Appendix J: Rainwater Harvesting Treatment and Management Requirements

This Appendix is provided as an example of requirements necessary for approval of use of reclaimed rainwater in non-potable water systems. It is not intended to regulate water retained by another BMP for use in irrigation and to meet stormwater retention volume requirements.

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J.1 Rainwater Harvesting Treatment and Management Requirements

J.1.1 Introduction

The majority of the information and requirements provided herein are excerpted from the 2017 Water Environment and Reuse Foundation Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems (DNWS Report), and much of the text is directly quoted. In some cases, text from this report has been modified to conform to the Stormwater Design Manual and Town of Bluffton review and inspection procedures.

The purpose of this appendix is to provide information and guidance through a risk-based framework to help designers and Town of Bluffton ensure that all rainwater harvesting systems are adequately protective of public health. This appendix identifies pathogen reduction targets that must be met and various treatment systems that can be used to meet the targets, as well as volatile organic compound (VOC) limits that must be achieved storage and distribution management considerations, operation and maintenance as well as long-term monitoring and reporting requirements are also discussed.

J.1.2 Pathogen Reduction Targets

Risk-based pathogen reduction targets have been developed based on analysis of potential human health risks associated with exposure to microbial hazards, and are based on a "10^{-4} Per Person per Year Benchmark." This means that the agreed-upon "tolerable" risk level is a probability of infection of 1 in 10,000 people per year. Pathogen reduction targets are expressed in terms of the 95th percentile Log_{10} Reduction Target (LRT). LRTs were developed for each source water and end use addressed in this appendix based on attaining the "tolerable" infection risk. If a system can maintain this level of treatment performance at all times, then the predicted probability of infection across the population will be less than the 1 in 10,000 benchmark for each pathogen 95% of the time.

The LRT for each non-potable use scenario is presented in Table 1 for healthy adults (values are based on the DNWS Report, although additional uses have been added). A rainwater harvesting system must maintain this level of treatment performance at all times for all three pathogen types: viruses, protozoa, and bacteria. When both general runoff and roof runoff (as defined below in Table 1) are combined, the reduction targets for general runoff shall apply. Similarly, when multiple uses are proposed, the highest reduction targets shall apply.

Table 1. Ninety-fifth percentile log10 pathogen reduction targets (LRT) to meet infection ppy benchmarks for healthy adults.

Water Source and Use	Log_{10} Reduction Targets for 10^{-4} Per Person Per Year Benchmarks		
	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
General Runoff[a]			
Cooling Towers[b]	–	–	–
Irrigation	5.0	4.5	4.0
Indoor Use	5.5	5.5	5.0
Roof Runoff[c]			
Cooling Towers[b]	–	–	–
Irrigation	N/A	Limited data available	3.5
Indoor Use	N/A	Limited data available	3.5

a. For the purposes of this appendix, general runoff means precipitation runoff from rain or snowmelt events that flows over land and/or impervious surfaces (e.g., streets, sidewalks, and parking lots). It also includes runoff from roofs or parking garages with frequent public access.

b. The pathogen risks associated with cooling towers and other uses in which there is no public exposure can be controlled by post-treatment management practices rather than initial treatment. The reason is that greater microbial risks from this use is likely to result from not controlling the growth of water-based pathogens (e.g., Legionella pneumophila, Pseudomonas aeruginosa, and non-tuberculous mycobacteria) that may proliferate in stagnant piped water. Management practices are discussed in Section J.1.7 Storage and Distribution Management Practices.

c. Roof runoff means precipitation from a rain event that is collected directly from a roof surface not subject to frequent public access.

The non-potable uses and LRTs included in Table 1 assume that human contact with the harvested water will be infrequent, and ingestion unintentional. Uses where frequent human contact with the harvested water is intended, like fountains or splash pads, will be considered similar to swimming pools, and must meet the standards defined by the Town of Bluffton. The remaining sections in this appendix only cover non-potable uses with infrequent human contact. Treatment and monitoring procedures for frequent contact uses will be reviewed on a case-by-case basis.

Treatment Process

A well-established and accepted concept in modern drinking water and water reuse practices is to attribute the log10 reduction of pathogen groups to specific technologies that are operated within defined limits, coupled with appropriate control points to demonstrate the proper performance of the technology. This is referred to as the log10 reduction value (LRV) and can be compared directly to the LRTs described in Section J.1.2 above. Various treatment processes and treatment trains can be used to obtain the LRT for each pathogen for a given combination of source water and end use. Sections J.1.5 and J.1.6 discuss a range of treatment processes and provide LRVs for each process.

J.1.3 Filtration

The removal of particulate matter, including pathogens, by size exclusion is of interest because filters can serve as a barrier to pathogens in water. Filtration is especially important because pathogens can be shielded by or embedded in particulate matter, reducing the effectiveness of subsequent disinfection processes. Typical values for pathogen group log10 reduction by filtration processes are summarized in Table 2.

Table 2. Typical values for pathogen reduction using filtration processes.

Barrier	Typical Log_{10} Reduction Values		
	Virus	Protozoa	Bacteria
Slow sand filter	2	4	2
Dual media filter with coagulant	1	2	1
Cartridge/bag filter (5-10 microns)	0	0	0
Cartridge/bag filter (3 microns or less)	0	3	0
Cartridge/bag filter (1 micron)	0	4	0
Diatomaceous earth	1	4	2
Microfilter	1	6	6
Ultrafilter or Nanofilter	6	6	6
Reverse osmosis	6	6	6

J.1.4 Disinfection

Processes for pathogen inactivation include disinfection by chlorine, peracetic acid, ozone, ultraviolet (UV) radiation, advanced oxidation, and pasteurization. Particles in water can inhibit effective disinfection through shading (in the case of UV) and shielding embedded pathogens. Larger particles may require more time for a disinfecting agent to penetrate the particle and reach an embedded pathogen; therefore, for any disinfectant to be effective, particles larger than 10 microns must be removed.

Typical values for the inactivation of pathogens for disinfection processes in filtered water are given in Table *3*, Table 4, and

Table 5. These values serve as a guide to the relative effectiveness of different disinfection technologies and are not for a specific microorganism.

Table 3. Typical values for various levels of the inactivation of enteric virus in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit[b]	Dose for Corresponding Log_{10} Reduction Value			
		1 Log_{10}	2 Log_{10}	3 Log_{10}	4 Log_{10}
Free chlorine	mg•min/L	–	1.5–1.8	2.2–2.6	3.0–3.5
Chloramine[a]	mg•min/L	–	370–400	550–600	750–800
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	–	0.25–0.30	0.35–0.45	0.50–0.60
Ultraviolet radiation	mJ/cm^2	50–60	90–110	140–150	180–200
Advanced oxidation	mJ/cm^2	10–20	50–60	70–80	110–130
Pasteurization (60°C)	Second	140	280	420	560
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter					
c. mJ/cm2 = Millijoules per square centimeter.					

Table 4. Typical values for various levels of the inactivation of parasitic protozoa in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit[b]	Dose for Corresponding Log_{10} Reduction Value			
		1 Log_{10}	2 Log_{10}	3 Log_{10}	4 Log_{10}
Free chlorine	mg•min/L	2,000–2,600	NA	NA	NA
Chloramine[a]	mg•min/L	NA	NA	NA	NA
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	4.0–4.5	8.0–8.5	12–13	NA
Ultraviolet radiation	mJ/cm^2	2–3	5–6	11–12	20–25
Advanced oxidation	mJ/cm^2	2–3	5–6	10–12	20–25
Pasteurization (60°C)	Second	30	60	90	120
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm2 = Millijoules per square centimeter.					

Table 5. Typical values for various levels of the inactivation of enteric bacteria in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit[b]	Dose for Corresponding Log_{10} Reduction Value			
		1 Log_{10}	2 Log_{10}	3 Log_{10}	4 Log_{10}
Free chlorine	mg•min/L	0.4–0.6	0.8–1.2	1.2–1.8	1.6–2.4
Chloramine[a]	mg•min/L	50–70	95–150	140–220	200–300
Peracetic acid	mg•min/L	10–25	40–60	75–125	150–200
Ozone	mg•min/L	0.005–0.01	0.01–0.02	0.02–0.03	0.03–0.04
Ultraviolet radiation	mJ/cm^2	10–15	20–30	30–45	40–60
Advanced oxidation	mJ/cm^2	4–6	6–8	8–10	10–12
Pasteurization (60°C)	Second	50	100	150	200
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm2 = Millijoules per square centimeter.					

J.1.5 Treatment Trains

Most non-potable water systems use a number of unit processes in series to accomplish treatment, known commonly as the “multiple barrier” approach. Multiple barriers are used to improve the reliability of a treatment approach through process redundancy, robustness, and resiliency. When multiple treatment barriers are used to achieve the pathogen LRT, the contribution from each barrier is cumulative; therefore, a reduction in performance by one process is mitigated by other processes in the treatment train.

In addition to these treatment barriers, operational and management barriers are used to ensure that systems are in place to respond to non-routine operation. Treatment barriers can be monitored using sensors and instrumentation for continuous process monitoring. An important ability is to take the treatment train offline automatically in the event of process malfunction.

If each barrier in a treatment train is independent, the LRVs for each process in the treatment train can be added together to obtain the overall treatment train LRV.

J.1.6 Volatile Organic Compounds

For rainwater harvesting systems that use general runoff from vehicular access areas as a source and will have some level of public exposure risk, the treated water must be tested for the presence of volatile organic compounds (VOCs); however, this does not apply when the water will be used for cooling towers or other “no public exposure” uses. The test must be performed by the system operator prior to commissioning of the system (see Commissioning) and prior to subsequent Town of Bluffton maintenance inspections (see Operational Monitoring and Reporting). VOC levels must be below the maximums indicated in Table 6. If any VOC levels exceed these limits, the rainwater harvesting system must not be utilized until the problem is satisfactorily addressed, and a successful test has been performed. VOC limit exceedances may be addressed through source controls or through provision of additional treatment devices.

Table 6. Volatile organic compound maximum concentrations.

VOC	Maximum Concentration (mg/L)[a]
Benzene	0.1
Carbon Tetrachloride	0.5
1,2-Dichlorobenzene	5.4
1,4-Dichlorobenzene	5.4
1,1 Dichloroethane	14.4
1,2 Dichloroethane	0.1
1,1-Dichloroethylene	0.1
cis-1,2-Dichloroethylene	28.4
trans-1,2-Dichloroethylene	28.4
Dichloromethane	3.1
1,2-Dichloropropane	12.6
1,3-Dichloropropene	0.2
Ethylbenzene	15.6
Methyl-tert-butyl ether	5.2
Monochlorobenzene	1.7
Styrene	7.7
1,1,2,2-Tetrachloroethane	0.3
Tetrachloroethylene	6.1
Toluene	6.8
1,2,4-Trichlorobenzene	1.4
1,1,1-Trichloroethane	68.2
1,1,2-Trichloroethane	1.6
Trichloroethylene	4.8
Trichlorofluoromethane	201.1
1,1,2-Trichloro-1,2,2-Trifluoroethane	272.9
Vinyl Chloride	0.1
Xylenes	15.6

a. Values determined by the San Francisco Department of Public Health based on U.S. Occupational Safety and Health Administration Permissible Exposure Limits for 8-hour inhalation exposures to selected VOCs.

J.1.7 Storage and Distribution Management Practices

To achieve the desired objectives of public health protection, treated water must be properly stored and distributed to prevent compromising the quality of water after treatment. For example, opportunistic pathogens like Legionella could grow in the distribution system, sewage could contaminate treated water, or lead and copper (which cause toxicity) could leach from piping. Producing adequate quality non-potable water that meets all the pathogen control criteria set forth in this appendix is the first step in ensuring proper public health protection. The final step in quality control is to manage properly 1) storage and distribution systems and 2) the uses of non-potable water.

In rainwater harvesting systems, neither significant/routine ingestion nor direct contact with the treated water product is typically anticipated due to limited exposures to non-potable water. Nevertheless, the occurrence of aerosol inhalation and indirect contact requires the careful management of DNW system storage and distribution systems to control exposures to non-tuberculous mycobacterial and Legionella pathogens. For example, even clean drinking water may allow biofilm growth of Legionella (aerosol pathogen risk) if the water temperature is between 25°C and 45°C and stagnates, resulting in the presence of minimal residual chlorine.

A number of approaches are available to control microbial regrowth in distribution systems, each with varying benefits and drawbacks that depend on the characteristics and use of the system. Below are some recommended approaches for controlling microbial growth in distribution systems:

- **Producing non-potable water low in carbonaceous material and nutrient content**
  The primary energy source for pathogen regrowth is organic carbon measured as assimilable organic carbon, biodegradable dissolved organic carbon, total organic carbon, and other essential nutrients, including nitrogen (N), phosphorous (P), and iron (Fe); therefore, the primary means to reduce the regrowth potential of pathogens is to provide highly treated water. Reducing the potential for regrowth is more important in large-scale buildings or neighborhood/district-scale projects where there will be more residence time (creating more opportunities for regrowth) in distribution systems that supply non-potable water.
- **Producing highly disinfected non-potable water**
  Low concentrations of microbes resulting from filtration and advanced means of disinfection have a reduced potential for regrowth if organic carbon levels are low. Otherwise, there may be a need for a residual disinfectant to manage growth in larger community systems that produce aerosols. Post-treatment disinfection with UV radiation is a recommended means of disinfection that does not increase levels of assimilable organic carbon or biodegradable dissolved organic carbon.
- **Using non-reactive, biologically stable materials of construction**
  Avoid the use of corrosive materials or organic materials that tend to protect microorganisms from disinfection and enhance the regrowth environment by the adsorption of organic compounds.
- **Maintaining a residual disinfectant**
  Different disinfectants offer advantages and disadvantages to overall water quality and system management. In general, a higher disinfectant residual provides lower regrowth. Many design and operation considerations are available for each specific system. It is recommended that a free chlorine residual of 0.2 milligrams per liter (mg/L) or monochloramine residual of 2 to 3 mg/L be maintained at or near the point of use to control microbial growth. Chloramine provides a better residual duration as compared to chlorine. Various combinations of UV,

chlorine, chloramine, ozone, and hydrogen peroxide are beneficial for specific disinfection goals. Periodic shock treatments with disinfectants and continuous disinfection looping of reservoirs help reduce the potential for regrowth and manage issues with biofilms. Stagnation resulting from dead zones or prolonged periods of zero-flow or low flow that create long residence times and allow disinfectants to dissipate and sediments to deposit result in improved conditions for regrowth and should be avoided.

- **Cleaning storage tanks**
  The required frequency of storage tank cleaning varies depending upon the quality of water stored, detention time in storage, temperature of the water, and nature of the tank. Tanks that are open to the atmosphere require more frequent cleaning.

- **Flushing the distribution system**
  The required frequency of distribution system flushing varies depending upon the quality of water transmitted, detention time in the distribution system, temperature of the water, and nature of the distribution system components. Periodic flushing is a good means of both removing sediments and scouring pipe walls. System design must include means for easily flushing pipes as part of routine maintenance.

- **Controlling temperature**
  Avoid the storage and distribution of non-potable water within 20°C to 45°C to reduce the potential for pathogen regrowth. Otherwise, consider a disinfection residual or point-of-use system, particularly if aerosols are generated.

The rainwater harvesting system designer and Person Responsible for Maintenance each should review published guidelines for the management of Legionella in distribution systems and implement as appropriate for each specific system. In particular, ANSI/ASHRAE Standard 188-2015 Legionellosis: Risk Management for Building Water Systems (2015) provides guidance on stormwater best management practices (BMPs) for both potable and non-potable water systems. It addresses management program responsibilities, system design, risk analysis, control mechanisms, monitoring, confirmation, and documentation. Although the ASHRAE Standard targets legionellosis, its rationales and approaches are applicable to all pathogens and health risks identified in this appendix.

J.1.8 Commissioning

In the process of initializing a rainwater harvesting system, the system must be evaluated for leaks in the storage unit and the performance of the components of the treatment and distribution system. A commissioning report of the evaluation is required at the initial startup of the system and anytime the system is brought back online after cleaning, flushing, and/or a hiatus of use (e.g., winter shutdown).

J.1.9 Operational Monitoring and Reporting

The Person Responsible for Maintenance, as identified in the Stormwater Management Plan (SWMP), must maintain the rainwater harvesting system in good working condition and assure adequate treatment of the harvested rainwater. All systems, with the exception of those installed in single-family homes, shall include continuous monitoring systems that are capable of determining if the rainwater harvesting system is operating within the design specification, and if all system components of the rainwater harvesting system are functional.

Data logs from continuous monitoring systems must be kept on file and produced upon request from <*local jurisdiction*>. In addition, annual reports must be generated that identify the following:

- Significant maintenance activities;
- Treatment modifications;
- Outages and malfunctions (including reasons and durations); and
- Steps taken to mitigate or eliminate recurrence of outages and malfunctions.

If there is a change of personnel—Person Responsible for Maintenance—it is the responsibility, within 15 business days, of the owner of the rainwater harvesting system or her/his agent to update the Town of Bluffton with the name and contact information of the new personnel.

An operation and maintenance manual that includes a schematic drawing of the system, standard operating procedures for the system, and maintenance schedule(s), as well as commissioning reports, field verification reports, and annual reports must be on site and produced upon request from Town of Bluffton.

J.1.10 Field Verification

Field verification is a performance confirmation of a rainwater harvesting system. It can be accomplished by physically observing the collection, storage, and distribution system, and the treatment process components. It can also be conducted using challenge testing, including surrogate microorganisms and/or other non-biological surrogates and typically involves manual collection of water samples for microbial analysis to check system performance in achieving LRTs. While not specifically required, Town of Bluffton construction or maintenance inspections may include field verification testing to ensure that the rainwater harvesting system is achieving its LRTs, and that operational monitoring and control systems are functional.

J.1.11 Design Report

A design report must be submitted with each rainwater harvesting system that includes, at a minimum, the following:

- Pathogen $\log_{10}$ reduction target
- Proposed treatment process and associated $\log_{10}$ reduction value
- Proposed storage and distribution management practices
- Identification of the Person Responsible for Maintenance
    - Operation and Maintenance Manual
- Reliability analysis that identifies the following:
    - How the equipment used to monitor treatment, operations, and water quality enables determination of whether the system is working as planned.
    - How the monitoring and controls of the system will enable the operator or automatic controls to intervene in the event of the production of off-specification water.
    - Remedies and provisions for operation disruption (e.g., power failures, vandalism, and excessive source contamination)
    - Unauthorized access limitations for the rainwater harvesting and distribution system.

J.1.12 Treatment Design Examples

Example 1: Rooftop Runoff for Landscape Irrigation

1) **Identify the $\log_{10}$ reduction targets for the reference pathogen groups.**
Since the roof will not allow frequent public access, the water source qualifies as roof runoff rather than general runoff. No LRT is provided for enteric bacteria or parasitic protozoa, but an LRT of 3.5 is defined for enteric bacteria.

2) **Select a treatment process to achieve the $\log_{10}$ reduction target.**
An ozone system with a CT value (the product of concentration and contact time) of 0.04 mg • min/L can achieve 4-$\log_{10}$ reduction of enteric bacteria. However, as all disinfection processes require removal of particles 10 microns or larger, a 10-micron cartridge filter or similar device will also be necessary (see Figure 1).

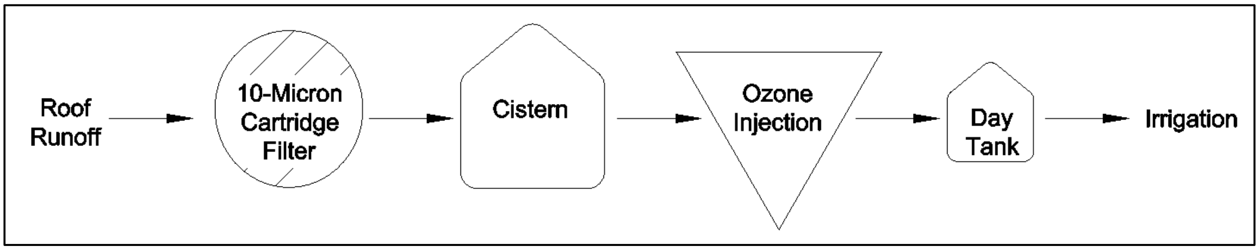

Figure 1. Example 1 treatment schematic.

Alternative treatment trains that also could meet the required LRT include the following:

- Microfiltration (i.e., 6-$\log_{10}$ reduction of bacteria).
- Sand filter with an equivalent effluent particle size distribution of 10 microns, followed by UV radiation with a dose of 40 to 60 mJ/cm2 (i.e., 4-$\log_{10}$ inactivation of bacteria).
- Cartridge filtration (10 microns), followed by chlorination with free chlorine with a CT value of 1.6 to 2.4 mg•min/L (i.e., 4-$\log_{10}$ inactivation of bacteria).

3) **Determine storage and distribution management practices.**
For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

4) **Identify maintenance and monitoring requirements and schedule of activities.**
These will vary based on the specific equipment and devices included in each design.

5) **Submit design report and SWMP.**

Example 2: General Runoff for Indoor Use

1) **Identify the $\log_{10}$ reduction targets for the reference pathogen groups.**
The proposed rainwater harvesting system will capture runoff from two different areas on a rooftop. The first area will have no public access, but the second area includes a patio area that is designed for public access. The combined water from the two areas is therefore considered "general runoff," and will need to be treated accordingly. The LRT for both enteric viruses and protozoa is 5.5, and the LRT for enteric bacteria is 5.0.

2) **Select a treatment process to achieve the $\log_{10}$ reduction target.**
An ultrafiltration system can achieve 6-$\log_{10}$ reduction of viruses, protozoa, and bacteria (see Figure 2).

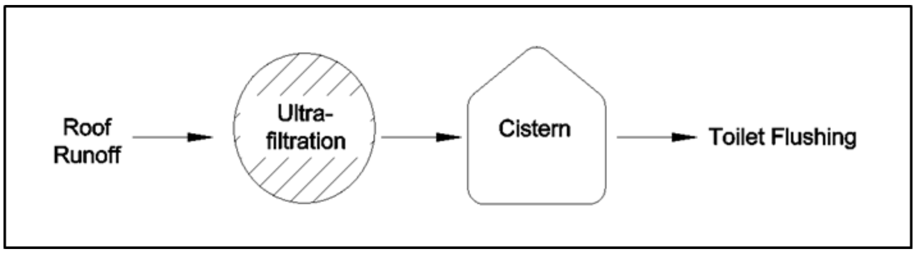

Figure 2. Example 2 treatment schematic.

The only alternative processes that can also meet the required LRTs are nanofiltration and reverse osmosis.

3) **Determine storage and distribution management practices.**
For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

4) **Identify maintenance and monitoring requirements and schedule of activities.**
These will vary based on the specific equipment and devices included in each design.

5) **Submit design report and SWMP.**

Example 3: Roof Runoff for Cooling Towers

1) **Identify the $\log_{10}$ reduction targets for the reference pathogen groups.**
   As there is not public exposure to the harvested rainwater, there are not initial treatment requirements. Chlorination may still be required to control the growth of opportunistic pathogens however (see Step 2).
2) **Determine storage and distribution management practices.**
   For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

   - Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
   - If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.
3) **Identify maintenance and monitoring requirements and schedule of activities.**
   These will vary based on the specific equipment and devices included in each design.
4) **Submit design report and SWMP.**

J.2 Rainwater Harvesting Storage Volume Calculator Instructions

Input Sheet

The cells of the spreadsheet are color coded as follows:

Color Code

(orange)	Title/New Category
(light green)	Required Entry value
(bright green)	Alternate Category Entry (if selected, do not enter value into "Required Entry value")
(yellow)	Final Category Value

Design Storm (inches)	
Cell L4	Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.
CONTRIBUTING DRAINAGE AREA (CDA)	
Cell L7, L9, L11	Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.

CONTRIBUTING BMPS	
Cell L17	Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the SoLoCo Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.
The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.	
IRRIGATION	
Cells L23, L25	Indicate the area to be irrigated in square feet and if the irrigation system as smart controls.
Row A31-L31	The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in either inches per week or gallons per month.
	The EPA WaterSense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2-LWA sheet, which can be found at the following link: https://www.epa.gov/watersense/water-budget-tool
INDOOR DEMAND - FLUSHING TOILETS/URINALS	
Cell L35	Indicate the number of people using the building.
Cells L35, L37	The values in **lines 35 and 37** can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively.
Cell L39	If the user knows the daily toilet and urinal demand, that value can be input into **line 39** and the information in the rows above will not be used.
Cells L44, L46, L48	Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.
INDOOR DEMAND - LAUNDRY	
Cell L54	Indicate the number of loads of laundry done each day.
Cell L54	The value in **line 54** can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load.
Cell L56	If the user knows the daily laundry demand, the value can be input into **line 56** and the information in the rows above will not be used.
Cells L60, L62	Indicate the first and last day of the week when the water will be used.
ADDITIONAL DAILY USE	
Row A71-L71	If there is any other additional daily use not covered in the spreadsheet, **line 69** can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day.
Cells L73, L75	Indicate the first and last day of the week when the water will be used.

COOLING TOWERS

Row A79-L79	If the rainwater collected is to be used for cooling towers, indicate in **line 79** the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.

The following section allows for additional contribution to the cistern from sources other than rainwater.

CONTRIBUTION FROM OTHER SOURCES

Row A88-L88	If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month
Cells L90, L92	Indicate the first and last day of the week when the water will be input.

FIRST FLUSH FILTER DIVERSION AND EFFICIENCY

This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWRv storm will be successfully captured. These minimum values can be altered if appropriate.

Cell L98	**Line 98** indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.
Cell L100	**Line 100** indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

Storage Volume Results Sheets

These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.

The table on this sheet has the following information.

- **Cistern Volume** (gallons) – This row gives a range of cistern sizes in gallons based on the CDA size.

- **Daily Average Available Storage Volume** (gallons or cubic feet) – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.

- **Overflow Volume (Sv)** (gallons or cubic feet) – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.