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Analysis of Primary Drainage System Capacity in Supporting Urban Flood Resilience for the NUFReP Project

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Abstract: *Urban flooding in Santi Village, Bima City, remains a problem despite the implementation of the National Urban Flood Resilience Project (NUFReP). This study aims to analyze the capacity of the primary drainage system to support urban flood resilience. The study employs a mixed-methods approach through hydrological and hydraulic analyses, as well as modeling using the Storm Water Management Model (SWMM). The hydrological analysis yielded a design flood discharge of 14.79 m^3/s, while the hydraulic analysis indicated a primary drainage capacity of 45.46 m^3/s with a flow velocity of 2.37 m/s. The SWMM simulation results showed that the water level remained below the channel's peak elevation without any overflow or surcharging, indicating that the channel capacity remains adequate with a utilization rate of approximately 32.53%. The study concluded that the primary drainage capacity is still capable of accommodating the design flood discharge, while the potential for flooding is more significantly influenced by sedimentation, debris blockages, and suboptimal maintenance and connectivity of the drainage network.*

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INTRODUCTION

Indonesia is a disaster prone country, both due to its location along the "Ring of Fire" (Soemabrata et al., 2018), which renders it vulnerable to geological disasters and its tropical geographic setting characterized by high rainfall variability, making it susceptible to hydrometeorological disasters such as flooding (Azizah et al., 2022). Erratic rainfall patterns ranging from normal to below normal levels have been observed in various regions, including West Nusa Tenggara (NTB) Province, specifically the Bima and Sumbawa areas. The most severe flood event in this region occurred in Bima City between late 2016 and early 2017; floodwaters reached depths of 1 to 4 meters, affecting several districts, including Mpunda District specifically Santi Urban Village (Yuniartanti, 2018).

A lack of public awareness and poorly maintained drainage infrastructure have compromised the capacity of channels to contain and convey runoff to rivers or final discharge points (Pratama et al., 2025). This situation impairs the drainage system's hydraulic function, manifesting as sedimentation, blockages caused by domestic waste, and structural damage to the channels (Putri, 2025). The cumulative effect of these issues increases the risk of water pooling or even flooding during periods of high rainfall, particularly in areas characterized by high residential density and significant land impermeability (Prayogo & Nusantara, 2025).

In response to the high flood risk, the central government through the Ministry of Public Works and the Nusa Tenggara I River Basin Organization (BBWS) is implementing the National Urban Flood Resilience Project (NUFReP), this initiative involves the construction and rehabilitation of six primary drainage sections across 12 urban villages in Bima City, including Santi (Sobatnu et al., 2023). The program aims to strengthen primary drainage infrastructure capacity to mitigate the risk of recurrent

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flooding in the area (Moon et al., 2024). However, the success of an infrastructure project is not guaranteed solely by the construction phase post-construction evaluation is essential to ensure that the completed drainage structures can effectively function according to their design capacity under actual hydrological conditions on the ground (Hidayat, 2022).

Flooding is a natural phenomenon characterized by the overflowing of water onto land that is normally dry (Majszak et al., 2026). As a disaster that frequently affects various regions across Indonesia, flooding has serious consequences for both local communities and the surrounding environment (Sari, 2026). The city of Bima in West Nusa Tenggara is one such area that frequently experiences flooding and inundation (Arashi et al., 2024).

Hydrologically, flooding occurs when the storage capacity of a river channel or the soil acting as an infiltration medium is insufficient to contain the volume of water generated by rainfall (Syahli et al., 2025). Consequently, attention must be paid to all factors contributing to floods as part of efforts to anticipate and mitigate the risk of future occurrences (Nugroho & Handayani, 2021).

A primary step in this context is to evaluate existing water management or drainage systems (Aliyda et al., 2026). Functionally, drainage is a system designed to convey water from one surface to another; its primary role is to collect and channel surface runoff specifically rainwater through a network of first level (tertiary) channels (Palawa'ae et al., 2024). Furthermore, Suaripin (2004) argues that drainage systems play a crucial role in urban spatial planning as a form of basic infrastructure designed to collect and convey excess water from an area, thereby preventing inundation (Paska Wijayanti, Gunarso, Teguh Yuono, 2022).This runoff is subsequently directed into second-level channels (secondary and primary) before finally being discharged into a river or the sea, which serves as the ultimate disposal point (Ija et al., 2024).

The primary issue addressed in this study is how to improve the performance of the existing primary drainage channels in Santi Urban Village which frequently experience flooding and inundation particularly those within the scope of the NUFReP project. Efforts to resolve this issue cannot be limited solely to increasing the technical capacity of the drainage channels; they must also take into account the social factors that influence performance effectiveness (Nadiana et al., 2023).

Several previous studies have examined drainage system analysis and urban flood control from various perspectives. Prayogo and Nusantara (2025) demonstrated that drainage planning based on hydrological and hydraulic analysis is effective in mitigating flood risk, particularly through the optimization of channel and retention basin capacities. Similarly, Nadiana et al. (2023) highlighted the importance of evaluating existing drainage channel capacities to determine the system's ability to handle design discharge levels. Palawa'ae et al. (2024) reinforced this view, noting that hydrological and hydraulic approaches to analyzing drainage capacity serve as effective measures to support urban flood mitigation efforts. Conversely, Natasya et al. (2025) found that damage to channel structures and the accumulation of debris impair drainage functionality, thereby increasing the risk of flooding.

Based on the literature review above, it is clear that previous studies have focused on hydrological and hydraulic analyses to determine the capacity of drainage channels or to identify the causes of flooding based on the physical conditions of the channels. However, studies specifically evaluating the post-construction performance of primary drainage systems in urban flood control projects remain limited, particularly regarding the National Urban Flood Resilience Project (NUFReP) in Santi Village, Bima City. Furthermore, most studies merely compare flood discharge with channel capacity without verifying flow conditions through hydraulic modeling.

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This study aims to address this gap by evaluating the capacity of the primary drainage structures constructed under the NUFReP project in Santi Urban Village. It employs quantitative hydrological and hydraulic analyses, alongside SWMM based modeling, to assess the channels' performance during peak rainfall. Consequently, the study is expected to provide new data and technical recommendations regarding the alignment of the constructed drainage infrastructure's performance with actual field requirements, while also enriching academic discourse on the post-construction evaluation of urban drainage infrastructure in coastal areas.

RESEARCH METHOD

Research Site

Santi Urban Village was purposively selected as the research site due to hydrological characteristics that make it vulnerable to urban flooding, aligning with the study's objectives. The area receives runoff from upstream zones, compounded by increased surface flow resulting from high rainfall intensity and expanding built up areas. Its topography ranging from relatively flat to depressed combined with limited primary drainage capacity, causes surface runoff to readily accumulate, leading to water pooling and even flooding in residential areas and along main roads.

Research Approach

Research methodology refers to the scientific approach used to obtain data systematically, in accordance with the established objectives and purposes of the research. The data generated through the research process is known as empirical data-data that must meet three primary criteria: validity, reliability, and objectivity (Azhari et al., 2023).This study employs a mixed-method approach that sequentially combines quantitative and qualitative methods; quantitative data are collected and analyzed first, then reinforced and further interpreted through qualitative data. The quantitative approach is used to evaluate the capacity of primary drainage channels through hydrological analysis (calculating design rainfall and design flood discharge) and hydraulic analysis (calculating the carrying capacity of existing channels), thereby yielding a numerical comparison between design discharge and existing channel capacity. The analysis results are input into the SWMM 5.1 application to determine the condition of existing channels during peak rainfall and identify the causes of inundation at the study site. The qualitative approach is used to explore non technical factors influencing drainage performance, such as community waste disposal habits and the level of participation in channel maintenance.

Data Types and Sources

The data in this study are categorized into primary and secondary data. Primary data were obtained directly from the field, comprising measurements of channel dimensions and the physical condition of the channels. Secondary data were acquired from relevant agencies or institutions, including rainfall data, land use maps, and technical design documents from the NUFReP Project. Quantitative data in this study were derived from rainfall records, channel dimension measurements, and project technical documents.

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Data Collection Techniques

Data collection was conducted systematically and in a structured manner to ensure data accuracy and validity, employing three primary methods. First, field surveys and measurements were carried out to obtain data on the physical dimensions of primary drainage channels such as width, depth, and bed slope as well as existing conditions regarding sedimentation, blockages, and structural damage; these data served as the basis for calculating hydraulic capacity. Second, documentation was used to gather visual records of channel conditions, maps, and technical designs from relevant agencies and the NUFReP Project management. Third, a literature review was conducted by examining literature, books, and scientific journals related to hydrology, hydraulics, and urban drainage systems; this served as both a theoretical foundation and a basis for comparison with the study's findings.

Swmm Simulation Process

The Storm Water Management Model (SWMM) simulation is used to analyze the performance of drainage systems in capturing and conveying stormwater runoff. Key parameters used include design rainfall intensity, catchment area, land slope, percentage of impervious area, Manning's roughness coefficient, and channel dimensions and slope. Simulation results including flow rate, water level, and channel capacity are used to evaluate whether the existing drainage system can accommodate the design flow rate or will experience overflow.

Methodological Constraints and Limitations

To ensure the reliability of the results, this study relies on rainfall and technical channel data obtained from official agencies, as well as direct field measurements, thereby ensuring the hydrological and hydraulic analysis process is methodologically sound. However, the study acknowledges inherent limitations regarding data availability specifically, the use of rainfall data from only the last five years as the basis for calculating design rainfall. This relatively short data timeframe may affect the accuracy of frequency analysis and rainfall return period estimates, given that hydrological principles generally recommend longer data series to obtain more representative design discharge estimates. Furthermore, potential issues such as missing data or inconsistent recording at rainfall observation stations could also impact the precision of the calculations.

Additional limitations arise from the completeness of secondary data regarding the NUFReP project's technical design; such data was not always fully available or up-to-date at the time of the study, requiring the analysis of the fit between existing capacity and project targets to be based on data available during the collection period. Despite these limitations, the study's approach combining primary field measurement data with secondary data from relevant agencies provides a sufficiently robust analytical basis to address the research objectives. The study also employs consistent criteria for data selection and processing, maintaining methodological transparency and ensuring that the analysis of primary drainage channel capacity in Santi Urban Village is defensible within the context of the aforementioned data limitations.

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RESULTS AND DISCUSSION

Rainfall Analysis

Rainfall analysis was conducted to determine the characteristics of rainfall in the study area as a basis for calculating rainfall intensity and flood discharge, as well as to evaluate the capacity of the primary drainage system to accommodate surface runoff.

Table 1. Total Rainfall

Year	Total Rainfall (mm)	Monthly Average (mm)
2021	1.715	142,92
2022	1.752	146,00
2023	1.412	117,67
2024	1.669	139,08
2025	1.760	146,67
2026*	1.204	100,33

*Note: Data for 2026 is still being collected and therefore does not yet cover a full year.

Table 1 shows that the total annual rainfall in the Santi Village area fluctuated during the observation period. The highest rainfall was recorded in 2025 at 1,760 mm, while the lowest occurred in 2026 at 1,204 mm, however these values cannot be directly compared because the 2026 data is incomplete. If only the complete annual data (2021–2025) are considered, the lowest rainfall occurred in 2023 at 1,412 mm. These conditions indicate that the study area experiences significant year to year variations in rainfall therefore, a reservoir capacity is needed that can accommodate changes in runoff due to these variations in rainfall intensity. These findings are consistent with a study by Prayogo and Nusantara (2025), which states that changes in rainfall intensity directly affect the amount of surface runoff and the capacity of urban drainage systems.

Statistical Analysis of Rainfall

A statistical analysis was conducted to determine the characteristics of the rainfall data distribution so that it could be used as a basis for selecting a probability distribution for hydrological analysis.

Table 2. Descriptive Statistics of Rainfall

Statistical Parameter	Value
Number of Data Points	6 years
Mean	1.585,33 mm
Median	1.692,00 mm
Maximum	1.760 mm
Minimum	1.204 mm
Range	556 mm

The descriptive statistics show that the average annual rainfall in the study area is 1,585.33 mm, with a median of 1,692.00 mm. The maximum rainfall reached 1,760 mm, while the minimum was 1,204 mm. The range of 556 mm indicates a fairly significant variation in rainfall between years. The difference between the mean and median values indicates that the distribution is influenced by

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relatively low rainfall in 2026, resulting in a distribution that is not entirely symmetrical. This variation must be taken into account in flood discharge analysis because the amount of rainfall directly affects the volume of runoff entering the primary drainage channels.

Analysis of Statistical Parameters

An analysis of statistical parameters was conducted to determine the characteristics of the rainfall data distribution so that it could be used as a basis for determining the most appropriate probability distribution for the analysis.

Table 3. Analysis of Rainfall Statistical Parameters

Statistical Parameter	Value
Number of Data Points (N)	6
Mean (mm)	1.585,33
Median (mm)	1.692,00
Standard Deviation (mm)	219.41
Variance (mm^2)	48.141,00
Coefficient of Variation (CV)	0,138
Skewness Coefficient (Cs)	-0,861
Kurtosis Coefficient (Ck)	2,451

Based on Table 3, it is evident that the average annual rainfall in the study area is 1,585.33 mm with a standard deviation of 219.41 mm, indicating that the variation in rainfall between years is moderate. The coefficient of variation (Cv) value of 0.138 indicates that the rainfall data is relatively homogeneous, making it suitable for use in hydrological frequency analysis. The skewness value of -0.861 indicates that the data distribution is slightly left-skewed, while the kurtosis value of 2.451 suggests that the data distribution approximates a normal distribution but has a slightly flatter peak. Overall, these statistical characteristics indicate that the rainfall data are of sufficiently good quality to proceed with probability distribution analysis and the determination of design rainfall.

Rainfall Trend Analysis

Rainfall trend analysis is conducted to identify trends in rainfall changes over the observation period, thereby providing an overview of the potential for an increase or decrease in flood risk in the future.

Table 4. Annual Rainfall Trends

Year	Rainfall (mm)	Change from Previous Year (%)
2021	1.715	-
2022	1.752	2,16
2023	1.412	-19,41
2024	1.669	18,20
2025	1.760	5,45
2026*	1.204	-31,59

*Note: The 2026 annual data does not yet cover a full year.

Table 4 shows that rainfall in the study area exhibits a fluctuating pattern from year to year. After increasing in 2022, rainfall declined quite sharply in 2023, then rose again in 2024 and reached

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its highest value in 2025 at 1,760 mm. Meanwhile, the value for 2026 shows a significant decrease; however, this trend cannot yet be used as a basis for conclusions because the available data does not cover a full year of observations. Overall, the rainfall trend indicates that the Santi Village area has relatively high rainfall variability; therefore, the primary drainage system must be designed based on extreme rainfall conditions, not merely on annual average values.

Analysis of Rainfall Probability Distributions

A probability distribution analysis was conducted to determine the most appropriate distribution method for calculating design rainfall, which is subsequently used as the basis for calculating design flood discharge.

Table 5. Results of the Probability Distribution Evaluation

Distribution	Statistical Criteria	Results	Status
Normal	Approximately meets criteria	Good	Accepted
Log Normal	Partially Meets Criteria	Satisfactory	Accepted
Gumbel	Meets All Criteria	Very Good	Accepted
Log Person III	Meets Criteria	Good	Accepted

The evaluation results indicate that all probability distributions can be used in hydrological analysis; however, the Gumbel distribution provides the best fit to the characteristics of the rainfall data in the study area. The Gumbel distribution is widely used in hydrological analysis because it is designed to model extreme events, including maximum rainfall and flood discharge. Therefore, the Gumbel distribution was selected as the basis for calculating design rainfall and design flood discharge in this study. The selection of this distribution also provides a higher level of safety in primary drainage planning because it accounts for the possibility of high-intensity rainfall.

Distribution Goodness-of-Fit Test

A distribution goodness-of-fit test was conducted to ensure that the selected probability distribution accurately fits the characteristics of the rainfall data in the study area.

Table 6. Results of the Distribution Goodness-of-Fit Test

Distribution	Uji Chi-Square	Uji Smirnov-Kolmogorov	Status
Normal	Accepted	Accepted	Suitable
Log Normal	Accepted	Accepted	Suitable
Gumbel	Accepted	Accepted	Suitable
Log Person III	Accepted	Accepted	Suitable

The results of the Chi-Square and Smirnov-Kolmogorov tests indicate that all probability distributions meet the suitability criteria because the test statistic values are below the critical values at a 5% significance level. Nevertheless, the Gumbel distribution was selected as the best distribution because it is better suited to describe the probability of extreme rainfall events. Consequently, the design rainfall calculations in this study used the Gumbel distribution as the basis for analyzing design flood discharge, so that the primary drainage design results are expected to be more conservative and capable of reducing the risk of runoff and flooding in the study area.

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Rainfall Intensity Analysis

A rainfall intensity analysis was conducted to determine the magnitude of rainfall intensity over various durations as a basis for calculating the design flood discharge, which will be compared with the primary drainage capacity.

Table 7. Results of Rainfall Intensity Analysis

Rainfall Duration	Rainfall Intensity (mm/hour)
1	136,42
2	86,57
3	66,38
4	54,79
5	47,08
6	41,50

Based on Table 7, it is evident that rainfall intensity decreases as the duration of rainfall increases. The highest intensity occurs during a one-hour duration at 136.42 mm/hour, then decreases to 41.50 mm/hour during a six-hour duration. This pattern is a common characteristic of rainfall in tropical regions, where short-duration rainfall tends to have higher intensity than long-duration rainfall. This condition causes surface runoff to increase rapidly at the onset of rainfall, making primary drainage capacity a critical factor in preventing puddles and flooding.

Flood Discharge Analysis

A flood discharge analysis was conducted using the rational method to estimate the amount of runoff entering the primary drainage channel as a result of the design rainfall in the study area.

Table 8. Flood Discharge Calculation Parameters

Parameter	Value
Runoff Coefficient (C)	0,75
Runoff Coefficient (A)	0,52 km^2
Rainfall Intensity (I)	134,42 mm/hour
Rational Constant	0,278

The flood discharge analysis in this study uses the rational method, which is commonly used to estimate peak discharge in relatively small catchment areas, such as urban areas. This method accounts for the effects of the runoff coefficient, rainfall intensity, and catchment area on the amount of runoff entering the drainage system. The equation for the rational method is as follows.

$$Q = 0.278 \times C \times I \times A$$

Table 9. Flood Discharge Calculation Results

Parameter	Value
Flood Discharge	14,79 m^3/second

Calculations using the rational method yielded a flood discharge of 14.79 m^3/second. This value indicates the estimated amount of surface runoff entering the primary drainage system during a design storm. The discharge rate is influenced by high rainfall intensity, the catchment area, and the prevalence of built-up areas, which result in a relatively high runoff coefficient. The greater the

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discharge entering the channel, the higher the risk of overflow if the drainage capacity is unable to handle that discharge optimally.

Design Discharge Analysis

A design discharge analysis is conducted to determine the discharge that the primary drainage system must be able to accommodate for various rainfall return periods.

Table 10. Design Discharge for Various Return Periods

Return Period	Design Discharge (m^3/second)
2 Years	10,82
5 Years	13,47
10 Years	15,83
25 Years	18,62
50 Years	20,84
100 Years	22,15

Table 10 shows that the design flow rate increases as the return period increases. The design flow rate for a 2 year return period is 10.82 m^3/second, while for a 100 year return period, it increases to 22.15 m^3/second. This increase indicates that the lower the probability of rainfall, the greater the discharge that the drainage system must accommodate. Therefore, in primary drainage planning, a specific return period is generally used, tailored to the function of the channel, to reduce the risk of ponding and flooding in urban areas.

Comparison of Flood Discharge with Design Discharge

A comparison between the flood discharge from the analysis and the design discharge was conducted to determine the safety level of the primary drainage system under various rainfall scenarios.

Table 11. Discharge Comparison

Parameter	Value (m^3/second)
Flood Discharge from Analysis	14,79
2 Year Design Discharge	10,82
5 Year Design Discharge	13,47
10 Year Design Discharge	15,83
25 Year Design Discharge	18,62

The comparison results show that the flood discharge from the analysis, at 14.79 m^3/second, exceeds the design discharges for the 2 year and 5 year return periods but remains below the 10-year design discharge. This situation indicates that if the primary drainage system is designed only for a two- or five-year return period, the likelihood of flooding remains quite high during heavy rainfall. Therefore, primary drainage planning should consider a design flow based on a return period of at least ten years or more to improve the system's safety against urban flooding.

Primary Drainage Capacity Analysis

A primary drainage capacity analysis was conducted to determine the capacity of existing channels to discharge flood flows occurring in the study area.

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Table 12. Dimensions of Existing Primary Drainage Channels

Parameter	Value
Channel Type	Open Channel
Channel Width (B)	6,00 m
Channel Height (H)	3,25 m
Wet Cross-Section Width	5,90 m

Based on field measurements, it was found that the primary drainage network at the study site has a channel width of 6.00 m and a channel height of 3.25 m, while the wet cross-section width reaches 5.90 m. These dimensions indicate that the primary channel is relatively large compared to secondary and tertiary drainage channels, and is therefore designed as the main channel for conveying surface runoff to the receiving water body. However, channel capacity is influenced not only by geometric dimensions but also by flow velocity, channel bed slope, surface roughness, and the magnitude of flood discharge entering the drainage system.

Wet Cross-Section Area Analysis

A wet cross-section area analysis is performed to determine the flow area used in calculating the primary drainage capacity.

Table 13. Wet Cross-Section Area Calculation

Parameter	Value
Wet Width (B)	5,90 m
Channel Height (H)	3,25 m
Wet Cross-Section Width A = B x H)	19,18 m^2

The calculation shows that the primary wet cross-sectional area is 19.18 m^2. This cross-sectional area represents the effective area through which water flows within the channel. The larger the wet cross-sectional area, the greater the volume of water the channel can convey within a given unit of time. Therefore, the cross-sectional area is one of the primary parameters in determining the primary capacity relative to the flood discharge occurring in the study area.

Flow Velocity Analysis

A flow velocity analysis was conducted to determine the velocity of water flowing through the primary drainage channel so that the channel's maximum capacity could be calculated.

Table 14. Channel Hydraulic Parameters

Parameter	Value
Manning's Coefficient (n)	Open Channel
Hydraulic Radius (R)	1,15 m
Channel Slope (S)	0,0015
Flow Velocity (V)	2,37 m/second

The results of the hydraulic analysis show that the flow velocity in the primary drainage channel reaches approximately 2.37 m/second. This velocity remains within a safe range for concrete channels, allowing the flow to transport light sediment without causing excessive erosion to the channel

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structure. The relatively high flow velocity also indicates that the channel is effective at accelerating runoff toward the river, thereby reducing the duration of flooding in residential areas.

Primary Drainage Capacity Analysis

The drainage capacity analysis is performed by multiplying the wet cross-sectional area by the flow velocity to obtain the maximum discharge that the channel can carry.

Table 15. Primary Drainage Capacity Calculation

Parameter	Value
Wet Cross-Sectional Area (A)	19,18 m^2
Flow Velocity (V)	2,37 m/second
Drainage Capacity Q = A X V	45,46 m^3/second

The primary drainage capacity calculation yields a maximum discharge of 45.46 m^3/second. This value indicates the channel's theoretical capacity to convey water based on the dimensional conditions and hydraulic parameters used. This capacity is significantly greater than the flood discharge resulting from the analysis; therefore, from a hydraulic standpoint, the primary drainage system still has sufficient capacity to handle surface runoff. Thus, if flooding still occurs in the field, the cause is likely not solely due to the channel's limited capacity but may also be influenced by sedimentation, debris blockages, obstructions at ancillary structures, or suboptimal connectivity between secondary and primary channels.

Comparative Analysis of Capacity and Flood Discharge

This analysis was conducted to determine whether the primary drainage capacity is still capable of accommodating the design flood discharge in the study area.

Table 16. Comparison of Drainage Capacity and Flood Discharge

Parameter	Value (m^3/second)
Analyzed Flood Discharge	14,79
Primary Drainage Capacity	45,46
Capacity Difference	30,67
Capacity Utilization Rate	32,53%

Based on the comparison results, it is evident that the primary drainage capacity of 45.46 m^3/second is still greater than the analyzed flood discharge of 14.79 m^3/second. The capacity utilization rate of the channel is only about 32.53%, indicating that, theoretically, the drainage system is still capable of conveying stormwater runoff without experiencing overflow. This finding suggests that the hydraulic capacity of the primary channel is more likely influenced by operational factors, such as sedimentation, cross-sectional narrowing due to deposits, blockages by debris, or delays in flow from secondary channels to the primary channel. Therefore, efforts to improve flood resilience should not only involve the physical construction of drainage infrastructure but also include regular channel maintenance and the management of an integrated drainage system.

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Analysis of SWMM Simulation Results

The analysis results are supported by a simulation using the Storm Water Management Model (SWMM). The water level profiles along the Node 1–5 route indicate that flow occurs normally without any overflow or surcharged flow. The water level fills only about 40–50% of the channel height, leaving sufficient capacity to accommodate the runoff discharge.

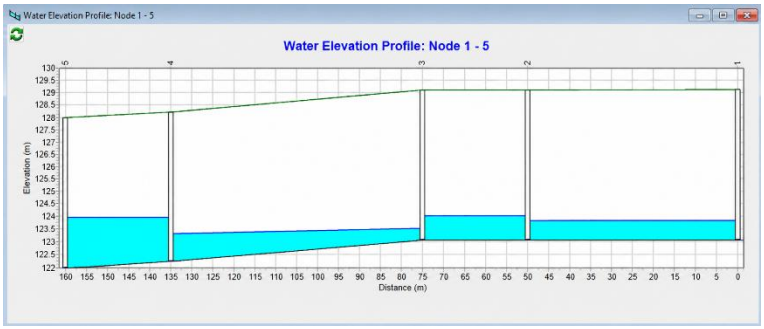

Figure 1. Simulation Results Using SWMM

Calculations show that the primary drainage capacity is 45.46 m^3/s, with a wet cross-sectional area of 19.18 m^2 and a flow velocity of 2.37 m/s. The SWMM simulation results show that all channel sections are still functioning optimally, as indicated by a stable water level that remains below the channel's crest elevation. These conditions indicate that the primary drainage capacity is still sufficient to accommodate the flood discharge of 14.79 m^3/s as determined by the analysis.

The results of this study offer a different contribution compared to previous research. While the studies by Prayogo and Nusantara (2025), Nadiana et al. (2023), and Palawa'ae et al. (2024) focused more on channel capacity analysis or drainage planning based on hydrological and hydraulic analysis, this study complements them through verification using SWMM modeling. The simulation results show that the water level profile remains below the channel crest elevation without any overflow or surcharging, thereby reinforcing the hydraulic calculation results that the primary drainage capacity is still adequate.

CONCLUSION

Based on the results of hydrological and hydraulic analyses, as well as SWMM simulations, the design flood discharge was determined to be 14.79 m^3/s, while the primary drainage capacity reached 45.46 m^3/s. This indicates that, from a hydraulic standpoint, the primary drainage channels in the NUFReP Project area in Santi Village are still capable of accommodating the flood discharge, with a capacity utilization rate of approximately 32.53%. Thus, channel capacity is not the primary cause of ponding or flooding at the study site. The problems that still occur are more influenced by operational factors, such as sedimentation, blockages caused by trash, and suboptimal connectivity and maintenance of the drainage network. Therefore, improving flood resilience requires not only adequate drainage infrastructure but also sustainable management and maintenance of the drainage system to ensure that the channels continue to function optimally.

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