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Client: Dalhousie University
Office of Sustainability

DALHOUSIE UNIVERSITY
Office of Sustainability

Department of Civil & Resource Engineering

Design of a Rainwater Harvesting & Treatment System for Non-Potable Use

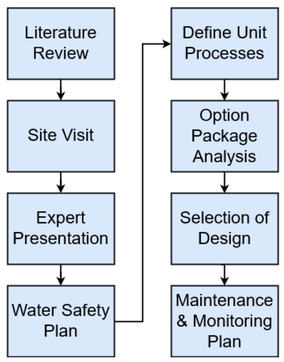
Abstract

Dalhousie University has three rainwater harvesting and treatment systems on their campuses which are used to supply non-potable water for toilet flushing. The objective of this project is to improve upon these systems by increasing reliability and reducing maintenance frequency while limiting capital costs.

Project Scope

- Design a rainwater harvesting and treatment system.
- Meet Canadian non-potable water standards.
- Consider capital and operating costs.
- Create monitoring and maintenance plan.
- Develop recommendations based on improved design.

Design Process



Treatment Guidelines (CSA 2018)

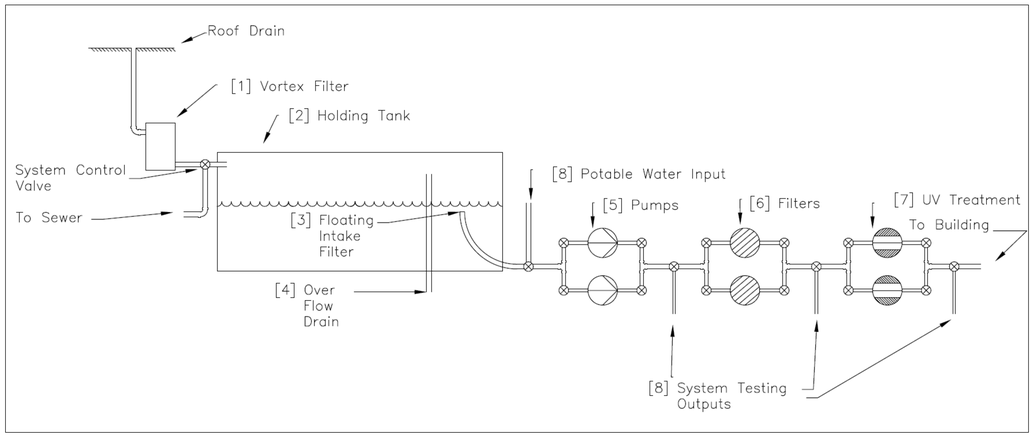
Likelihood of Exposure				
End uses	**Ingestion**	**Inhalation**	**Skin contact**	**Overall**
Toilet and urinal flushing	Rare	Possible	Possible	Possible

Performance Criteria		
Log Reduction (% Reduction)		
Viruses	Bacteria	Protozoa
0	2 (99%)	2 (99%)

Treatment Requirements		
Potential for human contact	**Minimum prescriptive requirements**	
	UV Filtration	UV disinfection
Medium	5 µm	16 mJ/cm^2

Output Water Quality Requirement			
End use tier	**Parameter**	**Turbidity** (NTU)	**HPC** (100 CFU/mL)
2	Median	≤2	<500
	Maximum	5	-

Design of System



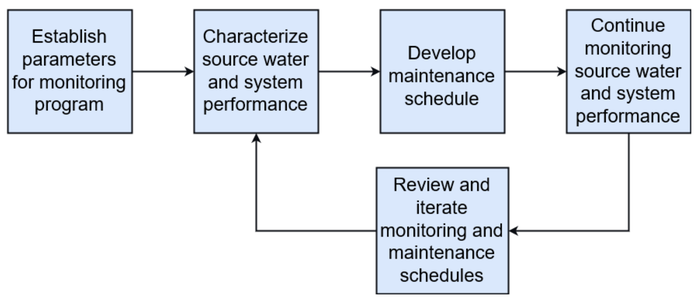
Schematic of design, not to scale.

Collected Data

Rain Cistern Raw Data for Mona Campbell Building Cistern					
Pre-filtration	**Season**	**Turbidity** (NTU)	**TOC** (mg/L)	**DOC** (mg/L)	**Transmittance** (%)
	Summer	0.66	2.31	2.11	92.2
	Winter	1.05	0.26	0.28	98.3
Post Filtration	**Season**	**Turbidity** (NTU)	**TOC** (mg/L)	**DOC** (mg/L)	**Transmittance** (%)
	Summer	0.27	2.17	2.18	93.2
	Winter	0.71	0.24	0.21	99

Recommendations

- Monitoring and Maintenance Plan Process



- Water storage should be considered early in building design process.
- Treatment processes should have redundancy and the ability to be isolated.
- Pumps and filters should be oversized to reduce maintenance.
- Potable water hookup should bypass filtration and UV processes.
- System operators should be educated in precautionary and responsive maintenance.

Details of Design

[1] Vortex Filter

- **Description** – Preliminary filtration system.
- **Specifications** – 380 µm stainless steel filter, maximum 33000 ft^2 catchment area.
- **Cost** – $742

[2] Cistern

- **Description** – Constructed within the building footprint.
- **Specifications** – 40000 L capacity.
- **Cost** - $9000

[3] Floating filter

- **Description** – Intake system providing higher quality effluent from the cistern.
- **Specifications** – 300 µm stainless steel filter.
- **Cost** - $685

[4] Overflow Valve

- **Description –** Drains to sewer if cistern reaches maximum capacity.
- **Specifications –** 4” outlet.
- **Cost -** $309.75

[5] Pump System

- **Description** – Parallel pumps used to boost rainwater or potable water through the system.
- **Specifications** – Max. Inlet 72 PSI, Max. Head 180 ft.
- **Cost** - $2200/each, $4400 total

[6] Cartridge Filter

- **Description** – Parallel pleated cellulose polyester filters that remove fine sediment.
- **Specifications** – 50 µm & 5 µm filters, Diameter 4.5”, Height 20”.
- **Cost** - $40.48/each, $196.38 total

[7] UV Disinfection

- **Description** – Parallel system uses ultraviolet light to inactivate pathogens within the rainwater.
- **Specifications** – Up to 46GPM, 9000 hr usage time, 254 nm UV intensity.
- **Cost** - $1125/each, $2300 total

Acknowledgements

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