Study of Inundation Management on Tertiary Drainage Channels in Keputih Tegal Surabaya City

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Abstract. In the case of heavy rain, several places in Surabaya are still submerged. The Keputih Tegal region is one of them. The Jalan Keputih Tegal channel is a tertiary drainage channel that drains into a secondary drainage channel on Jalan Raya Keputih before emptying into the Wonokromo river. The flood on Jalan Keputih Tegal occurred at a depth of 20 cm. The drainage channel on Jalan Keputih Tegal is the subject of this study, and the data utilized are secondary data in the form of rainfall data collected from the Public Works Department of Highways Surabaya and the SDMP (Surabaya Drainage Master Plan) map obtained from BAPPEKO Surabaya. The dimensions of the channel are 1.5 x 1.5 m with a capacity of 0.9 m3/s based on the flood flow from the CA region and the drainage system of the Keputih Tegal channel, which is impacted by the height of the secondary channel MAB. The channel's proportions allow for both flood discharge and backwater discharge. With a flow velocity of 0.4 m/s, the channel slope is planned to be 0.04 percent. This condition exceeds the allowed speed criteria for concrete channels, which are 1.5 m/s.

Keywords: Drainage, City of Surabaya, Secondary Canal, Terier Channel

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1. Introduction

Drainage plays a crucial role in managing water supply and preventing flooding. Drainage is the discharge, relocation, or channeling of water. In general, drainage is defined as a sequence of water structures that operate to minimize or evacuate stormwater from a certain area so that it can function adequately[1]. Drainage channels also play an important function in supporting a rain storm, which causes puddles, which frequently disrupt the comfort of all community activities on the road. Good road drainage can assist road performance[2]. If the function of the drainage is not achieved, it can cause inundation in the area of the drainage system[3]. Puddles occur if the water stops flowing, the condition of this stopped water can be caused by several factors such as topography, obstructed flow rate, and inability to drainage channels accommodate the discharge of floods that occur[4].

Some areas in Surabaya still experience inundation if there is rain with a high enough intensity. One of them is the Keputih Tegal area. The channel on Jalan Keputih Tegal is a tertiary drainage channel that flows towards the secondary drainage channel on Jalan Raya Keputih before it empties into the Wonokromo river. The puddle that occurred on Jalan Keputih Tegal occurred with a depth of 20 cm. The problem of inundation can interfere with the activities of residents, so it is necessary to do inundation management in the area.

Based on the background, this study focused on how many flood discharges occurred in the study area, the capacity of existing drainage channels in the study area able to accommodate the flood discharge that occurs and the appropriate drainage channel dimensions to handle puddles in the study area

2. Methods

The study plan is carried out in the form of information gathering (secondary and primary datacollection), field surveys, problem analysis, and development formulation. Conduct a field survey to determine the condition of existing drainage facilities, including, among other things, identifying and inventorying data and information on the development of infrastructure and existing drainage facilities, identifying and inventorying areas that have the potential for flooding and waterlogging, identifying environmental components that are predicted to be affected by a large and significant impact due to the development of drainage systems [3], [5]

The analytical work performed involves analysis as the foundation for developing the entire study. The hydrological analysis covered rainfall, discharge, hydraulics, and drainage systems to interpret the ideal dimension of terrier channel.

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The scope of this study is the drainage channel on Jalan Keputih Tegal and the data used is secondary data in the form of rainfall data obtained from the Bina Marga Surabaya Public Works Office and HRP (Surabaya Drainage Master Plan) map obtained from BAPPEKO Surabaya. Methodology which examine in this study is Analizing

3.Result and Discussion

3.1. Design Rainfall Analysis

Based on the map of the distribution of rain stations and study locations, it was found that the influential rain station for hydrological analysis in the Jalan Keputih Tegal area was Keputih Rain Station. So, for the next analysis will be used data for 10 years from the rain station.

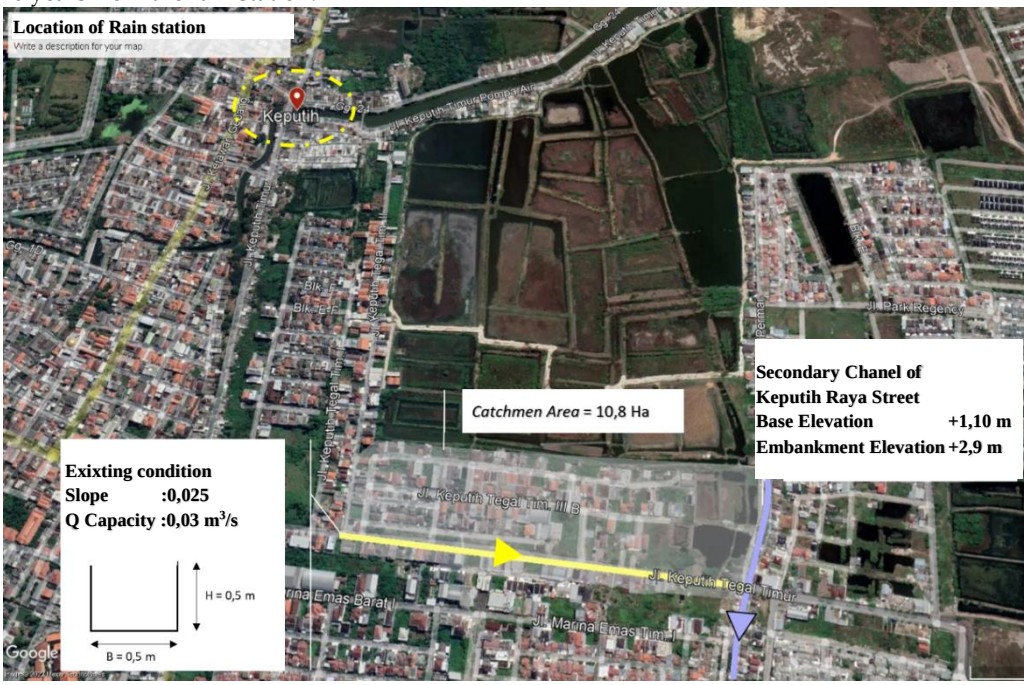

Fig. 1 Keputih Tegal channel drainage scheme and Rain Station influential (Source: Google Earth, 2019)

Table1. Maximum Rainfall of Keputih Rain Stations (RS) in 2010 – 2019 (Source: Bina Marga Surabaya Public Works Office,2019)

Year	RS Keputih
	mm
2010	90
2011	78
2012	85
2013	80
2014	134
2015	84
2016	164
2017	124
2018	49
2019	50

Based on rainfall data in Table 1, the results of planning rainfall in the study area are as follows:

Table2. Design Rainfall Analysis (*Source: Calculation Results)*

Return Period	Design Rain (mm)	
(Year)	Gumbel	Log Pearson III
1.25	57.83	66.67
2	90.23	87.82
5	133.84	121.82

10	162.70	144.40
Uji Chi Square α 1%		
Chi Square Count	7.00	3.00
Chi Square Kritis	13	13
Hypothesis	Accepted	Accepted
Uji Smirnov Kolmogorov a 1%		
D count	0.31	0.11
Critical D	0.49	0.49
Hypothesis	Accepted	Accepted

Based on Table 2, the rainfall design with Gumbel distribution has a greater result than Log Pearson III Distribution. So that for the next analysis will be used the results of the Gumbel Distribution. rainfall design with a 10-year return period for Gumbel Distribution of 162.70 mm. So that the results of this planning rainfall analysis are in accordance with rainfall data that has occurred for a period of 10 years in Table 1 with maximum rainfall. It was 164 mm in 2016.

3.2. Design Flood Discharge Analysis

Based on Figure 1, it is known that the Keputih Tegal tertiary channel holds discharge from the quaternary channel in the Keputih Tegal Timur IIIB area. So that the area of Catchment Area (CA) for the Keputih Tegal tertiary channel in this study is determined based on the area of settlement area in accordance with the SDMP (Surabaya Drainage Master Plan) map in 2018.

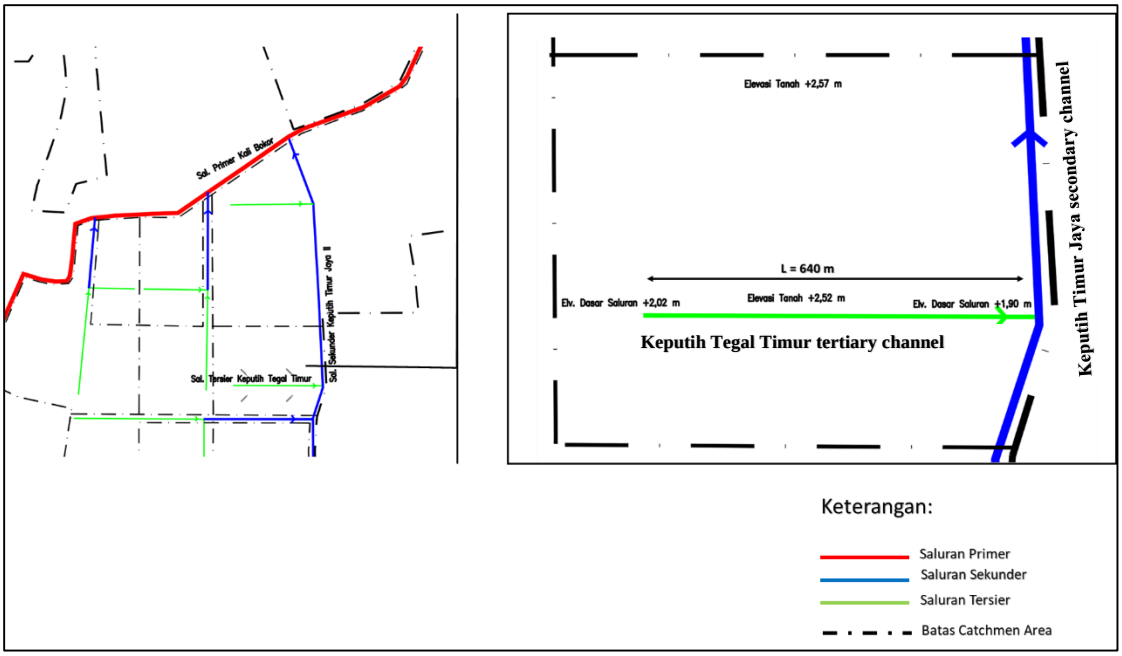

Fig 2. Drainage system on Jalan Keputih Tegal Timur (Kali Bokor Transmission System) (Source: Surabaya Drainage Master Plan (SDMP) 2018, BAPPEKO Surabaya)

Catchment The area of the Tertiary Channel of Keputih Tegal Timur is 10.8 Ha. In accordance with the area of Catchment Area, then when the flood discharge will be planned, which is 2 years with 5 years return period [6]

Table3. Flood Discharge Rational Method for Tertiary Channel Keputih Tegal (Source: Calculation result, 2021)

Review Point	CA (km²)	L (km)	S	Tc (hour)	I (mm/hour)		C	Q (m³/s)	
					2 Years	5 Years		2 Years	5 Years
Keputih Tegal Channel	0.108	0.64	0.0002	1.3	26.5	39.3	0.70	0.56	0.83

3.3. Drainage Channel Dimension Analysis and Flow Profile

Based on the results of measurements in the field and the calculation of flood discharge in Table 3, it can be known the capacity of existing channels and the dimensions of the plan in table 4.

Table4. *Capacity of Whitish Drainage Channel Tegal Existing Conditions and Plans (*Source: Calculation result, 2021)

Condition	B (m)	H (m)	A (m^2)	P (m)	R (m)	S	n	V (m/s)	Q (m^3/s)
Existing Dimensions	0.5	0.5	0.3	1.500	0.17	0.0002	0.035	0.12	0.03
Plan Dimensions	1.5	1.5	2.3	4.500	0.50	0.0004	0.03	0.40	0.90

In order to accommodate flood, discharge up to Tr 5, it takes a channel dimension of 1.5 x 1.5 m with a slope of 0.04%. It is planned that the channel is made of concrete and the flow speed is 0.4 m / sec. This condition still meets the concrete speed requirement, which is 1.5 m / sec.
Based on Figure 2, the Keputih Tegal drainage system flows towards the secondary channel of Keputih Raya, so that the flow conditions on the Keputih Tegal tertiary channel are affected by the high FWL (Flood Water Level) on the secondary channel.

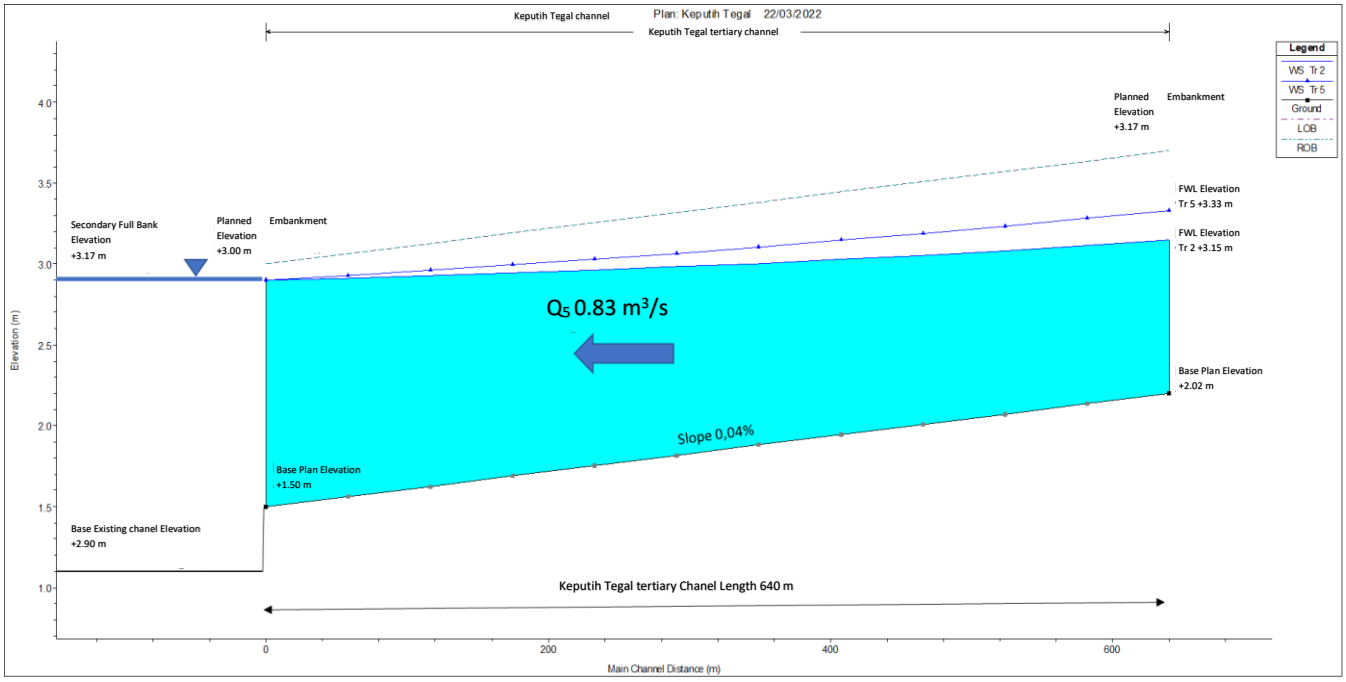

Figure 3. Keputih Tegal's Tertiary Channel Flow Profile Plan (Source: Calculation result, 2021)

Based on Figure 3, it is known that if the flow conditions on the secondary channel are at the maximum condition, namely full bank, with an elevation of FWL +2.9, then the dimensions of the tertiary channel plan are still white. able to accommodate discharges derived from the area catchment area and backwater.

6. Conclusion

Based on the results of the analysis, the formulation of problems in this study can be concluded as follows:

1. The flood discharge used in this study was on the 2-year and 5-year anniversary. With a discharge of 0.56 m3/sec and 0.83 m3/sec respectively
2. The existing dimensions of the Keputih Tegal tertiary channel have a capacity of 0.03 m3 / sec. So it can be known that the channel is not able to accommodate the flood discharge that occurs.
3. Based on the flood discharge from the CA area and the Keputih Tegal channel drainage system which is affected by the height of the secondary channel FWL, it takes a channel dimension of 1.5 x 1.5 m with a capacity of 0.9 m3 / sec. The dimensions of the channel are able to accommodate flood discharge and backwater discharge. The slope of the channel is planned to be 0.04% with a flow speed of 0.4 m / sec. This condition meets the permit speed requirements on concrete channels that have a value of < 1.5 m / sec.

References

[1] P. LINTAS, "Jurusan Teknik Sipil Fakultas Teknik Universitas 17 Agustus 1945 Samarinda Samarinda," *Core.Ac.Uk*, pp. 1–9, 1945, [Online]. Available: https://core.ac.uk/download/pdf/296265607.pdf.

[2] D. Fairizi, J. S. Negara, B. Palembang, and S. Selatan, "Analisis dan Evaluasi Saluran Drainase Pada Kawasan PERUMNAS Talang Kelapa di Subdas Lambirado Kota Palembang," *J. Tek. Sipil dan Lingkung.*, vol. 3, no. 1, pp. 755–765, 2015.

[3] I. N. T. City, "DRAINAGE HANDLING SYSTEM," vol. 20, no. 3, pp. 176–181, 2020.

[4] J. Suparmanto, M. Bisri, and R. W. Sayekti, "Berbasis Konservasi Air Di Kota Kupang Das Dendeng – Merdeka Propinsi Nusa Tenggara Timur."

[5] M. H. Thamrin, H. Ridho, and F. A. Nasution, "Institutional Coordination of Flood Control At Medan City in Mebidangro Cooperation Scheme," *Sosiohumaniora*, vol. 23, no. 3, p. 391, 2021, doi: 10.24198/sosiohumaniora.v23i3.31620.

[6] Suripin, *Drainase Perkotaan yang Berkelanjutan*. Yogyakarta: Andi offset, 2004.