

Calculating the Volume of Tanks for the Sanitation System

To determine the volume of the tanks needed to handle the greywater and blackwater independently, it is necessary to estimate the volume that will be entering. Estimated usage per person per day for greywater is seen below.

Water Use	Volume (L)	Description
Bathing	20	
Hand Washing	6	~1.5 L per wash about 4 times a day

Greywater Usage Breakdown

Based on these estimated usages for 10 people using the facility, the volumetric flow rate for greywater is seen in below.

Volumetric flow rates (Q)	Greywater	Total (L/d)	Total (L/h)
Per person	26	26	1.08
Total into system	260	260	10.83

Greywater Volumetric Flow Rates

Similarly, the estimated usage per person per day for blackwater is seen below.

Type	Volume (L)
Urine (per person per day)	1.1
Feces (per person per day)	0.2
Water (per flush)	4.28

Blackwater Usage Breakdown

Because the facility will only be opened during the day, calculations are based on an estimation of 2 flushes per person per day. The following volumetric flow rates for blackwater below is for an estimation of 10 people using the facility.

Volumetric flow rates (Q)	Blackwater	Total (L/d)	Total (L/h)
Per person	9.86	9.86	0.41
Total into system	98.60	98.60	4.11

Blackwater Volumetric Flow Rates

According to several studies, the hydraulic retention time (HRT) of ten hours is accurate and can be used to calculate the volume of the two tanks needed.

$$V = Q * \text{HRT}$$

$$V = 10.83 \text{ [L/hr]} * 10 \text{ [hr]}$$

$$V = 108.3 \text{ [L]}$$

$$V = \mathbf{0.108 \text{ [m}^3\text{]}}$$

In order to account for any changes in population or an increase in usage, a safety factor will be used. The original volume calculations are the minimum volume needed to handle the specified flow rates. For these purposes, a minimum of a 45 % safety factor will be used. The volume of the tank will be calculated:

$$0.108 \text{ m}^3 + 0.108(0.45) \text{ m}^3 = 0.16 \text{ m}^3$$

$$V = \mathbf{0.16 \text{ m}^3}$$

Due to the nature of the facility, the number of people using the facility will begin to increase as development is made. It is uncertain as to the approximate number of people who will be using the facility on a daily basis, and therefore, it is necessary to calculate the volume for varying number of uses. The volumes presented for greywater and for blackwater will help when determining what size tanks to purchase.

Number of Uses	V(m ³)	V (m ³) with safety
20	0.11	0.16
40	0.22	0.31
100	0.54	0.79

Volumes for a Greywater Tank for a Varying Number of Uses

Number of Uses	V(m ³)	V (m ³) with safety
20	0.04	0.06
40	0.08	0.12
100	0.21	0.30

Volumes for a Blackwater Tank for a Varying Number of Uses

Design Parameters

The following parameters significantly exceed the VPUU's expected initial use for the facility, but are designed to be conservative, allow for increased use in the future, and work with septic tanks of fairly standard size and design. Splitting greywater and blackwater reduces the expected demand on each system, and greywater demand for the "shower and sink only" facility should be less than what system designers typically assume for middle-income residential users.

Design Parameters	
People/day (max)	50
Uses/person/day	2
Total uses/day	100
Facility hours/day	12
HRT (hydraulic retention time (hours))	10
Sludge retention time (days)	20

Activity	--- Waste Generation ---			--- Tanks---	
	Waste/ use (L)	Facility/ day (L)	Facility/ hour (L)	Tank volume needed (L)	Installed Tanks for System (L)
Greywater					
Showers	80	800			
Hand Washing	4	400			
Greywater Total		1,200	100	1,000	2,200
Blackwater					
Urine (@1.1 L/person/day)	0.55	55			
Feces (@0.2 L/person/day)	0.1	10			
Flush Water	6	600			
Blackwater Total	6.7	665	55	554	3,600
Total Grey and Blackwater	6.7	1,865	155	1,554	3,600

References

1. Nguyen, Huong, Turgeon, Scott, and Matte, Joshua. (2010). "The Anaerobic Baffled Reactor: A study of the wastewater treatment process using the anaerobic baffled reactor."