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# The Widyatama Campus Environmental Planning Study refers to the Law of the Republic of Indonesia Number 26 of 2007 About Spatial Planning for Flood Discharge.

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**ABSTRACT**

Sustainable development in an area often causes land use changes that have a domino impact, especially in water resource management and flood discharge control. In the spirit of development, important aspects such as runoff management are often overlooked. This study aims to analyze the management of runoff water in the Widyatama campus area by referring to the Law of the Republic of Indonesia Number 26 of 2007 concerning Spatial Planning. The research method uses secondary data in the form of rainfall from the Bandung Climatology Station and manual surveys for land use and topographic analysis. The results showed that the intensity of rain at the 2-year recurrence period (I2) was 127.56 mm. Rainfall intensity is also calculated for 5, 10, 20, 25, 50, and 100-year recurrences. Based on this analysis, land modification or innovation is needed, one of which is the construction of a detention pond that functions to restore the amount of flow to the river according to the zero run-off concept. With a study area of 3.61 Ha, a detention pond is needed for rainfall over 5 years with a storage capacity of 240 m³. The implementation of this innovation is expected to reduce flood risk and improve water management in the study area.



## Introduction

Continuous development carried out in an area can result in land use changes that have a domino impact. With the spirit of development in many places, sometimes we forget other essential things such as water resource management, flood discharge control, and others, especially if we do not conduct an in-depth study of how an area must manage runoff water that occurs in the wall (Wismarini & Ningsih, 2010). The city of Bandung is a big city located in the highlands, with a high spirit of growth in the city of Bandung, there is a phenomenon where there are still areas or places that do not take into account run-off control in the area that is built (Sidi, 2018). The government made arrangements through Law Number 26 of 2007 in Article 29 paragraph 2 which states that the proportion of green open space in the city area is at least 30 percent of the area of the city area. As for the construction of the Building, according to the Bandung Mayor Regulation Number 1023 of 2016, it is stated that additional green open space is needed at least 10% to 20% of the minimum RTH. This means that in an area where there are tall buildings, 30% of the area is needed plus (10% to 20%) x 30% of the land area. The application of this regulation has a significant influence on hydrological studies because, with the addition of green open space, it can reduce the runoff coefficient (Composite C value) in an area. The reduction of runoff discharge can help in reducing discharge in rivers or channels that are the estuaries of an area that is built (Irvana, Johanies, & Supriyan, 2021).

In 2008, Government Regulation No. 26 of 2008 concerning the National Spatial Plan appeared, where in Article 106 paragraph 1 it is necessary to zone a groundwater recharge area by paying attention to the limited use of space for unbuilt cultivation activities that have a high ability to withstand rainwater runoff, the provision of infiltration wells and/or reservoirs on existing built land and the application of the principle of zero delta Q policy in every field activity The building power that the permit is proposed. (Sanit, 2018). Delta Q policy is a must so that each building must not result in an increase in water discharge to the drainage system or river flow system, meaning that an area that is developing must be able to innovate in reducing its flood discharge so that the peak discharge can remain the same as the condition before it was built. This regulation needs to be implemented in congested areas because in general congested areas do not have adequate catchment areas. (Arisanty et al., 2024).

The hydrological analysis is one part of the initial analysis in the design of hydraulic buildings. (Fauziyyah, 2016). Hydrological data is a very important information material in the implementation of an inventory of potential water resources, the proper utilization and management of water resources, and the rehabilitation of natural resources such as water, soil, and forests that have been damaged. (Samosir, 2020). Hydrological phenomena such as magnitude: rainfall, temperature, evaporation, duration of solar irradiation, wind speed, river discharge, river water level, flow velocity, and river sediment concentration will always change with time.

## Method

### Place and Time of Research

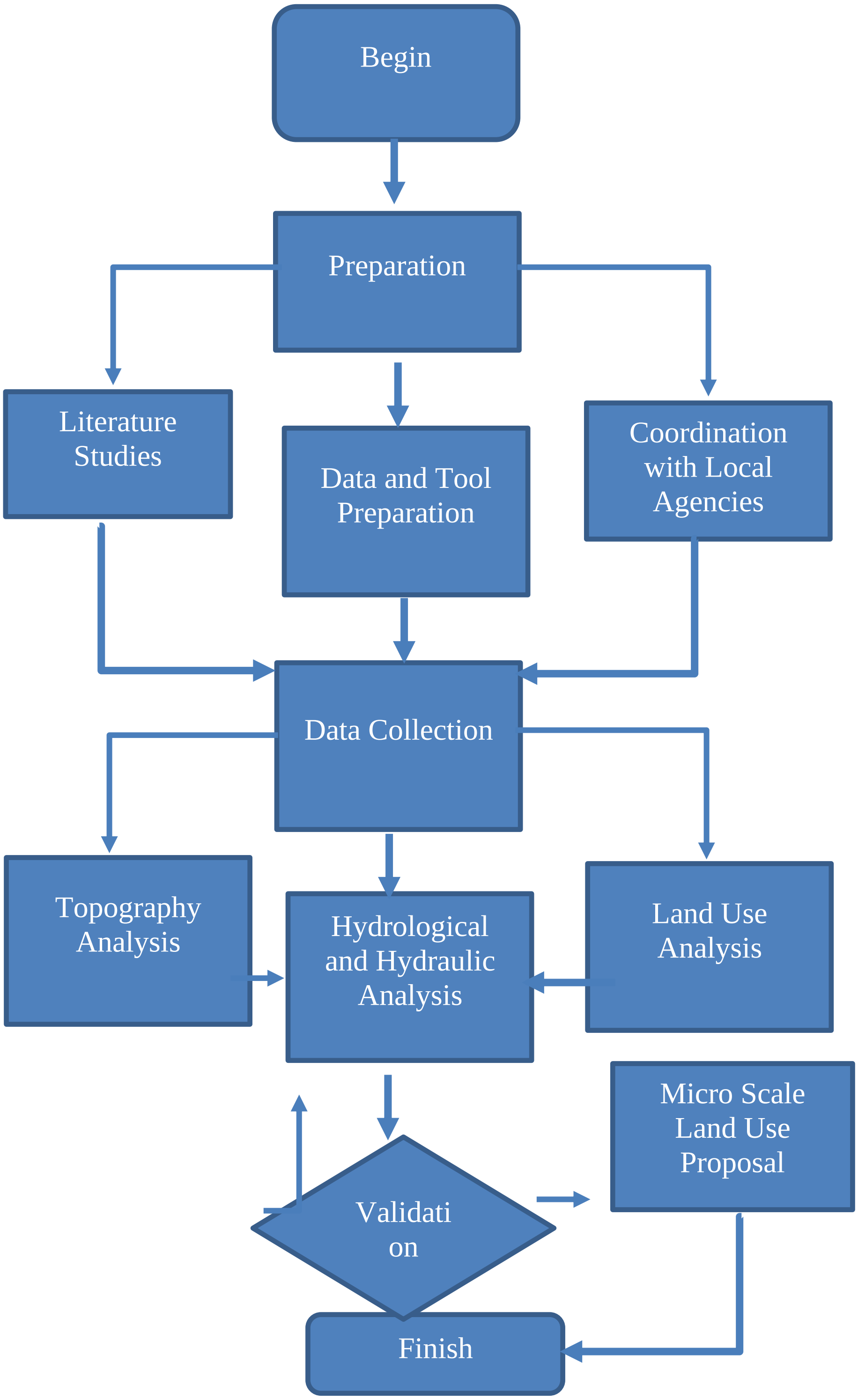
This research was carried out on the campus of Widyatama University, Jalan Cikura no 204A, Bandung City. In this study, the limit condition used is that the flood water level at the outlet is considered freefall and is not affected by the rise and fall of the water level in the river.

### Data and Data Sources

This research method uses secondary data in the form of rainfall data taken from the Bandung Climatology Station, while land use and topographic analysis are obtained by conducting a manual survey in the research area. The Bandung climatology station is 5.66 km straight from the study location and is considered to have an influence on the study location.

**Flow Diagram**

The following is the method of implementing this PKM activity:




**Gambar 1 Diagram Alir**

**Cost Budget Plan**

**Tabel 1**

**Anggara Biaya**

| No | Description | Unit | Volume | Unit Price (Rp) | Sum (Rp) |
|---|---|---|---|---|---|
| 1 | Topographic Measurements | 1 | Ls | 3.500.000 | 3.500.000 |
| 2 | Secondary Data Procurement | Year | 10 | 270.000 | 2.700.000 |
| 3 | Journal Publication Fee | bh | 1 | 1.000.000 | 1.000.000 |
| 4 | Consumption | pax | 10 | 30.000 | 300.000 |
| | Total Amount | | | | 7,500,000 |

## Results and Discussion

### Maximum Daily Rainfall Data

Referring to the Bandung Climatology Station, it was found that the maximum daily rainfall at the study site was as follows:

**Table 2**
**Curah Hujan Harian Maksimum**

| No | Tahun | Curah Hujan Max | Hari Hujan | Jumlah Curah Hujan |
|---|---|---|---|---|
| 1 | 2001 | 54 | 176 | 2430.6 |
| 2 | 2002 | 82.4 | 128 | 1910.7 |
| 3 | 2003 | 76 | 143 | 1865.2 |
| 4 | 2004 | 70.2 | 142 | 1910.4 |
| 5 | 2005 | 85 | 173 | 2303.8 |
| 6 | 2006 | 94.3 | 134 | 1687.5 |
| 7 | 2007 | 69.5 | 152 | 2161.8 |
| 8 | 2008 | 67.8 | 148 | 1964.2 |
| 9 | 2009 | 88.9 | 144 | 2076.3 |
| 10 | 2010 | 122.9 | 224 | 3674.2 |
| 11 | 2011 | 73.5 | 145 | 1769.3 |
| 12 | 2012 | 83 | 150 | 2486.7 |
| 13 | 2013 | 68.4 | 161 | 2276 |
| 14 | 2014 | 62 | 140 | 1940.8 |
| 15 | 2015 | 77.7 | 112 | 1902.3 |
| 16 | 2016 | 112.6 | 212 | 3385.8 |
| 17 | 2017 | 73.5 | 160 | 2206.7 |
| 18 | 2018 | 85.2 | 143 | 2172.1 |
| 19 | 2019 | 83.3 | 139 | 2013.9 |
| 20 | 2020 | 160 | 146 | 2342.4 |
| 21 | 2021 | 76.8 | 162 | 2165.9 |

The conditions of existing and built land use can be seen in the comparison table below.

**Table 3**
**Land Use**

| It | Types of Land Use | Existing Land Use | Built Land Use |
|---|---|---|---|
| 1 | Green Open Area | 3.56 hectares | 0.13 Ha |
| 2 | Building Area and Impervious | 0 | 3.43 hectares |
| | TOTAL | 3.56 hectares | 3.56 hectares |

Referring to SNI 2415 of 2016 concerning Procedures for Calculating Planned Flood Discharge, a runoff coefficient table is obtained with the details of the table below.

**Table 4 Runoff Coefficients**

| Jenis Daerah | Koefisien Aliran | Kondisi Permukaan | Koefisien Aliran |
|---|---|---|---|
| Daerah Perdagangan | | Jalan Aspal | |
| Kota | 0,70-0,95 | Aspal dan beton | 0,75-0,95 |
| Sekitar kita | 0,50-0,70 | Batu bata dan batako | 0,70-0,85 |
| Daerah Pemukiman | | Atap Rumah | 0,70-0,95 |
| Satu rumah | 0,30-0,50 | Halaman berumput, tanah pasir | |
| Banyak Rumah,terpisah | 0,40-0,60 | Datar, 2% | 0,05-0,10 |
| Banyak Rumah, rapat | 0,60-0,75 | Rata-rata,2-7 % | 0,10-0,15 |
| Pemukiman, pinggiran Kota | 0,25-0,40 | Curam, 7 % atau lebih | 0,15-0,20 |
| Apartemen | 0,50-0,70 | | |
| Daerah Industri | | Halaman berumput,tanah pasir padat | |
| Ringan | 0,50-0,80 | Datar, 2 % | 0,13-0,17 |
| Padat | 0,60-0,90 | Rata-Rata, 2-7 % | 0,18-0,22 |
| Lapangan, kuburan dan sejenisnya | 0,10-0,25 | Curam, 7 % atau lebih | 0,25-0,35 |
| Halaman, jalan kereta api dan sejenisnya | 0,20-0,35 | | |
| Lahan tidak terpelihara | 0,10-0,30 | | |

Referring to the data above, we can analyze the peak flood discharge at each time referring to the data of the runoff coefficient and planned rainfall. (Eato, Rengkung, & Van Rate, 2017).

**Conditions Before Waking Up**

The condition of the green open area is 3.56 Ha, the condition of the building area is 0 Ha, C Composite is 0.25. Referring to Kirpich in SNI 2415 2016, it is known that the way to calculate tc is:

$tc=0.0195\ L0.77\ ^{S-0.385}$

With the caption:

Tc = time (minutes)

L = Length of slope or area

S = Slope or area

In the study area, it is known that L is 181 m and S is 0.012

tc = 0.0195 x 1810.77 x 0.012-0.385

= 5.86 minutes

= 0.097 Hours

Precipitation intensity based on the Mononobe equation:

$$I = \left[\frac{R24}{24}\right]\left[\frac{24}{tc}\right]^{\frac{2}{3}}$$

The following is a calculation of the intensity of rain during the 2nd anniversary

$R_{24}$ = 78 mm

tc = 0.097 Jam

$$I = \left[\frac{78}{24}\right]\left[\frac{24}{5.86}\right]^{\frac{2}{3}} = 127.56\ mm$$

Based on the above data, it was obtained that the intensity of rain at the 2-year reage or I2 was 127.56 mm, in the same way, the rain intensity was obtained at the 2-year, 5-year, 10-year, 20-year, 25-year, 50-year, and 100-year repetitions.

**Table 5**
**Rekapitulasi Intensitas Hujan**

| No | Rain Again | Thick Rainfall | Rain Intensity |
|---|---|---|---|
| 1 | R2 | 78.04 | 127.55 |
| 2 | R5 | 97.29 | 159.02 |
| 3 | R10 | 112.42 | 183.75 |
| 4 | R20 | 128.80 | 210.53 |
| 5 | R25 | 134.41 | 219.70 |
| 6 | R50 | 153.03 | 250.13 |
| 7 | R100 | 173.72 | 283.95 |

Based on the intensity of the rain above, a follow-up analysis was carried out to find the potential for peak discharge that occurred in the area.

Qp = 0.00278 CIA

C = Runoff coefficient

I = Rainfall Intensity (mm/h)

A = Area (Ha)

In Qp for 2 years, you get:

Qp2 = 0.00278 x 0.25 x 127.55 mm x 3.56 Ha

= 0.32 m3/s

In the same way, the following is the recapitulation for the other repetitions:

**Table 6**
**Rekapitulasi Intensitas Hujan dan Debit Puncak**

| No | Rain Again | Thick Rainfall | Rain Intensity | Qp (m3/s) |
|---|---|---|---|---|
| 1 | R2 | 78.04 | 127.55 | 0.32 |
| 2 | R5 | 97.29 | 159.02 | 0.39 |
| 3 | R10 | 112.42 | 183.75 | 0.45 |
| 4 | R20 | 128.80 | 210.53 | 0.52 |
| 5 | R25 | 134.41 | 219.70 | 0.54 |
| 6 | R50 | 153.03 | 250.13 | 0.62 |
| 7 | R100 | 173.72 | 283.95 | 0.70 |

**Conditions After Waking Up**

The condition of the green open area is 0.13 Ha, and the condition of the building area and other impermeable areas is 3.43 Ha, C Composite = ((0.13 x 0.25) + (3.43 x 0.9))/3.56 = 0.88.

Referring to Kirpich in SNI 2415 2016, it is known that the way to calculate tc is:

tc=0.0195 L0.77 $^{S-0.385}$

With the caption:

Tc = time (minutes)

L = Length of slope or area

S = Slope or area

In the study area, it is known that L is 181 m and S is 0.012

tc = $0.0195 \times 181^{0.77} \times 0.012^{-0.385}$

= 5.86 minute

= 0.097 Hours

Precipitation intensity based on the Mononobe equation:

$$I = \left[\frac{R24}{24}\right]\left[\frac{24}{tc}\right]^{\frac{2}{3}}$$

Berikut ini perhitungan intensitas hujan kala ulang 2 Tahun

$R_{24}$ = 78 mm

tc = 0.097 Jam

$$I = \left[\frac{78}{24}\right]\left[\frac{24}{5.86}\right]^{\frac{2}{3}} = 127.56\ mm$$

Based on the above data, it was obtained that the intensity of rain at the 2-year reage or I2 was 127.56 mm, in the same way, the rain intensity was obtained at the 2-year, 5-year, 10-year, 20-year, 25-year, 50-year, and 100-year repetitions.

**Table 7**
**Recapitulation of Rain Intensity**

| No | Rain Again | Thick Rainfall | Rain Intensity |
|---|---|---|---|
| 1 | R2 | 78.04 | 127.55 |
| 2 | R5 | 97.29 | 159.02 |
| 3 | R10 | 112.42 | 183.75 |
| 4 | R20 | 128.80 | 210.53 |
| 5 | R25 | 134.41 | 219.70 |
| 6 | R50 | 153.03 | 250.13 |
| 7 | R100 | 173.72 | 283.95 |

Based on the intensity of the rain above, a follow-up analysis was carried out to find the potential for peak discharge that occurred in the area.

Qp = 0.00278 CIA
C = Runoff coefficient
I = Rainfall Intensity (mm/h)
A = Area (Ha)
In Qp for 2 years, you get:
Qp2 = 0.00278 x 0.88 x 127.55 mm x 3.56 Ha
= 1.11m3/s
In the same way, the following is the recapitulation for the other repetitions:

**Table 8**
**Recapitulation of Rainfall Intensity and Peak Discharge**

| No | Rain Again | Thick Rainfall | Rain Intensity | Qp (m3/s) |
|---|---|---|---|---|
| 1 | R2 | 78.04 | 127.55 | 1.11 |
| 2 | R5 | 97.29 | 159.02 | 1.38 |
| 3 | R10 | 112.42 | 183.75 | 1.59 |
| 4 | R20 | 128.80 | 210.53 | 1.83 |
| 5 | R25 | 134.41 | 219.70 | 1.91 |
| 6 | R50 | 153.03 | 250.13 | 2.17 |
| 7 | R100 | 173.72 | 283.95 | 2.46 |

Referring to the calculation above, it can be seen that there is a peak discharge difference that must be reduced, a recap of the peak discharge difference reduction can be seen in the analysis below.

**Table 9**
**Recapitulation of Peak Discharge Difference**

| No | Rain Again | Qp Before Construction | Qp After Construction | Qp Selisih (m3/s) |
|---|---|---|---|---|
| 1 | R2 | 0.32 | 1.11 | 0.79 |

| | | | | |
|---|---|---|---|---|
| 2 | R5 | 0.39 | 1.38 | 0.99 |
| 3 | R10 | 0.45 | 1.59 | 1.14 |
| 4 | R20 | 0.52 | 1.83 | 1.31 |
| 5 | R25 | 0.54 | 1.91 | 1.37 |
| 6 | R50 | 0.62 | 2.17 | 1.55 |
| 7 | R100 | 0.70 | 2.46 | 1.76 |

A graph of the change in peak and differential discharge data can be seen in the figure below.


**Figure 2 Graph of increased rainfall and the difference between initial and built conditions**

Referring to these conditions, innovations are needed that can adjust the field conditions to by Government Regulation No. 26 of 2008 concerning the National Spatial Plan. This was taken because adding 30% RTH was not considered to be the maximum to reduce flood discharge that entered the pond. Therefore, a storage area with a door that can be adjusted is needed so that the discharge issued is according to the regulations mentioned above. The peak discharge that occurs is calculated by assuming that the peak discharge occurs for 4 hours, therefore it can be seen that the difference in the graph for each flood discharge can be seen. According to (Abdussalam, 2020), the maximum discharge occurs during the concentration time, namely after the flow from the farthest place with the flow from other parts together to the measurement place and the flow immediately decreases again after the rain stops. The following is the graph data per minute with units per m3/s along with the difference and recommended incubation pond needs.

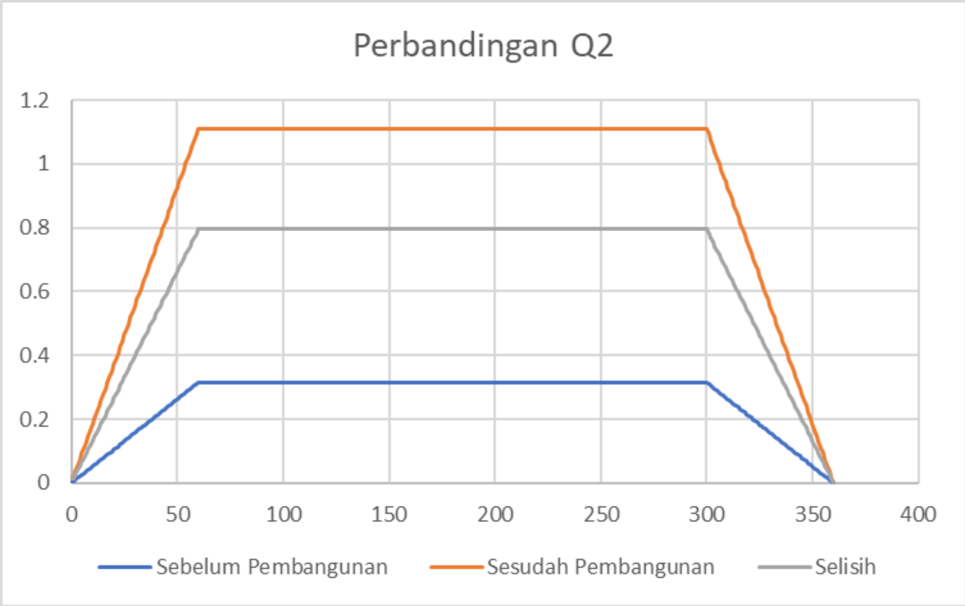



**Figure 3 Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 200 m3

**5th Anniversary**

The following is a comparison chart of the debits that come out at the 5-year repetition time along with the difference. (Suryanta & Nahib, 2016).

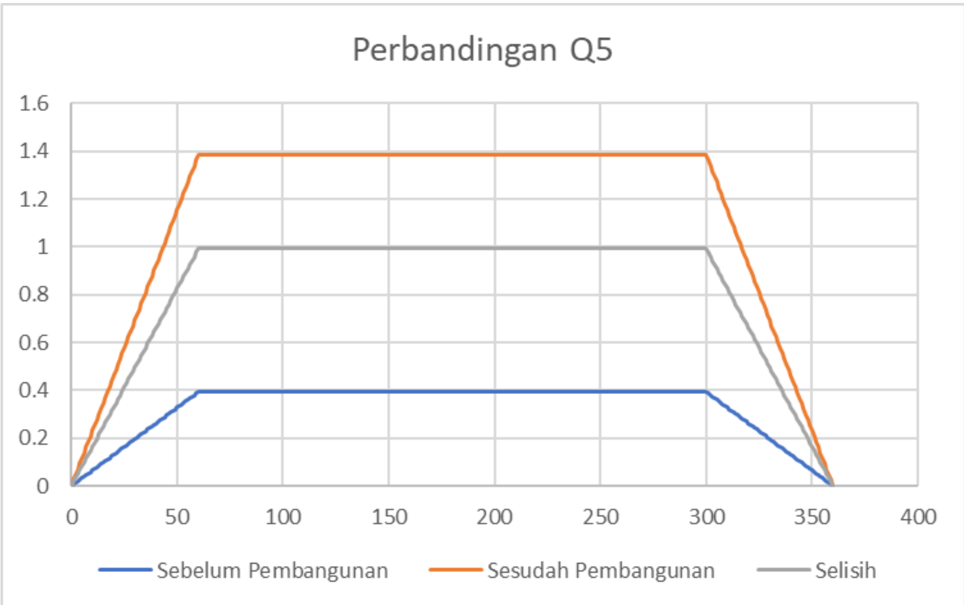



**Figure 4 Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 240 m3

**10th Anniversary**

The following is a comparison chart of the debits that come out at the 10-year repetition time and the difference.

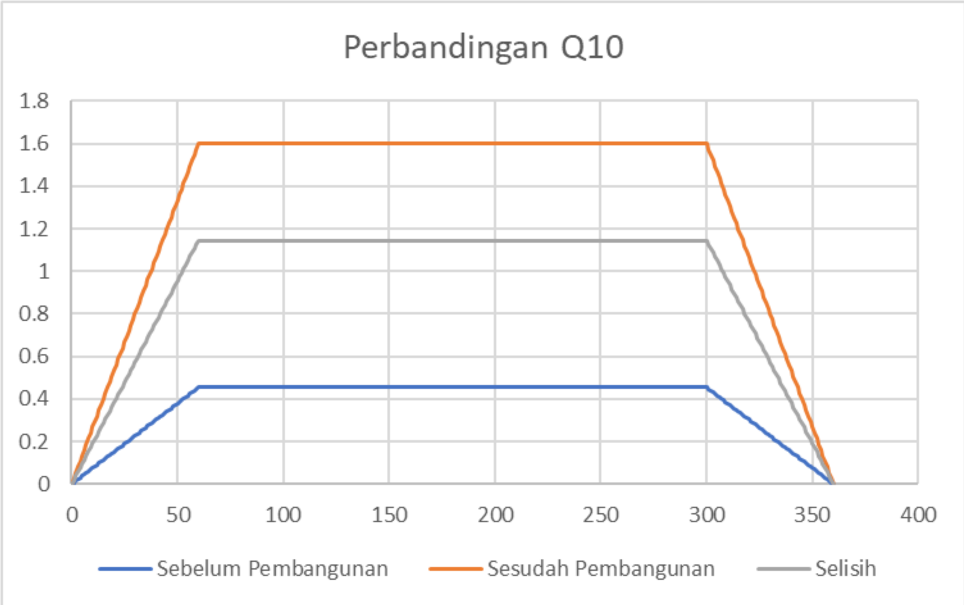



**Figure 5 Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 280 m3

**20th Anniversary**

The following is a comparison chart of the debits that come out at the 20-year reage period along with the difference.

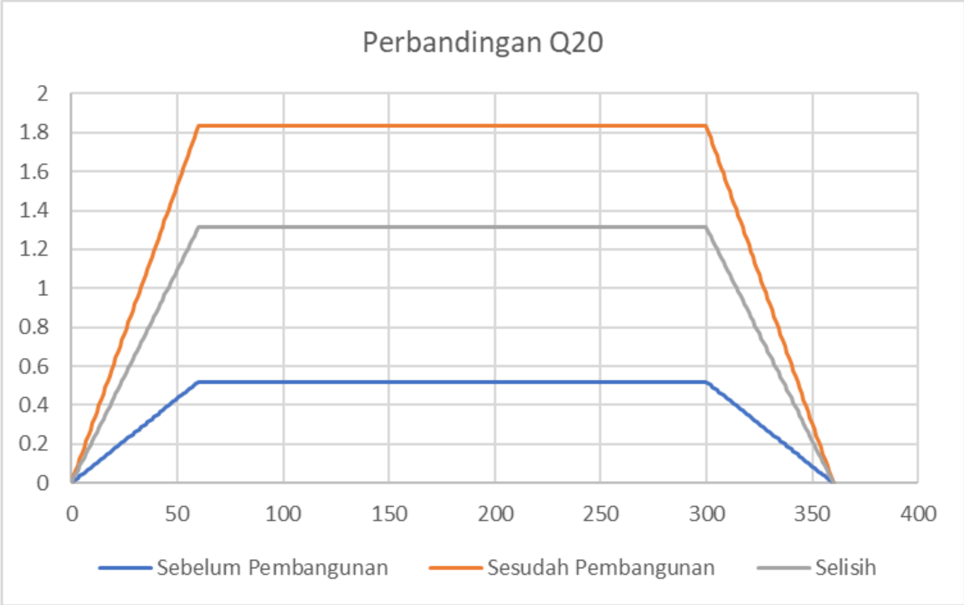



**Figure 6 Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 320 m3

**25th Anniversary**

The following is a comparison chart of the debits that come out at the 25-year range along with the difference.

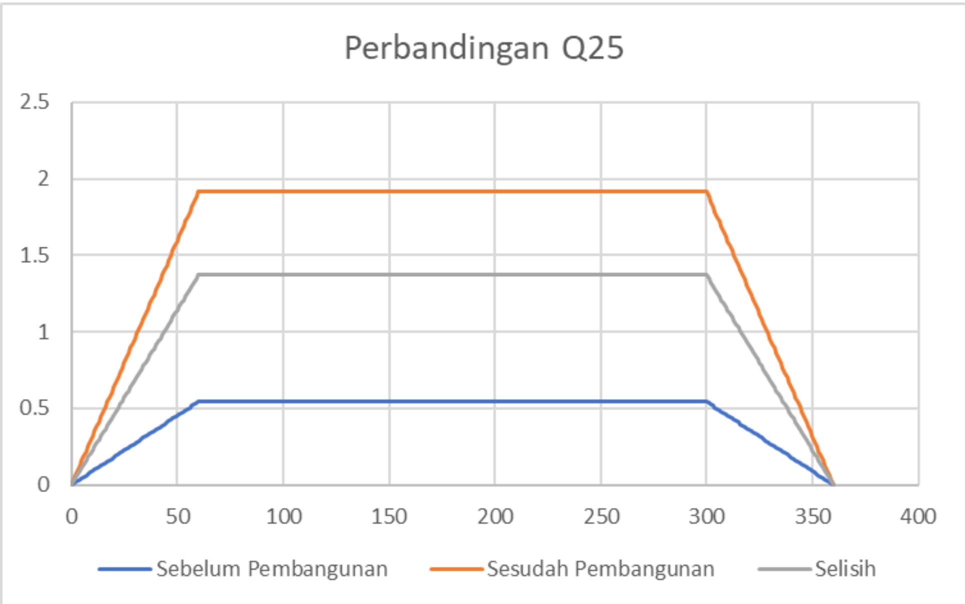



**Figure 7**
**Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 330 m3

50th Anniversary

The following is a comparison chart of the debits that come out at the 50-year reage period along with the difference.

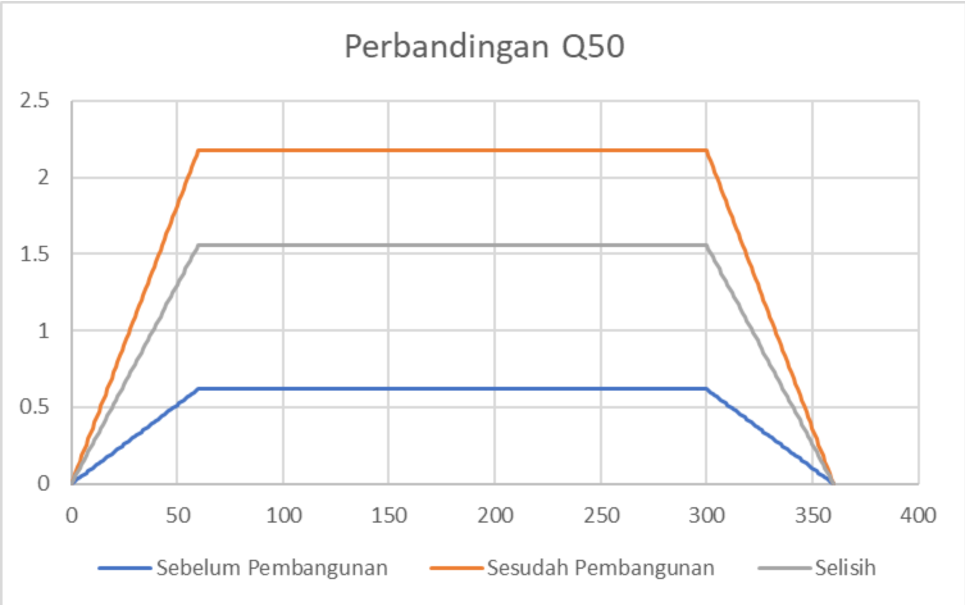



**Figure 8 Discharge Chart Comparison of Discharge During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 380 m3.

**100th Anniversary**

The following is a comparison chart of the debits that come out at the 100-year reage period along with the difference. (Juwono & Subagiyo, 2017).

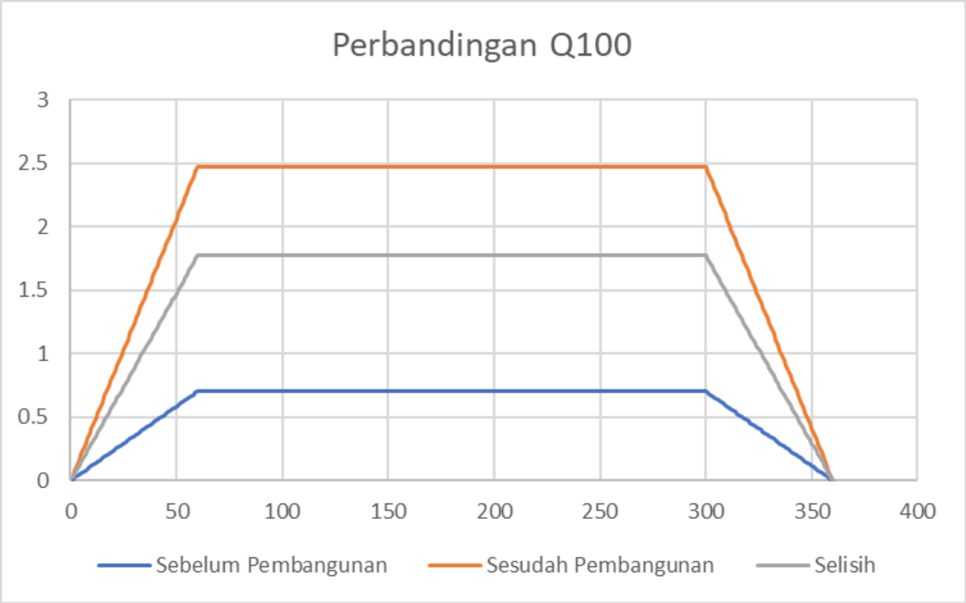



**Figure 9 Discharge Comparison Chart During Rain**

In this condition, the peak discharge occurs for 4 hours with the required pond volume of 425 m3.

## Conclusion

Referring to the analysis carried out, there needs to be modifications or innovations related to land conditions in the study area. The innovation can be in the form of a detention pond that functions to restore the amount of flow to the river in accordance with the zero run-off concept. The size of the detention pond needed varies according to the amount of rainfall analyzed. With an area of 3.61 Ha, the rainfall used is 5-year periodic rainfall with a storage requirement of 240 m3.

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