Jurnal Teknik Sipil: Vol 23, No. 1, February 2023, 86-92
Department of Civil Engineering, University of Tanjungpura.
ISSN: 1412-1576 (Print), 2621-8428 (Online), Indonesia

Constructions of UNTAN
**Jurnal Teknik Sipil**
Journal homepage: [https://jurnal.untan.ac.id/index.php/jtsuntan](https://jurnal.untan.ac.id/index.php/jtsuntan)

# Analysis of Water Demand and Availability in Wae Mese I Water Treatment Plant to Number of Customers in 2030 (Case Study: PERUMDA Air Minum Wae Mbeliling)

* Apolinaris Dasor[1], Faradlillah Saves[1]

[1]1Faculty of Enginering, University of 17 Agustus 1945 Surabaya, Indonesia
*e-mail: dasorapolinaris@gmail.com

## Abstract

Start with bathing, washing, and cooking, and then move from these three activities to the parts of the human body, one of which is water. The need for clean water is increasing along with population growth. In this study, an analysis of the need for and availability of clean water was carried out in the service area of the Wae Mese I Water Treatment Plant (WTP), which covers seven urban villages in the Kecamatan Komodo. Projected water demand is based on population growth from 2021 to 2030. Projected water availability is based on the production capacity of WTP Wae Mese I from 2021 to 2030. Based on projected water demand and availability, water balance and WTP production capacity were analyzed in 2030.

Based on the analysis of the results, the population in 2030 will reach 45715 people, and the total water demand in 2030 will be 62.06 liters/second. Meanwhile, the capacity of WTP Wae Mese I 40 liters/second has decreased to 33.81 liters/second in 2030. This results in a water deficit of 28.25 liters/second.

***Article history:***
*Submitted dd-mm-year*
*Revise on dd-mm-year*
*Published on dd-mm-year*

***Keyword:***
*WTP, Water, Needs, Availability, Production, Population.*

*DOI: http://dx.doi.org/10.26418/jtsft*

## 1. Introduction

Water in human life has a very vital function. Human daily activities are inextricably linked to water. From bathing, washing, and cooking to the elements of the human body, one of which also consists of water. The water in question is clean and does not contain chemical elements that can harm or interfere with the function of human organs. Since clean water is a need that will always be there, meeting water needs is related to getting enough water out and meeting quality standards. It must continuously meet the community's needs within a certain period. The development of clean water infrastructure needs attention from the government, the private sector, and the community.

PERUMDA Wae Mbeliling is a business unit owned by the West Manggarai district government and responsible for meeting the clean water needs of the community, which is also a form of government service to the community. PERUMDA's natural water sources for Wae Mbeliling drinking water come from Wae Mowol, Wae Moto, Wae Mbaru, Wae Kaca, Wae Cumpe, and the surface water of the Wae Mese river. The surface water of the Wae Mese River provides raw water for Labuan Bajo, the capital city of West Manggarai Regency. Labuan Bajo is made up of seven villages in the Komodo District. The five springs serve the people of Labuan Bajo through gravity.

In order to improve clean water services, it is crucial to figure out how much clean water is needed and available. The surface water of the Wae Mese River is utilized by building the Wae Mese I Water Treatment Plant (WTP) and distributed using a pump. Wae Mese I WTP services cover the area of the Komodo sub-district, which includes seven sub-districts. WTP production capacity was 40 liters/second, totaling 4,535 SR in 2021. Wae Mese I WTP's production capacity is insufficient for the community's water needs; it is proven that a system of distributing water twice a week is still implemented for several areas of clean water service. In the next ten years, until 2030, the number of people will grow, increasing the need for clean water. There may need to be more than the amount of clean water that is already available to meet the growing demand for it. Because of this, it is essential to look at the demand and supply of clean water for the next few years until 2030. This research gives a different way to solve the clean water problem, especially for the area served by the Wae Mese I WTP.

## 2. Materials and Methods

### 2.1. Theoretical Frame Work

This study aims to determine the need for water in the service area of the Wae Mese I water treatment plant from 2021–2030. Water demand increases along with population growth, so population projections are made. The Planning Criteria for the Directorate General of Human Settlements and Public Works Service, 1996, are also used to determine how much water is needed for homes and other places. Based on the results of the water demand analysis, it is known that the water treatment plant will be able to make enough water in 2030 to meet the needs of the Labuan Bajo community.

To make it easier to find out the order in which the final project work will be carried out, the author presents the work methodology in the following flowchart:

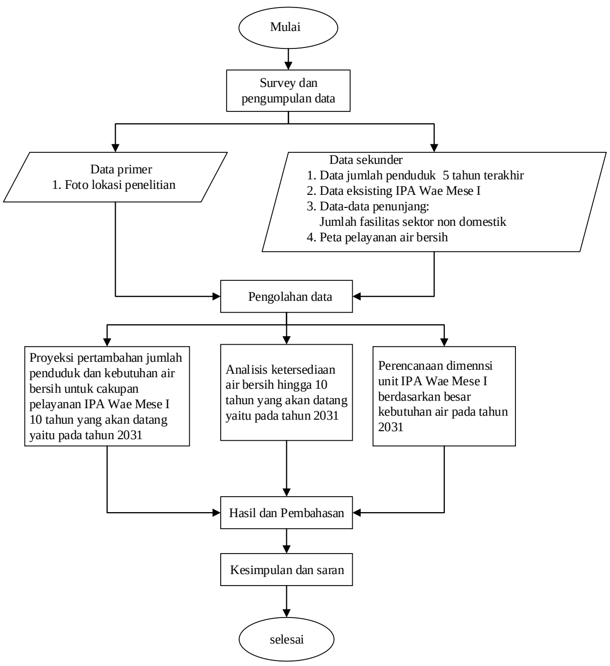


**Fig 1.** Research Flowchart

### 2.2. Research Location

The research location in this study is an area in Nusa Tenggara Timur Province that is included in the service area of the Wae Mese I Water Treatment Plan, PERUMDA Air Minum Wae Mbeliling, which includes Labuan Bajo and seven villages in the Kecamatan Komodo. The seven villages are, Macang Tanggar, Batu Cermin, Labuan Bajo, Wae Kelambu, Nggorang, Golo Bilas, and Gorontalo.

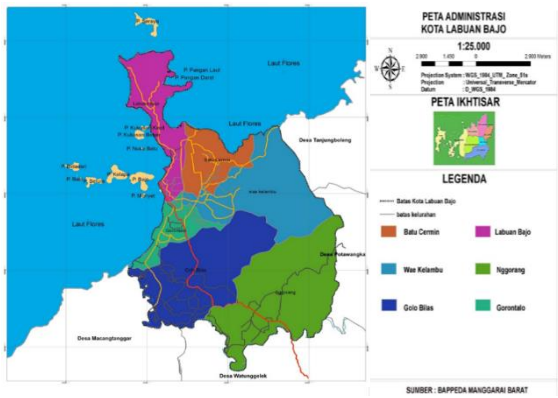


**Fig 2**. Labuan Bajo Administration Map

### 2.3. Data

Sources of data used in this research are secondary data and primary data. The data are as follows:

***a. Secondary Data***

Data was obtained from institutions related to research studies, in this case namely PERUMDA Wae Mbeliling Drinking Water. The secondary data is in the form of:

- Data the on population in the service area of Wae Mese I WTP for the last 5 years, namely 2016-2020.
- Existing data for Wae Mese I WTP, in the form of water discharge data and WTP units.
- Data supporting the number of facilities in the non-domestic sector, such as educational, and health.
- office, trade, public and recreational facilities, sports, and industry.
- Image of map of the clean water service area of Wae Mese I WTP.

***b. Primary Data***

Data is obtained by going down directly to the location/field. The primary data needed is field survey photos, Describe the data used, and how they were obtained.

## 2.4. Analysis Method

### 2.4.1. *Analysis of Population Growth*

In this study, population growth was calculated by;

- Geometric Method

  $Pn = Po(1+r)^n$ .....................................(1)

- Arithmetic method

  $Pn = Po(1+rn)$.....................................(2)

- Exponential method

  - $Pn = P_0 \; x \; e^{rn}$ ...................................(3)

Where:

Pn : population in year n projection (people)
Po : total population at the start of the projection
e : 2.7182818
r : average population increase (%)
n : projection period (years)

The basis for selecting the population projections used is the standard deviation calculation. The standard deviation (Sd) is a statistical value that determines the data distribution in the sample and how close the individual data points are to the average sample value. The standard deviation is the smallest because a slight standard deviation means that the data from the projection is not very different from the original data (BPS, 2010).

$$SD = \sqrt{\frac{\sum(Yi - Yn)^2}{n}} \quad \text{.........................................} \; (4)$$

SD = standard deviation

Yi = population projection data

Yn = average number of the initial population

n = amount of data

### 2.4.2. *Analysis of Clean Water Needs*

- **Domestic Water Demand**

There are many different types of water use in a community, such as household, public, commercial, and industrial uses. Domestic demand includes water for drinking, cooking, washing, laundering, and other household functions (Crouch et al, 2021). The water demand analysis in this study was conducted based on the size of the city as shown in the following table;

**Table 1**. Clean Water Planning Criteria

| Description | Cities Category Based on Total Population | | | | |
|---|---|---|---|---|---|
| | >1.000.000<br>I | 500.000 s/d 1.000.00<br>II | 100.000 s/d 500.000<br>III | 20.000 s/d 100.000<br>IV | < 20.000<br>IN |
| 1. Consumption of house connection units (SR) (liters/person/day) | >150 | 150-120 | 90-120 | 80-120 | 60-80 |
| 2. Consumption of hydrant units (HU) (liters/person/day) | 20-40 | 20-40 | 20-40 | 20-40 | 20-40 |
| 3. Non-domestic consumption | | | | | |
| a. Small business (liters/units/day) | 800 | 800 | | 600 | |
| b. Big business (liters/units/day) | 3000 | 3000 | | 1500 | |
| c. Large industry (liters/second/ha) | 0,2-0,8 | 0,2-0,8 | | 0,2-0,8 | |
| d. tourism(liters/second/ha) | 0,1-0,3 | 0,1-0,3 | | 0,1-0,3 | |
| 4. Water loss(%) | 20-30 | 20-30 | 20-30 | 20-30 | 20-30 |
| 5. Maximum daily factor | 1,15 | 1,15 | 1,15 | 1,15 | 1,15 |
| 6. peak hour factor | 1,5 | 1,5 | 1,5 | 1,5 | 1,5 |
| 7. Number of souls per SR (soul) | 5 | 5 | 5 | 5 | 5 |
| 8. Number of souls per HU (people) | 100 | 100 | 100 | 100 | 100 |
| 9. Residual pressure in distribution supply (meters) | 10 | 10 | 10 | 10 | 10 |
| 10. Operating hours (hours) | 24 | 24 | 24 | 24 | 24 |
| 11. Volume reservoir (% max day demand) | 15-25 | 15-25 | 15-25 | 15-25 | 15-25 |
| 12. SR: HU | 50 : 50 s/d 80 : 20 | 50 : 50 s/d 80 : 20 | 80 : 20 | 70 : 30 | 70 : 30 |
| 13. Service coverage(%) | 90 | 90 | 90 | 90 | 70 |

Source: Kriteria Perencanaan Direktorat Jenderal Cipta Karya, Dinas Pekerjaan Umum, 1996

- **Non-Domestic Water Demand**

Based on spatial plans, non-domestic water demand is the need for clean water for regional facilities and infrastructure that are already in place or are being built. Planning a water supply system in an area depends significantly on how many people live there and how fast they are growing (Mulyadi et al, 2022).

This study calculates non-domestic water demand based on the following table;

**Table 2**. City Non-Domestic Water Needs Categories I, II, III, IV

| Sector | Mark | Unit |
|---|---|---|
| School | 10 | liters/person/day |
| Hospital | 200 | liters/bed/day |
| Public health center | 2.000 | Liters/unit/day |
| Mosque | 3.000 | Liters/unit/day |
| Office | 10 | Liter/employee/day |
| Market | 12.000 | Liters/hectare/day |
| Shop | 500 | Liters/unit/day |
| Hotel | 150 | liters/bed/day |
| Restaurant | 100 | Liter/seat/day |
| Military complex | 60 | liters/person/day |
| Industrial area | 0,2-0,8 | Liters/second/ha |
| Tourism area | 0,1-0,3 | Liters/second/ha |

Source: Kriteria Perencanaan Direktorat Jenderal Cipta Karya, Dinas Pekerjaan Umum, 1996

### *2.4.3. Analysis of Discharge From WTP*

It is necessary to recapitulate the water discharge from the water treatment plant for the last five years. The analysis of the discharge from the WTP is intended to estimate the amount of water discharged from the Wae Mese I Water Treatment Plant that can be distributed over the next ten years, namely 2030. A linear regression formula can predict how much water will be available in 2030 based on data from the last five years, 2016–2020.

$Yn = a + (b.x)$...............................................(5)

Yn : total water debit in the nth year

a,b : costing

x : period of time (year)

N : amount of data

## 3. Result and Discussion

### 3.1. Analysis of Population Growth Result

The total number of people in the study area is the most critical factor in figuring out how much clean water they need. The population data used to calculate the average population growth is data on the population of 7 sub-districts in the Komodo sub-district, namely from 2016–2020. This population projection is planned for the next ten years, from 2021-2030.

The following is data on the population of the Komodo sub-district per village served by the Wae Mese WTP from 2016–2020.

**Table 3**. Data on the population in the Komodo District

| Village | Year | | | | |
|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 | 2020 |
| Golo Bilas | 4196 | 4306 | 4389 | 4622 | 4906 |
| Gorontalo | 7464 | 7245 | 6983 | 7166 | 7292 |
| Macang Tanggar | 3039 | 3048 | 3016 | 3179 | 3079 |
| Nggorang | 1761 | 1845 | 1900 | 2018 | 2201 |
| Wae Kelambu | 5652 | 5855 | 6308 | 6704 | 7676 |
| Batu Cermin | 5322 | 5403 | 5569 | 5712 | 6024 |
| Labuan Bajo | 7360 | 7203 | 6848 | 6915 | 6154 |
| **Amount** | **34794** | **34905** | **35013** | **36316** | **37332** |

Source: Kecamatan Komodo Dalam Angka 2017 – 2021

The annual population growth rate is then calculated to obtain the average population growth. An example of calculating the population growth rate for the Kecamatan Golo Bilas:

$r_n = \frac{Pn-Po}{Po}\ x\ 100\ \%$ ..................................(6)

$r_n$ : growth rate

$P_n$ : population in year n

$P_O$ : total population in the initial year

$$r_{2017} = \frac{P_{2017} - P_{2016}}{P_{2016}}\ x\ 100 =\ 2{,}62\ \%$$

The following is a recapitulation of the population growth rate for each village.

**Table 4**. The results of the population growth rate calculation in Kecamatan Komodo

| Village | Year | | | | | |
|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 | 2020 | Average (%) |
| Golo Bilas | .- | 2,62 | 1,93 | 5,31 | 6,14 | 4,00 |
| Gorontalo | - | -2,93 | -3,62 | 2,62 | 1,76 | -0,54 |
| Macang Tanggar | - | 0,30 | -1,05 | 5,40 | -3,15 | 0,38 |
| Nggorang | - | 4,77 | 2,98 | 6,21 | 9,07 | 5,76 |
| Wae Kelambu | - | 3,59 | 7,74 | 6,28 | 14,50 | 8,03 |
| Batu Cermin | - | 1,52 | 3,07 | 2,57 | 5,46 | 3,16 |
| Labuan Bajo | - | -2,13 | -4,93 | 0,98 | -11,01 | -4,27 |

The growth rate of the population is shown in Table 4. To predict the composition of the population, geometric, arithmetic, and exponential methods are used. The standard deviation for the arithmetic method is the lowest of the three ways to figure out population projections, so the population forecasting for the planning year (2021–2030) uses the arithmetic method.

An example of calculating the population forecasting for the Kecamatan Golo Bilas:

$P_n = P_{2020}(1 + (4\%\ x(Year_n - 2020)$

$P_{10(2030)} = 4906\ (1 + 4\ \%\ x\ 10) = 6869$ people.

In the same way, calculations were made for each of the areas analyzed, the results of which are shown below;

**Table 5**. Recapitulation of the results of the population forecast for 2021-2030 in each region under review

| Village | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| Golo Bilas | 5102 | 5299 | 5495 | 5691 | 5887 | 6084 | 6280 | 6476 | 6672 | 6869 |
| Gorontalo | 7252 | 7213 | 7173 | 7134 | 7094 | 7054 | 7015 | 6975 | 6936 | 6896 |
| Macang Tanggar | 3091 | 3102 | 3114 | 3125 | 3137 | 3149 | 3160 | 3172 | 3183 | 3195 |
| Nggorang | 2328 | 2454 | 2581 | 2708 | 2835 | 2961 | 3088 | 3215 | 3342 | 3468 |
| Wae Kelambu | 8292 | 8908 | 9524 | 10140 | 10756 | 11373 | 11989 | 12605 | 13221 | 13837 |
| Batu Cermin | 6214 | 6404 | 6594 | 6784 | 6975 | 7165 | 7355 | 7545 | 7735 | 7925 |
| Labuan Bajo | 5891 | 5628 | 5365 | 5102 | 4839 | 4577 | 4314 | 4051 | 3788 | 3525 |
| Total | 38170 | 39009 | 39847 | 40685 | 41524 | 42362 | 43200 | 44038 | 44877 | 45715 |

### 3.2. Analysis of Clean Water Needs Results

This study looks at the demand for clean water based on the standards set by Kriteria Perencanaan Direktorat Jenderal Cipta Karya, Dinas Pekerjaan Umum, 1996. Analysis of clean water demand is carried out for domestic clean water needs and non-domestic clean water needs.

#### *3.2.1. Results of domestic water demand analysis*

The domestic water demand analyzed in this study includes house connections (SR) and public hydrants (HU).

Based on Table 1 regarding clean water planning criteria, Kecamatan Komodo is categorized as a small town (IV) with a population between 20,000 - 100,000 people; the results are as follows;

**Table 6**. Results of Domestic Water Demand Analysis 2021-2030

| No | Year | Total Population | Service Coverage | | SR | | HU | |
|---|---|---|---|---|---|---|---|---|
| | | | % | People | % | People | % | People |
| [a] | [b] | [c] | [d] | [e] | [f] | [g] | [h] | [i] |
| 1 | 2021 | 38170 | 90 | 34353 | 70 | 24047 | 30 | 10306 |
| 2 | 2022 | 39009 | 90 | 35108 | 70 | 24575 | 30 | 10532 |
| 3 | 2023 | 39847 | 90 | 35862 | 70 | 25104 | 30 | 10759 |
| 4 | 2024 | 40685 | 90 | 36617 | 70 | 25632 | 30 | 10985 |
| 5 | 2025 | 41524 | 90 | 37371 | 70 | 26160 | 30 | 11211 |
| 6 | 2026 | 42362 | 90 | 38126 | 70 | 26688 | 30 | 11438 |
| 7 | 2027 | 43200 | 90 | 38880 | 70 | 27216 | 30 | 11664 |
| 8 | 2028 | 44038 | 90 | 39635 | 70 | 27744 | 30 | 11890 |
| 9 | 2029 | 44877 | 90 | 40389 | 70 | 28272 | 30 | 12117 |
| 10 | 2030 | 45715 | 90 | 41144 | 70 | 28801 | 30 | 12343 |

Furthermore, calculations were carried out to determine the total clean water demand (lt/day) distributed through SR and HU using the following equation;

$$SR = \frac{number\ of\ people\ x\ std.water\ usage\ (\frac{lIter}{person}/day)}{86400\ second}$$

$$HU = \frac{number\ of\ people\ x\ std.water\ usage\ (\frac{lIter}{person}/day)}{86400\ second}$$

By entering the SR value in column [g] and HU in column [i] contained in Table 6, the amount of water demand distributed through house connections and public hydrants is obtained as in the following table;

**Table 7**. Results of analysis of water demand distributed through house connections 2021- 2030

| No | Year | Number of Served Population (People) | Water Usage Standard (lt/person's/day) | Total Water Needs (lt/s) |
|---|---|---|---|---|
| [a] | [b] | [c] | [d] | [e] |
| 1 | 2021 | 24047 | 100 | 27,83 |
| 2 | 2022 | 24575 | 100 | 28,44 |
| 3 | 2023 | 25104 | 100 | 29,06 |
| 4 | 2024 | 25632 | 100 | 29,67 |
| 5 | 2025 | 26160 | 100 | 30,28 |
| 6 | 2026 | 26688 | 100 | 30,89 |
| 7 | 2027 | 27216 | 100 | 31,50 |
| 8 | 2028 | 27744 | 100 | 32,11 |
| 9 | 2029 | 28272 | 100 | 32,72 |
| 10 | 2030 | 28801 | 100 | 33,33 |

**Table 8**. Results of analysis of water demand distributed through public hydrants 2021- 2030

| No | Year | Number of Served Population (People) | Water Usage Standard (lt/person's/day) | Total Water Needs (lt/s) |
|---|---|---|---|---|
| [a] | [b] | [c] | [d] | [e] |
| 1 | 2021 | 10306 | 30 | 3,58 |
| 2 | 2022 | 10532 | 30 | 3,66 |
| 3 | 2023 | 10759 | 30 | 3,74 |
| 4 | 2024 | 10985 | 30 | 3,81 |
| 5 | 2025 | 11211 | 30 | 3,89 |
| 6 | 2026 | 11438 | 30 | 3,97 |
| 7 | 2027 | 11664 | 30 | 4,05 |
| 8 | 2028 | 11890 | 30 | 4,13 |
| 9 | 2029 | 12117 | 30 | 4,21 |
| 10 | 2030 | 12343 | 30 | 4,29 |

Tables 7 and 8 show that the required domestic water demand is 37.62 Lt/s, which is the domestic water demand in 2030.

The overall domestic water demand is as presented in the following table;

**Table 9**. Results of Domestic Water Demand Analysis

| Facility | Water Demand (L/s) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| | Domestic | | | | | | | | | |
| Home Connection (SR) | 27,83 | 28,44 | 29,06 | 29,67 | 30,28 | 30,89 | 31,50 | 32,11 | 32,72 | 33,33 |
| Public Hydrants (HU) | 3,58 | 3,66 | 3,74 | 3,81 | 3,89 | 3,97 | 4,05 | 4,13 | 4,21 | 4,29 |
| ***Total Domestic Water Demands (L/s)*** | ***31,41*** | ***32,10*** | ***32,79*** | ***33,48*** | ***34,17*** | ***34,86*** | ***35,55*** | ***36,24*** | ***36,93*** | ***37,62*** |

### *3.2.2. Results of non-domestic water demand analysis*

The analysis of non-domestic water demand in this study was calculated based on the provisions in Table 2, with the following results;

**Table 10**. Results of Non-Domestic Water Demand Analysis

| Facility | Water Demand (L/s) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| | Domestic | | | | | | | | | |
| Health | 0,76 | 0,76 | 0,76 | 0,76 | 0,76 | 1,13 | 1,13 | 1,13 | 1,13 | 1,13 |
| Education | 1,74 | 1,78 | 1,82 | 1,85 | 1,89 | 1,93 | 1,97 | 2,01 | 2,04 | 2,08 |
| Worship | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 |
| Hotel | 3,22 | 3,51 | 3,80 | 4,09 | 4,37 | 4,37 | 4,95 | 5,24 | 5,52 | 5,81 |
| Trade | 1,17 | 1,20 | 1,22 | 1,24 | 1,27 | 1,27 | 1,31 | 1,34 | 1,36 | 1,38 |
| Office | 0,145 | 0,153 | 0,161 | 0,168 | 0,176 | 0,184 | 0,191 | 0,199 | 0,206 | 0,214 |
| Airport and seaport | 1,45 | 1,64 | 1,82 | 2,01 | 2,19 | 2,18 | 2,56 | 2,75 | 2,94 | 3,12 |
| ***Total Non-Domestic Water Demands (L/s)*** | ***8,85*** | ***9,40*** | ***9,94*** | ***10,48*** | ***11,02*** | ***11,42*** | ***12,47*** | ***13,03*** | ***13,56*** | ***14,09*** |

The analysis of non-domestic water demand shows that the most significant water demand is for hotel activities, and the smallest is for offices.

From the results of the analysis, it can be seen that domestic water demand, especially for house connections, is still the largest demand compared to non-domestic water demand.

Based on the analysis results, domestic water demand is still higher than non-domestic water demand, especially for house connections. In summary and for clarity, the results can be seen in the following table.

**Table 11.** Recapitulation of the results of the calculation of clean water demand at the research site

| Facility | Water Demand (L/s) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
| | Domestic | | | | | | | | | |
| Home Connection (SR) | 27,83 | 28,44 | 29,06 | 29,67 | 30,28 | 30,89 | 31,50 | 32,11 | 32,72 | 33,33 |
| Public Hydrants (HU) | 3,58 | 3,66 | 3,74 | 3,81 | 3,89 | 3,97 | 4,05 | 4,13 | 4,21 | 4,29 |
| ***Total Domestic Water Demands (L/s)*** | ***31,41*** | ***32,10*** | ***32,79*** | ***33,48*** | ***34,17*** | ***34,86*** | ***35,55*** | ***36,24*** | ***36,93*** | ***37,62*** |
| | Non-Domestic | | | | | | | | | |
| Health | 0,76 | 0,76 | 0,76 | 0,76 | 0,76 | 1,13 | 1,13 | 1,13 | 1,13 | 1,13 |
| Education | 1,74 | 1,78 | 1,82 | 1,85 | 1,89 | 1,93 | 1,97 | 2,01 | 2,04 | 2,08 |
| Worship | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 | 0,36 |
| Hotel | 3,22 | 3,51 | 3,80 | 4,09 | 4,37 | 4,37 | 4,95 | 5,24 | 5,52 | 5,81 |
| Trade | 1,17 | 1,20 | 1,22 | 1,24 | 1,27 | 1,27 | 1,31 | 1,34 | 1,36 | 1,38 |
| Office | 0,145 | 0,153 | 0,161 | 0,168 | 0,176 | 0,184 | 0,191 | 0,199 | 0,206 | 0,214 |
| Airport and seaport | 1,45 | 1,64 | 1,82 | 2,01 | 2,19 | 2,18 | 2,56 | 2,75 | 2,94 | 3,12 |
| ***Total Non-Domestic Water Demands (L/s)*** | ***8,85*** | ***9,40*** | ***9,94*** | ***10,48*** | ***11,02*** | ***11,42*** | ***12,47*** | ***13,03*** | ***13,56*** | ***14,09*** |
| **Total (L/s)** | **40,26** | **41,50** | **42,73** | **43,96** | **45,19** | **46,28** | **48,02** | **49,27** | **50,49** | **51,71** |

Also, the total water demand in the study area was determined by adding 20% to the amount of water lost, as shown in Table 1, to obtain the total water demand in the study area, which is (total domestic water demand plus total non-domestic water demand) multiplied by 20%. The amount of water used daily and the busiest times can be calculated once the total water demand has been determined. Likewise, peak hour water demand is calculated by multiplying the peak hour demand factor by the total water demand. The maximum daily factor and peak hour demand can be seen in the provisions presented in Table 1.

**Table 12**. Water Loss and Total Water Demand at the Study Site in 2021-2030

| Year | Q Domestic and Non-Domestic (L/s) | Water Loss (L/s) | Total Water Needs (L/s) |
|---|---|---|---|
| 2021 | 40,26 | 8,05 | 48,31 |
| 2022 | 41,50 | 8,30 | 49,80 |
| 2023 | 42,73 | 8,55 | 51,28 |
| 2024 | 43,96 | 8,79 | 52,75 |
| 2025 | 45,19 | 9,04 | 54,22 |
| 2026 | 46,28 | 9,26 | 55,54 |
| 2027 | 48,02 | 9,60 | 57,63 |
| 2028 | 49,27 | 9,85 | 59,12 |
| 2029 | 50,49 | 10,10 | 60,58 |
| 2030 | 51,71 | 10,34 | 62,06 |

**Table 13**. Recapitulation of Water Demand Forecasting 2021-2030

| Year | Q Total (L/s) | Maximum daily requirement (L/s) Kolom [b] x 1,15 | Peak Hour Water Requirement (L/s) Kolom [b] x 1,5 |
|---|---|---|---|
| [a] | [b] | [c] | [d] |
| 2021 | 48,31 | 55,55 | 72,46 |
| 2022 | 49,80 | 57,27 | 74,71 |
| 2023 | 51,28 | 58,97 | 76,92 |
| 2024 | 52,75 | 60,66 | 79,13 |
| 2025 | 54,22 | 62,36 | 81,34 |
| 2026 | 55,54 | 63,87 | 83,31 |
| 2027 | 57,63 | 66,27 | 86,44 |
| 2028 | 59,12 | 67,99 | 88,68 |
| 2029 | 60,58 | 69,67 | 90,87 |
| 2030 | 62,06 | 71,37 | 93,09 |

### 3.3. Analysis of Water Availability

The linear regression method was used to determine how much water was available in the Wae Mese 1 WTP based on data from the last five years (2017–2021). Forecasted water availability is until 2030, so the water balance can be calculated until 2030.

**Table 14**. Calculation of Production Capacity Forecasting

| No | Year | X (Year to) | Y (Q Position) | $X^2$ | XY |
|---|---|---|---|---|---|
| 1 | 2017 | 0 | 38,6 | 0 | 0,0 |
| 2 | 2018 | 1 | 38,3 | 1 | 38,3 |
| 3 | 2019 | 2 | 37,9 | 4 | 75,8 |
| 4 | 2020 | 3 | 37,4 | 9 | 112,2 |
| 5 | 2021 | 4 | 37,2 | 16 | 148,8 |
| **n** | | **10** | **189,4** | **30** | **375,1** |

$$a = \frac{\sum Y.\sum X^2 - \sum X.\sum XY}{N.\sum X^2 - (\sum X)^2} = \frac{189{,}4\ x\ 30 - 10\ x\ 375{,}1}{5\ x\ 30 - (10)^2} = \frac{1931}{50}$$

= 38,6

$$b = \frac{N.\sum XY - \sum X.\sum Y}{N.\sum X^2 - (\sum X)^2} = \frac{5\ x\ 375{,}1 - 10.189{,}4}{5\ x30 - (10)^2} = -0{,}37$$

$$Yn = a + (b.x)$$

$$Y_{2021} = 38{,}6 + \left(-0{,}37x\ (2021 - 2017)\right) = 37{,}2\ liter/second$$

$$Y_{2030} = 38{,}6 + \left(-0{,}37x\ (2030 - 2017)\right) = 33{,}81\ liter/second$$

**Table 15**. Water Balance Forecasts 2021-2030

| Year | Q Production ($Q_P$) (L/s) | Q Needs ($Q_K$) (L/s) | $Q_P$ - $Q_K$ (L/s) |
|---|---|---|---|
| [a] | [b] | [c] | [d] |
| 2021 | 37,20 | 48,31 | -11,11 |
| 2022 | 36,77 | 49,07 | -12,30 |
| 2023 | 36,40 | 51,29 | -14,89 |
| 2024 | 36,03 | 52,75 | -16,72 |
| 2025 | 35,66 | 54,22 | -18,56 |
| 2026 | 35,29 | 55,91 | -20,62 |
| 2027 | 34,92 | 57,63 | -22,71 |
| 2028 | 34,55 | 59,12 | -24,57 |
| 2029 | 34,18 | 60,58 | -26,40 |
| 2030 | 33,81 | 62,06 | -28,25 |

Table 15 shows that the demand for clean water at the study site is higher than the amount of clean water that is currently available. To meet the clean water needs at the study site by 2030, either more clean water sources or more clean water storage capacity at the Wae Mese I Water Treatment Plant are needed.

### 3.4. Conclusion

From the results of the analysis that has been carried out, it can be concluded that, since 2021, the production capacity of the Wae Mese I WTP cannot meet the water needs in the service area, as can be seen from the comparison between the availability of produced water and the water demand of the population, which continues to increase until 2030. So, plans must be made to increase the amount of clean water that can be made or to build a new water treatment plant. The current service area is split into the WTP Wae Mese I service area and the new WTP service area.

### 3.5. Acknowledgment

I am grateful to all those who have cooperated with me during this research so that the results can be published. Thanks to JTS UNTAN as a place of journal publication. Hopefully, this research journal can be helpful in other studies in the field of civil engineering.

Finally, I would also like to thank the UNTAN Civil Engineering Journal Team (JTS) for publishing the results of this research so that it can be a valuable reference for developing the Wae Mese I Water Treatment Plant (WTP).

### 3.6. Author's Note

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

### 3.7. References

BPS. (2010). Pedoman Perhitungan Proyeksi Penduduk Dan Angkatan Kerja. Jakarta: BPS.

Crouch, M; Jacobs, H., E.; Speight, V. (2021). **Defining domestic water consumption based on personal water use activities**. Aqua, Water Infrastucture, Ecosystem, and Society.

Ditjen Cipta Karya. (1996). **Proyeksi Kebutuhan Air Dan Identifikasi Pola Fluktasi Pemakaian Air**.

Ditjen Cipta Karya. (2002). **Panduan Pengembangan Air Minum**.

Cipta Karya. (1998). **Juknis BPAM**, DPU.

Djoko, M. H. (2016). **Sumber Air Baku Utuk Air Minum**. Fakultar Teknik UI.

Fitri, R. (2016). **Optimalisasi PDAM Dalam Pengelolaan Air Minum Kota Medan**. ArchuGreen, 3(5).

Hendriyani, I. (2019). **Analisa Kebutuan Air Bersih IPA PDAM Samboja Kutai Karta Negara**. Media Ilmiah Teknik Sipil.

Kusumo. B. J. (2016). **Pola Konsumsi Air Untuk Kebutuhan Air Domestik Pada PDAM Di Kecamatan Manyaran Kabupaten Wonogiri. Surakarta**. Universitas Muhamammadiyah Surakarta.

Leasiwal, dkk. (2020). **Tinjauan Terhadap Kapasitas Produksi Instalasi Pengolahan Air Minum (IPAM) Paca di Kecamatan Tobelo Selatan**.Tekno Vol. 19/No. 77.

Menkes. (1990). **Peraturan Menteri Kesehatan No.416/Menkes/PER/IX/1990 Tentang Syarat-syarat Dan Pengawasan Kualitas Air**. Jakarta: Menteri Kesehatan RI.

Mulyadi, D; Wahyudi, S.I.; Soedarsono; Biantoro, A.,W. (2022). **Prediction Analysis of Domestic and Non-Domestic Water Needs in Serang City, Banten**. Resmilitaris, Vol. 12 No. 4 (2022): Vol.12 No. 4 (2022).

Pemerintah Indonesia. (2019). **Undang-Undang No.17 Tahun 2019 Tentang Sumber Daya Air**. Jakarta: Pemerintahan Pusat.

PP No. 122. (2015). **Sistem Penyediaan Air Minum**.

Prakoso, A. A. (2019). **Analisis Kebutuhan Air Bersih di Kecamatan Benowo Kota Surabaya Berdasarkan Proyeksi Pertumbuhan Penduduk 2029.Surabaya**. Repository UNTAG Surabaya.

Putra, R. F. A. (2019). **Analisis Debit Air Andalan PDAM Untuk Pelanggan Di Daerah Zona 5 Wilayah Surabaya Barat**. Surabaya: Teknik Sipil Untag Surabaya.

Ranzetti, S. (2015). **Non-household Water Demand: The Industrial and Commercial Sectors**. Global Issues in Water Policy book series (GLOB,volume 15). Understanding and Managing Urban Water in Transition pp 297–310. Springer.

Rustam. (2020). **Penglolaan Air Bersih Di PDAM Wae Mbeliling. Makassar**. Universitas Muhamammadiyah Makassar

Salim, M. A. (2019). **Analisis Kebutuhan dan Ketersediaan Air Bersih (Studi kasus: Kecamatan Bekasi Utara**. Jakarta: Repository UINJKT.

Silalahi, M.D. (2002). **Optimalisasi Sarana Yuridis Sebagai Upaya Menumbuhkan Masyarakat Sadar Urgensi Sumber Daya Air**. Majalah Air Minum, edisi No. 97 / th. XXIII Desember 2002.