

CLEAN WATER NETWORK PLANNING IN SOUTH LAMAKNEN DISTRICT, ATAMBUA CITY

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Abstract

The clean water supply system in the South Lamaknen District of Atambua City is based on existing conditions that the population of South Lamaknen District is (112,510 people) in fact: the number of villages and sub-districts in South Lamaknen District is (13), (8 Villages) and (5 Villages) served clean water (80%) and the number of residents who have not received clean water in Benteng Subdistrict and Lamaknen Selatan Subdistrict (20%), because residents in 2 subdistricts in Lamaknen Selatan Subdistrict still depend on dug wells which do not necessarily guarantee the clean water needed. As is the problem that every sub-district in Indonesia is still experiencing, including South Lamaknen Sub-district, in this case the distribution of clean water to customers. To realize this, it is necessary to plan a clean water network for the next 10 years which will meet the needs of the community in general so that it can be met evenly. Based on the research objective, namely planning clean water management in South Lamaknen District to meet community needs and public facilities. then based on the calculation results: the total amount of clean water needed for the South Lamaknen District Community until 2033 is 289 lt/s. In accordance with the clean water distribution hours, water will be supplied to residential areas 24 hours a day. In planning the clean water network using the EPANET program, in The pressure on the clean water network is (90.59m) with a max speed of (5.58m/s) so that it can reach 2 existing sub-districts.

Keywords: Water Resources, Clean Water, Network Planning.

INTRODUCTION

Population growth from year to year has increased so that it is necessary to add superstructure and infrastructure facilities in the South Lamaknen District with very limited geographical conditions with an area of $\pm$ (88.35km²) so that the management of clean water infrastructure is well regulated so that it can serve the needs of the community and public facilities. In general, water is a part of life on this earth that is inseparable from human life, animals and plants, especially in the world of agriculture, water plays a very important role in sustainability. Water is also not a new thing, because we all know that no life on this earth can last without water.

Water is also a primary means to improve the health of the community through the provision of clean water facilities both in terms of quality and quantity. In accordance with the results of observations in Lamaknen Selatan District, Atambua City. with a population of

112,510 people and the existing area, the need for clean water is usually well met. Judging from the various clean water facilities used by residents of Lamaknen Selatan District every day, one of them is taking clean water from water facilities run by PDAM to meet needs, both for washing, bathing, and for consumption as drinking water. based on existing conditions that the population of the District. Lamaknen Selatan is (112,510 people) it turns out: the number of villages and sub-districts in Lamaknen Selatan South District is (13), (8 sub-districts) and (5 villages) which are served by clean water (80%) and the number of residents who have not been served by clean water in Lamaknen Selatan South District (20%), because the residents in Lamaknen Selatan South District still depend on dug wells which do not necessarily guarantee the clean water needs they need.

LITERATURE REVIEW

Clean water is water that is used for daily needs for each person, Clean water also plays an important role for human health and needs, such as being used for bathing, washing, and more importantly for human consumption and will be cooked before drinking. Clean water greatly affects human needs and activities, therefore the availability of clean water is absolute so that humans can carry out daily life activities well, because water is very much needed by the human body and cannot be separated from the human body because $\pm 60\%$ of the human body consists of water.

Water quality generally refers to the quality or condition of water associated with a specific activity or need. Quantity, on the other hand, concerns the amount of water humans need for specific activities. Water is essential for life; no living creature on earth is immune to it. The human body itself is largely composed of water. The average human body contains 90% water by weight. For an adult, approximately 55-60% of body weight is water, for a child, approximately 65%, and for an infant, approximately 80%. Clean water is essential for fulfilling human needs for all activities. Therefore, it is important to understand how water is considered clean in terms of quality and usable in adequate quantities for daily human activities. In terms of quality, several requirements must be met, including physical quality, which includes odor, color, and taste; chemical quality, which includes pH, hardness, and so on; and biological quality, which is water free from disease-causing microorganisms. For human survival to proceed smoothly, clean water must also be available in adequate quantities according to human activities in a particular place and at a specific time.

To determine the level of clean water service in a region, it must be expressed as a percentage of the population within that service area or region. Therefore, for a given area, the service level can be as low as 60% or as high as 100%. The existing criteria state that the service level for the population is 50% to 100% of the population.

The piping system in the construction of a clean water supply system is an inseparable part of the clean water distribution system and this piping system is also called a pipe network which consists of Transmission Pipe System and Distribution Pipe System. The clean water transmission pipe system is a piping system installed from the raw water intake building to the clean water treatment building or usually called a reservoir. Meanwhile, the clean water pipe

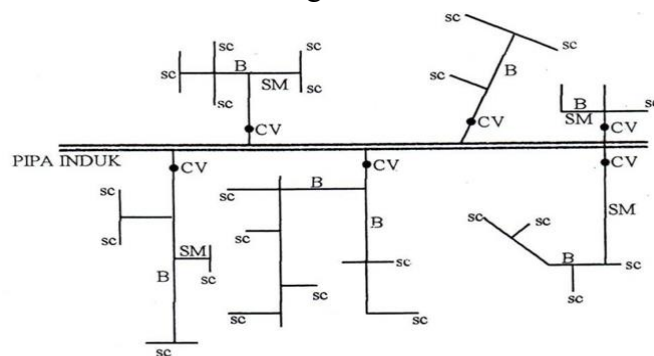
distribution system is the distribution or distribution of water through a piping system from the processing facility (reservoir) to the service area (consumer). Distribution piping also functions to channel water from the processing facility to consumers and is a delivery pipe that delivers water to customer connections.

The planning period for a clean water distribution system is highly dependent on distribution capacity. Other factors that significantly influence the planning period include Regional development plans, age of distribution pipes, available costs.

A pipe network system is needed to regularly distribute water to consumers, based on an analysis of clean water needs with sufficient pressure. In this case, hardy cross calculations are used in closed pipe networks and simple calculations in branching systems so that the pressure at the ends of the pipes and the pipe dimensions can be determined. Based on the installation of the pipes in the distribution pipe network system.

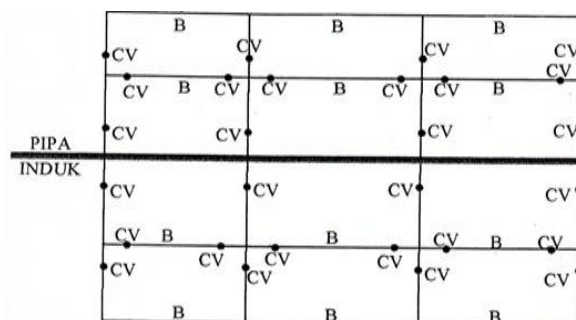
The dead end system or tree system is also called a branching system where clean water is channeled through a main pipe then from the main pipe a branch pipe is made to serve a predetermined area and several more branches to serve consumers in that area (see figure II.2) this system is suitable for areas where settlement development is irregular.

Figure 1.



This Gridiron System is often referred to as a closed system where each pipe branch is connected to one another. This system is often used in areas with relatively flat topography and interconnected and frequently intersecting road networks.

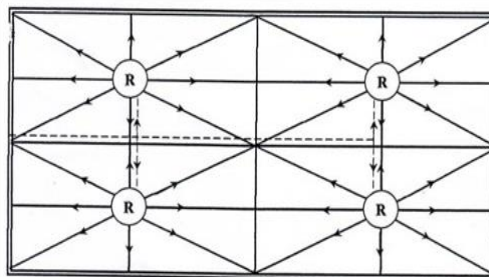
Figure 2.



The circle or ring system is a combination of a branching system and a closed system where the main pipe is placed around an area and then the branch pipes located on the inside are connected to the main pipe. Each point receives water from two directions (see figure II.3). This system is the best but requires many valves and longer pipes.

The radial system is the advantage of the circular system, in this system the water is pumped into a dividing reservoir which is placed in certain areas and the distribution pipes are placed radially and end at the service area boundary.

Figure 3.



This system provides fast service and easy pipe size calculations. This system is suitable for areas that only use one system. A combination of several systems is often implemented to suit local conditions.

EPANET (Environmental Protection Agency Network) is a computer program (model) that performs hydraulic simulations and water quality behavior in a drinking water distribution pipe network (pressurized pipes). A drinking water distribution network consists of pipes, nodes (pipe branches), pumps, water tanks or reservoirs and valves. The output generated from the EPANET program includes the flow rate in the pipe (lt/sec), water pressure from each point/node/junction which can be used for analysis in determining the operation of the installation, pump and reservoir.

RESEARCH METHOD

Primary data is data obtained from field observations in the form of water discharge measurement data (Q), topography (elevation) and pipe length (L), in addition to this, primary data also includes: clean water requirement data, water usage data per person, clean water discharge.

Secondary data is data obtained from related agencies and the results of literature studies such as population data, topographic maps around the location, literature studies, and the type of pump to be used.

Data analysis techniques were conducted using methods derived from literature studies. The steps involved are as follows :

1. Collect primary and secondary data, including technical data and other supporting data, for analysis of the clean water distribution network system.
2. Process population and facility data.
3. Analyze the available Q discharge.

4. Analyze the clean water demand that must be met by the spring.
5. Calculate energy losses to obtain the pump power to be used.
6. Calculate major and minor energy losses for the pipe transmission network.
7. Calculate the total energy loss by summing the major and minor energy losses.
8. Conduct planning by creating a clean water distribution network plan.
9. Plan the operational and maintenance system for the clean water network.

RESULT AND DISCUSSION

To determine clean water needs, it is necessary to know the population of the service area that is the consumer. This study, based on the data obtained, shows the population of Lamaknen South District from 2020 to 2023 as follows :

Table 1.

No	Year	Total Population
1	2020	107.719
2	2021	110.210
3	2022	111.236
4	2023	112.510

Based on data from the Central Statistics Office of Lamaknen South District in 2023, the population of Lamaknen South District in 2020 was 107,719 people, in 2023 it was 112,510, so to determine the percentage of population growth geometrically, the following equation is used :

$$\begin{aligned}
 P_n &= P_o (1 + r)^n \\
 112510 &= 107719 (1 + r)^4 \\
 (1 + r)^4 &= \frac{112510}{107719} = 1.04 \\
 r &= 0,005 = 0,5 \%
 \end{aligned}$$

Based on the geometric population growth percentage, $r = 0.5\%$ is obtained for Lamaknen South District. The population in 2024 is calculated using the geometric formula:

$$\begin{aligned}
 P_n &= P_o (1 + r)^n \\
 P_n &= 112.510 (1 + 0,5\%)^1 \\
 P_n &= 113.072 \text{ jiwa}
 \end{aligned}$$

Table 2.

No	Year	Total Population
Data		
1	2020	107.719
2	2021	110.210
3	2022	111.236
4	2023	112.510
Projection		

6	2024	113.072
7	2025	113.637
8	2026	114.205
9	2027	114.776
10	2028	115.349
11	2029	115.925
12	2030	116.504
13	2031	117.086
14	2032	117.671
15	2033	118.259

Lamaknen South District is included in the category of medium districts with a population of 118,259 people in 2033, the planned level of clean water needs is 150 liters/person/day, per house connection unit (SR) serves 7 people, the need for public hydrant (HU) is 30 liters/person/day with a population of 100 people. With a service area percentage of 80% of the population. So the estimated domestic water needs in 2033 are:

- Residents served : $118.259 \times 75\% = 94,607$ liters/second
- Number of house connections (SR) = $94,607 / 7 = 13.515$ units
- Water needs = $13.515 \times 7 \times 150$ liters/people/day = 141 liters/second
- HU/KU results = $24.182 / 100 = 241$ units
- Water needs = $241 \times 100 \times 30$ liters/people/day = 8 liters/second
- Total domestic water demand = $141 + 8 = 149$ liters/second

Non-domestic water needs include those for accommodation, tourism, restaurants, industry, education, offices, healthcare, and other purposes. This is estimated to account for 25% of domestic needs.

- Non-domestic water needs = $25\% \times 149$ liters/second = 38 liters/second

Social needs cover schools, government offices, places of worship, public water taps, and other social activities. The service percentage is planned at 5% of domestic needs.

- Social needs = $5\% \times 149$ liters/second = 10 liters/second

Water loss for Lamaknen Selatan District is allocated at 25% in the planning.

- Water loss = $25\% \times (149 + 38 + 10)$ liters/second = 49 liters/second

The average production requirement for clean water is calculated based on the sum of domestic water requirements, non-domestic water requirements and social requirements.

- Average needs = $(149 + 38 + 10) / 65\%$ liters/second

Maximum daily requirement for 2028 is (average production requirement x 1,15)

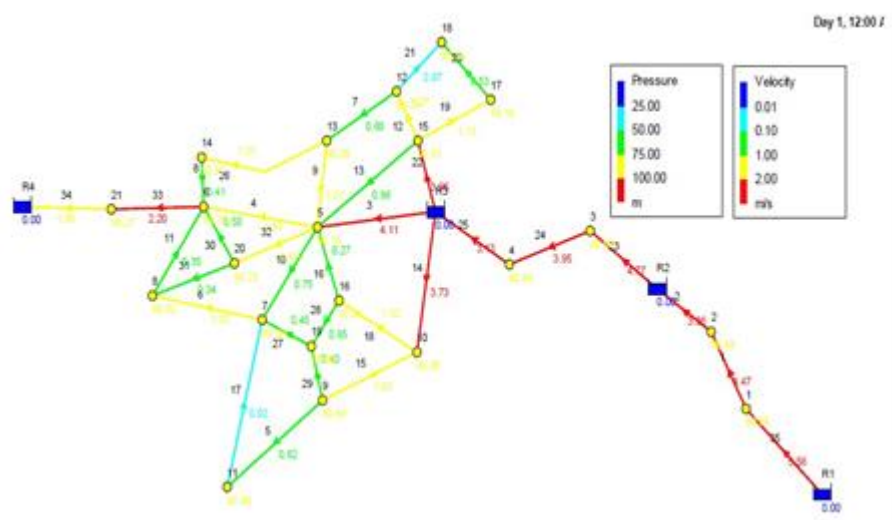
- Maximum daily requirement = 303 liters/second x 1,15 = 348 liters/second

The peak water requirement for Lamaknen Selatan District is 1.50 x the maximum daily requirement.

- Peak hour water demand = 1,50 x 348 liters/second = 522 liters/second

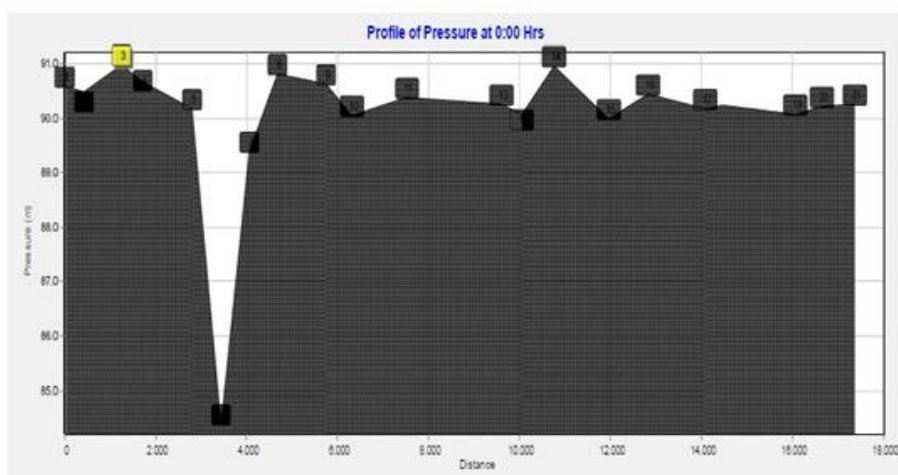
In the clean water network, 4 simulations were made using the Epanet program. In the 4th simulation, the pressure obtained met the requirements for the clean water network, as can be seen in the 4th simulation image below.

Figure 3.



To find out the pressure in the 4th simulation, you can see the Profile of pressure at 0:00 hours graph below :

Figure 4.



Pressure (nodes) :

Network Table - Nodes at 0:00 Hrs

Node ID	Elevation m	Base Demand LPS	Demand LPS	Head m	Pressure m
June 1	407	62.00	62.00	497.59	90.59
June 2	369	62.00	62.00	459.49	90.49
June 4	273	46.00	46.00	363.68	90.68
June 5	212	22.00	22.00	302.18	90.18
June 6	211	22.00	22.00	295.39	89.39
June 7	211	22.00	22.00	300.39	89.39
June 8	205	22.00	22.00	295.82	90.82
June 9	211	22.00	22.00	301.64	90.64
June 10	219	22.00	22.00	309.05	90.05
June 11	210	22.00	22.00	300.40	90.40
June 12	210	22.00	22.00	300.26	90.26
June 13	209	22.00	22.00	299.08	90.08
June 14	205	22.00	22.00	295.97	90.97
June 15	215	22.00	22.00	305.01	90.01
June 16	212	22.00	22.00	302.45	90.45
June 17	211	22.00	22.00	301.18	90.18
June 18	210	22.00	22.00	300.24	90.24
June 3	303	46.00	46.00	393.99	90.99
June 19	211	22.00	22.00	301.08	90.08

Speed (link) :

Network Table - Links at 0:00 Hrs

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Unit Headloss m/km	Friction Factor
Pipe 1	530	267	120	250.26	4.47	71.89	0.019
Pipe 2	530	267	120	188.26	3.36	42.43	0.020
Pipe 3	530	216	120	150.69	4.11	78.90	0.020
Pipe 4	530	216	120	56.50	1.54	12.82	0.023
Pipe 5	530	216	120	22.57	0.62	2.34	0.026
Pipe 6	530	165	120	22.46	1.05	8.63	0.025
Pipe 7	530	216	120	21.97	0.60	2.23	0.026
Pipe 8	530	216	120	-15.01	0.41	1.10	0.028
Pipe 9	530	216	120	-37.03	1.01	5.87	0.024
Pipe 10	530	216	120	27.49	0.75	3.38	0.025
Pipe 11	530	216	120	-12.80	0.35	0.82	0.028
Pipe 12	530	216	120	-46.54	1.27	8.96	0.024
Pipe 13	530	216	120	35.14	0.96	5.32	0.025
Pipe 14	530	216	120	136.78	3.73	65.95	0.020
Pipe 15	530	216	120	59.19	1.62	13.98	0.023
Pipe 16	530	216	120	-9.82	0.27	0.50	0.030
Pipe 17	530	216	120	-0.57	0.02	0.00	0.045
Pipe 18	530	216	120	-55.59	1.52	12.45	0.023
Pipe 19	530	216	120	41.43	1.13	7.22	0.024

Link ID	Length m	Diameter mm	Roughness	Flow LPS	Velocity m/s	Unit Headloss m/km	Friction Factor
Pipe 20	530	216	120	19.43	0.53	1.78	0.027
Pipe 21	530	216	120	-2.57	0.07	0.04	0.036
Pipe 22	530	216	120	145.11	3.96	73.58	0.020
Pipe 23	530	267	120	267.18	4.77	81.15	0.019
Pipe 24	530	267	120	221.18	3.95	57.19	0.019
Pipe 25	530	267	120	175.18	3.13	37.13	0.020
Pipe 26	530	216	120	-37.01	1.01	5.86	0.024
Pipe 27	530	216	120	-16.40	0.45	1.30	0.027
Pipe 28	530	216	120	-23.78	0.65	2.58	0.026
Pipe 29	530	216	120	-14.62	0.40	1.05	0.028
Pipe 30	530	216	120	-18.28	0.50	1.59	0.027
Pipe 31	530	216	120	12.34	0.34	0.77	0.029
Pipe 32	530	216	120	-52.61	1.44	11.24	0.023
Pipe 33	530	216	120	80.58	2.20	24.75	0.022
Pipe 34	530	216	120	58.58	1.60	13.71	0.023
Pipe 35	530	267	120	312.26	5.58	108.32	0.018

CONCLUSION

Based on the research objective, namely planning clean water management in Lamaknen South District to meet the needs of the community and public facilities, based on the calculation results: the total amount of clean water needed for the Lamaknen South District Community until 2033 is 289 lt/sec. In accordance with the clean water distribution hours, water will be distributed to residential areas 24 hours a day.

In Lamaknen South District, there are 2 sub-districts that have not been served, so the clean water network was added and redesigned using the EPANET program and the pressure in the clean water network was obtained at (90,59) with a maximum speed of (5,58m/s) so that it can be reached in Lamaknen South sub-district.

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