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Analysis Of Water Status Quality And Flood And Innundation Causes In Rawa Matang Hanau Irrigation Area Balangan District

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Abstract:*Matang Hanau is an irrigated swamp area located in Lampihong District, Balangan Regency this will be developed into a swamp irrigation area. The area is inhabited by transmigration community with oil palm gardening as their livelihood. The plantations products obtained were unsatisfactory because the land was often flooded due to flooding that often occurs during the rainy season.The transmigration community is also challenged with the clean water problem for their daily needs.The community must fulfill their need for drinking water by buying from outside the transmigration area.Whereas bathing and washing, they use water in the existing channel of the swamp irrigation. On channels where people use the water, there are cages of chicken and cattle farms, so that the water used by the community has been polluted by the waste of chicken and cattle farms. Along with the use of water in these channels, health problem such asitchiness arises.*

This study analyzes the status of the channel's water quality by using the pollution index method and analyzes the causes of floods and inundation. Research regarding the causes of flooding and inundation was taken uses the QGIS application with the Rivergis plugin to model channel geometry which is then analyzed using the hec-race application to determine the hydrodynamic model on the channel.The analysis results of the water status quality by the pollution index method suggested that the water in the swamp irrigation channel was lightly polluted.Analysis of the causes of flooding and inundation on the existing channel to the flood debit plan with a return period of 1 year, 2 years, 5 years, and 10 years gives the results that the existing channel section is unable to accommodate the smallest flood debit that occurs at 2 years return of 10.94 m3/sec, thus causing flooding due to the water levels that exceed the depth of the channel so that it floods the plantation area.Based on the study results, the existing channel must be redesigned in order to accommodate the largest flood debit with a 10-years return period of 14.66 m3/sec. It was then analyzed by hec-race where it shows the hydrodynamic model of the channel crossing to the largest flood debit plan.

Keywords: *Matang Hanau, QGis, RiverGis, Hec-Ras, Flood*

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I. Introduction

The irrigated swamp area of Matang Hanau is a transmigration area of Papuyuan, which is inhabited by approximately two hundreds family heads from various regions outside of Kalimantan. The transmigration community has oil palm plantations as their livelihood. Since 2014 until now, their outcomefrom oil palm plantations was not optimal because the plantation land can no longer be cultivated or functioned due to the floodedland (Edinayanti, 2018).

Due to this condition,transmigration communities of LajarPapuyuanfind that it is difficult to plant crops.Another problem faced by transmigration communities in LajarPapuyuan is accessibility to clean water. Theywere forced out of the transmigration area to meet their needs of clean water for cooking and drinking by buying it. Whereas for bathing and washing, they use water in the channel even though it has polluted with human and livestock wastes such as chickens and cattle (Edinayanti, 2018).

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II. Theoritical Review

Government Regulation of Republic of Indonesia No. 82 (2001) states that "Water is one of the natural resources that has a very important function for human life and life, as well as to promote general welfare, so that it is the basic capital and the main factor of development". The bad quality water will result in bad environmental conditions that will affect the humans health and safety and the lives of other living beings.

State Minister of Environment (2003), through the Decree of the Minister of Environment No. 115 of 2003 explains that "water quality is a condition of water quality measured and / or tested according to certain parameters and certain methods based on the applicable legislation".The status of water quality can be defined as the level of water quality conditions that indicate pollutant conditions or good conditions in a water source within a certain time by comparing it with the established quality standards (Ministry of Environment 2003). The established quality standard is standard that has been determined based on Government Regulation No. 82 of 2001.

In Indonesia, the method used for evaluating the quality of water bodies with a water quality index is regulated in the Decree of the Minister of Environment No. 115 of 2003 concerning guidelines for determining the status of water quality. Based on article 2 of the Decree of the Minister of Environment No. 115 of 2003, the water status quality can be determined by the STORET method or the Pollution Index Method (IP) (Aziz 2003).

According to SK SNI M-18-1989-F (1989), it is explained that floods are relatively high flows and are not accommodated by river or channel flows. The flow here is referred to the flow of water whose source can be from anywhere, so that the water comes out of a river or channel because the river and its channel have exceeded its capacity due to flood debit, this condition is called flood.

The planned flood debitcan be calculatedby using several methods including the empirical relationship between rainfall and runoff. This is the most widely developed method, so that some equations are obtained, namely the rational method. In the Department of Public Works, SK SNI M-18-1989-F (1989), it was explained that the Rational Method could be used for knowing the size of the drainage area <5000 Ha.

Channel section modeling and channel geometry were taken by using the open source QGis application and the RiverGis plugin. RiverGIS is a QGIS plugin for creating geometry of the Hec-Ras flow model from spatial data. RiverGIS(Typical RiverGIS) workflow:

HEC-RAS is an application program that integrates graphical user interface features, hydraulic analysis, data management and storage, graphics, and reporting (Istiarto 2014).

1. Create a new database scheme for the model
2. Set the spatial projection of the model
3. Create / import model geometry (river lines, cross sections, hydraulic structures)
4. Build a river network (topology, which is achieving connectivity and order, achieving length)
5. Calculate cross-section attributes (stations, downstream lengths, etc.) and vertical shapes (DTM raster probes)
6. Find Manning roughness coefficient for cross section
7. Determine data across additional sections (embankment, ineffective flow area and barrier)
8. Build hydraulic structures (bridges / culverts, inline and lateral structures, storage areas, etc.).
9. Create the Import GIS - HEC-RAS file

III. Methods Of Study

Analysis of water quality status was taken in four sample points, namely, TS.1, TS.2, TS.3 and TS.4. The study begins with taking water samples to four sample points, which are then analyzed in the laboratory to get the parameter value to obtain the Ci / Lijvalue The value is used to determine the maximum value of Ci / Lij ((Ci / Lij) M) and the value Average Ci / Lij ((Ci / Lij) R), then proceed with the calculation of pollution index for j (PIj) designation. Results of the pollution index calculation for the designation of j (PIj) will determine the condition of water quality in accordance with the Decree of the Minister of Environment No. 115 of 2003 concerning guidelines for determining the status of water quality, namely:

$0 \leq PIj \leq 1.0$ → meet quality standards (good condition)
$1.0 < PIj \leq 5.0$ → lightly polluted
$5.0 < PIj \leq 10$ → medium polluted
$PIj > 10$ → heavily polluted

Research into the causes of floods and inundations that occur begins with data collection consisting of primary data in the form of channel profile measurements and secondary data in the form of DEM maps obtained from https://scihub.copernicus.eu and monthly maximum rainfall data obtained from BMKG Banjarbaru.Rainfall data is used for hydrological analysis to obtain flood debit plans with rational methods. The planned debit is in the form of flood debit at 2 years, 5 years, and 10 years.

The obtained debit is used as one of the data in the hec-race application for analyzing the existing hydrodynamic model of the channel by using the lowest flood debit, i.e. flood debit at 2 years return time of 10.94 m3/sec. The largest flood debit at 10 years is 14.66 m3/sec, the debit will be used to analyze the hydrodynamic model of the channel cross section design if it turns out that the existing channel cannot accommodate the lowest flood debit.

IV. Results And Discussion

As an index-based method, the IP method is built based on two quality indices. The first is the average index (Ci / Li) R. This index shows the average level of pollution of all parameters in one observation. The second is the maximum index (Ci / Li) M. This index shows a dominant type of parameter that causes a decrease in water quality at one observation. The results of river water quality analysis on the surface of Matang Hanau's DIR channel are presented in the following table:

Table 1.Results of Water Quality Analysis

Parameters	**Unit**	**Location of Sample Collection**			
		TS.1	**TS.2**	**TS.3**	**TS.4**
Physics					
pH	-	6.2	6.26	6.08	6.2
Total Suspended Solid (TSS)	mg/L	10	7.5	8.8	17
Total Dissolved Solid (TDS)	mg/L	70	75	69	54
ChemicalInorganic					
DO	mg/L	2.6	4.2	4.2	1.6
BOD	mg/L	5	10	8	10
COD	mg/L	44	22	34	60
NO_3	mg/L	1	1	1	1
NO_2	mg/L	0.02	0.02	0.02	0.02
Cadmium (Cd)	mg/L	0.006	0.006	0.006	0.006
Copper (Cu)	mg/L	0.033	0.033	0.033	0.033
Chemical Inorganic					
Detergent	µg/L	115	115	110	110
Microbiology					
E-coli	Total/100mL	540	540	23	540
Total coliform	Total/100mL	540	540	31	540

Source: In Situ and Laboratory Test Results

Based on the test results, the parameters are used as analytical material to obtain the water quality status by using the pollution index method, while the following results are obtained from the analysis of the quality standard I:

Table 2. Results of **Analysis of Water Quality Status on Quality Standards I**

Location	IP Value Quality Standard I	Water Quality Status	Debit (m/s)
TS.I	3,92	Lightly Polluted	0,09
TS.II	3,92	Lightly Polluted	0,11
TS.III	3,23	Lightly Polluted	0,12
TS.IV	4,22	Lightly Polluted	0,04

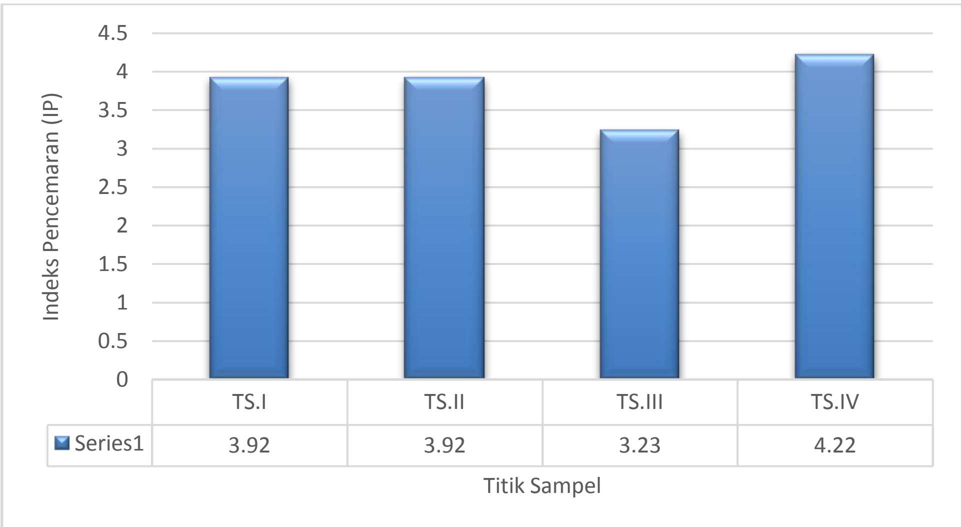


Figure 1.Results of Pollution Index Analysis on Quality Standards I

The analysis indicates that all IP values for all sample points against quality standards are in the range of 1.0 <PIj ≤ 5.0 which identifies that the water condition in the channel is lightly polluted against the quality standard I as the designation of raw water clean water.

Based on the test results, the parameters are used as analysis material to obtain the status of water quality using the pollution index method, while the obtained results of the analysis of quality standards II are presented in the following table:

Table 3.Results of Analysis of Water Quality Status on Quality Standards II

Location	IP Value Quality Standard II	Water Quality Status	Debit (m/s)
TS.I	1,89	Lightly Polluted	0,09
TS.II	2,89	Lightly Polluted	0,11
TS.III	2,62	Lightly Polluted	0,12
TS.IV	3,07	Lightly Polluted	0,04

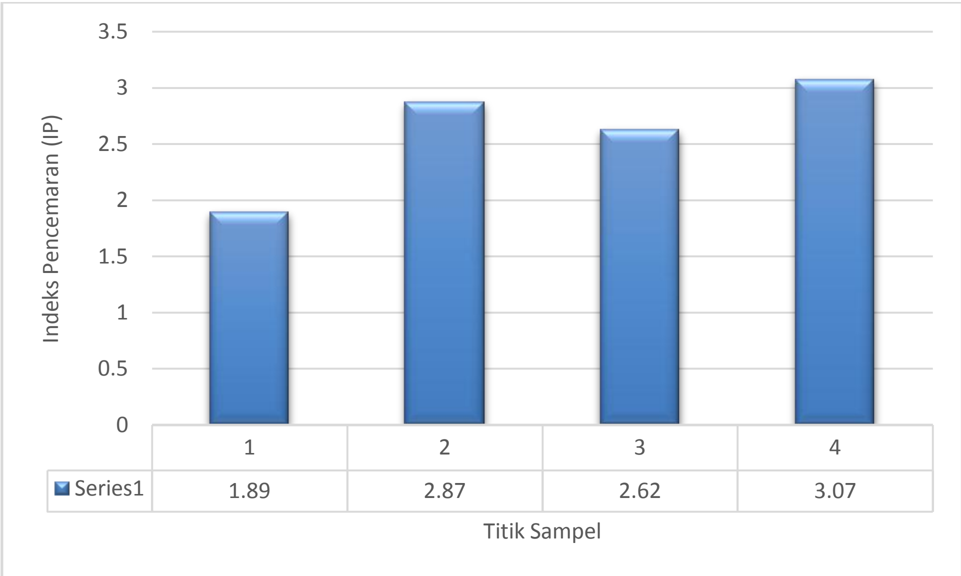


Figure 2.Results of Pollution Index Analysis on Quality Standards II

The analysis indicates that all IP values for all sample points against the quality standard are in the range of 1.0 <PIj ≤ 5.0 which identifies that the condition of the water in the channel is lightly polluted against the quality standard II as water designated for agricultural and plantation purposes.

The calculation of maximum average daily rainfall is started by sorting the rainfall data from the largest to the smallest at each station. The average rainfall calculation will be presented in table form.

Table1.Calculation of Average Maximum Daily Rainfall

No.	Stations			
	MurungPudak	South Paringin	North Amuntai	Average Rainfall
1	174	138	169	160,33
2	131	133	162	142,00
3	120	117	151	129,33
4	115	106	136	119,00
5	113	105	99	105,67
6	87	85	93	88,33
7	78	83	91	84,00
8	78	75	91	81,33
9	40	58	87	61,67
10	33	41	87	53,67
11	33	29	77	46,33

The calculation or estimation of the amount of flood debit that will occur in various return periods with good results can be done by the analysis of the Rational Method. Equation $Q = 0.278 \times C \times I_T \times A$. The debit of the rational method plan is presented in Table 5 below:

Table2.Flood Debit Plan Rational Method

No.	Return Periods (Years)	A (km^2)	R_{24} (mm)	L (km)	H (km)	C	w (km/hour)	tc (mm/hour)	I (mm/hour)	Qt (m^3/sec)
1	2	10.90	112.31	5.546	0.02	0.7	0.62	8.96	9.03	10.94
2	5	10.90	133.35	5.546	0.02	0.7	0.62	8.96	10.72	12.99
3	10	10.90	150.44	5.546	0.02	0.7	0.62	8.96	12.09	14.66

Source :Analysis Results

Evaluation of the existing channel begins with the imitation of channel geometry using the Qgis 2.18.18 application and using model elevation data (DEM) obtained from https://scihub.copernicus.eu. Imitation of channel geometry in gis application is supported by rivergis application. The results of geometry imitation can be seen in Figures 3 and 4.

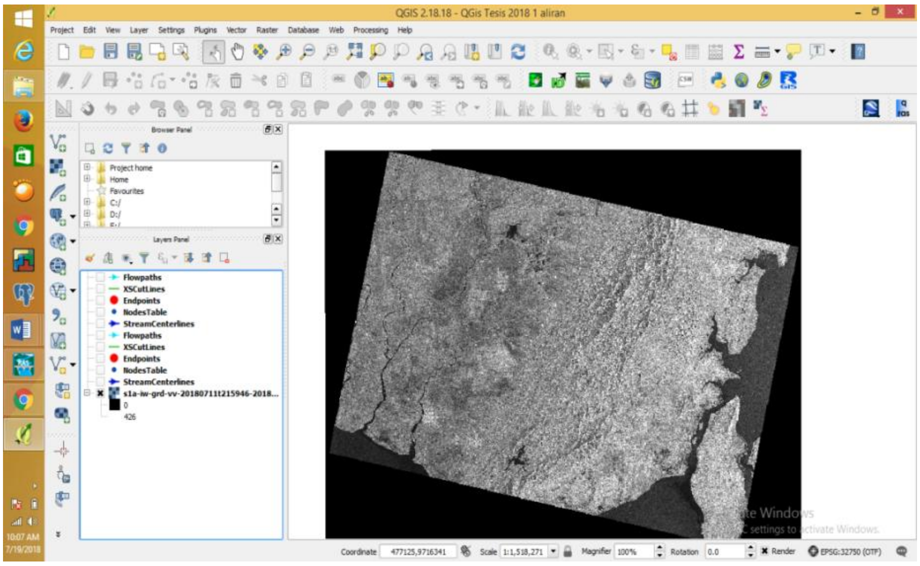


Figure1. **DEM Layer (Source: Analysis)**

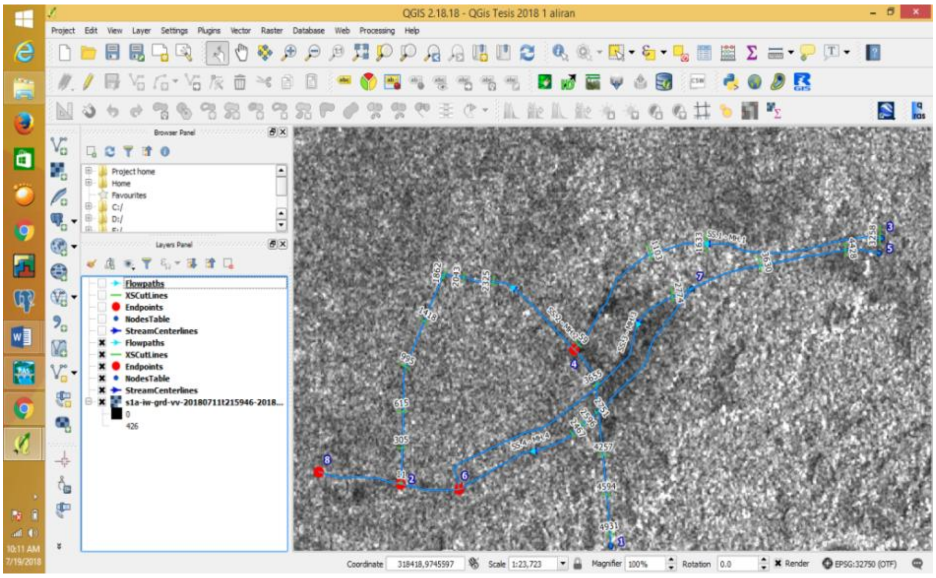


Figure 4. **Results of Channel Geometry Imitation (Source: Analysis)**

After the channel geometry imitation is complete, the channel geometry is converted to a hec-race file using the RiverGis plugin. The geometry of the converted channel is imported into hec-race as the channel geometry for the hydraulic analysis process, as shown in figure 4.6.

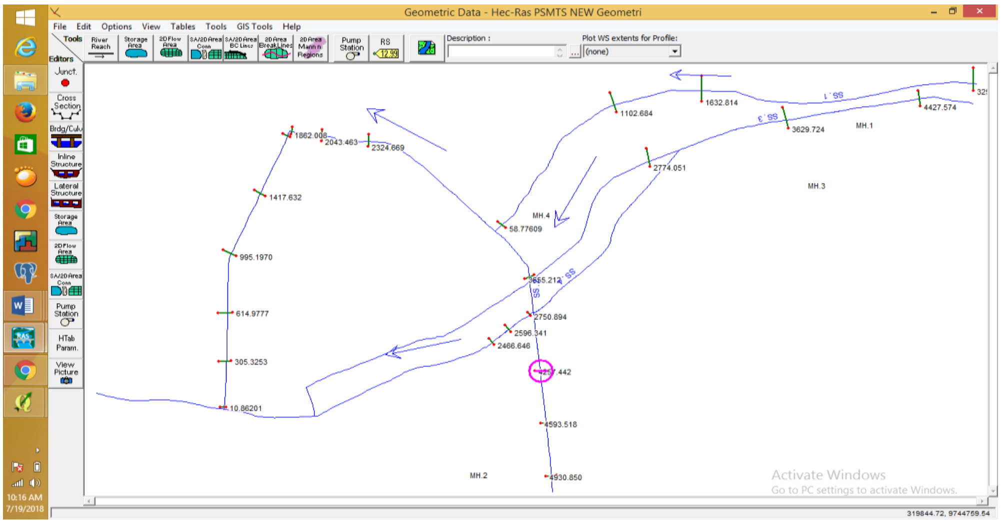
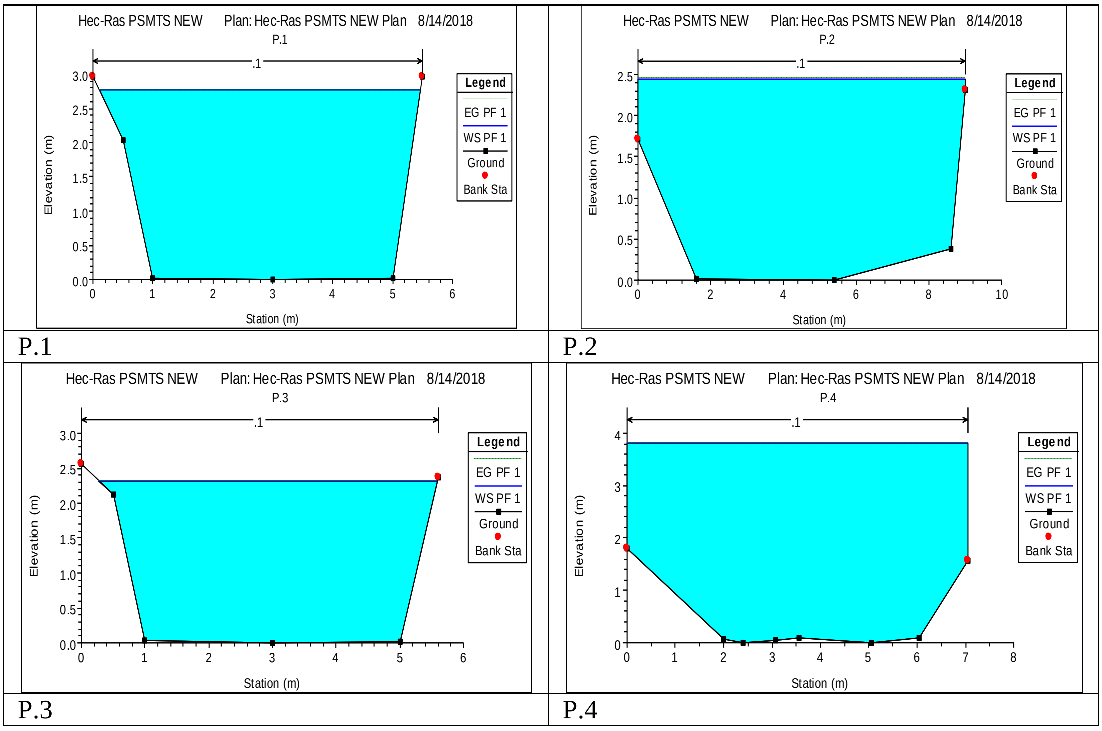


Figure 5.Channel Geometry Results Imported from Qgis (Source: Analysis)

Based on the analysis results by using the rational method, the smallest planned flood debit was 10.94 m^3/sec at the 2-years return period (Q_2) and the largest planned flood debit was 14.66 m^3/sec in the 10-years return period (Q_{10}).

Hec-Ras simulation was used to predict the condition of the channel section and water level in the existing channel using the smallest discharge. Different roughness values for each channel were reviewed. Roughness values for SS.1, SS.2 and SS. 4 were the flow of grass, deep grooves, or flood paths with trees and shrubs (Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush) in accordance with table II.9 with roughness value of 0.1. Roughness value for SS.3 channel takes form of clean and straight flow, full water level, no gap or deep part (kedung) (clean, straight, full, no rifts or deep pools) with value of 0.030. The results of the existing channel simulation on the smallest plan flood debit are can be seen in Figure 6.



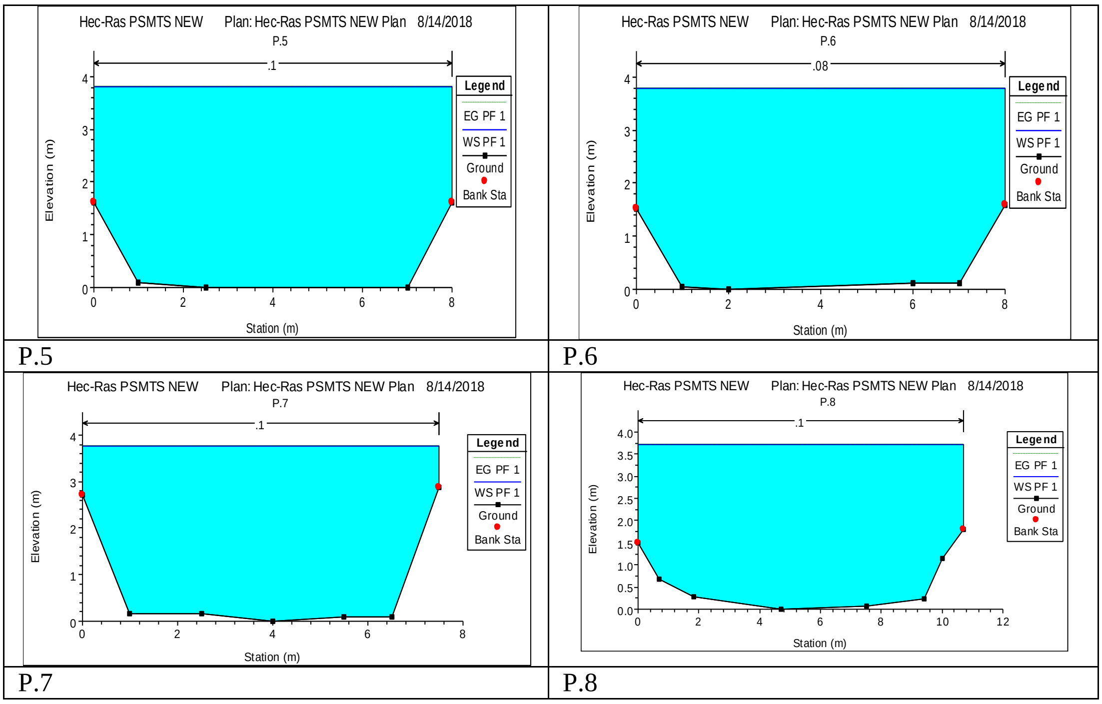


Figure 6.Results of Hec-Race Simulation of Debit Plans Q1

Based on results of the hec-race application simulation with a 2-years return period, all channel sections are unable to accommodate the flood debit, so that a rise in water level exceeds the height of the channel section whereit causes flooding in the Matang Hanau swamp irrigation area. Based on the analysis results, it is necessary to redesign the cross section of the channel with a 10-years flood debit.

Based on the design calculation, the channel dimension can accommodate the flood debit plan. Based on the data - design data of channel dimensions and flood debit plan, the simulation was taken with Hec-race application. Simulation results can be seen in the following figure:

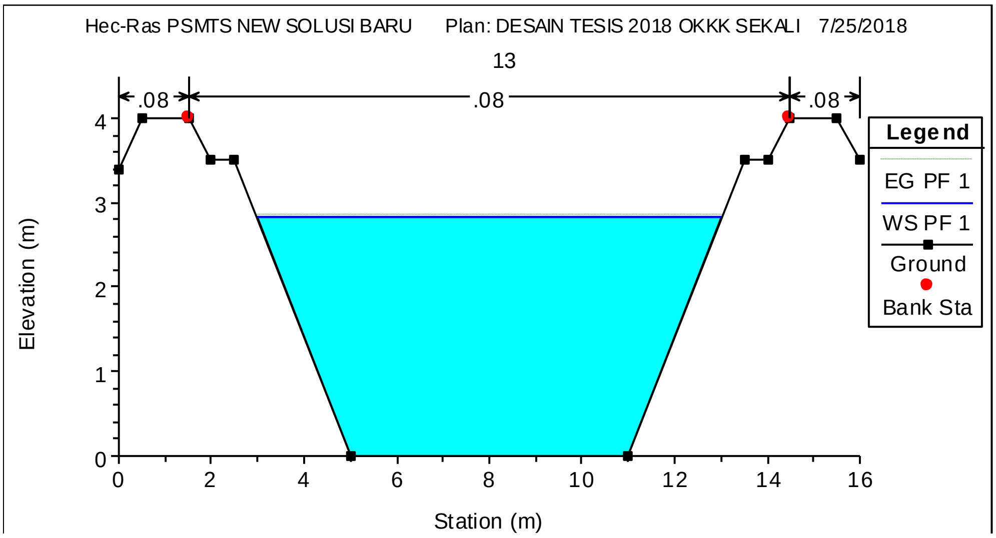


Figure 7.Cross Section Simulation P.1 SS.1-MH.1 (Source: Analysis)

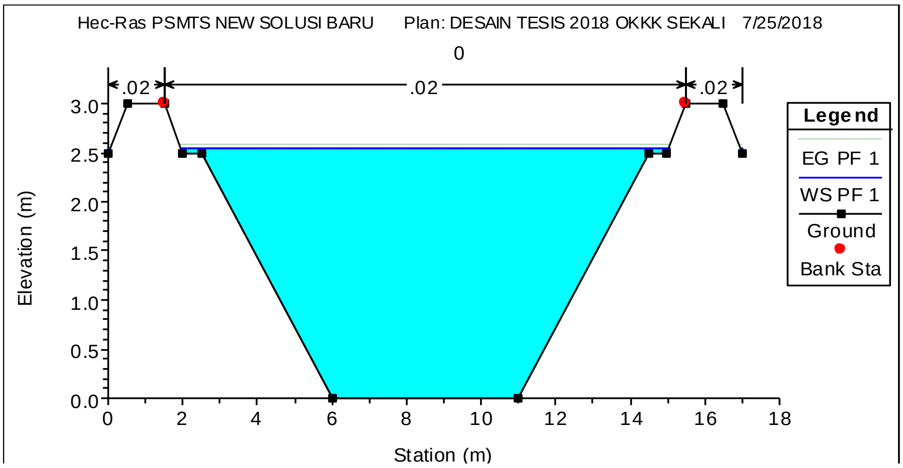


Figure 8.CrossSection Section P.5 SS.2-MH.2 (Source: Analysis)

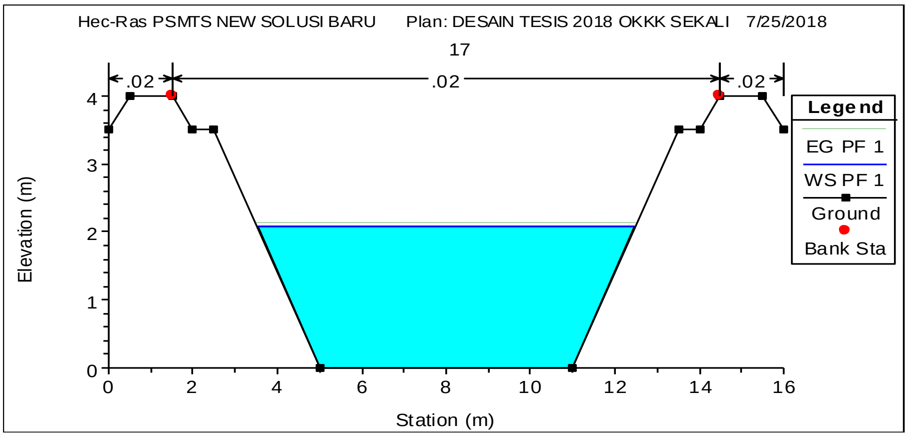


Figure 9.Cross Section Simulation P.18 SS.3-MH.3 (Source: Analysis)

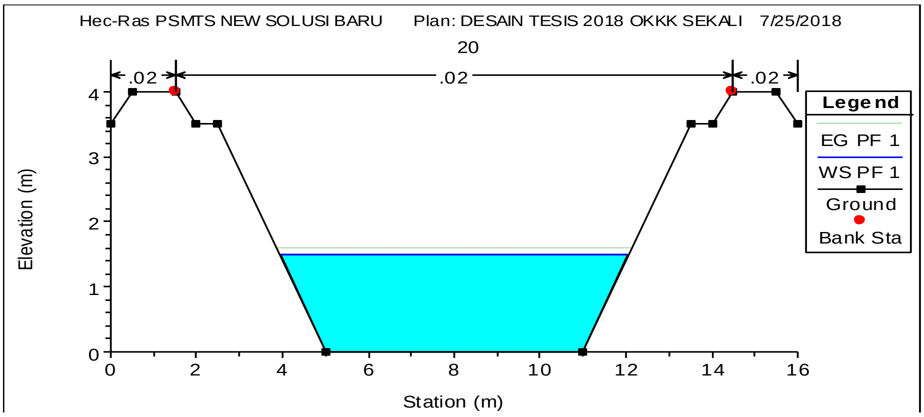


Figure 10.Simulation of Section Section P.21 SS.4-MH.4 (Source: Analysis)

V. Conclusion

Some conclusions can be drawn from the study are as follows:

1. The analysis results suggested that the water quality status at the study site was identified as mildly polluted against quality standard I as raw material for clean water and standard quality II as water for livestock and agriculture.
2. Laboratory test results revealed that the polluted parameters were DO, BOD, COD, Copper and E-Coli.
3. Based on the results of the hec-ras application simulation, it can be seen that the condition of the existing channel cannot accommodate the smallest flood debit plan, which is 2.85m^3/sec.So that the water overflows the channel causing the flooded land due to the exceeded water level in the existing channel crossing capacity.

4. The hydrodynamic model of the Hec-Ras application simulation results shows that the condition of the existing channel section is unable to pass by the planned flood debit.
5. Based on the results of a cross-section redesign, the channel is able to accommodate a 10-years return flood debit (Q_{10}) of 14.66 m^3/sec.

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