PLANNING DRAINAGE CHANNELS AND INFILTRATION WELLS AS AN EFFORT TO REDUCE FLOOD INUNDATION IN THE CAMPUS AREA OF UNIVERSITAS NEGERI PADANG AIR TAWAR

Reviza Fatihah Rahmi
Jurusan Teknik Sipil, Fakultas Teknik, Universitas Negeri Padang
revizafatihah@gmail.com

Abstract

Universitas Negeri Padang Air Tawar Campus area faces the problem of flood inundation which is getting worse due to increased rainfall and land use change. This research aims to plan the channel drainage system and infiltration wells in the area as an effort to reduce flood inundation. With increasing rainfall and land use change, the existing drainage system is unable to accommodate water runoff, causing inundation at various points. The methods used in this research include hydrological analysis to determine the planned flood discharge, drainage channel dimension planning, and infiltration well planning. The results of the analysis show that the dimensions of the existing drainage channel need to be enlarged, with the channel height planned to be 2.3 m and 4 m wide. In addition, 358 infiltration wells with a diameter of 1 m and a depth of 2 m are planned to increase the infiltration capacity of rainwater. The study also found that the implementation of the planned drainage system can reduce flood inundation by 70% during the rainy season. This research is expected to provide an effective solution in overcoming the problem of flood inundation in the campus area. © *2025 American Society of Civil Engineers.*

Keywords: Drainage; Flood inundation; Infiltration ponds; Hydrology; Universitas Negeri Padang Air Tawar.

Article History:
Received: June 2025
Reviewed: June 2025
Published: June 2025

Plagirism Checker No 234
Prefix DOI: 10.8734/Kohesi.v1i2.365

INTRODUCTION

The implementation of the green building concept in Indonesia has not been optimized, although there are many regulations on the application of green buildings. Urban Green Building is a network/system created to reduce/address urban problems and climate change by involving nature (Ching & Shapiro, 2020). It includes guidelines for green building criteria and certification, as well as regulations on implementing green building in offices. These rules are made to ensure that government buildings, public facilities, and educational institutions such as schools and universities follow sustainable practices. The green building concept is a comprehensive approach that covers the planning, construction, operation, and maintenance stages, with a focus on energy efficiency and environmental conservation (Syah, 2023). Adhering to these criteria complies with Indonesia's green building regulations and supports sustainable development goals to create sustainable cities and communities.

One example of the application of the green building concept in Indonesia can be seen at the Air Tawar Campus of Padang State University. Currently, the campus is in the process of gradual construction and renovation to achieve the goal of becoming a green campus. In planning the design of the building and its infrastructure, the main focus is directed towards the application of the green building concept. The design, construction and operational processes of the building are carried out with the aim of minimizing or even eliminating negative impacts on the environment and creating a positive impact on the surrounding climate and ecosystem. The campus' success in implementing the green building concept is evident through achievements in the UI Green Metric 2021, where Universitas Negeri Padang made it into the top 50 National Environmental Care Campus, competing with around 900 other universities in Indonesia. This shows the campus's commitment to protecting the environment and contributing to nature conservation more broadly (Syah, 2023). The existing condition of the drainage based on observations in the field shows that the current condition of the existing building is not optimal, with some parts of the channel wall damaged and cracked. The channel retaining height is also decreasing, causing the channel to not be able to accommodate runoff properly and resulting in flooding during the rainy season. Sediment thickness is also increasing, reducing the function of the channel.

Conditions where drainage channels are unable to accommodate runoff that occurs and the area of green open space (RTH) is insufficient so that inundation or flooding occurs on the Air Tawar campus (Zikri, 2023). This is the effect of land use utilization on the campus environment such as the construction of new buildings, the construction of concrete and asphalt pavements which resulted in changes in the natural conveyance coefficient (C) of the campus which was once a green open space. The effect of development that is not balanced with the availability of green open space and the construction of infiltration devices in an effort to absorb rainwater into the ground.

Observations showed that the primary channel around the FEB Library, which has dimensions of 1.63 m × 0.90 m, was unable to accommodate the flow during heavy rains due to sedimentation, causing water to overflow onto the road.

Pict 1. Primary Drainage Channel at Faculty of Economics

Visual images showing the condition of the channels and puddles in the Faculty of Economics area emphasize this problem. This condition shows that the existing drainage system is not well organized. Each area has different characteristics, so the approach to mitigation must also be specific, not copying patterns from other areas that have different problems.

Based on observations, these puddles arise due to the poor and unorganized existing drainage system and the regulation of the existing system. Often the drainage problems of an area are considered the same as other areas, even though they have different characteristics. Likewise, in terms of overcoming existing problems, often equate the pattern of problem solving with existing solutions in other areas, while the source of the problems faced is much different from the existing ones. A good drainage system is an integrated infrastructure network designed to regulate the flow of water in an urban environment. A good drainage system must fulfill several requirements, namely: adequate drainage channels, the slope of the channel base is appropriate, water does not seep / seep into the channel, drainage channels are systematically connected to the drainage system.

Drainage system is a series of activities that form an effort to drain water, both surface water (runoff), and groundwater (underground water) from an area or area. The drainage system is an important part of a well-organized urban area that must also be followed by the arrangement of a drainage system that functions to reduce or remove excess water from an area or land so that it does not cause puddles that can disrupt community activities and can even cause socio-economic losses, especially those concerning aspects of environmental health of settlements (Dimitri Fairizi, 2015).

Due to the complexity of drainage problems on the UNP Air Tawar campus, it is necessary to plan drainage channels, drainage with a technical approach (making channels) and (non-technical approach) such as infiltration ponds. In an effort to reduce surface runoff, a drainage system is needed that functions to control water that can overcome flooding and overcome drought, one of these drainage systems is infiltration wells (Fernanda, 2019). Infiltration wells are an effort to increase the infiltration of rainwater into the ground and minimize surface flow. Combining infiltration ponds with road drainage is an effective alternative because road drainage is below the settlement so that it facilitates drainage.

Drainage is a system consisting of water structures that function to drain or reduce excess water from an area so that the land can be utilized optimally. This system is generally equipped with various buildings such as culverts, siphons, aqueducts, spillways, sluice gates, tando ponds, and pumping stations. For mixed systems, the water will first be treated at the WWTP before being discharged into the receiving water body so as not to pollute the environment (Suripin, 2004).

According to Permen PUPR No. 12/PRT/M/2014, drainage functions to drain excess water to the receiving water body and has an important role in urban water management. Urban drainage is divided into storm drainage and sewerage systems, and is physically divided into open and closed systems. The shape of the drainage channels used also varies, including trapezoidal, rectangular, and triangular, each of which has advantages according to technical and spatial needs (Suripin, 2004).

Drainage system planning needs to consider the principle of sustainability that involves managing rainwater runoff structurally and non-structurally, such as by building rainwater retention facilities (Suripin, 2004). One of the technologies used in rainwater management is infiltration ponds, which function to collect rainwater so that it can seep into the ground. These wells help reduce surface runoff, prevent flooding, and maintain groundwater levels (Azis et al., 2016; Iriani, 2013; Sunjoto, 1989). The technical standards and dimensions of infiltration ponds have been established in SNI 03-2453-2002 and the guidelines of the Ministry of PUPR, with requirements including a minimum groundwater depth of 1.5 m and soil permeability of more than 2.0 cm/hour (Ministry of PUPR, 2018).

To measure the ability of soil to absorb water, a permeability test is conducted using the Falling Head method with a certain formula to obtain the permeability coefficient (Braja, 1985; Hardiyatmo, 2012; Fernanda, 2019). The value of this coefficient is strongly influenced by soil type, where gravel soil has the highest permeability and clay the lowest. In calculating the volume of infiltration wells, a formula based on the diameter and depth of the well is used to determine the water storage capacity (Sunyoto, 2016).

Hydrological analysis is an important part of planning drainage systems and other hydraulic structures. The science of hydrology includes the observation and analysis of rainfall, water distribution, and its impact on the environment and human activities. The hydrological information obtained, such as rainfall data, is essential for designing structures such as weirs, culverts and embankments, as well as determining the dimensions and capacity of drainage systems (Triatmojo, 2013; Rurung et al., 2019). Without accurate hydrological data, effective and efficient hydraulic planning is difficult.

With the complexity of the existing problems, it is important to conduct a study that focuses on evaluating the dimensions of existing drainage channels at the UNP Air Tawar Campus, as well as planning drainage systems and infiltration ponds as technical and non-technical efforts to reduce inundation and flooding in a sustainable manner.

METHODOLOGY

This research was conducted in the Universitas Negeri Padang Air Tawar campus area, precisely at the Faculty of Economics. This location was chosen based on the results of an initial survey that showed problems in the drainage system and the limited function of land as a rainwater catchment area. The initial step of the research was to identify the problem through direct observation of the condition of the drainage channel and the potential of the land to be used as an infiltration well. Location mapping was conducted using Google Maps to obtain a visual and spatial overview of the area.

The research procedure starts from the preparation stage to the field investigation stage. This stage involves collecting accurate data to support the planning of drainage systems and infiltration ponds. In this process, researchers referred to the Ministry of Public Works and Housing (PUPR) Guidelines, which are national standards in water infrastructure development, including infiltration pond planning (Ministry of PUPR, 2021). This guideline considers Indonesia's unique conditions, such as high rainfall, tropical climate and soil characteristics. The guideline's strength lies in the specific provisions on the dimensions of infiltration ponds and the depth to the groundwater table, to ensure the effectiveness of the infiltration system.

The preparation stage includes determining data needs, collecting references in the form of journals and previous theses, and recording related agencies. An initial survey was conducted to obtain an overview of the existing conditions of the field. After that, data was collected in two types, namely primary and secondary data. Primary data was obtained from soil permeability tests at the Soil Mechanics Laboratory of Universitas Negeri Padang. Meanwhile, secondary data included topographic data (elevation contours and channel length) and rainfall data for the last ten years (2014-2023) taken from Teluk Bayur Maritime Meteorological Station.

Data analysis was conducted to support the re-planning of the drainage system at the study site. This analysis includes calculation of maximum rainfall and its consistency, calculation of planned rainfall using Normal, Log-Normal, Log Pearson Type III, and E.J. Gumbel methods. Data distribution suitability tests were conducted using the Chi-Square and Kolmogorov-Smirnov tests to ensure the best distribution. Rainfall intensity was calculated using the *Mononobe method* (Suripin, 2004:67), which produces rainfall intensity (i) based on daily rainfall.

The planning of flood discharge uses various return times (2, 5, 10, and 25 years). Furthermore, the capacity of the existing drainage channel is analyzed to assess whether it can accommodate the discharge. If it is insufficient, then channel re-planning is carried out. Infiltration system planning using infiltration ponds was prepared based on PUPR guidelines and the Sunjoto method (1988), which considers the volume of rainwater storage based on the roof area and other pavement areas.

The planning of infiltration ponds is done with the following steps: determine the minimum diameter of the well (0.8 m), determine the depth based on the groundwater table (minimum 1.5 m if deep, maximum 1 m if shallow), and calculate the volume of the well using the tube volume geometry formula:

$$V = \frac{1}{4}\pi\, D^2\, H$$

- Description:
  VVV = Infiltration well volume (m³)
  DDD = Infiltration well diameter (m)
  HHH = Depth of infiltration well (m).

The number of infiltration wells required is calculated by dividing the total volume of rainwater planned by the volume of one well. The placement of wells also takes into account the technical conditions and layout of the field so that it is effective in accommodating water runoff.

The data analysis technique is continued by calculating the average rainfall of the area using the Thiessen Polygon method. The planned rainfall was obtained from the best distribution method from the fit test. Next, the planned flood discharge is calculated based on rainfall intensity and runoff coefficient (C), which is determined from land and surface characteristics. This runoff discharge becomes the basis for determining the channel dimensions and the number of infiltration wells.

The soil permeability coefficient is calculated using the well test method, to determine the ability of the soil to absorb water. This value is an important parameter in determining the infiltration time and effectiveness of the well system. After all the data is obtained, the volume of water from the roof and land is calculated, and used to determine the dimensions and number of wells based on the method of Sunjoto (1988).

With this approach, the drainage system and infiltration wells are expected to be a solution for flood management and stormwater management in the UNP Air Tawar Campus area in an effective and sustainable manner.

RESULTS AND DISCUSSION

The rainfall data used is the maximum daily rainfall data for the last 10 years from 2014-2023 obtained from Teluk Bayur Maritime Meteorological Station. monthly rainfall variability from 2014 to 2023. It can be seen that monthly rainfall varies, with some months such as January, March and December tending to have higher rainfall. The year 2023 recorded a significant spike, especially in January, where rainfall reached over 384.5 mm, much higher than in previous years. While there is no consistent pattern from year to year, some years such as 2016 and 2023 show higher rainfall spikes than others, while 2019 and 2021 are relatively lower. The results of the analysis of annual maximum daily rainfall for 10 years from 2014-2023 obtained from the results of the analysis are seen the maximum rainfall levels for 10 years from 2014-2023 recorded at the Teluk Bayur Maritime Meteorological Station. The peak of maximum rainfall in 2023 was precisely in July with a total rainfall of 384.5 mm.

The distribution pattern is done by analyzing the maximum daily rainfall data obtained using frequency analysis. To determine the distribution pattern to be used in determining the return period, the statistical parameters of the rainfall data are sought. In analyzing the frequency distribution of rainfall data there are several “continuous probability distributions” that are often used, namely: Normal distribution, Gumbel distribution, Log Normal distribution, Log Pearson III distribution.

The data used is the maximum daily rainfall data (Xi) by calculating the rainfall plan as follows. Normal distribution rainfall data can be seen in Table 1.

Table 1. Maximum Daily Rainfall Data with Normalized Data

No	Year	Xi	Xi-X	$(Xi\text{-}X)^2$
1	2023	384.50	154.62	23907.34
2	2014	313.00	83.12	6908.93
3	2017	259.50	29.62	877.34
4	2019	239.00	9.12	83.17
5	2021	210.30	-19.58	383.38
6	2016	206.00	-23.88	570.25
7	2022	186.40	-43.48	1890.51
8	2015	177.20	-52.68	2775.18
9	2018	172.40	-57.48	3303.95
10	2020	150.50	-79.38	6301.18
	Σ	**2298.8**		**47001.2560**
n	=	10		
X	=	229.88		
Sx	=	72.2659		
Sn	=	0.9496		
Yn	=	0.4952		

1) Average (X)

$$X = \frac{\sum Xi}{n}$$

∑Xi = 2298.8
n = 10
X = 229.88

2) Standard deviation (Sx)

$$Sx = \sqrt{\frac{\sum(Xi - X)2}{n - 1}}$$

∑(Xi−X)2 = 47001.2560
N = 10
Sx = 72.2659

Based on the results of the calculation of design rainfall with the normal distribution method, the results for return periods of 2, 5, 10, 25 and 50 years are obtained as shown in the following table.

Table 2. Rain Recurrence Period by Normal Method

PUH	K	Sx	Rmax
2	0	72.2659	229.88
5	0.84	72.2659	290.58
10	1.28	72.2659	322.38
25	1.64	72.2659	348.40
50	2.05	72.2659	378.03

The calculation of the Log Normal Distribution rainfall plan is carried out with the following calculations. Log Normal Distribution rainfall data can be seen in Table 3.

Table 3. Maximum Daily Rainfall Data with Log Normal Method

No	Year	Xi	Log Xi	Log Xi - Log X	(Log Xi - Log X)^2	(Log Xi - Log X)^3
1	2023	384.50	2.5849	0.2406	0.0579	0.0139
2	2014	313.00	2.4955	0.1513	0.0229	0.0035
3	2017	259.50	2.4141	0.0699	0.0049	0.0003
4	2019	239.00	2.3784	0.0341	0.0012	0.0000
5	2021	210.30	2.3228	-	0.0005	0.0000
6	2016	206.00	2.3139	-	0.0009	0.0000
7	2022	186.40	2.2704	-	0.0054	-0.0004
8	2015	177.20	2.2485	-	0.0092	-0.0009
9	2018	172.40	2.2365	-	0.0116	-0.0013
10	2020	150.50	2.1775	-	0.0278	-0.0046
	Σ	**2298.8**	**23.4427**	**0.0000**	**0.1422**	**0.0106**

n	=	10
Log X	=	2.3443
S	=	0.12572
Cs	=	0.125

1) Standard deviation (S)

$$S = \sqrt{\frac{\sum(Log\ Xi - Log\ X)^2}{n-1}}$$

$$S = \sqrt{\frac{0.1422}{10-1}}$$

$$S = 0.12572$$

2) Skewness Coefficient (Cs)

$$Cs = \frac{\sum(LogXi - LogX)^3}{n.S^3}$$

$$Cs = \frac{0.0106}{10.(0.12572)^3}$$

$$Cs = \frac{0.0106}{0.01985} = 0.125$$

The following distribution analysis calculation data using the Log Normal method, can be seen in the following table.

Table 4. Rain Recurrence Period with Log Normal Method

PUH	Log X	K	S	Xt
2	2.3443	0	0.1257	220.94
5	2.3443	0.84	0.1257	281.75
10	2.3443	1.28	0.1257	320.03
25	2.3443	1.64	0.1257	355.18
50	2.3443	2.05	0.1257	399.94

The calculation of the Log Pearson III distribution rainfall plan is carried out with the following calculations. Log Pearson III distribution rainfall data can be seen in Table 5.

Table 5. Maximum Daily Rainfall Data with Log Pearson III Method

No	Year	Xi	Log Xi	Log Xi-Log X	(Log Xi - Log X)^2	(Log Xi - Log X)^3
1	2023	384.50	2.5849	0.2406	0.05790	0.01393
2	2014	313.00	2.4955	0.1513	0.02288	0.00346
3	2017	259.50	2.4141	0.0699	0.00488	0.00034
4	2019	239.00	2.3784	0.0341	0.00116	0.00004
5	2021	210.30	2.3228	-0.0214	0.00046	-0.00001
6	2016	206.00	2.3139	-0.0304	0.00092	-0.00003
7	2022	186.40	2.2704	-0.0738	0.00545	-0.00040
8	2015	177.20	2.2485	-0.0958	0.00918	-0.00088
9	2018	172.40	2.2365	-0.1077	0.01161	-0.00125
10	2020	150.50	2.1775	-0.1667	0.02780	-0.00463
	Σ	**2298.80**	**23.4427**		**0.14225**	**0.01057**

N	=	10
Log X	=	2.3443
S	=	0.1257
Cs	=	0.0093

1) Standard deviation (S)

$$S = \sqrt{\frac{\sum(Log\ Xi - Log\ X)^2}{n-1}}$$

$$S = \sqrt{\frac{0.1422}{10-1}}$$

$$S = 0.1257$$

2) Skewness Coefficient (Cs)

$$Cs = \frac{\sum(LogXi - LogX)^3}{(n-1).(n-2)S^2}$$

$$Cs = \frac{0.01057}{(10-1)(10-2)(0.1257)^2}$$

$$Cs = 0.0093$$

The following distribution analysis calculation data using the Log Pearson Type III method, can be seen in the Table 6.

Table 6. Rain Recurrence Period with Log Pearson III Method

PUH	G	G*S	Log X	Xt
2	0.000	0.0000	2.344	220.94
5	0.842	0.1059	2.450	281.92
10	1.282	0.1612	2.505	320.21
25	1.751	0.2201	2.564	366.78
50	2.054	0.2582	2.602	400.40

The calculation of the Gumbel Distribution rainfall plan is carried out with the following calculations. Gumbel Distribution rainfall data can be seen in Table 7.

Table 7. Maximum Daily Rainfall Data with Gumbel Method

No	Year	Xi	Xi-X	(Xi-X)^2
1	2023	384.50	154.62	23907.34
2	2014	313.00	83.12	6908.93
3	2017	259.50	29.62	877.34
4	2019	239.00	9.12	83.17
5	2021	210.30	-19.58	383.38
6	2016	206.00	-23.88	570.25
7	2022	186.40	-43.48	1890.51
8	2015	177.20	-52.68	2775.18
9	2018	172.40	-57.48	3303.95
10	2020	150.50	-79.38	6301.18
	Σ	**2298.8**		**47001.26**

n	=	10
X	=	229.88
Sx	=	72.26591
Sn	=	0.9496
Yn	=	0.4952

1) Average (X)

$$X = \frac{\sum Xi}{n}$$

ΣXi = 2298.8
n = 10
X = 229.88

2) Standard deviation (Sx)

$$Sx = \sqrt{\frac{\sum(Xi - X)2}{n - 1}}$$

Σ(Xi−X)2 = 47001.26

N =10
Sx =72.2659

The following distribution analysis calculation data using the Gumbel method, can be seen in the table 8.

Table 8. Rain Return Period with Gumbel Method

PUH	Yt	K	Rmax (mm)
2	0.36651	-0.1355	220.09
5	1.49994	1.0581	306.34
10	2.25037	1.8483	363.45
25	2.97020	2.6064	418.23
50	3.90194	3.5876	489.14

The distribution test is carried out to determine the probability distribution that has been calculated whether it can represent the statistical distribution that will be analyzed further.

From the calculation of the Chi-Quadrat Method, the distribution that meets to analyze rainfall data in this study is the Gumbel Probability Distribution, Normal, Log Normal and Log Pearson III Distribution for more details can be seen in the Appendix and the results of the Chi-Quadrat distribution test recapitulation can be seen in the table below.

Table 9. Chi Square Test Calculation Results

Probability Distribution	X^2 Count	X^2cr	X2 ? X^2cr	Description
Gumbel	4	5.991	X2 < X^2cr	Accepted
Normal	12	5.991	X2 > X^2cr	Not Accepted
Log Normal	0	5.991	X2 < X^2cr	Accepted
Log Pearson III	0	5.991	X2 < X^2cr	Accepted

From the calculation of the Smirnov-Kolmogorov Method or test with the requirement that the critical ΔP is less than 0.409. Distributions that meet to analyze rainfall data in this study are the Gumbel Probability Distribution, Normal, Log Normal and Log Pearson III Distribution for more details can be seen in the Appendix and the results of the Smirnov-Kolmogorov distribution test recapitulation can be seen in Table 10.

Table 10. Smirnov-Kolmogorov Test Calculation Results

Probability Distribution	ΔP Count	ΔPcr	DP ?	Description
Gumbel	0.09	0.409	<	Accepted
Normal	0.58	0.409	>	Not Accepted
Log Normal	0.53	0.409	>	Not Accepted
Log Pearson III	0.93	0.409	>	Not Accepted

Based on the results of testing 2 methods, namely: Chi-Square ($x2$) method and Smirnov-Kolmogorov method, it can be concluded that the best distribution for analyzing rainfall data in this study is the Gumbel Probability Distribution.

The calculation of rainfall intensity aims to analyze rainfall intensity and describe the IDF curve. The calculation of rainfall intensity uses the *Mononobe Method*. The *Mononobe method* is a formula for calculating rainfall intensity at any time based on monthly rainfall data. The calculation with the equation is continued for the duration and depth of rain, the value of rainfall intensity for various rainfall durations using the *Mononobe method*. The longer the rain duration, the smaller the rain intensity value, this predicts that the shorter the period of rainfall, the greater the intensity because rain is not always continuous. The calculation is done with a duration of up to 420 (minutes). The results of calculations using the *Mononobe Method* showed that the rain intensity of the 2-year return period was 76.29980789 mm/hour, the 5-year return period was 106.2028888 mm/hour and the 10-year return period was 126.0013304 mm/hour.

In calculating the discharge, you can use the runoff coefficient value (c) according to the location conditions to see the rain intensity coefficient value obtained from the *Mononobe* formula method taken for a duration of 24 hours. For the area (Adi can be from around the nearest research location, namely the Padang State University Campus Area, Faculty of Economics with an area of 30,834.00 m^2. Some debit calculations are as follows:

1. DAS Size (A) = 1,467 km^2
2. River Length (L) = 151,23 m
3. River Slope (I) = 0.007

   $Q = 0.278 . C . I . A$

The runoff coefficient is an indicator of whether a watershed is constrained. The size of the C value depends on the permeability and ability of the soil to hold water. The runoff coefficient is presented in Table 11.

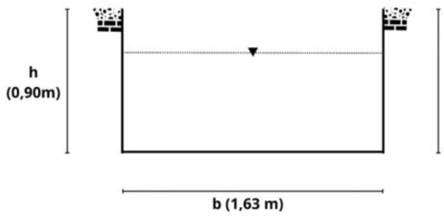
Table 11. Run-off Coefficient (C)

No	Land Use System	C	Area	%	C rerata
			km2		%
1	Village/Settlement	0,6	661,04	30,0	18,0
2	Forest	0,3	396,63	18,0	5,4
3	Bush	0,4	44,07	2,0	0,8
4	Rainfed Rice Field	0,5	0,00	0,0	0,0
5	Technical Rice Field	0,5	594,94	27,0	13,5
6	Tegalan / field	0,4	264,42	12,0	4,8
7	Garden / Plantation	0,4	242,38	11,0	4,4
Total			**2203,48**		**46,9**

Table 12. Calculation of Rational Plan Flood Discharge

No	Recurrence Time	R24	S	L	Area	Tc	I	C	Q Plan
	Year	mm		m	Km^2	hour	mm/hour		m^3/sec
1	2	220.09	0.007	151.2	1.467	21.133	3.942	0.6	0.96
2	5	306.34	0.007	151.2	1.467	21.133	5.487	0.6	1.34
3	10	363.45	0.007	151.2	1.467	21.133	6.510	0.6	1.59
4	25	418.23	0.007	151.2	1.467	21.133	7.492	0.6	1.83
5	50	489.14	0.007	151.2	1.467	21.133	8.762	0.6	2.14

In this analysis, planning is carried out related to unqualified drainage channels in the UNP economic faculty area. Re-planning the dimensions of this channel as part of the urban drainage system being studied. After knowing the unqualified channel, the new channel dimensions are planned, the method used is the Trial and Error method by changing the height (h) and width (b) of the unqualified channel. The size of the existing drainage channel is height (h) 0.90 m and width (b) 1.63 m, which can be seen from the following picture:

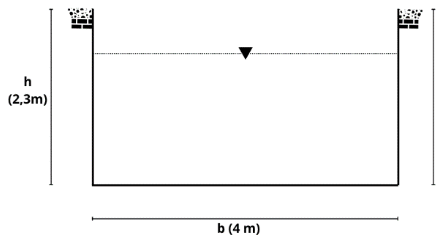


Pict 2. Existing Channel Dimensions

The changes in channel height (h) and channel width (b) are due to changes in the value of h (channel height) to 2.3 m and channel width (b) to 4 m from the calculation of the guard height and are expected to have a significant effect on the capacity of the drainage channel and this planning is also an important aspect in ensuring the smooth flow of rainwater and preventing potential flooding in the UNP economic faculty area. The calculation of the planned channel dimensions can be seen in Table 13.

Table 13. Calculation of Plan Channel Dimensions

Channel Name	C	Tc (hour)	I (mm/hour)	Area (A)	Qplannin g	Qexsisting	Result (Qexs>Qplan)
Primer	0,6	21,13	3,942	9,2	0,965	0,97	Memenuhi



Pict 3. Perencanaan Dimensi Saluran

The value of k or the coefficient of soil permeability is directly proportional and affects the calculation of density and the amount of water that seeps through the soil pore cavity. The following is the calculation of the coefficient of soil permeability at the experimental site:

Testing constant head permeameter:

- Tube Diameter : 6,355
- Tube Height : 17,1

Formula: $K = \frac{Q.L}{T.H.4}$

Sample cross-sectional area

$$\frac{1}{4}\pi D2 = \frac{1}{4}\ 3{,}14\ x\ 6{,}355$$

$$= \frac{1}{4}\ 3{,}14\ x\ 40.386025$$

$$= 31.703$$

1) Test 1
   - Initial height : 65 cm
   - Sample height : 7,1 cm
   - Time : 1 minute
   - Water Volume : 200,92 ml

$$K = \frac{Q.L}{t.h.4} = \frac{200{,}92\,.\,7{,}1}{60\,.\,65\,.\,31{,}703} = 0{,}011$$

2) Test 2
   - Initial height : 60 cm
   - Sample height : 7,1 cm
   - Time : 1 minute
   - Water Volume : 172,70 ml

$$K = \frac{Q.L}{t.h.4} = \frac{172{,}70\,.\,7{,}1}{60\,.\,60\,.\,31{,}703} = 0{,}010$$

3) Test 3
   - Initial height : 55 cm
   - Sample height : 7,1 cm
   - Time : 1 minute
   - Water Volume : 121,98 ml

$$K = \frac{Q.L}{t.h.4} = \frac{121{,}98\,.\,7{,}1}{60\,.\,55\,.\,31{,}703} = 0{,}008$$

The permeability coefficient value is influenced by the type of soil, in the UNP Air Tawar campus area, the Faculty of Economics has been tested and analyzed, based on the analysis obtained the results of the soil permeability test value as follows:

Table 14. Soil Permeability Test Value Results

No	Name	Permeability (k)			Soil Type
		cm/s	cm/hour	m/day	
1	Test 1	0,011	39,60	9,504	Sandy Soil
2	Test 2	0,010	36,00	8,640	
3	Test 3	0,008	28,80	6,912	

From the table, the results of soil permeability testing at the site are obtained so that it meets the technical requirements for infiltration well planning.

Rainwater infiltration building planning is planned on a site with an area of 30,834.00 m2 and a building area of 5,124 m2 is an infiltration well, this is based on the design of infiltration wells that do not require a large enough area and construction that is not too complicated in accordance with their functions and benefits. In planning this infiltration well, it has the dimensions of an infiltration well with a circular base area. The following are the results of the analysis of infiltration wells based on SNI 03-2453-2002 with the procedures for planning rainwater infiltration wells that have been analyzed, the planning of infiltration wells with the dimensions of a circular base area with a flood volume of 578.52 m3 is obtained, the volume of rainwater that infiltrates is 6.002 m3 and the dimensions obtained for infiltration wells are 1 m in diameter with a depth of 2 m and the number of infiltration wells is 358 infiltration wells. The distance of the placement of infiltration wells to the building has been determined based on SNI, while the distance of infiltration wells for the entire building from the roof runoff is 1.5m.

CONCLUSION

Based on the results of the analysis, it can be concluded that the study site has a high level of rainfall, with an annual average of 229.88 mm. The lowest rainfall was recorded in 2020 with a value of 150.5 mm, while the highest rainfall occurred in the same year, reaching 385.5 mm. This high rainfall has the potential to trigger flooding. To overcome this, a re-planning of unqualified drainage channel dimensions was carried out using the Trial and Error method. The redesign was carried out by adjusting the channel height (h) to 2.3 m and the channel width (b) to 4 m. The redesign also included the construction of wells. In addition, the planning also included the construction of infiltration wells designed with a circular base of 1 m diameter and 2 m depth. The volume of water that can be stored to reduce potential flooding is 578.52 m^3, with the volume of rainwater that can infiltrate amounting to 6.002 m^3. A total of 358 infiltration ponds are planned to meet the needs of the area, with a minimum placement distance of 1.5 m from the building, in accordance with the provisions of SNI.

REFERENCES

Astika, M. N., & Cahyonugroho, O. H. (2020). “Evaluasi Sistem Drainase Di Wilayah Kecamatan Waru, Kabupaten Sidoarjo Dengan Software Hec-Ras”. *EnviroUS*, *1*(1), 55-64.

Dimitri Fairizi, 2015. “Analisis dan Evaluasi Saluran Drainase pada Kawasan Perumnas Talang Kelapa di Subdas Lambidarjo Kota Palembang”. Palembang: Universitas Sriwijaya. *Jurnal Teknik Sipil dan Lingkungan*. https://ejournal.unsri.ac.id/index.php/jtsl/article/view/520

Ditjen Cipta Karya Kementerian Pekerjaan Umum. 2013. *Buku Panduan Pengelolaan Drainase Secara Terpadu Berwawasan Lingkungan (Ecodrain)*. Kementerian Pekerjaan Umum, Jakarta.

Edisono, Sutarto. 1997. *Drainase Perkotaan*. Jakarta: Gunadarma.

Kementerian Pekerjaan Umum dan Perumahan Rakyat. (2018). *Pedoman Penyelenggaraan Drainase di Kawasan Pemukiman*. Jakarta: Kementerian PUPR.

Kodoatie, R. J., & Sjarief, R. (2010). *Tata ruang air*. Penerbit Andi.

Sunyoto. (2016). *Teknik Drainase Pro-Air*. Yogyakarta: Andi Offset.

Suripin. 2004, *Sistem Drainase Perkotaan Yang Berkelanjutan*, ANDI. Yogyakarta

Suhardjono. 2015. *Drainase Perkotaan*. Universitas Brawijaya, Malang

Syah, N. (2023). “Perencanaan Sistem Drainase Berwawasan Lingkungan Pada Kampus Air Tawar Universitas Negeri Padang”. *CIVED*, *10*(2), 627-638.

Tendean, F., Suhardjono, S., & Yuliani, E. (2015). “KAJIAN PENANGANAN BANJIR SUNGAI ANAFRE DI KOTA JAYAPURA”. *Jurnal Teknik Pengairan: Journal of Water Resources Engineering*, *6*(2), 175-185.

Triatmodjo, B. (2008). *Hidrologi Terapan*. Yogyakarta: Beta Offset.

Triatmodjo, B. (2013). *Hidrologi Terapan*. Cetakan Ketiga. Beta Offset. Yogyakarta. Indonesia.

Wesli. (2008). *Drainase Perkotaan*. Yogyakarta: Graha Ilmu.