Planning of clean water distribution network Kamosope Village, Pasir Putih District, Muna Regency

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Abstract. The availability of clean water is essential for human life because clean water is the primary human need. It is imperative to plan a clean water supply system that is appropriately managed. Kamosope Village does not yet have a reasonable and adequate clean water network system, so it is necessary to plan a sound clean water supply network system to serve the community. The source of water to be used is river water. The designed clean water network system collects water from the river then the water is distributed to the population through a gravity system. The clean water network system is planned to meet the needs of clean water until 2029. The need for clean water is calculated based on the projected population using the Least Square method. From the calculation results, the need for clean water in Kamosope Village in 2029, with 723 people, reaches 1.753 liters/second. Kamosope river discharge based on field measurements using the buoy method is 0.535 m³/second or 107 liters/second. Distribution pipe diameters are the inch, 1 inch, 1½ inch, and 2 inches. EPANET 2.0 software is used to design the clean water network system.

1. Introduction
The need for raw water for various purposes, pristine water for households, public places, and industry will continue to increase based on the growing Population and development pace in multiple fields. On the other hand, the current supply of clean water infrastructure is still relatively limited, so it has not met all water needs. The availability of clean water is also faced by residents in the Kamosope Village area, Pasir Putih District Muna Regency. Even though the site has adequate water sources (river water), the problem is how to optimally capture and distribute water from these water sources so that residents can utilize it. Facilities and infrastructure in the raw water supply system such as public service tanks, and pressure relief tanks that need to be designed and built so that the community can meet their water needs without having to bother taking them directly to water sources that are sometimes very difficult to reach. By paying attention to the location and the existing potential, it is hoped that the need for clean water in Kamosope Village, Pasir Putih District, Muna Regency can be fulfilled.

The total population in 2019 in Kamosope Village, Pasir Putih District, Muna Regency was 723 people. The population continues to increase and increase water needs and limited water availability, causing an imbalance between demand and availability in Kamosope Village, Pasir Putih Subdistrict, Muna Regency. Must be immediately addressed clean water problems with several alternatives, one of which is to build infrastructure to meet raw water needs for the community. This study aims to plan a clean water network system to meet the clean water needs of the local community until 2029.
2. Literature Review

2.1 Definition of Water

Water can flow, churn, rotate through various obstacles to the flow through it. The existence of water in nature is very dependent on the surrounding natural environment and the area it passes through, which continuously flows following the hydrological cycle or water cycle that moves from the sea to the land and back again to the ocean. EPANET is designed as a tool to achieve and realize an understanding of the movement and fate of water content in distribution networks. It can also be used for the analysis of various distribution network applications [1 - 2]. EPANET is designed as a tool to achieve and realize an understanding of the movement and fate of water content in distribution networks. It can also be used for the analysis of various distribution network applications. For example for design, hydraulic model calibration, residual chlorine analysis, and customer analysis [3].

Based on the Decree of the Minister of Health of the Republic of Indonesia concerning the health requirements of the office and industrial work environment, there is an understanding of clean water, namely, water that is used for daily needs and its quality meets the health requirements of clean water by statutory regulations. - valid invitation and can be drunk when cooked [4, 5].

According to Government Regulation concerning water quality management and water pollution control, water is everything that is on, above, or below the ground surface; this means surface water, groundwater, rainwater, and seawater. Water is one of the carriers of disease originating from feces to reach humans. So that water that enters the human body in food and drinks does not cause disease. Water treatment either from sources, transmission, or distribution networks is necessary to prevent infection contact between feces as a source of disease with needed water [6, 7].

2.2 Water Demand Analysis

1. Domestic Needs

Domestic needs are water needs used in private residential places to meet daily needs such as cooking, drinking, washing, and other household needs. The unit used is liter/person/day [8].

2. Non-Domestic Needs

The standard for non-domestic water needs is the need for clean water outside of household needs. Non-domestic water needs include [9].

2.3 Population Projection

The population projection is an estimate of the population in the next few years. It is adjusted to the desired planning period based on population growth data for the last three years, as well as the average increase in population over the last three years. Descriptive grouping of data is influenced by the population in year n.

1. Arithmetic Method

Population projections using the arithmetic method assume that the population increases by the same amount every year. Equations used in the arithmetic method:

$$Pt = Po \left(1 + r \cdot t\right)$$

$$r = \left(\frac{Pt}{Po}\right) - 1$$

Information:

$Pt =$ Total population in year $t$

$Po =$ Total population in the base year

$r =$ Population growth rate

$t =$ Period between the base year and year $t$ (in years)

1. Geometric Method

Population projection using the geometric method assumes that the population increases geometrically and the rate of growth is considered the same every year. Equations used in the geometric method:
\[ Pt = Po \left(1 + r\right)^n \]
\[ r = \left(\frac{Pt}{Po}\right)^{1/t} - 1 \]

Information:
Pt = Total population in year t
Po = Total population in the base year
r = Population growth rate
t = Period between the base year and year t (in years)

2.4 Least Square Method
Population projection using the Least Square method assumes that population growth is influenced by deaths, births, and migration. The equation used in the Least Square method:

\[ \hat{Y} = a + b.X \]
\[ a = \frac{\sum Y_i}{n} \]
\[ b = \frac{\sum X_iY_i}{\sum X_i^2} \]

Where:
Y = Total population in the last year
a = Total population in the last year
b = Average population growth
n = Number of years of base projection
X = Number of future projected years
Xi = Variable coding
Yi = Initial population

2.5 Discharge Measurement Method
Discharge is the flow rate of water (in the form of water volume) that passes through a cross-section of the river per unit of time. In SI units, the amount of discharge is expressed in cubic meters per second (m³/s). To calculate the flow of water sources directly in the field, you can use the formula:

\[ Q = V \times A \]

Where:
Q = Flow rate (m³/s)
V = flow rate (m/s)
A = Wet cross-sectional area (m²)

2.6 Program EPANET 2.0
Programs Epanet is a public-domain computer program for modeling pipelines developed by the U.S. Environmental Protection Agency (USEPA). The planet can simulate hydraulic behavior and water quality in channels. Simulation of hydraulic behavior can be carried out for a single time or several times, for example, 24 hours. The classic problem of flow in pipelines states that flow discharge and point pressure energy in pipelines are parameters to be known. Two equations are needed to solve this problem. The first equation requires the conversion of discharge (continuity) to be fulfilled at every node (junction) [10].

3. Methods
The location of the study was conducted in Kamosope Village, Pasir Putih Subdistrict, Muna Regency. The following research locations can be seen in the next picture:
Observation and Data Analysis Phase
After collecting data, the next step is processing the data analysis. The steps in this stage are as follows:
1. Calculating the need for clean water
   a. Accurate water demand survey needs
   b. Population projection
2. Debit calculation
   a. River discharge using the buoy method
3. Calculation of piping using the Epanet 2.0 program
   The piping system data is simulated in the Planet 2.0 program to obtain the distribution system closest to the field conditions. This is done by calibrating the model created. The results obtained from this simulation include speed, static head, pressure, and pressure loss on each pipe segment.
4. Final Stage
   In the final stage, what is done is drawing conclusions and suggestions. The judgment obtained results from processing and analyzing the problems of planning the distribution of clean water, which is based on the research objectives. Suggestions made are things that have not been and will be carried out in further in-depth research.

4. Discussion
Raw Water Source Discharge Calculation Analysis
Because the shape of the river sketch is assumed to be a trapezoidal shape, to find its area, the formula for the area of a trapezoid is used.
\[
A = \frac{(B + m \cdot h) \cdot h}{2}
\]
\[
= \frac{(3.93 + 1.034) \cdot 0.34}{2}
\]
\[
= 1.45 \text{ m}^2
\]
So the discharge of river water sources are:
\[
Q = V \times A
\]
\[
= 0.079 \times 1.45
\]
\[
= 0.114 \text{ m}^3/\text{second or 114 L/second}
\]
So the average discharge of river water sources is
\[
Q_{\text{average}} = \frac{(\text{Point 1} + \text{Point 2} + \text{Point 3} + \text{Point 4} + \text{Point 5})}{5}
\]
\[
= \frac{(0.116 + 0.099 + 0.095 + 0.111 + 0.114)}{5}
\]
\[
= \frac{0.535}{5} = 0/107 \text{ m}^3/\text{second or 107 L/second}
\]
Population Projection
Population projections are used to predict the population in the next few years in the study area. Point of Population can determine the number of water needs of a site.
d. Recapitulation of Population Projection Results
The following table compares the correlation factors of each method.

| No | Year | Arithmetic | Geometric | Least Square |
|----|------|------------|-----------|--------------|
| 1  | 2020 | 738        | 738       | 740          |
| 2  | 2021 | 753        | 754       | 755          |
| 3  | 2022 | 769        | 770       | 770          |
| 4  | 2023 | 785        | 786       | 785          |
| 5  | 2024 | 801        | 802       | 800          |
| 6  | 2025 | 818        | 819       | 815          |
| 7  | 2026 | 835        | 836       | 830          |
| 8  | 2027 | 853        | 854       | 845          |
| 9  | 2028 | 871        | 872       | 860          |
| 10 | 2029 | 889        | 890       | 875          |

| standard deviation | correlation Factor |
|--------------------|--------------------|
| 48.27              | 0.96               |
| 48.45              | 0.61               |
| 43.08              | 1                  |

Based on the comparison of the calculation of the correlation factor method, which is close to 1, the method used is the Least Square Method. Thus, the analysis of population projections in the Lalanggasu Hamlet, Sani-Sani Village, uses the Least Square method. The results of data analysis on domestic clean water needs for the next ten years can be seen in the following table.

| No | Year | Number of Population (people) | Service Coverage (%) | Number of people served (people) | Average Water Consumption (L/person/day) | Total Usage (L/day) | Number of Needs (L/sec) |
|----|------|-------------------------------|----------------------|----------------------------------|----------------------------------------|---------------------|-------------------------|
| 1  | 2019 | 723                           | 70                   | 506                              | 80                                     | 40480               | 0.469                   |
| 2  | 2020 | 740                           | 70                   | 518                              | 80                                     | 41440               | 0.480                   |
| 3  | 2021 | 755                           | 75                   | 566                              | 80                                     | 45300               | 0.424                   |
| 4  | 2022 | 770                           | 75                   | 578                              | 80                                     | 46200               | 0.535                   |
| 5  | 2023 | 785                           | 75                   | 589                              | 80                                     | 47100               | 0.545                   |
| 6  | 2024 | 800                           | 75                   | 600                              | 80                                     | 48000               | 0.556                   |
| 7  | 2025 | 815                           | 80                   | 652                              | 80                                     | 52160               | 0.604                   |
| 8  | 2026 | 830                           | 80                   | 664                              | 80                                     | 53120               | 0.615                   |
| 9  | 2027 | 845                           | 80                   | 676                              | 80                                     | 54080               | 0.626                   |
| 10 | 2028 | 860                           | 85                   | 731                              | 80                                     | 58480               | 0.677                   |
| 11 | 2029 | 875                           | 85                   | 744                              | 80                                     | 59500               | 0.689                   |
Based on the table above, it can be seen that the service coverage in 2019 was 70%, and the average water consumption was 80 liters/person/day based on the Real Demand Survey so that the number of liters/second water needs is obtained from 2019 to 2029.

Analysis of Non-Domestic Clean Water Needs. Kamosope Village has three public facilities, namely a mosque, a health center, and a market. Non-Domestic Facilities in Kamosope Village are as follows:

| No | Year | Domestic Sector (L/sec) | Non-domestic Sector Mosque (L/sec) | Quantity (L/Sec) |
|----|------|-------------------------|-----------------------------------|-----------------|
| 1  | 2019 | 0.469                   | 0.113                             | 0.582           |
| 2  | 2020 | 0.480                   | 0.113                             | 0.593           |
| 3  | 2021 | 0.424                   | 0.113                             | 0.567           |
| 4  | 2022 | 0.535                   | 0.113                             | 0.648           |
| 5  | 2023 | 0.545                   | 0.113                             | 0.658           |
| 6  | 2024 | 0.556                   | 0.113                             | 0.669           |
| 7  | 2025 | 0.604                   | 0.113                             | 0.717           |
| 8  | 2026 | 0.615                   | 0.113                             | 0.728           |
| 9  | 2027 | 0.626                   | 0.113                             | 0.739           |
| 10 | 2028 | 0.677                   | 0.113                             | 0.790           |
| 11 | 2029 | 0.689                   | 0.113                             | 0.802           |

The table above shows the total demand for clean water for the domestic and non-domestic sectors from 2019 to 2029.

![Figure 2 EPANET 2.0 Backdrop Pipeline Design](image-url)
Table 4 Water Production Needs in Kamosope Village

| No | Description                                | Unit | 2019  | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 |
|----|-------------------------------------------|------|-------|------|------|------|------|------|------|------|------|------|------|
| 1  | Total Population                          | People | 723   | 740  | 755  | 770  | 785  | 800  | 815  | 830  | 845  | 860  | 875  |
| 2  | Service Coverage                          | %    | 70    | 70   | 75   | 75   | 75   | 80   | 80   | 80   | 85   | 85   | 85   |
| 3  | Serviced Residents                        | people | 506   | 516  | 564  | 576  | 587  | 598  | 654  | 666  | 758  | 818  | 831  |
| 4  | Domestic Water Needs                      | L/sec | 0.46  | 0.48 | 0.52 | 0.53 | 0.54 | 0.55 | 0.60 | 0.61 | 0.62 | 0.67 | 0.68 |
| 5  | Non-Domestic Water Needs                  | L/sec | 0.11  | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 | 0.11 |
| 6  | Domestic + Non Domestic Water Needs       | L/sec | 0.58  | 0.59 | 0.63 | 0.64 | 0.65 | 0.66 | 0.71 | 072  | 073  | 0.79 | 0.80 |
| 7  | Water Loss                                | %     | 25    | 25   | 25   | 25   | 25   | 25   | 25   | 25   | 25   | 25   | 25   |
|    |                                            | L/sec | 0.14  | 0.14 | 0.15 | 0.16 | 0.16 | 0.16 | 0.17 | 0.18 | 0.18 | 0.19 | 0.20 |
| 8  | Average Water Needs                       | L/sec | 0.72  | 0.74 | 0.79 | 0.81 | 0.82 | 0.83 | 0.89 | 0.91 | 0.92 | 0.98 | 1.00 |
| 9  | Keb. Maximum Daily Water (fhm=1.20)       | L/sec | 0.87  | 0.89 | 0.95 | 0.97 | 0.98 | 1.00 | 1.07 | 1.09 | 1.10 | 1.18 | 1.20 |
| 10 | Keb. Maximum Hours (fjm=1.75)             | L/sec | 1.27  | 1.29 | 1.39 | 1.41 | 1.43 | 1.46 | 1.56 | 1.59 | 1.61 | 1.72 | 1.75 |
| 11 | Production Needs                          | L/sec | 0.87  | 0.89 | 0.95 | 0.97 | 0.98 | 0.90 | 1.07 | 1.09 | 1.10 | 1.18 | 1.20 |
| 12 | Production Capacity (springs)             |       | 107   | 107  | 107  | 107  | 107  | 107  | 107  | 107  | 107  | 107  | 107  |

1. Population = 723 people
2. Service Coverage = 70% (Based on Field)
3. Serviced population = 506 people
4. Domestic water demand = 0.469
5. Non-domestic water demand = 0.113
6. Domestic and non-domestic water needs
7. Water loss = 25% (Based on Field)
8. Average water requirement = 0.728 (total requirement *25%)
9. Keb. Maximum daily water
10. Keb. Maximum hour water
11. Production needs = Maximum daily water
12. Production Capacity = 107

Processing Results With Epanet 2.0 Program
Table 5 Analysis of Velocity and Headloss with the Planet 2.0 Program in 2029

| Pipe No | Pipe Diameter (mm) | Pipe Diameter (inch) | Length (m) | Pipe Type | Roughness Coefficient | Velocity (m/s) | Headloss Units (m/km) |
|---------|--------------------|----------------------|------------|-----------|------------------------|----------------|------------------------|
| 1       | 60                 | 2                    | 2002       | PVC       | 140                    | 0.68           | 9.48                   |
| 2       | 60                 | 2                    | 274        | PVC       | 140                    | 0.66           | 8.87                   |
| 3       | 48                 | 1 1/2                | 56         | PVC       | 140                    | 0.62           | 10.46                  |
| 4       | 32                 | 1                    | 61         | PVC       | 140                    | 0.39           | 7.07                   |
| 5       | 48                 | 1 1/2                | 131        | PVC       | 140                    | 0.42           | 5.09                   |
| 6       | 32                 | 1                    | 79         | PVC       | 140                    | 0.38           | 6.66                   |
| 7       | 32                 | 1                    | 154        | PVC       | 140                    | 0.40           | 7.45                   |
| 8       | 48                 | 1 1/2                | 315        | PVC       | 140                    | 0.38           | 4.08                   |
| 9       | 26                 | 3/4                  | 104        | PVC       | 140                    | 0.41           | 9.75                   |
| 10      | 26                 | 3/4                  | 31         | PVC       | 140                    | 0.41           | 9.75                   |

Based on the results of running with the epanet 2.0 program, it is known that the most considerable velocity on pipe 1 is 0.68 m/s and the lowest rate on pipes 6 and 8 is 0.38 m/s. Meanwhile, the largest headloss unit on pipe 3 is 10.46 m/km, and the lowest is on pipe 8, which is 4.08 m/km.

Table 6 Analysis of Pressure and Program Epanet 2.0 the Year 2029

| No. Node | Elevation (m) | Basic Needs (L/sec) | Pressure (m) |
|----------|---------------|----------------------|--------------|
| 1        | 63            | 0.068                | 57.03        |
| 2        | 43            | 0.049                | 74.60        |
| 3        | 43            | 0.049                | 74.01        |
| 4        | 41            | 0.315                | 75.58        |
| 5        | 45            | 0.137                | 71.35        |
| 6        | 41            | 0.305                | 74.82        |
| 7        | 44            | 0.324                | 71.20        |
| 8        | 40            | 0.246                | 76.31        |
| 9        | 39            | 0.217                | 76.30        |
| 10       | 39            | 0.217                | 77.01        |
| 11       | 139           | 1.927                | 0.00         |

Based on the results of running with the epanet 2.0 program, the pressure value (pressure) on nodes 1-11 is still at the determined efficiency standards (10-100m). The most excellent compressive value is at node 10, 77.01 m, while the smallest compressive value is at node 1, which is 57.03 m.
Table 7 Total Pipe Requirements

| No | Pipe diameter (mm) | Pipe Diameter (inch) | Pipe Trunk Size (m) | Length (m) | Number of Pipes (Rod) |
|----|--------------------|----------------------|---------------------|------------|-----------------------|
| 1  | 60                 | 2                    | 4                   | 2002       | 500                   |
| 2  | 60                 | 2                    | 4                   | 274        | 68                    |
| 3  | 48                 | 1 1/2                | 4                   | 56         | 14                    |
| 4  | 32                 | 1                    | 4                   | 61         | 15                    |
| 5  | 48                 | 1 1/2                | 4                   | 131        | 33                    |
| 6  | 32                 | 1                    | 4                   | 79         | 20                    |
| 7  | 32                 | 1                    | 4                   | 154        | 39                    |
| 8  | 48                 | 1 1/2                | 4                   | 316        | 79                    |
| 9  | 26                 | 3/4                  | 4                   | 104        | 26                    |
| 10 | 26                 | 3/4                  | 4                   | 31         | 8                     |
|    |                    |                      |                     | 3208       | 802                   |

Based on the table of total pipe requirements above, the total pipe needs of Kamosope Village are 798 rods. For pipe diameters 1 and 2 use 2 pipes, pipe 3, 5, and 8 use pipe 1 1/2", pipe 4, 6, and pipe 7 use pipe 1 while for pipe 9 and pipe 10 use pipe 3/4", with the number of pipes 1 which is 500 rods, pipe 2 is 68 rods, pipe 3 is 14 rods, pipe 4 is 15 rods, pipe 5 is 33 rods, pipe 6 is 20 rods, pipe 7 is 39 rods, pipe 8 namely 79 rods, pipe 9 which is 26 rods and pipe 10 which is 8 rods.

5. Conclusions
Based on the results of research and discussion that has been carried out, the following conclusions can be drawn. The total Population of Kamosope Village in 2019 was 723 people with a total water need of 0.728 Liters/Second. While the projected Population of Kamosope Village in 2029 is 978 people with a projected water demand of 1.102 Liters/Second.

Based on the buoy method, the water discharge on the Kamosope river is obtained (Q) in 2020, namely, Point 1 = 0.116 m$^3$/Liter, Point 2 = 0.099 m$^3$/Liter, Point 3 = 0.095 m$^3$/Liter, Point 4 = 0.111 m$^3$/Liter, Point 5 = 0.091 m$^3$/Liter, Point 6 = 0.114 m$^3$/Liter. The average water discharge (Q) of the Kamosope River is 0.107 m$^3$/Liter or 107 Liters/Second.

The results of data processing with the Planet 2.0 application used the type of pipe in this plan is a P.V.C. pipe of 802 rods. The length of the stem is 4 meters with a diameter and number of stems, namely 2" as many as 568 stems, 1 1/2" as many as 126, 1" as many as 74 stems, 3/4" as many as 34 stems.

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