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# INUNDATION ANALYSIS OF SOUTH JAKARTA JALAN TIONG AREA USING HEC-RAS

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***ABSTRACT***

The Tiong Channel is located on Jalan Tiong Karet Kuningan, South Jakarta, geographically located between 6°13'06.5" South Latitude and 106°49'17.0" East Longitude. On Jalan Tiong often floods when the rainy season arrives. The flood was caused by several factors, one of which was the drainage channel that could not function properly. At several points in the water channel that will lead to the Krukut River there is a lot of plastic waste from residents which causes narrowing of the channel. The non-uniform channel dimensions are also the cause of flooding, there are several channel points that experience narrowing. From the above conditions, it is necessary to do an analysis of flood problems in the Tiong Karet Kuningan Canal area of South Jakarta to find out whether the Tiong Karet Kuningan Canal in South Jakarta can still accommodate water discharge based on rainfall in the last 10 years and whether the Tiong Karet Kuningan Canal in South Jakarta needs to be normalized. Based on the results of manual calculations and the HEC-RAS application, the Tiong Karet Kuningan Canal in South Jakarta cannot accommodate water discharge based on rainfall in the last 10 years of 12.61 m3/s. At point 0 – point 350 it is necessary to normalize by widening the channel to 2 m and increasing the depth/height of the channel to 2 m. and planning of sluice gates on the downstream of the canal.

***Keywords:*** channels 1, floods 2, pumps 3, sluice 4 and HEC-RAS 5

## 1. INTRODUCTION

Jalan Tiong is an environmental road where ordinary residents pass through the road. The road is in a basin area and has a canal that collects water flow from several surrounding complexes. The average depth of the canal is 1.3 meters from the face of Jalan Tiong, with a width of 1.5 meters, with a catchment area of 0.31 km2.

When it rains with a high enough intensity, problems with flooding or inundation start to arise. Based on information from local residents, when it rains with high intensity for 1-2 hours, the water level from the canal has risen and inundated the settlements by up to 50 cm. but this flood did not last long if the rain had stopped then the flood also slowly receded. The things that cause flooding are the channel narrowing and sedimentation originating from silt, plastic waste and inadequate utilities around the channel which narrows the cross-sectional area of the channel so that the flowing water is not accommodated and overflows into residential areas.

The channel flow on Jalan Tiong leads to the main channel, namely the large river on the west side, namely the Krukut River. In this area there is no drainage pump which is expected to be able to help remove excess flow discharge. Drainage is a technical measure to reduce excess water, whether it comes from rainwater, seepage, or excess irrigation water from an area/land, so that the function of the area/land is not disturbed (Suripin, 2004).

From these conditions, the author wants to analyze the problems that cause flooding in the Tiong Street area, South Jakarta, which is hoped from this analysis can be input for local agencies and the government so they can deal with frequent flooding problems.

## 2. THEORETICAL BASIS

The DKI Public Works Service Book explains that flooding is a condition when the water flow and/or water level elevation in a river or river or canal is larger or higher than normal. Puddles that arise in low areas as a result are also included in this definition.

Inundation is an event where water stops or water does not flow. It is possible that in one location there is a pool of water even though the water level in the river is still below average. However, the substance remains the same. It means the same as there is stagnant water. It's just that, technically the handling can be different because one is caused by the overflow of water in the river/river, while the other is caused by no water flowing because it is blocked by a canal.

The fundamental difference between a flood and a puddle lies in how high the water level is. If the water that has stagnated after heavy rains in Jakarta is at a height of no more than 40 centimeters, then it is simply referred to as the puddle phase. If the stagnant water is more than 40 cm and has to make people evacuate on a large scale, then this is categorized as a flood (Teguh, 2015).

Hydrology is one of the factors needed to solve a problem of water resources. Hydrological analysis is an important step in planning drainage because it can determine the amount of runoff or discharge that must be accommodated. The data included in hydrology are the area of the drainage area, the size and frequency of the planned rain intensity and the water catchment area.

Hidrologic Engineering Center (HEC) U.S. Army Corps of Engineering in 1995 developed HEC-RAS which is a non-commercial software. This program is designed to calculate water level profiles for steady and gradually varied flow in natural or man-made channels. HEC-RAS has the main objective to calculate the water level elevation at the cross-sectional location studied along a river or stream for certain flow values. Profile calculations are performed on cross-sections with known or estimated initial conditions, then proceed upstream for subcritical flow types and downstream for supercritical flow types (Bedient et al, 2008).

### Research purposes

The purpose of this study is to determine the magnitude of the flood discharge in the south jakarta tiong road channel, with Q10 and identify flood-prone areas and provide solutions to flooding problems that occur in the south jakarta tiong road channel,

### Research sites

The location for this research is Jalan Tiong, South Jakarta, which is a flood area.


**Figure 1.** Viewed Location Points

(Source: Analysis Results Using Google Earth)

## Research methodology

### Research flow chart

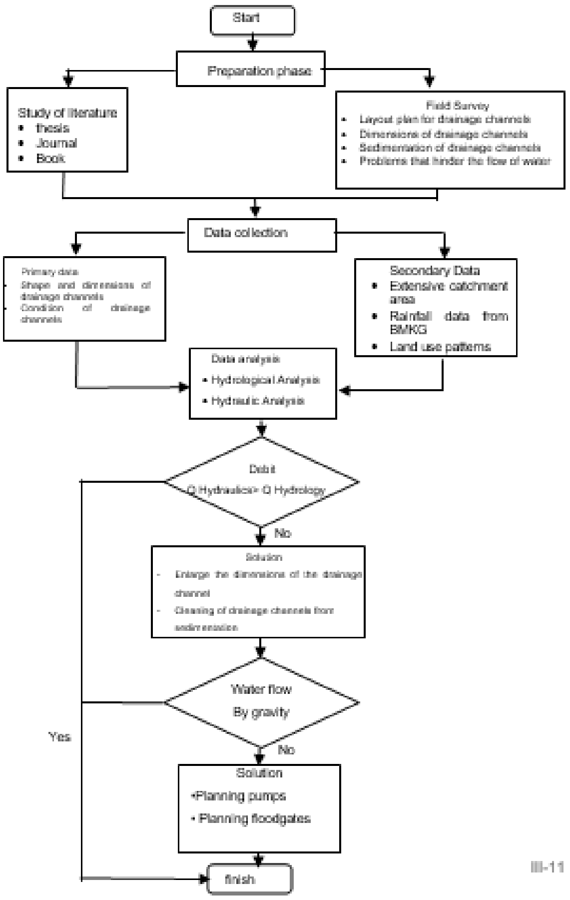



**Figure 2. Flow chart**

### Data collection

1. Primary Data
   Primary data is data obtained by direct observation in the field, primary data consists of:
   a. Drainage channel
      The data taken is the wall of the channel to determine the value of manning roughness, height and width of the channel.

   b. Secondary data
      Secondary data is data obtained from agencies that are related to planning, controlling and handling floods. Includes Study Location, Catchment area, Rainfall, Land use Map and existing river discharge.

## 3. RESULTS AND DISCUSSION

### Hydrological Analysis

Hydrological data includes, among other things, the area of the drainage area, the amount and frequency of rainfall intensity. The size of the catchment area will affect surface runoff, while the catchment area can be determined from aerial photographs or topographical maps. This is intended so that the hydrological analysis can approach the actual conditions that occur in the field. Rainfall data were obtained from rain gauge stations and rain post stations located in the area around the study site and can represent the frequency of rainfall that falls in the catchment area. In determining the catchment area, it can be viewed from the highest elevation to the highest elevation. Lowest. The planned flood discharge planning is based on the amount of rainfall in the planned return period in accordance with the Log Person III Distribution standard. For the analysis of the planned rainfall, 25 years of observational data from the Kemayoran rainfall recording station were used.

### Calculation of Return Period Hydrology

Determine the hydrological design of the return period (T) in accordance with the area of the catchment area of the Tiong Road area obtained from Google Earth and direct surveys to the location, with an area of 309,447 m2 or converted to 0.309 km2, therefore according to table 2.8 a 5 year return period is used . As for the residential area of the metropolitan city, the return period will be increased one notch above the standard. So the return period used is the return period (T) of 10 years.


**Figure 3.** Catchment Area of Jalan Tiong Street, South Jakarta

## Rainfall analysis

The rainfall data used for 25 years from 1999 to 2023. The rainfall data obtained is the maximum daily rainfall data from the nearest station, namely: Kemayoran Meteorological Station. Rain data taken is the biggest rain in each year. The data can be seen in table 1 as follows:

**Table 1.** Maximum annual return period rainfall data

| No | Year | Monthly rainfall data (mm) | | | | | | | | | | | | Rain max |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Des | |
| 1 | 1999 | 50,1 | 50,2 | 13,6 | 17,4 | 47,4 | 21,4 | 147,2 | 0,3 | 38,6 | 46 | 54,4 | 77,4 | 147,2 |
| 2 | 2000 | 94,8 | 60,8 | 22,5 | 58,5 | 30,2 | 20,8 | 3,8 | 27,6 | 14 | 10,5 | 30,6 | 42 | 94,8 |
| 3 | 2001 | 82,2 | 55,6 | 41,7 | 50,8 | 28,8 | 45,5 | 11,6 | 50,2 | 5 | 39,3 | 44,4 | 51,4 | 82,2 |
| 4 | 2002 | 107,6 | 168,5 | 104,8 | 22,1 | 35,5 | 1,2 | 60,5 | 0 | 0 | 3 | 38 | 50,2 | 168,5 |
| 5 | 2003 | 59 | 89,3 | 35,9 | 41 | 27,4 | 3,2 | 0 | 2,1 | 13,6 | 71,2 | 87 | 199,7 | 199,7 |
| 6 | 2004 | 57,5 | 66 | 74,5 | 129,3 | 24,7 | 43 | 40,5 | 17,3 | 0 | 26,7 | 18 | 63,5 | 129,3 |
| 7 | 2005 | 124,1 | 63,3 | 95,7 | 45,8 | 29 | 33,8 | 61,4 | 19,5 | 44,8 | 53 | 49,8 | 23,6 | 124,1 |
| 8 | 2006 | 65 | 71,1 | 61,2 | 72 | 30 | 27,6 | 19,8 | 0 | 0,2 | 10,6 | 17 | 28,9 | 72 |
| 9 | 2007 | 68,4 | 234,7 | 35,9 | 49,4 | 70,8 | 52,4 | 32,9 | 32,1 | 23,4 | 26,3 | 25,6 | 84 | 234,7 |
| 10 | 2008 | 117 | 192,7 | 49,3 | 75,6 | 15,7 | 20 | 9,5 | 24,6 | 94,4 | 45,8 | 26,2 | 50,4 | 192,7 |
| 11 | 2009 | 122,5 | 38,3 | 68,1 | 56 | 101,5 | 32 | 7 | 4,5 | 76,5 | 47 | 112 | 59,2 | 122,5 |
| 12 | 2010 | 73,9 | 68 | 85,7 | 20,7 | 21 | 43,8 | 73 | 55,5 | 57,9 | 93 | 39,9 | 52,2 | 93 |
| 13 | 2011 | 37 | 119,2 | 49 | 32,5 | 62,8 | 30,6 | 7,4 | 1,5 | 50,4 | 21,4 | 14 | 67,2 | 119,2 |
| 14 | 2012 | 55,7 | 16 | 56,3 | 59 | 42,4 | 42,6 | 21 | 0 | 19,2 | 12,5 | 105,2 | 54,2 | 105,2 |
| 15 | 2013 | 193,4 | 35,6 | 38 | 48,2 | 38,9 | 42,3 | 42,3 | 26,6 | 25,4 | 65,1 | 41,6 | 70,6 | 193,4 |
| 16 | 2014 | 147,9 | 108,2 | 26,2 | 53,5 | 12,1 | 62 | 46 | 36,9 | 0,1 | 37,5 | 41 | 49 | 147,9 |
| 17 | 2015 | 134,3 | 277,5 | 55,3 | 33,3 | 16,6 | 6,9 | 0 | 5,2 | 0 | 0 | 54,1 | 93,2 | 277,5 |
| 18 | 2016 | 30,8 | 115 | 90,8 | 124,5 | 53 | 59 | 76 | 50 | 59,8 | 21 | 51 | 14,8 | 124,5 |
| 19 | 2017 | 45 | 179,7 | 23,3 | 49,6 | 46,5 | 45,5 | 81,4 | 0,8 | 71 | 50 | 60,7 | 90,7 | 179,7 |
| 20 | 2018 | 46,4 | 104,6 | 51 | 52,3 | 7,8 | 6,7 | 14,5 | 32,8 | 36,6 | 94,5 | 47 | 23,4 | 104,6 |
| 21 | 2019 | 86,6 | 49 | 90,5 | 50,6 | 24,5 | 18,1 | 0 | 0 | 0 | 1 | 33 | 40 | 90,5 |
| 22 | 2020 | 145,3 | 277,5 | 63,6 | 72 | 29 | 6,5 | 9 | 68,3 | 2,5 | 57,6 | 26 | 34,8 | 277,5 |
| 23 | 2021 | 43,8 | 94,1 | 67,2 | 73,4 | 92,2 | 31,4 | 17,8 | 66,5 | 36,7 | 55,3 | 34 | 65,6 | 94,1 |
| 24 | 2022 | 204 | 88,3 | 34,5 | 66,6 | 35,2 | 32,6 | 36 | 15,4 | 55,8 | 48,6 | 42,4 | 38,5 | 204 |
| 25 | 2023 | 35,3 | 76,9 | 79,5 | 66,6 | 45,5 | 1,7 | 0 | 0 | 0 | 0 | 0 | 0 | 79,5 |

Analysis of the frequency of rainfall is needed to determine the appropriate type of distribution (distribution) and according to the requirements for selecting the type of distribution.

**Table 2.** Calculation of distribution for rainfall

| Tahun | Xi | Xi - X | $(Xi-X)^2$ | $(Xi-X)^3$ | $(Xi-X)^4$ |
|---|---|---|---|---|---|
| 1999 | 147,2 | 1 | 1 | 1 | 0,57 |
| 2000 | 94,8 | -52 | 2656 | -136846 | 7051930,00 |
| 2001 | 82,2 | -64 | 4113 | -263769 | 16916056,83 |
| 2002 | 168,5 | 22 | 491 | 10894 | 241493,84 |
| 2003 | 199,7 | 53 | 2848 | 152000 | 8111920,96 |
| 2004 | 129,3 | -17 | 290 | -4941 | 84151,64 |
| 2005 | 124,1 | -22 | 494 | -10988 | 244294,75 |
| 2006 | 72 | -74 | 5525 | -410703 | 30528345,84 |
| 2007 | 234,7 | 88 | 7809 | 690057 | 60978972,69 |
| 2008 | 192,7 | 46 | 2150 | 99691 | 4622463,12 |
| 2009 | 122,5 | -24 | 568 | -13536 | 322583,36 |
| 2010 | 93 | -53 | 2844 | -151692 | 8090055,14 |
| 2011 | 119,2 | -27 | 736 | -19973 | 541910,09 |
| 2012 | 105,2 | -41 | 1692 | -69589 | 2862327,40 |
| 2013 | 193,4 | 47 | 2215 | 104274 | 4907982,20 |
| 2014 | 147,9 | 2 | 2 | 4 | 6,04 |
| 2015 | 277,5 | 131 | 17205 | 2256751 | 296013546,75 |
| 2016 | 124,5 | -22 | 477 | -10406 | 227182,09 |
| 2017 | 179,7 | 33 | 1113 | 37153 | 1239711,72 |
| 2018 | 104,6 | -42 | 1742 | -72679 | 3033030,62 |
| 2019 | 90,5 | -56 | 3117 | -174040 | 9717012,05 |
| 2020 | 277,5 | 131 | 17205 | 2256751 | 296013546,75 |
| 2021 | 94,1 | -52 | 2728 | -142498 | 7442976,06 |
| 2022 | 204 | 58 | 3326 | 191781 | 11059603,55 |
| 2023 | 79,5 | -67 | 4467 | -298506 | 19949767,18 |
| **Total** | **3658,3** | **0** | **85814,5944** | **4019189,788** | **790200871,2** |

## Average Rainfall

Average value ($\bar{X}$) $= \dfrac{\sum_{i=1}^{n} \log Xi}{\text{n}}$

$= \dfrac{3.658{,}3}{25}$

$= 146{,}33$

## Standard deviation (Sd)

Standard deviation (Sd) $= \sqrt{\dfrac{\sum_{i=1}^{n}(Xi-X)^2}{\text{n}-1}}$

$= \sqrt{\dfrac{85.814{,}59}{25-1}}$

$= 59{,}80$

## Coefficient of Variation

Coefficient of Variation $= \dfrac{59{,}80}{146{,}33}$

$= 0{,}41$

## Slope coefficient

Slope coefficient (Cs)= $\dfrac{n\,.\ \sum_{i=1}^{n}(Xi - X)^3}{(\text{n}-1).(n-2)\ .\ (Sd)^3}$

$= \dfrac{25\ x\ 4019189{,}788}{(25-1)\ \text{x}\ (25-2)\ x\ 59{,}80^3}$

$= 0{,}85$

## Sharpness coefficient

Sharpness coefficient (Ck)= $\dfrac{n\,.\ \sum_{i=1}^{n}(Xi - X)^4}{(\text{n}-1).(n-2)\ .(n-3).(Sd)^4}$

$= \dfrac{25^2\ x\ 790200871{,}2}{24\ \text{x}\ 23\ x\ 22\ x\ (59{,}80)^4}$

$= 3{,}18$

## Distribution method

The following table results of calculations to determine the distribution method:

**Table 3.** Calculation results of the distribution method and the terms of the distribution method.

| No | Distribution | Condition | Results | Information |
|---|---|---|---|---|
| 1 | Gumbel | Cs = 1.1396 | Cs = 0.85 | Does not meet the |
| | | Ck = 5.4002 | Ck = 3.18 | Does not meet the |
| 2 | Normal | Cs = 0 | Cs = 0.85 | Does not meet the |
| | | Ck = 3 | Ck = 3.18 | Does not meet the |
| 3 | Log Normal | Cs = 3 atau 3Cv | Cs = 0.85 | Does not meet the |
| | | | Cv = 0.41 | |
| 4 | Log Person III | have no conditions | Cs = 0.85 | **Fulfil** |
| | | | Ck = 3.18 | **Fulfil** |

Based on the calculation and analysis of rainfall data, the method that meets the requirements is the Pearson III log.

## Pearson Log Method Plan Rainfall III

To determine the magnitude of the planned flood discharge, the method used is the Type III Log Person Method. The log pearson III method has no requirements on the slope coefficient and sharpness coefficient to calculate the design rainfall.

**Table 4.** Planned rainfall Pearson log method III

| Tahun | Xi | Log Xi | LogXi-LogX | $(LogXi-LogX)^2$ | $(LogXi-LogX)^3$ |
|---|---|---|---|---|---|
| 1999 | 147,2 | 2,1679 | 0,0354 | 0,0013 | 0,0000 |
| 2000 | 94,8 | 1,9768 | -0,1557 | 0,0242 | -0,0038 |
| 2001 | 82,2 | 1,9149 | -0,2176 | 0,0474 | -0,0103 |
| 2002 | 168,5 | 2,2266 | 0,0941 | 0,0089 | 0,0008 |
| 2003 | 199,7 | 2,3004 | 0,1679 | 0,0282 | 0,0047 |
| 2004 | 129,3 | 2,1116 | -0,0209 | 0,0004 | 0,0000 |
| 2005 | 124,1 | 2,0938 | -0,0387 | 0,0015 | -0,0001 |
| 2006 | 72 | 1,8573 | -0,2751 | 0,0757 | -0,0208 |
| 2007 | 234,7 | 2,3705 | 0,2380 | 0,0567 | 0,0135 |
| 2008 | 192,7 | 2,2849 | 0,1524 | 0,0232 | 0,0035 |
| 2009 | 122,5 | 2,0881 | -0,0443 | 0,0020 | -0,0001 |
| 2010 | 93 | 1,9685 | -0,1640 | 0,0269 | -0,0044 |
| 2011 | 119,2 | 2,0763 | -0,0562 | 0,0032 | -0,0002 |
| 2012 | 105,2 | 2,0220 | -0,1105 | 0,0122 | -0,0013 |
| 2013 | 193,4 | 2,2865 | 0,1540 | 0,0237 | 0,0037 |
| 2014 | 147,9 | 2,1700 | 0,0375 | 0,0014 | 0,0001 |
| 2015 | 277,5 | 2,4433 | 0,3108 | 0,0966 | 0,0300 |
| 2016 | 124,5 | 2,0952 | -0,0373 | 0,0014 | -0,0001 |
| 2017 | 179,7 | 2,2545 | 0,1221 | 0,0149 | 0,0018 |
| 2018 | 104,6 | 2,0195 | -0,1129 | 0,0128 | -0,0014 |
| 2019 | 90,5 | 1,9566 | -0,1758 | 0,0309 | -0,0054 |
| 2020 | 277,5 | 2,4433 | 0,3108 | 0,0966 | 0,0300 |
| 2021 | 94,1 | 1,9736 | -0,1589 | 0,0252 | -0,0040 |
| 2022 | 204 | 2,3096 | 0,1771 | 0,0314 | 0,0056 |
| 2023 | 79,5 | 1,9004 | -0,2321 | 0,0539 | -0,0125 |
| **Jumlah** | **3.658,30** | **53,31** | **0,00** | **0,70** | **0,03** |

## Calculating Average X Log Value

The average log ẋ value is calculated by the following formula:

$$\text{Log } \dot{x} = \frac{\sum_{i=1}^{n} \log Xi}{n}$$

$$= \frac{53{,}31}{25}$$

$$= 2{,}13$$

## Calculating the standard deviation of the log person III

The standard deviation of log x can be calculated using the following formula

$$\text{Sd Log x} = \left[\frac{\sum_{i=1}^{n} (\log Xi - \log x)^2}{n-1}\right]^{0.5}$$

$$= \left[\frac{0{,}70}{24}\right]^{0.5}$$

$$= 0{,}17$$

## Calculating the slope coefficient (Cs)

The slope coefficient value can be calculated by the following formula

$$Cs = \frac{n \cdot \sum_{i=1}^{n} (\log Xi - \log x)^3}{(n-1)(n-2) \cdot S^3}$$

$$= \frac{25 \, x \, 0{,}03}{(25-1)(25-2) \cdot 0{,}17^3}$$

$$= 0{,}27$$

## Return Period Maximum Rainfall

Calculating the amount of rainfall for the repeated year period in the distribution of log person III as follows:

*Log XT = log ẋ + KT * Sd log x*

The value of the frequency factor (KT) is obtained by interpolating for periods (T) of 2, 5, 10, 25, 50, 100, and 200 years, if it is known that the slope coefficient (Cs) is 0.27, then the frequency factor value is as follows:

**Table 5.** Value of the frequency factor (KT) for the Pearson III Log distribution

| CS | Period In Years | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 100 | 200 |
| 0,3 | -0,050 | 0,824 | 1,309 | 1,849 | 2,211 | 2,544 | 2,856 |
| **0,27** | **-0,044** | **0,826** | **1,306** | **1,839** | **2,193** | **2,520** | **2,825** |
| 0,2 | -0,033 | 0,830 | 1,301 | 1,818 | 2,159 | 2,472 | 2,763 |

Source: Applied Hydrology (Bambang Triatmodjo, 2008)

*Log XT = log ẋ + KT * Sd log x*

*Log XT* = 2,13 + ( 1,839 * 0,17 )

= 2,45

The formula for calculating rainfall for the return period is the opposite of the XT or Antilog log *XT*

*XT* = Antilog *XT*

= Antilog 2,44

= 279,61

**Table 6** maximum rainfall return period**.**

| Period (T) | Log X | Mark (KT) | Sd log x | Log Xt | Antilog Xt (mm) |
|---|---|---|---|---|---|
| 2 | 2,13 | -0,044264764 | 0,17 | 2,12 | 133,33 |
| 5 | 2,13 | 0,826024201 | 0,17 | 2,27 | 187,75 |
| 10 | 2,13 | 1,306301065 | 0,17 | 2,36 | 226,80 |
| 25 | 2,13 | 1,838541628 | 0,17 | 2,45 | 279,61 |
| 50 | 2,13 | 2,193456924 | 0,17 | 2,51 | 321,51 |
| 100 | 2,13 | 2,519709588 | 0,17 | 2,56 | 365,53 |
| 200 | 2,13 | 2,824624884 | 0,17 | 2,62 | 412,11 |

Source: Calculation Results.

**Design Debit Analysis (Qt)**

The following is the calculation stage for the planned channel discharge:

- Run-off coefficient (C)

To determine the run off coefficient (C), the catchment area is divided into 2 parts, namely housing and roads.

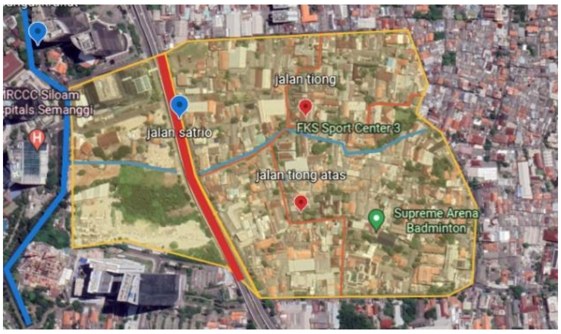



**Figure 4.** Allotment of land functions.

The value of the run off coefficient (C) according to table 2.9 for the type of residential area is 0.75 and 0.95 for roads. With a catchment area of 0.309 km$^2$

How to determine the area in table 4.7 by surveying the field and plotting it using the Google Earth application.

**Table 7.** Result of channel Flow Coefficient calculation.

| No | Region | Wide (A) km2 | Koef. Run off | Koef. Run off |
|---|---|---|---|---|
| 1 | Road | 0,0212 | 0,95 | 0,02014 |
| 2 | Housing area | 0,288247 | 0,75 | 0,21618525 |
| | Total | 0,309447 | | 0,23632525 |

Average C calculation:

$$C \text{ average} = \frac{\sum_{i=1}^{n} Ci \cdot Ai}{\sum_{i=1}^{n} Ai} = \frac{0{,}02014+0{,}21618525}{0{,}0212+0{,}288247} = \frac{0{,}23632525}{0{,}309447} = 0{,}76$$

- Channel tilt

The slope and length of the channel are obtained from google earth. From the measurement results the Tiong canal has a length of 580 meters, the upstream elevation is 13.5 m and the downstream elevation is 8 m. The following is the calculation of the slope of the Tiong PHB channel:

$$S = \frac{\Delta H}{L} = \frac{(13{,}5-8)}{580} = 0{,}0095$$

- Concentration time (Tc)

$$Tc = \frac{0{,}0195 \; x \; L^{0{,}77}}{S^{0{,}385}} = \frac{0{,}0195 \; x \; 580^{0{,}77}}{0{,}0095^{0{,}385}} = 15{,}79 \text{ Minute} = 0{,}26 \text{ hour}$$

- Rain Intensity (I)

Rainfall intensity can be calculated using the Mononobe formula, with the available rainfall data being the average daily maximum rainfall data.

$$\text{Rain Intensity } I = \frac{R_{24}}{24}\left(\frac{24}{tc}\right)^{2/3}$$

Where :

I = rainfall intensity

Tc = concentration time

**Table 8.** Result of rain intensity calculation

| Return period (T) | design rainfall (R) | concentration time (Tc) | rainfall intensity (I) |
|---|---|---|---|
| year | mm | hr | mm/hr |
| 2 | 133,33 | 0,26 | 112,84 |
| 5 | 187,75 | 0,26 | 158,90 |
| 10 | 226,80 | 0,26 | **191,94** |
| 25 | 279,61 | 0,26 | 236,64 |
| 50 | 321,51 | 0,26 | 272,09 |
| 100 | 365,53 | 0,26 | 309,35 |
| 200 | 412,11 | 0,26 | 348,77 |

Source: Calculation Results.

**Plan channel discharge (Q_Hydroligi)**

Planned channel discharge can be calculated by the formula

Q = 0.278 x C x I x A

Where :

Q = Peak discharge of surface runoff (m$^3$/sec)

C = Flow rate

A = Area of catchment area (Km$^2$)

I = Rainfall intensity (mm/hour)

**Table 9**. Calculation results of planned channel discharge

| Return period (T) | Run off coefficient (c) | Area (A) | rainfall intensity (I) | Discharge (Q) |
|---|---|---|---|---|
| year | | km2 | mm/hr | m3/sec |
| 2 | 0,76 | 0,31 | 112,84 | 7,41 |
| 5 | 0,76 | 0,31 | 158,90 | 10,44 |
| 10 | 0,76 | 0,31 | 191,94 | **12,61** |
| 25 | 0,76 | 0,31 | 236,64 | 15,55 |
| 50 | 0,76 | 0,31 | 272,09 | 17,88 |
| 100 | 0,76 | 0,31 | 309,35 | 20,32 |
| 200 | 0,76 | 0,31 | 348,77 | 22,91 |

## Existing Channel Discharge (QHydraulics)

Hydraulic analysis aims to determine the ability of the cross section to accommodate the design discharge.

**Existing Channel Hydraulics Analysis (Qs)**

The construction of the Tiong canal wall is made of split stone masonry, according to table 2.9, the value of the Manning coefficient is 0.012. The following is the calculation of the existing channel discharge at each channel point, namely point 0 to point 580

**Table 10.** Calculation of the cross-sectional area and wet circumference of the channel.

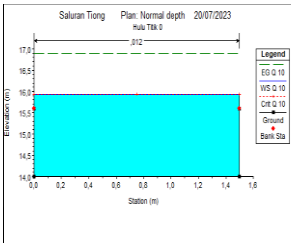
| Point | channel height (h) | channel width (b) | A | P |
|---|---|---|---|---|
| | | | (b.h) | (b+2.h) |
| 0+00 | 1,60 | 1,50 | 2,40 | 4,70 |
| 0+025 | 1,65 | 1,45 | 2,39 | 4,75 |
| 0+050 | 1,55 | 1,40 | 2,17 | 4,50 |
| 0+075 | 1,60 | 1,50 | 2,40 | 4,70 |
| 0+100 | 1,50 | 1,50 | 2,25 | 4,50 |
| 0+125 | 1,85 | 1,25 | 2,31 | 4,95 |
| 0+150 | 1,61 | 1,45 | 2,33 | 4,67 |
| 0+175 | 1,20 | 1,55 | 1,86 | 3,95 |
| 0+200 | 1,25 | 1,65 | 2,06 | 4,15 |
| 0+225 | 1,40 | 1,55 | 2,17 | 4,35 |
| 0+250 | 1,50 | 1,40 | 2,10 | 4,40 |
| 0+275 | 1,55 | 1,50 | 2,33 | 4,60 |
| 0+300 | 1,60 | 1,45 | 2,32 | 4,65 |
| 0+325 | 1,60 | 1,50 | 2,40 | 4,70 |
| 0+350 | 1,50 | 1,50 | 2,25 | 4,50 |
| 0+375 | 2,00 | 1,80 | 3,60 | 5,80 |
| 0+400 | 2,00 | 1,90 | 3,80 | 5,90 |
| 0+425 | 2,00 | 2,00 | 4,00 | 6,00 |
| 0+450 | 2,00 | 2,20 | 4,40 | 6,20 |
| 0+475 | 2,20 | 2,50 | 5,50 | 6,90 |
| 0+500 | 2,20 | 2,50 | 5,50 | 6,90 |
| 0+525 | 2,30 | 3,00 | 6,90 | 7,60 |
| 0+550 | 2,40 | 3,00 | 7,20 | 7,80 |
| 0+575 | 2,50 | 3,00 | 7,50 | 8,00 |
| 0+580 | 2,50 | 3,00 | 7,50 | 8,00 |

To determine whether or not it overflows, that is by matching the calculation results of the existing channel discharge (Qhydrologics) with the planned channel discharge (Qhidrology), which is equal to 12.61 $m^3$/sec.

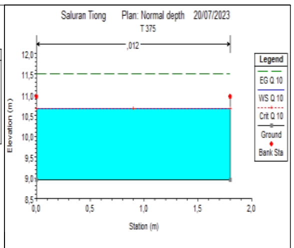
**Table 11**. Calculation of the cross-sectional area and wet circumference of the channel.

| Point | No | cross-sectional area | wet around | hydraulic spokes | koef manning | s | flow speed | Channel discharge | Debit plan 25 year |
|---|---|---|---|---|---|---|---|---|---|
| | | A | P | R | n | | V (m/det) | Q hidrolika ($m^3$/det) | Q hidologi (m/det) |
| | | $m^2$ | (m) | (m) | | | | | |
| 0+00 | 0 | 2,40 | 4,70 | 0,51 | 0,012 | 0,0095 | 5,184 | 12,44 | **overflow** |
| 0+025 | 1 | 2,39 | 4,75 | 0,50 | 0,012 | 0,0095 | 5,137 | 12,29 | **overflow** |
| 0+050 | 2 | 2,17 | 4,50 | 0,48 | 0,012 | 0,0095 | 4,990 | 10,83 | **overflow** |
| 0+075 | 3 | 2,40 | 4,70 | 0,51 | 0,012 | 0,0095 | 5,184 | 12,44 | **overflow** |
| 0+100 | 4 | 2,25 | 4,50 | 0,50 | 0,012 | 0,0095 | 5,112 | 11,50 | **overflow** |
| 0+125 | 5 | 2,31 | 4,95 | 0,47 | 0,012 | 0,0095 | 4,886 | 11,30 | **overflow** |
| 0+150 | 6 | 2,33 | 4,67 | 0,50 | 0,012 | 0,0095 | 5,111 | 11,93 | **overflow** |
| 0+175 | 7 | 1,86 | 3,95 | 0,47 | 0,012 | 0,0095 | 4,912 | 9,14 | **overflow** |
| 0+200 | 8 | 2,06 | 4,15 | 0,50 | 0,012 | 0,0095 | 5,092 | 10,50 | **overflow** |
| 0+225 | 9 | 2,17 | 4,35 | 0,50 | 0,012 | 0,0095 | 5,104 | 11,08 | **overflow** |
| 0+250 | 10 | 2,10 | 4,40 | 0,48 | 0,012 | 0,0095 | 4,956 | 10,41 | **overflow** |
| 0+275 | 11 | 2,33 | 4,60 | 0,51 | 0,012 | 0,0095 | 5,149 | 11,97 | **overflow** |
| 0+300 | 12 | 2,32 | 4,65 | 0,50 | 0,012 | 0,0095 | 5,105 | 11,84 | **overflow** |
| 0+325 | 13 | 2,40 | 4,70 | 0,51 | 0,012 | 0,0095 | 5,184 | 12,44 | **overflow** |
| 0+350 | 14 | 2,25 | 4,50 | 0,50 | 0,012 | 0,0095 | 5,112 | 11,50 | **overflow** |
| 0+375 | 15 | 3,60 | 5,80 | 0,62 | 0,012 | 0,0095 | 5,905 | 21,26 | Not Overflow |
| 0+400 | 16 | 3,80 | 5,90 | 0,64 | 0,012 | 0,0095 | 6,052 | 23,00 | Not Overflow |
| 0+425 | 17 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+450 | 18 | 4,40 | 6,20 | 0,71 | 0,012 | 0,0095 | 6,456 | 28,41 | Not Overflow |
| 0+475 | 19 | 5,50 | 6,90 | 0,80 | 0,012 | 0,0095 | 6,976 | 38,37 | Not Overflow |
| 0+500 | 20 | 5,50 | 6,90 | 0,80 | 0,012 | 0,0095 | 6,976 | 38,37 | Not Overflow |
| 0+525 | 21 | 6,90 | 7,60 | 0,91 | 0,012 | 0,0095 | 7,609 | 52,50 | Not Overflow |
| 0+550 | 22 | 7,20 | 7,80 | 0,92 | 0,012 | 0,0095 | 7,693 | 55,39 | Not Overflow |
| 0+575 | 23 | 7,50 | 8,00 | 0,94 | 0,012 | 0,0095 | 7,773 | 58,30 | Not Overflow |
| 0+580 | 24 | 7,50 | 8,00 | 0,94 | 0,012 | 0,0095 | 7,773 | 58,30 | Not Overflow |

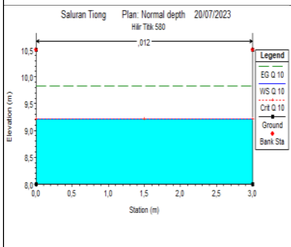
## .Analysis using HEC RAS



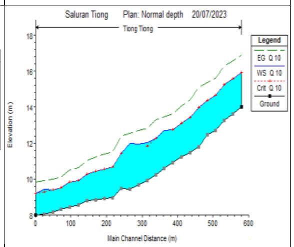

Upstream Point T 0 The channel is unable to accommodate the planned discharge.




The T375 Channel point is capable of accommodating the planned discharge.




The T 580 Channel Downstream Point is able to accommodate the planned




Output long cross section

**Table 12.** Overall Station Hydraulic Analysis Results

| Reach | River Sta | Profile | Q Total | Min Ch El | W.S. Elev | Crit W.S. | E.G. Elev | E.G. Slope | Vel Chnl | Flow Area | T Wi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (m3/s) | (m) | (m) | (m) | (m) | (m/m) | (m/s) | (m2) | (r |
| Tiong | 580 | Q 10 | 12,61 | 14 | 15,93 | 15,93 | 16,9 | 0,006247 | 4,37 | 2,89 | 1 |
| Tiong | 555,83* | Q 10 | 12,61 | 13,6 | 15,57 | 15,57 | 16,56 | 0,00655 | 4,42 | 2,86 | 1, |
| Tiong | 531,67* | Q 10 | 12,61 | 13,25 | 15,27 | 15,27 | 16,28 | 0,00688 | 4,47 | 2,82 | 1 |
| Tiong | 507,50* | Q 10 | 12,61 | 12,71 | 14,64 | 14,64 | 15,61 | 0,006247 | 4,37 | 2,89 | 1 |
| Tiong | 483,33* | Q 10 | 12,61 | 12,46 | 14,39 | 14,39 | 15,36 | 0,006244 | 4,37 | 2,89 | 1 |
| Tiong | 459,17* | Q 10 | 12,61 | 11,8 | 13,98 | 13,98 | 15,07 | 0,008078 | 4,63 | 2,72 | 1, |
| Tiong | 435,00* | Q 10 | 12,61 | 11,46 | 13,43 | 13,43 | 14,42 | 0,006545 | 4,41 | 2,86 | 1, |
| Tiong | 410,83* | Q 10 | 12,61 | 11,21 | 13,1 | 13,1 | 14,04 | 0,005941 | 4,31 | 2,93 | 1, |
| Tiong | 386,67* | Q 10 | 12,61 | 10,91 | 12,72 | 12,72 | 13,63 | 0,005457 | 4,22 | 2,99 | 1, |
| Tiong | 362,50* | Q 10 | 12,61 | 10,57 | 12,69 | | 13,44 | 0,004492 | 3,83 | 3,29 | 1, |
| Tiong | 338,33* | Q 10 | 12,61 | 10,25 | 12,27 | 12,27 | 13,28 | 0,006849 | 4,46 | 2,83 | 1 |
| Tiong | 314,17* | Q 10 | 12,61 | 9,9 | 12,01 | 11,83 | 12,82 | 0,005018 | 3,98 | 3,17 | 1 |
| Tiong | 290,00* | Q 10 | 12,61 | 9,67 | 11,93 | | 12,69 | 0,004736 | 3,85 | 3,28 | 1, |
| Tiong | 265,83* | Q 10 | 12,61 | 9,45 | 11,97 | | 12,53 | 0,003344 | 3,34 | 3,77 | 1 |
| Tiong | 241,67* | Q 10 | 12,61 | 9,49 | 11,42 | 11,42 | 12,39 | 0,006244 | 4,37 | 2,89 | 1 |
| Tiong | 217,50* | Q 10 | 12,61 | 8,95 | 10,66 | 10,66 | 11,52 | 0,004887 | 4,1 | 3,08 | 1 |
| Tiong | 193,33* | Q 10 | 12,61 | 8,9 | 10,55 | 10,55 | 11,37 | 0,004578 | 4,02 | 3,13 | 1 |
| Tiong | 169,17* | Q 10 | 12,61 | 8,83 | 10,42 | 10,42 | 11,22 | 0,004314 | 3,96 | 3,19 | [illegible] |
| Tiong | 145,00* | Q 10 | 12,61 | 8,78 | 10,27 | 10,27 | 11,02 | 0,003911 | 3,84 | 3,28 | 2 |
| Tiong | 120,83* | Q 10 | 12,61 | 8,55 | 9,92 | 9,92 | 10,61 | 0,003443 | 3,68 | 3,42 | 2 |
| Tiong | 96,67* | Q 10 | 12,61 | 8,45 | 9,82 | 9,82 | 10,51 | 0,003441 | 3,68 | 3,42 | 2 |
| Tiong | 72,50* | Q 10 | 12,61 | 8,3 | 9,51 | 9,51 | 10,13 | 0,002946 | 3,47 | 3,64 | [illegible] |
| Tiong | 48,33* | Q 10 | 12,61 | 8,17 | 9,39 | 9,38 | 10 | 0,002875 | 3,43 | 3,67 | [illegible] |
| Tiong | 24,17* | Q 10 | 12,61 | 8,05 | 9,42 | 9,26 | 9,9 | 0,002127 | 3,07 | 4,1 | [illegible] |
| Tiong | 0 | Q 10 | 12,61 | 8 | 9,21 | 9,21 | 9,83 | 0,002947 | 3,47 | 3,64 | [illegible] |

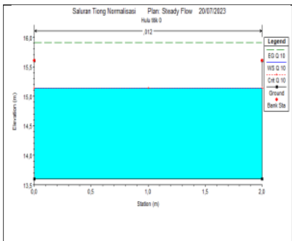
### Table 13. Dimension Enlargement

| Point | Existing channel | | after normalization | |
|---|---|---|---|---|
| | Channel height | Channel width | Channel height | Channel width |
| 0+00 | 1,60 | 1,50 | 2,00 | 2,00 |
| 0+025 | 1,65 | 1,45 | 2,00 | 2,00 |
| 0+050 | 1,55 | 1,40 | 2,00 | 2,00 |
| 0+075 | 1,60 | 1,50 | 2,00 | 2,00 |
| 0+100 | 1,50 | 1,50 | 2,00 | 2,00 |
| 0+125 | 1,85 | 1,25 | 2,00 | 2,00 |
| 0+150 | 1,61 | 1,45 | 2,00 | 2,00 |
| 0+175 | 1,20 | 1,55 | 2,00 | 2,00 |
| 0+200 | 1,25 | 1,65 | 2,00 | 2,00 |
| 0+225 | 1,40 | 1,55 | 2,00 | 2,00 |
| 0+250 | 1,50 | 1,40 | 2,00 | 2,00 |
| 0+275 | 1,55 | 1,50 | 2,00 | 2,00 |
| 0+300 | 1,60 | 1,45 | 2,00 | 2,00 |
| 0+325 | 1,60 | 1,50 | 2,00 | 2,00 |
| 0+350 | 1,50 | 1,50 | 2,00 | 2,00 |
| 0+375 | 2,00 | 1,80 | 2,00 | 2,00 |
| 0+400 | 2,00 | 1,90 | 2,00 | 2,00 |
| 0+425 | 2,00 | 2,00 | 2,00 | 2,00 |
| 0+450 | 2,00 | 2,20 | 2,00 | 2,20 |
| 0+475 | 2,20 | 2,50 | 2,20 | 2,50 |
| 0+500 | 2,20 | 2,50 | 2,20 | 2,50 |
| 0+525 | 2,30 | 3,00 | 2,30 | 3,00 |
| 0+550 | 2,40 | 3,00 | 2,40 | 3,00 |
| 0+575 | 2,50 | 3,00 | 2,50 | 3,00 |
| 0+580 | 2,50 | 3,00 | 2,50 | 3,00 |

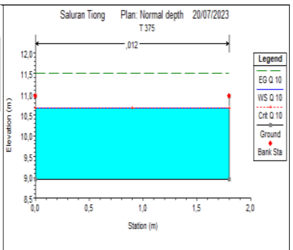
### Table 14. Channel calculation after normalization.

| Point | No | cross-sectional area | wet around | hydraulic spokes | koef manning | s | flow speed | Channel discharge | Debit plan 25 year |
|---|---|---|---|---|---|---|---|---|---|
| | | A | P | R | n | | V (m/det) | Q hidrolika ($m^3$/det) | Q hidologi (m/det) |
| | | $m^2$ | (m) | (m) | | | | | |
| 0+00 | 0 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+025 | 1 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+050 | 2 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+075 | 3 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+100 | 4 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+125 | 5 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+150 | 6 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+175 | 7 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+200 | 8 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+225 | 9 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+250 | 10 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+275 | 11 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+300 | 12 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+325 | 13 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+350 | 14 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+375 | 15 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+400 | 16 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+425 | 17 | 4,00 | 6,00 | 0,67 | 0,012 | 0,0095 | 6,193 | 24,77 | Not Overflow |
| 0+450 | 18 | 4,40 | 6,20 | 0,71 | 0,012 | 0,0095 | 6,456 | 24,77 | Not Overflow |
| 0+475 | 19 | 5,50 | 6,90 | 0,80 | 0,012 | 0,0095 | 6,976 | 24,77 | Not Overflow |
| 0+500 | 20 | 5,50 | 6,90 | 0,80 | 0,012 | 0,0095 | 6,976 | 28,41 | Not Overflow |
| 0+525 | 21 | 6,90 | 7,60 | 0,91 | 0,012 | 0,0095 | 7,609 | 38,37 | Not Overflow |
| 0+550 | 22 | 7,20 | 7,80 | 0,92 | 0,012 | 0,0095 | 7,693 | 38,37 | Not Overflow |
| 0+575 | 23 | 7,50 | 8,00 | 0,94 | 0,012 | 0,0095 | 7,773 | 52,50 | Not Overflow |
| 0+580 | 24 | 7,50 | 8,00 | 0,94 | 0,012 | 0,0095 | 7,773 | 55,39 | Not Overflow |

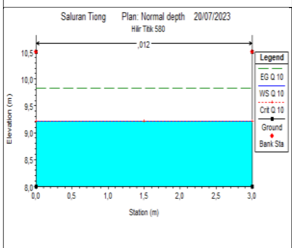
### Analysis using HEC RAS After Normalization



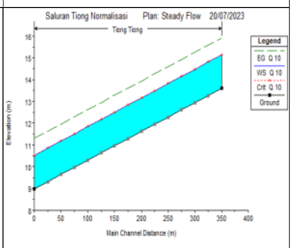
Upstream Point T 0 Channel is able to accommodate the planned discharge.



The T375 Channel point is capable of accommodating the planned discharge.



The T 580 Channel Downstream Point is able to accommodate the planned



Output long cross section

## 4. CUNCLUSION

The conclusions from the research that has been done are:

1. Puddles or floods occur at point 0 – point 350 or 350 meters long.
2. Handling flooding in the canal at point 0 – point 350, namely by: widening and elevating the canal from the existing condition of 1.5 m x 1.5 m, to 2 m x 2 m.
3. Increasing the role of the community to love the environment by not throwing garbage into rivers or canals.

Drain the canal where there is sedimentation and garbage

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