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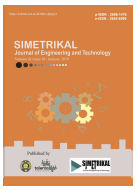

The Design of the Network of Wastewater and Storm Runoff for the Medan Resort City Housing Area

Christo Manurung[1], Netti Herlina[1], Joni Mulyadi[1], and Irvan[2*]

[1]*Department of Enviromental Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia 20155*
[2]*Department of Chemical Engineering, Faculty of Engineering, Universitas Sumatera Utara, Medan, Indonesia 20155*

Abstract. The expansion of the settlement results in the increasing need for clean water and will also produce much greater wastewater. The wastewater produced by household has no economic values and if directly dumped into a body of water such as the drainage and river, it can affect the water quality in the area. The wastewater and drainage which are managed properly will create a clean and healthy environment. Medan Resort City will plan the control of the domestic wastewater which shall be collected at one place in the wastewater treatment plant (WWTP). In the plan, there are drainage and pipes to the flow of rain water and domestic wastewater using gravity. The peak value of runoff was 2.12 m^3/s obtained by using the rational formula. The form used is the channel-shaped trapezoid with depth variations ranging from 0.43-1.15 meters. Domestic wastewater is channeled to the WWTP pipes with diameters of 100 mm, 200 mm, and 300 mm. The total discharge of that wastewater flowed to the WWTP was 31.65 L/s. The pipe used is a special wastewater pipe SNI no. 06-0162-1987.

Keyword: Distribution, water, WWTP, Medan resort city

Abstrak. *Berkembangnya pemukiman penduduk mengakibatkan kebutuhan akan air bersih meningkat dan juga akan menghasilkan air buangan yang jauh lebih besar. Air buangan yang dihasilkan oleh rumah tangga tidak memiliki nilai ekonomis dan kurang baik jika langsung dibuang ke badan air seperti drainase dan sungai karena dapat mempengaruhi kualitas air di daerah tersebut. Air buangan dan drainase yang dikelola dengan baik akan menciptakan lingkungan yang bersih dan sehat. Perumahan Medan Resort City merencanakan penyaluran air buangan secara off-site yaitu pengolahan yang dikumpulkan pada satu tempat di instalasi pengelolaan air buangan. Dalam merencanakan ada saluran drainase terbuka untuk pengaliran air hujan saja dan pengaliran air buangan domestik dengan saluran tertutup secara gravitasi . Nilai debit puncak limpasan hujan untuk drainase 2,12 m^3/detik didapat dengan menggunakan rumus rasional. Bentuk saluran yang digunakan adalah berbentuk trapesium dengan kedalaman variasi mulai dari 0,43 hingga 1,15 meter. Untuk air buangan domestik dialirkan ke IPAL dengan menggunakan pipa dengan diameter 100 mm, 200 mm, dan 300 mm total debit air buangan yang dialirkan ke IPAL sebesar 31,65 L/detik. Pipa yang digunakan adalah pipa khusus air buangan dengan no SNI 06-0162-1987.*

Kata kunci : *air buangan domestik, drainase, jaringan pipa, Medan Resort city*

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*Corresponding author at: Department of Chemical Engineering, Faculty of Engineering, Universitas Sumatera Utara, Jl. Almamater, Medan 20155

E-mail address: irvan@usu.ac.id
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1 Introduction

Waste water is undesirable waste water that does not have the economic value generated from a process either industrial or household. The results of all processing both industry and household produce waste water from an activity that is related to daily life. Domestic waste is divided into two types, gray water and black water. Gray water is a domestic wastewater from households such as used water for washing and bathing, while black water is a domestic wastewater from latrines in the form of urine, feces and spilled water [1].

A good distribution of wastewater requires an adequate system, namely distribution of wastewater, drainage methods, piping systems, urban transmission and distribution systems, and water treatment buildings [2]. Properly managed wastewater distribution will create a clean and healthy environment. In developed countries, housing drainage channels and waste water channels are not equated because wastewater has its own channel and requires further special treatment [3].

The existing conditions in the Medan Resort City housing will be planned by the growers only using septic tanks as a facility of domestic waste disposal where it is still not optimal in its designation. Medan Housing Resort City has not used the installation of domestic wastewater treatment as a centralized community sanitation facility. A centralized and drainage distribution system for domestic wastewater aims to [4]:

a. Prevent the spread of disease through wastewater
b. Prevent pollution to the environment
c. Improve the quality of public health.

By planning these purposes, it can support the creation of a healthy and productive community environment. This study aims to determine the discharge of wastewater and the peak discharge of rainwater for drainage and then planning a domestic wastewater distribution system and a drainage system that fits the location in the Medan Resort City housing.

2. Design Methods

The first stage is to collect various types of literature ie books and scientific papers related to this experiment. The second stage is direct observation to the project location and to fix the location of the research and the location of data collection that is deemed necessary. The third stage is collecting data, primary data and secondary data. Primary data is documentation only. Secondary data were Medan Resort City site plan and housing elevation maps.

2.1 Primary Data

Some pictures were used as the documentation for the completeness of experimental data.

2.2 Secondary Data

2.2.1 Site Plan

A housing development plan consist of the number of houses, roads and public facilities in the Medan Resort City housing.

2.2.2 Housing Elevation

Housing elevation as obtained from the contour planning map and is used to see the lowest place for distribution used by gravity.

3. Result and Discussion

In this plan, it was known that the number of houses was 730, assuming that each house has 5 residents, as seen in Fig 1.

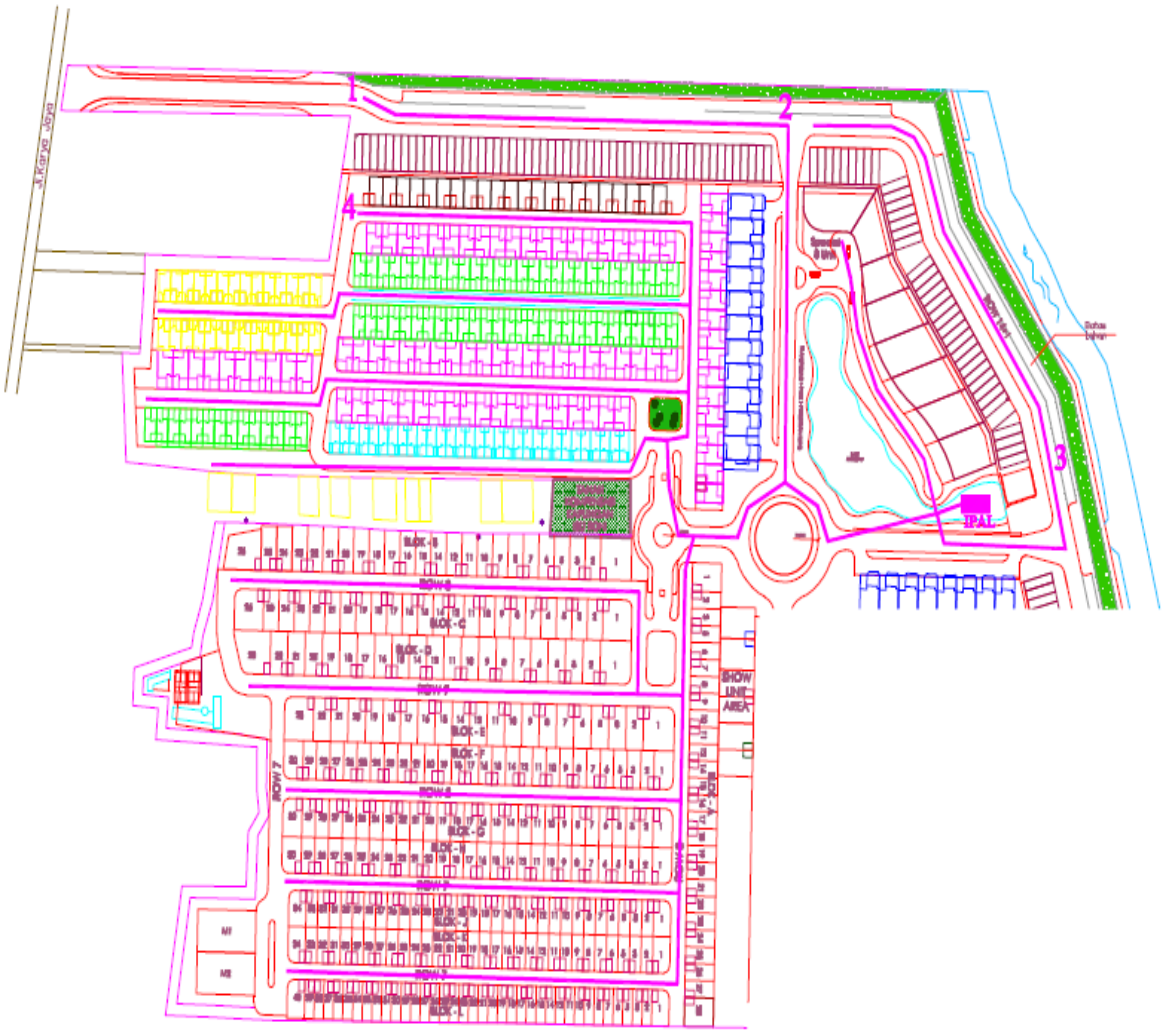

Figure 1. Site Plan Map

3.1 Rain Return Period

The rain return period for the Medan Resort City housing for 5 years later. Rainfall intensity was calculated with the Monobe equation [5].

$$I = \frac{R24}{24}\left(\frac{24}{t}\right)^{2/3} \quad (1)$$

where I = rainfall intensity (mm/hour), T = duration of rainfall (hours), R24 = maximum rainfall in 24 hours (mm). The rainy return period 5 years is seen in Table 1.

Table 1. Rainy Return Period 5 Years

No	t (min)	I (mm/hour)
1	5	200.27
2	10	126.16
3	20	79.48
4	30	60.65
5	40	50.07
6	60	38.21
7	80	31.54
8	120	24.07

Then we determine the concentration time that will be used as the intensity of rain [6]. Using the Kiprich equation, namely:

$$tc = \left(\frac{0.87 \times L^2}{1000 \times S}\right)^{0.385} \quad (2)$$

The farthest distance in this plan was 472.18 meters with a concentration time of 23.06 minutes. This time was used to determine the intensity of rain. From the result, obtained the rain intensity of 72.28 mm/h.

3.2 The Peak Discharge of Rain Runoff Calculation

The peak discharge of rain runoff calculation is tabulated in Table 2.

Table 2. The Peak Discharge of Rain Runoff at Rainfall Intensity of 72.28 mm/h

No	Block	Area (km^2)	*C*, Combination	*Q*, Region (m^3/sec)
1	AA 1	0.00467	0.74	0.06944
2	AA2	0.00778	0.78	0.12194
3	AB	0.00609	0.75	0.09178
4	AC	0.00753	0.8	0.12105
5	AD 1	0.00313	0.8	0.05031
6	AD 2	0.00366	0.67	0.04927
7	AE	0.00282	0.53	0.08001
8	A	0.00504	0.79	0.09112
9	B	0.00574	0.79	0.06540
10	C	0.00412	0.79	0.06905
11	D	0.00435	0.79	0.06381
12	E	0.00402	0.79	0.06715
13	F	0.00423	0.79	0.06778
14	G	0.00427	0.79	0.06873
15	H	0.00433	0.79	0.08763
16	I	0.00552	0.79	0.02921
17	J	0.00184	0.79	0.02810
18	K	0.00177	0.79	0.02953
19	L	0.00186	0.79	0.02778
20	M	0.00175	0.79	0.08842
21	N	0.00557	0.79	0.08191
22	O	0.00516	0.79	0.08588
23	P	0.00541	0.79	0.08604
24	Q	0.00542	0.79	0.09572
25	R	0.00603	0.79	0.06937
26	S	0.00437	0.79	0.07540
27	T	0.00475	0.79	0.06731
28	U	0.00424	0.79	0.07508
29	V	0.00473	0.79	0.08509
30	W	0.00536	0.79	0.01502

The peak discharge of storm has been calculated by using a rational equation:

$$Q_p = 0{,}278 \times C \times i \times A \tag{3}$$

where Qp = the peak discharge of rain runoff (m^3/sec), C = coefficient value C for sub drain area, I = rain intensity (mm / hour).

3.3 Drainage Channel Dimensions

The drainage channel that will be planned in the Medan Resort City Housing is an open trapezoidal channel with more economical and sufficient land availability. The slope of the drainage that will be used will follow the slope of the available land [7]. The planned channel wall is a stone pair with less smooth cement plastering conditions [8]. In this planning there was two water bodies receiving rainwater, namely; collected in the lake and dumped directly into the river [9]. The total rainwater discharge that must be flowed was 2.12 m^3/second. With the distribution flowing into the river was 0.2832 m^3/sec and the flow to the lake was 1.8362 m^3/second (Figure 2).

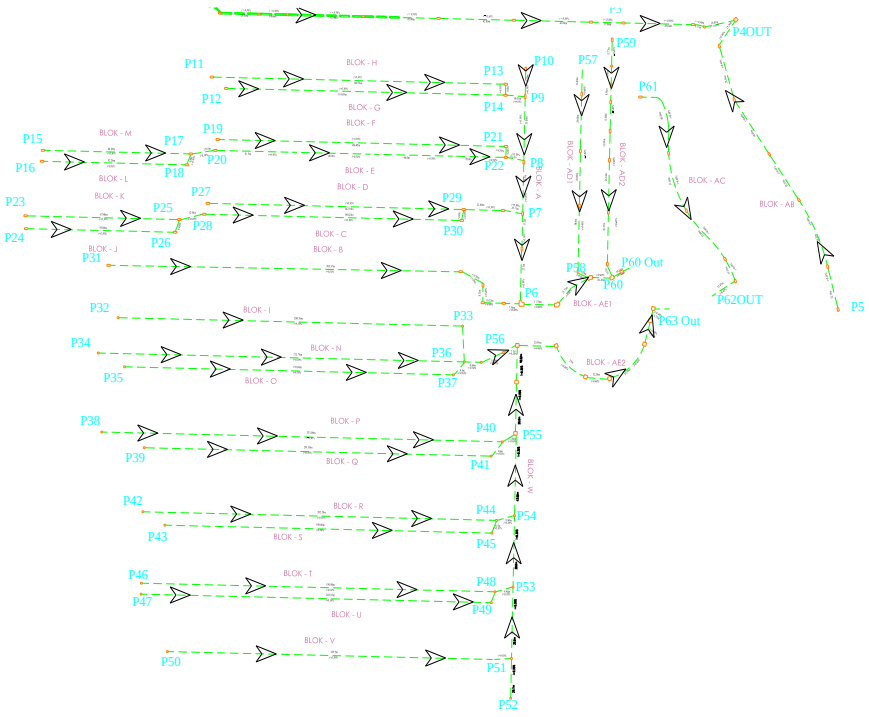

Figure 2. Map of Drainage System

3.4 Wastewater Pipe Channels

Pipeline hydraulic calculation includes pipe dimensions, flow time, and pipe profile [10]. There are three types of pipes used, diameter 150, 200, and 300 mm with a total pipe length of 3380,81 meters. The slope is all the same which is equal to 0.005. Distribution of wastewater to the WWTP with peak discharge 31.6746 l/second will serve as many as 3650 people (Figure 3).

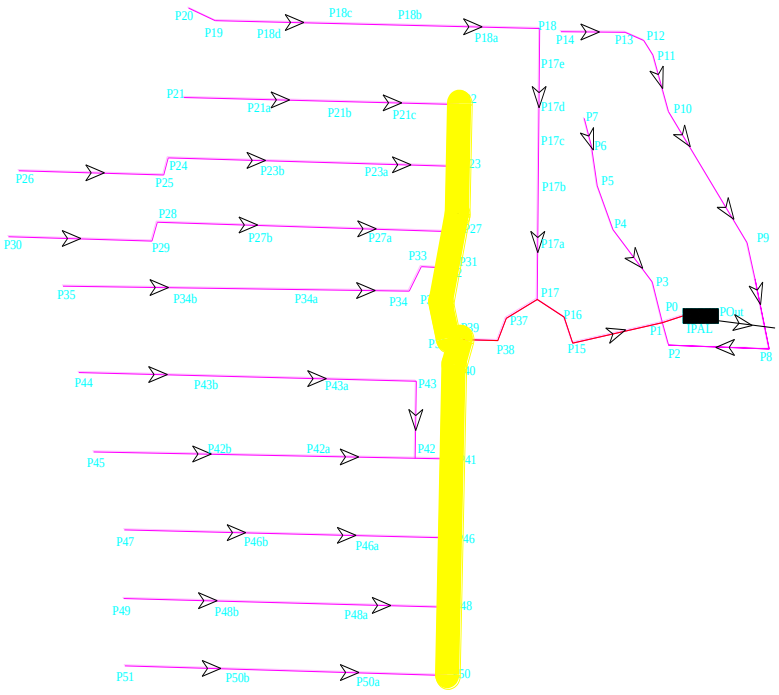

Figure 3. Map of Wastewater Pipes

3.5 Flushing

There were sixteen pipelines that must use a flushing tub [11]. Due to the high cost of flushing, the flushing is only done once a month, with a total required volume of 43,988 m^3.

3.6 Manhole

Manhole is functions as a channel inspection hole when a blockage occurs which causes the channel to be disturbed and also serves as a connector for each turn [12], [13]. In this study, this manhole was placed at each turn with distance of 50 m. In this way, 86 manhole pieces were designed. Manhole cover has a diameter of 0.6 m with steel plate material.

4. Conclusions

The drainage design was carried out based on rainfall with a 5 year return period with rainfall intensity obtained by using the Tablot equation, obtained the intensity was 111.028 mm/h [14]. The peak discharge of rain runoff was obtained by using rational equation, obtained the discharge was 3,2555 m^3/second. In planning of the wastewater distribution, the discharge was carried out by calculated the number of existing houses with assuming each house was inhabited by 5 people [15]–[17], so there were 3695 people, obtained the total discharge of wastewater was 31.6746 l/sec. Distribution of wastewater in the Medan Resort City Housing uses closed

channels using PVC pipes specifically for wastewater. The diameter of the wastewater pipe were 150, 200, and 300 mm with a total length of 3,380.63 m.

Acknowledgement

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