4 year 2017
		3-5	(D. Mara & Pearson, 1998)
Efficiency decline BOD	H	>60	Candy Public Works Number 4 year 2017
Depth pool	H	1 - 2	Candy Public Works Number 4 year 2017
		1 – 1.5	(Coggins et al., 2017)
Ratio long And wide	p : l	(2-4) : 1	Candy Public Works Number 4 year 2017
Burden BOD volumetric		40 - 60	Candy Public Works Number 4 year 2017

According to (Verbyla & Mihelcic, 2015) the efficiency of removing BOD, COD, Ammonia, and TSS levels in anaerobic ponds is respectively 33%, 16%, 20-80%, and 16%. The test results showed that apart from TSS, other parameters decreased at the outlet where BOD decreased by 22.5%, COD levels decreased by 21.2%, and ammonia levels decreased by 32.4%. Fatty oil content and total coliform decreased by 16.6% and 67.9%, respectively.

The Sidokumpul IPLT maturation pond has a depth of 1 meter with dimensions of length and width of 12 meters and 8 meters respectively. When compared with the design criteria, the existing condition of the Sidokumpul IPLT maturation pond unit is still within the recommended range. In addition, the results of calculating the surface organic load of 16 kg/ha/day show that this value is still in the typical range of

10-40 kg/ha/day (Silva, 1991) . Optimization of pond maturation can be done by draining the pond due to the same like the facultative pool, since it was put into operation the maturation pool has never been drained. This is done to further optimize the performance of processing units.

Recommendations on Results of Evaluation of Technical Aspects

Based on the results of the evaluation of the technical aspects that have been carried out, it is concluded that the existing service level is still far from the initial plan of 60%. This is indicated by the lack of socialization of the community in the field of sanitation, especially making latrines with SNI and the period for routinely draining septic tanks. Recommendations related to this problem are that the IPLT is more proactive in outreach to the community regarding services, as well as compiling a

scheduled sludge service program (LLTT) to increase the influent of sludge.

The performance of the sludge treatment unit at the Sidokumpul IPLT based on the incoming pollutant load is mostly still optimal. However, based on the results of the efficiency analysis for each unit, it can be seen that the facultative and maturation units have very low processing efficiency and are far from the recommended typical efficiency values. This causes the effluent from the sludge produced to still not meet quality standards, so it can be concluded that the treatment units that require optimization are facultative and maturation pond units. The two units require draining and operating in accordance with the SOP so that the effluent produced can meet quality standards.

CONCLUSION

Based on the results of the evaluation of the technical aspects that have been carried out, it is concluded that the level of service in the existing service area and overall is only 5% and 10%, these figures are still far from the initial plan of 60%. The existing fecal sludge generation rate is 0.31 liters/person/day, this figure is also smaller than the planning design of 0.5 liters/person/day. In addition, the performance of the sludge treatment unit at Sidokumpul IPLT is still mostly optimal. So that the required treatment units that require optimization are facultative and maturation pond units. It is not necessary to

redesign these two units at this time, based on the high TSS value at the outlet of the maturation pond, it is suggested that dewatering is carried out in the maturation and facultative ponds because there are indications of high sludge deposition.

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First publication right:

Asian Journal of Engineering, Social and Health (AJESH)

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