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Analysis of Flood Control Plan in Cibitung Kertagraha Housing, Bekasi District

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Abstract

The change in the function of land to housing can cause a decrease in the level of the water absorption zone that occurs in the area and can cause inundation or even flooding. Housing can be categorized as good, that is, it must have drainage facilities that can drain rainwater quickly and not cause stagnation of water even though the rainfall is very high. Therefore, the right solution to tackle standing water, drainage problems, and flooding in Kertagraha housing is to create a retention pond because in the kertagraha housing there is no final storage system that is suitable for dealing with flooding,The location of this research is located in Sukarukun Village, Sukatani District, Cibitung, Bekasi Regency with the category of housing area. In this study, a hydrological analysis was carried out with rainfall data from the Rain Post Station located in Sukatani and the TRMM Rain Post located in Cikarang within a 10-year return period starting from 2010-2019, and the planned flood discharge data were obtained. Furthermore, hydraulic analysis is carried out to determine the flood discharge capacity in the existing drainage channels and to plan the volume of the storage pool. After that, the retention pond design planning is carried out.In the calculation analysis, it is found that the planned rain discharge value in the next 10 years is 7.393 m³ / second using the Haspers method. The total capacity of the storage pool is 12,385 m³, with the dimensions of the retention pond, namely P = 70m, L = 20m, T = 10meter. With a concentration time of 1675 seconds. Based on the analysis carried out and there is sufficient land, this retention pond is the best solution to overcome the flood problem in Kertagraha housing.

Keywords:
Floods, Hydrology, Haspers Methods, Hydraulics, Retention Pools.

1. Introduction

Flood disaster is a natural condition in which water cannot be stored in the drainage channel or water flow is blocked in the main channel, so that it overflows the surrounding area (flood plain). According to Suripin, "Sustainable Urban Drainage System".

Flood control is an effort made to minimize the risk of flooding that can occur. Mitigation that can be done is by means of structural and non structural methods. Structural mitigation includes technical physical development such as dams, retention ponds, check dams, Groundsill, Retarding Basin, Polder Construction, Infiltration Well, River Network System, River Repair, Embankment Protection, Sudetan, and Estuary Repair, while non-structural such as Watershed management, land use management, erosion control, flood area development, flood area management, emergency handling, flood forecasting, flood warning and control of coastal areas (Robert J. Kodoatie & Roestam Sjarief, 2010)

Kertagraha housing itself is located in the Cibitung area of Bekasi Regency, with topographical conditions in the lowlands surrounded by villages and rice fields, so this housing is very at risk of flooding when the rainfall is high. Floods often occur in the southern area in the kertagraha housing area because the area is the lowest point of land surface conditions. Outside the housing area, there is the nearest river, namely the embankment river with a width of ± 8 meters and an average depth of 6 meters. Therefore, the authors will analyze and plan flood control using a storage pool which is calculated from the maximum flood discharge obtained in the kertagraha housing area from the average over the last 10 years period.

Increasing population growth and drainage management have an impact on changing the function of land use as happened in residential areas, especially in the Kertagraha housing area. Therefore, the authors get problems such as: Stagnation of water in housing occurs when the rainfall is very high and stable, especially in the area of the lowest point of the housing area, water overflows from the existing drainage system, as a result the puddles that occur are not controlled, are the existence of a proper final disposal system in the residential area, the southern area of the housing section, the condition of the land contour is very low so it is not possible to make several housing units in the housing so the discharge accommodated by the channel will gather in the lowest point

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Of the many problems that exist above, if action is not taken immediately it will make it difficult for the population and will aggravate and expand the flood-prone areas in the housing area. Countermeasures that must be done to minimize the floods that come every rainy season are building infrastructure in the form of construction of storage ponds or retention ponds which function to divert excess water discharge that cannot yet flow into rivers.

The aims and objectives of the preparation of the final project are as follows: Analyzing the rainfall to get the maximum flood discharge in the Kertagraha Housing area, Planning a storage pool to deal with flooding that occurs in the Kertagraha Housing area and Planning an outflow system to the volume of the retention pond.

This research will serve as a reference for the government and housing developers to control the potential for flooding in the Cibitung area, Bekasi district and other areas, then provide additional knowledge to readers regarding the calculation of flood discharge, retention pond volume, and discharge discharge system from retention ponds.

2. Research Methods

The method used by the writer in this thesis research is quantitative method and descriptive method. The data from this study were collected and then processed and analyzed. Furthermore, to analyze and find the maximum flood discharge in the kertagraha housing itself the author uses data collection techniques using the Rational Method and the Haspers Method.

The data needed to find the maximum flood discharge is rainfall data, the rainfall data that the author gets comes from the nearest rain station, namely the Sukatani rainfall station and the TRWM rainfall station, Central Cikarang. then Contour data, Contour data is needed to calculate the water flow rate from upstream to downstream. The author obtained contour data from the developer and also surveyed several problematic places during the rain, and reviewed the area to be used as a flood control area. And the last one, namely Watershed Data (DAS), Mapping of watershed boundaries (DAS) is one of the main parameters used as a boundary for determining the catchment area in kertagraha housing which the authors conducted research.

This research was conducted with various systematic work steps in order to obtain optimal results. The research work step is a series of procedures and steps in conducting structured research that is systematic and directed so that the objectives of the research can be achieved properly.

Flowchart view is a "diagram that provides an overview of the flow from one scene to another" (Munir 2012, p. 102). The steps used by the author in this study are seen in the research flowchart as follows:

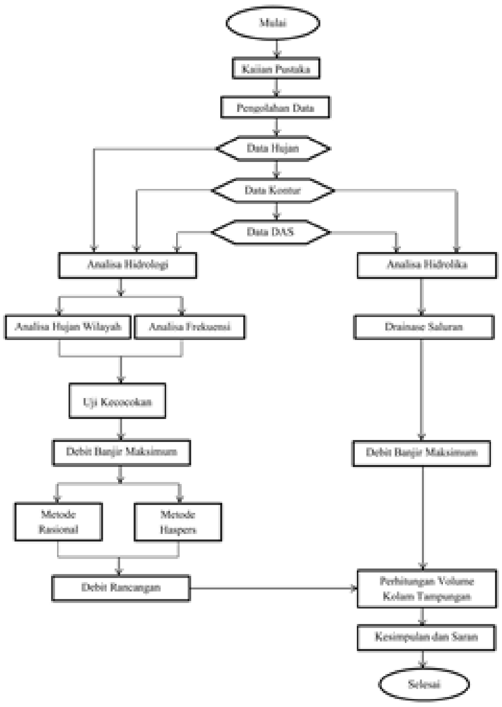

Figure 1. literature review

In principle, a literature review or literature review is carried out to find out some important things related to the topic or research issue that we raise. The literature review that the author uses in the preparation of this thesis comes from books, journals, articles and related lecturer guidance which aims as a reference in the preparation and makes it easier to analyze the calculations contained in this study. In data processing, the authors collect the necessary data by visiting the rainfall station, reviewing the location of the kertagraha housing area, and obtaining data from the developer which aims to assist in analyzing flood control in the residential area. The following is the sequence of calculations that the authors use in this study:

2.1. Hydrological Analysis

Hydrological analysis is needed to determine the hydrological characteristics of the watershed areas in kertagraha housing. Hydrological analysis is used to determine the planned flood discharge in a flood control plan. The data for determining the planned flood discharge in this final project is rainfall data, where rainfall is one of several data that can be used to estimate the amount of planned flood discharge.

1. Regional Rain Analysis

   According to Suyono Sosrodarsono, Ir (1977) rainfall and discharge data are very important data in planning rainwater reservoirs. There are three methods used in calculating the watershed average rainfall (DAS), namely the arithmetic average (algebra) method, the Thiessen polygon method and the Isohyet method.

2. Concentration Time

   Concentration time (tc) is the time required for water points to flow from the farthest hydraulic point in the flow area to an inlet, so that td = tc, meaning that at that time the entire flow area contributes to the flow at the point. the.

   tc = t0 + td

   Where :

   tc = concentration time

   t0 = in-let time

   t1 = conduit time

   L = Channel Length

   V = Kec. Channel average

3. Frequency Analysis

   Frequency analysis is a prediction in the sense of obtaining a probability for the occurrence of a hydrological event in the form of a planned discharge / raindrop which serves as the basis for calculating hydrological planning to anticipate any possibilities that will occur.

   In frequency analysis, the results obtained depend on the quality and length of the data. The shorter the data available, the more storage that occurs. In statistical science, there are several types of frequency distribution and four types of distribution that are widely used in the field of hydrology, namely:

   - Normal Distribution
   - Normal Log Distribution
   - Gumbel distribution
   - Pearson Type II Log Distribution

4. Fit Test

   Distribution fit test analysis is carried out to test the suitability of the frequency distribution of the data sample against the probability distribution function which is expected to describe or represent the frequency distribution. The method that the authors use in the fit test is the Chi-Square and Smirnov-Kolmogorov test.

5. Rainfall Intensity Analysis

   Rainfall in the short term is expressed in intensity per hour which is called the intensity of rainfall. Rain of high intensity generally occurs for a short time. The relationship between rainfall intensity and rainfall time has been formulated, which generally depends on local parameters.

   $$I = \frac{R_{24}}{24}\left(\frac{24}{t}\right)^{m}$$

   Where :

   I = Rainfall intensity (mm / hour)

   t = Length of rainfall (hours)

   R24 = Maximum rainfall in 24 hours (mm)

   m = according to Van Breen's figure is taken m = 2/3

   (CD. Soemarto, 1993, Engineering Hydrology)

6. Maximum Flood discharge calculation

   In the process of calculating the maximum flood discharge that the author uses in this study, there are 2 methods, namely the rational method:

   Q = 0.278.CIA

   Where :

   Q: Discharge (m3 / sec)

   0.278 : Constant, used if the unit area uses km2

C : Flow coefficient
I : Rainfall intensity during concentration time (mm / hour)
A : Area of flow (km2)

and the haspers method:

$Qmax = \alpha \times \beta \times I \times A$

where Qmax is the maximum flowrate (m3 / s), α is the flow coefficient, β is the reduction coefficient, I is the maximum rainfall (m3 / s / km2), A is the area of the drainage area (km2).

2.2. Hydraulics Analysis

Hydraulic analysis aims to determine the ability of the cross section to accommodate the planned discharge. As happened in Kertagraha housing, one of the causes of flooding is due to the inability of the cross section to accommodate the flood discharge that occurred and it is not suitable for the final storage system.

1. Drainage

In general, drainage is defined as a series of water structures whose function is to reduce and or remove excess water from an area or land, so that the land can be optimally functioned. The water level in the channel (h) and the channel width (b) are the parameters for determining the wet area (A). The wet area (A) is analyzed based on the rain discharge (Q) which is also the channel discharge and the water flow velocity in the channel (V):

$Q = A \cdot V$

$A = Q / V$

V is the velocity of water flow in the drainage channel, which is obtained from Table 2.1 or analyzed by the Manning formula or the Chezy formula. To calculate the speed of water flow in a channel, it is determined based on:

Table 1. Velotic of Water Flow

Channel I Slope (%)	Velocity V (m / s)
<1	0.40
1 - <2	0.60
2 - <4	0.90
4 - <6	1.20
6 - <10	1.50
10 - <15	2.40

(Source: Abdul Halim., 2002)

2. Retention Pool

A retention pool is a tub or pool that can accommodate or absorb the temporary water contained in it. In this type of pond, the water that enters the inlet must be able to accommodate the water according to the planned capacity so that it can reduce peak flow during overflow, so that the pool functions as a place to reduce flood discharge due to the additional time to concentrate water for flow on the surface. The capacity of the retention pond that can accommodate the volume of water at the time of the peak flood discharge is calculated using the general equation below:

$$V = \int_0^t (Q\,in - Q\,out)\,dt$$

Where :
V : The volume of the pool
t : The initial time the water enters the inlet
t0 : When the water comes out of the outflow
Qin : Inflow discharge

3. Result and Discussion

The research location of this final project is located in the Sukarukun village, Sukatani district, Bekasi Regency, West Java. This residential area has a land area of 91,406 m2.

Figure 2. Source: Google Earth

In planning a good drainage system, it is necessary to pay attention to the contour conditions or topographic map of the area to be studied, because it is useful for knowing the flow of water from upstream to downstream, here is a land contour map in the Kertagraha housing area of Bekasi district. The results of the discussion contain the following descriptions:

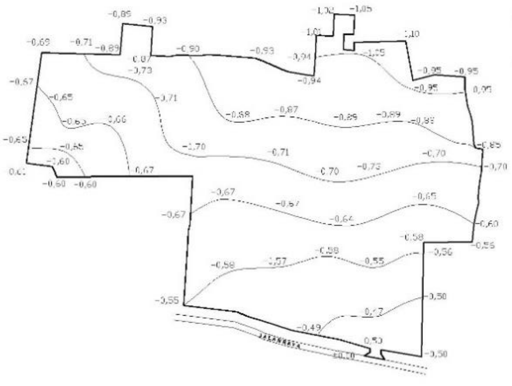

Figure 3. Source: Developer.

Topographic maps are useful for providing information about whereabouts, locations, and distances, such as the location of residents, travel routes and communications. Topographic maps were obtained from the Kertagraha housing developer on November 24, 2020. The topographic map contains information such as ground level and , existing river, spot level and land boundary. The elevation from the zero point of the residential building to the road surface is +50,000 centimeters.

3.1. Calculation Analysis

3.1.1. Hydrological Analysis

Table 2. Rainfall Data

Year	Rain Thickness (mm)		Algebraic Mean	
	Sukatani data	TRMM Cikarang data	P	N
Yrs.	Ch. Max.	Ch. Max.		
2010	87.00	96.80	183.80	91.90
2011	51.00	89.60	140.60	70.30
2012	101.00	94.40	195.40	97.70
2013	141.00	161.00	302.00	151.00
2014	167.00	115.50	282.50	141.25
2015	95.00	124.60	219.60	109.80
2016	87.00	111.60	198.60	99.30
2017	140.00	167.09	307.09	153.55
2018	94.00	0.00	94.00	47.00
2019	130.00	140.40	270.40	135.20

Source: Rainfall Data of Sukatani Post & TRMM Cikarang Post.

a. Frequency Analysis

Table 3. Statistical Parameters

Year	Xi	Xi-Xr	$(xi-Xr)^2$	$(xi-Xr)^3$	$(xi-Xr)^4$
2010	91,90	-17,80	316,82	-5639,28	100376,31
2011	70,30	-39,40	1552,32	-61160,66	2409699,25
2012	97,70	-12,00	143,99	-1727,78	20732,54
2013	151,00	41,30	1705,73	70447,56	2909519,27
2014	141,25	31,55	995,43	31406,44	990888,95
2015	109,80	0,10	0,01	0,00	0,00
2016	99,30	-10,40	108,15	-1124,70	11696,92
2017	153,55	43,85	1922,43	84289,81	3695728,92
2018	47,00	-62,70	3931,23	-246485,99	15454548,1
2019	135,20	25,50	650,28	16582,35	422858,23
∑	1.097	0,00	11.326	113.412	26.016.048

Source: Calculation Results

Table 4. Rainfall with Gumbel Method Return Period

No	Rt Year	yt=_In(In(Rt/-1)))	Yn	Sn	K=Yt-Yn/Sn	Xr	SD	Rn (mm)
1	2	10	0,4952	0,9496	-0,14	109,70	35,48	104,89
2	5	10	0,4952	0,9496	1,06	109,70	35,48	147,23
3	10	10	0,4952	0,9496	1,85	109,70	35,48	175,27
4	25	10	0,4952	0,9496	2,85	109,70	35,48	210,69
5	50	10	0,4952	0,9596	3,59	109,70	35,48	236,97
6	100	10	0,4952	0,9596	4,32	109,70	35,48	263,05

Source: Calculation Results

Table 5. Analysis of the Frequency of Rain with the Normal Distribution Method

No	Rt year	yt=_In(In(Rt/-1)))	Xr	SD	KT	Rn (mm)
1	2	10	109,70	35,48	0,0000	109,70
2	5	10	109,70	35,48	0,8400	139,50
3	10	10	109,70	35,48	1,2800	155,11
4	25	10	109,70	35,48	1,6400	167,88
5	50	10	109,70	35,48	2,0500	182,42
6	100	10	109,70	35,48	2,3300	192,36

Source: Calculation Results

Table 6. Analysis of Rain Frequency, Normal Log Distribution Method

No	Rt year	Yr	Sy	Log Rn	Rn (mm)
1	2	2,0156	0,1626	2,0156	103,6571
2	5	2,0156	0,1626	2,1522	141,9688
3	10	2,0156	0,1626	2,2237	167,3949
4	25	2,0156	0,1626	2,2823	191,5500
5	50	2,0156	0,1626	2,3490	223,3331
6	100	2,0156	0,1626	2,3945	248,0186

Source: Calculation Results

Table 7. Frequency Distribution of the Log Person III Method

No	Year	Rainfall X	CH0, Log X	(log x-log X')	(log x-log $X')^2$	(log x-log $X')^3$	Ln X	(log x-log $X')^4$
1	2009	91,90	1,96	-0,0523	0,0027	-0,0001	4,5207	0,00001
2	2010	70,30	1,85	-0,1686	0,0284	-0,0048	4,2528	0,00081
3	2011	97,70	1,99	-0,0257	0,0007	0,0000	4,5819	0,00000
4	2012	151,00	2,18	0,1634	0,0267	0,0044	5,0173	0,00071
5	2013	141,25	2,15	0,1344	0,0181	0,0024	4,9505	0,00033
6	2014	109,80	2,04	0,0250	0,0006	0,0000	4,6987	0,00000
7	2015	99,30	2,00	-0,0187	0,0003	0,0000	4,5981	0,00000
8	2016	153,55	2,19	0,1706	0,0291	0,0050	5,0340	0,00085
9	2017	47,00	1,67	-0,3435	0,1180	-0,0405	3,8501	0,01392
10	2018	135,20	2,13	0,1154	0,0133	0,0015	4,90676	0,00018
∑		1,097	20,16	0,000	0,2380	0,0322	46,4109	0,0168

Source: Calculation Results

Below is a table recapitulation of the results of the calculation of the frequency of rain analysis whether it matches the predetermined requirements or not, specifically for the log person III distribution analysis, there are no restrictions in the requirements.

Table 8. Analysis to Determine

No	Distribution	Requirement	Count Results		Information
1	Gumbel	$Cs \leq 1{,}1396$	C_s	-0,35	Accepted
		$Ck \leq 5{,}4003$	C_k	3,26	Accepted
2	Normal	$C_s = 0$	C_s	-0,35	Rejected
		$C_k = 3$	C_k	3,26	Rejected
3	Log Normal	$C_s = C_v^3+3C_v$ $Cs = 0{,}365$	C_s	0,24	Rejected
		$C_k=C_v^8+6C_v^6+15C_v^4+16C_v^2+3$ $CK = 3{,}238$	C_k	3,10	Rejected
4	Log Person III	Tidak Ada Batasan	C_s	-1,040	Accepted
			C_k	4,768	Accepted

Source: Calculation Results

Analysis to determine the flood discharge plan that will be used in the planning of this storage pool, the results of the calculation of the rainfall plan for the T year period can be seesn from the terms of the distribution type of the table above. The conclusion from the table above that can be used is the type of Gumbel distribution.

b. Fit Test Chi-Square Test

Table 9. Recapitulation of X² and X²cr

Probability Distribution	X2	DK	X2cr	Information
Gumbel	3,00	3,800	7,815	Accepted
Normal	1,00	3,800	7,815	Accepted
Log Normal	6,00	3,800	7,815	Accepted
Log Person III	4,00	3,800	7,815	Accepted

Source: Calculation Results

Based on the results of the calculations in the table above, it can be concluded that the distribution test of the chi square method of all distribution methods is acceptable, then the Smirnov Kolmogorof test is then carried out.

c. Kolmogrov's Smirnov test

The following is a table of the results of the Smirnov Kolmogorof harmony test using the Gumbel method.

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Table 10. The Smirnov-Kolmogorov test.

Period (Year)	Xt	m	P(x)=m/(n+1)	P(x<)	f(t)	P'(x)=m/(n-1)	D
2	104,9	1	0,143	0,857	-1,44	0,200	0,057
5	147,2	2	0,286	0,714	-0,72	0,400	0,114
10	175,3	3	0,429	0,571	-0,25	0,600	0,171
25	210,7	4	0,571	0,429	0,36	0,800	0,229
50	237,0	5	0,714	0,286	0,80	1,000	0,286
100	263,1	6	0,857	0,143	1,25	1,200	0,343

Source: Calculation Results

d. Rain CuraH Intensity

The following is an example of calculating rainfall intensity using the Mononobe method with a 10 year return period.

Table 11. Rainfall for the return period using the gumbel method.

Re-period T (Thn)	Xt
2	104,89
5	147,23
10	175,27
25	210,69
50	236,97
100	263,05

$$\mathbf{I} = \frac{\mathbf{175{,}27}}{\mathbf{24}}\ \mathbf{x}\left(\frac{\mathbf{24}}{\frac{\mathbf{5\ \mathit{menit}}}{\mathbf{60\ \mathit{menit}}}}\right)^{\mathbf{2/3}} = 318.5 \text{ mm / hour}$$

From the above calculations, it is obtained I = 318.5 mm / hour. Below is a table of the results of calculating the intensity of rain using the Dr Mononobe method:

Table 12. 10 Year Return Period Rain Table.

t(minute)	t(hour)	R24/24	24/t	(24/t)^2/3	1(mm/hour)
0	0,000	7,303			
5	0,083	7,303	288	43,611	318,5
10	0,167	7,303	144	27,473	200,6
15	0,250	7,303	96	20,966	153,1
20	0,333	7,303	72	17,307	126,4
45	0,750	7,303	32	10,079	73,6
60	1,000	7,303	24	8,320	60,8
120	2,000	7,303	12	5,241	38,3
180	3,000	7,303	8	4,000	29,2
360	6,000	7,303	4	2,250	18,4
720	12,000	7,303	2	1,587	11,6

Source: Calculation Results

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Table 13. Hourly Rain Table.

t(hour)	r2	r5	r10	r25	r50	r100
	104,89	147,23	175,27	210,69	236,97	263,05
1	36,36	51,04	60,76	73,04	82,15	91,20
2	22,91	32,16	38,28	46,01	51,75	57,45
3	17,48	24,54	29,21	35,12	39,49	43,84
4	14,43	20,26	24,11	28,99	32,60	36,19
5	12,44	17,46	20,78	24,98	28,10	31,19
6	11,01	15,46	18,40	22,12	24,88	27,62
7	9,94	13,95	16,60	19,96	22,45	24,92
8	9,09	12,76	15,19	18,26	20,54	22,80
9	8,40	11,80	14,04	16,88	18,99	21,08
10	7,83	11,00	13,09	15,74	17,70	19,65
11	7,35	10,32	12,28	14,77	16,61	18,44
12	6,94	9,74	11,59	13,94	15,67	17,40
13	6,58	9,23	10,99	13,21	14,86	16,49
14	6,26	8,79	10,46	12,57	14,14	15,70
15	5,98	8,39	9,99	12,01	13,51	14,99
16	5,73	8,04	9,57	11,50	12,94	14,36
17	5,50	7,72	9,19	11,05	12,43	13,79
18	5,29	7,43	8,85	10,63	11,96	13,28
19	5,11	7,17	8,53	10,26	11,54	12,81
20	4,94	6,93	8,25	9,91	11,15	12,38
21	4,78	6,71	7,98	9,60	10,79	11,98
22	4,63	6,5	7,74	9,30	10,46	11,62
23	4,5	6,31	7,51	9,03	10,16	11,28
24	4,37	6,13	7,3	8,78	9,87	10,96

Source: Calculation Results

The rain intensity of the planning area is presented in the following graph:

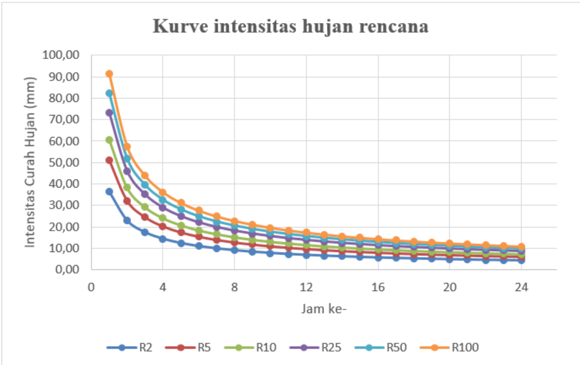

Figure 2. Graph of planned rainfall intensity.

Maximum Flood discharge calculation
Calculation Analysis:
The area of the residential area watershed = 9,140 hectares
Primary Channel Length (L) = 615 meters
The height difference from upstream to downstream (H) = 1 meter

1. Rain Intensity:
   Look for the slope i = H / (0.9 x L)
   = 1m / (0.9 x 615m) = 0.00181 meters
   Seek speed
   V = 72 x S ^ 6
   V = 72 x 〖0.00181〗 ^ 6 = 0.263 m / hour
2. Finding Concentration Time:
   tc = 0.0133Lxi ^ (- 0.6)
   tc = 0.0133. 0.615. 〖0.00181〗 ^ (- 0.6) = 0.3779 hours or 0.3779 x 60 = 22,676 minutes
   Finds Rain intensity for a 10 year return period.
   R24 = 263.05mm
   I = R24 / 24 x (24 / tc) ^ (2/3)
   = (263.05mm) / 24x (24 / (0.3779)) ^ (2/3)
   = 179.57 mm
3. Rational Method
   Flow coefficient C = Ct + Cs + CV
   the conditions of the research location were obtained,
   C = Ct + Cs + CV
   C = 0.03 + 0.26 + 0.28
   = 0.57
   From the above calculations, the peak discharge using the Rational method is as follows:
   Q = 0.278.CIA or Q = (C. I. A) / (3.60)
   Q = 0.278 x 0.57 x 179.57 x 0.091
   = 2,5989m³ / sec
4. Haspers Method
   The data obtained are:
   - Watershed area = 0.0914 km2
   - River length (L) = 0.615 km
   - Upstream Elevation = 5 meters
   - Downstream Elevation = 4 meters
   - Difference in height (h) = 1 meter

   Finding the slope (I)
   i = h / L = 1/615 = 0.00163
   Find the area coefficient of rain

$$\frac{1}{\beta} = 1 + \frac{0{,}465 + (3{,}70\ x\ 10^{0{,}40.0{,}733})}{0{,}465^2 + 15}\ \text{X}\ \frac{91{,}406^{0{,}75}}{12} = 1{,}003$$

$$\boldsymbol{\beta = 1 / 1{,}003 = 0{,}997\ km/jam}$$

For the calculation of the 10 year return period is obtained
R = 175.27 mm
If t <2 hours, the formula is used:

$$r = \frac{t\ x\ R}{t + 1 - 0{,}0008(260 - R)(2 - t)^2}$$

$$r = \frac{0{,}465\ x\ 175{,}27}{0{,}465 + 1 - 0{,}0008(260 - 175{,}27)(2 - 0{,}465\ )^2}$$

$$r = 137{,}446$$

Next is to find q for a period of 10 years,

$$q = \frac{r}{3{,}6\ \text{x}\ \text{t}}$$

Where r = specified return period rainfall (mm)

$$q = \frac{137{,}446}{3{,}6\ \text{x}\ 0{,}465} = 82{,}048$$

So to determine the flood discharge the 10 year return period is
Q = 0.988 x 0.997 x 82.048 x 0.09141
= 7.393 m³ / sec
From the results of the calculation of the two methods above, the flood discharge is obtained as follows:

Table 14. Recapitulation of Flood Discharge Used.

Method	Q 10 year (m3/det)
Rasional	2,599 m3/det
Haspers	7,393 m3/det

Source: Calculation Results

3.1.2. Hydraulics Analysis

a. Drainage Channels

Table 15. Kertagraha Housing Channel Data

Channel Type	Wide	High	Broad m^3	Long m	Total m^3
Primer	3 2,5	2	5,5	615	3382,5
Sekunder	0,6 0,6	0,9	0,54	1223,72	660,8
tersier	0,5 0,5	0,5	0,25	14594	3648,5

1. Calculation of the volume of rain flow in the catchment area to design dranage
   Am= 91406 m^2 (water catchment area)
   I = 263.05 mm / h (obtained from the calculation of the frequency analysis method of the gumbel)
   C = 1 (flow coefficient for housing)
   Qm (volume of rain flow)
   = (1/3600000) x C x I x Am
   = (1/3600000) x 1 x 263.05 x 91406
   = 6.679 m^3 / s
2. Find the drainage capacity using manning's formula. The roughness factor is obtained from the table Typical manning roughness coefficient, (n).
   a. Calculate runoff flow
   Q = WA x V
   = 4 m^2 x 2.207 m / sec
   = 8.829 m^3 / sec
   Qm (volume of rain flow) ≤ Q (flow in channel)
   From the above calculations, it is obtained:
   Qm = 6,679 m^3
   Q = 8.829 m^3 / sec
   Check 6,679 m^3 ≤ 8,829m^3 / s, then the existing channel is safe.

   b. Retention Pool
   Based on the flood hydrograph that enters the retention pond
   Qmak = maximum flood discharge
   = 7.393 m^3 / sec
   n = 2
   tc = Concentration Time
   = 0.465 hours or 1675 seconds
   The formula if using an outlet pump:
   Vt = ((Qmak - Qp) ². N. Tc) / (2. Qmak)
   The formula if not using an outlet pump:
   Vt = (Qmak². N. Tc) / 2. Qmak

Because in the research the author calculates the volume of the temporary flood retention pond, which can reduce the flood discharge so that it does not overflow in the residential area, then an intact pump is used to channel water to the city canal, therefore the formula used to find the storage volume is as follows.

Vt = (Qmak². N. Tc) / 2. Qmak
Vt = ((7,393² x 2 x 1675) / (2. 7,393)
Vt = 12,385 m^3
Simple calculation of infiltration pond
The planned volume of the flood retention pond uses a formula
Vt = 0.855. C. A .R

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Where :

A	= Area of land	= 91.406 m²
C	= Runoff coefficient	= 0.988 (obtained from the calculation of the haspers method)
R	= 10 year period rain intensity	= 175.27 mm
R	= 175.27 / 1000	= 0.17527 m
Vt	= 0.855. C. A .R	
Vt	= 0.855. 0.988. 91,406 m². 0.17527 m	
Vt	= 13,538 m³	

Table 16. Recapitulation Calculation of the volume of flood retention ponds

Method	
Hidrograf	Simple
12.385 m3	13.538 m3

Source: Calculation Results

Figure 4. Planned flood retention ponds.

Planned Retention Pool Area
=width 20 mx length 70 m
= 1400 m²

Checking,
A =Pool area retention plan
1250 m² = 1400m²

From the above calculations, the dimensions of the planned flood retention pond are:

Long = 70 meters
Wide = 20 meters
High = 10 meters

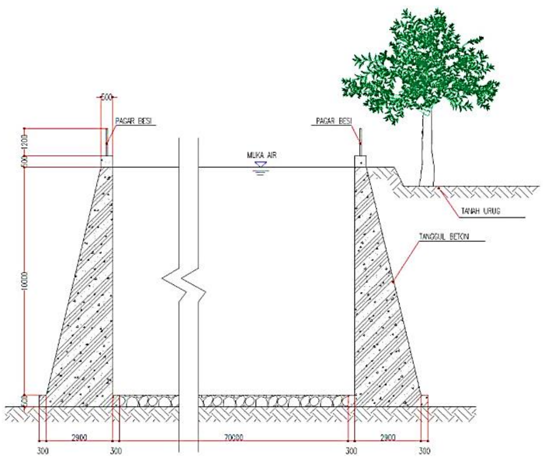

Figure 5. Size of the Flood

The size of the flood retention pond is 1400m² with a width of 20meter, a length of 70meter, and a depth of 10m which is planned to be able to accommodate the flood discharge with a 10-year return period of 12,385 m³. obtained from the maximum planned flood discharge using the haspers method of 7.393 m³ / second with a concentration time of 1675 seconds.

With an outlet system leading to the city channel using a pipe system and a flood gate.
as follows :

Figure 6. Pipa System

Figure 7. a Floot Gate

4. Conclussion

Based on the results of the research that has been done, it can be concluded:

1. The planned flood discharge in the kertagraha housing area reaches 7.393 m³ / second which is calculated using the haspers method and the planned flood discharge is 2.599m³ / second using the rational method. With 175.27 mm of rain in a 10 year return period.
2. Furthermore, the size of the retention pond is obtained to accommodate the flood discharge of the Kertagraha housing area with a width of 20 meters, a length of 70 meters and a depth of 10 meters. The total volume of retention ponds in the Kertagraha residential area is 14000 m³ with an area of 1400 m² which will be made in a rectangular shape, while the design flood discharge produced by the hydrograph method is 12385 m³ with an area of 1238.5 m², so the difference is more than 1615 m³ of storage pool. The pond is planned to accommodate the final drainage from the Kertagraha housing area and then channeled to the city channel.

5. Suggestion

From the results of the research that has been done there are several things that can be suggested, namely as follows:

1. We recommend that for further research it is necessary to analyze the water level of the embankment river to determine the maximum flood period and prevent the occurrence of river water levels beyond the height limit of the Kertagraha housing embankment.
2. The author suggests that further research can calculate the structure of the existing retention ponds and new ponds in the event of housing development and to plan a better outflow system with more detailed tools and calculations.
3. For the developer or developer, if there is a development in the Kertagraha housing development, it is better to recalculate the planned flood discharge that will occur, because the excess of the previous storage pool was only 1615 m³. If there is limited land, you can use a pump system for outflow to the city channel if at any time the Flood Retention pool is unable to accommodate the flood discharge from the Kertagraha housing area and runoff from the embankment river.

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