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A study of the clean water supply system in Pemalang regency water supply company

I D Komalasari^{1*}, B P Samadikun¹, A Sarminingsih¹

¹ Department of Environmental Engineering, Faculty of Engineering, Universitas Diponegoro, Prof. H. Soedarto S.H, Tembalang, Semarang, 50275, Indonesia

ivondesi@students.undip.ac.id

Abstract. The Regional Public Company for drinking water in Pemalang Regency is an official agency given the authority to provide and serve water needs in the Pemalang Regency area. Based on the 2020 BPKP, service coverage is still low. Namely, administrative service coverage of 12.74% and technical service coverage of 18.50%, so the service coverage still does not meet the target and achievement of access to decent drinking water. Based on the BPKP 2020-2024, it is necessary to evaluate the management of the clean water supply system, which aims to improve clean water services in the Pemalang City area. Data analysis was done descriptively. The analysis results will describe the clean water supply system management and evaluation based on appropriate standards, regulations, and literature studies. In addition, analysis using the EPANET program is used for SPAM improvement plans. The same is done for the study of raw water availability and water demand until 2030. The evaluation results found that the existing condition of Pemalang City SPAM is still able to supply clean water needs in the Pemalang City area until 2022, and Perumda must have started looking for supplements or additional discharge to meet drinking water needs up to 2030.

1. Introduction

Water is one of the vital elements in human life. The availability of water in nature is very abundant, but the availability of ready-to-consume water is still relatively small. In Indonesia, three problems related to water supply are encountered i.e water availability [1], supply imbalances [2] and water loss [3]. Therefore, to obtain water that meets drinking water standards, an effective and efficient treatment and distribution process is needed [4]

Drinking water is one of the basic needs indispensable in improving the quality of human life and determining the economic growth of a region [5]. The provision of drinking water to the community is the responsibility of the local government. The Regional Public Company (Perumda) for Drinking Water Tirta Mulia, Pemalang Regency, is an official agency to provide and serve clean water needs in the Pemalang Regency area. Based on the 2020 BPKP Pre Audit report [6], Perumda Water Drinking Tirta Mulia Pemalang Regency at the end of 2020 had 56,201 SR customers, with a water loss rate of 26.93%. The service coverage of Pemalang Regency Drinking Water Perumda in 2020 is still low, namely the administrative service coverage of 12.74% and the technical service coverage of 18.50% [6][7].

The Sustainable Development Goals (SDGs) target, which is a continuation of the MDGs, states that access to clean water for all people in the world must be met by the end of 2030. Based on the target of drinking water services, it is necessary to evaluate the drinking water supply system, especially in the Pemalang City area. In improving drinking water services in Pemalang City, an analysis of the



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availability of raw water in water sources is carried out. The analysis of the availability of raw water is intended to determine the fulfillment of sustainable drinking water needs.

2. Methodology

The formulation of the problem in this research is to examine the development of the drinking water supply system (SPAM) in Pemalang City. Systematically starting from literature study, data collection, data analysis, analysis of calculation results, and recommendations and conclusions. These steps can be seen in Figure 1 the following flow chart:

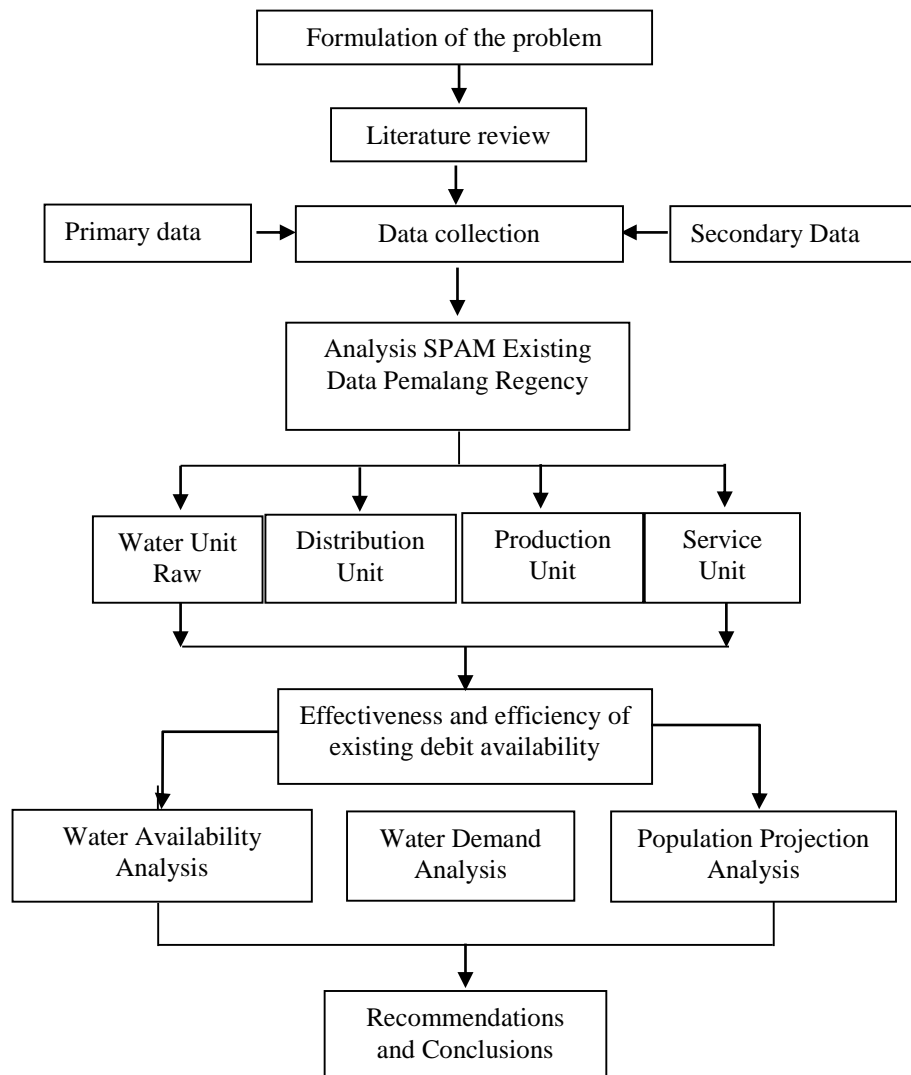


Figure 1. Research method.

2.1. Data collection

Data collection techniques used are observations on the management of clean water supply systems, interviews with clean water managers and customers, and documentation of clean water management. The data collected are qualitative and quantitative, including regional physical data, socio-economic data, and data on the condition of the management of the clean water supply system. Data analysis was done descriptively. The analysis results will describe the clean water supply system management and evaluation based on appropriate standards, regulations, and literature studies.

2.2. Data analysis

Data analysis carried out in this study includes:

2.2.1. Water demand analysis. The total water demand is calculated based on the projected number of water users up to 2030 and the average demand for each user after adding 20% as a factor of water loss (leakage). This total requirement is used to determine whether the existing water sources are still sufficient. The following calculation determines the water requirement:

a. Domestic Water Needs

Calculation Population x Water Demand Everyone's Water Usage Formula

$$\text{Consumption} = \frac{\text{Total Water Usage (Liters/Day)}}{\text{Number of Family Members (person)}} \quad (2.1)$$

b. Calculation of Non-Domestic Water Needs

$$\text{Non-Domestic Water Usage} = 20\% \times \text{Domestic Water Usage} \quad (2.2)$$

Notes: 20% (Domestic Water Needs)

2.2.2. Population projection analysis using geometric projection method. The equations used are:

$$P_n = P_o (1+r)^n \quad (2.3)$$

Where:

- P_n = total population in a year – n
- P_o = total population in the first year
- R = average percentage increase per year (%)
- N = projection period

Projection of Population Growth in Pemalang and Bantarbolang Sub-districts is 0.2% per year and for Taman District is 0.21% according to BPS data for Pemalang Regency in the last three years.

2.2.3. Schematic analysis of the piping network with the help of the EPANET 2.0 program. The program is a computer program (software) with a Windows interface that can perform single or multiple-period simulations of hydraulic behavior and water quality in pressurized pipelines.

3. Results and discussion

3.1. Existing conditions

Perumda Pemalang Regency manages the handling of clean water in Pemalang City in the City Area area. Based on the performance evaluation data of the Tirta Mulia Regional Public Drinking Water Company, Pemalang Regency for the 2020 Financial Year by the Central Java Province BPKP, the condition of clean water services in the Pemalang city area is as follows:

a. Raw water unit

1. Name of raw water source: Telaga Gede Spring, Moga Springs
2. Water drainage system : Gravity
3. Raw water capacity : 1,950 liters/sec
4. Raw water discharge : 600 liters/sec

b. Production Unit

1. Installed capacity : 18,973,440 m³
2. Production capacity : 10,290,091 m³ (326 liters/sec)
3. Distribution capacity : 10,290,091 m³
4. Unused capacity : 8,683,349 m³
5. Pipe length : 30,828 meters
6. Operating hours : 8,768 hours

c. Distribution Unit

1. Number of reservoirs : 4 units
2. Reservoir capacity : 3,500 m³
3. Flow system : Gravity
4. Pipe length : 725,648 meters
5. Irrigation system : Gravity

d. Service Unit

1. Service area : Pemalang District, Taman District and Bantarbolang District.
2. Coverage of water services : 12.74% The calculation for 2020 is based on BPS data (average ratio of 1 household = 3.25 inhabitants).
3. Leakage rate : 26.93%.
4. Number of House Connections : 40,074 SR.

This evaluation is based on Regulation of the Minister of Public Works 2007 Number 18 [8].

3.2. Existing condition evaluation

Evaluation of the drinking water supply system in the Pemalang City area includes several things, including raw water units, production units, distribution units, service units, and the influencing factors as the basis for further development planning.

3.2.1. Raw water unit evaluation. The source of raw water used by the Pemalang Regency Perumda comes from the Telaga Gede spring and the Moga spring. The source discharge potential is $\pm 1,950$ liters/sec, and the installed capacity is 600 lt/sec. Until the end of 2020, the number of house connections (SR) in the Pemalang City area is 40,074 SR, so the average amount of water demand includes domestic and non-domestic needs for the Pemalang City area of 101.57 liters/sec. Assuming drinking water consumption in the area The city for each house connection (SR) is 100 liters/day/person. The installed capacity is 600 liters/sec with a water production capacity of 326 liters/sec. The remaining amount of raw water is 600 liters/sec-326 liters/sec=274 liters/second. Based on the remaining raw water's calculation results, 274 liters/sec, then Perumda Pemalang city area can still meet raw water needs by using natural water sources from Telaga Gede springs and Moga springs. The Health Office of Pemalang Regency carried out a sampling of raw water to determine the quality of the existing water, which included Physical Parameter Test, Organic Chemistry, and Total Coliform. Based on the test results of the three parameters tested, none of the parameters exceeds the standard for drinking water quality in Permenkes No. 32 of 2017 [9].

3.2.2. Production unit evaluation. Pemalang Regency Perumda does not have a Water Treatment Plant (IPA) because the raw water source is taken directly from the spring and drainage using a gravity system. From the springs, the water is stored in Brocaptering and then enters the BPT before entering the reservoir. The production capacity is 326 liters/sec. Based on the projected results of clean water needs in 2020, the maximum daily water demand is 111.73 liters/second. The difference between the maximum daily water requirement and the current production capacity is 326 liters/sec-111.73 liters/sec =214 liters/sec. The production capacity can still meet the need for clean water in the Pemalang City area. The transmission system in the Pemalang City area uses ACP, PVC, and HDPE pipes with a diameter of 350 mm and a length of 30,828 meters. From the calculation results of the evaluation of the transmission system using the Epanet 2.0 program, the residual pressure is ± 150 atm. Images of the results of the analysis using the EPANET 2.0 program can be seen below:

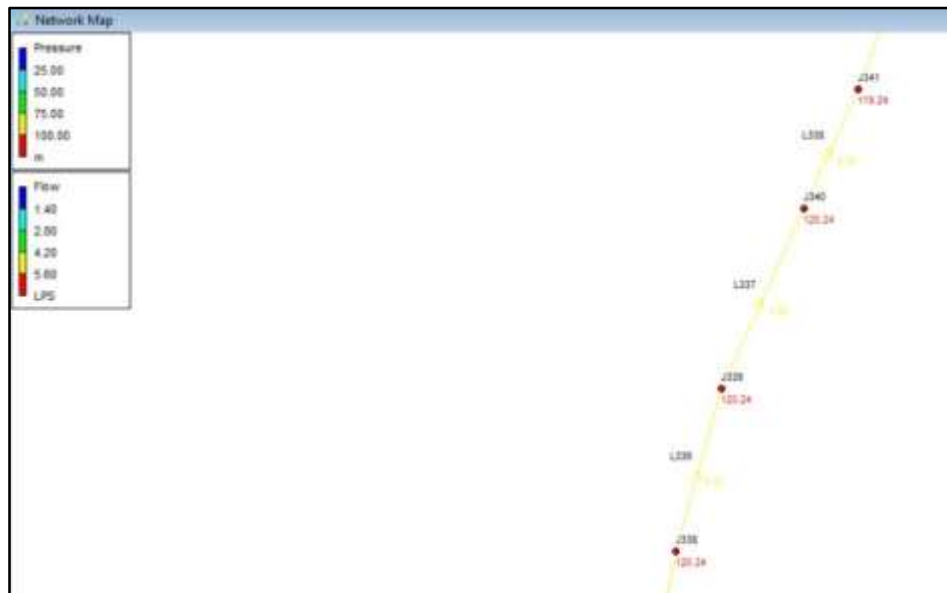


Figure 2. Network analysis using the EPANET.

3.2.3. Distribution system evaluation. Perumda in the city area has four reservoirs and six pressure-suppressing tubs. It is used quite a lot due to the difference in high elevation with the gravity system's service area. Based on the projection of the maximum daily water demand in 2020, the reservoir volume is 1,931 m³, so that the existing reservoir with a capacity of 3,500 m³ can still accommodate the current water needs.

3.2.4. Service system evaluation. Evaluation of the distribution system includes service duration, water pressure in the clean water service area, leakage rate, and service coverage. The drinking water distribution system in the Pematang City area has a different duration of service in each service area. It is due to differences in the ability of natural water sources to supply customers' clean water needs. The duration of drinking water service ranges from 22 hours to 24 hours. The absence of a zone system also causes the water not to be distributed evenly. Evaluation of the ideal service duration based on the design criteria of the Department of Settlement and Regional Infrastructure Research and Development Agency [10] is 24 hours so that it meets the specified criteria. Meanwhile, based on the State Development Audit Agency (BPKP) audit report, the leakage rate at Perumda was 26.93%. Leaks are caused by damaged customer water meters or damage to pipelines [10]. The leakage rate in the distribution pipe is 15% to 30%, while in the existing condition, the leakage rate is 26.93%, the leakage rate in the distribution pipe has met the design criteria. The service area of the Pematang City area consists of 3 sub-districts, namely, Pematang District, Taman District, and Bantarbolang District, with service coverage still low at 12.74%, so the current level of service still does not meet the design criteria. The design criteria for the level of service are 80% of the total population of urban communities.

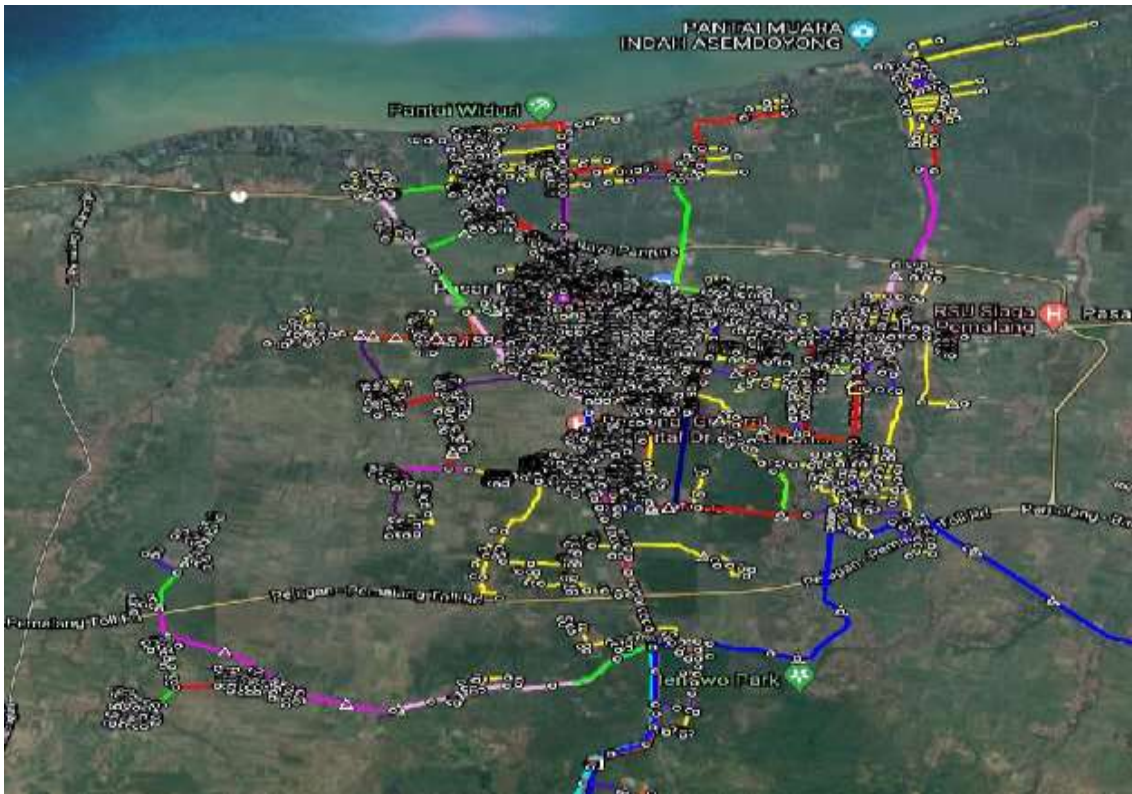


Figure 3. Map of Pemalang city area pipeline.

Evaluation of water pressure in the service area with Epanet 2.0 simulation. The steps that must be taken in running the EPANET program are as follows:

1. Draw a system network that has been created and enter data regarding elevation, discharge, pipe diameter, and pipe length
2. Process the data by pressing the RUN. button
3. Checking the data processed by the program.

Data that must be considered include speed, headloss, and pressure at each node. The analysis results of the pipes used for the primary distribution network to tertiary distribution/services are from HDPE pipes with a diameter of 400 to 63 mm. From the simulation results using the Epanet 2.0 program, there are several service areas, especially in the end areas that are not under pressure but still flowing, so that in some service areas at the very end, it is necessary to add pumps. The table of analysis results using the EPANET 2.0 program can be seen below.

Table 1. Results of node analysis using the EPANET 2.0 program in transmission pipe

Node ID	Elevation m	Demand LPS	Head m	Pressure m	Quality
Junc J454	17.00	0.00	164.21	147.21	0.00
Junc J455	16.00	0.00	164.21	148.21	0.00
Junc J456	15.00	0.00	164.30	149.20	0.00
Junc J457	17.00	0.00	164.30	147.20	0.00
Junc J458	14.00	0.00	164.30	150.20	0.00
Junc J459	13.00	0.00	164.30	151.20	0.00
Junc J460	15.00	0.00	164.30	149.20	0.00
Junc J461	14.00	0.00	164.30	150.20	0.00
Junc J463	16.00	0.00	164.30	148.20	0.00
Junc J464	16.00	0.00	164.20	148.20	0.00
Junc J465	15.00	0.00	164.20	148.20	0.00
Junc J466	16.00	0.00	164.20	148.20	0.00
Junc J467	16.00	0.00	164.20	151.20	0.00
Junc J468	15.00	0.00	164.20	149.20	0.00
Junc J469	14.00	0.00	164.20	150.20	0.00
Reserv R1	166.00	-5.42	164.34	-1.66	0.00

Table 2. Results of node analysis using the EPANET 2.0 program in distribution pipe

Node ID	Elevation m	Demand LPS	Head m	Pressure m	Quality
Junc J1408	7.00	0.0000	164.18	157.18	0.00
Junc J1409	8.00	0.1815	164.14	156.14	0.00
Junc J1410	10.00	0.616	164.14	154.14	0.00
Junc J1411	10.00	0.2035	164.14	154.14	0.00
Junc J1412	9.00	0.1925	164.14	155.14	0.00
Junc J1413	7.00	0.0000	164.14	157.14	0.00
Junc J1414	6.00	0.0000	164.14	158.14	0.00
Junc J1415	13.00	0.234	164.18	151.18	0.00
Junc J1416	12.00	0.15	164.15	152.15	0.00
Junc J1417	12.00	0.15	164.14	152.14	0.00
Junc J1418	11.00	0.06	164.14	153.14	0.00
Junc J1419	11.00	0.196	164.13	153.13	0.00
Junc J1420	12.00	0.252	164.12	152.12	0.00
Junc J1421	11.00	0.1792	164.11	153.11	0.00

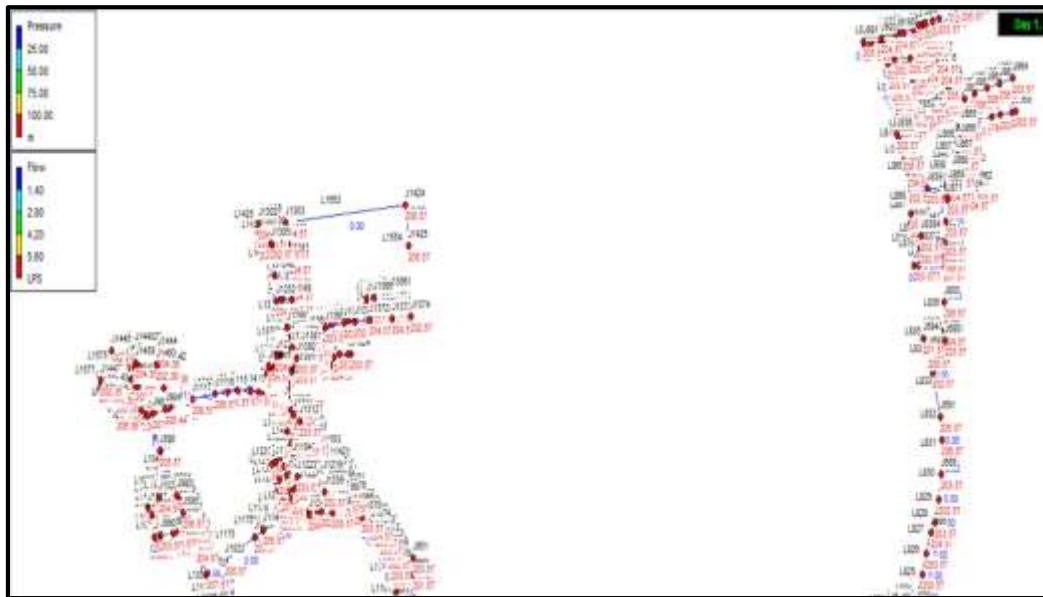


Figure 4. The flow system using the Epanet 2.0 program.

3.3. Raw water management plan for sustainable drinking water supply

In support of the Target Sustainable Development Goals (SDGs), which is a continuation of the MDGs, access to clean water for all people in the world must be fulfilled by the end of 2030. It is necessary to analyze drinking water needs up to 2030 and an analysis of the availability of raw water. The analysis of the availability of raw water is intended to determine the fulfillment of sustainable drinking water needs [11]. This is due to the complexity of water supply systems in developing countries, especially in Indonesia. [12]

3.3.1. Raw water availability. Analysis of raw water availability using projected water demand until 2030. Projections are carried out on population data which is then calculated using the following assumptions [13]:

1. The need for clean water is 100 liters/person/day
2. Water leakage factor 20%
3. Assumption of service percentage is 80%
4. The need for peak hours with a peak hour factor of 1.5
5. Maximum day requirement with maximum day factor 1.1

From the calculation of population projections up to 2030, the projected water needs for urban areas up to 2030 are as follows:

Table 3. Projection of water demand in the Pematang area in 2020 - 2030.

Year	Population (people)	Average water demand (liters/sec)	Water loss (liters/sec)	Maximum water demand (liters/sec)	Peak hour water demand (liters/sec)
2020	479,856	101.57	16.93	111.73	152.35
2021	489,642	244.82	40.80	269.30	367.23
2022	495,423	330.28	55.05	363.31	495.42
2023	505,528	421.27	70.21	463.40	631.91
2024	515,839	515.84	85.97	567.42	773.76
2025	521,987	608.98	101.50	669.88	913.48
2026	532,636	710.18	118.36	781.20	1,065.27

Year	Population (people)	Average water demand (liters/sec)	Water loss (liters/sec)	Maximum water demand (liters/sec)	Peak hour water demand (liters/sec)
2027	543,502	815.25	135.88	896.78	1,222.88
2028	554,590	831.89	138.65	915.07	1,247.83
2029	565,905	848.86	141.48	933.74	1,273.29
2030	577,451	962.42	160.40	1,058.66	1,443.63

From the calculation results of the projected drinking water needs in the Pematang City area, it is found that the average water demand in 2030 is 962.42 liters/sec and the water demand at peak hours is 1,443.63 lt/s'. Currently, the installed capacity is 600 liters/second, so based on the calculation table above for the average water demand, the installed capacity is still capable of supplying up to 2025, but for water needs at peak hours, the installed capacity is only able to supply until 2022. Pematang Regency Perumda must start looking for supplementary or additional debits to supply the debit needs from 2022 to 2030.

4. Conclusion

Based on the results of the study, the following conclusions can be drawn:

1. The existing condition of raw water can still meet the need for clean water in the Pematang City area until 2022.
2. In the distribution pipeline network, especially at the very end of the service area, it is necessary to have additional pumps so that the pressure in the service area is evenly distributed according to the design criteria.
3. There needs to be a zone system so that the pressure in the service area is evenly distributed and the service time is 24 hours.
4. In 2022, Perumda must have started looking for supplementation or other discharge to meet drinking water needs in 2022 to 2030.

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