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UTILIZATION OF RAINWATER TO REDUCE WATER RUNOFF DISCHARGE IN THE KELAPA GADING PUMP BUILDING AREA USING THE SUNJOTO METHOD

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ABSTRACT

Increased development of community facilities triggers changes in land use that result in less open land for infiltration. This causes run-off and little rainwater is absorbed by the soil. For this reason, it is necessary to make a reservoir in the form of an infiltration well that functions to accommodate and absorb rainwater into the ground slowly. The purpose of this study was to determine the number and point of infiltration wells. The research was conducted at the Kelapa Gading Pumping Building located in North Jakarta. The address of the registered entity is Jl. Gading Mas Timur I No. 17, RT.12 / RW.10, Pegangsaan Dua Village, Kelapa Gading District, North Jakarta City, where the Kelapa Gading Pump Building stands on an area of ± 4,000 m2, has a reservoir with an area of ± 1,955 m2 with supporting buildings in the form: 1. pump building of 160 m2, 2. substation house of 35 m2, 3. transformer house of 75 m2, 4. employee mess of 52 m2, 5. generator house of 75 m2. This research uses survey methods in the form of measurements, interviews, and to obtain the required data. Based on the data and calculation analysis according to SNI 846-2017, a circular infiltration well with a diameter of 1meter and a depth of 2 meters to 2.5 meters can be determined.

Keywords: *flooding, hydrology, infiltration wells*

1. PRELIMINARY

Kelapa Gading Pump House is a flood control facility located in North Jakarta. The registered address of the entity is Jl. Gading Mas Timur I No. 17, Rt.12/Rw.10, Pegangsaan Dua Village, Kelapa Gading District, North Jakarta City with latitude coordinates -6.16653300000 and longitude coordinates 106.91354800000, since it was built the Kelapa Gading Pump Building North Jakarta has played an important role in overcoming flooding, there are several areas handled by the Kelapa Gading Pump Building North Jakarta, namely the Mayor Complex, East Boulevard, and Accordion Street.

Kelapa Gading Pump Building stands on an area of ± 4,000 m2, has a reservoir with an area of ± 1,955 m2 with supporting buildings in the form of:

- Pump building covering an area of 160 m2
- Substation house covering an area of 35 m2
- Transformer House covering an area of 75 m2
- Employee Mess covering an area of 52 m2

- Generator House covering an area of 75 m2

During this time, rainwater that flows through the roof of the Kelapa Gading Pump Building building or directly falls to the ground is simply flowed into the reservoir or water channel, this causes an increase in runoff discharge into water storage channels and reservoirs, coupled with the amount of garbage that causes obstruction of the channel causing water to overflow causing flooding and puddles.

In order to reduce rainwater runoff into sewers, infiltration ponds can be one solution to reduce rainwater runoff into sewers, so it is hoped that it can reduce rainwater discharge by collecting rainwater into infiltration wells where rainwater can later be absorbed back into the ground.

By utilizing rainwater that is infiltrated into the ground with infiltration wells, it is hoped that it can reduce seawater infiltration in the Kelapa Gading Pump Building in order to preserve the depleted groundwater and can also reduce runoff discharge into the channel and into the water reservoir.

To manage these infrastructure problems, an environmentally sound drainage system is needed, with the basic principle of controlling excess surface water so that it can be channeled in a controlled manner and has more opportunity to absorb into the soil.

2. IMPLEMENTATION METHOD

The data used in this study are primary data and secondary data. Primary data obtained in the form of rainfall data obtained from BMKG and the results of soil sample tests taken from the Kelapa Gading Pump Building, North Jakarta. While the secondary data used is in the form of land use obtained from the survey results in the Kelapa Gading Pump Building Area.

3. RESULTS AND DISCUSSION

Rainfall data in this study was obtained through the Tanjung Priok rainfall station (STA Priok), Kemayoran Station (STA Kemayoran), and Halim Perdana Kusuma Station (STA Halim), the data was obtained from the Meteorology, Climatology and Geophysics Agency (BMKG), by downloading through the BMKG website.

For rainfall of 3 (three) rain stations, the Thiessen Polygon method cannot be used, so it uses 1 (one) nearest station, namely: Tanjung Priok Station. The location of the Tanjung Priok rainfall station observation is latitude -6.10781LS and 106.88053BT.

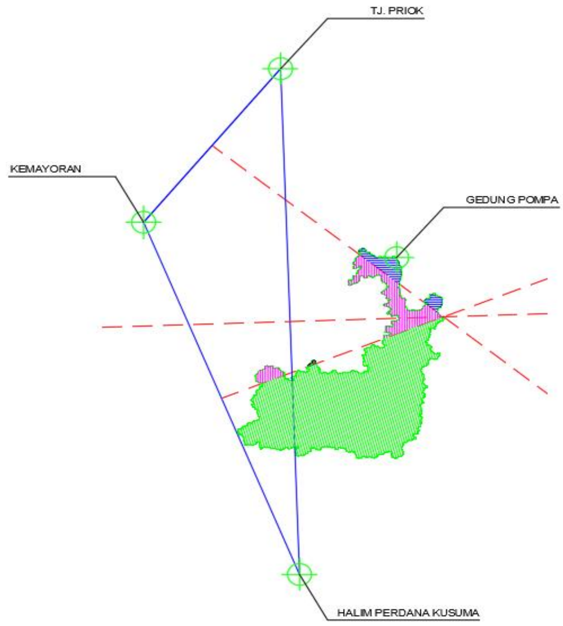


Figure 1. Location of rain stations

Table 1. Rainfall distribution calculation

Total Data (n)	Year	Varian Value (Xi)	(Xi - X)	(Xi - X)^2	(Xi - X)^3	(Xi - X)^4
1	2012	94,40	-23,05	531,09	-12239,28	282059,75
2	2013	161,00	43,55	1897,00	82622,90	3598603,04
3	2014	120,80	3,35	11,25	37,75	126,63
4	2015	124,60	7,15	51,19	366,22	2620,16
5	2016	111,60	-5,85	34,17	-199,74	1167,54
6	2017	136,30	18,85	355,49	6702,68	126375,90
7	2018	101,20	-16,25	263,91	-4287,42	69651,02
8	2019	78,00	-39,45	1555,94	-61374,91	2420961,37
9	2020	101,00	-16,45	270,45	-4447,72	73144,81
10	2021	155,00	37,55	1410,34	52964,82	1989069,87
11	2022	108,00	-9,45	89,22	-842,69	7959,60
Amount ∑		1291,90	**0,00**	**6470,07**	**59302,62**	**8571739,70**
X		117,45				

Average rainfall calculation

$$X = \frac{\sum_{i=1}^{n} Xi}{n}$$

$$= (1291{,}90/11)$$

$$= 117{,}45$$

Standard Deviation Calculation

$$Sd = \sqrt{\frac{\sum_{i=1}^{n}(Xi-X)^2}{n-1}}$$

$$= \sqrt{\frac{6470.07}{10}}$$

$$= 25{,}44$$

Coefficient of variation calculation

$$(Cv) = \frac{Sd}{X}$$

$$= \frac{25.44}{117.45}$$

$$= 0{,}22$$

Slope coefficient calculation

$$(Cs) = \frac{n\sum_{i=1}^{i}(Xi-X)^3}{(n-1)\ x\ (n-2)\ x\ (Sd)^3}$$

$$= \frac{11\ x\ 59302.62}{10\ x\ 9\ x\ (25.44)^3}$$

$$= 0{,}44$$

Sharpness coefficient calculation

$$(Ck) = \frac{n^2\sum_{i=1}^{i}(Xi-X)^4}{(n-1)\ x\ (n-2)\ x\ (n-3) x\ (Sd)^4}$$

$$= \frac{11^2\ x\ 8571739.70}{10\ x\ 9\ x\ 8\ x\ (25.44)^4}$$

$$= 3{,}44$$

Table 2. Rainfall distribution calculation

No	Distribution	Requirements	Calculation	Remarks
1	Gumbel	Cs = 1,1396 Ck = 5,4002	0,440 3,441	Not compliant
2	Normal	Cs = 0 Ck = 3	0,440 3,441	Not compliant
3	Log Normal	Cs = 3 atau 3 Cv	0,14 19,00	Not compliant
4	Log Pearson III	Doesn't have condition	0,440 3,440	Fulfill

Source : SNI 215:2016

Based on the calculation and analysis of rainfall data, the method that meets the requirements is Log Pearson III.

The following are the steps in calculating the rainfall plan using the log pearson III method.

Table 3. Design standards for drainage channels

Total Data (n)	Year	Variant Value (Xi)	log Xi	Log Xi - Log X	(Log Xi - Log X)^2	(Log Xi - Log X)^3	(Log Xi - Log X)^4
1	2012	94.40	1.975	-0.086	0.007	-0.001	0.000
2	2013	161.00	2.207	0.146	0.021	0.003	0.000
3	2014	120.80	2.082	0.021	0.000	0.000	0.000
4	2015	124.60	2.096	0.035	0.001	0.000	0.000
5	2016	111.60	2.048	-0.013	0.000	0.000	0.000
6	2017	136.30	2.134	0.074	0.005	0.000	0.000
7	2018	101.20	2.005	-0.055	0.003	0.000	0.000
8	2019	78.00	1.892	-0.169	0.028	-0.005	0.001
9	2020	101.00	2.004	-0.056	0.003	0.000	0.000
10	2021	155.00	2.190	0.130	0.017	0.002	0.000
11	2022	108.00	2.033	-0.027	0.001	0.000	0.000
Amount Σ		1291.900	22.667	0.000000	0.088224	-0.000024	0.001652

Source : Calculation result

The frequency factor (KT) values for the Log Pearson III distribution (positive skewness) can be seen in table 4 and for the Log Pearson III Distribution (negative skewness) can be seen in table 5.

After calculating the average rainfall, standard deviation (Sd), coefficient of variation (Cv), slope coefficient (Cs) and sharpness coefficient (Ck), then calculate the return period according to the qualified method, the following table shows the calculation results to determine the distribution method.

Table 4. Frequency factor value (Kt) for the Log Pearson III distribution (positive Cs or G skewness)

Skew				**Return period in years**			
coefficient	**2**	**5**	**10**	**25**	**50**	**100**	**200**
C_s or G				**Exceedence probability**			
	0.50	0.20	0.10	0.04	0.02	0.01	0.005
3.0	-0.396	0.420	1.180	2.278	3.152	4.051	4.970
2.9	-0.390	0.440	1.195	2.277	3.134	4.013	4.909
2.8	-0.384	0.460	1.210	2.275	3.114	3.973	4.847
2.7	-0.376	0.479	1.224	2.272	3.093	3.932	3.783
2.6	-0.368	0.499	1.238	2.267	3.071	3.889	4.718
2.5	-0.360	0.518	1.250	2.262	3.048	3.845	4.652
2.4	-0.351	0.537	1.262	2.256	3.023	3.800	4.584
2.3	-0.341	0.555	1.274	2.248	2.997	3.753	4.515
2.2	-0.330	0.574	1.284	2.240	2.970	3.705	4.444
2.1	-0.319	0.592	1.294	2.230	2.942	3.656	4.372
2.0	-0.307	0.609	1.302	2.219	2.912	3.605	4.298
1.9	-0.294	0.627	1.310	2.207	2.881	3.553	4.223
1.8	-0.282	0.643	1.318	2,193	2.848	3.499	4.147

1.7	-0.268	0.660	1.324	2.179	2.815	3.444	4.069
1.6	-0.254	0.675	1.329	2.163	2.780	3.388	3.990
1.5	-0.240	0.690	1.333	2.146	2.743	3.330	3.910
1.4	-0.225	0.705	1.337	2.128	2.706	3.271	3.828
1.3	-0.210	0.719	1.339	2.108	2.666	3.211	3.745
1.2	-0.195	0.732	1.340	2.087	2.626	3.149	3.661
1.1	-0.180	0.745	1.341	2.066	2.585	3.087	3.575
1.0	-0.164	0.758	1.340	2.043	2.542	3.022	3.489
0.9	-0.148	0.769	1.339	2.018	2.498	2.957	3.401
0.8	-0.132	0.780	1.336	1.993	2.453	2.891	3.312
0.7	-0.116	0.790	1.333	1.967	2.407	2.824	3.223
0.6	-0.099	0.800	1.328	1.939	2.359	2.755	3.132
0.5	-0.083	0.808	1.323	1.910	2.311	2.686	3.041
0.4	-0.066	0.816	1.317	1.880	2.261	2.615	2.949
0.3	-0.050	0.824	1.309	1.849	2.211	2.544	2.856
0.2	-0.033	0.830	1.301	1.818	2.159	2.472	2.763
0.1	-0.017	0.836	1.292	1.785	2.107	2.400	2.670
0,0	0.000	0.842	1.282	1.751	2.054	2.326	2.576

Source : Hidrologi terapan (Bambang Triatmodjo, 2008)

Table 5. Frequency factor value (Kt) for the Log Pearson III distribution (negative Cs or G skewness)

Skew	**Return period in years**						
coefficient	**2**	**5**	**10**	**25**	**50**	**100**	**200**
C_s or G	**Exceedence probability**						
	0.50	**0.20**	**0.10**	**0.04**	**0.02**	**0.01**	**0.005**
0	0	0.842	1.282	1.751	2.054	2.326	2.576
-0.1	0.417	0.846	1.270	1.716	2.000	2.252	2.482
-0.2	0.033	0.850	1.258	1.680	1.945	2.178	2.388
-0.3	0.05	0.853	1.245	1.643	1.890	2.104	2.294
-0.4	0.066	0.855	1.231	1.606	1.834	2.029	2.241
-0.5	0.083	0.856	1.216	1.567	1.777	1.995	2.108
-0.6	0.099	0.857	1.240	1.528	1.720	1.880	2.016
-0.7	0.116	0.857	1.183	1.488	1.663	1.806	1.926
-0.8	0.132	0.856	1.166	1.448	1.606	1.733	1.837
-0.9	0.148	0.854	1.147	1.407	1.549	1.660	1.749
-0.10	0.164	0.852	1.128	1.366	1.492	1.588	1.664
-1.1	0.180	0.848	1.107	1.324	1.435	1.518	1.581
-1.2	0.195	0.844	1.086	1.282	1.379	1.449	1.501
-1.3	0.210	0.838	1.064	1.240	1.324	1.383	1.424
-1.4	0.225	0.832	1.041	1.198	1.270	1.318	1.351
-1,5	0.240	0.825	1.018	1.157	1.217	1.256	1.282
-1.6	0.254	0.817	0.994	1.116	1.166	1.197	1.216
-1.7	0.286	0.808	0.970	1.075	1.116	1.140	1.155
-1.8	0.282	0.799	0.945	1.035	1.059	1.087	1.097
-1.9	0.294	0.788	0.920	0.996	1.023	1.037	1.044
-2.0	0.307	0.777	0.895	0.959	0.980	0.990	0.995
-2.1	0.319	0.765	0.869	4.923	0.939	0.346	0.949
-2.2	0.330	0.752	0.844	0.888	0.900	0.905	0.907
-2.3	0.341	0.739	0.819	0.855	0.864	0.867	0.869
-2.4	0.351	0.752	0.795	0.823	0.826	0.832	0.833
-2.5	0.306	0.711	0.771	0.793	0.798	0.799	0.800
-2.6	0.368	0.696	0.747	0.764	0.768	0.769	0.769

-2.7	0.376	0.681	0.724	0.738	0.740	0.740	0.741
-2.8	0.384	0.666	0.702	0.712	0.714	0.714	0.714
-2.9	0.390	0.651	0.681	0.683	0.689	0.690	0.690
-3.0	0.396	0.636	0.666	0.666	0.666	0.667	0.667

Source : Hidrologi terapan (Bambang Triatmodjo, 2008)

The value of the frequency factor (KT) for the Log Pearson III distribution when the

slope coefficient (Cs) of -0.004 is known is as follows:

Table 6. Frequency factor (KT) value for Log Pearson III distribution

Value Interpolation KT							
CS	**2**	**5**	**10**	**25**	**50**	**100**	**200**
0	0,000	0,842	1,282	1,751	2,054	2,326	2,576
-0,1	0,017	0,846	1,270	1,716	2,000	2,252	2,482
-0,004	0,001	0,842	1,282	1,750	2,052	2,323	2,573

Analysis of the 5-year return period plan according to table 6. KT = 0.842

After the values, Log x, Sd log x and KT are obtained, then proceed to analyze the maximum daily rainfall.

Table 7. Maximum rainfall return period

Period (T)	Log X	Value KT	Sd Log X	Log Xt	Anti Log (mm)
2	2,061	0,001	0,094	2,061	114,996
5	2,061	0,842	0,094	2,140	137,952
10	2,061	1,282	0,094	2,181	151,706
25	2,061	1,750	0,094	2,225	167,871
50	2,061	2,052	0,094	2,253	179,214
100	2,061	2,323	0,094	2,279	190,044
200	2,061	2,573	0,094	2,302	200,571

Calculating Concentration Time (TC)

The formula for finding the concentration time

concentration is:

$t_c = (0{,}0195 \cdot L^{0{,}77}) \cdot (S^{-0{,}385})$

Wich:

Tc = Concentration time (minutes)

L = Length of the waterway from the farthest point to the point under review (km),

S = average slope of the waterway area, so that the concentration time is obtained as follows

as follows:

Area 1 (pump building)

$L_{(tile\ roof)}$ = 52 m

$S_{(gutter)}$ = 0,00001923

$t_c = 0{,}0195 \cdot 52^{0{,}77} \cdot 0{,}00001923^{-0{,}385}$

= 26,731 minute

= 0,446 hour

Table 8. Concentration Time (Tc)

No	Area	Remarks	Gutter Slope (S)	L (m)	Tc	Tc
					minute	**hour**
1	Gedung Pompa	roof tile	0,00000192	52	64,866	1,081
2	Gardu	concrete roof	0,0000050	20	21,514	0,359
3	Trafo	roof tile	0,00000244	41	49,295	0,822
4	Mess karyawan	roof tile	0,00000256	39	46,528	0,775
5	Rumah Genset	roof tile	0,00000278	36	42,419	0,707

Calculating Rainfall Intensity

Mononobe formula as follows:

$I = \frac{R_{24}}{24}\left[\frac{24}{t}\right]^{2/3}$

I = Rainfall Intensity (mm/hour)

Tc = Rainfall Concentration Time (hour),

R24 = Maximum rainfall in 1 day (mm/hour).

Area 1 (pump building)

$I = \frac{137{,}925}{24} \cdot \left(\frac{24}{0{,}446}\right)^{\frac{2}{3}}$

= 81,987 mm/hour

The results of the recapitulation of the calculation of the concentration time in the catchment area can be seen in the following table.

Table 9. Rainfall Intensity Calculation

No	Area	Repeat Period	Rainfall Plan		Rainfall Intensity (I)
			Log Pearson III	Tc (h)	Log Pearson III (mm/h)
1	Gedung Pompa	5	137,95	0,446	81,987
2	Gardu	5	137,95	0,148	171,110
3	Trafo	5	137,95	0,339	98,452
4	Mess karyawan	5	137,95	0,320	102,317
5	Rumah Genset	5	137,95	0,291	108,822

Design Discharge Without Infiltration Wells

The calculation of design runoff discharge is calculated using the rational method.

Area 1 (pump building)

$\overline{C}1$ = 0,95

I1 = 81,987 mm/h

A1 = 0,01600 ha

Q1 = 0,002778 . $\overline{C}1$. I1 . A1

= 0,002778 . 0,95 . 81,987 . 0,01600

= 0,0034644 m^3/s

The results of the recapitulation of the calculation of the design runoff discharge without infiltration wells in the catchment area can be seen in Table 10.

Table 10. Design runoff discharge without infiltration wells

No	Sample Area	C	I	A	Q
			(mm/h)	(ha)	(m^3/s)
1	Gedung Pompa	0,95	81,987	0,01600	0,0034644
2	Gardu	0,95	171,110	0,00250	0,0011298
3	Trafo	0,95	98,452	0,00585	0,0015211
4	Mess Karyawan	0,95	102,317	0,00520	0,0014051
5	Rumah Genset	0,95	108,822	0,00800	0,0022992

The design of infiltration wells uses the Sunjoto method.

This calculation is carried out based on the Sunjoto method, the value of the soil type coefficient obtained through boring tests in the Kelapa Gading Pump Building Area is silty clay (silt), so it has a permeability coefficient price of 0.001 cm3 / second.

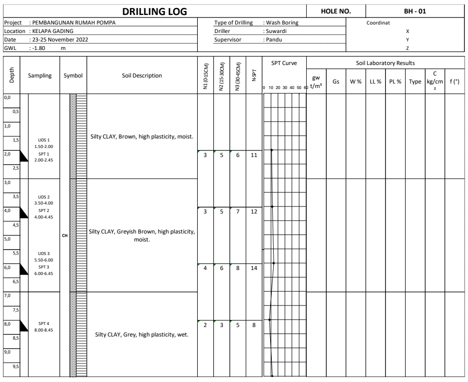


Figure 2. Drilling Log Test

Table 11 Permeability values of different types of materials

No	Soil Type	K	
		cm/second	ft/minute
1	Gravel	1,0-100	2,0-200
2	Rough Sand	1,0-0,01	2,0-0,02
3	Fine Sand	0,01-0,001	0,02-0,002
4	Silt	0,001-0,00001	0,002-0,00002
5	Clay	<0,000001	<0,000002

Source : Braja M. Das (principle of geotechnical engineering 7th edition solution manual)

The example of calculating rainwater infiltration wells using the Sunjoto method.

$R_{5\ years}$ = 137,952 mm
$C_{(roof)}$ = 0,75 – 0,95 (used 0,95)
Intensitas hujan = 81,987 mm/h
A atap = 0,01600 ha
H_{plan} = 1,5 m (groundwater level 1,8 m)

Infiltration well plan diameter

Diameter (D) = 1 m

Radius (R) = 0,5 m

Design inflow discharge (Q)

Q = 0,002778 . C . I . A

= 0,002778 . 0,95 . 1 . 0,01600

= 0,0035 m3/detik

Geometric factor (F)

Geometric factor using 5.5 × R

F = 5,5 × 0,5
= 2,75

Soil permeability coefficient (K)

K = 0,00001 m/s (Silt Soil)

Rainfall duration (td)

Calculation of frequency duration intensity using the alternative block method.

R_{24} = 137,952 mm

T = 1 Jam

$$R_t = \frac{R_{24}}{24}\left(\frac{24}{T}\right)^{\frac{2}{3}}$$

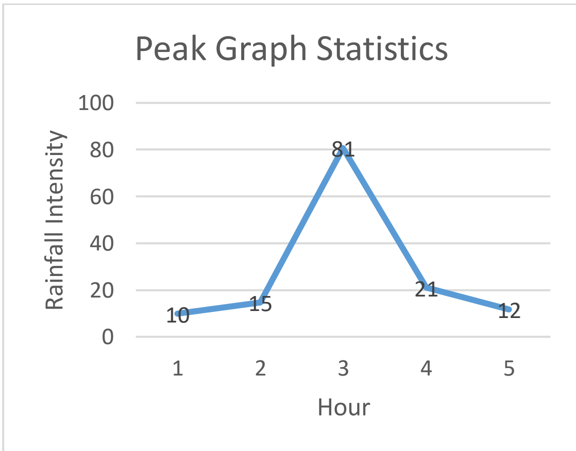
$$R_t = \frac{137{,}952}{24}\left(\frac{24}{1}\right)^{\frac{2}{3}}$$

$$R_t = 47{,}8252\ mm/jam$$

$$P = l_t \cdot T_d$$

$$P = 47{,}8252 \cdot 1$$

$$P = 47{,}8252\ mm$$



from the above graph, the intensity of the rain duration frequency (td) is 3 hours.

Effective depth of infiltration well (H)

$$H = \frac{Q}{F.K}\left(1 - e^{\frac{-F.K.t_d}{\pi.R^2}}\right)$$

$$=\frac{0{,}0035}{2{,}75\ .\ 0{,}00001}\left(1-e^{\frac{-2{,}75.0{,}00001.10800}{\pi.0{,}5^2}}\right)$$
$= 6{,}4597$ m

Total Number Of Infiltration Wells (n)

$$n = \frac{H_{effective}}{H_{plan}}$$
$$= \frac{6{,}74}{1{,}5}$$
= 3,78 pcs
= 5 pcs

Table 12 Infiltration well calculation using the Sunjoto method

Area	***Ro of Area***	***I***	***C***	***Q***	***F***	***K***	***td***	***H effective***	***H plan***	***n***	***Roundup***
	(ha)	**(mm/h)**	**Roof**	**(m³/s)**	**(5,5 x R)**	**(m/s)**	**(h)**	**(m)**	**(m)**		
Gedung Pompa	0,001600	82,1	0,95	0,0035	2,75	0,00001	3	6,74	1,5	4,5	5
Gardu	0,00250	171,4	0,95	0,0011	2,75	0,00001	3	2,33	1,5	1,6	2
Trafo	0,00585	98,6	0,95	0,0015	2,75	0,00001	3	3,14	1,5	2,1	3
Mess Karyawan	0,00520	102,5	0,95	0,0014	2,75	0,00001	3	2,90	1,5	1,9	2
Rumah Genset	0,00800	109,0	0,95	0,0023	2,75	0,00001	3	4,74	1,5	3,2	4

Comparison Of Runoff Discharge

Runoff Discharge Before There Is Infiltration Wells

The results of the calculation of design runoff discharge before infiltration wells using previous calculations can be seen using the previous calculations contained in table 10.

Runoff Discharge After Infiltration Ponds

The design runoff discharge after infiltration ponds is calculated without the weight of rain falling on the roof. An example of calculating the design runoff discharge after infiltration wells at the Kelapa Gading Pump House location is as follows.

Roofless Surface Runoff Coefficient

C2 (Halaman) = 0,1

A2 (Halaman) = 0,03360

$$\bar{C} = \frac{\sum_{i=1}^{n} Ci.Ai}{\sum_{i=1}^{n} Ai}$$
$$= \frac{C1.A1+C2.A2}{A1+A2}$$
$$= \frac{01.0{,}03360+0{,}7.0{,}01760}{0{,}03360+0{,}01760}$$
= 0,30625 m3/second

Determination of Infiltration Well Points

Determination of infiltration well points based on the results of location surveys and spatial plans in the Kelapa Gading Pump Building Area, the location of infiltration wells is adjusted to the yard of each building. The water drainage system from the roof of the building uses gutters and is channeled through pipes that go directly to the infiltration wells.

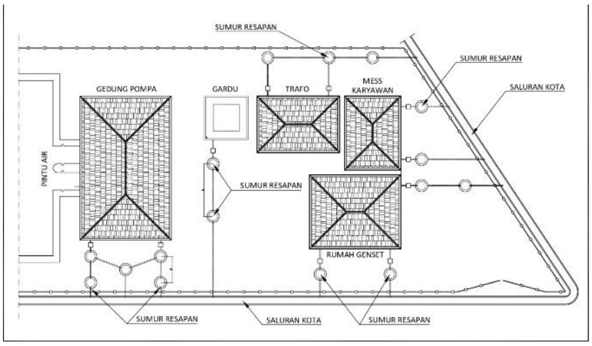


Figure 3. Infiltration Well Plan

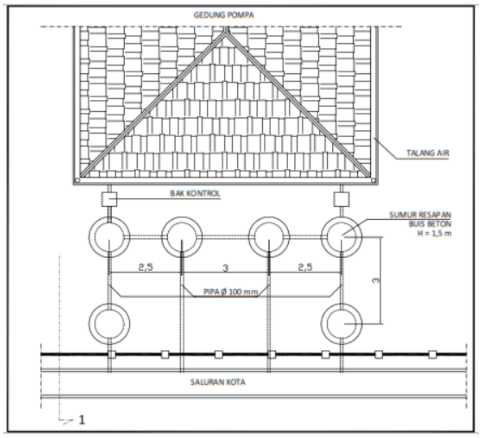


Figure 4. Pump Building Plan

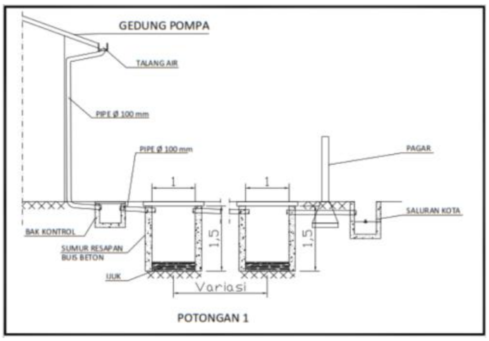


Figure 5.Section (infiltration well)

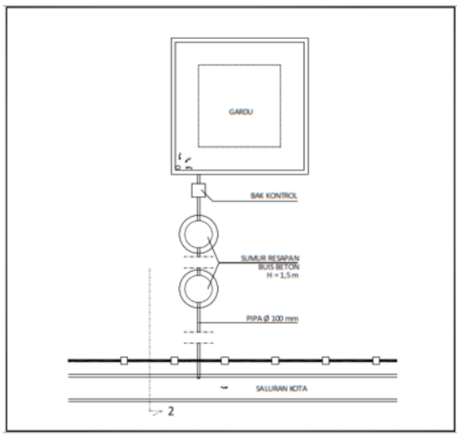


Figure 6. Substation Plan

Table 12 Roofless combined runoff

No	Sample Area	Description	C	Area (Ha)	C
1	Gedung Pompa	Roof	-	-	0,30625
		Yard	0,1	0,03360	
		Paving	0,7	0,01760	
2	Gardu	Roof	-	-	0,3
		Yard	0,1	0,00500	
		Paving	0,7	0,00250	
3	Trafo	Roof	-	-	0,214286
		Yard	0,1	0,00765	
		Paving	0,7	0,00180	
4	Mess karyawan	Roof	-	-	0,304588
		Yard	0,1	0,01078	
		Paving	0,7	0,00558	
5	Rumah Genset	Roof	-	-	0,244156
		Yard	0,1	0,01170	
		Paving	0,7	0,00370	

Design Runoff Discharge After Infiltration Wells

$\bar{C}1$ = 0,30625

I1 = 81,987 mm/hour

A1 = 0,03360 ha

Q1 = $0{,}002778 \cdot \bar{C}1 \cdot I1 \cdot A1$

Runoff Discharge Reduction

The following is an example of calculating the reduction of runoff discharge and the effectiveness of rainwater infiltration wells at the Kelapa Gading Pump House.

Qdecrease = Qbefore - Qafter
= 0,008281 – 0,005309
= 0,002972 m^3/second
Effectiveness = 64 %

Table 13 Roofless combined runoff

Sample Area	Qbefore	Qafter	Qreduced	Effectiveness
Gedung Pompa	0,002921	0,002346	0,000575	80%
Gardu	0,000953	0,0007142	0,000239	75%
Trafo	0,001283	0,0004490	0,000834	35%
Mess Karyawan	0,001158	0,0009342	0,000251	79%
Rumah Genset	0,001939	0,0008648	0,001074	45%
Total	0,008281	0,005309	0,002972	64%

4. CONCLUSION

Based on the calculation of the dimensions and number of infiltration ponds using the SNI 8456-2017 method and the Sunjoto method, it is found that the Sunjoto method is more effective than the SNI 8456-2017 method in terms of the number with the same dimensions.

The amount of rainwater runoff discharge is reduced after the infiltration well is 0.002972 m3/second, with details that can be seen in table 13.

Based on the calculation of runoff discharge after the rainwater infiltration wells in the Kelapa Gading Pump Building Area, North Jakarta, the presentation of the effectiveness of infiltration wells is obtained as much as 64%.

REFERENCES

Asdak, C. H. A. Y. (1995). Pengelolaan Daerah Aliran Sungai. Hidrologi dan Pengelolaan Daerah Aliran Sungai, 12.

Bambang, T. (2008). Hidrologi terapan. Beta Offset, Yogyakarta, 59, 50.

Basri, M. (2017). Perencanaan Sumur Resapan Untuk Pengendalian Banjir Di Kecamatan Ujung Bulu Kabupaten Bulukumba. Jurusan Sipil Pengairan Dan Perencanaan, Makassar.Bawono, P. P. (2021). Perancangan Sumur Resapan Pada Bangunan Rumah Tinggal Di Daerah Jalan Nusa Indah, Condongcatur, Depok, Sleman, Yogyakarta (Design Of Infiltration Wells In Residential House Building In The Area Of Nusa Indah Street, Condongcatur, Depok, Sleman, Yogyakarta).

Bisri, M., & Prastya, T. A. N. (2009). Imbuhan Air tanah Buatan Untuk Mereduksi Genangan (Studi Kasus Di Kecamatan Batu Kota Batu). Rekayasa Sipil, 3(1), 77-90.

Buchanan, T. J., & Somers, W. P. (1969). Discharge measurements at gaging stations (p. 65). Washington, DC: US Government Printing Office.

Das, B. M. (2021). Principles of geotechnical engineering. Cengage learning.

Data Online Pusat Database-BMKG. (2023). Diambil kembali dari https://www.dataonline.bmkg.go.id: https://www.dataonline.bmkg.go.id

Karya, D. P. U. D. C. (2012). Tata cara penyusunan rencana induk sistem drainase perkotaan. Jakarta: Budi Yuwono.

Kodoatie, R. J. (2002). Sugiyanto. Beberapa Penyebab Banjir dan Metode Pengendaliannya dalam Perspektif

Lingkungan. Yogyakarta: Pustaka Pelajar.
Kusnaedi, I. (1995). Sumur Resapan untuk Pemukiman Perkotaan dan Pedesaan. Penebar Swadaya, Jakarta.
Linsley Jr, R. K., Kohler, M. A., & Paulhus, J. L. (1975). Hydrology for engineers.
Nasional, B. S. (2016). Tata cara perhitungan debit banjir rencana. SNI, 2415, 2016.
Nasional, B. S. (2017). SNI 8456-2017 Sumur dan Parit Resapan Air Hujan.
Prasetya, A. (2006). Kajian Tinggi Genangan Banjir Sungai Code, di Daerah Perkotaan.
Sunjoto, S. (2011). Teknik Drainase Pro-Air. Jurusan Teknik Sipil & Lingkungan, Universitas Gadjah Mada, Yogyakarta.
Suripin (watervoorziening.). (2004). Sistem drainase perkotaan yang berkelanjutan. Andi.
Umum, M. P. (2014). Peraturan Menteri Pekerjaan Umum Nomor 12/PRT/M/2014 Tentang Penyelenggaran Sistem Drainase Perkotaan. Jakarta: Sekretariat Negara.