Drainage Capacity Analysis in The Area of Angke Jaya Tambora West Jakarta

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Abstract

Drainage is used to reduce and remove excess water in an area so that the area can be optimally enabled. This research aims to analyze and examine the drainage problems in the Angke Jaya Tambora West Jakarta Housing area, the drain channels are poorly maintained and often flooding. The data used in this study are primary and secondary, in the planning of flood debt calculations used 2nd anniversary. For the calculation of flood discharge plan to use rational method and coupled with the discharge of flood household, and the result will be compared with existing conditions of drainage channels in the residential area Angke Jaya Tambora West Jakarta. Obtained flood discharge plan of 13.225 m³/sec, for the existing condition of drainage channels 5 channels enter the category is not safe because the condition of existing capacity of channels is less than flood discharge plan, namely channels A4, D5, D6, D8, and D9. The planning of the wells to accommodate the excess discharge flooding, and it takes 19 pieces of replacement wells on the A4 channel, 1 on the D5, D, D8, and D9 channels.

Keywords
Drainage, Hydrological Analysis, Flood Discharge Plans, Absorption Wells.

1. Introduction

Population growth in Indonesia is increasing every year and requires a lot of land to be used as dwellings, especially in urban areas. The narrowness of the land and the large number of residential developments and supporting facilities make many unnecessary land uses. The impact of a large number of human activities and lack of attention to the environment gives rise to many natural disasters, such as floods that most often occur in urban areas. During high rainfall it is not uncommon for water to flood in the streets and until flooding can occur, this is due to a lack of community attention to land use and drainage channels. Stagnant water or flooding that can also occur due to lack of functioning drainage channels or channels that are inadequate in accommodating water discharge. If no action is taken to overcome this problem it will disrupt community activities and hamper economic, social and cultural development.

Planning and maintenance of drainage channels is needed to maintain and regulate the flow of water to create a healthy and comfortable environment. Drainage system in general can be interpreted as a prasarana that functions to drain excess water from an area to receiving water bodies such as rivers. Drainage can also be interpreted as a system of drainage of clean water and wastewater from residential areas, industries, agriculture, road bodies and other pavement surfaces, as well as channeling excess water in general, whether in the form of rainwater, wastewater or other dirty water that comes out of the area concerned to water bodies or artificial recharge buildings.

In this study, researchers will conduct research on the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta, which is a residential area that pays little attention to the drainage system and not infrequently the streets in the housing area are flooded during high rainfall.

1.1 Identification Problems
1. Full channel condition (10 cm height only)
2. The drainage on the channel is not smooth.
3. Sedimentation builds up in drainage channels.
4. There are a number of residential houses that have advanced to the street, covering the existing drainage, and making it difficult to clean the debris.
1.2. Problem Solving
1. What is the condition of the drainage channels in the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta?
2. What is the flood discharge in the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta?
3. Do you need to plan for a new dimension of drainage in the Angke Jaya Housing area, Kelurahan Angke, Tambora District, West Jakarta?

1.3. Purpose and Objectives
1. Knowing the condition of drainage channels in the area of Angke Jaya Housing, Angke Village, Tambora District, West Jakarta.
2. Knowing the magnitude of flood discharge in the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta.
3. Knowing whether or not the new dimension of drainage channel planning is needed in the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta.

1.4 Benefits of Research
At this writing the benefit gained is knowing whether the design of drainage channels in the Angke Jaya Housing area, Angke Village, Tambora District, West Jakarta is sufficient to accommodate flood plans that have been analyzed later, and concludes whether it is necessary to plan a new drainage channel in the Housing area Angke Jaya, Angke Village, Tambora District, West Jakarta.

1.5 Scope and Limitation of Problems
1. The location of the study was conducted in the area of Angke Jaya Housing, Angke Village, Tambora District, West Jakarta.
2. It only calculates the discharge of water from rainwater and household waste water.
3. Not calculating a budget plan.
4. Only calculates dimensions.

1.6 Library Review
Drainage which is derived from English drainage means to drain, drain, dispose, or drain water. In the field of civil engineering, drainage in general can be defined as a technical measure to reduce excess water, whether coming from rain water, seepage, or excess irrigation water from an area / land, so that the function of the area / land is not disrupted. Drainage can also be interpreted as an effort to control groundwater quality in relation to salinity (Suripin,2004:7) According to Bambang Triatmodjo (2015:1), hydrology is the science related to water on earth, both regarding its occurrence, distribution and distribution, its properties and its relationship with its environment, especially with living things. Hydrological planning can be found in several activities such as planning and operating water buildings, water supply for various purposes (clean water, irrigation, fisheries, animal husbandry), hydroelectric power, flood control, erosion and sedimentation control, water transportation, drainage, controlling pollution, waste water, etc.

2. Methodology

1. Study of literature
   At this stage what is done in this study is to identify problems in the drainage system that occur in the Angke Jaya Housing Area, Kel. Angke, Kec. Tambora, West Jakarta and literature study on the Drinase system as reference material and knowledge in the process of data collection, data processing, research results, to get conclusions in this study.

2. Data collection
   The data needed in this study are primary data and secondary data, which will be explained as follows:
   1) Primary Data
Primary data is population data to determine household wastewater discharge for the purpose of calculating flood discharge plans, and existing conditions of drainage channels including channel length, channel width, depth, channel elevation, channel type and channel catchment area to determine channel capacity requirements to accommodate incoming water discharge.

2) Second Data
Secondary data is data of minimum daily maximum rainfall for the last 10 years obtained from relevant agencies for the purposes of calculating flood discharge plans, and maps of the Angke Jaya Housing Area, Kel. Angke, Kec. Tambora, West Jakarta.

3. Data Processing
At this stage after all the necessary data has been collected, data processing will be carried out with the stages of the calculation of the flood discharge plan and the calculation of the capacity of the existing drainage channels.

4. Data Processing Results
After the results of data processing will be obtained the results of planned discharge and channel discharge, and if the channel discharge is greater than the planned flood discharge then the calculation of the dimensions of the new drainage channel is not carried out, and vice versa if the planned flood discharge is greater than the channel discharge it will be taken into account dimensions of new drainage channels.

2.1 Research Methods
The research methodology used in this thesis is an evaluative descriptive analysis, a method that evaluates objective conditions in a situation that is the object of research, and the object of the study is the drainage channel in the Angke Jaya Housing Area, Kel. Angke, Kec. Tambora, West Jakarta.

2.2 Research Location and Time
In this final project, the research will be conducted in August 2019 until September 2019. The research location is in the Angke Jaya Housing Area, Kel. Angke, Kec. Tambora, West Jakarta. The location map of the study can be seen in Picture 2.1.

3. Hydrological Analysis
Hydrological analysis calculations are used to get flood discharge into the drainage channel being evaluated. The stages of the hydrological analysis calculation are as follows:
1. Calculate regional rainfall
2. Analysis of the frequency of rainfall plans  
3. Selection of distribution type  
4. Test data compatibility

3.1 Rainfall Area Analysis  
Rainfall data used is rainfall data for 10 years, namely from 2009 to 2018, rainfall data obtained from the Climatology and Geophysics Meteorological Agency.

Table 3.1. Daily / Month Maximum Rainfall Data (mm / day)

| Tahun | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Ags | Spt | Okt | Nov | Des |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 2009  | 87.1| 35.4| 26.9| 73.4| 22.4| 15.7| 6   | 15  | 16  | 39  | 48.5|     |
| 2010  | 82.1| 88.3| 52.9| 13.7| 83.2| 44  | 28.3| 18.4| 56.1| 52  | 29.3| 69.3|
| 2011  | 31.0| 56.1| 30.6| 6.5 | 62  | 59  | 31.3| 10  | 2.8 | 34.3| 78.2| 66.4|
| 2012  | 48.9| 60.9| 60.1| 50.1| 43.6| 21.9| 25  | 0   | 24.6| 0.1 | 75.2| 59.4|
| 2013  | 117.8| 55.7 | 52.7 | 34  | 47  | 46.4| 37.7| 71.8| 0.6 | 43.8 | 77.2| 81.5|
| 2014  | 156.1| 284  | 185.9| 50.9 | 165.3| 43 | 33.7| 71.8| 53.7| 0   | 46.4| 84.1|
| 2015  | 133.4| 247  | 54  | 56.7 | 29.1 | 25.2| 2.5 | 0   | 16  | 0   | 57.4|     |
| 2016  | 34.9 | 100.8| 50.9 | 122.7| 66.4 | 75.5| 33.4| 42.3| 39.2| 40.3| 29.1| 6.6 |
| 2017  | 82.8 | 145.8| 26.3 | 41.3 | 44.3 | 73.4| 19.8| 1.9 | 45.2| 22.3| 39.1| 68.1|
| 2018  | 68.3 | 100.3| 129.6| 69.3 | 14.7 | 12.2| 0   | 46  | 15  | 54.1 | 39.8| 11.9|

Source: Climatology and Geophysics Meteorological Agency

Table 3.2 Daily / Year Maximum Rainfall Data (mm / day)

| Tahun | Curah Hujan Maksimum |
|-------|----------------------|
| 2009  | 149.9                |
| 2010  | 89.3                 |
| 2011  | 76.5                 |
| 2012  | 75.1                 |
| 2013  | 117.8                |
| 2014  | 284                  |
| 2015  | 247                  |
| 2016  | 112.7                |
| 2017  | 148.6                |
| 2018  | 129.6                |

Source: Climatology and Geophysics Meteorological Agency

3.2. Analysis of Frequency of Rainfall Plans  
Rainfall analysis of this plan is carried out to find out the maximum daily rainfall that will be used to calculate the flood discharge plan. The following calculations use the Normal Distribution, Normal Log Distribution, Log-Person III Distribution, and Gumbel Distribution.

3.2.1. Normal Distribution  
The following calculation is the probability of rainfall for a 10 year return period with a Normal distribution.

Calculate the average value of variat (\( \bar{X} \))

\[ \bar{X} = \frac{\sum X_i}{n} \]

\[ \bar{X} = \frac{1430.5}{10} = 143.05 \text{ mm/hari} \]
Table 3.3 Normal Distribution Calculation

| No | Tahun | Curah Hujan Kerasan (Xb) | X | (X – X̄) | (X – X̄)^2 | (X – X̄)^2 * Fb |
|----|-------|--------------------------|---|----------|------------|----------------|
| 1  | 2009  | 148.9                    | 143.05 | 5.85      | 34.22      | 200.20         |
| 2  | 2010  | 88.3                     | 143.05 | -54.75    | 3009.69    | 164116.55      |
| 3  | 2011  | 78.5                     | 143.05 | -64.55    | 4166.70    | 289860.05      |
| 4  | 2012  | 75.1                     | 143.05 | -68.13    | 4624.52    | 331941.91      |
| 5  | 2013  | 117.8                    | 143.05 | -25.25    | 637.76     | 66094.85       |
| 6  | 2014  | 284                      | 143.05 | 140.95    | 19866.90   | 280239.91      |
| 7  | 2015  | 247                      | 143.05 | 103.95    | 10705.60   | 1133242.38     |
| 8  | 2016  | 117.7                    | 143.05 | -25.25    | 637.76     | 66094.85       |
| 9  | 2017  | 148.6                    | 143.05 | 5.55      | 30.80      | 170.95         |
| 10 | 2018  | 129.6                    | 143.05 | -13.45    | 180.90     | 2433.14        |

Calculation of rainfall with a return period with the Normal distribution can be seen in table 4.4

Table 3.4 Calculation of Rainfall for Birthday of T Year with Normal Distribution

| Periode Ulang T (tahun) | X | S | K_T | X_T |
|-------------------------|---|---|-----|-----|
| 2                       | 143.05 | 70.126 | 0.84 | 201.9558 |
| 5                       | 143.05 | 70.126 | 1.28 | 232.8113 |
| 10                      | 143.05 | 70.126 | 1.64 | 258.0566 |
| 20                      | 143.05 | 70.126 | 2.05 | 286.8083 |
| 50                      | 143.05 | 70.126 | 2.33 | 306.4436 |

Source: Calculation Analysis Results

3.2.2. Log Normal Distribution

Following is the calculation of the rainfall probability re-distribution period of the Normal Log. Calculate the average value of variate (log X)

\[
\log X = \frac{\sum \log X}{n}
\]

\[
\log X = \frac{21.14}{10} = 2.114 \text{ mm/day}
\]

Table 3.5 Calculation of Normal Log Distribution

| No | Tahun | X | Log X | Log X | Log X | (Log X - \log S)^2 | (Log X - \log S)^2 * \frac{Fb(X)}{2} | \log X | (\log X - \log S)^2 |
|----|-------|---|-------|-------|-------|-------------------|-----------------------------------|-------|-------------------|
| 1  | 2009  | 148.9 | 2.17 | 2.16 | 0.02 | 0.00003050 | 0.000000527 | 0.000000009 |
| 2  | 2010  | 88.3 | 1.95 | 2.16 | -0.21 | 0.0439016 | -0.00919858 | 0.00192735 |
| 3  | 2011  | 78.5 | 1.89 | 2.16 | -0.26 | 0.0670218 | -0.01790167 | 0.00461378 |
| 4  | 2012  | 75.1 | 1.88 | 2.16 | -0.28 | 0.078149 | -0.02191635 | 0.0066135 |
| 5  | 2013  | 117.8 | 2.07 | 2.16 | -0.08 | 0.071173 | -0.0099999 | 0.00000964 |
| 6  | 2014  | 284 | 2.45 | 2.16 | 0.36 | 0.088708 | 0.02544843 | 0.00786322 |
| 7  | 2015  | 247 | 2.09 | 2.16 | 0.24 | 0.056282 | 0.0134732 | 0.00316645 |
| 8  | 2016  | 117.2 | 2.05 | 2.16 | -0.10 | 0.010725 | -0.00111077 | 0.000115036 |
| 9  | 2017  | 148.6 | 2.17 | 2.16 | 0.02 | 0.00002735 | 0.00000472 | 0.000000657 |
| 10 | 2018  | 129.6 | 2.11 | 2.16 | -0.04 | 0.001839 | -0.0007866 | 0.000003182 |

\[
\sum = 1430.50
\]

\[
\begin{align*}
\sum \text{Log X} & = 21.14 \\
\sum \text{Log X} & = 21.55 \\
\sum \text{Log X} & = 0.41 \\
\sum \text{Log X} & = 0.26 \\
\sum \text{Log X} & = -0.01 \\
\sum \text{Log X} & = 0.023877463
\end{align*}
\]

Source: Calculation Analysis Results
Table 3.6 Calculation of Rainfall for Birthday of T Year with Normal Log Distribution

| Periode Ulang T (tahun) | Log $\bar{X}$ | S | $K_T$ | $Y_T$ |
|-------------------------|---------------|---|-------|-------|
| 2                       | 2,114         | 0,199 | 0     | 2,114 |
| 5                       | 2,114         | 0,199 | 0,84  | 2,28116 |
| 10                      | 2,114         | 0,199 | 1,28  | 2,36872 |
| 20                      | 2,114         | 0,199 | 1,64  | 2,44036 |
| 50                      | 2,114         | 0,199 | 2,05  | 2,52195 |
| 100                     | 2,114         | 0,199 | 2,33  | 2,57767 |

Source: Calculation Analysis Results

3.2.3. Log Person III Distribution

Following is the calculation of the probability of rainfall with the Log Pearson III distribution.

Table 3.7 Calculation Log Pearson III Distribution

| No | Tahun | X   | Log X | $\log \bar{X}$ | $\log Y_T$ | $\log Y_T^2$ | $\sum(\log X - \log Y_T)$ |
|----|-------|-----|-------|----------------|------------|-------------|---------------------------|
| 1  | 2009  | 148,50 | 2,17 | 2,16 | 0,02 | 0,000306 | 0,00000527 | 0,00000092 |
| 2  | 2010  | 88,30  | 1,95 | 2,16 | -0,21 | 0,043946 | -0,0095938 | 0,001027353 |
| 3  | 2011  | 78,50  | 1,89 | 2,16 | -0,26 | 0,067922 | 0,0170017 | 0,00613378 |
| 4  | 2012  | 75,10  | 1,88 | 2,16 | -0,28 | 0,070349 | -0,0211622 | 0,006133217 |
| 5  | 2013  | 117,80 | 2,07 | 2,16 | -0,08 | 0,007137 | -0,0059599 | 0,00059604 |
| 6  | 2014  | 244,40 | 2,45 | 2,16 | 0,30 | 0,088700 | 0,02641845 | 0,007662271 |
| 7  | 2015  | 247,00 | 2,39 | 2,16 | 0,24 | 0,095268 | 0,01334732 | 0,003166105 |
| 8  | 2016  | 112,70 | 2,05 | 2,16 | -0,10 | 0,010725 | -0,0011077 | 0,000115036 |
| 9  | 2017  | 148,60 | 2,17 | 2,16 | 0,02 | 0,000273 | 0.00000452 | 0.000000075 |
| 10 | 2018  | 129,60 | 2,11 | 2,16 | -0,04 | 0,001838 | -0,0007386 | 0,000003382 |
| Σ  | 1403,50 | 21,14 | 0,41 | 0,36 | -0,01 | 0,02937463 | 0,00000000 |

Source: Calculation Analysis Results

The steps in using the Log Person III distribution are as follows:

Calculate the average price (log X)

$$\log \bar{X} = \frac{\sum \log X}{n}$$

Calculate Standard Deviation Price (S)

$$S = \sqrt{\frac{\sum_{i=1}^{n} (\log X_i - \log \bar{X})^2}{n-1}}$$

Calculate the coefficient of skewness

$$G = \frac{\sum_{i=1}^{n} (\log X_i - \log \bar{X})^3}{10 \times (n-1)(n-2)s^3}$$

Calculate the rain or flood logarithm with a return period $T$

The $K$ value (Interpolation) is a standardized variable for $X$, the magnitude of which depends on the coefficient of $G$, can be seen in the table $K$ Value for the Distribution of Person Log III.
Table 3.8 K value (interpolation)

| Periode Ulang | G       |
|---------------|---------|
|               | -0,1    |
|               | 0,0000176 |
|               | 0,0     |
| 2             | 0,0165  |
| 5             | 0,846   |
| 10            | 1,27    |
| 25            | 1,7155  |
| 50            | 1,998   |

Source: Calculation Analysis Results

Log $X_T = \log \bar{X} + K.s$

Log $X_T = 2,114 + 0,00825 \times 0,199$

Log $X_T = 2,116$

$X_T = 130,617 \text{ mm/day}$

Table 3.9 XT Calculation

| Periode Ulang | Kemencengan | K       | Log $X_T$ | $X_T$ |
|---------------|-------------|---------|-----------|-------|
| 2             | 0,00825     | 2,116   | 130,617   |
| 5             | 0,844       | 2,281956| 191,406   |
| 10            | 1,276       | 2,367924| 233,305   |
| 25            | 1,73325     | 2,45891675 | 287,685 |
| 50            | 2,0245      | 2,5168755 | 328,757 |

Source: Calculation Analysis Results

3.2.4. Gumbel Distribution

Calculate the average value of variat (log X)

$\bar{X} = \frac{\sum X_i}{n}$

$\bar{X} = \frac{1430,5}{10} = 143,05 \text{ mm/hari}$

Table 3.10. Gumbel Distribution Calculation

| No. | Tahun | Cukup Hujan | $X_i$  | $(X_i - \bar{X})$ | $(X_i - \bar{X})^2$ | $(X_i - \bar{X})^3$ | $(X_i - \bar{X})^4$ |
|-----|-------|-------------|-------|-------------------|---------------------|---------------------|---------------------|
| 1   | 2009  | 140,5       | 140,05| 5,05              | 34,25               | 100,20              | 3171,28             |
| 2   | 2010  | 88,30       | 140,05| -54,75            | 2997,56             | -104115,95          | -1805388,04         |
| 3   | 2011  | 78,50       | 140,05| -61,55            | 3783,06             | -2261234,01         | -67031304,03        |
| 4   | 2012  | 140,5      | 140,05| 0,45              | 0,20                | 0,00                | 0,00                |
| 5   | 2013  | 117,80      | 140,05| -22,25            | 502,56              | -95099,04           | -13260446,56        |
| 6   | 2014  | 82,60       | 140,05| -57,45            | 3260,56             | -192149,01          | -58847834,04        |
| 7   | 2015  | 247,60      | 140,05| 103,95            | 10805,06            | 1122242,38          | 1216761046,39       |
| 8   | 2016  | 112,70      | 140,05| -27,30            | 747,69              | -141899,01          | -226601524,06       |
| 9   | 2017  | 148,60      | 140,05| 8,60              | 73,96               | 80,96               | 1535,36             |
| 10  | 2018  | 129,60      | 140,05| -10,45            | 110,02              | -630,99             | -13646449,99        |

$\sum = 1430,50$  \quad 0,00  \quad 46708,50  \quad 1139088,68  \quad 5604410088,23

Source: Calculation Analysis Results
Yn, Sn, and Ytr values are obtained from the Reduce Mean (Yn), Reduced Standard Deviation (Sn), and Reduced Variate (YTr) tables. Calculation of the probability value of rainfall for a 10 year return period with the Gumbel distribution is as follows:

\[ X_{10} = \bar{X} + \frac{Y_{10} - Y_n}{S_n} \times 70,126 \]

\[ X_{10} = 143,05 + \frac{22510 - 0,4952}{0,9496} \times 70,126 \]

\[ = 272,712 \text{ mm/day} \]

### 3.2.5. Selection of Distribution Type

Statistical parameters in the selection of this type of distribution needed are Standard Deviation (S), Skewness Coefficient (Cs), Kurtosis Measurement (Ck) and Variation Coefficient (Cv). Here are the results of the calculation:

| Distribution Type | Cs = 0 | Cs \geq 1 | Cs \geq 1,14 |
|-------------------|--------|-----------|--------------|
| Normal            |        | Cs = -0.206 | Cs = -0.575 |
|                   |        | Cs = 0.341  | Cs = 0.335   |
| Log Normal        |        | Cs = 0.272  | Cs = 0.355   |
|                   |        |              |              |
| Gumbel            | Cs = 1,14 | Cs = -0.206 | Cs = 0.341   |
|                   | Cs = 5,40 |              |              |
| Log Person III    | Cs = 0  | Atau selain nilai distes | Cs = 0.575 |
|                   |        |              | Cs = 0.335   |

Source: Calculation Analysis Results

From the calculation results presented in table 4.11, it can be concluded that the type of distribution that can be taken is the Log Person III distribution.

### 3.3. Data Match Test

#### 3.3.1. Chi Square Test

Before carrying out the calculation of the data suitability test, first carry out data processing, which is to sort data from the largest to the smallest as presented in table 4.12.

| Tahun | Curah Hujan Maksimum |
|-------|----------------------|
| 2009  | 148,9                |
| 2010  | 88,3                 |
| 2011  | 78,5                 |
| 2012  | 75,1                 |
| 2013  | 117,8                |
| 2014  | 284                  |
| 2015  | 247                  |
| 2016  | 112,7                |
| 2017  | 148,6                |
| 2018  | 129,6                |

Source: Calculation Analysis Results

The next stage is to calculate the distribution class (G), which is as follows:

\[ G = 1 + 3,33 \log (n) \]

\[ G = 1 + 3,33 \log (10) \]
The distribution class used 10 pieces of data is 5. As an interval class that is used every 20%. Data intervals are taken from the reset period as follows:

The results of the calculation of the distribution class above are then included as class interval classes in each probability distribution.

From the calculation of the distribution of Log Person III are as follows:

\[ S = 0.199 \]
\[ G = -0.0000176 \]

From table 2.2 the interpolation is done so that the K value for each interval is as follows:

| Interval | K5 | K2.5 | K1.67 | K1.25 |
|----------|----|------|-------|-------|
| X5       | 0.842001 | 0.140336 | -0.37048 | -0.842 |

Following is the calculation of the class interval for the distribution of Log Person III

Log X5 = + K5. S.
\[ = 2.114 + (0.842001 \times 0.199) \]
\[ = 2.282 \]
X5 = 191,426

Log X2.5 = + K5. S.
\[ = 2.114 + (0.140336 \times 0.199) \]
\[ = 2.142 \]
X2.5 = 138.68

Log X1.67 = + K5. S.
\[ = 2.114 + (-0.37048 \times 0.199) \]
\[ = 2.041 \]
X1.67 = 109,901

Log X1.25 = + K5. S.
\[ = 2.114 + (-0.842 \times 0.199) \]
\[ = 1.947 \]
X1.25 = 88,512

### Table 3.13. Chi Square Test

| No | Sub Kelas | Jumlah Data | Oi | Ei | \( \chi^2 \) |
|----|-----------|-------------|----|----|-------------|
| 1  | P < 88,512| 10          | 2  | 1  | 0.5         |
| 2  | 88,512 < P < 109,901 | 10 | 2  | -2 | 2           |
| 3  | 109,901 < P < 138,68 | 10 | 2  | 1  | 0.5         |
| 4  | 138,68 < P < 191,426 | 10 | 2  | 0  | 0           |
| 5  | P > 191,426  | 10          | 2  | 0  | 0           |

Source: Calculation Analysis Results

\[ Ei = \frac{n}{k} = \frac{10}{5} = 2 \]
\[ (DK) = 5 - (2 + 1) = 2 \]

From Table 4.13 it is known, based on Table 2.7 the critical value for the Chi-squared distribution at the degree of confidence (\( \alpha \)) = 0.05 or 5% obtained value Because the Pearson III log distribution equation can be accepted.

### 3.3.2. Smirnov Kolmogorov Test

The results of calculations can be seen in table 4.14, an example of calculation using data in 2008, which is as follows:
a. Sorting rain data from large to small can be seen in table 4.12, and look for opportunities with the opportunity formula as follows:

\[
P(\text{Log}X) = \frac{m}{n+1}
\]
\[
P(\text{Log}X) = \frac{1}{10+1} = 0.091
\]

b. Look for the value of \( P(X <) \):

\[
P(\text{Log}X <) = 1 - P(\text{Log}X)
\]
\[
= 1 - 0.091 = 0.909
\]

c. Look for the value \( f(t) \):

\[
f(t) = \frac{\log X - \log \bar{X}}{S} = \frac{2.113 - 2.114}{0.199} = -0.007
\]

d. the value of \( P'(\text{Log}X) \) is searched using the area table under the normal curve of \( f(t) \) with the value:

\[
P(\text{Log}X) = \frac{m}{n-1}
\]
\[
P(\text{Log}X) = \frac{1}{10-1} = 0.111
\]

Up to value \( '\text{Log}X' \):

\[
P'(\text{Log}X <) = 1 - P'(\text{Log}X)
\]
\[
= 1 - 0.111 = 0.889
\]

Find the \( D \) value using the formula:

\[
D = P(\text{Log}X <) - P'(\text{Log}X <) = 0.909 - 0.889 = 0.020
\]

| Table 3.14. Calculation Results of the Smirnov Kolmogorov Test Distribution Person Log III |
|---|---|---|---|---|---|---|---|
| M | X | Log X | P(\text{Log}X) | P(\text{Log}X}< | P'(\text{Log}X}< | P(\text{Log}X) | P(\text{Log}X}< | D |
| 1 | 146.90 | 2.172 | 0.991 | 0.206 | 0.111 | 0.089 | 0.005 |
| 2 | 88.30 | 1.960 | 0.382 | 0.118 | 0.044 | 0.222 | 0.778 | 0.040 |
| 3 | 76.10 | 1.895 | 0.273 | 0.077 | 0.010 | 0.323 | 0.677 | 0.060 |
| 4 | 75.10 | 1.836 | 0.364 | 0.614 | 1.010 | 0.644 | 0.356 | 0.080 |
| 5 | 117.30 | 2.015 | 0.455 | 0.545 | -0.233 | 0.550 | 0.466 | 0.101 |
| 6 | 284.00 | 2.452 | 0.565 | 0.452 | 1.700 | 0.067 | 0.130 | -0.120 |
| 7 | 247.00 | 2.199 | 0.366 | 0.464 | 1.400 | 0.778 | 0.022 | 0.100 |
| 8 | 112.70 | 2.052 | 0.273 | 0.013 | -0.832 | 0.999 | 0.111 | 0.162 |
| 9 | 140.60 | 2.172 | 0.318 | 0.182 | 0.192 | 1.000 | 0.000 | 0.182 |
| 10 | 129.60 | 2.152 | 0.989 | 0.093 | 0.007 | 1.111 | 0.011 | 0.000 |

Source: Calculation Analysis Results

From Table 4.14. above it can be concluded that \( D_{\text{max}} = 0.202 \) on the 9th sequence data. By using Table 2.8, Critical value of \( D_0 \) for Smirnov-Kolmogorov test with a degree of confidence of 5% and \( n = 10 \), then obtained \( D_0 = 0.41 \). Because the value of \( D_{\text{max}} < D_0 \) then Pearson log distribution distribution III can be accepted.

### 3.4 Calculation of Flood Discharge Plan

The design of flood discharge calculation is carried out to get the flood discharge entering the drainage.

#### 3.4.1 Flow Coefficient

Flow coefficient (C) is a constant price, a ratio between the rain that flows on the surface and the rain water that falls. In the Angke Jaya Tambora Housing Area of West Jakarta, the study was included in the character of multiunit housing (combined), so that the value obtained in accordance with table 2.9 was 0.60 to 0.75 and the highest value was taken, 0.75.
3.4.2 Calculation of Time of Concentration of Channels

The results of the calculation of the complete concentration time are presented in table 4.16.

| No. Subarea | L (m) | S (m) | n | A (m²) | P (m) | R (m) | V (m/s) | tc (min) | tc (sec) |
|-------------|-------|-------|---|--------|-------|-------|--------|---------|---------|
| A1          | 102.50| 0.02  | 0.01| 22.48  | 0.60  | 0.60  | 0.23   | 3.75    | 0.46    | 22.92   |
| A2          | 69.33 | 0.01  | 0.01| 17.67  | 0.25  | 0.25  | 0.18   | 2.68    | 0.43    | 18.10   |
| A3          | 125.70| 0.01  | 0.01| 43.14  | 0.48  | 0.48  | 0.24   | 2.46    | 0.85    | 43.99   |
| A4          | 240.05| 0.00  | 0.01| 113.86 | 0.40  | 0.40  | 0.22   | 1.69    | 2.37    | 116.22  |
| B1          | 125.70| 0.01  | 0.01| 43.14  | 0.48  | 0.48  | 0.24   | 2.46    | 0.85    | 43.99   |
| B2          | 69.33 | 0.01  | 0.01| 17.67  | 0.25  | 0.25  | 0.18   | 2.68    | 0.43    | 18.10   |
| B3          | 128.50| 0.01  | 0.01| 44.59  | 0.48  | 0.48  | 0.24   | 2.43    | 0.88    | 45.47   |
| B4          | 52.60 | 0.02  | 0.01| 11.68  | 0.40  | 0.40  | 0.22   | 3.61    | 0.24    | 11.92   |
| C1          | 128.50| 0.01  | 0.01| 44.59  | 0.48  | 0.48  | 0.24   | 2.43    | 0.88    | 45.47   |
| C2          | 69.33 | 0.01  | 0.01| 17.67  | 0.30  | 0.30  | 0.28   | 2.70    | 0.43    | 18.10   |
| C3          | 125.00| 0.01  | 0.01| 42.78  | 0.48  | 0.48  | 0.24   | 2.47    | 0.84    | 43.63   |
| C4          | 52.60 | 0.02  | 0.01| 11.68  | 0.40  | 0.40  | 0.22   | 3.61    | 0.24    | 11.92   |
| D1          | 308.13| 0.00  | 0.01| 165.97 | 0.56  | 0.56  | 0.30   | 1.59    | 3.21    | 167.17  |
| D2          | 308.13| 0.00  | 0.01| 165.97 | 0.36  | 0.36  | 0.20   | 1.40    | 3.65    | 167.62  |
| D3          | 31.20 | 0.03  | 0.01| 5.34   | 0.20  | 0.20  | 0.14   | 1.34    | 0.15    | 5.48    |
| D4          | 52.60 | 0.02  | 0.01| 11.68  | 0.48  | 0.48  | 0.24   | 3.80    | 0.23    | 11.91   |
| D5          | 31.00 | 0.03  | 0.01| 5.28   | 0.16  | 0.16  | 0.10   | 1.20    | 0.13    | 5.34    |
| D6          | 31.00 | 0.03  | 0.01| 5.28   | 0.16  | 0.16  | 0.10   | 1.20    | 0.13    | 5.34    |
| D7          | 52.60 | 0.02  | 0.01| 11.68  | 0.48  | 0.48  | 0.24   | 3.80    | 0.23    | 11.91   |
| D8          | 25.00 | 0.04  | 0.01| 3.83   | 0.12  | 0.12  | 0.11   | 3.26    | 0.13    | 3.95    |
| D9          | 25.00 | 0.04  | 0.01| 3.83   | 0.12  | 0.12  | 0.11   | 3.26    | 0.13    | 3.95    |
| D10         | 52.60 | 0.02  | 0.01| 11.68  | 0.48  | 0.48  | 0.24   | 3.80    | 0.23    | 11.91   |
| D11         | 51.25 | 0.02  | 0.01| 11.25  | 0.56  | 0.56  | 0.25   | 4.01    | 0.21    | 11.44   |
| D12         | 51.25 | 0.02  | 0.01| 11.25  | 0.56  | 0.56  | 0.25   | 4.01    | 0.21    | 11.44   |
| D13         | 208.00| 0.00  | 0.01| 91.85  | 0.36  | 0.36  | 0.20   | 1.69    | 2.05    | 93.88   |
| D14         | 101.50| 0.03  | 0.01| 31.30  | 0.56  | 0.56  | 0.23   | 2.78    | 0.61    | 33.12   |
| D15         | 101.50| 0.01  | 0.01| 31.30  | 0.56  | 0.56  | 0.23   | 2.78    | 0.61    | 33.12   |

Source: Calculation Analysis Results

3.4.3 Calculation of Intensity of Rainfall Area

The return period that will be used in the calculation of rainfall intensity is a return period of 2 years. Rainfall intensity is calculated using the mononobe formula with the concentration time value (tc).

Calculation of rainfall intensity on channel A1 is as follows:

\[ I = \frac{24}{(24\sqrt{\frac{tc}{2}})} \]

\[ I = \left(\frac{130.617}{24}\right) \cdot \left(\frac{24}{22.92/60}\right)^{\frac{2}{3}} = 86.011 \text{ mm/hour} \]

The results of a complete rainfall intensity calculation are presented in table 4.16.
### Table 3.16. Rainfall Intensity (I)

| No | Xc  | t_1 | t_2 | I  |
|----|-----|-----|-----|----|
|    | mm/hr | min | min | mm/jam |
| A1 | 120.617 | 22.920 | 0.382 | 86.011 |
| A2 | 130.617 | 18.100 | 0.302 | 106.673 |
| A3 | 130.617 | 43.990 | 0.733 | 55.692 |
| A4 | 130.617 | 116.220 | 1.937 | 29.141 |
| B1 | 120.617 | 42.990 | 0.733 | 55.692 |
| B2 | 120.617 | 18.100 | 0.302 | 106.673 |
| B3 | 120.617 | 45.670 | 0.758 | 54.477 |
| B4 | 120.617 | 11.920 | 0.199 | 132.998 |
| C1 | 120.617 | 45.670 | 0.758 | 54.477 |
| C2 | 130.617 | 18.100 | 0.302 | 106.673 |
| C3 | 130.617 | 43.630 | 0.727 | 55.998 |
| C4 | 130.617 | 11.920 | 0.199 | 132.998 |
| D1 | 130.617 | 167.170 | 2.788 | 22.870 |
| D2 | 130.617 | 167.620 | 2.794 | 22.870 |
| D3 | 130.617 | 5.480 | 0.091 | 223.277 |
| D4 | 130.617 | 11.910 | 0.199 | 133.073 |
| D5 | 130.617 | 5.440 | 0.091 | 224.370 |
| D6 | 130.617 | 5.440 | 0.091 | 224.370 |
| D7 | 130.617 | 11.910 | 0.199 | 133.073 |
| D8 | 130.617 | 3.950 | 0.050 | 277.250 |
| D9 | 130.617 | 3.950 | 0.050 | 277.250 |
| D10 | 130.617 | 11.910 | 0.199 | 133.073 |
| D11 | 130.617 | 11.440 | 0.101 | 136.693 |
| D12 | 130.617 | 11.440 | 0.101 | 136.693 |
| D13 | 130.617 | 0.380 | 1.565 | 33.568 |
| D14 | 120.617 | 31.920 | 0.332 | 68.969 |
| D15 | 120.617 | 31.920 | 0.332 | 68.969 |

Source: Calculation Analysis Results

#### 3.4.4 Distribution of Catchment Areas

Catchment area calculations are done using the help of Autocad software. The catchment area can be seen in Figure 4.1, and the area of drainage catchment area can be seen in table 4.15.

![Figure 3.1. Catchment Area](Source: Personal Image)
### Table 3.17. Capture Area of Drainage

| No. Saluran | Jalan | Pemukiman | Jumlah |
|-------------|-------|-----------|--------|
|             | m²    | km²      | m²    | km² |
| A1          | 245.2273 | 0.00023 | 245.2273 | 0.00023 |
| A2          | 236.9808 | 0.00023 | 556   | 0.00070 |
| A3          | 277.48   | 0.00058 | 2866  | 0.00143 |
| A4          | 120.025  | 0.00012 | 705   | 0.00074 |
| B1          | 237.49   | 0.00028 | 1600  | 0.00224 |
| B2          | 226.9983 | 0.00023 | 626   | 0.00087 |
| B3          | 367.6965 | 0.00087 | 2091  | 0.00247 |
| B4          | 120.025  | 0.00013 | 576   | 0.00069 |
| C1          | 367.6965 | 0.00037 | 1862  | 0.00234 |
| C2          | 226.9983 | 0.00023 | 500   | 0.00068 |
| C3          | 386.125  | 0.00031 | 1825  | 0.00231 |
| C4          | 120.025  | 0.00012 | 319   | 0.00043 |
| D1          | 153.6625 | 0.00015 | 98    | 0.00111 |
| D2          | 153.6625 | 0.00015 | 852   | 0.00109 |
| D3          | 66.2225  | 0.00010 | 339   | 0.00043 |
| D4          | 120.025  | 0.00012 | 527   | 0.00067 |
| D5          | 116.25   | 0.00012 | 379   | 0.00035 |
| D6          | 116.25   | 0.00012 | 374   | 0.00040 |
| D7          | 120.025  | 0.00012 | 411   | 0.00046 |
| D8          | 62.715   | 0.00006 | 154   | 0.00017 |
| D9          | 62.715   | 0.00006 | 277   | 0.00034 |
| D10         | 120.025  | 0.00012 | 403   | 0.00053 |
| D11         | 357.975  | 0.00036 | 353   | 0.00041 |
| D12         | 66.22    | 0.00007 | 613   | 0.00071 |
| D13         | 679.725  | 0.00068 | 3006  | 0.00374 |
| D14         | 274.1875 | 0.00027 | 919   | 0.00197 |
| D15         | 274.1875 | 0.00027 | 891   | 0.00198 |

Source: Calculation Analysis Results

### 3.4.5 Calculation of Rain Water Flow Discharge

### Table 3.18. Rainwater Flow Discharge

| No. Saluran | C | I | A | Qp | Qp total |
|-------------|---|---|---|----|---------|
|             | mm/h | m³/s | m² | m³/det | m³/det |
| A1          | 0.75 | 89.011 | 0.00251 | 0.04383 | 0.04383 |
| A2          | 0.75 | 100.673 | 0.00676 | 0.01602 | 0.01602 |
| A3          | 0.75 | 55.692 | 0.00314 | 0.00650 | 0.00650 |
| A4          | 0.75 | 29.141 | 0.00683 | 0.00150 | 0.00150 |
| B1          | 0.75 | 55.692 | 0.00225 | 0.01608 | 0.01608 |
| B2          | 0.75 | 100.673 | 0.00086 | 0.01799 | 0.01799 |
| B3          | 0.75 | 54.477 | 0.00246 | 0.01292 | 0.01292 |
| B4          | 0.75 | 102.998 | 0.0007 | 0.01930 | 0.01930 |
| C1          | 0.75 | 54.477 | 0.00233 | 0.02654 | 0.02654 |
| C2          | 0.75 | 100.673 | 0.00082 | 0.01728 | 0.01728 |
| C3          | 0.75 | 55.998 | 0.00213 | 0.02488 | 0.02488 |
| C4          | 0.75 | 102.998 | 0.00064 | 0.01722 | 0.01722 |
| C5          | 0.75 | 22.877 | 0.00114 | 0.00544 | 0.00544 |
| D1          | 0.75 | 22.877 | 0.00110 | 0.00478 | 0.00478 |
| D2          | 0.75 | 22.877 | 0.00114 | 0.00544 | 0.00544 |
| D3          | 0.75 | 133.073 | 0.00666 | 0.01823 | 0.01823 |
| D4          | 0.75 | 224.371 | 0.00505 | 0.01216 | 0.01216 |
| D5          | 0.75 | 224.371 | 0.00505 | 0.01216 | 0.01216 |
| D6          | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D7          | 0.75 | 224.371 | 0.00505 | 0.01216 | 0.01216 |
| D8          | 0.75 | 224.371 | 0.00505 | 0.01216 | 0.01216 |
| D9          | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D10         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D11         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D12         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D13         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D14         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |
| D15         | 0.75 | 133.073 | 0.00505 | 0.01216 | 0.01216 |

Source: Calculation Analysis Results

Calculation of rainwater flow rate using the rational method formula, the following is the calculation of rainwater flow rate for channel D2, which is as follows:

\[
Q_p = 0.278 \text{ C.I.A}
\]
Qp = 0.278. (0.75). (22.829). (0.00101)  
Qp = 0.01022 m³/sec  
For channel D2, an additional water discharge from D1 flow is added,  
Qp D1 + Q_p D2 = 0.00544 + 0.00478  
Qtotal D2 = 0.01022 m³/sec  
The full calculation will be presented in table 4.18.

3.4.6 Calculation of Dirty Water Discharge

The calculated dirty water discharge is the water debit that comes from household waste, and other buildings. The amount is affected by the large number of residents and the average water needs of the population. Estimates for the average disposal of liquid waste per person per day are presented in table 2.10, and it is concluded that the amount of waste water per person per day is 400 liters. Following are the calculations for channel D2.

Q_ak = Pn x 400 liters / person / day  
Q_ak = Pn x 0.00463 liter / person / sec  
Q_ak = 45 x 0.00463 liter / person / sec  
Q_ak = 0.2083 m³/sec  
The complete calculation for dirty water discharge has been presented in table 3.19.

Tabel 3.19. Debit Air Kotor

| No. Saluran | Jumlah Rumah | Jumlah Orang | Air Bebasan | Air Bebasan Source: Calculation Analysis Results |
|-------------|--------------|--------------|-------------|-------------------------------------------------|
|             |              |              | m³/dt       | Qk m³/dt                                        |
| A1          | 17           | 68           | 0.00463     | 0.2484 0.356                                   |
| A2          | 2            | 9            | 0.00463     | 0.0417 0.455                                   |
| A3          | 17           | 66           | 0.00463     | 0.3056 0.384                                   |
| A4          | 2            | 10           | 0.00463     | 0.0463 1.398                                   |
| B1          | 18           | 70           | 0.00463     | 0.3241 0.403                                   |
| B2          | 2            | 9            | 0.00463     | 0.0417 0.679                                   |
| B3          | 18           | 61           | 0.00463     | 0.2824 0.319                                   |
| B4          | 2            | 10           | 0.00463     | 0.0463 0.644                                   |
| C1          | 18           | 50           | 0.00463     | 0.2735 0.310                                   |
| C2          | 2            | 8            | 0.00463     | 0.0379 0.677                                   |
| C3          | 17           | 58           | 0.00463     | 0.2685 0.560                                   |
| C4          | 2            | 9            | 0.00463     | 0.0417 0.310                                   |
| D1          | 10           | 48           | 0.00463     | 0.2222 0.222                                   |
| D2          | 9            | 45           | 0.00463     | 0.2083 0.451                                   |
| D3          | 2            | 8            | 0.00463     | 0.0379 0.408                                   |
| D4          | 2            | 7            | 0.00463     | 0.0324 0.500                                   |
| D5          | 3            | 9            | 0.00463     | 0.0417 0.542                                   |
| D6          | 3            | 8            | 0.00463     | 0.0379 0.379                                   |
| D7          | 3            | 7            | 0.00463     | 0.0324 0.461                                   |
| D8          | 3            | 9            | 0.00463     | 0.0417 0.653                                   |
| D9          | 3            | 9            | 0.00463     | 0.0417 0.694                                   |
| D10         | 5            | 20           | 0.00463     | 0.0226 0.787                                   |
| D11         | 4            | 18           | 0.00463     | 0.0333 0.870                                   |
| D12         | 12           | 48           | 0.00463     | 0.2222 0.481                                   |
| D13         | 18           | 56           | 0.00463     | 0.5595 0.559                                   |
| D14         | 13           | 52           | 0.00463     | 0.2407 0.722                                   |
| D15         | 11           | 44           | 0.00463     | 0.2037 1.674                                   |

3.4.7. Calculation of Flood Discharge Plan
In the calculation of flood discharges in the Angke Jaya Tambora Housing Area of West Jakarta, namely rainwater flow discharges added with dirty water discharge.  
The following is a calculation on channel A1.

Qf = Q_p total + Q_k total  
Qf = 0.00053 + 0.042  
Qf = 0.043 m³/dt  
The complete calculations for flood discharge are presented in table 3.20.
### 3.5 Calculation of Drainage Channel Dimensions

After knowing the planned flood discharge in the West Jakarta Angora Jaya Tambora Housing Area, the dimensions of the existing drainage channel will be calculated to determine whether or not the channel is sufficient to accommodate the planned flood discharge. Furthermore, if there are unsafe channels, a new drainage channel calculation will be performed to determine the dimensions of the safe channel.

#### 3.5.1 Calculation of Existing Drainage Channel Dimensions

Berikut merupakan perhitungan untuk saluran A1:

- b = 0.6
- h = 1
- $S = 0.02$
- $A = bh$
- $A = 0.6 \times 1 = 0.6 \text{ m}^2$
- $P = b + 2h$
- $P = 0.6 + (2 \times 1) = 2.60$
- $R = \frac{A}{P}$
- $R = \frac{0.60}{2.60} = 0.23 \text{ m}$
- $V = \frac{1}{n} \frac{2^{\frac{1}{2}} \sigma}{R^{\frac{1}{2}} S^{\frac{1}{2}}}$
- $V = \frac{1}{0.01} \frac{2^{\frac{1}{2}} \cdot 0.02^{\frac{1}{2}}}{0.23^{\frac{1}{2}} \cdot 0.02^{\frac{1}{2}}}$
- $V = 3.75 \text{ m/sec}$

### Table 3.20. Flood Discharge Plan

| No | Saluran | $Q_{p \text{ total}}$ | $Q_{c \text{ total}}$ | $Q_r$ |
|----|---------|---------------------|---------------------|-----|
| A1 | 0.06318 | 0.356 | 0.418 |
| A2 | 0.06355 | 0.475 | 0.532 |
| A3 | 0.07376 | 0.384 | 0.456 |
| A4 | 0.19424 | 1.388 | 1.522 |
| B1 | 0.06134 | 0.403 | 0.464 |
| B2 | 0.03526 | 0.079 | 0.114 |
| B3 | 0.04519 | 0.319 | 0.365 |
| B4 | 0.09339 | 0.644 | 0.735 |
| C1 | 0.04373 | 0.310 | 0.354 |
| C2 | 0.01728 | 0.037 | 0.054 |
| C3 | 0.02488 | 0.269 | 0.293 |
| C4 | 0.04260 | 0.310 | 0.353 |
| D1 | 0.00544 | 0.222 | 0.228 |
| D2 | 0.01022 | 0.431 | 0.441 |
| D3 | 0.03047 | 0.458 | 0.498 |
| D4 | 0.04870 | 0.500 | 0.549 |
| D5 | 0.07166 | 0.542 | 0.514 |
| D6 | 0.09317 | 0.579 | 0.571 |
| D7 | 0.10754 | 0.611 | 0.719 |
| D8 | 0.12010 | 0.653 | 0.773 |
| D9 | 0.13979 | 0.694 | 0.834 |
| D10 | 0.15436 | 0.787 | 0.941 |
| D11 | 0.17402 | 0.870 | 1.045 |
| D12 | 0.10574 | 0.481 | 0.527 |
| D13 | 0.02624 | 0.259 | 0.286 |
| D14 | 0.06289 | 0.722 | 0.785 |
| D15 | 0.01937 | 1.074 | 1.265 |

Source: Calculation Analysis Results
If $Q_{\text{sal}} > Q_{\text{rencana}}$, the drainage channel is able to accommodate the flow of flood discharge, and declared safe. If the Channel $<$ $Q_{\text{rage}}$ drainage plan is able to accommodate the flow of flood discharge, and declared unsafe. The full calculation is presented in table 3.21.

**Figure 3.2. Drainage Channel Cut**

![Drainage Channel Cut](Source: Personal Image)

**Table 3.21. Calculation of Existing Drainage Channel Dimensions**

| No | Saluran | W | L | $Q_{\text{rencana}}$ | $Q_{\text{sal}}$ | Kategori | Aman/Tidak Aman |
|----|---------|---|---|----------------------|-----------------|----------|----------------|
| A  | 8.80    | 5.00 | 4.00 | 3.75 | 2.25 | 0.50 | Aman |
| A1 | 6.78    | 3.12 | 2.00 | 1.98 | 0.96 | 0.33 | Aman |
| A2 | 8.06    | 5.00 | 4.00 | 3.48 | 0.86 | 0.13 | Tidak Aman |
| A3 | 8.00    | 5.00 | 4.00 | 4.89 | 0.86 | 0.13 | Tidak Aman |
| A4 | 8.00    | 5.00 | 4.00 | 6.08 | 0.86 | 0.13 | Tidak Aman |
| B1 | 8.00    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| B2 | 8.00    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| B3 | 8.00    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| B4 | 8.00    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| C1 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| C2 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| C3 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| C4 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D1 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D2 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D3 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D4 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D5 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D6 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D7 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D8 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D9 | 8.80    | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D10| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D11| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D12| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D13| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D14| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |
| D15| 8.80   | 5.00 | 4.00 | 2.40 | 0.96 | 0.40 | Aman |

Source: Calculation Analysis Results

Berdasarkan perhitungan dimensi saluran drainase eksisting pada tabel 3.21, ditemukan saluran yang masuk dalam kategori “tidak aman”, karena kapasitas saluran tidak cukup untuk menampung debit banjir rencana, yaitu pada saluran A4, D5, D6, D8, dan D9. Dalam mengatasi hal ini akan direncanakan sumur resapan.

### 3.6 Infiltration Wells Plan

The infiltration well planning is used in draining excess water discharge in several “unsafe” channels, by draining rainwater that falls from the roofs of residents’ homes to seep into the ground by storing the water in the infiltration well. Channels that fall into the “unsafe” category will be presented in table 3.22, as follows:
Table 3.22 Channels By Unsafe Categories (Q drainage channels <Q plan)

| No Saluran | Qsel (m³/det) | Qrencana (m³/det) | Kelebhan Debit | Kategori |
|------------|---------------|------------------|---------------|---------|
| A4         | 0.68          | 1.59             | 0.92          | Tidak Aman |
| D5         | 0.54          | 0.61             | 0.08          | Tidak Aman |
| D6         | 0.54          | 0.67             | 0.13          | Tidak Aman |
| D8         | 0.39          | 0.77             | 0.38          | Tidak Aman |
| D9         | 0.39          | 0.83             | 0.44          | Tidak Aman |

Source: Calculation Analysis Results

Based on table 3.22, there are channels that fall into the "unsafe" category, so that an infiltration well will be planned.

### 3.6.1 Infiltration Wells Construction

1. Channels of income / expenditure using pralon pipes.
2. The well wall can use masonry without plastering
3. The bottom of the well and the gaps between the soil excavation and the wall where the water is absorbed are filled with fibers / gravel.

### 3.6.2 Discharge of Rainfall Plans on the Roof Surface

To find out the flow of rain that enters the infiltration well, it is necessary to know in advance the flow of rain falling through the roof of the residents' houses. Example calculation using No. A4 channels as follows:

\[ Q_{masuk} = 0.278 \times C.I.A \]

Is known:
- Catap = 0.75 (based on Table 2.9. Runoff Coefficient Standard)
- IA4 = 29.14 mm / hour
- Aatap = 80 m² = 0.0080 km²

So, Q masuk is:

\[ Q_{masuk} = 0.278 \times 0.75 \times 29.14 \times 0.0080 = 0.048607 \text{ m}^3 / \text{sec} \]

Calculation of rain discharges that fall to the roof surface will be presented in full in table 3.23, as follows:

Table 3.23 Rainwater Discharge Falls on the Roof

| No Saluran | C | I | Atrum | Aatap | Qmasuk |
|------------|---|---|-------|-------|--------|
| A4         | 0.75 | 29.14 | $0.00$ | $0.008$ | 0.048607 |
| D5         | 0.75 | 224.57 | $0.00$ | $0.008$ | 0.374249 |
| D6         | 0.75 | 224.57 | $0.00$ | $0.008$ | 0.374249 |
| D8         | 0.75 | 277.716 | $0.00$ | $0.008$ | 0.463264 |
| D9         | 0.75 | 277.716 | $0.00$ | $0.008$ | 0.463264 |

Source: Calculation Analysis Results

### 4.6.3 Discharge of Absorption Well Absorption

Furthermore, it is necessary to know the discharge of rainwater that enters the absorption well (Qresapan). The calculation refers to No. Channel A4, as follows:
Qresapan = F. K. H

**Infiltration Wells Design Plan:**

Is known:
- Qresapan = Discharge that can be absorbed by infiltration wells (m³/sec)
- Type of blank wells with circular appearance
- The planned well diameter is 2 m = R = 1 m
- F = geometric / circumference factor = 2 x 3.14 x 1 = 3.14 m
- K = For the soil permeability value, it is assumed that the value of K = 10^{-2} cm / s = 10^{-4} m / s for the shaft soil.

\[
Q_{\text{resapan}} = F \cdot K \cdot H
\]

\[
Q_{\text{resapan}} = 3.14 \cdot 10^{-4} \cdot 2
\]

\[
Q_{\text{resapan}} = 0.000628 \text{ m}^3 / \text{sec}
\]

For complete Qresapan calculation will be presented in table 4.24, as follows:

| JENIS TANAH       | k (cm/sec) | NAMA             |
|------------------|------------|------------------|
| Kerikil          | > 10^5     | High permeability|
| kerikil lunak panir | 10^3 – 10^4 | Medium permeability |
| panir sungai lunak lunak tdk padat | 10^5 – 10^7 | Low permeability |
| limu padat lunak leupung | 10^5 – 10^7 | Very low permeability |
| Leupung           | < 10^{-5}  | Impervious (resistant) |

\( H = \) Assumption of infiltration well depth = 2 m

**Infiltration Wells Calculation:**

\[
Q_{\text{resapan}} = F \cdot K \cdot H
\]

\[
Q_{\text{resapan}} = 3.14 \cdot 10^{-4} \cdot 2
\]

\[
Q_{\text{resapan}} = 0.000628 \text{ m}^3 / \text{sec}
\]

For complete Qresapan calculation will be presented in table 4.24, as follows:
### 3.6.4 Residual Water Discharge Flowing into Drainage Channels

Furthermore, it will be found the difference in the remaining discharge from the rain discharge that has been accommodated into the infiltration well, by way of Qmasuk (Table 4.23) reduced by Qresapan (Table 4.24). The following is an example of a calculation that refers to No. A4 channel:

**Is known :**
- \( Q_{in} = 0.048607 \text{ m}^3 / \text{sec} \) (Table 4.23)
- \( Q_{infiltration} = 0.000628 \) (table 4.24)

**Settlement :**

\[
Q_{tampung} = Q_{masuk} - Q_{resapan} \\
= 0.048607 - 0.000628 \\
= 0.047979 \text{ m}^3 / \text{sec}
\]

For the calculation of the complete infiltration wells collected discharge will be presented in table 4.25 as follows :

### Table 3.25 Discharge accommodated in infiltration wells

| No Saluran | Qmasuk atap (m³/dtk) (4) | Qresapan (m³/dtk) (5) | Qtampung (m³/dtk) (6) = (5) - (4) |
|------------|--------------------------|-----------------------|-------------------------------|
| A4         | 0.048607                 | 0.000628              | 0.047979                      |
| D5         | 0.374249                 | 0.000628              | 0.373621                      |
| D6         | 0.374249                 | 0.000628              | 0.373621                      |
| D8         | 0.463264                 | 0.000628              | 0.462636                      |
| D9         | 0.463264                 | 0.000628              | 0.462636                      |

Source : Calculation Analysis Results

### 4.6.5 Total Infiltration Wells Needs

After knowing the difference in the remaining discharge from the rain discharge that has been accommodated into the infiltration well, it can be seen the amount of infiltration well needs in the area of the house in each Channel Number. Example calculation refers to No. A4 channel:

**Is known :**
- Discharge Excess A4 = 0.92 m³ / sec (Table 4.22)
- \( Q_{tampung} = 0.047979 \text{ m}^3 / \text{sec} \)

**Settlement :**

\[
\text{Jumlah Sumur Resapan} = \frac{\text{Kelebihan Debit}}{Q_{tampung}}
\]

The calculation of the number of recharge well requirements in full is presented in table 4.26 as follows :
Table 3.26 Amount of Infiltration Wells Needs

| No Saluran | Qlebih (m³/dtk) (3) = (2) - (1) | Qtampung (m³/dtk) (6) = (5) - (4) | Jumlah Sumur Resapan (7) = (2) : (6) |
|------------|---------------------------------|---------------------------------|----------------------------------|
| A4         | 0.92                            | 0.047979                        | 19                               |
| D5         | 0.08                            | 0.373621                        | 1                                |
| D6         | 0.13                            | 0.373621                        | 1                                |
| D8         | 0.38                            | 0.462636                        | 1                                |
| D9         | 0.44                            | 0.462636                        | 1                                |

Source: Calculation Analysis Results

From Table 3.26, it is known that the number of infiltration wells needed in A4 Channel is 19 units, Channel D5, D6, D8, and D9 are 1 piece.

4. Conclusion

From the results of the analysis and discussion in the previous chapter and answer from the formulation of the problem, the following conclusions can be drawn:
1. The condition of the drainage canal in Angke Jaya Tambora Housing Area West Jakarta is poorly maintained, there are many houses that progress to cover the existing channels, making the channel difficult to clean, so there is a lot of garbage in the channel and accumulation of sedimentation. There are 5 channels that are concluded to be "unsafe", because the planned flood discharge is greater than the drainage capacity, namely on channels A4, D5, D6, D8, and D9.
2. The need for flood drainage capacity in the Angke Jaya Tambora Housing Area of West Jakarta is 13,225 m³ / second.

5.2 Suggestions

Suggestions that can be delivered at the writing of this thesis after getting the results and solutions provided, the advice that will be given are as follows:
1. Regular cleaning of drainage channels, on sedimentation and rubbish in the drainage channel.
2. Construction of infiltration wells on channels A4, D5, D6, D8, D9 can be carried out, so that in the rainy season stagnant water can be diverted to infiltration wells.

5. References

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