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CAPACITY OF SUNTER C RIVER IN NORTH JAKARTA

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ABSTRACT

Sunter C river is located on Yos Sudarso street at coordinates 6°8'32,63" South Latitude, 106°53'25,78" East Longitude and downstream Sunter C river is located on Sunter Barat river street coordinates 6°8'24,78" South Latitude, 106°51'24.68" East Longitude. In area around the Sunter C river, there are still frequent floods every time the rainy season arrives because of the narrowing of canal section in upstream area of Sunter C river and Sunter C river water can't flow gravitationally to Sentiong river because the base elevation of Sentiong river is higher than Sunter C river. From the above conditions, it's necessary to analyze the problem of flooding in Sunter C river area to find out whether Sunter C river can still accommodate water discharge based on rainfall in the last 10 years and does the Sunter C river need normalization. Based on the results of manual calculations and HEC-RAS application, the Sunter C river can't accommodate water discharge based on rainfall for the last 10 years of 15.88 m^3/s. At point 0 - point 3 it is necessary to normalize by widening the cross-section from 3.6 m to 8 m and at point 4 from 4.8 m to 8 m.

Keywords: *Sunter C River, flood, HEC-RAS*

1. PRELIMINARY

In area around the Sunter C River, floods often occur every time the rainy season arrives. Flood is a problem that often occurs in local community. One of the factors that causes frequent flooding is the narrowing of the canal section in upstream area of the Sunter C River, which causes a reduction in volume of water that can be accommodated by Sunter C River. Another factor that causes frequent flooding is the elevation of the base of Sentiong River which is higher than bottom of Sunter C River so that water from Sunter C River cannot flow naturally into Sentiong River.

From the above conditions, it is necessary to analyze the problem of flooding in Sunter C River area which is expected to be an input for the government so that it can immediately deal with frequent flood problems.

The purpose of this analysis are:

1. Knowing whether existing canal discharge ($Q_{hydraulics}$) exceeds planned canal discharge ($Q_{hydrology}$) causing flooding.

2. Knowing whether cross section of Sunter C River can still accommodate water discharge based on rainfall in the last 10 years.
3. Knowing whether it is necessary to normalize Sunter C River canal.

2. THEORETICAL BASIS

Watershed (DAS)

Watershed is a land area which is an integral part of rivers and their tributaries which functions to accommodate, store and distribute water. Watershed on a small scale are called catchment areas, which are land areas bounded by ridges or boundaries, topographic dividing boundary. Which functions to receive, store and drain the rainfall that falls on it.

Return Period Hydrological Design

Table1. Hydrological Design Criteria for Urban Drainage Systems

Typology of City	Catchment Area (Ha)			
	< 10	10 – 100	101 – 500	> 500
Metropolitan City	2 Years	2 Years – 5 Years	5 Years – 10 Years	5 Years – 10 Years
Big City	2 Years	2 Years – 5 Years	2 Years – 5 Years	5 Years – 10 Years
Medium City	2 Years	2 Years – 5 Years	2 Years – 5 Years	5 Years – 10 Years
Small City	2 Years	2 Years	2 Years	2 Years

Source: Permen. PU No. 12 about implementation of urban drainage system, 2014

Probability Distribution

1. Average score

$$\bar{X} = \sum_{i=1}^{n} \frac{Xi}{n} \quad (1)$$

Information:
$\bar{X}$: Average score
Xi : Variant score
n : Amount of data

2. Standard deviation

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(Xi-\bar{X})^2}{n-1}} \quad (2)$$

Information:
S_x : Standard deviation
$\bar{X}$: Average value
Xi : Variant value
n : Amount of data

3. Variant coefficient

$$Cv = \frac{Sx}{\bar{X}} \quad (3)$$

Information:
Cv : Variant coefficient
S_x : Standard deviation
$\bar{X}$: Average score

4. Skewness

$$Cs = \frac{n.\sum_{i=1}^{n}(Xi-\bar{X})^3}{(n-1).(n-2).Sx^3} \quad (4)$$

Information:
Cs : Skewness
S_x : Standard deviation
n : Amount of data

Types of Data Distribution

Table 2. Statistic Parameter Requirements of a Distribution

No.	Distribution	Requirements
1	Gumbel	$C_s = 1,14$ $C_k = 5,4$
2	Normal	$C_s = 0$ $C_k = 3$
3	Log Normal	$C_s = C_v^3 + 3C_v$ $C_k = C_v^8 + 6C_v^6 + 15C_v^4 + 16C_v^2 + 3$
4	Log Pearson III	Apart from the above values

Source: Bambang, T (2008)

1. Gumbel Method

$$X_t = \bar{X} + \frac{Y_t - Y_n}{Sn}.S_x \quad (5)$$

Information:
X_t : Rainfall plan (mm)
Y_t : Reduced variate parameter Gumbel
Y_n : Reduced mean

2. Distribution Log Pearson III Method

$$\text{Log } X_{(t)} = \text{Log } \bar{X} + K_{(t)}.S_{(x)} \quad (6)$$

Information:
$\text{Log } X_t$: Rainfall plan (mm)

$\text{Log}\,\overline{X}$: Rainfall average value (mm)
K_t : Frequency factor (Log Pearson III)
S_x : Standard deviation

Discharge Canal Plan ($Q_{hydrology}$)

1. Rational Method
$$Q = 0{,}278\,.\,C\,.\,I\,.\,A \quad (7)$$
Information:
Q : Flood discharge (m^3/s)
C : Run off coefficient
I : Rainfall intensity (mm/hour)
A : Catchment area (km^2)
2. Run Off coefficient
$$C_{rata-rata} = \frac{\sum_{i=1}^{n} C_i\,A_i}{\sum_{i=1}^{n} A_i} \quad (8)$$
Information:
C : Run off coefficient
A : Catchment area (km^2)
3. Concentration time
$$T_c = \frac{0{,}0195\,.L^{0{,}77}}{S^{0{,}385}} \quad (9)$$
Information:
Tc : Concentration time (minute)
L : Water passage length (m)
S : Canal slope
4. Concentration time
$$I = \frac{R_{24}}{24}\left[\frac{24}{Tc}\right]^{2/3} \quad (10)$$
Information:
R_{24} : Rainfall in 24 hours (mm)
Tc : Concentration time (hour)
I : Rainfall intensity (mm/hour)

Existing Drain Discharge ($Q_{hydraulics}$)

1. Canal discharge
$$Q = A\,.\,V \quad (11)$$
Information:
Q : Flow (m^3/s)
A : Wet cross-sectional area (m)
V : Average flow speed (m/s)
2. Flow speed
$$V = \frac{1}{n}.\,R^{2/3}.\,S^{1/2} \quad (12)$$
Information:
V : Average flow speed (m/s)
n : Manning's roughness coefficient
r : Hydraulic radius (m)
s : Canal slope
3. Rainfall Intensity
$$I = \frac{R_{24}}{24}\left[\frac{24}{Tc}\right]^{2/3} \quad (13)$$
Information:
R_{24} : 24 hours rainfall plan (mm)
Tc : Concentration time (hour)
I : Rainfall intensity (mm/hour)

Program HEC-RAS

HEC-RAS (Hydrologic Engineering Center – River Analysis System) is a program application to model river flow made by HEC (Hydrolic Engineering Center) which is a division within the IWR (Institute for Water Resources) under the USACE (US Army Corps of Engineering). In HEC-RAS application there are four main components, namely as follows:

1. Steady flow water surface profiles
This module functions to calculate water level profile to steady gradually varied flow. The program is able to model river networks, dendritic rivers, and single rivers.
2. Unsteady flow simulation
This module is able to simulate one-dimensional non-permanent flow in rivers with complex canals.
3. Sediment transport
This module is able to simulate one-dimensional sediment transport (simulate changes in the riverbed) due to scouring or deposition for a long time (generally annually), but it can also simulate changes in riverbeds due to a number of large floods.
4. Water quality analysis
This module can be used to analyze quality of water in rivers. HEC-RAS can be used to analyze water temperature and transport simulation such as: algae, oxygen levels, nitrogen levels and etc.

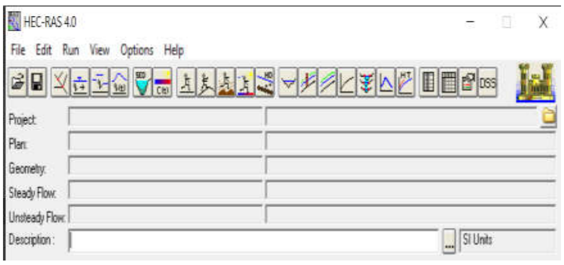

Figure 1. Program View of HEC-RAS

3. RESEARCH METHODS

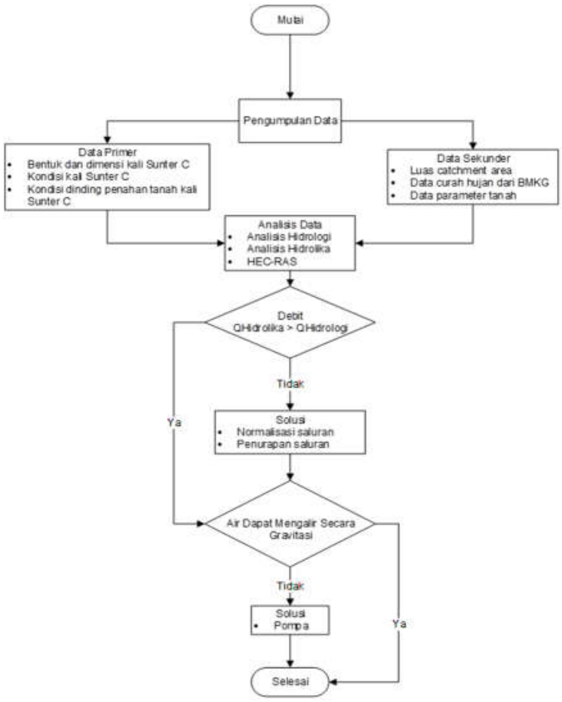

Figure 2. Stages of Research Methods

4. RESULTS AND DISCUSSION

Hydrological Design Return Period (T)

Sunter C River is based on Table 1 with an area > 500 Ha using a return period (T) of 10 years.

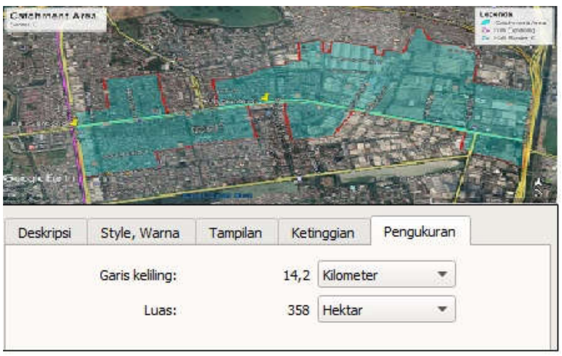

Figure 3. Catchment Area

Probability Distribution

1. Maximum rainfall

Table 3. Maximum Rainfall

No	Year	Maximum rainfall
1	2010	93
2	2011	119,2
3	2012	105,2
4	2013	193,4
5	2014	147,9
6	2015	277,5
7	2016	124,5
8	2017	179,7
9	2018	104,6
10	2019	86,6

Course: BMKG Kemayoran

Table 4. Calculation of Rainfall Distribution

Amount of Data (n)	Year	Variant Score (X_i)	$(X_i - \bar{X})$	$(X_i - \bar{X})^2$	$(X_i - \bar{X})^3$	$(X_i - \bar{X})^4$
1	2010	93,00	-50,16	2.516,03	-126.203,84	6.330.384,82
2	2011	119,20	-23,96	574,08	-13.755,00	329.569,68
3	2012	105,20	-37,96	1.440,96	-54.698,90	2.076.370,33
4	2013	193,40	50,24	2.524,06	126.808,65	6.370.866,77
5	2014	147,90	4,74	22,47	106,50	504,79
6	2015	277,50	134,34	18.047,24	2.424.465,63	325.702.712,80
7	2016	124,50	-18,66	348,20	-6.497,33	121.240,18
8	2017	179,70	36,54	1.335,17	48.787,17	1.782.683,20
9	2018	104,60	-38,56	1.486,87	-57.333,85	2.210.793,10
10	2019	86,60	-56,56	3.199,03	-180.937,34	10.233.815,97
Total (Σ)		1.431,60	0,00	31.494,10	2.160.741,69	355.158.941,65

a. Average score

$$\bar{X} = \sum_{i=1}^{n} Xi/n = \frac{1431{,}60}{10} = 143{,}16$$

b. Standard deviation (S_x)

To find the standard deviation, the following formula is used:

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(Xi - \bar{X})^2}{n-1}}$$

$$= \sqrt{\frac{31494{,}10}{10-1}}$$

$$= 59{,}16$$

c. Variant coefficient (C_v)

$$Cv = \frac{S}{\bar{X}} = \frac{59{,}16}{143{,}16} = 0{,}41$$

d. Slope coefficient (C_s)

$$Cs = \frac{n \times \sum_{i=1}^{n}(Xi - \bar{X})^3}{(n-1) \times (n-2) \times S_x{}^3}$$

$$= \frac{10 \times 2160741{,}69}{(10-1) \times (10-2) \times 59{,}16^3}$$

$$= 1{,}45$$

e. Sharpness coefficient (C_k)

$$Ck = \frac{n^2 \times \sum_{i=1}^{n}(Xi - \bar{X})^4}{(n-1) \times (n-2) \times (n-3) \times S_x{}^4}$$

$$= \frac{10^2 \times 355158941{,}65}{(10-1) \times (10-2) \times (10-3) \times 59{,}16^4}$$

$$= 5{,}75$$

f. Distribution type

Table 5. Calculation of Rainfall Disribution

No.	**Distribution**	**Requirement**	**Calculation**	**Information**
1	Gumbel	Cs = 1,14	Cs = 1,45	Not qualify
		Ck = 5,4	Ck = 5,75	Not qualify
2	Normal	Cs = 0	Cs = 1,45	Not qualify
		Ck = 3	Ck = 5,75	Not qualify
3	Log Normal	Cs = 1,31	Cs = 1,45	Not qualify
		Ck = 6,20	Ck = 5,75	Not qualify
4	Log Pearson III	Apart from the above scores		Qualify

Based on calculations from rainfall data analysis, the type of distribution that meets the requirements is Log Pearson III distribution.

2. Log Pearson III Method

Table 6. Rainfall Distribution

Jumlah Data (n)	Tahun	Nilai Varian (Xi)	Log Xi	$LogXi - Log\bar{X}$	$(LogXi - Log\bar{X})^2$	$(LogXi - Log\bar{X})^3$
1	2010	93,00	1,97	-0,1588	0,0252	-0,0040
2	2011	119,20	2,08	-0,0510	0,0026	-0,0001
3	2012	105,20	2,02	-0,1053	0,0111	-0,0012
4	2013	193,40	2,29	0,1591	0,0253	0,0040
5	2014	147,90	2,17	0,0426	0,0018	0,0001
6	2015	277,50	2,44	0,3159	0,0998	0,0315
7	2016	124,50	2,10	-0,0322	0,0010	0,0000
8	2017	179,70	2,25	0,1272	0,0162	0,0021
9	2018	104,60	2,02	-0,1078	0,0116	-0,0013
10	2019	86,60	1,94	-0,1898	0,0360	-0,0068
Jumlah (∑)		1.431,60	21,27	0,0000	0,2308	0,0243

a. Average score

$$Log\,\bar{X} = \sum_{i=1}^{n} Log\,Xi/n = \frac{21{,}27}{10} = 2{,}13$$

b. Standard deviation (S_x)

$$S_x = \sqrt{\frac{\sum_{i=1}^{n}(LogXi - Log\bar{X})^2}{n-1}}$$

$$= \sqrt{\frac{0{,}23}{10-1}}$$

$$= 0{,}16$$

c. Variant coefficient (C_v)

$$Cv = \frac{S}{\bar{X}} = \frac{59{,}16}{143{,}16} = 0{,}41$$

d. Slope coefficient (C_s)

$$Cs = \frac{n \times \sum_{i=1}^{n}(Xi - \bar{X})^3}{(n-1) \times (n-2) \times S_x{}^3}$$

$$= \frac{10 \times 2160741{,}69}{(10-1) \times (10-2) \times 59{,}16^3}$$

$$= 1{,}45$$

e. Frequency factor score (K_t)

Table 7. Frequency Factor Score (K_t)

Period (T)	**Cs**	**Score (K_t)**
2	0,82	-0,135
5	0,82	0,778
10	0,82	1,337
25	0,82	1,998
50	0,82	2,462
100	0,82	2,905

200	0,82	3,331

f. Rainfall return period plan

Table 8. Rainfall Plan

Period (T)	$\text{Log}\bar{X}$	Score (K_i)	S_x	$\text{Log}X_i = \text{Log}\bar{X} + K_i$	Antilog X_i (mm)
2	2,13	-0,135	0,16	2,11	127,56
5	2,13	0,778	0,16	2,25	178,61
10	2,13	1,337	0,16	2,34	219,49
25	2,13	1,998	0,16	2,45	280,06
50	2,13	2,462	0,16	2,52	332,31
100	2,13	2,905	0,16	2,59	391,27
200	2,13	3,31	0,16	2,66	457,81

Discharge Canal Plan ($Q_{hydology}$)

1. Run off coefficient

Figure 4. Land Use Map

Table 9. Run Off Coefficient Score

No.	Territory	Large (A) Km²	Run Off Coefficient (C)	Run Off Coefficient Combine (A * C)
1	Housing	1,43	0,75	1,0725
2	Industry	2,03	0,90	1,827
3	Road	0,12	0,95	0,1140
Total (∑)		3,58		3,0135

$$C_{rata-rata} = \frac{\sum_{i=1}^{n} C_i A_i}{\sum_{i=1}^{n} A_i} = \frac{1{,}0725 + 1{,}827 + 0{,}1140}{1{,}43 + 2{,}03 + 0{,}12} = \frac{3{,}0135}{3{,}58} = 0{,}84$$

2. Slope of the canal
Based on the measurement results the Sunter C River has a length of 3.787 m, the upstream elevation (point 0) is 0,423 m and the downstream elevation (point 72) is 0,213 m.

$$S = \frac{\Delta H}{L} = \frac{(0{,}423 - 0{,}213)}{3787} = 0.0001$$

3. Discharge canal plan ($Q_{hydrology}$)

Table 10. Discharge Canal Plan ($Q_{hydrology}$)

Return Period (T) Year	*Run Off* coefficient ($C_{average}$)	Large (A) Km²	Rainfall Intensity (I) mm/hour	Discharge Canal Plan (Q) m³/s
2	0,84	3,58	11,01	9,23
5	0,84	3,58	15,42	12,92
10	0,84	3,58	18,95	15,88
25	0,84	3,58	24,17	20,26
50	0,84	3,58	28,68	24,04
100	0,84	3,58	33,77	28,30
200	0,84	3,58	39,52	33,11

Existing Channel Discharge ($Q_{hydrology}$) HEC-RAS

1. Before normalization

Table 11. Existing Channel Discharge ($Q_{hydrology}$)

Point	Cross-Sectional Area (A)	Flow Velocity (V)	Existing Canal Discharge ($Q_{hydraulics}$)	< / >	Discharge plan 10 years ($Q_{hydrology}$)	Info
	m²	m/s	m³/s		m³/s	
0	4,488	0,241	1,08	<	15,88	overflow
1	4,712	0,244	1,15	<	15,88	overflow
2	4,739	0,245	1,16	<	15,88	overflow

3	7,249	0,275	1,99	<	15,88	overflow
4	7,216	0,274	1,98	<	15,88	overflow
5	10,910	0,296	3,23	<	15,88	overflow
6	10,663	0,300	3,20	<	15,88	overflow
7	14,859	0,338	5,03	<	15,88	overflow
8	11,736	0,306	3,59	<	15,88	Melimpas
9	13,883	0,330	4,58	<	15,88	overflow
10	15,197	0,341	5,18	<	15,88	overflow
11	13,861	0,333	4,62	<	15,88	overflow
12	12,805	0,324	4,14	<	15,88	overflow
13	14,441	0,350	5,05	<	15,88	overflow
14	14,886	0,320	4,76	<	15,88	overflow
15	13,379	0,324	4,33	<	15,88	overflow
16	16,709	0,368	6,15	<	15,88	overflow
17	14,211	0,341	4,85	<	15,88	overflow
18	13,922	0,342	4,77	<	15,88	overflow
19	16,201	0,364	5,89	<	15,88	overflow
20	13,862	0,339	4,70	<	15,88	overflow
21	14,731	0,351	5,17	<	15,88	overflow
22	15,224	0,354	5,38	<	15,88	overflow
23	13,962	0,340	4,75	<	15,88	overflow
24	14,417	0,348	5,01	<	15,88	overflow
25	22,152	0,428	9,47	<	15,88	overflow
26	16,246	0,373	6,06	<	15,88	overflow
27	16,189	0,372	6,02	<	15,88	overflow
28	17,319	0,383	6,64	<	15,88	overflow
29	15,641	0,365	5,72	<	15,88	overflow
30	16,396	0,372	6,10	<	15,88	overflow
31	15,290	0,357	5,46	<	15,88	overflow
32	13,267	0,331	4,40	<	15,88	overflow
33	14,212	0,348	4,94	<	15,88	overflow
34	14,750	0,352	5,19	<	15,88	overflow
35	15,628	0,366	5,71	<	15,88	overflow
36	15,714	0,379	5,96	<	15,88	overflow
37	14,790	0,361	5,34	<	15,88	overflow
38	18,015	0,383	6,90	<	15,88	overflow
39	15,889	0,370	5,88	<	15,88	overflow
40	14,933	0,358	5,35	<	15,88	overflow

41	14,701	0,350	5,15	<	15,88	overflow
42	15,225	0,356	5,42	<	15,88	overflow
43	14,456	0,344	4,97	<	15,88	overflow
44	14,322	0,341	4,88	<	15,88	overflow
45	16,149	0,356	5,75	<	15,88	Melimpas
46	24,147	0,417	10,08	<	15,88	overflow
47	16,792	0,362	6,08	<	15,88	overflow
48	16,426	0,361	5,94	<	15,88	overflow
49	15,579	0,359	5,59	<	15,88	overflow
50	17,482	0,379	6,62	<	15,88	overflow
51	17,570	0,380	6,68	<	15,88	overflow
52	21,365	0,389	8,30	<	15,88	overflow
53	19,213	0,380	7,30	<	15,88	overflow
54	19,826	0,389	7,70	<	15,88	overflow
55	20,083	0,391	7,85	<	15,88	overflow
56	20,001	0,393	7,86	<	15,88	overflow
57	19,877	0,391	7,77	<	15,88	overflow
58	15,084	0,331	4,99	<	15,88	overflow
59	17,256	0,372	6,42	<	15,88	overflow
60	19,936	0,384	7,65	<	15,88	overflow
61	18,039	0,371	6,70	<	15,88	overflow
62	18,090	0,367	6,63	<	15,88	overflow
63	25,081	0,418	10,48	<	15,88	overflow
64	20,065	0,388	7,79	<	15,88	overflow
65	16,208	0,372	6,03	<	15,88	overflow
66	19,538	0,384	7,50	<	15,88	overflow
67	24,723	0,423	10,46	<	15,88	overflow
68	18,658	0,372	6,93	<	15,88	overflow
69	20,528	0,391	8,02	<	15,88	overflow
70	21,326	0,388	8,28	<	15,88	overflow
71	18,338	0,369	6,77	<	15,88	overflow
72	12,405	0,343	4,26	<	15,88	overflow

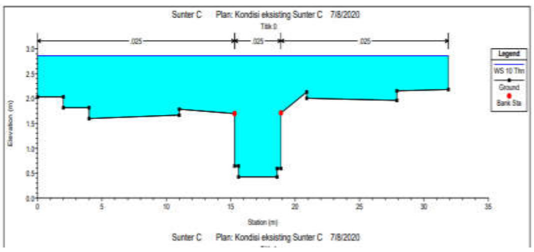

Figure 5. Output HEC-RAS

Based on the calculation results of the HEC-RAS application, the Sunter C River channel can not accommodate the 10 year plan discharge. Then the Sunter C channel requires normalization.

2. After normalization

Table 12. Existing Channel Discharge ($Q_{hydraulics}$)

Point	Cross-Sectional Area (A)	Flow Velocity (V)	Canal Discharge (Qhydraulics)	< / >	Discharge plan 10 years (Qhydrology)	Info
	m^2	m/det	m^3/det		m^3/det	
0	20,616	0,773	15,93	>	15,88	Not overflow
1	21,352	0,784	16,74	>	15,88	Not overflow
2	21,416	0,785	16,81	>	15,88	Not overflow
3	21,760	0,790	17,19	>	15,88	Not overflow
4	21,832	0,791	17,27	>	15,88	Not overflow
5	25,830	0,816	21,08	>	15,88	Not overflow
6	21,394	0,774	16,55	>	15,88	Not overflow
7	31,312	0,874	27,36	>	15,88	Not overflow
8	24,729	0,807	19,95	>	15,88	Not overflow
9	27,780	0,831	23,10	>	15,88	Not overflow
10	29,042	0,845	24,54	>	15,88	Not overflow
11	27,950	0,843	23,55	>	15,88	Not overflow
12	26,380	0,823	21,70	>	15,88	Not overflow
13	27,106	0,842	22,84	>	15,88	Not overflow
14	27,731	0,849	23,54	>	15,88	Not overflow
15	28,182	0,838	23,62	>	15,88	Not overflow
16	30,202	0,870	26,29	>	15,88	Not overflow
17	27,666	0,842	23,30	>	15,88	Not overflow
18	26,829	0,837	22,46	>	15,88	Not overflow
19	30,051	0,869	26,10	>	15,88	Not overflow
20	28,756	0,856	24,61	>	15,88	Not overflow
21	29,819	0,872	26,00	>	15,88	Not overflow
22	31,047	0,884	27,44	>	15,88	Not overflow
23	29,072	0,862	25,05	>	15,88	Not overflow
24	28,659	0,859	24,61	>	15,88	Not overflow

25	34,115	0,939	32,04	>	15,88	Not overflow
26	30,244	0,885	26,77	>	15,88	Not overflow
27	31,846	0,904	28,78	>	15,88	Not overflow
28	32,274	0,913	29,46	>	15,88	Not overflow
29	31,372	0,897	28,15	>	15,88	Not overflow
30	32,336	0,918	29,68	>	15,88	Not overflow
31	30,261	0,884	26,76	>	15,88	Not overflow
32	28,748	0,857	24,63	>	15,88	Not overflow
33	24,152	0,834	20,14	>	15,88	Not overflow
34	30,117	0,877	26,42	>	15,88	Not overflow
35	31,262	0,897	28,03	>	15,88	Not overflow
36	25,597	0,851	21,77	>	15,88	Not overflow
37	26,210	0,841	22,05	>	15,88	Not overflow
38	30,773	0,890	27,38	>	15,88	Not overflow
39	28,656	0,875	25,07	>	15,88	Not overflow
40	26,921	0,850	22,87	>	15,88	Not overflow
41	27,069	0,849	22,99	>	15,88	Not overflow
42	27,546	0,855	23,55	>	15,88	Not overflow
43	27,240	0,845	23,02	>	15,88	Not overflow
44	27,931	0,851	23,77	>	15,88	Not overflow
45	30,292	0,872	26,40	>	15,88	Not overflow
46	34,547	0,909	31,39	>	15,88	Not overflow
47	28,576	0,855	24,44	>	15,88	Not overflow
48	27,317	0,852	23,28	>	15,88	Not overflow
49	28,267	0,859	24,28	>	15,88	Not overflow
50	28,444	0,859	24,44	>	15,88	Not overflow
51	28,091	0,856	24,04	>	15,88	Not overflow
52	35,281	0,902	31,84	>	15,88	Not overflow
53	30,873	0,866	26,72	>	15,88	Not overflow

54	31,337	0,876	27,46	>	15,88	Not overflow
55	32,198	0,886	28,53	>	15,88	Not overflow
56	31,991	0,889	28,46	>	15,88	Not overflow
57	32,380	0,893	28,92	>	15,88	Not overflow
58	31,964	0,879	28,10	>	15,88	Not overflow
59	29,088	0,866	25,20	>	15,88	Not overflow
60	32,451	0,891	28,90	>	15,88	Not overflow
61	30,919	0,876	27,10	>	15,88	Not overflow
62	33,791	0,898	30,35	>	15,88	Not overflow
63	33,554	0,885	29,71	>	15,88	Not overflow
64	32,072	0,888	28,48	>	15,88	Not overflow
65	27,428	0,861	23,61	>	15,88	Not overflow
66	31,913	0,889	28,36	>	15,88	Not overflow
67	35,636	0,909	32,40	>	15,88	Not overflow
68	27,748	0,861	23,89	>	15,88	Not overflow
69	34,047	0,904	30,77	>	15,88	Not overflow
70	35,283	0,905	31,94	>	15,88	Not overflow
71	32,199	0,873	28,11	>	15,88	Not overflow
72	22,708	0,801	18,20	>	15,88	Not overflow

5. CONCLUSION

Based on the results of data analysis, several conclusions were obtained, including:

1. The discharge of existing canal ($Q_{hydraulics}$) at Sunter C River exceeds planned canal discharge ($Q_{hydrology}$) causing flooding.
2. In data analysis from point 0 to 72, Sunter C River can't accommodate the water discharge based on rainfall data for the last 10 years which is 15,88 m^3/s.
3. It's necessary to normalize Sunter C River by replacing the retaining wall which was previously made of stone walls which were cemented into concrete sheetpile so that water doesn't overflow during the rainy season. At point 0 – point 3, it's necessary to widen the section previously from 3,6 m to 8 m and at point 4 which was previously 4,8 m to 8 m.

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