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Evaluation of the Capacity of the DT8 Outfall Channel to Handle Design Flood Discharge Using the Rational Method in Babelan Subdistrict, Bekasi Regency

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ABSTRACT

DT8 serves as the basis for a normalization plan derived from the design flood discharge. Rainfall intensity was calculated using the Mononobe method, while the design flood discharge was determined using the Rational Method. Subsequently, channel capacity was analyzed using Manning's equation, incorporating cross-sectional area, wetted perimeter, hydraulic radius, channel slope, and Manning's roughness coefficient. The results indicate that the Log Pearson Type III distribution was the most suitable fit; the design flood discharges for return periods of 5, 10, 25, 50, and 100 years were 25.18 m^3/s, 30.20 m^3/s, 36.55 m^3/s, 41.25 m^3/s, and 45.92 m^3/s, respectively. Meanwhile, the capacity of the DT8 drainage channel is 20,361 m^3/s, meaning the channel can only accommodate the design flood discharge for a two-year return period. Sediment accumulation reduces flow capacity if left unaddressed. Therefore, normalization through sediment dredging and routine maintenance is recommended to preserve channel capacity and mitigate the risk of future inundation.

Keywords: *Channel Capacity, Design Flood Discharge, Rational Method, DT8 Outfall Channel, Bekasi Regency.*

1. INTRODUCTION

Babelan District, located in Bekasi Regency, is a lowland area with an area of approximately 59.41 km^2 and is at an average altitude of 0 to 13 meters, located above sea level, so it is easily inundated and experiences flooding during heavy rain, based on data from the Bekasi Regency Regional Disaster Management Agency, the area. One of the issues of concern is flooding occurring around the DT8 drainage channel in Babelan District. It shows that there is an imbalance between the channel's capacity and the amount of water flow that flows from the runoff that occurs. This phenomenon is in line with hydrological studies which state that there are changes in land use and a reduction in area [1]–[3].

Therefore, the region's geographic and water conditions are crucial factors in understanding the flooding problem. Flooding occurred in the DT8 drainage channel in Babelan District. This indicates that the drainage channel cannot accommodate the amount of water that flows into it, causing it to overflow into the surrounding area. This situation is worsened by data from the Bekasi Regency Regional Disaster Management Agency, which records that in several major flooding incidents, the Babelan region is among the districts that experience extensive inundation, occurring repeatedly each year.

The flooding occurred due to an overflowing DT8 drainage channel. This disruption occurred as water overflowed onto the road and entered the area. According to data from the Bekasi

Regency Regional Disaster Management Agency (BPBD), flooding in the Babelan area is still occurring. The channel's capacity and increased runoff discharge are due to changes.

Another problem with the DT8 drainage channel is the accumulation of silt, which reduces the channel's width. This sedimentation generally occurs due to a lack of routine maintenance and the flow of clay from the catchment area. Illegal structures block the water flow, reducing the channel's width. Sedimentation and illegal structures in the drainage channel can reduce its water holding capacity by more than 30% [4]–[6].

Based on these various issues, a technical study is needed to consider the capacity of the DT8 drainage channel by analyzing the amount of water flow. The condition of the rainwater catchment area directly affects the amount of flow [7].

2. METHODS

2.1 Data Analysis Methods

2.1.1 Analysis of DT8 Drainage Channel Capacity against Design Flood Discharge Using the Rational Method

The analysis of the DT8 Drainage Channel capacity against the design flood discharge was conducted to evaluate the existing channel's ability to accommodate the calculated flow discharge using the Rational Method. This analysis begins by calculating the channel capacity based on the cross-sectional dimensions, channel bed slope, Manning's roughness coefficient, wet cross-sectional area, wet perimeter, hydraulic radius, and flow velocity using the Manning Equation. The obtained channel capacity is then compared with the design flood discharge to determine whether the channel can still accommodate the discharge that occurs. If the channel capacity is greater than or equal to the design flood discharge, then the channel is declared to still meet the required capacity. Conversely, if the channel capacity is smaller than the design flood discharge, then the channel is considered unable to accommodate the flow so that normalization efforts are needed to increase the channel's capacity and reduce the possibility of inundation or flooding in the area [8].

Topics discussed in this research include:

1) Existing channel dimension data.

   Existing channel dimension data was obtained through direct field measurements, including channel bed width, channel height, channel length, and channel bed slope. This data was used as the basis for channel capacity analysis.

   $$Q = A \times V$$

2) Calculation of wet cross-sectional area (A).

   The wet cross-sectional area is the cross-sectional area of the flow that is filled with water.

   $$A = b \times h$$

3) Calculation of wet perimeter (P).

   Wet perimeter is the length of the side of the channel that is in direct contact with the water flow.

   $$P = b + 2h$$

4) Calculation of hydraulic radius (R).

   The hydraulic radius indicates the ratio between the cross-sectional area of the flow and the wetted circumference.

   $$R = A / P$$

5) Determination of Manning's roughness coefficient (n).

   The Manning coefficient is determined based on the type of channel material referring to the Manning table.

6) Determination of the channel base slope (S).
   The slope of the channel bed is calculated based on the difference in elevation over the length of the channel.
   S = ΔH / L
7) Calculation of flow velocity (V).
   The flow velocity is calculated using the Manning Equation.
   V = (1/n) × R^(2/3) × S^(1/2)
8) Calculation of channel capacity (Q) using the Manning Equation.
   The channel capacity is calculated to determine the maximum discharge that can be flowed.
   Q = 1/n AR2/3 S1/2
9) Comparison of channel capacity with design flood discharge.
   The channel capacity is compared with the design flood discharge. If Q channel ≥ Q flood then the channel is safe, whereas if Q channel < Q flood then an evaluation is required.
10) Evaluate channel normalization needs based on comparison results.
   The evaluation is carried out based on the results of comparing the channel capacity with the design flood discharge.

2.2 Analysis Results Discussion Method

2.2.1 Discussion of the Results of the Analysis of the DT8 Drainage Channel Capacity against the Design Flood Discharge Using the Rational Method

The discussion on the analysis results of the DT8 Drainage Channel capacity against the design flood discharge was conducted to evaluate the extent to which the existing channel is able to receive the flood discharge calculated using the Rational Method. The analysis was conducted based on current conditions by calculating the inundated cross-sectional area, inundated perimeter, hydraulic radius, channel bed slope, Manning roughness coefficient, and flow velocity using the Manning formula. The results of the channel capacity calculation were then compared with the design flood discharge to determine whether the channel capacity was able to increase the flood discharge [9].

3. RESULTS AND DISCUSSION

3.1 Analysis of DT8 Drainage Channel Capacity against Design Discharge Using the Rational Method

Hydraulic analysis of the drainage channel cross-section in the District 8 Channel area was carried out by comparing the designed flood discharge with the channel's capacity to accommodate the flood discharge.

1) Channel Cross-sectional Area From the survey results, the shape of the drainage channel was obtained

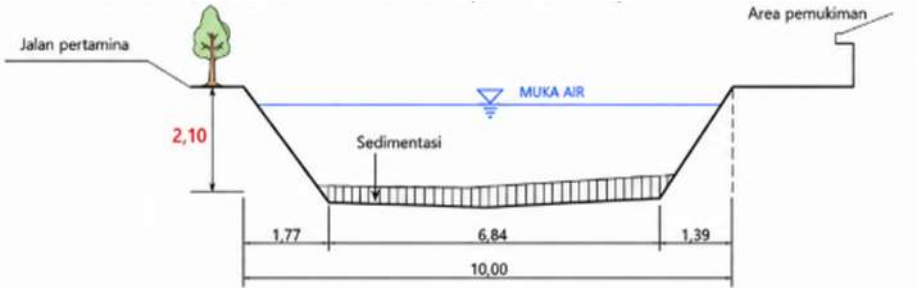


Figure 1. Illustration of Existing Channel
Source: Project Data

It is known

- Channel height (h) = 2.10 m
- Base width (b) = 6.84 m
- Top width (T) = 10.00 m
- Left embankment projection = 1.77 m
- Right embankment projection = 1.39 m
- Manning's coefficient n = 0.025
- Channel length = 1,000 m

$A = \frac{(T+b)}{2}\ x\ h$
A = (10 + 6.84)/2 x 2.1
A = 17,682 m2

2) Wet Circumference (P)

The wet circumference value is used as a reference in calculating the hydraulic radius, which is then needed to analyze the flow velocity using the Manning Equation.

The following is the calculation for the wet circumference. This calculation is based on Figure 1.

Left Side Length

$L_1=\sqrt{2{,}1^2 + 1{,}77^2}$
L_1= 2,746 m
Right Side Length
L2 = √2,121,392
L2 = 2.518 m
So that
P = 6.84+2.746+2.518
P = 12.104 m

3) Hydraulic Radius (R)

R = A/P
R = 17.682 /12.104
R = 1.461 m

4) Channel Slope Channel slope is a hydraulic parameter used to determine the slope of the channel bed. The slope of a channel affects how fast water flows and how much water the channel can carry.

The following is a calculation of the channel slope based on the difference in channel base elevation and the length of the channel under review.

$$S = \frac{\Delta H}{L}$$



Figure 2. Illustration of Channel Slope

Source: Research Processing

It is known:

Upstream Base Elevation = 2.3m
Downstream Base Elevation = 1.8 m
Channel Length (L) = 1000
ΔH = 2.3 – 1.8 = 0.5 m
S = $\frac{\Delta H}{L}$
S = 0.5 / 1000
S = 0.0005 m or 0.05%

5) Manning Speed

Flow velocity is an important factor in hydraulic analysis, used to determine how well a channel can conduct water. The flow velocity calculation in this study uses the Manning equation, which takes into account the influence of the channel roughness coefficient (n), hydraulic radius (R), and channel bed slope (S). In this study, the channel used was a crushed stone channel that was soaked, so the Manning coefficient (n) value was used at 0.025.

Table 1. Manning Coefficient

No	Channel Type	Manning coefficient (n)
1	Coated cast iron	0.014
2	Glass	0.010
3	Concrete channel	0.013
4	Bricks covered with mortar	0.015
5	Cemented stone masonry	0.025
6	Clean land channel	0.022
7	Land channel	0.030
8	Channel with new bottom and grass banks	0.040
9	Channels in the rock excavation	0.040

Source: Manning roughness coefficient (Triadmodjo, 1993)

Manning's Flow Coefficient for Cemented Crushed Stone Channel Conditions = 0.025
V = $\frac{1}{n} x R\frac{2}{3} x S\frac{1}{2}$
V = 1/0.025 x 1.4612/3 x 0.00051/2
V = 1.151 m/sec

So the capacity of the channel cross-section
Q = V x A
Q = 1.151 x 17.682
Q = 20,361 m3/sec

6) Sedimentation Calculations Channel sedimentation is the process of deposition of materials carried by water flow at the bottom of the channel, which causes the cross-

sectional area of the water flow to become narrower. The following calculation of the sedimentation cross-sectional area is carried out to determine how much influence the sediment has on the channel's capacity.

Sediment Cross-Section Area
As = bxt
US = 6.84 x 0.2
US = 1,368 m2
Sediment Volume
Vs = As×L
Vs = 1.368×1000
Vs = 1,368 m3

7) Comparison of Channel Capacity with Design Flood Discharge The following is a comparison of the DT8 Drainage Channel's capacity with the planned flood discharge at various return periods. This comparison aims to determine how well the channel is able to accommodate and channel the resulting flood discharge, thereby determining the extent of the channel's capacity to handle the planned discharge.

Table 3. Comparison of channel capacity and flood discharge

	Return Period (years)	Q (m3/sec)	Channel Cap	Information
1	Q flood	16.91	20.36	Secure channel
2	2	17.60		Secure channel
3	5	25.18		Unsafe channel
4	10	30.20		Unsafe channel
5	25	36.55		Unsafe channel
6	50	41.25		Unsafe channel
7	100	45.92		Unsafe channel

Source: Research Processing

The comparison results show that compared to the channel capacity to determine how much the DT8 drainage channel is able to accommodate the planned flood discharge, which is obtained from hydrological analysis. Based on the calculation results using the Manning equation, the existing channel capacity is 20,361 m³/second. Meanwhile, the planned flood discharge for each return period of 2, 5, 10, 25, 50, and 100 years is 17.60 m³/second, 25.18 m³/second, 30.20 m³/second, 36.55 m³/second, 41.25 m³/second, and 45.92 m³/second.

Meanwhile, the DT8 drainage channel capacity of 20.36 m³/second can only accommodate flood discharge during a 2-year return period of 17.60 m³/second.

The flood water discharge reached 25.18 to 45.92 m³/second, which exceeded the channel's capacity, so the channel was deemed unsafe.

3.2 Discussion of the Results of the Analysis of the DT8 Drainage Channel Capacity on the Design Flood Discharge Using the Rational Method

Based on hydraulic analysis, the DT8 drainage channel has a capacity of 20,361 m³/s with a flow rate of 1,151 m/s. Sedimentation calculations indicate a sediment volume of 1,368 m³, which could significantly reduce the channel's capacity, necessitating regular cleaning.

On the 2nd anniversary, the channel could still accommodate a flood water discharge of 17.60m³/second. However, during the 5- to 100-year return period, flood discharge reached 25.18 to 45.92 m³/second, exceeding the channel's capacity. Therefore, the channel is safe for a 2-year return period, but could experience inundation and overflow during a longer return period. This indicates that the existing channel is not large enough to accommodate floodwaters that occur more

frequently. The longer the return period, the greater the volume of floodwater that must flow through the channel. The difference between flood discharge and channel capacity indicates that the channel is unable to drain water optimally. Therefore, further checks are needed to determine the channel's ability to prevent inundation and flooding. The results of this analysis can be used as a reference in taking steps to manage the channel at the studied location.

CONCLUSION

Based on the evaluation results in the DT8 drainage channel, it was found that the channel cross-sectional area was 17,682 m2, the wetted circumference reached 12,104 m, and the hydraulic radius was 1,461 m. With a channel bed slope of 0.0005 or 0.05% and a Manning roughness coefficient of 0.025, a flow velocity of 1,151 m/s was obtained. From the calculation of Q = V × A, the current channel cross-sectional capacity was obtained at 20,361 m3/s.

Based on the comparison results, at a 2-year return period with a channel capacity of 20,361 m^3/second, this capacity is still greater than the current flood discharge which reaches 16.91 m^3/second. Furthermore, at a 2-year return period with a discharge of 17.60 m^3/second, the channel is still able to accommodate the flood discharge. However, at return periods of 5, 10, 25, 50, and 100 years, the flood discharge reached 25.18 m^3/second; 30.20 m^3/second; 36.55 m^3/second; 41.25 m^3/second; and 45.92 m^3/second, respectively, which already exceeds the capacity of the current channel which is 20,361 m^3/second.

Therefore, the current DT8 drainage channel is only capable and safe for use within a 2-year return period, while it cannot accommodate the planned flood discharge within a 5- to 100-year return period. This condition could lead to flooding and overflow if rainfall is more frequent.

REFERENCES

[1] D. Syafriyandi, D. A. Maharani, D. Al-Ghifani, V. Purwayanti, and W. O. Nurhaidar, "Evaluation of drainage system performance for surface runoff control in residential areas using the rational method," *J. Konstr. dan Infrastruktur*, vol. 14, no. 2, 2026, doi: 10.33603/jki.v14i2.11962.

[2] B. Triatmodjo, *Hidrologi terapan*. Beta Offset, 2019.

[3] B. Triatmodjo, *Hidraulika II*. Beta Offset, 2008.

[4] C. N. X. Quang, N. N. H. Giang, H. V Hoa, and P. Q. Hung, "Effects of sediment deposit on the hydraulic performance of the urban stormwater drainage system," *IOP Conf. Ser. Earth Environ. Sci.*, vol. 964, no. 1, p. 12020, 2022, doi: 10.1088/1755-1315/964/1/012020.

[5] Suripin, *Sistem drainase perkotaan yang berkelanjutan*. Andi Offset, 2004.

[6] V. Te Chow, *Open-channel hydraulics*. McGraw-Hill, 1959.

[7] S. L. Rahma, Sunarsih, and Mussadun, "Assessing urban flooding and drainage system performance in urban area: A Mononobe equation and Manning formula approach," *J. Pengelolaan Sumberd. Alam dan Lingkung.*, vol. 14, no. 3, p. 463, 2024, doi: 10.29244/jpsl.14.3.463.

[8] J. N. B. Campos, T. M. C. Studart, F. A. Souza Filho, and V. C. Porto, "On the rainfall intensity–duration–frequency curves, partial-area effect and the rational method: Theory and the engineering practice," *Water*, vol. 12, no. 10, p. 2730, 2020, doi: 10.3390/w12102730.

[9] C. Jun, X. Qin, T. Y. Gan, Y.-K. Tung, and C. De Michele, "Bivariate frequency analysis of rainfall intensity and duration for urban stormwater infrastructure design," *J. Hydrol.*, vol. 553, pp. 374–383, 2017, doi: 10.1016/j.jhydrol.2017.08.004.