The planning rain water harvesting integrated wells in public facilities in the village of Kayu Besi

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Abstract. Continuous and excessive use of groundwater causes a decrease in the water table, as well as drought during the dry season. Land use change causes reduced water infiltration, leading to flooding and inundation during the rainy season. This happened in KayuBesi Village, which is located in PudingBesar District, Bangka Regency. The purpose of this planning is to determine the dimensions of the rain water harvesting pool integrated with infiltration wells in the village office as the center of the village government and the mosque as the center of worship. The method used to calculate the volume of rainwater collected in a rain water harvesting pond is the result of substitution and modification made by Maryono from the relationship between discharge, volume of rainwater, and duration of rain with the relationship between discharge, speed of rainwater, and the cross-sectional area of the gutter pipe. The method used to calculate the depth of the infiltration well is the Sunjoto method. The results of the planning for the KayuBesi Village Office obtained the dimensions of the rain water harvesting pool with a pool length of 5 m, a pool width of 4 m and a pool height of 1.5 m, as well as an infiltration well with a diameter of 1 m and a depth of 2.5 m, while for the KayuBesi Village Mosque obtained the dimensions of the rain water harvesting pond with a pool length of 6 m, a pool width of 5.5 m, and a pool height of 1.6 m, as well as an infiltration well with a diameter of 1 m and a depth of 4.5 m.

1. Introduction
Kayu Besi Village is located in Puding Besar District, Bangka Regency, Bangka Belitung Islands Province. Kayu Besi Village has a small spring potential. Kayu Besi Village has difficulty with clean water during the rainy and dry seasons, especially people who use dug wells. The well is dug at a depth of 6-9 m, at the bottom of the well there is a layer of rock, when it doesn't rain for 2 weeks or it rains with low intensity, the dug well will dry up. The drought and clean water crisis occurred because of the excessive and continuous use of groundwater which resulted in the groundwater level getting deeper, as well as the reduction in water catchment areas, namely forests being replaced by oil palm plantations, while there were no groundwater conservation efforts. During the rainy season, dug wells will collect rainwater and the resulting water is cloudy. Rain with high intensity and long duration resulted in flooding in the transmigration area of Kayu Besi Village. Rainwater available during rainy days is not utilized and is allowed to become surface runoff, coupled with the presence of oil palm plantations in Kayu Besi Village, making surface water unable to be absorbed into the ground so that it will flow into the Kayu Besi River (which has been polluted with palm oil waste) and overflows causing flooding. Based on these problems, an integrated PAH pond is planned for infiltration wells to reduce or replace groundwater use, fill and improve groundwater quality.
Planning the dimensions of PAH ponds that have been carried out to overcome the difficulty of clean water and groundwater filling in rural areas and educational buildings. Water savings by using rainwater at Yarmouk University and to provide recommendations for increasing water efficiency use to minimize water waste and reduce the water bill. Results showed that a maximum of 99,000 m$^3$/y of rainwater can be collected, 37,000 m$^3$/y of it from roofs of buildings and 62,000 m$^3$/y from open impervious areas, provided that all surfaces are used and all runoff from the surfaces are collected [1]. In India, the investigation verified the extent to which adaptation of the adapted technologies in conserving water resources in heterogeneous land patterns. The methodology opted for rainwater harvesting after appropriate information of land and topography give efficient, effective and significant results [2].

2. Research Methods
Planning the volume of PAH ponds and catchment wells can use a variety of methods. Methods used in previous planning include: was field surveys and laboratory testing to obtain data spatial analysis model using a Geographical Information System (GIS) to obtain the right number and location of infiltration wells in supporting rainwater harvesting efforts [3], also processed using hydrological analysis and hydraulic analysis [4].

The method used to calculate the volume of the PAH pond is the Maryono Method (2016) and the method used to calculate the capacity of infiltration wells is the Sunjoto Method (1988).

a. Calculating the Volume of the PAH Pool
The volume of the PAH pool is calculated by the Maryono Method (2016) which is the result of a substitution of the similarity of the relationship between discharge, rainwater volume, and rainwater duration with the relationship between discharge, rainwater velocity, and cross-sectional area of gutter pipes[5]. In determining the volume of the required PAH pool, it is determined based on the discharge of rainwater runoff, raw water needs, and the volume of rainwater that can be accommodated.

b. Determining the Type of Land
In the planning of catchment wells, it is required to know the type of soil to determine the value of the coefficient of soil permeability at the planning site. Soil type is determined by the USCS (Unified Soil Classification System) [6] and SNI 03–6371-2000 Methods of Classifying Soil by Means of Unification [7].

c. Calculating the Depth of Catchment Wells
The depth of catchment wells is calculated using the Sunjoto Method (1988)[8]. This method is used because the value obtained has the best reliability to apply on a household scale.

In the planning of PAH ponds and catchment wells must be considered the construction materials[9], [10]. The materials used should take into account the placement of the PAH pool and the area of available land [11], [12]. In designing a PAH pool should pay attention to the materials used to get good water quality [13], [14]. In the planning design pay attention to SNI 8456:2017 [15].

3. Result and Discussion
The mainstay of rainfall occurred in 2015 amounted to 759.8 mm/year. Based on the analysis of the probability distribution of rain data for 25 years, the value of the planned rain ($R_{24}$) obtained is the result of the Gumbel Probability Distribution, which is 99.696mm.

Based on the tests that have been carried out in the laboratory, the recapitulation of soil types in KayuBesi Village can be seen in Table 1.
Table 1. Recapitulation of soil types in KayuBesi Village

| Soil sample (a) | Cu (b)   | Note. (c) | Cc (d) | Note. (e) | Group symbol (f) | Name of soil type (g)                                      |
|-----------------|----------|-----------|--------|-----------|-----------------|----------------------------------------------------------|
| 1               | 4.795    | Does not meet the | 0.379  | Does not meet the | SP               | Poorly graded sand, gravel sand, little or no fine grain |
| 2               | 9.232    | Fulfill   | 1.977  | Fulfill   | SW              | Fine graded sand, gravel sand, little or no fine grain   |
| 3               | 4.366    | Does not meet the | 1.060  | Fulfill   | SP              | Poorly graded sand, gravel sand, little or no fine grain |
| 4               | 6.108    | Fulfill   | 0.286  | Does not meet the | SP              | Poorly graded sand, gravel sand, little or no fine grain |
| 5               | 1.469    | Does not meet the | 0.960  | Does not meet the | SP              | Poorly graded sand, gravel sand, little or no fine grain |

The results of the sand category according to SNI 03-6371-2000 in this plan are shown in Table 2.

Table 2. Classification of soil in KayuBesi Village according to SNI 03-6371-2000

| Sand Category (a) | Soil-1 (b) | Soil-2 (c) | Soil-3 (d) | Soil-4 (e) | Soil-5 (f) |
|-------------------|------------|------------|------------|------------|------------|
| Rough sand        | 100        | 100        | 100        | 100        | 100        |
| % Passed filter No. 4 | 100        | 11.600     | 15.040     | 8.020      | 5.880      |
| Retained weight (grams) | 90.250    | 210.950    | 250.200    | 134.250    | 39.350     |
| Medium sand       | 81.950     | 57.810     | 49.960     | 73.150     | 92.130     |
| % Passed filter No. 10 | 81.950     | 9.220      | 6.490      | 9.470      | 10.220     |
| Retained weight (grams) | 186.100   | 219.400    | 206.500    | 140.100    | 97.050     |
| Fine sand         | 44.730     | 13.930     | 8.660      | 45.130     | 72.720     |
| % Passed filter No. 40 | 44.730     | 2.200      | 1.770      | 3.070      | 2.660      |
| Retained weight (grams) | 221.150   | 67.500     | 40.200     | 221.800    | 361.050    |

From the table above, it can be explained as follows.

a. Soil samples 1, 4, and 5 were classified as fine sand, with a coefficient of soil permeability (K) between 0.01 - 0.001 cm/second.

b. Soil samples 2 and 3 were classified as sand with a soil permeability coefficient (K) between 1.00 - 0.001 cm/second.

Then calculate the volume of the integrated PAH pond infiltration wells. The village office has the building area is 154 m², the roof area is 208 m², and the number of employees as many as 18 people. KayuBesi village mosque has a building area of 351.1 m², with a roof area of 407 m². The recapitulation of the dimensions of the integrated PAH pond infiltration wells can be seen in Table 3.
Table 3. Recapitulation of the dimensions of the integrated PAH pond infiltration wells

| Building type   | Roof area (m²) | Total water requirement (m³/week) | Runoff Discharge (m³/hour) | Rainwater supply (m³/week) | PAH pool dimensions (m) | Infiltration well dimensions (m) |
|----------------|---------------|----------------------------------|---------------------------|----------------------------|-------------------------|----------------------------------|
|                 | (a)           | (b)                              | (c)                       | (d)                       | (e)                     | (f) (g) (h) (i) (j)              |
| village office  | 208           | 2.7                              | 4,303                     | 25.814                    | 4.5                     | 4 1.5 1 2.5                        |
| Mosque          | 407           | 122.885                          | 8,419                     | 50.511                    | 6                       | 5.5 1.6 1 4.5                      |

From the results of the calculation of raw water needs and the volume of rainwater that can be accommodated, it can be described as follows:

a. Rainwater that can be accommodated from the roof of the KayuBesi Village Office is 26 m³/week. This value is greater than the need for raw water at the KayuBesi Village Office. From this comparison, the collected rainwater can completely replace groundwater.

b. Rainwater that can be accommodated from the roof of the KayuBesi Village Mosque is 51 m³/week. This value is smaller than the raw water requirement at the KayuBesi Village Mosque. From this comparison, the collected rainwater can help reduce the use of groundwater, so that the use of groundwater used every week becomes 67.885 m³/week.

The design and placement of an integrated PAH pond infiltration wells at the KayuBesi Village Office can be seen in Figure 1 and Figure 2, while the KayuBesi Mosque can be seen in Figure 3 and Figure 4.

Figure 1. Plan of integrated PAH pond infiltration well at KayuBesi Village Office
Figure 2. Pieces of A-A KayuBesi Village Office

Figure 3. Plan of integrated PAH pond infiltration well at KayuBesi Village Mosque
4. Conclusion

Based on the results of the Planning of Integrated Rainwater Collection Ponds (PAH) in Infiltration Wells at Public Facilities in KayuBesi Village, the following conclusions were obtained.

a. For the Kayu Besi Village Office, the dimensions of the PAH pond are 5 m long, 4 m wide, and 1.5 m high, and the infiltration well diameter is 1 m with a depth of 2.5 m.

b. For Mosque In KayuBesi Village, the dimensions of the PAH pond are 6 m long, 5.5 m wide, 1.6 m high, and the infiltration well diameter is 1 m with a depth of 4.5 m.

This integrated PAH pool catchment well is effectively and efficiently applied in people's lives. With existing water sources in the form of rainwater that is always available, and excess water can be accommodated and evaporated into catchment wells to fill and improve the quality of groundwater. In determining the volume of integrated PAH ponds catchment wells can be determined by a simple method and reliable results if applied in the community.

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