Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN : 2550-0023

Vol 19, No 1, 2022, 137-147
Article available at [homepage presipitasi]

Regional Case Study

Application of Water Conservation Concept in X Apartment Bogor Regency

Eka Wardhani[1]*, Windya Sefniza Putri[1]

[1]Department of Environmental Engineering, Faculty of Civil Engineering and Planning, National Institute of Technology, Bandung, PHH Mustafa Strret No. 23, Bandung, Indonesia 40124
*Corresponding author, e-mail: ekawardhani08@gmail.com

Abstract

The increase of population in Bogor Regency is directly proportional to the rapid development of residential building construction, one of which is apartment buildings. This resulted in the need for clean water also increased. Water conservation is an effort to maintain the availability of clean water in sufficient quality and quantity to serve the current and future needs of clean water. The application of the concept of water conservation in Apartment X in Bogor Regency can be done using WAC 2 (Water Fixtures) and WAC 3 (Water Recycle). Apartment X building has a building population of 998 people with daily clean water needs of 91,545 liter/day. The wastewater generated by the apartment building is 73,236 liter/day. It is estimated that the implementation of water conservation could save the use of clean water by 28.08% or around 25,701.42 liter/day.

Keywords: Apartment; water conservation; water recycle

1. Introduction

The development of various fields in Indonesia has increased rapidly. One area that is experiencing rapid growth is the construction of residential buildings. One of the factors that influence the development of an area is the population in that area. According to data owned by the Bogor Regency Central Statistics Agency (2020), Bogor Regency in 2019 recorded having a population of 4,699,282 people. The development carried out in Bogor Regency includes various types of buildings, including hotel and apartment buildings. Apartment X Building is a residential building consisting of 21 floors and located in Pabuaran Village, Cibinong District, Bogor Regency. The increase in the number of hotel and apartment buildings has increased the population accompanied by an increase in the need for clean water. The circumstances nowadays is that Bogor Regency is experiencing lack of ground water availability, that it is almost impossible to only depend on one source of water. One way that could be done to overcome the increasing water demand is by applying the concept of water conservation. Therefore this research is done to design a system where the new building is able to maintain water availability and quality efficiently.

Water conservation (WAC) is an effort made to maintain the continuity of water availability in terms of quantity and quality both now and in the future. According to the Green Building Consultant (2021), the WAC concept that can be applied consists of 2 prerequisite WAC categories and 6 WAC categories. The prerequisite WAC categories in question are WAC P1 (Water Metering) and WAC P2 (Water

Calculation/Calculation of Water Use) where these two prerequisite WAC categories must be applied before implementing other WAC categories. The six WAC categories in question are WAC 1 (Water Reduction), WAC 2 (Water Fixtures/Water Features), WAC 3 (Water Recycling), WAC 4 (Alternative Water Resources), WAC 5 (Rainwater Harvesting), and WAC 6 (Water Efficiency Landscaping) (Green Building Consultant, 2021). In addition to the WAC P1 and WAC P2 concepts that must be applied at the beginning of building construction, the water conservation concept that wants to be applied to increase the percentage of water savings in Apartment X is the WAC 2 and WAC 3 concepts. The use of the WAC 2 concept which is the use of water features can save the use of clean water is due to the high efficiency of the plumbing equipment used, while the application of WAC 3, namely water recycling, can save the use of clean water by utilizing treated wastewater, this water becomes an alternative water source so that for flushing purposes it is not necessary to use a clean water source from the LOCAL WATER COMPANY.

Several studies have been carried out on the application of water conservation aspects in several places with the same type of building, such as the application of WAC 2 and WAC 3 at the Menara Cibinong Tower E Apartments which can save water use up to 33% or 305.88 m^3/day (Wahyudi et al., 2019), the application of rainwater harvesting at the Cibinong Tower which can save 3.48% of clean water (Anantika et al., 2019), water savings in the Panghegar Resort Dago Golf-Hotel& Spa Building which can save 34% of usage water or the equivalent of 141,690 liter/day (Rinka et al., 2014), as well as the application of rainwater utilization and water recycling in Apartment X which can save 54.22% of water use or 51,089.72 liter/day in the dry season and 31.75% or 29,748.46 liter/day (David et al., 2019).

The result of this study is expected to show the amount of water use that can be saved after implementing water conservation in the form of installing water-saving plumbing equipment and reusing gray water that has been treated at the sewage treatment plant.

2. Methodology

This research method consists of several stages, namely calculating the need for clean water, wastewater generation, water-saving efficiency with the application of WAC 2, and water-saving efficiency with the application of WAC 3. The calculation of water needs begins with calculating the building population. The calculation of the building population is done by dividing the effective area of the room by the standard area of the individual room (Neufert, 2002). Clean water needs are calculated by multiplying the building population with the standard for clean water requirements (SNI 03-7065-2005). The value of clean water requirements obtained is used to obtain the amount of wastewater generated. The wastewater produced is 80% of the clean water needs with a percentage of 75% gray water and 25% black water (Hardjosuprapto, 2000). The equations used in calculating the population, clean water needs, clean water generation, and gray water and black water types of wastewater can be seen in equations 1-5.

$$\text{Total Population} = \frac{\text{Broad Effective (m}^2\text{)}}{\text{Standard Population (m}^2\text{/person)}} \quad (1)$$

$$\text{Clean Water Needs} = \text{Total Population (person) x Clean Water Consumption Standard(l/p/day)} \quad (2)$$

$$Q_{wastewater} = 80\% \text{ x Clean Water Needs} \quad (3)$$

$$\text{Q Grey Water} = 75\% \text{ x } Q_{wastewater} \quad (4)$$

$$\text{Q Black Water} = 25\% \text{ x } Q_{wastewater} \quad (5)$$

There are two types of water conservation concepts that will be applied in this plan, which are WAC2 (Water Fixture) and WAC3 (Water Recycle) points. These two concepts were chosen because the availability of water from clean water sources in the planning area is threatened with a clean water crisis and requires buildings to implement water conservation efforts to save on clean water use from LOCAL

WATER COMPANY. The installation of water fixtures is one of the efforts to save the output of clean water sourced from the LOCAL WATER COMPANY while the water recycling implemented can reduce the use of clean water from the taps by using processed wastewater instead for flushing purposes. The water feature in question is a plumbing device that can save on clean water use such as a water closet flush valve or faucet with high efficiency. Water-saving plumbing equipment such as water closet tanks, urinals, lavatory, faucets, and showers used in this planning uses brand X plumbing equipment. It's because the X brand plumbing equipment uses water-saving technology compared to conventional plumbing equipment. The things that are considered in the use of brand X plumbing equipment are in terms of price and availability in the market. The comparison of the amount of water used in water-saving plumbing equipment and conventional plumbing equipment and water consumption standards can be seen in **Table 1.** and **Table 2.** The calculation of the amount of water that can be saved by using water-saving plumbing equipment can be done by equation 6.

The amount of water that can be saved = Conventional water usage – water-saving equipment usage (6)

Table 1. Comparison of water needs in conventional and water-saving plumbing equipment

No.	*Plumbing Tools*	X *Brand Water Usage* (L/*flush*)	
		Conventional*	**Water Saving**
1.	Water Closet Tank	6	4.5
2.	Urinal Flush Valve	4	0.47
3.	Lavatory	8	5
4.	Faucet	8	5
5.	Shower	9	6

*Source: *Green Building Council Indonesia,* 2013

Table 2. Water consumption standard

No.	Types of Use of Plumbing Tools	Occupancy (%)	Usage Factor	Unit
1.	Water Closet (Male)	50	0.30	Average usage per person per day
2.	Water Closet (Female)	50	2.30	Average usage per person per day
3.	Urinal Use	50	2.00	Average usage per person per day
4.	No Urinal	50	2.30	Average usage per person per day
5.	Hand washing duration	100	0.15	Minutes/usage
6.	Shower Usage Duration	5	5.0	Minutes/usage
7.	Tap Usage	100	2.50	Per Day

Source: Green Building Council Indonesia, 2013

Occupancy is the percentage of plumbing equipment usage while the usage factor indicates the number of plumbing equipment used. There are differences in the units for the use of water closets, urinals, showers, and water taps where for the use of water closets and urinals the average unit of use/person/day is used, and for the use of showers and faucets the units of use are minutes/usage. This is because the use of water closets and urinals is calculated from the number of temporary flushes for faucets and showers calculated from the length of time the water comes out during the use of the plumbing device. The gray water produced will be processed in the Sewage Treatment Plant (STP) for further reuse for flushing purposes in the water closet and urinal plumbing equipment. The reuse of treated water is included in the application of WAC point 3, namely, water recycling. According to GBCI (2013), sources of gray water that can be recycled are wastewater that comes from the use of the lavatory, ablution faucets, showers, as well as pool water, and other water. The function of recycled water is for flushing purposes. Before calculating the amount of recycled water produced, the flushing requirement is calculated by multiplying the water needs for plumbing equipment by the frequency of daily plumbing use. The amount of flushing requirement obtained can be used to calculate the amount of wastewater recycling by multiplying the flushing requirement by the number of uses and the number of populations. The equation used in the calculation of the amount of wastewater recycling is presented in equations 7-8.

Flushing Needs = Plumbing equipment water needs x Plumbing equipment daily usage (7)
Recycled Water = Flushing needs x Total Usage x Total Population (8)

The calculation results of the application of WAC2 and WAC3 points are used in calculating the amount of water conservation efforts that are applied. The results of this calculation can show the amount of water that can be saved by using the concepts of WAC2 and WAC3 as an effort to implement water conservation in the X Apartment building. The equation for calculating the amount of water conservation efforts can be seen in equations 9-10.

Water Conservation Efforts = Water-saving equipment usage + Recycled Water (9)

$$\text{Water-saving percentage} = \frac{\text{Water conservation efforts}}{\text{Clean water needs}} \times 100\% \quad (10)$$

3. Result and Discussion

Apartment X building is a residential building consisting of 20 floors plus 1 top floor, where the 1st floor is intended for shops, 2nd to 20th floors served as residential areas and there is a top floor that has a prayer room and hall that can be accessed by general guests (non-residents). X apartment is 65 meters high (Apartment X, 2021). The location of apartment X is presented in Figure 1. Apartment X building has a total number of 291 residential units and 14 shophouses. The building area of Apartment X is 647.80 m². The shophouse units in Apartment Building X consist of 3 types, namely type C22, C33, and C44, while the residential units consist of 8 types, namely types T22, T33, T44, T45, T55, T66, T77, and T88. The types of shophouses and residential units in the X Apartment building are distinguished according to the area of the unit. The floor designation in Apartment Building X in detail can be seen in Table 3.

Table 3. Room function

Floor	Room Function	Number of Units	Area (m²)
1st Floor (*Ground Floor*)	Shophouse Type C22	8	22.48
	Shophouse Type C33	5	32.63
	Shophouse Type C44	1	43.50
	Lobby	1	60.03
	Panel, transformer, and generator room	1	56.94
2nd – 18th Floor	Residential Unit Type T22	8	18.90
	Residential Unit Type T33	7	29.93
	Residential Unit Type T44	1	37.80
	Residential Unit Type T45	1	39.69
19nd – 20th Floor	Residential Unit Type T44	2	37.80
	Residential Unit Type T45	1	39.69
	Residential Unit Type T55	1	48.83
	Residential Unit Type T66	1	56.70
	Residential Unit Type T77	2	67.73

Floor	Room Function	Number of Units	Area (m^2)
	Residential Unit Type T88	1	75.60
	Panel Room	1	1.78
Top Floor	Auditorium	1	53.14
	Mosque	1	95.85
	Hall	1	41.99

Source: X Apartement, 2021

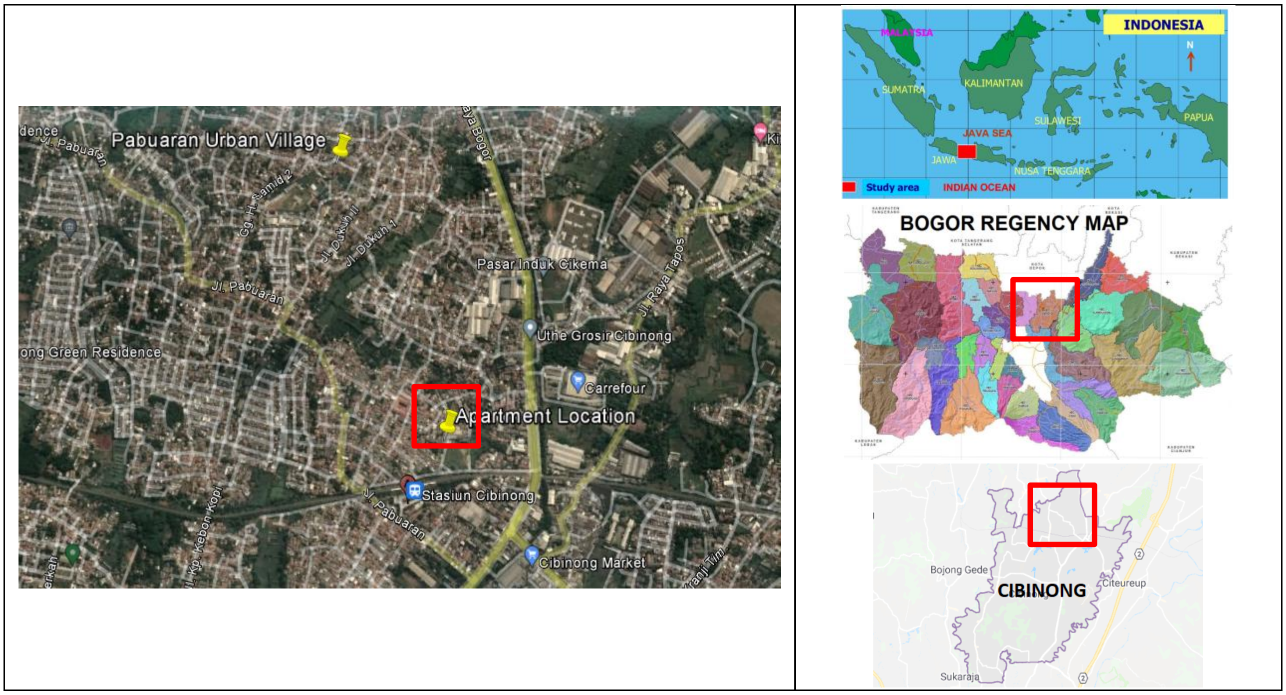

Figure 1. X apartement plan location at bogor regency

The estimated population in Apartment Building X is calculated using equation 1 and then the data is used to calculate the need for clean water. Referring to data sourced from the Central Bureau of Statistics of Bogor Regency (2020), the percentage comparison of the male and female populations is 50.4% for men and 49.6% for women. The percentage of male and female population comparisons becomes a reference in calculating the need for non-room plumbing equipment for public bathrooms located on the top floor. This percentage can be used to find each male and female population and then determine the number of plumbing equipment needed by comparing the population with the minimum plumbing equipment requirement standard listed in SNI 8153:2015. The calculation of the total population in the X Apartment Building is carried out using equation 2 with the calculation results of 998 people. The results of the calculation of non-room plumbing tools and the total population of the X Apartment building are presented in Table 4. and Table 5.

Table 4. Public plumbing tools unit

Floor	Total Population	Comparison(%)		Population		Closet		Lavatory		Urinal
		Male	Female	Male	Female	Male	Female	Male	Female	
Top Floor	91	50.4	49.6	46	45	1	3	1	1	1

Table 5. Total population of X apartment

Floor	**Total Population**
Shophouse at 1st Floor	90
Residential Unit at 2nd – 20th Floor	817
Top Floor	91
Total	998

The source of clean water used by Apartment Building X comes from the Regional Drinking Water Company (LOCAL WATER COMPANY) of Bogor Regency. The clean water drainage system planned is divided into two types of clean water, namely primary clean water and secondary clean water. Primary clean water is clean water sourced from Tirta Kahuripan and is used for plumbing equipment such as showers, faucets, lavatory, and jet sprays, while secondary clean water is water that comes from the processing of the Sewage Treatment Plant (STP) which will later be used for flushing needs on plumbing equipment such as water closet tanks and urinals. Calculation of the amount of daily clean water needs in Apartment Building X can help determine the estimated amount of clean water needed to meet the needs of clean water in Apartment Building X. Equation 2 is used to determine the amount of clean water needed in the building. The results of the calculation of the need for clean water in Apartment Building X can be seen in Table 6.

Table 6. Recapitulation of clean water needs per day

Floor	**Clean Water Needs (liter/day)**
Shophouse at 1st Floor	8.905
Residential Unit at 2nd – 20th Floor	81.605
Top Floor	1.035
Total of Clean Water Needs (liter/day)	91.545

Planning for clean water flow in Apartment Building X is equipped with 4 tanks consisting of 2 groundwater tanks (GWT) and 2 roof tanks (RT). GWT functions as a storage tank for clean water from water treatment plant. The clean water is not directly pumped to the RT because the supply of clean water from the water treatment plant is not always stable, so a storage tank is needed to maintain the availability of water to meet the needs of clean water in the building. RT is a water storage tank located at the top of the building which functions as a water storage tank for the peak water needs of the building. The capacity and dimensions of the RT are affected by fluctuations in water usage at certain hours in the building, while the GWT capacity is influenced by the daily water requirements of the building. The flow of water starts from the primary clean water source, namely Tirta Kahuripan, primary clean water is then stored in GWT1, which has a capacity of 109.85 m^3 with dimensions of 9 m (p) x 4.5 m (l) x 3 m (t), before pumped to RT1. The pump used in the flow of clean water from GWT1 to RT1 is an SP 17-10 type pump with a capacity of 305.17 L/min with an efficiency of 69% and a pump power of 4.92 kiloWatt. Primary clean water stored in RT1, with the capacity of 32.04 m^3 with dimensions of 6 m (p) x 3 m (l) x 2 m (t), is then channeled to plumbing equipment such as faucets, jet spray, kitchen sinks, lavatory, and showers. The use of plumbing equipment will eventually produce wastewater in the form of gray water and black water. These two types of wastewater require treatment first because gray water will be reused for flushing purposes and black water must meet the requirements of domestic wastewater quality standards before being channeled into water bodies. Domestic wastewater quality standards are regulated in the Minister of Environment and Forestry Regulation Number 68 of 2016 which can be seen in Table 7.

Table 7. Domestic wastewater quality standard

Parameter	Unit	Maximum Rate
pH	-	6-9
BOD	mg/L	30
COD	mg/L	100
TSS	mg/L	30
Oil and Fat	mg/L	5
Ammonia	mg/L	10
Total Coliform	Unit/100 mL	3.000
Flow Rate	L/person/day	100

Source: PeremenLHK No. 68, 2016

Domestic wastewater resulting from household activities contributes to surface water pollution by 78.9%. Domestic wastewater in question is non-toilet wastewater originating from the use of water for bathing, washing, and kitchen purposes (Busyairi et al., 2020). This non-toilet domestic wastewater, also known as gray water, will be channeled to the sewage treatment plant (STP) using a gravity system. Gray water wastewater that has been treated in the STP, the gray water type wastewater is turned into secondary clean water which will be used for flushing purposes. This secondary clean water is stored in the GWT2 tank, which has a capacity of 49.43 m^3 with dimensions of 6 m (w) x 3 m (l) x 3 m (h), then it will be pumped to RT2, which has a capacity of 14.42 m^3 with dimensions of 4 m (p).) x 2 m (l) x 2 m (t), before flowing into plumbing equipment that uses a flush such as water closet tanks and urinals. The pump used for secondary water flow from GWT2 to RT2 is an SP 9-13 type pump with a capacity of 137.3 L/minute with a pump efficiency of 69.8% and a pump power of 1.94 kiloWatt. This type of plumbing equipment closet tank and urinal will also produce waste in the form of black water type wastewater. This type of black water wastewater will flow into the septic tank. The septic tank used in the treatment of black water wastewater is a biofive septic tank with an anaerobic system with dimensions of 9 m (p) x 1.1 m (l) x 2.15 m (t). The septic tank which has two biofilter media, namely PVC Honeycomb and Bio ball, can convert fecal sludge into a liquid that can be flowed into waterways because this tank is also equipped with a disinfectant tube (Biofive, 2021). The schematic of water flow in Apartment Building X can be seen in Figure 2.

Wastewater generation resulting from activities using plumbing equipment can be estimated using equations 3-5. The recapitulation of the calculation of wastewater generation in Apartment Building X is presented in Table 8.

Table 8. Recapitulation of total wastewater produced

Wastewater Type	Total Production (liter/day)
Grey Water	54,927
Black Water	18,309
Total Wastewater Produced (liter/day)	73,236

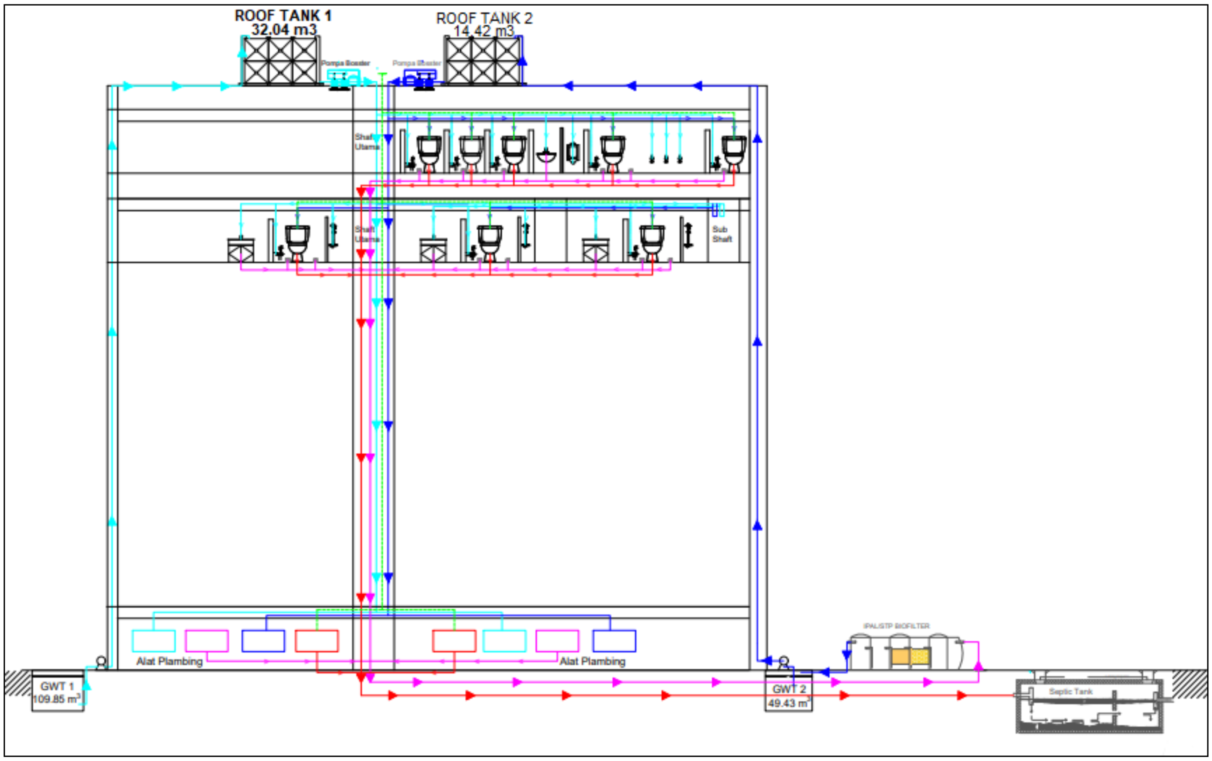

Figure 2. Water flow schematic

3.1. Application of Water Conservation 2 (Water Fixture)

The installation of water-saving plumbing equipment is an effort to implement WAC2 points to reduce water use. The installed water-saving plumbing equipment is expected to reduce water use compared to conventional plumbing equipment usage. The calculation of conventional plumbing equipment water usage and water-saving plumbing equipment presented in Table 9. Based on this table the percentage of water savings from urinals reaches 88% or 162.38 liter/day occupies the largest position compared to other plumbing equipment.

The results of the calculation of the application of WAC2 it is known that the use of water using conventional plumbing is 14,243.2 liter/day and by using X brand water-saving plumbing is 9,831.32 liter/day. Based on equation 6, it is found that the amount of water that can be saved by using a water-saving plumbing device is 4,411.88 liter/day. The percentage of water savings obtained is 30.98%.

Table 9. Water usage using conventional and water saving plumbing tools

Plumbing Tools	Population	Water Usage (liter/day)		Water Saving (liter/day)	Water Saving Percentage (%)
		Conventional	Water Saving		
WC Male (Public)	46	41.4	31.05	10.35	25
WC Female(Public)	45	310.5	238.05	72.45	23
WC (Personal)	907	6,258.3	4,693.73	1,564.6	25
Urinal	46	184	21.62	162.38	88
Lavatory	91	138	86.25	51.75	37
Faucet	907	2,721	1,700.63	1,020.4	37
Shower	816	4,590	3,060	1,530	33
Total		14,243.2	9,831.32	4,411.88	-

3.2. Application of Water Conservation 3 (Water Recycle)

Water conservation efforts in Apartment Building X, apart from implementing WAC2, are water recycling which is included in WAC3 points. The recycled water is gray water, which comes from the use of plumbing equipment such as lavatory, kitchen sinks, and waste water from the floor drain. The generation of gray water wastewater can be seen in Table 7. The application of water recycling can help water conservation efforts because the availability and stability of the supply of clean water can be maintained (Lahji, 2015).

STP is a system that can process domestic wastewater into class 2 clean water which can be used as water for flushing needs or directly discharged into receiving water bodies (Topare et al., 2019). The type of STP used is STP Biotechno which is made of fiberglass with a maximum efficiency of 90%. STP biotechno is suitable to be applied to apartments and is safe to use to treat gray water wastewater into clean water that is suitable for flushing needs or flowed directly into waterways (Biotechno, 2021). STP biotechno involves two systems, namely aerobic and anaerobic systems. These two systems when combined can be an effective combination to reduce organic levels such as BOD, COD, TSS, Ammonia, TDS, and Total Coliform in water with affordable operational costs (Busyairi et al., 2019). Processing that occurs in STP biotechno involves a rotating biological contactor (RBC). RBC is a biological water treatment that uses attached culture. At this stage, Bio-chemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) are set aside. Processing efficiency using this RBC reaches 80–85% (Rahmawati et al., 2019). The advantage of using RBC in waste treatment is that RBC does not require a large area and the oxygen supply is easily obtained naturally from the rotation of the disc (Rahmawati et al., 2019).

The amount of waste water recycling is influenced by the frequency of flushing and the need for flushing in a building. Flushing frequency shows how often the toilet and urinal are used in one day. The use of a water closet and urinal type of plumbing device is usually associated with urination and defecation. The frequency of urination varies from person to person but ranges from 6–8 times per person per day, while for defecation the frequency ranges from 1–3 times per person per day (Choerunnisa, 2020). The frequency of flushing can be distinguished according to the type of building population. The frequency of flushing for WC for building occupants is 5 times/day/person, and for building visitors/guests is 2 times/day/person for WC and the same amount for urinals (David et al., 2019). Occupants are people who live or have the status as owners of residential units and shop houses in apartment buildings, while the intended guests are people who do not live or own residential units and shop houses in apartment buildings but are shophouse visitors or have access to the rooms in the apartment building. apartments such as halls or mosques on the top floor. The calculation of the need for recycled water is carried out using equations 7 and 8, the detailed calculation results are presented in Table 10.

Table 10. Total of recycled wastewater

Population Type	Fixtures Type	Total Population	Flushing Frequency	Flushing Needs (L/flush)	Water Recycling Needs (Liter/day)
Resident	WC	907	5	22.5	20,385
Guest	WC	91	5	22.5	819
	Urinal		2	0.94	85.54
Total					21,290

3.3. Application of Water Conservation Efficiency

Water conservation efforts implemented in Apartment Building X consist of two types of WAC categories, namely the installation of water-saving plumbing equipment included in WAC 2 and water recycling which is included in WAC 3. Clean water is sourced from LOCAL WATER COMPANY Tirta

Kahuripan where the need for clean water in the X apartment building itself reaches 91.545 liter/day. The use of water-saving plumbing equipment and water recycling is expected to reduce the usage of clean water sourced from local water company. The balance of clean water and wastewater is presented in Figure 3.

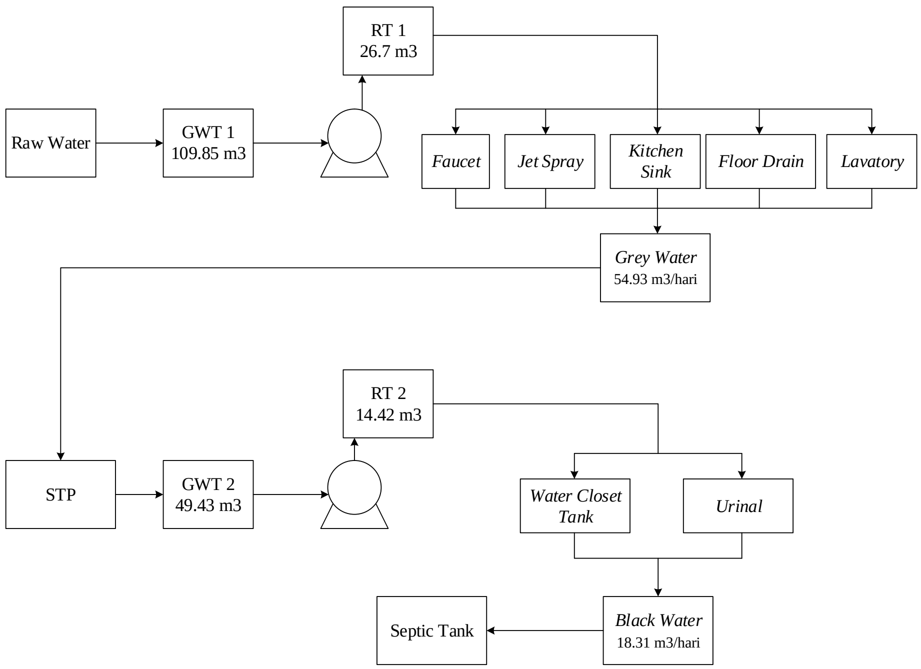

Figure 3. Clean water and wastewater balance

The application of the concept of WAC2 and WAC3 is estimated to be able to save 25,701.42 liter/day or 28.08% of the total clean water needs of the Apartment X building of 91,545 liter/day. The application of WAC 2 saves the use of clean water by 4,411.88 liter/day while the application of WAC 3 is estimated to save clean water by 21,290 liter/day. The amount of water conservation efforts can be calculated using equations 9 and 10. The results of the calculation of the amount of water conservation efforts can be seen in Table 11.

Table 11. Recapitulation of water conservation efforts

Clean Water Needs (liter/day)	Water Saving by WAC2 Application (liter/day)	Recycled Water by WAC3 Application (liter/day)	Water Conservation Effort (liter/day)	Water Saving Percentage (%)
91,545	4,411.88	21,290.00	25,701.42	28.08

This 28.08% saving in water usage compared to research conducted on other similar buildings can be said to be quite low. For example, the research conducted in the Cibinong Tower E apartment building with the application of the same WAC points, namely WAC 2 and 3, which can save water usage by up to 33%. This can be influenced by differences in the number of needs and daily use in the building. Increased water use savings can be achieved in other ways, namely implementing other WAC points such as adding rainwater harvesting or water efficiency landscaping.

4. Conclusion

Apartment X building has a building population of 998 people with daily clean water needs of 91,545 liter/day. The wastewater generated by the apartment building is 73,236 liter/day, with details of black water being 18,309 liter/day and 54,927 liter/day for gray water. The implementation of water conservation efforts in Apartment X is estimated to be able to save 28.08% of clean water use or 25,701.42 liter/day.

References

Anantika, T., Wardhani, E., & Halomoan, N. 2019. Application of green building concept (Rainwater harvesting) at Menara Cibinong Apartment. Journal of Architectural Research and Education Volume 1 (2)

Biofive. 2021. Spesifikasi septic tank https://www.biofive.co.id

Biotechno. 2021. Spesifikasi STP. https://www.biotechno.co.id

Busyairi, M., Adriyanti, N., Kahar, A., Nurcahya, D., Sariyadi., Hudayana, T.D. 2020. Efektivitas pengolahan air limbah domestik grey water dengan proses biofilter anaerob dan biofilter aerob (Studi kasus: IPAL INBIS Permata Bunda, Bontang). Serambi Engineering Volume V (4), 1306-1312.

Badan Pusat Statistik Kabupaten Bogor. 2020. Kabupaten Bogor dalam angka 2020. Bogor: BPS Kab. Bogor

Choerunnisa, D., K., Pharmawati, K., & Nurprabowo, A. 2020. Perencanaan konsep konservasi air gedung universitas swasta di wilayah utara Kota Bandung. Jurnal Sumberdaya Alam dan Lingkungan Volume 7 (3), 124-134.

David, V. V., Pharmawati, K., & Usman, D. K. 2019. Implementasi konsep konservasi air di gedung apartemen X. Serambi Engineering Volume IV, 694-702.

Green Building Consultant. 2021. Water conservation. https://bangunanhijau.com/gb/new-building2-0-green-building/wac-nb/

Green Building Council Indonesia. 2013. Greenship rating tools: greenship for the new building version 1.1 summary of criteria and benchmarks. Jakarta.

Hardjosuprapto, M., M. 2000. Penyaluran air buangan. Bandung: Institut Teknologi Bandung.

Lahji, K., & Kusumawati, L. 2015. Konservasi dan efisiensi pada tahap perancangan bangunan gedung studi kasus gedung nobel. Trijurnal, 93-105.

Neufert, Ernst. 2002. Data arsitek, jilid 2, (diterjemahkan oleh : Dr. Ing Sunarto Tjahyadi; Dr. Ferryanto Chaidir). Jakarta: Erlangga. 2015.

Peraturan Menteri Lingkungan Hidup dan Kehutanan Nomor 68 Tahun 2016 tentang Baku mutu ir imbah domestik.

Rahmawati, G.A., Wardhani, E., & Sulistiowati, L.A. 2019. Perencanaan instalasi pengolahan air limbah mal X Kota Bandung. Serambi Engineering, Volume IV (2), 522-531.

Rinka, D.A., Sururi, M., R., & Wardhani, E. 2014. Perencanaan sistem plambing air limbah dengan penerapan konsep green building pada gedung panghegar resort Dago Golf-Hotel&Spa. Jurnal Reka Lingkungan, Volume 2, (2).

SNI 03-7065-2005. (2005). Tata perencanaan sistem plambing. Jakarta: BSN.

SNI 8153:2015 (2015). Sistem plambing pada bangunan gedung. Jakarta: BSN.

Topare, N., J., Attar, S., & Manfe, M. 2019. Sewage/wastewater treatment technologies : a review

Wahyudi, & Wardhani, E. 2019. The use of plumbing tools saving water with efforts to save clean water with application of green building concept at menara cibinong apartment. Journal of Architectural Research and Education Volume 1 (2).