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ANALYSIS OF THE CROSS-SECTION PLANNING OF JEPARA'S SECONDARY CHANNELS IN SERAYU IRRIGATION AREA OF SUMPIUH IRRIGATION CHANNELS CILACAP CENTRAL JAVA

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ABSTRACT

Central Java is one of the provinces in Indonesia that relies on the agricultural sector. The agricultural center in the province is located in the Cilacap regency. In order to improve agricultural products, adequate facilities and infrastructure are required, one of which is the Jepara Secondary Channel. Channels on the Secondary Channel Jepara majority is no longer worth using. So much agricultural land is less maximal in water utilization. On the Jepara secondary channel, there is no similar cross-section of channels; some use a cross-section of soil, stone, and concrete, and there is cross-sectional damage. A cross-sectional planning analysis of secondary channels needs to be conducted with the problem. Consider effective rainfall analysis, irrigation needs analysis, and available hydraulic analysis. The results obtained from the analysis should indicate that the discharge flowed by the existing channel (Qs) must be greater than or equal to the planned discharge ($Q0$). Based on the results, two channels cannot accommodate the discharge of water needs ($Q0$), so it needs to be redesigned. However, by analyzing cross sections along channels with a varied cross-section shape. Then planned design for all fields by using alternative four. This is because a cross-sectional combination of the trapezoid and u-ditch 70x80 cm can shorten the working time and make construction costs more affordable.

Keywords Secondary Channels; Capacity of Existing Channels; Redesign
Paper type Research paper

INTRODUCTION

Reinforce national water and food resistance, then require maintenance of the irrigation system to be more optimal. The majority of Irrigation systems in the Cilacap Regency Area have been unsuitable. As a result, much agricultural land is not optimal in terms of water utilization. Therefore, it requires enhancing the irrigation system by rebuilding primary and secondary channels with new construction that is more modern, sturdy, and durable [1]–[6].

Definition of Irrigation

Based on Peraturan Pemerintah No. 20 Tahun 2006, about irrigation, irrigation is a provision, regulation, and disposal of water to support agriculture, including surface irrigation, swamp irrigation, underground water irrigation, pump irrigation, and pond irrigation [7]–[12].

Classification of Irrigation System

Reviewed by the method of setting, method of water flow measurement, and the facilities differentiated into three levels i.e. [5], [1], [6], [3], [4], [2].

1. Simple irrigation system;
2. Semi-technical irrigation system; and
3. Technical irrigation system.

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Needs of Irrigation Water

Net field water requirement (NFR) is affected by NFR factors considering rainfall effective (Re). The differences of requirement by taking water irrigation (DR), also determined by considering irrigation of factor efficiency overall (e), calculation of requirement of irrigation water with formula i.e.

$$NFR = Etc + P + WLR - Re \quad (1)$$

$$DR = NFR/e \quad (2)$$

Irrigation Channels

Irrigation channels are water-carrying ducts from the source (e.g. river) to the land to flow. Irrigation channels are building and complementary buildings necessary for the provision, distribution, administration, use, and disposal of irrigation water.

Planning of Irrigation Water

It consists of the planning discharge plan, efficiency, and planning of hydrolysis. Discharge plan for channels calculate by formula i.e.

$$Q = q \, x \, A \quad (3)$$

$$Q = \frac{NFR}{e} \, x \, A \quad (4)$$

Annotation:

Q	: discharge plan, l/dt
A	: large area irrigated, ha
NFR	: net field water requirement in the land, l/dt/ha
e	: efficiency overall (65%)

Efficiency for planning purposes is considered a fifth to a quarter of the amount of water taken will be lost before it reaches the water. Water use should be as efficient as possible, especially for areas with limited availability.

Hydrolysis planning used an economic cross-section plan of open channels. The most economical cross-section is a cross-section that has a maximum discharge (Q) at a particular area (A). A cross-section will result in a maximum debit when the maximum R or minimum P value. According to Strickler, the debit formula shown in Figure 1 is as follows.

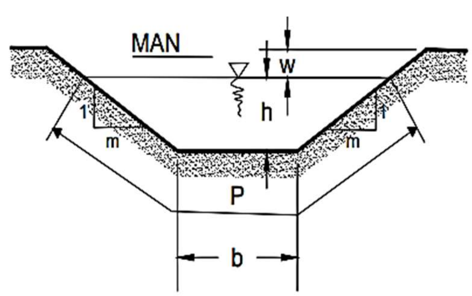

Figure 1. The channel transverse cut parameters

$$Q = V \, x \, A \quad (5)$$

where:

$$V = k \, R^{2/3} I^{1/2} \quad (6)$$

$$R = A/P \quad (7)$$

$$A = bh + mh^2 \quad (8)$$

$$P = b + 2h\sqrt{1 + m^2} \quad (9)$$

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To calculate *h* and *b* used method trial and error, where:

Q	: discharge plan, $m^{1/3}/dt$
V	: streaming speed, *m/s*
k	: coefficient of strickler roughness
I	: channel base slope (plan)
m	: talud slope
n	: *b/h*
b	: channel base width (*m*)
h	: high water (*m*)

METHOD

The research was conducted Analysis of The Cross Section Planning of Jepara's Secondary Channels, in Serayu Irrigation Area of Sumpiuh Irrigation Channels, Cilacap-Central Java. This study conducted data collection, namely existing channel data, topographic data, and hydrological data.

Research Sites

The location of this research was carried out in the Jepara's secondary channel. Jepara's secondary channel was located in Jepara Wetan village until Jepara Kulon Village, Cilacap regency area, Central Java Province. This channel has a length of 7900 meters and is divided into nine sections as shown in Figure 2.

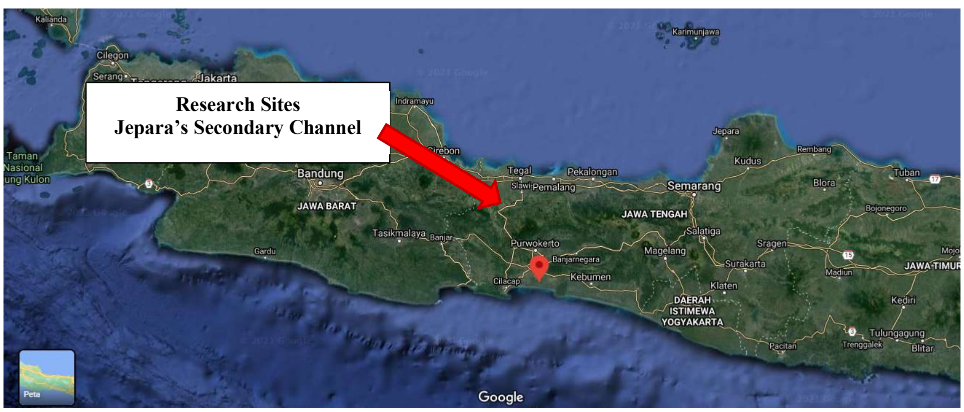

Figure 2. The research sites

Data Processing

The data processing of data collection is as follows:

1. Existing channel data, topographic data, and hydrological data are used to calculate the discharge of existing channels (*Qs*). Then, we analyzed $Qs \geq Q_{0;}$ if it does not meet these requirements, it is necessary to plan the design of existing channels.
2. The plan of designing existing channels with a new cross-section must match the planned discharge of *Q0* and qualify for a new cross-sectional irrigation channel (*Qr*) ≥ *Q0*.

DISCUSSION

In order to analyze the capacity of the existing irrigation channel in Jepara's Secondary Channel to know receiving and channeling excess water, it can be planned to redesign with a new cross-section with the following stages required.

Rainfall Effective (R80)

The results of the effective rainfall calculation are shown in Table 1.

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TABLE 1. EFFECTIVE RAINFALL CALCULATION (R80)

No	Year	Regional rainfall (mm/year)	After Sorted		P (%)
			Year	Regional average rain	
11	2009	3586,6	2018	191	92%
10	2010	5067,9	2017	283	83%
9	2011	2888	2016	289	75%
8	2012	3015,2	2019	1968,9	67%
7	2013	3158	2015	2276	58%
6	2014	3847	2011	2888	50%
5	2015	2276	2012	3015,2	42%
4	2016	289	2013	3158	33%
3	2017	283	2009	3586,6	25%
2	2018	191	2014	3847	17%
1	2019	1968,9	2010	5067,9	8%

Resources: Analysis Results

TABLE 2. RAINFALL CALCULATION FOR PADDY AND PALAWIJA

Month	Days	R80 (mm)	Re = 70% x R80 (mm)	Re Paddy (mm)	Re = 50% x R80 (mm)	Re Palawija (mm)
January	31	263,1	184,17	5,94	131,55	4,24
February	28	196,6	137,62	4,92	98,3	3,51
March	31	387	270,9	8,74	193,5	6,24
April	30	214,6	150,22	5,01	107,3	3,58
Mey	31	628,9	440,23	14,20	314,45	10,14
June	30	447,2	313,04	10,43	223,6	7,45
July	31	343	240,1	7,75	171,5	5,53
August	31	389	272,3	8,78	194,5	6,27
September	30	661,9	463,33	15,44	330,95	11,03
October	31	601,2	420,84	13,58	300,6	9,70
November	30	365,1	255,57	8,52	182,55	6,09
December	31	570,3	399,21	12,88	285,15	9,20

Resources: Analysis Results

Evapotranspiration calculation

Results of the evapotranspiration calculation with the modified penman method, i.e., are shown in Table 3.

Water Needs during Land Preparation

The water needed during land preparation is shown in Table 4. At the same time, the analysis of irrigation water needs is shown in Table 5.

Based on Table 5, NFR and DR values are:
NFR min = 0.0009 m3/sec/ha
DR min = 0.00144 m3/sec/ha
Water needs for each section of the Jepara's Secondary Line are shown in Table 6. Detailed each section views are shown in Figures 3-6.

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TABLE 3. RECAPITULATION OF EVAPOTRANSPIRATION CALCULATION OF MODIFIED PENMAN METHOD

No	Description	Unit	Month											
			Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**	**Okt**	**Nov**	**Dec**
1	Air Temperature (T)	ºC	27,7	27,9	28,2	28,3	28	27,4	26,9	27,1	27,1	27,2	27,7	27,3
2	Relative Humidity (Rh)	%	81	82	81	81	86	85	84	82	86	84	83	83
3	Wind velocity (U)	km/day	133,3	133,3	133,3	133,3	133,3	177,8	222,2	311,1	177,8	133,3	133,3	133,3
4	Sunshine (s = n/N)	%	49,39	52,01	58,32	63,94	70,97	58,65	61,32	57,67	59,1	50,94	29,13	52,13
	Calculation Rns (r=0.25)													
5	Ra	mm/hr	18,42	18,42	18,42	18,42	18,42	18,42	18,42	18,42	18,42	18,42	18,42	18,42
6	Rns = (1-r) Ra (0.25+0.5xs)	mm/hr	6,87	6,87	6,87	6,87	6,87	6,87	6,87	6,87	6,87	6,87	6,87	6,87
	Calculation Rnl													
7	σT4	-	19,3	19,3	19,3	19,3	19,3	19,3	19,3	19,3	19,3	19,3	19,3	19,3
8	ea	mbar	37,23	37,67	38,33	38,56	37,89	36,58	35,52	35,94	35,94	36,16	37,23	36,37
9	ed = Rh x ea	mbar	30,16	30,89	31,05	31,23	32,58	31,10	29,84	29,47	30,91	30,37	30,90	30,19
10	Ved	-	5,49	5,56	5,57	5,59	5,71	5,58	5,46	5,43	5,56	5,51	5,56	5,49
11	(0.34 - 0.044 x Ved)	-	0,10	0,10	0,09	0,09	0,09	0,09	0,10	0,10	0,10	0,10	0,10	0,10
12	(0.1 + 0.9 x s)	-	0,54	0,54	0,54	0,54	0,54	0,54	0,54	0,54	0,54	0,54	0,54	0,54
13	Rnl = (7) x (11) x (12)	mm/day	1,00	0,97	0,96	0,95	0,90	0,96	1,01	1,03	0,97	0,99	0,97	1,00
	Calculation Ea													
14	(ea -ed)	-	7,07	6,78	7,28	7,33	5,30	5,49	5,68	6,47	5,03	5,78	6,33	6,18
15	f(u) = 0.27 (1+U/100)	-	0,630	0,630	0,630	0,630	0,630	0,750	0,870	1,110	0,750	0,630	0,630	0,630
16	Ea = (14) * (15)	mm/day	4,46	4,27	4,59	4,62	3,34	4,12	4,95	7,18	3,77	3,64	3,99	3,90
	Calculation Eto													
17	C	-	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
18	w	-	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76	0,76

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No	Description	Unit	Month											
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Okt	Nov	Dec
19	(1-w)	-	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24
20	Rn = Rns - Rnl	mm/day	5,87	5,90	5,90	5,91	5,96	5,91	5,85	5,84	5,90	5,88	5,90	5,87
21	Eto = C (w x Rn + (1-w) x Ea)	mm/day	5,529	5,507	5,588	5,600	5,335	5,476	5,637	6,162	5,388	5,341	5,439	5,395
		mm/month	171,40	154,20	173,23	168,00	165,39	164,28	174,73	191,02	161,65	165,56	163,18	167,25

Resources: Analysis Results

TABLE 4. WATER NEEDS DURING LAND PREPARATION

Month	Eto (mm/hr)	Eo = 1.1 x Eto (mm/hr)	P (mm/hr)	M = Eo + P (mm/hr)	k = M x T/S			
					T = 30 hari		T = 45 hari	
					S = 250 (mm)	S = 300 (mm)	S = 250 (mm)	S = 300 (mm)
January	5,53	6,08	3	9,08	1,09	0,91	1,63	1,36
February	5,51	6,06	3	9,06	1,09	0,91	1,63	1,36
March	5,59	6,15	3	9,15	1,10	0,91	1,65	1,37
April	5,60	6,16	3	9,16	1,10	0,92	1,65	1,37
Mey	5,34	5,87	3	8,87	1,06	0,89	1,60	1,33
June	5,48	6,02	3	9,02	1,08	0,90	1,62	1,35
July	5,64	6,20	3	9,20	1,10	0,92	1,66	1,38
August	6,16	6,78	3	9,78	1,17	0,98	1,76	1,47
September	5,39	5,93	3	8,93	1,07	0,89	1,61	1,34
October	5,34	5,87	3	8,87	1,06	0,89	1,60	1,33
November	5,44	5,98	3	8,98	1,08	0,90	1,62	1,35
December	5,40	5,93	3	8,93	1,07	0,89	1,61	1,34

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TABLE 5. ANALYSIS OF IRRIGATION WATER NEEDS

Month		Re Paddy mm/d	Re Palawija mm/d	Eto mm/d	P mm/d	WLR mm/d	Coeff. Paddy C	Coeff. Palawija C	Etc		NFR		DR		NFR		DR	
									Paddy (mm/d)	Palawija (mm/d)	Paddy (lt/dt/d)	Palawija (lt/dt/d)	Paddy (lt/dt/d)	Palawija (lt/dt/d)	Paddy (lt/dt/d)	Palawija (m3/dt/d)	Paddy (lt/dt/d)	Palawija (m3/dt/d)
January	I	5,94	4,24	5,53	3		LP		9,35		0,74		1,14		0,0074		0,0114	
	II						1,1		6,08		0,70		1,08		0,0070		0,0108	
February	I	4,92	3,51	5,51	3		1,1		6,06		0,48		0,74		0,0048		0,0074	
	II						1,1		6,06		0,70		1,08		0,0070		0,0108	
March	I	8,74	6,24	5,59	3		1,24		6,93		0,14		0,21		0,0014		0,0021	
	II					1,65	1,05		5,87		0,87		1,34		0,0087		0,0134	
April	I	5,01	3,58	5,60	3	1,65	0,95		5,32		0,57		0,88		0,0057		0,0088	
	II					1,65	0				0,19		0,29		0,0019		0,0029	
May	I	14,20	10,14	5,34	3	1,65					1,11		1,70		0,0111		0,0170	
	II							0,75		4,00		0,46		0,71		0,0046		0,0071
June	I	10,43	7,45	5,48	3			0,96		5,26		0,09		0,14		0,0009		0,0014
	II							1		5,48		0,63		0,98		0,0063		0,0098
July	I	7,75	5,53	5,64	3			0,82		4,62		0,24		0,37		0,0024		0,0037
	II							0,45		2,54		0,29		0,45		0,0029		0,0045
August	I	8,78	6,27	6,16	3													
	II																	
September	I	15,44	11,03	5,39	3		LP		9,35		0,36		0,55		0,0036		0,0055	
	II						1,1		5,93		0,69		1,06		0,0069		0,0106	
October	I	13,58	9,70	5,34	3		1,1		5,87		0,54		0,84		0,0054		0,0084	
	II						1,05		5,61		0,65		1,00		0,0065		0,0100	
November	I	8,52	6,09	5,44	3	1,65	1,05		5,71		0,21		0,33		0,0021		0,0033	
	II					1,65	0,95		5,17		0,79		1,21		0,0079		0,0121	
December	I	12,88	9,20	5,40	3	1,65	0				0,95		1,47		0,0095		0,0147	
	II					1,65					0,19		0,29		0,0019		0,0029	

Resources: Analysis Results

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TABLE 6. WATER SUPPLY DISCHARGE (*QO*)

No	Stage	L (m)	A (ha)	q (m^3/sec/ha)	Q_0 (m^3/sec)
1	Stage 1a (HM 00+00 - 19+27)	1927	367	0,0014	0,530
2	Stage 1b (HM 19+50 - 22+45)	295	362	0,0014	0,523
3	Stage 1 (HM 22+50 - 24+45)	195	357	0,0014	0,515
4	Stage 2a (HM 24+50 - 40+90)	1640	270	0,0014	0,390
5	Stage 2 (HM 41+00 - 51+67)	1067	265	0,0014	0,383
6	Stage 3 (HM 51+67 - 51+72)	5	224	0,0014	0,323
7	Stage 4 (HM 51+72 - 51+87)	15	124	0,0014	0,179
8	Stage 5 (HM 52+00 - 69+30)	1730	109	0,0014	0,157
9	Stage 6 (HM 69+50 - 79+00)	950	97	0,0014	0,140

Resources: Analysis Results

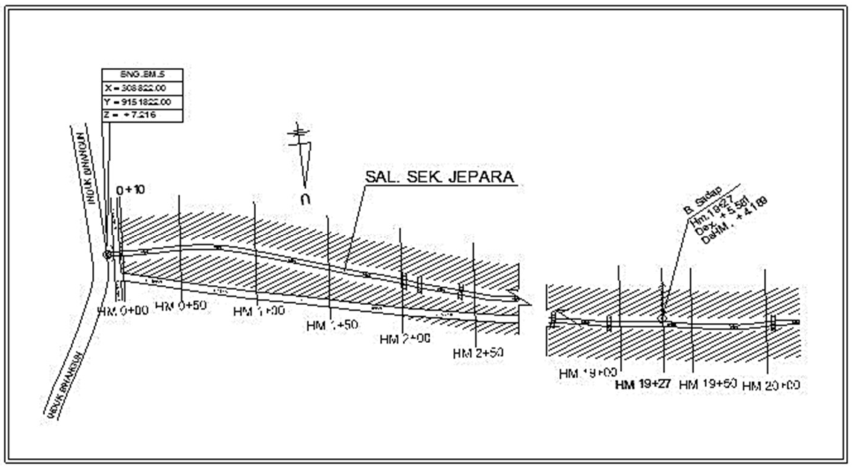

Figure 3. Plan View of the 1A Section

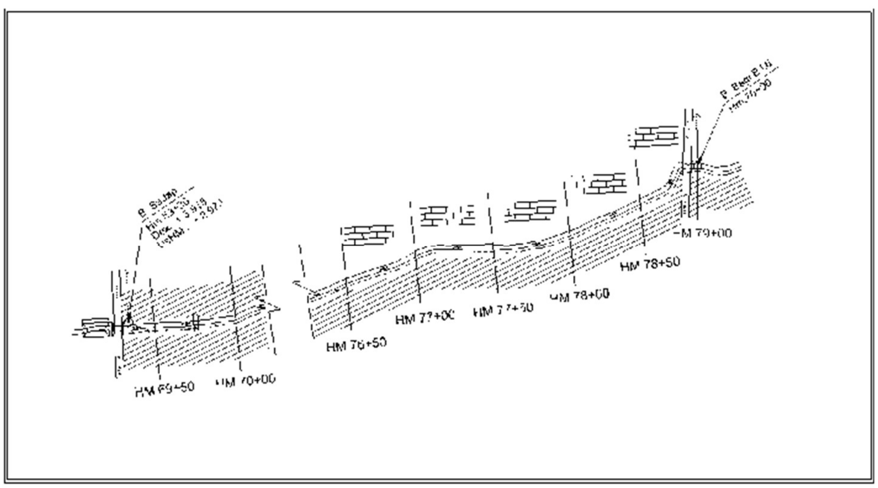

Figure 4. Plan View of the 6 Section

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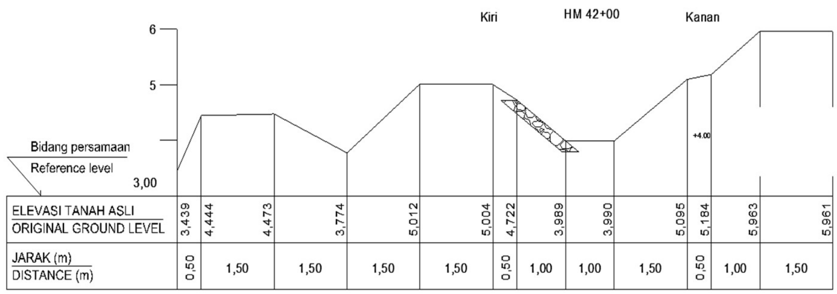

Figure 5. Existing HM 42+00

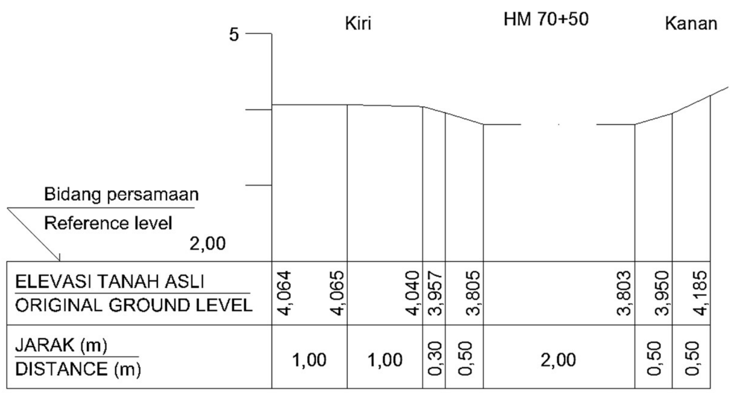

Figure 6. Existing HM 70+50

Existing Channel Capacity

Calculating existing channel capacity is performed using the Strickler formula, and the result is obtained in Table 7.

TABLE 7 RECAPITULATION OF EXISTING CHANNEL CAPACITY CALCULATION

No	Stage	b (m)	h (m)	m	k	A (m²)	P (m)	R (m)	S	V (m/dt)	Qs (m³/sec)
1	Stage 1a (HM 00+00 - 19+27)	0,60	0,89	1	50	1,33	3,12	0,43	0,00021	0,41	0,542
2	Stage 1b (HM 19+50 - 22+45)	0,60	0,95	1	50	1,47	3,29	0,45	0,00021	0,42	0,623
3	Stage 1 (HM 22+50 - 24+45)	0,60	0,83	1	50	1,19	2,95	0,40	0,00021	0,39	0,468
4	Stage 2a (HM 24+50 - 40+90)	0,80	0,80	1	50	1,28	3,06	0,42	0,00019	0,38	0,487
5	Stage 2 (HM 41+00 - 51+67)	0,70	0,85	1	50	1,32	3,10	0,42	0,00019	0,38	0,507
6	Stage 3 (HM 51+67 - 51+72)	1,00	0,88	0	50	0,88	2,75	0,32	0,00025	0,37	0,323
7	Stage 4 (HM 51+72 - 51+87)	0,80	0,70	0	50	0,56	2,21	0,26	0,00025	0,32	0,179
8	Stage 5 (HM 52+00 - 69+30)	0,50	0,70	1	50	0,84	2,48	0,34	0,00030	0,42	0,353
9	Stage 6 (HM 69+50 - 79+00)	0,70	0,40	1	50	0,44	1,83	0,24	0,00022	0,29	0,126
	Total					**9,30**	**24,79**	**3,27**		**3,39**	**3,610**

Resources: Analysis Results

An analysis should be performed between existing channel discharge (*Qs*) and water supply discharge (*Q0*) to determine if an existing channel needs to be redesigned or not. If the discharge of existing channels (*Qs*) ≥ water needs discharge (*Q0*), then there is no need to redesign the irrigation channel. However, if the discharge of existing channels (*Qs*) ≤ water needs discharge (*Q0*), then it is necessary to redesign. The following results of the analysis of existing channel discharge (*Qs*) and water needs discharge (*Q0*) are shown in Table 8.

TABLE 8. *QS* AND *Q0* ANALYSIS RESULTS

No	Stage	Qs m³/dt	Q0 m³/dt	Evaluation	Notification
1	Stage 1a (HM 00+00 - 19+27)	0,542	0,530	Qs > Q0	No Redesign Needed
2	Stage 1b (HM 19+50 - 22+45)	0,623	0,523	Qs > Q0	No Redesign Needed
3	Stage 1 (HM 22+50 - 24+45)	0,468	0,515	Qs < Q0	Redesign Needed
4	Stage 2a (HM 24+50 - 40+90)	0,487	0,390	Qs > Q0	No Redesign Needed
5	Stage 2 (HM 41+00 - 51+67)	0,507	0,383	Qs > Q0	No Redesign Needed
6	Stage 3 (HM 51+67 - 51+72)	0,323	0,323	Qs = Q0	Redesign Needed
7	Stage 4 (HM 51+72 - 51+87)	0,179	0,179	Qs > Q0	No Redesign Needed
8	Stage 5 (HM 52+00 - 69+30)	0,353	0,157	Qs > Q0	No Redesign Needed
9	Stage 6 (HM 69+50 - 79+00)	0,126	0,140	Qs < Q0	Redesign Needed

Resources: Analysis Results

The analysis results in Table 8 show that the channels that need redesigning are section 1, section 6, and section 9. However, based on the fact that in the field where the cross-section of channels is used on the Jepara secondary channel, each section has a cross-section shape that varies from using concrete, stone, and soil pairs. Then it is necessary to plan the redesign for the entire field.

Channel Design Plan

The channel design in this study is planned to use 4 (four) alternative designs. The design of the planned channel must qualify for a new cross-sectional irrigation channel (*Qr*) ≥ *Qinitial* (*Q0*). Here are alternative designs with a new cross-section.

1. Alternative Design 1.

TABLE 9. RECAPITULATION OF ALTERNATIVE DESIGN 1

No	Stage	b (m)	h (m)	w (m)	m	k	A (m²)	P (m)	R (m)	S	V (m/sec)	Qr (m³/sec)
1	Stage 1a (HM 00+00 - 19+27)	1,20	0,84	0,40	1	50	1,73	3,59	0,48	0,00010	0,31	0,530
2	Stage 1b (HM 19+50 - 22+45)	1,00	0,75	0,40	1	50	1,32	3,12	0,42	0,00020	0,40	0,523
3	Stage 1 (HM 22+50 - 24+45)	1,00	0,75	0,40	1	50	1,30	3,11	0,42	0,00020	0,40	0,515
4	Stage 2a (HM 24+50 - 40+90)	1,00	0,64	0,40	1	50	1,06	2,82	0,38	0,00020	0,37	0,390
5	Stage 2 (HM 41+00 - 51+67)	0,80	0,70	0,40	1	50	1,04	2,77	0,38	0,00020	0,37	0,383
6	Stage 3 (HM 51+67 - 51+72)	1,00	0,88	0,40	0	50	0,88	2,75	0,32	0,00025	0,37	0,323
7	Stage 4 (HM 51+72 - 51+87)	0,80	0,70	0,40	0	50	0,56	2,21	0,26	0,00025	0,32	0,179
8	Stage 5 (HM 52+00 - 69+30)	0,60	0,44	0,40	1	50	0,46	1,85	0,25	0,00030	0,34	0,157
9	Stage 6 (HM 69+50 - 79+00)	0,50	0,48	0,40	1	50	0,47	1,86	0,25	0,00022	0,30	0,140
	Total						**8,81**	**24,08**	**3,15**		**3,16**	**3,138**

Resources: Analysis Results

TABLE 10. RECAPITULATION OF RESULTS ALTERNATIVE DESIGN 1

No	Stage	Qr (m³/sec)	Q0 (m³/sec)	Evaluation	Notification
1	Stage 1a (HM 00+00 - 19+27)	0,530	0,530	Qr > Q0	OK
2	Stage 1b (HM 19+50 - 22+45)	0,523	0,523	Qr > Q0	OK
3	Stage 1 (HM 22+50 - 24+45)	0,515	0,515	Qr > Q0	OK
4	Stage 2a (HM 24+50 - 40+90)	0,390	0,390	Qr > Q0	OK
5	Stage 2 (HM 41+00 - 51+67)	0,383	0,383	Qr > Q0	OK
6	Stage 3 (HM 51+67 - 51+72)	0,323	0,323	Qr > Q0	OK
7	Stage 4 (HM 51+72 - 51+87)	0,179	0,179	Qr > Q0	OK
8	Stage 5 (HM 52+00 - 69+30)	0,157	0,157	Qr > Q0	OK
9	Stage 6 (HM 69+50 - 79+00)	0,140	0,140	Qr > Q0	OK

Resources: Analysis Results

From the calculation results in Tables 9 and 10, it can be noted that the dimensions of the planned channel are eligible, namely *Qr* ≥ *Q0*. This alternative design 1 is a planned irrigation channel with a rectangular cross-section shape.

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2. Alternative Design 2.

TABLE 11. RECAPITULATION OF ALTERNATIVE DESIGN 2

No	Stage	b (m)	h (m)	w (m)	m	k	A (m²)	P (m)	R (m)	S	V (m/sec)	Qr (m³/sec)
1	Ruas 1a (HM 00+00 - 19+27)	1,20	0,76	0,40	1	50	1,49	3,35	0,44	0,00015	0,36	0,530
2	Ruas 1b (HM 19+50 - 22+45)	1,00	0,81	0,40	1	50	1,46	3,29	0,44	0,00015	0,36	0,523
3	Ruas 1 (HM 22+50 - 24+45)	1,00	0,80	0,40	1	50	1,45	3,27	0,44	0,00015	0,36	0,514
4	Ruas 2a (HM 24+50 - 40+90)	0,90	0,72	0,40	1	50	1,17	2,95	0,40	0,00015	0,33	0,389
5	Ruas 2 (HM 41+00 - 51+67)	0,90	0,72	0,40	1	50	1,16	2,93	0,40	0,00015	0,33	0,382
6	Ruas 3 (HM 51+67 - 51+72)	0,90	0,66	0,40	1	50	1,02	2,76	0,37	0,00015	0,32	0,323
7	Ruas 4 (HM 51+72 - 51+87)	0,80	0,50	0,40	1	50	0,66	2,23	0,30	0,00015	0,27	0,179
8	Ruas 5 (HM 52+00 - 69+30)	0,60	0,49	0,40	1	50	0,53	1,98	0,27	0,00020	0,29	0,157
9	Ruas 6 (HM 69+50 - 79+00)	0,50	0,49	0,40	1	50	0,49	1,89	0,26	0,00020	0,29	0,140
	Total						**9,43**	**24,64**	**3,32**		**2,90**	**3,137**

Resources: Analysis Results

TABLE 12. RECAPITULATION OF RESULTS ALTERNATIVE DESIGN 2

No	Stage	Qr (m³/sec)	Q0 (m³/sec)	Evaluation	Notification
1	Stage 1a (HM 00+00 - 19+27)	0,530	0,528	Qr > Q0	OK
2	Stage 1b (HM 19+50 - 22+45)	0,523	0,521	Qr > Q0	OK
3	Stage 1 (HM 22+50 - 24+45)	0,514	0,514	Qr > Q0	OK
4	Stage 2a (HM 24+50 - 40+90)	0,389	0,389	Qr > Q0	OK
5	Stage 2 (HM 41+00 - 51+67)	0,382	0,382	Qr > Q0	OK
6	Stage 3 (HM 51+67 - 51+72)	0,323	0,323	Qr > Q0	OK
7	Stage 4 (HM 51+72 - 51+87)	0,179	0,179	Qr > Q0	OK
8	Stage 5 (HM 52+00 - 69+30)	0,157	0,157	Qr > Q0	OK
9	Stage 6 (HM 69+50 - 79+00)	0,140	0,140	Qr > Q0	OK

Resources: Analysis Results

From the calculation results in Tables 11 and 12, it can be noted that the dimensions of the planned channel are eligible, namely $Qr \geq Q0$. This alternative design 2 is a planned irrigation channel with a rectangular cross-section shape.

3. Alternative Design 3

TABLE 13. RECAPITULATION OF ALTERNATIVE DESIGN 2

No	Stage	b (m)	h (m)	w (m)	m	k	A (m²)	P (m)	R (m)	S	V (m/sec)	Qr (m³/sec)
1	Stage 1a (HM 00+00 - 19+27)	1,00	0,81	0,50	1	50	1,48	3,30	0,45	0,00015	0,36	0,530
2	Stage 1b (HM 19+50 - 22+45)	1,00	0,81	0,50	1	50	1,46	3,29	0,44	0,00015	0,36	0,523
3	Stage 1 (HM 22+50 - 24+45)	1,00	0,80	0,50	1	50	1,45	3,27	0,44	0,00015	0,36	0,514
4	Stage 2a (HM 24+50 - 40+90)	0,90	0,72	0,40	1	50	1,17	2,95	0,40	0,00015	0,33	0,389
5	Stage 2 (HM 41+00 - 51+67)	0,90	0,72	0,40	1	50	1,16	2,93	0,40	0,00015	0,33	0,382
6	Stage 3 (HM 51+67 - 51+72)	0,90	0,66	0,40	1	50	1,02	2,76	0,37	0,00015	0,32	0,323
7	Stage 4 (HM 51+72 - 51+87)	0,80	0,50	0,40	1	50	0,66	2,23	0,30	0,00015	0,27	0,179
8	Stage 5 (HM 52+00 - 69+30)	0,60	0,49	0,40	1	50	0,53	1,98	0,27	0,00020	0,29	0,157
9	Stage 6 (HM 69+50 - 79+00)	0,50	0,49	0,40	1	50	0,49	1,89	0,26	0,00020	0,29	0,140
	Total							9,42	24,59	3,32		2,90

Resources: Analysis Results

TABLE 14. RECAPITULATION OF RESULTS ALTERNATIVE DESIGN 2

No	Stage	Qr (m³/sec)	Q0 (m³/sec)	Evaluation	Notification
1	Stage 1a (HM 00+00 - 19+27)	0,530	0,528	Qr > Q0	OK
2	Stage 1b (HM 19+50 - 22+45)	0,523	0,521	Qr > Q0	OK
3	Stage 1 (HM 22+50 - 24+45)	0,514	0,514	Qr > Q0	OK
4	Stage 2a (HM 24+50 - 40+90)	0,389	0,389	Qr > Q0	OK
5	Stage 2 (HM 41+00 - 51+67)	0,382	0,382	Qr > Q0	OK
6	Stage 3 (HM 51+67 - 51+72)	0,323	0,323	Qr > Q0	OK
7	Stage 4 (HM 51+72 - 51+87)	0,179	0,179	Qr > Q0	OK
8	Stage 5 (HM 52+00 - 69+30)	0,157	0,157	Qr > Q0	OK
9	Stage 6 (HM 69+50 - 79+00)	0,140	0,140	Qr > Q0	OK

Resources: Analysis Results

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From the calculation results listed in Tables 13 and 14, it can be noted that the dimensions of the planned channel are eligible, namely *Qr ≥ Q0*. In this alternative design 3 is planned irrigation channel with the form of a cross-section of trapezoids. Therefore, it is also necessary to know the dimensions of the channel cross-sectional slope (Htilted) are shown in Table 15.

TABLE 15. RECAPITULATION OF HTILTED CALCULATION RESULTS BY ALTERNATIVE DESIGN 3

No	Stage	h (m)	w (m)	m	H bent (m)	Rounded up
1	Stage 1a (HM 00+00 - 19+27)	0,81	0,50	1,00	1,504	1,500
2	Stage 1b (HM 19+50 - 22+45)	0,81	0,50	1,00	1,496	1,500
3	Stage 1 (HM 22+50 - 24+45)	0,80	0,50	1,00	1,488	1,500
4	Stage 2a (HM 24+50 - 40+90)	0,72	0,40	1,00	1,306	1,300
5	Stage 2 (HM 41+00 - 51+67)	0,72	0,40	1,00	1,296	1,300
6	Stage 3 (HM 51+67 - 51+72)	0,66	0,40	1,00	1,211	1,200
7	Stage 4 (HM 51+72 - 51+87)	0,50	0,40	1,00	0,997	1,000
8	Stage 5 (HM 52+00 - 69+30)	0,49	0,40	1,00	0,974	1,000
9	Stage 6 (HM 69+50 - 79+00)	0,49	0,40	1,00	0,979	1,000

Resources: Analysis Results

4. Alternative Design 4

TABLE 16. RECAPITULATION OF ALTERNATIVE DESIGN 2

No	Stage	b (m)	h (m)	w (m)	m	k	A (m²)	P (m)	R (m)	S	V (m/sec)	Qr (m³/sec)
1	Stage 1a (HM 00+00 - 19+27)	0,80	0,88	0,40	1	50	1,47	3,28	0,45	0,00015	0,36	0,530
2	Stage 1b (HM 19+50 - 22+45)	0,80	0,87	0,40	1	50	1,46	3,26	0,45	0,00015	0,36	0,523
3	Stage 1 (HM 22+50 - 24+45)	0,80	0,87	0,40	1	50	1,44	3,25	0,44	0,00015	0,36	0,514
4	Stage 2a (HM 24+50 - 40+90)	0,80	0,83	0,40	1	50	1,36	3,16	0,43	0,00010	0,29	0,389
5	Stage 2 (HM 41+00 - 51+67)	0,80	0,83	0,40	1	50	1,34	3,14	0,43	0,00010	0,28	0,382
6	Stage 3 (HM 51+67 - 51+72)	0,80	0,76	0,40	1	50	1,19	2,95	0,40	0,00010	0,27	0,323
7	Stage 4 (HM 51+72 - 51+87)	0,40	0,76	0,40	0	50	0,30	1,92	0,16	0,00162	0,59	0,179
8	Stage 5 (HM 52+00 - 69+30)	0,70	0,61	0,40	0	50	0,43	1,92	0,22	0,00040	0,37	0,157
9	Stage 6 (HM 69+50 - 79+00)	0,70	0,59	0,40	0	50	0,41	1,88	0,22	0,00035	0,34	0,140
	Total							9,41	24,76	3,20		3,21

Resources: Analysis Results

TABLE 17. RECAPITULATION OF RESULTS ALTERNATIVE DESIGN 2

No	Stage	Qr (m³/sec)	Q0 (m³/sec)	Evaluation	Notification
1	Stage 1a (HM 00+00 - 19+27)	0,530	0,528	Qr > Q0	OK
2	Stage 1b (HM 19+50 - 22+45)	0,523	0,521	Qr > Q0	OK
3	Stage 1 (HM 22+50 - 24+45)	0,514	0,514	Qr < Q0	OK
4	Stage 2a (HM 24+50 - 40+90)	0,389	0,389	Qr > Q0	OK
5	Stage 2 (HM 41+00 - 51+67)	0,382	0,382	Qr > Q0	OK
6	Stage 3 (HM 51+67 - 51+72)	0,323	0,323	Qr < Q0	OK
7	Stage 4 (HM 51+72 - 51+87)	0,179	0,179	Qr > Q0	OK
8	Stage 5 (HM 52+00 - 69+30)	0,157	0,157	Qr > Q0	OK
9	Stage 6 (HM 69+50 - 79+00)	0,140	0,140	Qr > Q0	OK

Resources: Analysis Results

From the calculation results in Tables 16 and 17, it can be noted that the dimensions of the planned channel are eligible, namely Qr ≥ Q0. The alternative design 4 (four) is a planned irrigation channel in the form of a trapezoidal cross-section on sections 1a to section 4 and a u-ditch on sections 5 and 6. Therefore, it is also necessary to know the dimensions of the channel cross-sectional slope (Htitled) and the height of the u-ditch (Hu-ditch).

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TABLE 18. RECAPITULATION OF HTILTED CALCULATION RESULTS BY ALTERNATIVE DESIGN 4

No	Stage	h (m)	w (m)	m	H bent (m)	Rounded up
1	Stage 1a (HM 00+00 - 19+27)	0,88	0,40	1,00	1,523	1,500
2	Stage 1b (HM 19+50 - 22+45)	0,87	0,40	1,00	1,515	1,500
3	Stage 1 (HM 22+50 - 24+45)	0,87	0,40	1,00	1,507	1,500
4	Stage 2a (HM 24+50 - 40+90)	0,83	0,40	1,00	1,462	1,300
5	Stage 2 (HM 41+00 - 51+67)	0,83	0,40	1,00	1,452	1,300
6	Stage 3 (HM 51+67 - 51+72)	0,76	0,40	1,00	1,358	1,200
7	Stage 4 (HM 51+72 - 51+87)	0,76	0,40	0,00	0,960	1,000

Resources: Analysis Results

TABLE 19. RECAPITULATION OF HU-DITCH CALCULATION RESULTS BY ALTERNATIVE DESIGN 4

No	Stage	b (m)	h (m)	w (m)	Hu-ditch (m)	U-ditch (cm)
1	Stage 5 (HM 52+00 - 69+30)	0,70	0,61	0,40	0,81	70 x 80
2	Stage 6 (HM 69+50 - 79+00)	0,70	0,59	0,40	0,79	70 x 80

Resources: Analysis Results

Based on the design of the planned channel, which has 4 (four) alternative designs, namely alternative designs 1, 2, 3, and 4, it is known that the four alternatives have been qualified, namely $Qr \geq Q0$. Next, this study used an alternative design 4. The reason is that alternative design 4 has a cross-sectional channel that varies from the open channel in the form of a trapezoidal cross-section and u-ditch with a size of 70 x 80 cm.

CONCLUSION

Based on the results of previous discussions, it can be suggested that the ability of the existing channel irrigation capacity in Jepara's Secondary Channel to receive and distribute excess water is not optimal. This is because the existing channel discharge (Qs) and water supply required to irrigate land ($Q0$) do not meet the $Qs \geq Q0$. These ineligible existing channels occur in sections 1, 3, and 6. For Jepara's secondary channel design corresponds to the planned discharge, alternative design 4.

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