Rainwater Harvesting Guidelines

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DEVELOPMENT &
BUILDING APPROVALS

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Contents

RAINWATER HARVESTING GUIDELINES: FOR INTERNAL NON-POTABLE USE

The purpose of this handbook is to outline the best installation practices for rainwater harvesting systems in the city of Calgary. The document highlights The City of Calgary Development and Building Approvals (DBA) permitting and inspection process for a person or company installing a residential rainwater harvesting system for use within buildings. Although this handbook focuses on residential rainwater harvesting systems, the overall principles will apply to institiutional, commercial and industrial buildings, with the need for professional engineering and oversight when required.

Where appropriate, this handbook refers readers to the Alberta Building Code (2006), National Plumbing Code (2010), National Standards of Canada (2007), the Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010), and The City of Calgary Water Resources document titled Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice. Please consult these documents for additional details, rules and regulations.

Rainwater harvesting

Introduction

What is rainwater harvesting?

The City of Calgary supports the use of green building technologies in the design and construction of homes and buildings. The practice and process of rainwater harvesting for non-potable reuse is one example of green building technologies that improves our housing stock, conserves water, and has multiple benefits for both the homeowner and community. This document outlines the practice of rainwater harvesting, the process of collecting, storing and reusing rainwater for non-potable purposes.

Rainwater harvesting initiatives

The City of Calgary currently promotes the collection of rainwater in rain barrels and rain tanks for watering yards and gardens. In the summer, residential potable water use increases by 40 per cent due to outdoor watering. Rain barrels are a popular method of harvesting rainwater. They are inexpensive, simple to use, and do not require a permit to install. Search calgary.ca "rain barrels" for more information.

The City of Calgary, Water Resources is developing a Low Impact Development Source Control Practices Manual which will include the Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice. The comprehensive guide will focus on design and construction guidelines primarily for larger developments to optimize stormwater management. Readers will be directed to reference this guide for more information on specific rainwater harvesting components and calculations.

Rainwater quality

Water quality is determined by its microbiological, chemical and physical properties (e.g. pH, colour, odour, turbidity and bacteria). City tap water has been filtered, treated and tested at a municipal facility to meet a mandated standard of quality, making it safe for human use — in showers, etc., and to drink. Rainwater does not meet these water quality standards and is therefore considered non-potable, or unsafe for drinking, showering, dishwashing and several other uses.

What can I do with the rainwater I collect?

Rainwater has the potential to harbour pathogenic organisms (i.e. E. coli) that would be harmful to humans if consumed. The use of rainwater in our homes requires precaution, safety measures and education to ensure that its end use is managed properly. Currently, the Public Safety Division of Alberta Municipal Affairs only allows stored rainwater to be used for toilet and urinal flushing and outdoor subsurface irrigation. All other uses are not permitted due to concerns with contact or aerosol inhalation of non-potable water. In the future, the permitted non-potable uses for stored rainwater could be expanded, but only upon approval from Alberta Municipal Affairs.

Permitted uses 2011[3]	Prohibited uses 2011[4]	
• toilets and urinals • outdoor subsurface irrigation	• drinking • kitchen faucets • lavatory faucets • showers and baths	• laundry • dishwashers • hose bibs • surface/spray irrigation

Are there rainwater quality standards for the permitted uses?

There are currently no standards outlined in the Alberta Building Code (2006) for the quality of rainwater for the permitted non-potable uses. However, the provincial government is adopting CSA Standard B128.3-12 Performance of Non-Potable Water Reuse Systems which will provide water quality standards for water that is being reused within the home or building, regardless of source. In addition, the Canadian Guidelines for Domestic Reclaimed Water for Use in Toilet and Urinal Flushing (2010) outlines specific water quality parameters for the use of reclaimed water in toilet and urinal flushing. These guidelines could be used as guidance for acceptable water quality for further applicable uses of rainwater.

Please be aware that rainwater use in Canada is sometimes referred to as “reclaimed” water or “grey water,” which are both very different from rainwater. Reclaimed water is the filtered and treated output water from a municipal or small scale wastewater treatment system. Grey water is the wastewater from showers/baths, bathroom sinks and laundry machines (this does not include waste from toilets/urinals and kitchen wastewater). Both reclaimed water and greywater must abide by the water quality guidelines mentioned above, and are not discussed in these guidelines.

Because reclaimed water or grey water has a much higher potential to host pathogens and other contaminants, it must be treated more rigorously than rainwater if it is to be re-used. The treatment and use of the reclaimed water, grey water and stormwater (rainwater that is collected from surface other that roofs) are **NOT** covered under this handbook. Use of the types of waste water are reviewed on a case-by-case basis by the authority having jurisdiction, and must be submitted as an alternative solution (a unique, performance-based design) meeting specific requirements as contained in the Canadian Guidelines for Domestic Reclaimed Water for Use in Toilets and Urinal Flushing. Additional information on the approval and standards related to these systems may be found on the Alberta Municipal Affairs website.

Plumbing rainwater into a home for permitted non-potable uses requires planning and design considerations to address site conditions and follow mandated installation and inspection requirements. The homeowner, home builder, or contractor installing a rainwater harvesting system is required to obtain the necessary permits and call for all the associated inspections. Due to the complexity of these systems, homeowners are encouraged to consult with and employ a certified plumber, electrician and/or engineer to design and install a rainwater harvesting system. Product suppliers may also provide guidance on the design of a system, and can offer recommendations to contractors familiar with the installation of rainwater harvesting systems and associated components.

The City of Calgary Development and Building Approvals process for installing a rainwater harvesting system

The following information outlines the process involved when one wishes to install a rainwater harvesting system for internal, non-potable use in Calgary.

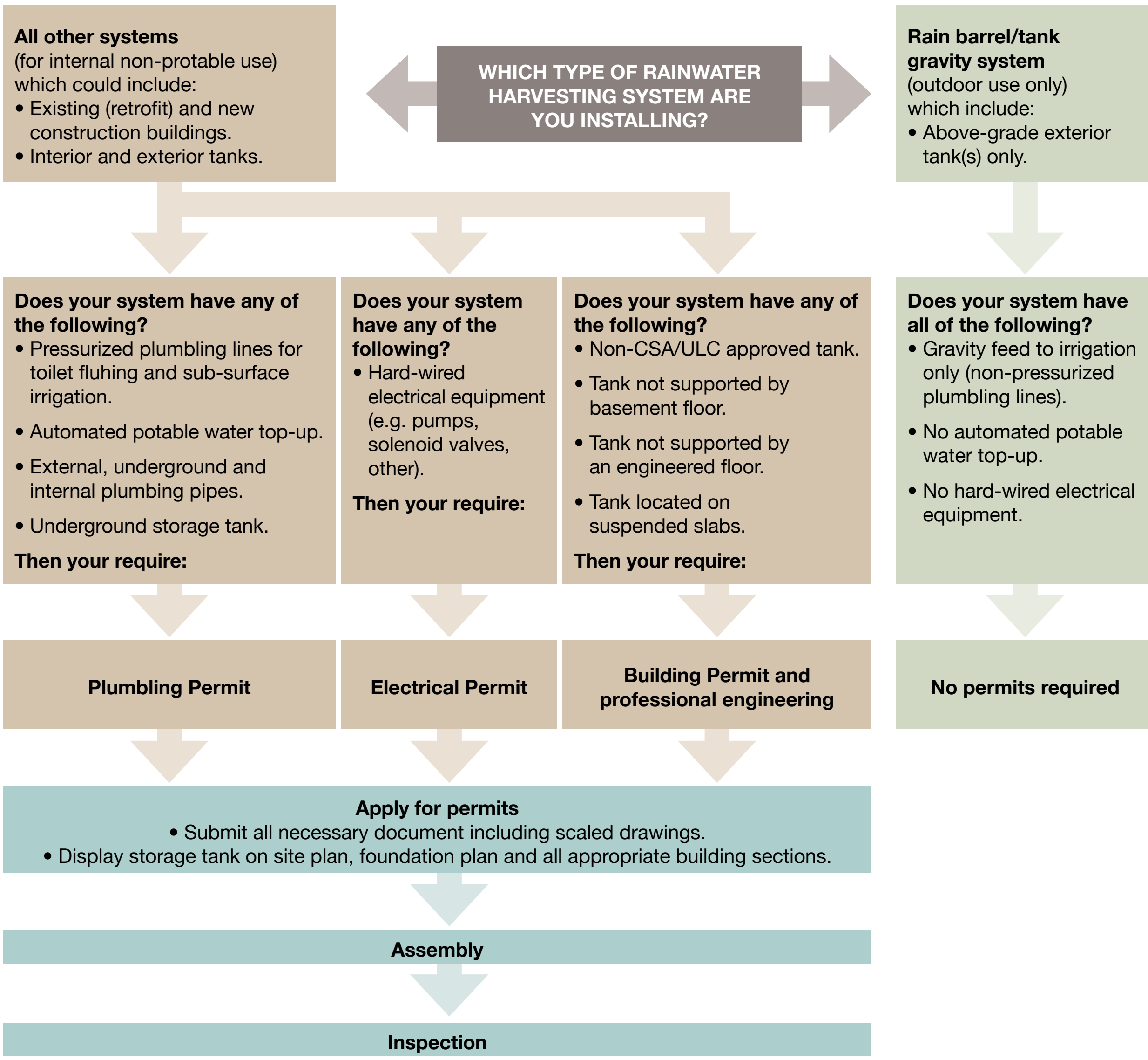
Permits: The installation of a rainwater harvesting system requires specific permits and scaled drawings. All permits must be in place before work begins and can be obtained by the homeowner (Homeowner's permits – http://www.calgary.ca/PDA/DBA/Documents/brochures/plumbing_permits.pdf), home builder (Single Construction Permit – http://www.calgary.ca/PDA/DBA/Documents/building/construction_permit_application.pdf), or a certified contractor (Contractor's permits – http://www.calgary.ca/PDA/DBA/Documents/building/contractors-plumbing-permit-application-PL1212.pdf). The person or company who obtains the permit is responsible for all the work performed under that permit.

Rough-in for future use: Rough-in installation of rainwater harvesting systems in new construction provides homeowners and builders with an option for future use, while saving initial capital costs, meeting existing green building certification compliance, and providing future growth opportunities to the building. Homeowners and home builders must be aware that any portion of the system that is roughed-in will require inspections, and meet all safety codes, even if the system is not finalized or commissioned.

Inspections: The person or company who obtains the permit is also responsible for booking inspections. To request an inspection, phone 3-1-1 prior to 2 p.m. the day before you require the inspection. One permit is entitled to two inspections only.

For reference, there are "INSPECTION REQUIRED" stamps placed throughout this handbook to highlight that an inspection may be required for specific components.

The information contained in the following flow chart highlights the process required for permits and inspections



What are the benefits of rainwater harvesting?

There are several benefits to a residential rainwater harvesting system for internal, non-potable use, including:

- Protecting and conserving fresh water supplies.
- Reducing stormwater runoff.
- Reducing homeowner's potable water use.

How much will a rainwater harvesting system cost me?

The cost of rainwater harvesting systems varies widely depending on the size, type and location of the storage tank, excavation costs, complexity of the conveyance network, complexity of the distribution system, post-storage filtration, and labour costs associated with contracted installations. Homeowners can expect approximate costs to range from $6,000 to $14,000[5] for a comprehensive system. Combined with the current cost of municipal water, a rainwater harvesting system has a lengthy return on the investment. Homeowner's should be aware that at present time, their goal of installing a rainwater harvesting system would be mainly for water conservation.

Handbook outline

A rainwater harvesting systems is comprised of multiple parts and components, and can be installed in several different ways. These guidelines have been created to aid you in designing and building a rainwater system for a residential home. Each section of the guidelines follows a sequence of events, from the collection of rainwater through to its use within the home. Additional information on best practice management, maintenance, contact information, references and appendices are included for reference.

Each section of the guidelines has been organized into the following format:

- Introduction
- Key image
- System detail
- System description
- References

For ease of explanation, figures 1 and 2 below showcase one example of a full rainwater harvesting system for internal, non-potable use. A key image will be referenced at the beginning of each section and can be used to navigate through the document while following the water path.

Figure 1: Example of a rainwater harvesting system

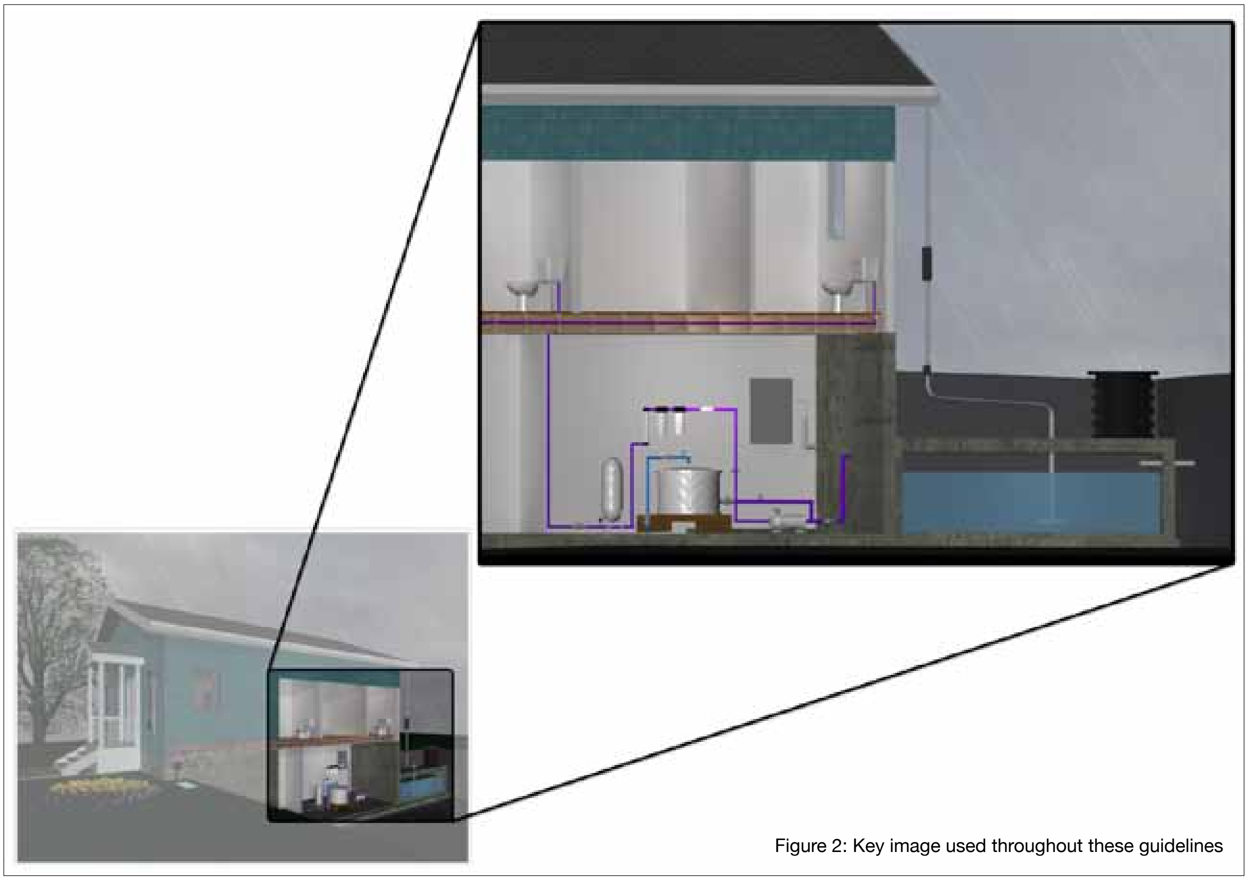


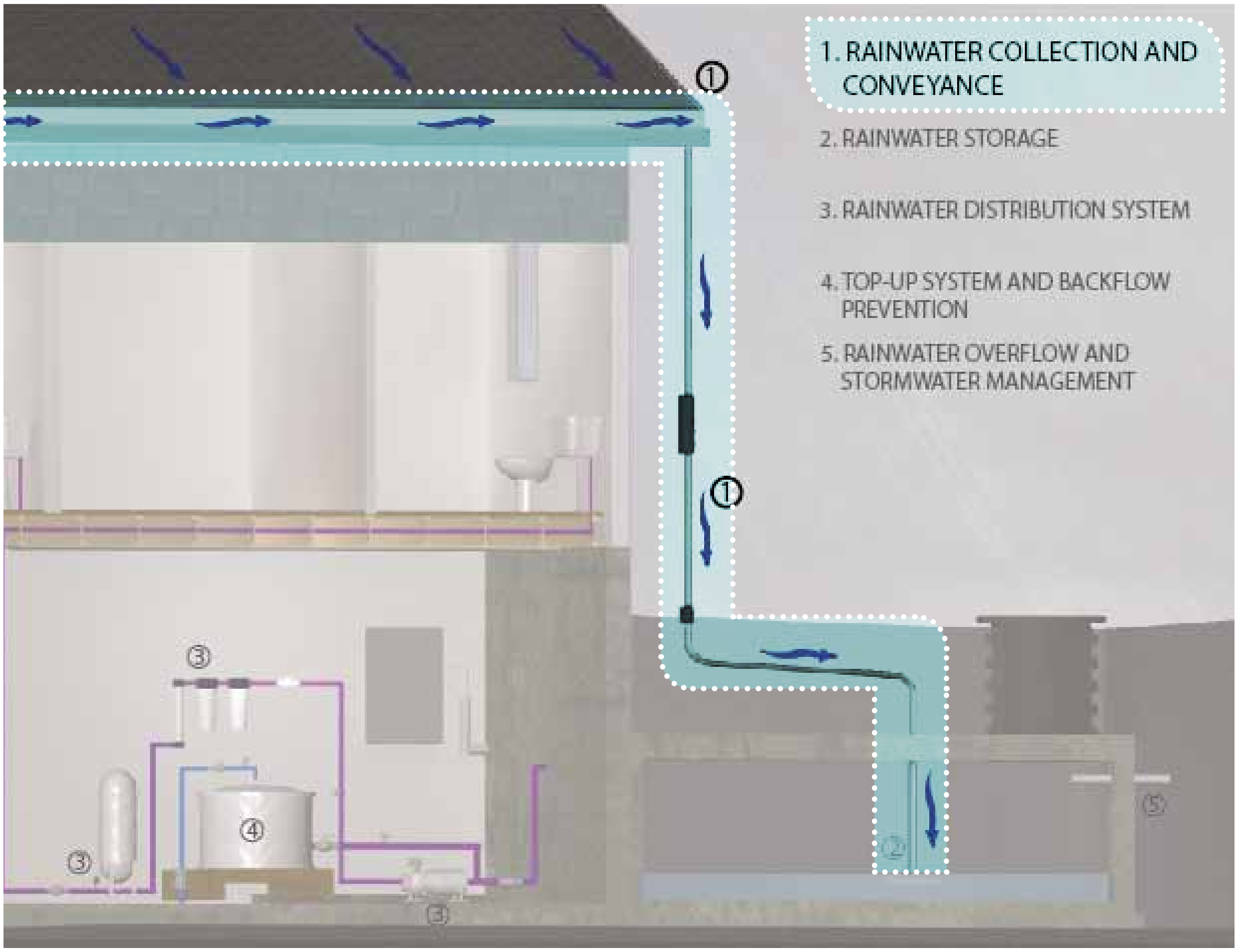
Figure 2: Key image used throughout these guidelines

01 Rainwater collection and conveyance

Introduction

Rainwater harvesting requires collection of rainwater from the roof and distribution through gutters (eavestroughs), downspouts and conveyance pipes, which then connect to the cistern or storage tank. This section describes the best roof type for rainwater collection, an overview of gutters and downspouts, and details for directing rainwater through conveyance pipes to your rainwater cistern.

Key image



System detail – collection and conveyance

Figure 3 below details the information that will be covered in this section with respect to rainwater collection and conveyance. Notes and comments have been provided to summarize primary requirements.

(For close-up, use zoom feature in toolbar.)

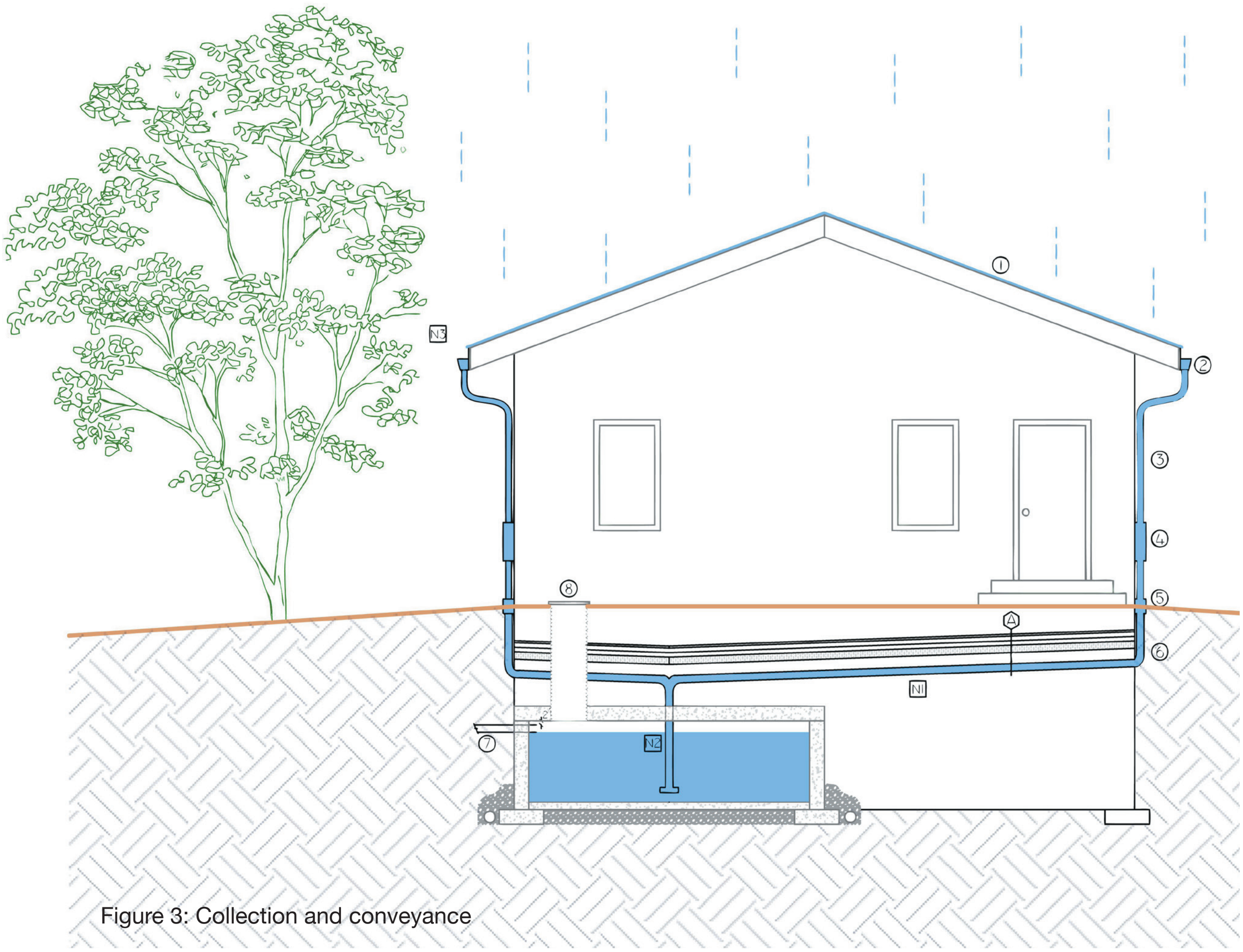


Figure 3: Collection and conveyance

MATERIALS

(1) ROOF SURFACE
-ONLY PERMITTED COLLECTION SURFACE
-METAL ROOFING QUALITY AND HIGHER COLLECTION EFFICIENCY
-NSF P151 CERTIFIED FOR HIGHER QUALITY WATER
-ASPHALT, WOOD SHINGLE, & OTHER MATERIALS WILL SUFFICE
-COLLECT FROM GREATEST ROOF SURFACE AREA

(2) EAVESTROUGH
-TYPICAL INDUSTRY STANDARD
GUTTER GUARD TO PREVENT DEBRIS

(3) DOWNSPOUT
-TYPICAL INDUSTRY STANDARD
-LOCATE CLOSE AS POSSIBLE TO STORAGE TANK

(4) PRE-STORAGE TREATMENT DEVICE
-IMPROVES WATER QUALITY PRIOR TO STORAGE
-OPTIONS: LEAF BEATER, FIRST-FLUSH SYSTEM, IN-GROUND FILTER

(5) DOWNSPOUT TO CONVEYANCE PIPE TRANSITION

(6) CONVEYANCE PIPE

(7) OVERFLOW PIPE

(8) ACCESS HATCH

ASSEMBLIES

(A) UNDERGROUND CONVEYANCE: TOP TO BOTTOM
-WARNING TAPE
-TRACE WIRE
-XTPS RIGID INSULATION
-CONVEYANCE PIPE

NOTES

N1 CONVEYANCE PIPE INSTALLATION
-ENSURE AGAINST BURIED SERVICE OR UTILITY LINES: "CALL BEFORE YOU DIG"
-PROPERLY EXCAVATED SPACE (NPC 2.3.5.1)
-BURIED BELOW FROST PENETRATION DEPTH OR INSULATED WITH XTPS RIGID INSULATION OR HEAT TRACED
-TRACER WIRE FOR LOCATING AND WARNING TAPE NO LESS THAN 300mm (12") ABOVE PIPE

PIPE SLOPE
-0.5% MINIMUM
-2% INDUSTRY STANDARD
->2% PREFERRED TO AID RAINWATER DRAINAGE & PREVENT FREEZING IN WINTER

PIPE MATERIAL
-RECOMMENDED: PVC SYSTEM 15 (SCHED. 40)
-MINIMUM: PVC SDR35 OR ABS
-UV RATED WHERE EXPOSED TO SUN

PIPE SIZE
-4" DIAMETER FOR ROOF AREAS 0-200 M^2
-6" DIAMETER FOR ROOF AREAS 200-500 M^2
->6" FOR LARGER ROOF AREAS

N2 INLET PIPE CONNECTION TO TANK
-NO LOWER THAN OVERFLOW HEIGHT
-RECOMMEND 2" ABOVE OVERFLOW PIPE HEIGHT
-CALMED INLET AT BOTTOM OF PIPE

N3 ADJACENT TREES
-TRIM OVERHANGING TREES & FOLIAGE

System description – collection

What type of roof (catchment) surface should I use?

According to The City of Calgary Development and Building Approvals And Alberta Municipal Affairs, roofs are the only surface permitted for residential rainwater collection. Paved surfaces and lawns are not allowed for residential catchment because of their potential for contamination from pesticides, vehicle oils and other pollutants. A roof's composition will play a part both in its collection efficiency and the quality of rainwater it produces. If very high-quality rainwater is desired, roofing materials with NSF P151[6] certification should be used. The most common roofing materials are detailed below.

Asphalt shingle: Asphalt is the most common roofing material in Calgary and is sufficient for rainwater collection. Collection efficiency from asphalt is reduced due to its rough surface and ability to collect and evaporate surface water. Additionally, particulates and other contaminants can dislodge from asphalt shingles, which can negatively affect rainwater quality.

Metal roofing: Because of its smooth, clean surface, metal roofing has higher collection efficiency and is generally the recommended option for rainwater harvesting systems. In some suburban communities with set architectural guidelines, homeowners may not be able to choose this roofing option.

Other roofing materials: Wood shingles (or shakes), recycled or non-recycled rubber, clay tiles, and lightweight concrete tiles are also acceptable materials for catchment surfaces. Because of their varied rough surfaces, they are subject to lower collection efficiencies. Built-up roof membranes and "green roof" installations are not typically recommended for rainwater harvesting as they may add contaminants to the water collected.

How much water can be collected?

In theory, one litre of water can be collected for every millimetre of rainfall landing on one square metre of collection surface.

Total roof area (m^2) x Annual rainfall (mm) = Potential collection (L)

In practice, calculating potential collection volumes is more complex. For detailed information on the amount of rainwater that can be collected from your roof, please reference Appendix A.

How is the rainwater conveyed from my roof to the storage tank?

Gutters and downspouts: Rainwater will run off your roof surface, accumulate in the gutters and travel down toward grade through downspouts. Standard gutter (eavestrough) and downspout sizes and installation methods are sufficient for a residential rainwater harvesting system. Most eavestroughs are 125 mm (5") K-style aluminum or galvanized steel, with a slope between 0.5 and 2 per cent. Typical downspouts are 50 x 75 mm (2 x 3") or 75 x 75 mm (3 x 3") aluminum or galvanized steel.[7]

If rainwater is to be collected during the winter months, extra consideration should be made to reduce ice buildup at gutter bends and elbows.

Downspout location: It is important to plan downspout locations in relation to the rainwater storage tank. Downspouts should be in close proximity to the storage tank in order to reduce the length of conveyance pipe while collecting rainwater from the full roof surface. Additionally, downspouts will require some form of pre-storage filtration or treatment device (discussed below) and a connection to conveyance pipe at or near grade. For aesthetic reasons, homeowners may wish to hide downspout and filtration devices from sightlines.

Rainwater quality and pre-storage treatment

Several factors affect rainwater quality before it reaches the storage tank. Site conditions, such as proximity to roadways and industry, may affect the quality of rainwater landing on roof surfaces by imparting dissolved chemicals and metals. Quality is further affected by the material of the roof surface, which can leach contaminants. Debris from overhanging foliage, animal and bird droppings also play a role in rainwater's final composition. To help improve the quality of stored rainwater, homeowners are encouraged to install some form of pre-storage filtration or treatment device.

Pre-storage devices are simple in design and operate using gravity flow to separate debris from rainwater before it moves into the storage tank. Many devices are designed to discard or flush away the initial, polluted roof water runoff, and therefore cause a minimal decrease in the overall harvesting capacity. Concise considerations of pre-storage rainwater filtration are outlined in Appendix B.

Examples of pre-storage treatment


GUTTER GUARD


FIRST-FLUSH


LEAF BEATER

IN-GROUND FILTER

System description – conveyance pipe

Conveyance pipe transports rainwater from the downspout to the storage tank. Required materials and code issues are detailed below. In addition, care must be taken to ensure adequate sealing of all penetrations in the building envelope to ensure that unwanted air and moisture are prevented from entering or exiting the building.

Material: Where conveyance pipe is above grade and exposed to the sun, UV-rated pipe must be installed. For underground installation, a minimum of PVC sewer grade pipe (SDR35) or ABS pipe is required. Higher grades of pipe, such as PVC System 15 (Schedule 40), have a thicker, more durable wall and can minimize the possibility of breakage. Pipe material must meet the requirements of applicable codes and standards.

Size: In accordance with Calgary's rainfall amounts, a minimum of 4" diameter pipe is required for typical (smaller) roof areas (< 200 m^2 (2153 ft^2)), with the required pipe size increasing according to roof catchment area. For example, a 6" diameter pipe is required for roof areas 200 m^2 (2153 ft2) to 550 m^2 (5920 ft^2), and diameters greater than 6" are required for very large roofs.

Slope: 0.5 per cent is the allowed minimum, but a 2 per cent slope is industry standard. Where conditions allow, greater than 2 per cent is ideal for increasing drainage of rainwater and decreasing the possibility of rainwater freezing during colder months. Note that the slope and distance to the top of below-grade storage tanks should be calculated for compliance.

Permanent warning tape and tracer wire: In order to locate buried, non-metallic pipes, permanent warning tape and tracer wire must be installed a minimum of 300 mm (12") above the pipe, in accordance with CAN/CSA B128.1-06 Clause 12.3.[9]

Backfill: Pipes must be located on a proper drainage bed in an appropriately sized trench and backfilled in accordance with applicable Provincial codes and regulations. For backfill image, please refer to Appendix C.

Winter considerations: If a homeowner wishes to collect snow melt during the winter months and the conveyance pipes could not be buried below Calgary's frost penetration depth (≈ 1.83 m), then insulation should be installed above the pipes to prevent the snow melt from freezing inside the pipe. The preferred insulation type to use is rigid extruded polystyrene (XTPS) foam insulation. Using heat trace wire will keep water from freezing in the pipes, but it is energy intensive and not the suggested method for winterization. Please see Appendix C: Conveyance pipe winterization, for more detail.

References

Additional information on codes, standards and guidelines related to the collection and conveyance of rainwater are summarized in the table below.

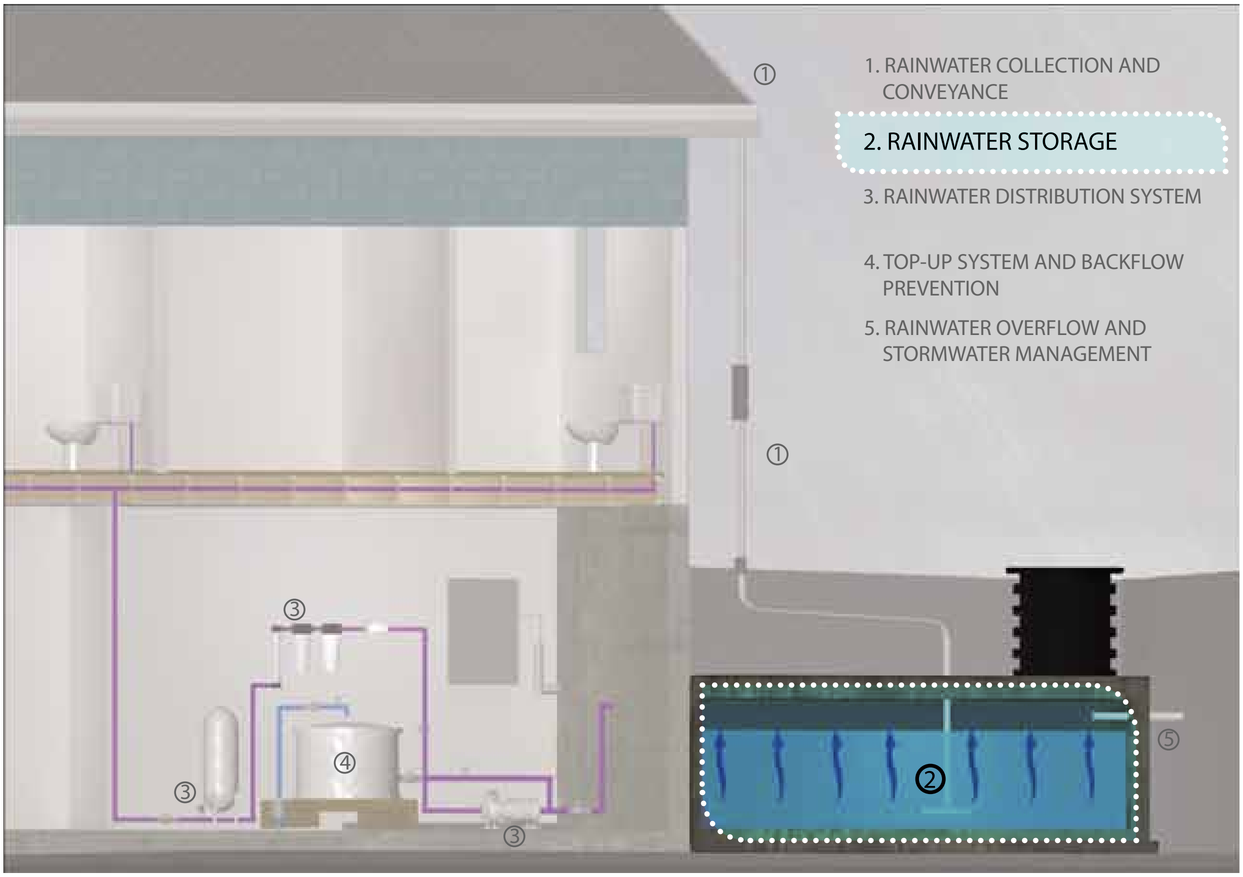
Rainwater collection and conveyance	
Codes, standards and guidelines	**Applicable clauses, sections, chapters and additional info**
Alberta Building Code (2006)	• Division B, Appendix C – Table C-2: Design Data for Selected Locations in Alberta
National Plumbing Code (2010)	• Section 2.2.5.10. Plastic Pipe, Fittings and Solvent Cement Used Underground; 2.2.5.12. Plastic Pipe, Fittings and Solvent Cement Used in Buildings; 2.3.4.5. Support for Horizontal Piping; 2.3.4.6 Support for Underground Horizontal Piping; 2.3.5.1. and Appendix A-2.3.5.1.(1) Backfill of Pipe Trench; 2.3.5.4. Protection from Frost; 2.4.7. Cleanouts; 2.4.10.4. Hydraulic Loads from Roofs or Paved Surfaces; 2.4.10.9. Hydraulic Loads on Storm or Combined Building Drains or Sewers
National Standards of Canada (2007) CAN/CSA-B128.1-06	• Clause 10 – Separation • Clause 12.3 – Markings for Buried Pipe
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)	• Chapter 1: Rainwater Catchment and Conveyance • Appendix A: Collection losses from catchment surfaces, Sizing Gutters and Downspouts, Sizing Conveyance Pipe, Frost Penetration and Freezing Protection • Chapter 3: Rainwater Quality and Treatment • Page 38: additional details on sizing of first-flush chambers and settling tank volumes

02 Rainwater storage

Introduction

Once rainwater passes through the conveyance network, it is deposited in a storage tank or cistern located below grade outside the house or in a basement. In certain cases, a rainwater cistern can be located above grade (for summer use only) or in a heated garage. As the storage tank is the most important and usually most expensive component of the rainwater harvesting system, it's best to consider the options during a home's design stage. This will allow for some flexibility in the tank's location, configuration and slope of conveyance pipe from downspouts.

Key image



System detail

Figure 4 below details the information that will be covered in this section with respect to rainwater storage. Please note image materials and notations for summary requirements. Additional information and a brief explanation of the components involved in rainwater storage follows this image.

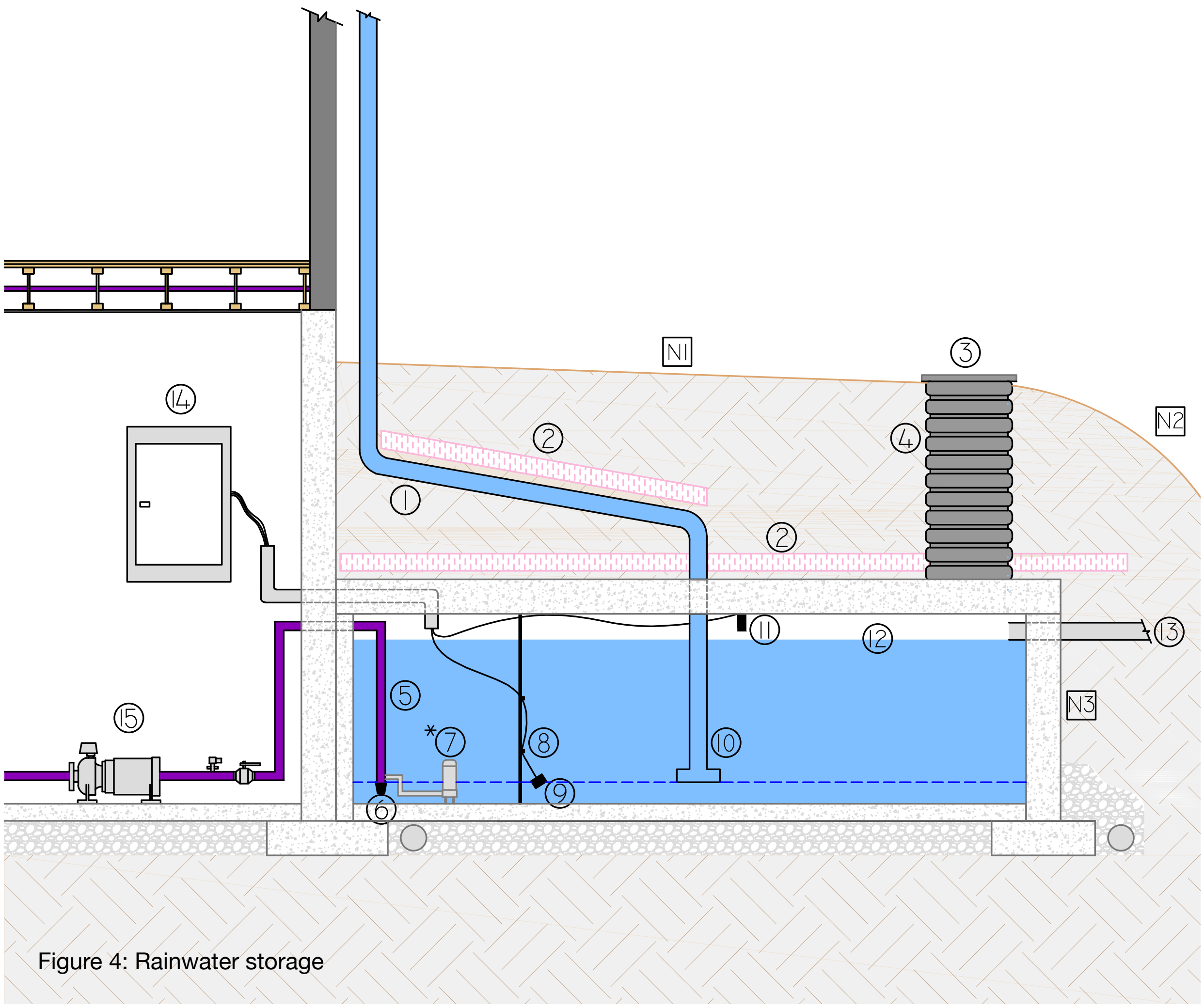


Figure 4: Rainwater storage

MATERIALS

1. **CONVEYANCE PIPE**
2. **XTPS RIGID FOAM INSULATION**
   - FOR SHALLOW INSTALLATIONS
3. **ACCESS HATCH**
   - EASILY ACCESSIBLE
   - NO SMALLER THAN 450MM (18")
   - LOCKABLE
   - ANY ADDITIONAL OPENINGS LARGER THAN 150MM (6") MUST BE LOCKED
4. **ACCESS RISER**
5. **SUCTION LINE**
   - FOR PUMP LOCATED INDOORS
6. **FOOT VALVE**
   - FOR PUMP LOCATED INDOORS
7. **SUBMERSIBLE PUMP**
   - USED INSTEAD OF INDOOR PUMP*
8. **FLOAT SWITCH**
   - LOW LEVEL (MINIMUM WATER LEVEL TRIGGERS MAKE-UP WATER SYSTEM)
9. **LOW WATER LEVEL**
10. **CALMED INLET**
    - DIRECTS INCOMING WATER AWAY FROM BOTTOM TO KEEP SEDIMENT FROM STIRRING UP
11. **ULTRASONIC WATER LEVEL SENSOR**
12. **HIGH WATER LEVEL**
13. **OVERFLOW PIPE**
    - INSTALL 2" BELOW CONVEYANCE PIPE ENTRY
    - PIPE DIMENSION MUST MATCH OR EXCEED THAT OF INLET PIPE
14. **ELECTRICAL PANEL**
15. **JET PUMP**

NOTES

N1 VENTING REQUIRED; NORMALLY SUFFICIENT THROUGH CONVEYANCE & OVERFLOW DRAINAGE PIPES

N2 GRADE ELEVATION DIFFERENCE REQUIRED FOR OVERFLOW GRAVITY FEED

N3 -PREFABRICATED UNDERGROUND TANKS MUST COMPLY WITH CSA B66 CLAUSE 4.1
-ABOVE GRADE OR TANKS BUILT ON-SITE MUST BE DESIGNED & CONSTRUCTED ACCOURDING TO GOOD ENGINEERING PRACTICE

System description

What are my choices for storage tanks?

Material: Storage tanks can be fabricated from many different materials, including high-density polyethylene (plastic), fibreglass, metal, concrete, and crate and bag. A homeowner or system designer may choose to integrate a storage tank into the foundation wall (a cast-in-place cistern), place it in an appropriate location in the front or back yard, or size the mechanical room with sufficient space to fit a plastic or fiberglass storage tank inside the home. An engineer's approval is required if the storage tank will be integrated into the home (cast-in-place, located below a suspended concrete slab, or located on a floor other than a basement or garage). For an existing home, a more likely choice will be a plastic (high-density polyethylene), fiberglass, or precast concrete storage tank, located on the exterior of the home below or above grade.

Note: Certain tank materials may leach contaminants into the rainwater (e.g. plastic, metal or concrete), so if high-quality rainwater is desired (for aesthetic reasons, or to prolong post-storage filters), homeowners should inquire about this possibility when sourcing a storage tank. An NSF/ANSI Standard 61 (2008) on a plastic tank certifies that no contaminants will leach from its surface. Specific materials and compounds used for sealing and waterproofing concrete (for cast-in-place and precast concrete tanks) also follow a certification process to eliminate leaching of contaminants.

Examples of storage tanks


ABOVE-GRADE POLYETHYLENE


BELOW-GRADE POLYETHYLENE

FIBERGLASS



CAST-IN-PLACE CONCRETE


CRATE AND BAG

Additional details of the rainwater storage tank

Installations: If a prefabricated underground storage tank is used for a rainwater harvesting system, it must comply with CSA B66 Clause 4.1. If a storage tank is going to be integrated into the building or have heavy structural loads on top of it (i.e. vehicles), the design supporting the loads must be approved by a professional engineer.

Call before you dig: Alberta ONE Call should be called to locate any underground service lines where a storage tank is planned to be buried. The installation, bedding and backfilling of storage tanks should be carried out as per Alberta Building Code (2006) and the manufacturer's installation requirements. The Alberta Private Sewage Systems Standard of Practice (2009) can also be a useful resource for these purposes.

Access: The entryway (access hatch) of storage tanks needs to be easily accessible and sized with a dimension no smaller than 450 mm (18 in). A 24" or larger access hatch is recommended to allow for physical entry and the installation and regular maintenance of any internal equipment inside the cistern. All access hatches need to be drip-proof and non-corrosive. Any persons entering the storage tank will need to comply with Part 5 – Confined Spaces of the Alberta Occupational Health and Safety Code (2009).

Tank connection and pest control: All connections to the storage tank must be properly sealed and watertight. Any additional openings that are connected to storage tanks which are larger than 150 mm (6 inches) need to have lockable covers. Any connections or openings exposed above grade should include insect or vermin screens to prevent access to the cistern.

Overflow pipe: The overflow pipe exiting the storage tank needs to be sized to match or exceed the size of the inlet conveyance pipe, and should terminate with a screen.

Calmed inlet: The conveyance pipe entering the storage tank should be brought down near the bottom of the tank and have a 90-degree bend or a U-shaped bend. This ensures incoming rainwater is directed away from the bottom of the tank, not stirring up any potential sediment that has accumulated.

Venting: Storage tanks require venting to allow for proper drainage and to release any build-up of humidity or any noxious gases. Venting through the conveyance pipe and the overflow pipe is usually sufficient for a residential installation.

Dead space: There is normally a 4" – 6" unused portion of rainwater at the bottom of the storage tank, typically called the "dead space" and retained to ensure the submersible pump or the suction line does not run dry.

Cold weather considerations: Underground storage tanks should be installed below the frost penetration depth. If this is not possible, the storage tank should be covered with rigid XTPS foam insulation or it could be located in a heated or temperature-regulated space (basement or heated garage). Above-grade storage tanks need to be drained and decommissioned during the winter.

What are the factors involved in choosing a storage tank?

Beyond the basic volume capacity, there are many factors to consider when choosing a storage tank. These include: intended rainwater use, desired storage capacity, site conditions, buried service lines and utilities, site accessibility for excavation and installation, available space for the storage tank, property right-of-ways, property setbacks, below-grade burial depth, local rainfall quantities, available roof catchment area, and budget. Refer to the table titled Storage Tank Selection in Appendix E for additional details on storage tank selection. Although most users would select only one storage tank, property restrictions, structural piles or buried utilities may require dividing your system into two or three separate tanks.

How much will a rainwater storage tank cost?

The cost of storage tanks varies significantly and is often the major cost of any rainwater harvesting system. Beyond delivery fees, prices range based on the size and type of tank and are typically less expensive for plastic polyethylene, crate and bag or above-grade tanks. Fibreglass, precast concrete and poured-in-place cisterns are the most expensive, with labour and engineering adding additional costs to each cistern choice. Consumers for residential applications should expect to pay between $0.30 – $0.75 per litre of storage.

What size storage tank will my system require?

Sizing your rainwater storage tank may be the most comprehensive component to the overall system design. Sizing will typically be based on the amount of water a homeowner wishes to conserve annually, and may involve a general estimate or detailed assessment of application use and water demands. Sizing of the storage tank will depend on the intended and combined rainwater "load," including the number of toilets in regular use, outdoor irrigation demands, roof catchment area, local rainfall quantities, and potential growth. Details on the amount of potential rainwater collection are outlined in Appendix A. How to properly size a cistern storage tank is outlined in Appendix D. Please refer to the Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice document for more information.

References

Additional information on codes, standards and guidelines that relate to the storage of rainwater are summarized in the table below.

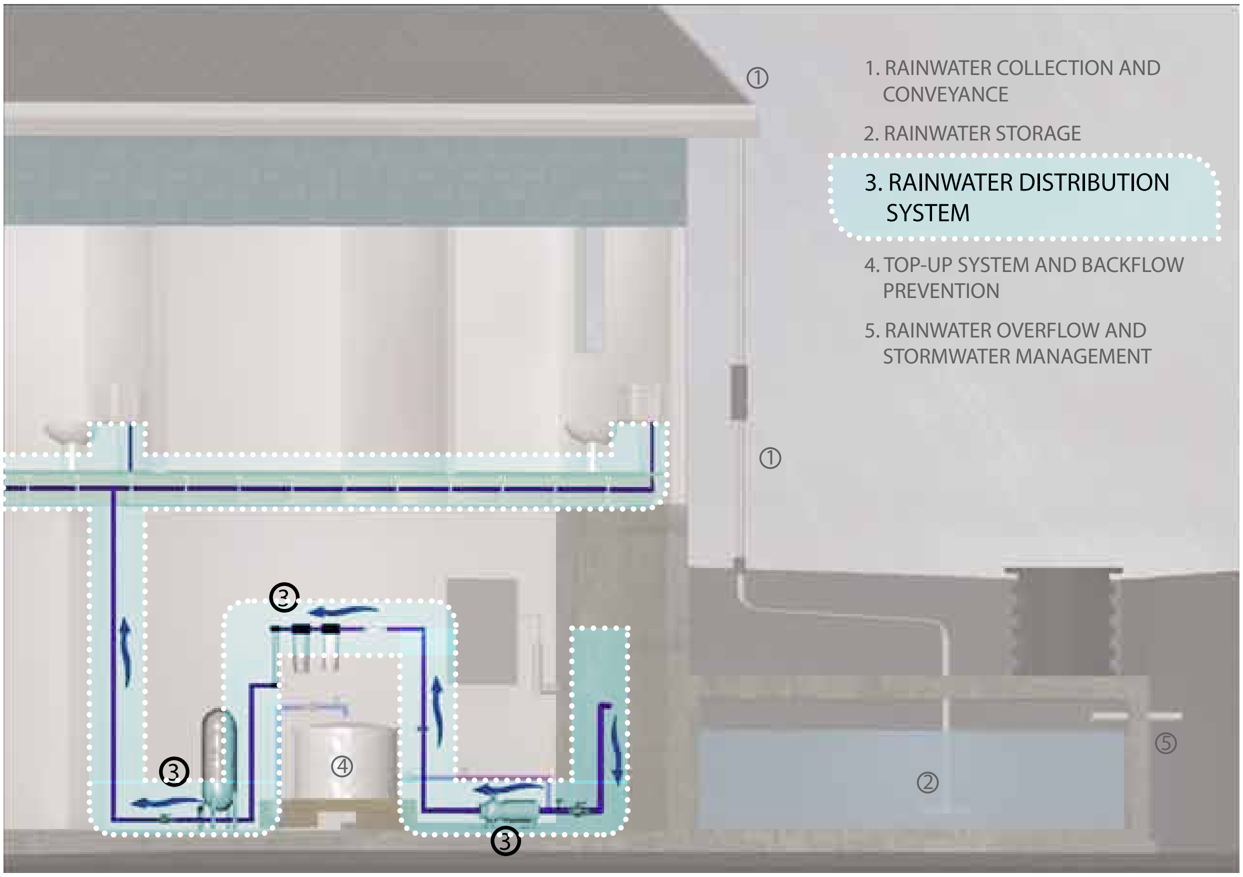
Rainwater storage	
Codes, standards and guidelines	**Applicable clauses, sections, chapters and additional info**
National Standards of Canada CAN/CSA-B128.1-06 (2007)	Clause 7.0 – Storage Tanks
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)	• Chapter 2 – Rainwater Storage and Tank Sizing • Appendix B: Rainwater Storage and Tank Sizing: Rainwater Harvesting Design Tool and Rainwater Storage Tank Sizing Table
Alberta Private Sewage Systems Standard of Practice (2009)	• Utilize as a reference for rainwater storage tanks (installations and connections) • Section 2.5.2.7. Piping Connections to Tank; 4.2.1.3. Infiltration/Exfiltration Prevention; 4.2.2.1. Separation Distances; 4.2.2.3. Septic Tank Manhole Access Not Buried; 4.2.2.6. Insulation of Tank; 4.2.2.7. Base for Septic Tank
Alberta Occupational Health and Safety Code (2009)	Part 5 – Confined Spaces

03 Rainwater distribution system

Introduction

The rainwater distribution system refers to the delivery of rainwater from a cistern into the home. Distribution systems include pumps, pressure sensors and switches, pressure tanks, dedicated plumbing lines, and additional plumbing components and parts. Consumers should be aware that distribution systems, filtration systems and top-up/back-flow systems (covered next in Section Four) work in conjunction and will likely require both plumbing and electrical inspections.

Key image



System detail

Figure 5 below details the information that will be covered in this section with respect to the rainwater distribution system, pumps, piping, components and filters. Additional information and a brief explanation of the components involved in the rainwater distribution system follow this image.

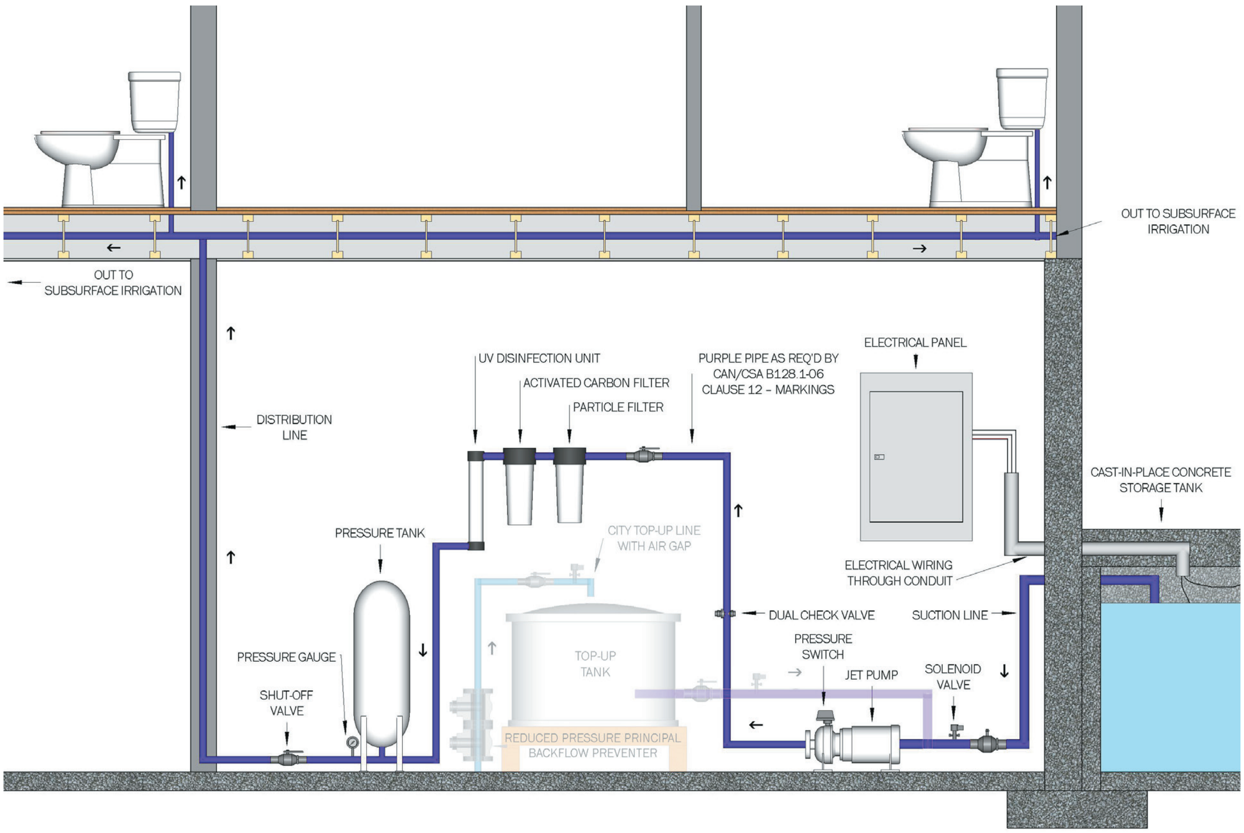


Figure 5: Distribution system

System description

Distribution systems for rainwater harvesting are comprised of pumps, pressure tanks, sensors, dedicated plumbing pipe and filters. The design and configuration of these systems is primarily dependant on the type of pump a homeowner selects: jet pumps, which are located inside the home, or submersible pumps, located inside the storage tank. See Figure 6 below for pump types and sizing considerations.

Pump type	Considerations
Jet 	• Easy to inspect, repair or replace when located inside the home. • Generally less expensive than other types. • Must be located in a temperature-controlled space, usually the mechanical room. • Must be primed and are therefore more difficult to commission. • Pump run time may be noisy and bothersome to homeowners (noise dampening or soundproofing might need to be considered).
Submersible 	• Longer lifespan. • More efficient. • Less noisy than jet pump. • Less space required inside the home. • Must be removed from tank for inspection, repair or replacement. • Pump malfunction or dry running—a state in which the pump is sucking air instead of water—can be difficult to detect.
Pump sizing	**Considerations**
How do I determine the size and flow rate of the pump?	• Where will the pump be located (inside the home, inside the tank, or elsewhere)? • How many and what types of fixtures will the pump be supplying through the distribution system (for flow rate)? • What pressure is required for the fixtures (for pump head pressure calculations)? • To what overall height will the water be pumped (for pump head pressure calculations)? • What voltage do you want to use: 120V or 240V?

Figure 6: Pump types and sizing considerations

Jet and submersible pumps are classified by their configuration as "constant speed" (CS) or "variable speed drive" (VSD), also known as "variable frequency drive" (VFD).

Constant speed pumps: When a system detects a significant pressure drop, CS pumps deliver water at a constant speed to restore the levels in the pressure tank. They typically require a larger pressure tank, which could be an issue if space is limited. CS pumps are generally less expensive than VSD pumps.

Variable speed drive: VSD pumps maintain a constant pressure while varying—increasing or decreasing—their speed. They offer the ability to use smaller pressure tanks, and some pumps have micro-pressure tanks inside the pump itself. VSD pumps are smaller, more energy efficient, and often have built-in dry run protection, ensuring that the pump never takes in air instead of water. VSD pumps are more expensive than CS pumps.

Pressure tank: Depending on the type of pump used, a pressure tank may be required. Pressure tanks maintain constant pressure in the system and reducing the time the pump must run. Pressure tanks vary in size depending on the pump installed, the amount of space available, the desired storage capacity and flow rate requirements. A pump supplier, plumber, or rainwater harvesting professional can help determine the type of equipment that best suits a system's needs.

Additional plumbing components and parts required in the distribution system are listed below:

Pressure sensor: A pressure sensor (or switch) measures the pressure within the pressure tank. If an open fixture draws rainwater from the pressure tank and the pressure in the tank goes below a determined amount, the sensor will switch the pump on until the water pressure in the tank is restored to the required amount.

Purple pipe: A key component of the rainwater harvesting system consists of the dedicated non-potable plumbing lines that comply with CAN/CSA B128.1-06 Clause 10: Separation[10] and 12: Markings.[11] All installed pipes are required to be purple in colour, distinguishing them from potable water lines. To prevent cross-connection, they must be separated from potable water lines by 100 mm for above-grade, and 300 mm for below-grade installations. All end use appliances plumbed with purple pipe must be clearly marked with a non-potable warning label.

Non-potable signage: In compliance with CAN/CSA B128.1-06 Clause 12.4, where non-potable water exits from its permitted outlet points, it must be clearly and permanently marked with a sign that is no less than 100 mm x 100 mm, which states: "Warning: Non-potable Water – Do Not Drink."

Rainwater suction pipe: Suction pipe provides a plumbing connection between an internal jet pump and the water in the cistern. As such, this pipe often penetrates the envelope of your building and must be pressure rated, suited for burial for below-grade installations, protected from freezing and sealed appropriately. Water will always be present in the suction pipe.

Rainwater distribution pipe: Distribution pipe, or purple pipe, carries rainwater to toilets and permitted use appliances within the home. Distribution pipe runs from the pump or pressure tank to non-potable fixtures.

Does my rainwater require post-storage treatment?

Despite having an initial filter which flushes the leaves and other debris from the rainwater, it is recommended that homeowners install some form of post-storage filtration and treatment device. Post storage filtration and treatment will improve the quality of water entering the home from the cistern. Typically, post storage filtration equipment requires a conditioned environment and is located in the mechanical room for filtration maintenance and electrical supply. Post storage water treatment typically consists of UV disinfection lamps, particle filters and, potentially, carbon or reverse osmosis filters. Although filtration significantly improves water quality, it is still deemed to be non-potable.

See Appendix F: Post-storage rainwater filtration and treatment, for more information.

References

Additional information on codes, standards and guidelines that relate to the distribution of rainwater are summarized in the table below.

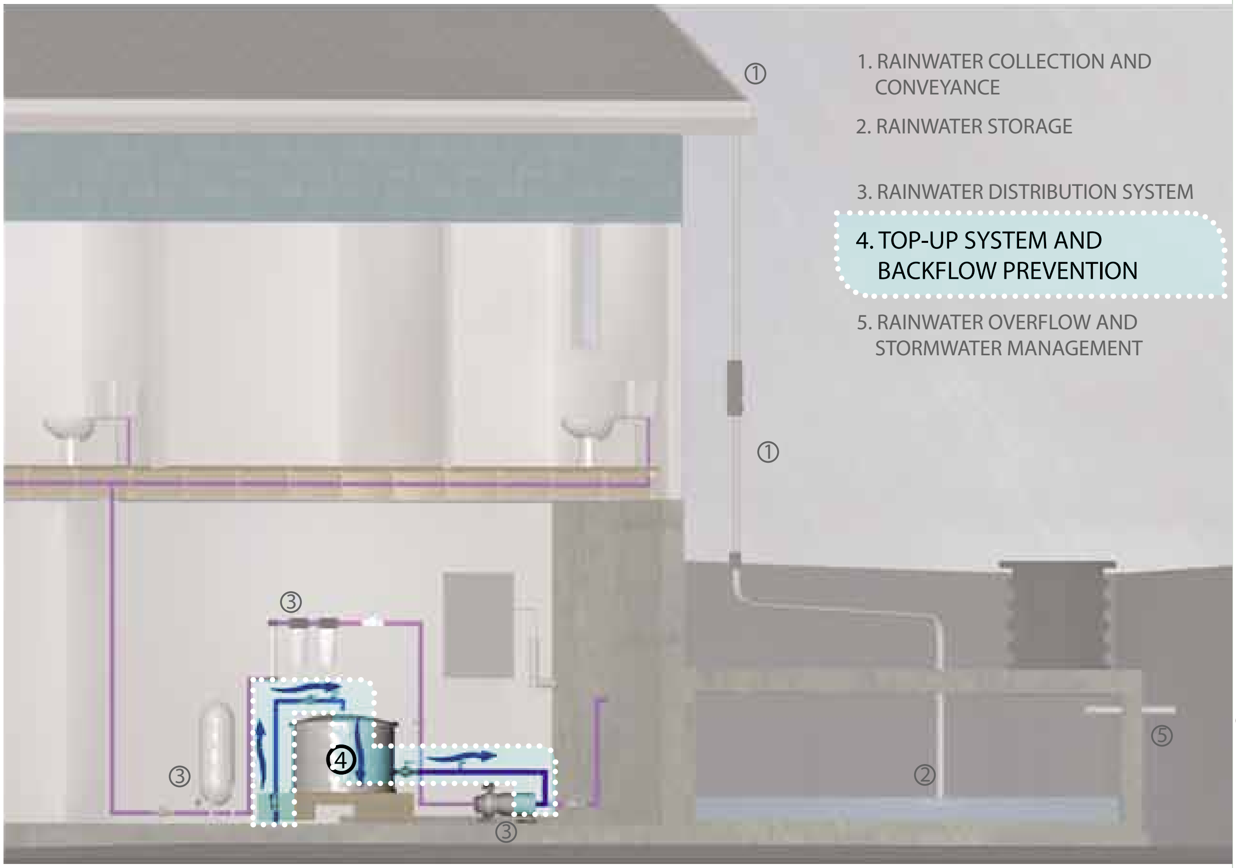
Rainwater distribution system	
Codes, standards and guidelines	**Applicable clauses, sections, chapters and additional info**
Alberta Building Code (2006)	• Section 7.2.1.2 (8) Plumbing Systems and Fixtures
National Plumbing Code (2010)	• Section 2.2.5.5 Polyethylene Pipe and Fittings; 2.2.5.7. Crosslinked Polyethylene Pipe and Fittings; 2.2.5.8. PVC Pipe and Fittings; 2.2.5.9. CPVC Pipe, Fittings and Solvent Cements
National Standards of Canada (2007) CAN/CSA-B128.1-06	• Clause 5 – Installation Requirements • Clause 9 – Pumps • Clause 10 – Separation • Clause 11 – Testing • Clause 12 – Markings
National Standards of Canada (2007) CAN/CSA-C22.2 No. 108	• Clause 9.1: Pumps must comply with CAN/CSA-C22.2 No. 108
National Standards of Canada (2012)CAN/CSA-B128.3-12	• Water quality standards
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)	• Chapter 5: Pump and Pressurized Distribution System • Appendix C: Pump and Pressurized Distribution System – Calculation of Required Pump Capacity, Calculation of Required Pressure from Pump Head, Calculation of Friction Loss, Calculation of Pressure Tank Size and Calculation of Pipe Size • Chapter 3: Rainwater Quality and Treatment
Canadian Electrical Code (2009)	• All equipment with electrical connections must be installed in accordance with relevant electrical code

04 Top-up systems and backflow prevention

Introduction

Depending on how you have sized your cistern, a lack of rainfall throughout the winter season may cause your cistern to run dry. In order to meet the home's non-potable water demands, most rainwater harvesting systems need to be replenished by The City's potable water supply. This will ensure that even if your cistern is dry, toilets can be flushed and irrigation can be automated. The potable water connection to a rainwater harvesting system is called a top-up or a make-up system, and must follow very strict precautions to prevent backflow and cross-contamination. Top-up systems are comprised of isolation valves and air gaps to ensure there is no contamination of the potable water supply from potential rainwater contaminants.

Key image



System detail

Figures 7 and 8 below detail two options for rainwater top-up systems that are discussed in this section. Additional information and a brief explanation of the components follow these images.

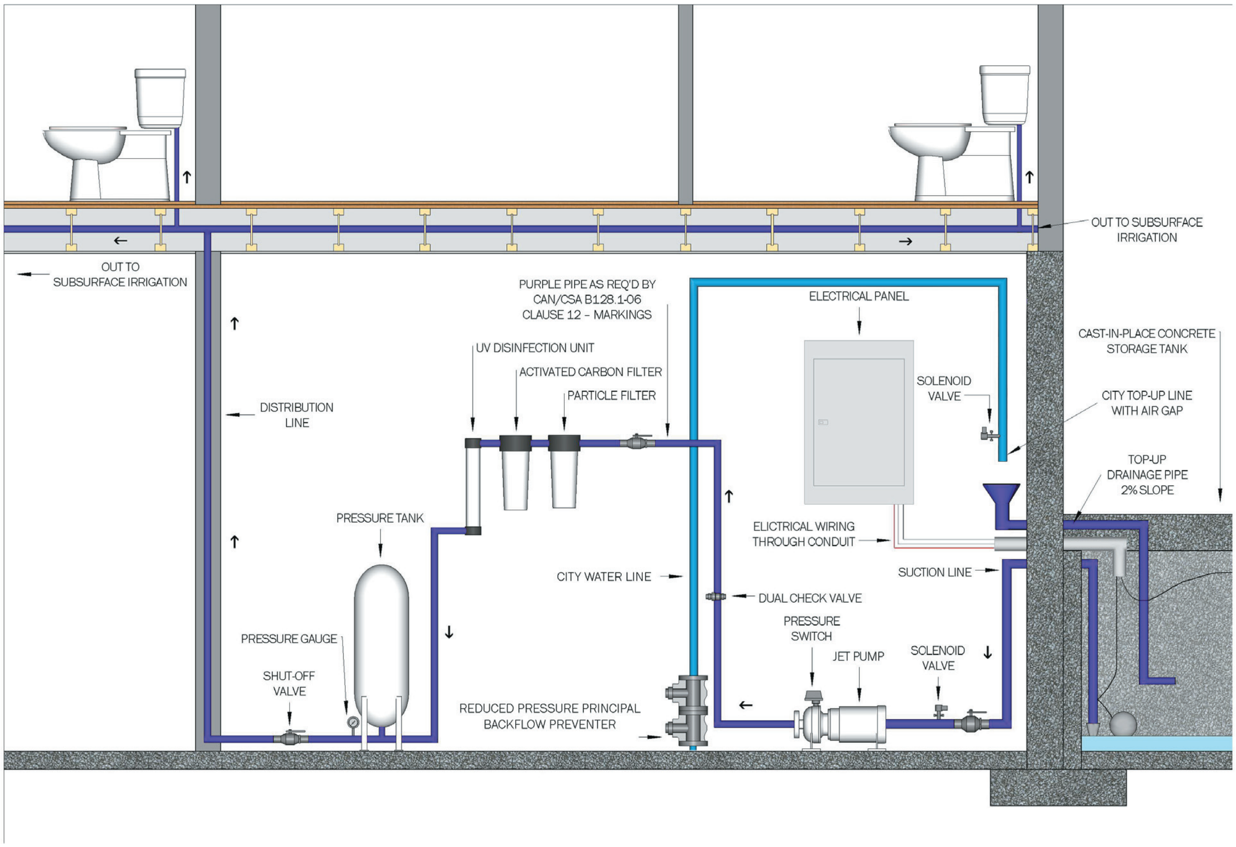


Figure 7: OPTION 1 – Top-up drainage pipe and backflow prevention.

– Need description of options.

– Top-up system feeds directly into main storage tank.

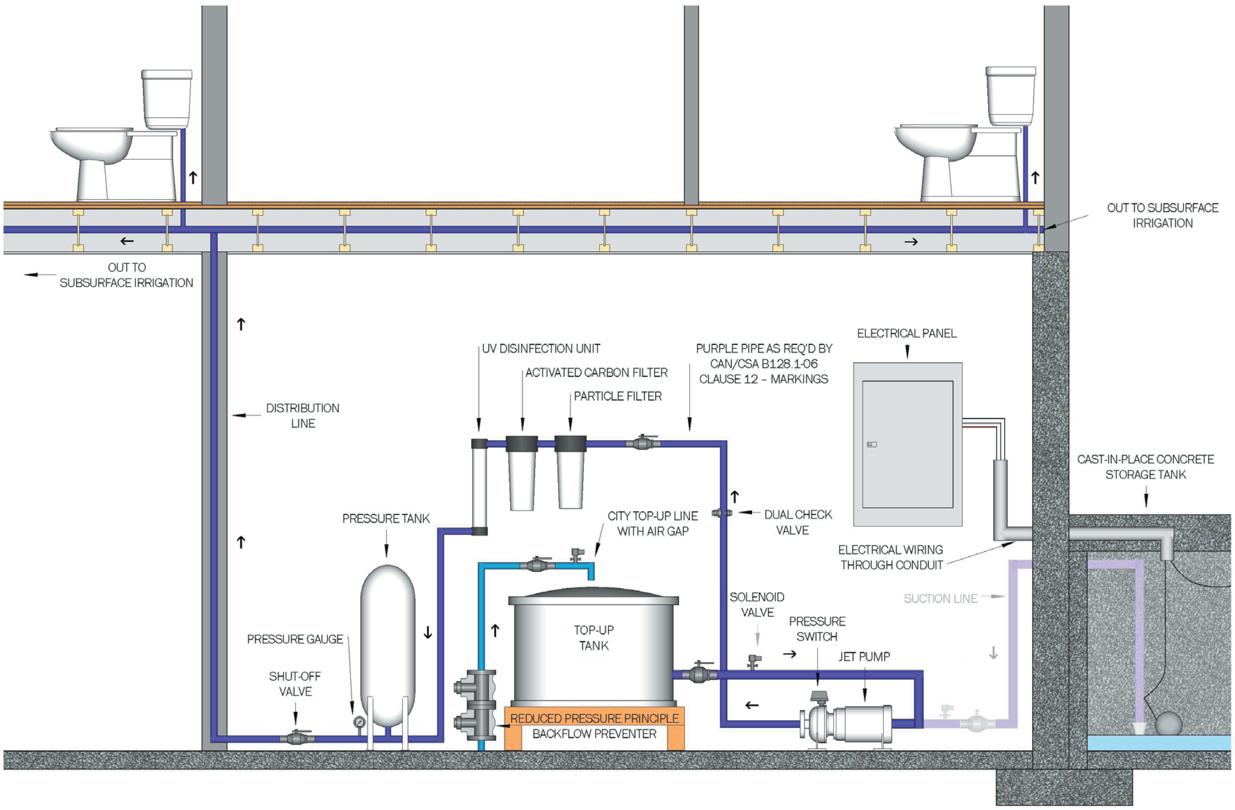


Figure 8: OPTION 2 – Top-up tank and backflow prevention.

– Need description of options.

– Top-up system bypasses main storage tank to secondary top-up tank.

System description

What happens during times of insufficient rainfall?

When stored rainwater reaches a low level in the storage tank, a control device, such as a float switch or water level sensor, activates a top-up system to replenish the rainwater system with enough water to continue functioning properly. One form of top-up system entails gravity feeding a small, pre-determined volume of City water back into the cistern (Option 1 above). City water simply replenishes the cistern water level until the float switch sensor is deactivated and the rainwater harvesting system continues to function normally.

A second option has an additional make-up tank located in the home. When the cistern float switch activates, the cistern suction solenoid valve closes, allowing the top up solenoid to open and draw City water from the small internal make-up tank located in your mechanical room. This tank then supplies all of the water to your non-potable appliances until rainwater levels have returned in the cistern (Option 2 above).

Both cistern and small top-up tank systems can be configured to replenish automatically with float switches and solenoid valves, or manually by the homeowner after the low-level switch or sensor has engaged. An automated top-up system is the recommended option to ensure water delivery at all times.

Control equipment for top-up systems

Water level sensor: There are several devices that can measure and monitor water levels within a storage tank. Some use simple float switches, while others employ more complicated equipment, such as ultrasonic sensors, pressure transducers, or floating gauges. Water level devices typically control warning lights, solenoid valves and pumps.

Float switch: A float switch is tethered to a support structure within the storage tank (and the internal top-up tank, if present), and floats or hangs depending on the water levels within. It activates an on/off setting, depending on its up/down position within the water. The float switch acts as a trigger to open or close a solenoid valve or to turn a pump on or off, both to prevent the pump from running dry and to avoid overflow.

Solenoid valve: A solenoid is an electronically controlled valve that is wired in conjunction with a float switch, which opens or closes depending on the up/down position of the float switch. In an automated top-up system, a low-water level float switch triggers the connected solenoid valve on the suction line to close. A second solenoid valve on the top-up system opens to allow City water to flow.

Shut-off valve: Shut-off valves are installed in the distribution system and are manually operated to isolate or shut off a piece of equipment or section of pipe.

NOTE: Control equipment, including top-up drainage pipe, backflow preventers and all valves, must be sized to operate properly. Most of the control equipment in a top-up system requires power. Proper attention must be taken to tank location and adequate gaskets to ensure that electrical wiring is waterproofed. A rainwater harvesting professional and certified electrician should be consulted for the installation and code compliance of all top-up control equipment.

How do I prevent backflow and cross-contamination?

Backflow and cross-contamination is when the possibility of rainwater entering the potable water system exists. Despite The City's pressurized water supply, contaminants from rainwater can work their way back through the potable water supply, which can lead to serious community health risks. As such, premise isolation and an air gap or "zone protection" are mandatory to prevent the possibility of cross-contamination between these two water supplies. Both are fundamental components of any rainwater top-up system.

Premise isolation: A backflow prevention device, such as a reduced pressure principle backflow preventer, is required to be installed on the main City water supply line entering the home. This device ensures that non-potable water within the home cannot backflow and contaminate the City's main potable water line. Backflow preventers must comply with CAN/CSA-B64.10.[12]

Air gap (zone protection): The greatest risk of cross-contamination between potable and non-potable water supplies exists in the top-up system. An air gap is a required form of zone protection that prevents the possibility of backflow in the top-up system. The air gap allows water to fall freely from one pipe into a storage tank, like running your kitchen faucet into a bucket. The air gap typically consists of one pipe that delivers water into a funnel-shaped collection pipe, creating a failsafe physical separation between potable and non-potable water lines. This gap must be visible inside the home and located above the overflow discharge of the rainwater storage tank so that it cannot backflow into the top-up line. It must be installed above the collection point at a minimum of 25 mm (1") higher, or twice the diameter of the potable top-up water line.[13]

References

Additional information on codes, standards and guidelines that relate to the top-up and backflow prevention of rainwater are summarized in the table below.

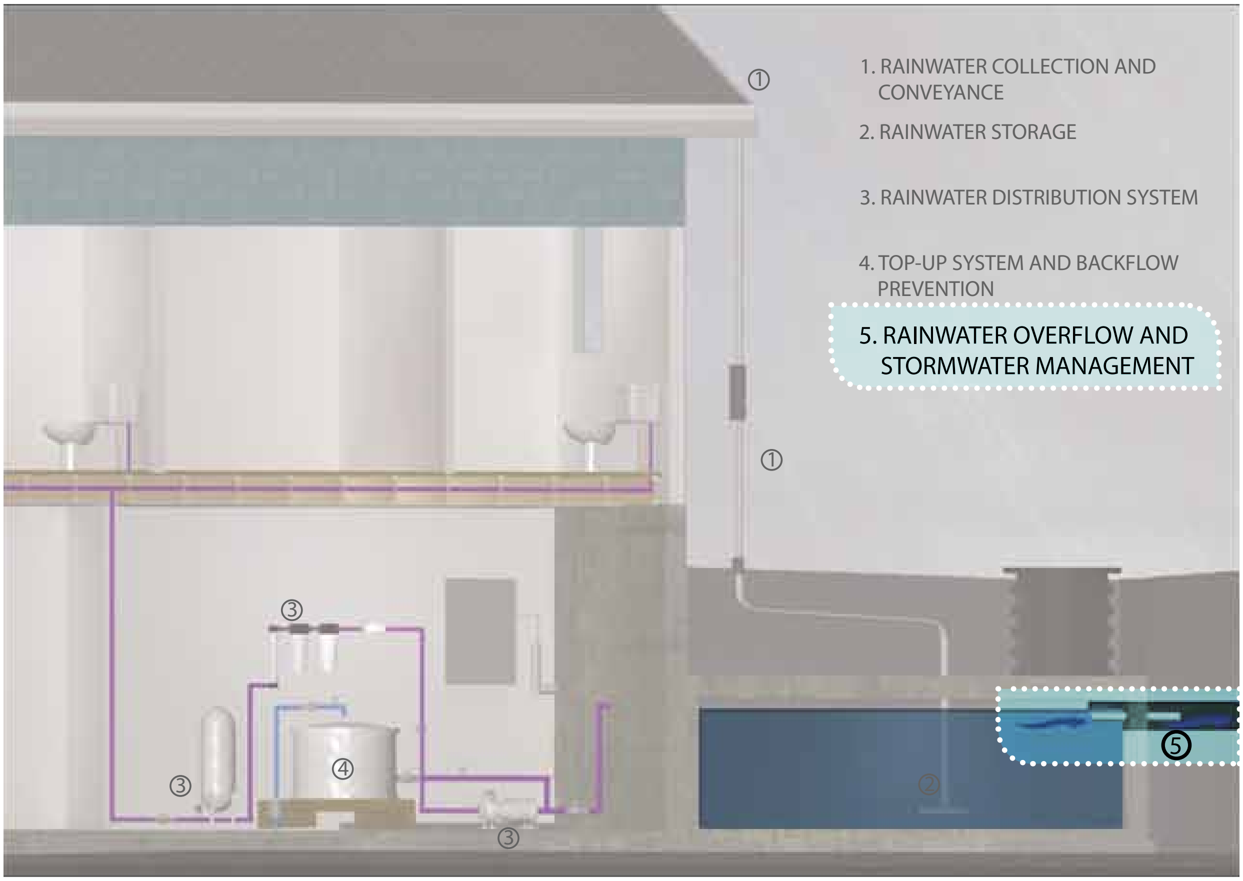
Top-up system and backflow prevention	
Codes, standards and guidelines	**Applicable clauses, sections, chapters and additional info**
Alberta Building Code (2006)	• Section 7.2.1.2 (8) Plumbing Systems and Fixtures
National Plumbing Code (2010)	• Section 2.2.10.15 Water Hammer Arresters; 2.6.1.11 Thermal Expansion; 2.6.2.1 (3) Connection of Systems; 2.6.2.6 Premise Isolation; 2.6.2.9 Air Gap; 2.7.1.1 Not Permitted
National Standards of Canada (2007) CAN/CSA-B128.1-06	• Clause 6 – Backflow Prevention • Clause 11.2 – Cross-Connection Test
National Standards of Canada (2001) CAN/CSA Standard B64.10	• Appendix B – Table B1 • Section 4.3.4.2 Premise Isolation • **NOTE:** NPC (2005) refers to CAN/CSA B64.10 (2001)
National Standards of Canada (2007) CAN/CSA Standard B64.10	• Appendix B – Table B1 • Section 5.3.4 Premise Isolation
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)	• Chapter 4: Make-up Water System and Backflow Prevention
Canadian Electrical Code (2009)	• All equipment with electrical connections must be installed in accordance with relevant electrical code

05 Rainwater overflow and stormwater management

Introduction

In the event of an undersized cistern or excessive rainfall throughout the season, rainwater may fill the cistern storage tank and overflow. All rainwater harvesting systems must incorporate a suitable and permitted overflow discharge system to adequately distribute rainwater that can do longer fit within the cistern. Overflow systems must be sized similarly to the conveyance supply of water and consider site restraints, permitted tie-in to City infrastructure and potential landscaping and stormwater management practices. Please refer to the Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice document for more information.

Key image



Four main factors apply to the choice of an overflow discharge location:

1. Stormwater management requirements: There may be special requirements enforced by the municipality. The home or building may be located in an environmentally sensitive area, or the stormwater system may not be able to handle extra stormwater flows. Connection to the public drainage system is subject to City of Calgary Water Resources' approval as part of an overall stormwater management plan.

2. Applicable Provincial codes, regulations and municipal bylaws: There may be restricted locations and methods of discharging overflows. Refer to the table under References in this section for a detailed listing.

3. Location of the storage tank: Discharging overflow from below-grade tanks is more complicated than discharging from above-grade tanks.

4. Site conditions: Topography, available space and presence of buried service lines affect the overflow discharge location.

The easiest method of overflow discharge is to gravity feed the overflow to grade and manage it within the homeowner's property. Gravity fed systems require significant elevation changes in the property to allow an above- or below-grade tank to drain below the elevation of the cistern overflow pipe downhill and away from other structures. The final discharge should be controlled to prevent erosion of soils and property.

The most common method of discharging overflow with a below-grade cistern is to pump the excess water to grade with a separate, dedicated overflow pump. The pumped overflow should be directed to a landscaping feature, such as a rain garden or stormwater retention pond where water eventually evaporates.

Pumping overflow water from the cistern into The City's stormwater collection infrastructure requires a backflow prevention valve, Development Permit application and approval. This method may not be permitted by the municipality because it increases the strain on the municipal stormwater system, or it may be unavailable to homes and properties in older neighbourhoods with limited stormwater connections. Refer to Water Resources' Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice for additional information.

Reference Figure 9 below for considerations to the management of overflow.

Overflow pipe: It is recommended that the overflow pipe exit the rainwater storage tank at 50 mm (2") below the height at which the rainwater conveyance pipe enters the tank. At a minimum, the overflow pipe must be at the same height or lower than the conveyance pipe. This will ensure that excess water will not back up the conveyance pipe. A filter or screen is recommended at the end of each overflow pipe to prevent insects and pests from entering the cistern.

Larger scale stormwater management systems are not specifically addressed in these guidelines. Overflow for multi-family or commercial buildings may require additional stormwater management in order to ensure a controlled release of overflow into the stormwater system. Management of larger overflow volumes often relies on a detention tank, or dedicated volume in the existing cistern to automatically discharge excess volumes with predetermined rates and control valves. Refer to Water Resources' Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice for additional information.

Overflow management	
Discharge method	**Considerations**
To grade via gravity flow. Most applicable for above-grade tanks; more difficult for below-grade tanks, unless the site has a hill or elevation change to allow for appropriate discharge.	• Easiest method to design, install and manage. • Low probability of rainwater to backflow up drainage pipe. • Can be used to feed a rain garden. • May cause soil erosion at discharge point if not installed properly. • Could be a safety concern during large overflows. • Piping could freeze in cold weather (piping needs to be installed appropriately to mitigate this problem).
To grade via pump-assisted flow. Applies to below-grade or integrated tanks, without the ability to discharge via gravity to grade; discharge outlet must be located so that all flow stays within the property limits.	• Used only when gravity flow is not an option. • Pump could break down or become inoperable in a power outage. • Larger pump may be required to handle excessive overflows.
To storm sewer via pump-assisted flow. Applies to below-grade or integrated tanks without the ability to discharge via gravity to the storm sewer.	• Pump could break down or become inoperable in a power outage. • Larger pump may be required to handle excessive overflows.

Figure 9: Overflow management and considerations

References

Additional information on codes, standards and guidelines that relate to the overflow of rainwater and stormwater management are summarized in the table below.

Rainwater overflow and stormwater management	
Codes, standards and guidelines	**Applicable clauses, sections, chapters and additional info**
National Plumbing Code (2010)	• Section 2.4.2.2 (1) Connection of Overflows from Rainwater Tanks
National Standards of Canada (2007)	• CAN/CSA-B128.1-06 • Clause 7 – Storage Tank • Clause 7.7: The capacity of the overflow(s) shall be no less than the capacity of the inlet(s) • Clause 7.8: If the storage tank is intended to store non-potable water from sources other than stormwater, the overflow(s) shall be connected to the sanitary drainage system. If the storage tank is intended to store stormwater only, the overflow(s) shall discharge in accordance with local regulations
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)	• Chapter 6: Overflow Provisions and Stormwater Management • Appendix D: Overflow Provisions and Stormwater Management – Utilizing a Rainwater Storage Tank for Retention and Detention for Stormwater Management Purposes
Stormwater Management Guidelines for the Province of Alberta (1999)	• Section 6.3.3 On-lot Infiltration Systems
Alberta Private Sewage Systems Standard of Practice (2009)	• Section 7.1.1.2 (2), (3) Site Evaluation; Section 7.1.2.1 Number of Soil Profiles Investigated; Section 7.1.2.2 Minimum Depth of Soil Investigation
Drainage Bylaw 37M2005	• Section 6: Directing Stormwater Drainage
Community Standards Bylaw 5M2004	• Section 41: Water Eavestroughs and Downspouts

06 Rainwater harvesting system maintenance best practices

Introduction

Every installed rainwater harvesting system will require ongoing maintenance. Maintenance of the system's components must be carried out by the homeowner, unless there is an alternative maintenance agreement with the builder or contractor who installed the system. The suggested maintenance frequency and requirements of the rainwater harvesting system's components are highlighted in the tables below.

Section 1: Rainwater collection and conveyance		
Inspection item	**Inspection frequency**	**Maintenance requirement**
Roof surface	Every six months.	• Hose down or sweep the roof surface to remove dirt and debris, making sure not to allow dirt and debris to enter the conveyance pipe. • Trim overhanging trees and foliage.
Conveyance network • Eavestroughs • Downspouts • Downspout to conveyance pipe connection	Every six months.	• Remove accumulated dirt, debris, leaves, etc. • Install eavestrough screens to reduce debris entering eaves. • Inspect downspout to conveyance pipe connections to make sure they are secure. • Repair damaged sections as needed.
Pre-storage treatment component • Gutter guard • First-flush device • Leaf beater • In-ground filters • Settling chamber	After several rainfall events, or as outlined by manufacturer.	• Clean out the first-flush chamber and other pre-storage devices to guarantee that they are free of accumulated debris. • Certain devices are designed to be self-cleaning. • Winterize or decommission for the winter months. • Investigate impact of traffic or pets on in-ground filters.
Conveyance pipe	Periodically in cold weather.	• Remove ice buildup. • Winterize if required with insulation and/or heat trace wire.

Section 2: Rainwater storage		
Storage tanks: above and below grade	Once annually: inspect inside of tank.	• Leakage: Repair cracks and connections as needed, following manufacturer's specifications and all safety precautions regarding confined spaces. • Sediment and debris buildup: Pump out accumulated sediment and debris using an appropriately sized effluent or sump pump. • Freezing below grade: Install the cistern below frost penetration depth, winterize with insulation or heating system, install in heated or temperature regulated space (basement or heated garage). • Freezing above grade: Decommission and drain during winter months. • Pest control: Ensure any screens on pipes exiting the storage tank (i.e. overflow pipe) are in place and in good repair.
NOTE: Entry and inspection of storage tanks must be carried out by following Part 5 – Confined Spaces of the Alberta Occupational Health and Safety Code (2009) and all additional safety precautions.		
Section 3: Rainwater distribution system		
Pump and pressurized distribution system	Once annually	• Check that the pump and pressure system are functioning properly. • Inspect for pump wear and overheating. • Ensure there are no leaks in the distribution plumbing lines. • Check the pressure system when no demands are placed on it. If the pump continually cycles on and off, there may be a leak in the distribution plumbing lines, or an issue with a foot or check valve.
Non-potable warning labels	Once annually	• Ensure they are present, and replace as necessary.
Post-storage filtration and treatment devices Filters, disinfection units and other devices.	Every three months or as outlined by manufacturer	• Replace filters or filter media. • Maintain disinfection units by replacing UV lamps or chlorine. • Clean or replace other components.
NOTE: If issues arise with the pump or pressurized distribution system, refer to Alberta Guidelines for Residential Rainwater Harvesting Systems, Chapter 5.5: Management Guidelines (pp. 75-77), for comprehensive troubleshooting details.		

Section 4: Top-up system and backflow prevention		
Top-up system: float switches, solenoid valves, top-up drainage piping	Every six months, even if functioning properly, or as needed when issues arise.	• Ensure the appropriate control equipment was chosen and installed properly. • Visually inspect the amount of water in the storage tank to see if top-up should be occurring. • Verify that electricity is supplied to all necessary equipment (pump, solenoid valves, water level sensor, float switches, etc.). • Ensure that a closed valve is not restricting the potable water supply. • Verify top-up tank area in mechanical room is dry; exhaust humid rooms with fan.
Backflow preventer and air gap	Once annually	• Refer to CAN/CSA-B64.10.1-07 Maintenance and Field Testing of Backflow Preventers.
NOTE: If the issue is not found in a preliminary inspection, refer to Alberta Guidelines for Residential Rainwater Harvesting Systems, Chapter 4.5 Management Guidelines (pp. 57-59), for comprehensive maintenance information.		

Section 5: Rainwater overflow and stormwater management		
Discharge pipe: above grade	Once annually	• Examine discharge location for erosion. If there are signs of erosion, install a “splash pad” or section of rock or gravel. • Inspect the screen of the lockable cover at the end of the discharge pipe and remove any dirt and debris buildup. • Inspect drainage pipe for dirt and debris buildup, and remove as needed to prevent clogging.
Discharge pipe: below grade	As needed: when the overflow system is blocked or performing poorly.	• Check for signs of water damage to the rainwater tank, access hatch, and internal components located above the maximum water level. • Check for signs of water leakage from the access hatch. • Check for signs of water leakage from the downspout to conveyance pipe connection and the top-up system air gap.
NOTE: If there are ongoing issues with the overflow system, refer to subsection 6.5 Management Guidelines (page 90) of the Alberta Guidelines for Residential Rainwater Harvesting Systems for additional troubleshooting details.		

07 Homeowner's checklist and maintenance log

This checklist ensures that adequate information is collected during the installation phase of the rainwater harvesting system. It can be used as a diagnostic tool in the event of a problem within the system, and should be passed on to a new homeowner after a home sale. This checklist also serves as a maintenance log for the ongoing upkeep of the rainwater harvesting system (as per CAN/CSA-B128.2-06 Clause 5.2 – Maintenance).

1. What type of roofing material is used? Asphalt ____ Metal ____ Other ______________________________

2. Do trees or foliage overhang the catchment surface? Yes ______ No ________
How will it be managed? ____

3. Are downspouts located close to the storage tank? Yes _______ No ________
Explain ____

4. What pre-storage treatment devices are installed? Eavestrough screen _________ Downspout filter ________
First-flush device __________ In-ground filter _________ Settling chamber _________ Other _________________
N/A ___________ Explain ____

5. Are the pre-storage treatment devices winterized or decommissioned?
Winterized _____ How? ____
Decommissioned _______ How? ____

6. What type of conveyance pipe is used? PVC SDR35 ______ PVC system 15 (Schedule 40) ______ ABS _____
Other ____

7. What is the conveyance pipe's slope? 0.5%–2% ________________ 2% _____________ >2% ____________

8. At what depth is the conveyance pipe buried? ____________________ metres (or __________________ feet)

9. Is insulation installed above the conveyance pipe? Yes ______ No _______
Explain ____

10. What is the insulation type and thickness? _________ mm (or _______ inches) Type: _________ N/A ________

11. Is the conveyance pipe heat traced? Yes _______ No _______ Explain ________________________________

12. Is tracer wire (for locating buried non-metallic pipe) installed above the conveyance pipe?
Yes _____No_____Explain ____

13. What is the storage tank type? HDPE ______________ Fiberglass _____________ Cast-in-place___________
Precast concrete __________Crate and bag ___________ Other ____

14. What is the storage tank size? _____________ litres (or ___________ US gallons)

15. Where is the storage tank located? Above grade__________ Where?_____________________________
Below grade___________ How deep?____
Building integrated _______________ Where?____

16. What type of post-storage treatment is used? Particle filter ________ Micron _________ Other filter _______
UV disinfection _________ Chlorination _________ Ozonation __________ Other disinfection _________________

17. Is the required purple pipe (or purple marking) installed on the suction and distribution pipe?
Yes _____ No ____ Explain ____

18. Is the required "Warning: Non-potable Water — Do Not Drink" signage installed at each non-potable outlet point? Yes ______ No _______ Explain ____

19. Is the pump appropriately rated for the number of fixtures and pump head? Yes __________ No __________
Explain ____

20. Is the pressure tank appropriately sized for the installed pump? Yes ________________ No ______________
Explain ____

21. How is the top-up system installed? Automated ____________________ Manual _______________________
Internal top-up tank _________________________ Gravity feed into main storage tank ______________________

22. Is the control equipment of the top-up system functioning properly?
Yes _____ No ____ Explain ____

23. What type of backflow and cross-connection prevention methods are used?
Air _____________ Devices ________ Explain ____

24. What method of overflow control is installed?
Gravity fed to grade _____________ Pump to grade ________________ Pump to storm sewer _______________
Explain ____

25. Has the rainwater system and all of its components been thoroughly explained to the homeowner?
Yes _____ No ____ Explain ____

26. How will the rainwater harvesting system be maintained? Homeowner _____ Rainwater system installer ____
Both _______ Explain ____

08 Important contact information and useful links

The City of Calgary Development and Building Approvals
Phone: 311
calgary.ca/PDA/DBA/Pages/home.aspx

Alberta One-Call Corporation (Call Before You Dig)
Phone: 1-800-242-3447
www.alberta1call.com/index.html

Alberta Municipal Affairs
Public Safety Division
Phone: 1-866-421-6929

Alberta Municipal Affairs
Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010)
www.municipalaffairs.alberta.ca/documents/ss/STANDATA/plumbing/AlbertaHandbook2010.pdf

The City of Calgary Water Resources
Visit calgary.ca and search water resources

List of abbreviations: Rainwater Harvesting Guidelines: for internal non-potable use

ABS: Acrylonitrile Butadiene Styrene; hard, black plastic pipe commonly used in plumbing systems.

CSA: Canadian Standards Association; non-profit, member-based organization testing products and materials to ensure they meet recognized safety and manufacturing standards.

DBA: Development and Building Approvals; The City of Calgary business unit that deals in the review and inspection of building projects.

HDPE: High-density polyethylene; type of plastic, notable for its durability and relative chemical inertness.

NPC: National Plumbing Code; document stating the health safety and installation practices for plumbing systems in Canada.

NSF: National Sanitation Foundation; non-government, non-profit organization that develops standards related to public health and safety, notably with respect to water and sanitary services.

PVC: Polyvinyl chloride (plastic); type of plastic used in many construction materials and pipes requiring corrosion resistance and durability.

SDR: Standard Dimension Ratio; the ratio of pipe diameter to wall thickness, expressed as the diameter of the pipe divided by the wall thickness. For a given diameter, the lower the number, the stronger the pipe will be.

WR: Water Resources; The City of Calgary business unit that manages the distribution and quality of the municipal water supply.

XTPS: Extruded polystyrene; fine grained foam plastic insulation board used for insulating materials that may be subject to periodic wetting; not to be confused with expanded polystyrene.

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Appendices

APPENDIX A: COLLECTION VOLUME CALCULATION

APPENDIX B: PRE-STORAGE FILTRATION AND TREATMENT

APPENDIX C: CONVEYANCE PIPE WINTERIZATION

APPENDIX D: STORAGE TANK SIZING

APPENDIX E: STORAGE TANK SELECTION

APPENDIX F: POST STORAGE RAINWATER FILTRATION AND TREATMENT

APPENDIX A:

COLLECTION VOLUME CALCULATION

How much water can be collected?

Roof size is the predominant factor in the amount of rainwater that can be collected in a rainwater harvesting system. The larger your roof, the more potential you have to collect rainwater. As noted in Section One, consideration must be given to downspout locations and conveyance pipe length to ensure that water can be directed into your cistern. Similarly, collection from multiple roof surfaces can be co-ordinated and directed into one central storage tank.

In theory, one litre of water can be collected for every millimetre of rainfall landing on one square metre of collection surface.

Total Roof Area (m^2) x Annual Rainfall (mm) = Potential Collection (L)

Calgary's rainy season typically spans the months of April to October, with an average of 320.6 mm[1] of rainwater per year. According to the equation above, a house with a total roof area of 102 m^2 (1,100 ft^2), has the capacity to collect 32.7 m^3 or 32,700 litres of rainwater from this annual rainfall.

Although the formula above provides a guide on the total potential annual collection volume, there will be losses due to: the wetting of roof surfaces; the evaporation off of a hot roof surface; pre-storage treatment devices; and various environmental factors such as wind.

Calculating your potential rainwater collection volume must take into account these initial losses. Reference Table 1 for example values of the initial wetting factor and collection efficiency ratio factors attributed to various roof catchment surfaces.[2]

Approximate wetting factors and collection efficiencies for various roof surfaces

Roof catchment material	Initial wetting factor (mm)	Collection efficiencies (%)
Metal roof	0.25	80.0
Asphalt shingle roof	0.5	80.0
Fiberglass roof	0.5	80.0
Asphalt built-up flat roof	1.5	80.0
Rubber flat roof	1.5	80.0
Wood shingles	Varies	Varies – assume 80.0
Clay tiles	Varies	Varies – assume 80.0

Table 1: Wetting factors and collection efficiencies

In addition to the losses expressed above, local climatic variations in Calgary will alter collection amounts. For instance, rainfalls can be localized, occurring in some areas of the city only. Rainfall amounts also vary greatly from season to season and even year to year. To better assist in sizing rainwater harvesting systems, it is recommended that rainfall volumes be analyzed on a daily basis. Collection volumes on any given day for your area can be taken from Environment Canada's National Climate Data and Information Archive: Weather offices.

Symbols and Notes:

1 m^3 = 1,000 L

CV = Collection volume associated to a daily rainfall (m^3)*

RA = Roof area (m^2)

CE = Collection efficiency of the roof surface
(including losses from Pre-storage Filtration) (%)

DR = Daily rainfall (m)
NOTE: Convert rainfall from millimetres (mm) to metres (m).
1 mm = 0.001 m

WF = Wetting factor (m)
NOTE: Convert rainfall from millimetres (mm) to metres (m).
1 mm = 0.001 m

Equation:

$$CV = [RA \times CE \times (DR - WF)]$$

Example:

June 6, 2004 = 45.8[3] mm of rainfall
90mm of rain/30 days = 3mm/day
Asphalt roof area = 102 m^2 + 80% efficiency factor
$CV = [102\ m^2 \times 0.8 \times (0.0458\ m - 0.0005\ m)]$
CV = 3.696 m^3 or 3,696 litres

The large storm event on June 6, 2004 could produce 3,696 litres of rainwater for a roof area of 102 m^2.

***NOTE:** To calculate the expended daily rainfall overages, divide the average monthly rainfall (in mm) by the number of calendar days.

What size of storage tank should I choose?

The capacity of the storage tank will also be a factor in the amount of rainwater collected. Once a storage tank is full, the additional rainwater, called overflow, is discharged and therefore not available for future use. Sizing of storage tanks is discussed in Appendix D.

APPENDIX B:

PRESTORAGE RAINWATER FILTRATION AND TREATMENT

Pre-storage filtration devices are usually simple in design, and separate debris from rainwater before it moves down through the conveyance pipe and into your cistern. Most pre-storage filtration devices are gravity fed from the downspout and are designed to discard a small portion of the initial rainwater runoff. Discarding the initial rainwater runoff eliminates the most polluted water as it contains leaves, dirt, debris and bird and animal droppings which accumulate between rainfall events.

Pre-storage rainwater filters will minimally decrease the overall harvesting capacity, and have been included in the collection efficiency calculations in Appendix A.

See Table 2 below for types and considerations of pre-storage rainwater filtration and treatment. Refer to the Water Resources (WR) document titled Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice for comprehensive information on pre-storage treatment.

Pre-storage rainwater filtration and treatment	
Type	**Considerations**
Eavestrough screens and gutter guards	• Prevents leaves, branches and other large debris from entering the eavestrough/gutter and downspout.
Downspout filter (i.e. Leaf Beater™)	• Prevents leaves, branches and other large debris from entering conveyance pipes.
First-flush diverter	• Discards (flushes away) a predetermined amount of initial rainwater that is typically the most polluted.
Settling chamber	• Settles out debris and particulates in a chamber that is sized for a predetermined amount of initial rainwater.
In-ground filtration device	• Disposes of debris and predetermined amounts of initial rainwater underground. • Not permitted for use in Calgary if bypass device is connected to the sewer system to accommodate disposal.
NOTE: Depending on the type of pre-storage treatment device, winterizing and/or decommissioning may be required.	

Table 2: Types and considerations for pre-storage rainwater filtration and treatment

APPENDIX C:

CONVEYANCE PIPE WINTERIZATION

What considerations should be taken for Calgary's winter weather?

Collecting snow melt during chinook days throughout Calgary's winter is possible, but will require additional infrastructure and material. If a homeowner wishes to collect snow melt during the winter months, the conveyance pipes should be buried below Calgary's frost penetration depth (≈ 1.83 m).

For extra precaution in preventing snow melt from freezing inside the pipe, it is recommended that XTPS rigid foam insulation be installed above the pipes. For shallow conveyance pipe, another option is to heat the pipe with heat tracing wire (electrical resistance wire that warms the pipe). It must be noted that this method is energy intensive and may not be the most suitable option for the energy conscious homeowner.

Refer to Table 3 for the minimum thickness of insulation to be used in relation to the conveyance pipe burial depth (i.e. the amount of backfill over the insulation).

Winterizing: insulation above buried conveyance pipes	
Pipe burial depth and amount of backfill over the insulation	**Minimum thickness of rigid XTPS foam insulation**
≤ 0.6 m	100 mm
≤ 0.9 m	90 mm
≤ 1.2 m	75 mm
≤ 1.5 m	65 mm
≤ 1.8 m	50 mm
≤ 2.1 m	40 mm
NOTE: Calgary's frost penetration depth ≈ 1.83 m	
Recreated from the Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010).	

Table 3: Thickness of rigid XTPS foam insulation above buried conveyance pipes

Winterization detail conveyance

The width of rigid XTPS foam insulation to install above the conveyance pipe varies depending on three factors: the local frost penetration depth (Calgary's frost penetration depth is approximately 1.83 m), the depth of the insulation, and the diameter of the pipe. The width of insulation to be installed above conveyance pipe can be calculated using the equation shown in Figure 1 below:

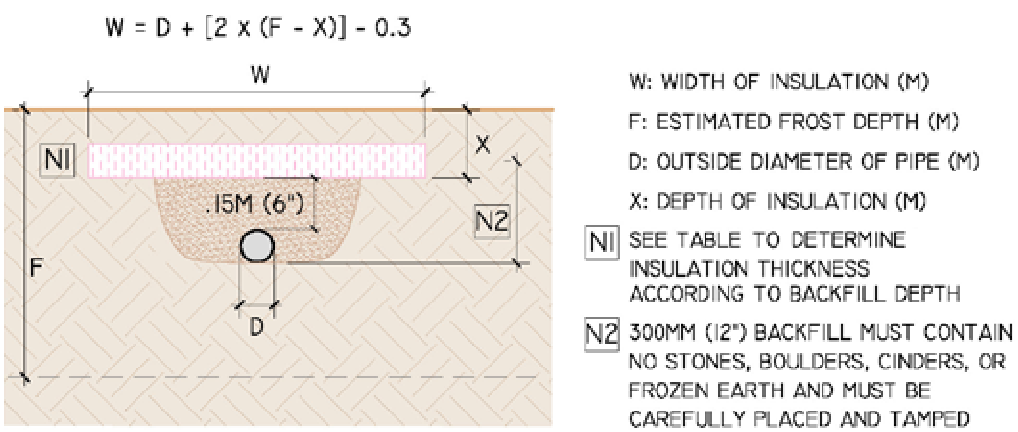


Figure 1: Insulation requirements above pipe

APPENDIX D:

STORAGE TANK SIZING

Sizing your cistern is often the most complex component of any rainwater harvesting system. Locating where on your property the cistern is located might determine its final size and should consider the location of buried service lines, space limitations, site accessibility, property setbacks and aesthetics if the cistern is to be located above grade.

Sizing of the cistern storage tank itself is dependent on the total annual rainwater load and seasonal provision of water. Homeowners should list their intended rainwater uses (i.e. number of toilets/urinals in regular use and outdoor irrigation demands), to understand their rainwater load. Cistern storage tanks maybe sized for future permitted uses or stormwater control reasons as well.

In each case, the total rainwater load volume must be compared to the total potential collection volume, as well as roof catchment area, local rainfall quantities, and stormwater management requirements. Finally, cistern sizing must take into account the amount of water stored from summer rainfall events to adequately provide water during winter periods, when water collection is limited.

What size storage tank will my system require?

Adequately sizing your system must compare your average daily collection of rainwater to the average daily rainwater load. In Calgary, daily rainfall amounts vary significantly from year to year. SAIT Polytechnic, alongside other research institutes, the authors of the Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010), product manufacturers and Water Resources' Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice have a developed comprehensive calculation tools for properly sizing cisterns based on historical average daily rainfall data.

Local rainfall quantities: Calgary does not receive consistent rainfall from spring to fall, which in turn does not consistently replenish the rainwater in a storage tank. A homeowner or contractor may choose a larger tank size to store rainwater when the opportunity arises and provide prolonged storage during rainfall shortages.

Stormwater management: If the home has a small yard, or a new home is being built under a green building program (such as LEED®), on-site stormwater management may be achieved by sizing the storage tank for retention purposes.

NOTE: Oversizing a tank potentially wastes money and space, but it may allow for prolonged storage and use of rainwater into the winter months when rainfall has ceased. Undersizing a tank might lead to chronic overflowing and limited rainwater use. Many rainwater harvesting professionals simplify their calculations by comparing the roof area to potential daily use. These charts are a good reference, but are only approximations. Sizing based on these charts may lead to overflow or undersized cisterns and additional top-up requirements.

How do I calculate my rainwater use?

For simplicity, this appendix provides a few sample calculations to determine daily rainwater load based on permitted uses, and a reference chart for adequately sizing your cistern or storage tank to meet these demands. The reference chart is based on an average daily rainwater demand over the course of one year. To determine the average daily rainwater demand over a year, the following examples have been provided.

Example one – Indoor rainwater load:

Indoor rainwater demand can be calculated by multiplying the number of residents by the flush rate of the toilets in the home by the average number of flushes per person per day.

- 4 residents
- Toilet flush rate of 6 litres per flush
- Average 5 flushes per person per day

Equation:

Indoor daily rainwater load =
6 litres/flush X 4 residents X 5 flushes/person/day

Indoor daily rainwater load =
120 litres per day for toilet flushing.

Example two – Outdoor rainwater load:

Outdoor daily rainwater demand can be calculated by multiplying the irrigation system's water output by the area of yard to be irrigated, and the number of uses in a week. Divide this total by seven (7) days in a week to get your average outdoor daily rainwater load. It should be noted that xeriscaping and drought resistant landscaping will drastically reduce the draw of rainwater from the cistern storage tank. Similarly, the following calculation should average the seasonal irrigation requirements by the number of rainfall events per week, ensuring that you are not watering your lawn while it is raining. Water Resources recommends 25.4 mm of water per week to maintain a healthy lawn:

- 25.4 mm over an area of 1m^2 equals = 25.4 litres
- 30 m^2 of yard to be irrigated)

Equation:

Outdoor daily rainwater load =
(25.4 litres X 30 m^2) ÷ 7

Outdoor daily rainwater load =
109 litres per day for irrigation (seasonal only).

Average daily rainwater load:

- Daily indoor rainwater demand = 120 litres per day
- Daily outdoor rainwater demand = 109 litres per day

Equation:

Average daily rainwater load =
indoor daily rainwater load +
outdoor daily rainwater load

Average daily rainwater load =
120 L/day + 109 L/ day

Average daily rainwater load =
229 L/day

NOTE: Although your outdoor daily rainwater load only applies for four (4) months of the year, the additional storage capacity for irrigation will offset fall and early winter indoor daily rainwater loads when there is a lack of rainfall.

Please see the following chart, recreated from page 108 of the Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010) for a simplified cistern sizing calculation. Homeowners are encouraged to reference the Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice for additional detail.

Storage Tank Sizing Chart (in litres)

Daily rainwater demand (litres/day)	Roof Area in m²																		
	50	100	150	200	250	300	350	400	450	500	600	700	800	900	1000	1500	2000	2500	3000
50	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	5000	5000	5000	5000	5000
100	2000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	5000	5000	5000	5000	5000
150	2000	4000	4000	4000	4000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000	5000
200	2000	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500
250	-	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500	7500
300	-	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	10000	10000	10000	10000
350	-	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	10000	10000	10000	10000
400	-	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	10000	10000	10000	10000
450	-	4000	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	10000	10000	10000	10000
500	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
600	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
700	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
800	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
900	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
1000	-	-	4000	4000	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
1500	-	-	-	-	4000	5000	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
2000	-	-	-	-	-	-	5000	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
2500	-	-	-	-	-	-	-	5000	7500	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000
3000	-	-	-	-	-	-	-	-	-	7500	7500	10000	10000	10000	10000	15000	15000	15000	15000

Recreated from Table B-3 of the *Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook* (2010)

How were the recommended storage volumes determined from the above chart? (The explanation below is referenced from p. 107 of the Alberta Guidelines for Residential Rainwater Harvesting Systems Handbook (2010).)

- Rainwater storage tanks of increasing storage capacities were modelled using the Rainwater Harvesting Design Tool for each unique combination of daily rainwater load and roof area.
- While comparing multiple tank sizes against each other (i.e. larger versus smaller), if the larger tank capacity provided a significant increase in the water savings of the overall rainwater system, then the design tool suggested using the larger tank.
- The modelling process was repeated with larger storage tank volumes until the water savings offered by the larger tank was deemed to be insignificant.
- Tank sizing chart is base on the incremental savings in water through the use of collected rainwater, but does not ensure that the daily rainwater demand as shown will be met without reliance on make-up water. Detailed calculations to optimize the system should be carried out as part of final design of a system. Refer to Water Resources' Comprehensive Guide for Rainwater Harvesting as a Stormwater Best Management Practice for more information.
- The criteria that was used to distinguish between significant and insignificant water savings is described here:
    - If the larger tank provides ≥ 2.5% increase in water savings per 1,000 litres, pick the larger tank and repeat the process again to see if the next size up will provide these savings.
    - If the larger tank provides < 2.5% increase in water savings per 1,000 litres, then do not pick this tank size, and stick with the previous one that met the ≥ 2.5% criteria.

APPENDIX E:

STORAGE TANK SELECTION

Table 4 below showcases considerations between the different storage tank options for a rainwater harvesting system.

Storage tank selection		
Location	**Type**	**Considerations**
Above grade (outside)	• High-density polyethylene (HDPE) • Metal • Bladder style (below a deck)	• Overflow discharge location. • Property right-of-way and setbacks. • No cost or very low site excavation costs. • Drained and decommissioned during winter months. • Only seasonal usage for subsurface irrigation systems. • Many different volumes and tank dimensions.
Below grade (outside)	• High-density polyethylene (HDPE) • Fibreglass • Crate and bag • Precast concrete	• Overflow discharge location and method. • Location of buried service lines. • Located at the lowest elevation from the conveyance pipe to allow gravity flow of rainwater. • Site accessibility for excavation machinery. • CSA requirement: prefabricated below-grade tanks need to comply with Clause 4.1 of CSA B66. • Location of access hatch (manway) for annual service. • Property right-of-way and setbacks. • Structural loading if under a driveway or an area with added weight at surface. • Insulate above the tank or use a heating system for year-round use. • Can be buried below frost depth (with tanks that are rated for deeper burial), to allow year-round use. • Excavation increases overall system cost. • Many different volumes and tank dimensions.

Storage tank selection		
Location	**Type**	**Considerations**
Building integrated	• Cast-in-place concrete	• Overflow discharge location and method. • Interior must be sealed and waterproofed by certified installer. • Tank included on the foundation plan of architectural drawing set. • Property right-of-way and setbacks. • Tank size and dimensions can be designed to best fit each site. • Concrete costs allow for greater economies of scale – larger tanks can be created compared to the same cost for a smaller plastic tank. • Potential for extra excavation increases overall cost of system. • Structural engineering required for walls and lid – increases overall cost of the system. • Volumes and tank dimensions can be adapted to each site.
Inside a basement or heated garage	• High-density polyethylene (HDPE) • Fibreglass	• Overflow discharge location and method. • Location of basement drain or sump pump in close proximity to tank. • Tank size and dimensions must fit within allocated space. • Engineered floor required – if not located on concrete floor. • Installation of tank before the floor plate is installed. • Venting of tank to exterior to release any noxious gas buildup. • No excavation costs. • Allows for year-round use. • Size of tank lessens usable floor space. • Volumes and dimensions must be sized appropriately to fit within the chosen location.

Table 4: Storage tank selection

APPENDIX F:

POST STORAGE RAINWATER FILTRATION AND TREATMENT

While not mandated, it is recommended that homeowners install some form of post-storage filtration and treatment device to improve the quality of stored water in a rainwater harvesting system (see Table 5 below).

Post-storage filtration devices are typically pressurized and treat more complex water quality issues. Post-storage disinfection devices treat microbiological impurities and normally require power. One form of post-storage treatment is a 5, 10, or 20 micron particle filter, followed by an ultraviolet (UV) disinfection unit.[4] There are several other forms of filtration and treatment which can be used individually or combined. See Table 5 below for additional details.

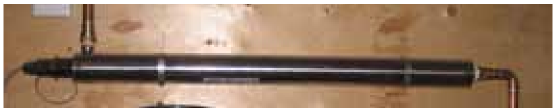
Post-storage rainwater filtration and treatment	
Type	**Considerations**
Filtration: particle, sand or membrane filters 	• Filter out the finer particulates and sediments from rainwater, removing suspended solids and turbidity.
Disinfection (1): UV lamps or chlorination equipment 	• Most popular methods to disinfect and remove microbiological or pathogenic contaminants that may reside within rainwater.
Disinfection (2): Ozonation, slow sand filters and thermal treatment	• Additional methods that can assist in removing microbiological or pathogenic contaminants.
Additional methods: Activated carbon, ozonation and reverse osmosis	• Helps to mitigate colour and odour.

Table 5: Types and considerations for post-storage filtration and treatment

4. Government of Alberta, Municipal Affairs. Alberta Guidelines for Residential Rainwater Harvesting Systems – Handbook. Crown in the right of Alberta, 2010, p. 33.