Rainwater Harvesting and Climate Change

Ensuring Sustainable Water Supplies for Humanity's Future

"POUR UN MEILLEUR AVENIR"

"FOR A BETTER FUTURE"

January 2018

www.bathurstsustainabledevelopment.com
Draft

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Cover Photo Credits:

Bathurst Sustainable Development Rainwater Collector; Zee News; India; John Deer, The African Alliance of Rhode Island; Stormsaver Ltd

Thank you to the New Brunswick Environmental Trust Fund and several N.B. community gardens for their kind support and participation in this project!

1. Rainwater Harvesting

Rainwater harvesting is an ancient water system and it was the first type of municipal water collection and supply system used in the world. Archaeological evidence says that rainwater harvesting goes as far back as 4000 years ago and many cisterns built as early as 2000 B.C. are still in use today.

Rainwater is a free, renewable and sustainable source of fresh water. Millions of people around the world are drinking rainwater. It rainwater is naturally distilled water and represents clean drinking water when it falls directly from the sky. If it falls on roofs or structures, it needs to be treated before it is considered safe for drinking. It is currently mandated to be used in many countries where little rain fall occurs and is incorporated into building requirements. It can also be used for grey water needs such as flushing toilets, showers and cleaning, and for outdoor uses. Rainwater can be stored in retention ponds or water silos for agricultural irrigation or in municipal reservoirs.

If every roof in existence in the world today was retrofitted to harvest rainwater for potable and non potable water uses, and if greywater was collected and recycled, the world would be in a position of water abundance rather than water scarcity. In urban cities, when rainwater falls off of roofs and structures onto pavement and cement, it is considered a storm water problem which must be managed at huge financial costs. We then let it drain away into the oceans which contributes to sea level rise and ocean desalination. However, if the rainwater was harvested and used to support humanity's needs, it would be considered a precious natural resource. *Brenda Kelley, 2018*

2. Climate Change and Water Scarcity

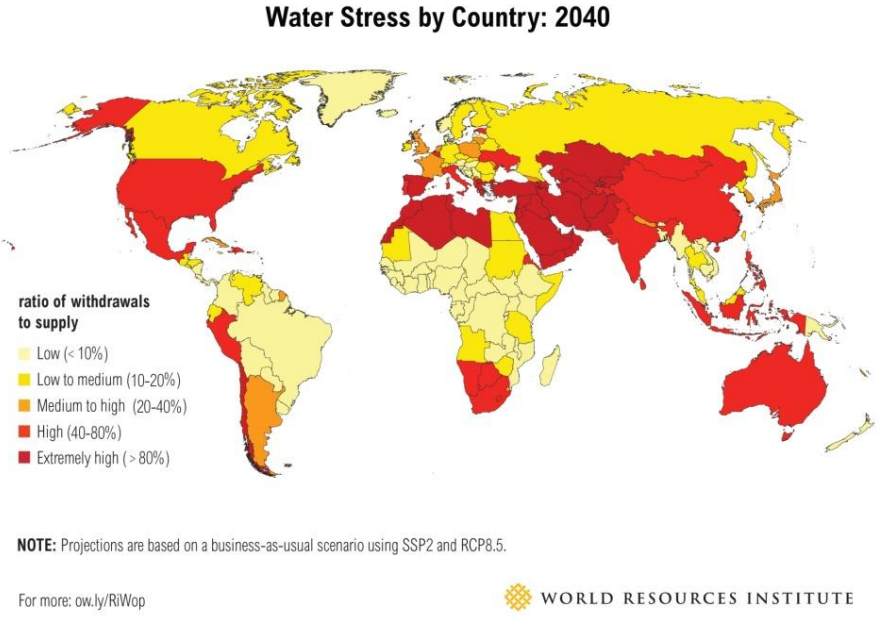
The Earth's climate and water cycle are changing. We have just experienced the three warmest years on record between 2015 and 2017. In 2011, the World Resource Institute stated that 33 of the world's arid countries will face total depletion of "natural" fresh water (from rivers, streams, springs, glacier melt, lakes) by 2040. Areas of the USA, China and India are also experiencing shortages. Cape Town, South Africa, forecasts that they will be completely depleted of freshwater by mid 2018.

Canada is considered a water-rich nation; however, certain regions are already experiencing increasing water scarcity. Water levels in the Great Lakes are at an all time low. Many municipalities, businesses, agricultural operations and homeowners in Canada, including communities in New Brunswick, Nova Scotia and PEI, are experiencing shortages of ground and surface water.

In the context of climate change, weather variability, longer periods of drought, diminishing glaciers, increasing temperatures and evaporation rates are quickly leading to global water scarcity. Extreme precipitation events, storm surges, salt water intrusion and flooding are increasing the contamination levels of fresh water resources. Water scarcity for agriculture coupled with a rise from 7 to 9 billion in global population between 2030 and 2050 will increase food scarcity, possibly as soon as 2030. Our ability to remain living on planet Earth is dependent on the availability of potable water for human consumption and for agriculture.

Among the most serious science and environmental policy issues confronting society are the potential changes in the Earth's water cycle due to climate change. The science community now generally agrees that the Earth's climate is undergoing changes in response to natural variability, including solar variability, and increasing concentrations of greenhouse gases and aerosols. Furthermore, agreement is widespread that these changes may profoundly affect atmospheric water vapor concentrations, clouds, precipitation patterns, and runoff and stream flow patterns…Orbiting satellites are now collecting data relevant to all aspects of the hydrologic cycle…" *Mike Carlowicz,: NASA: GRACE data.*

The United Nations' "*World Water Development Report", released in 2016,* states that the planet will face a 40 percent shortfall in fresh water within 15 years. Both the World Bank and the United Nations say the shortfall in fresh water will lead to a shortfall in food availability needed to feed the global population possibly as early as 2030 — just 12 years from now.



3. **Water Scarcity Act**

Water is essential for all human life. It is also essential for food production, community prosperity, and human health and wellbeing.

Development of a **Water Scarcity or Water Sustainability Act** will help communities and regulators better define essential and non essential water use priorities on a year round basis and can include enforceable specific natural fresh water use restrictions.

Goals would be to:

- reduce exploitation and increase protection of the remaining natural fresh water resources and their watersheds,
- mandate the adoption of and transition to rainwater harvesting for residential, commercial, industrial and agricultural buildings and sectors for potable and non potable water use and greywater recycling,
- increase enforceable natural fresh water use restrictions.

Adoption of a Water Scarcity Act, along with public education about water scarcity and rainwater harvesting, will lessen society's waste of natural fresh water resources and will encourage society to be proactive and establish "alternative potable and non potable" rainwater harvesting systems now rather than letting communities and ecosystems be negatively impacted after the depletion of natural water resources.

4. **Standards and Codes for Rain Water Harvesting/Collection**

In April 2011, the International Code Council ICC, as an ANSI-accredited standards developer, and CSA Group provided notice of the intent for the development of an ANSI consensus standard for the design and installation of rainwater harvesting systems which will be available for adoption by Canadian and USA communities. The CSA Group is a global provider of testing, inspection and certification services and a leader in safety and environmental certification for Canada and the US.

Incoming Standard: (April 2018)Rainwater Collection System Design & Installation for Potable and Non Potable Rainwater Systems

https://www.iccsafe.org/is-rcsdi/

Standard BSR/ICC 805-201x: **Overview of Items Proposed for Inclusion in the Standards**

Scope. The provisions of this standard shall apply to the design, installation and equipment used for rainwater collection systems intended to collect, store, treat, distribute, and utilize rainwater for **potable** and non potable applications. This standard is intended to apply to new rainwater collection installations as well as alterations, additions, maintenance, relocations, replacement and repairs to existing installations. This includes systems designed for residential, commercial, industrial, and agricultural applications on buildings, structures and sites as well as fire department connections to rainwater collection storage tanks.

Backflow protection. Where rainwater tanks provide water for potable uses, the water supply to automatic sprinkler and standpipe systems shall be protected against backflow as required by the local plumbing code.

Backwater valve. Backwater valves shall be installed on each overflow and tank drain pipe in accordance with local plumbing codes.

Potable water testing. Collected rainwater to be utilized for approved **potable** applications shall be tested. Accumulated water to be tested shall be the result of not less than two rainfall events. Water quality testing shall be performed in accordance with the latest edition of APHA–Standard Methods for the Examination of Water and Wastewater. **Annual tests required.** Accumulated rainwater used for approved potable applications shall be tested prior to initial use and annually thereafter for Escherichia coli, total coliform count, heterotrophic bacteria and cryptosporidium.

Quarterly tests required. Accumulated rainwater used for approved **potable** applications shall be tested prior to initial use and quarterly thereafter for pH, filterable solids, residual chlorine if disinfection is used, and turbidity. The pH shall be tested in accordance with ASTM D 5464; filterable solids shall be tested in accordance with ASTM D 5907; residual chlorine shall be tested in accordance with ASTM D 1253; and turbidity shall be tested in accordance with ASTM D 6698.

Appendix F: Rain Water Uses

1) Non-potable collected rainwater utilization a) Landscape irrigation b) Water features and ornamental fountains c) Swimming pools and spas d) Toilet and urinal flushing e) Automatic fire suppression systems f) Fire pump testing g) Trap primering h) Clothes washing i) Cooling tower makeup j) Industrial processes k) Hose bibbs l) Carwashes m) Roof cooling n) Agricultural cooling cells o) Evaporative coolers p) Subsurface infiltration and groundwater recharge

2) Potable collected rainwater utilization a) Drinking and cooking b) Bathing c) Dishwashing d) Animal watering e) Swimming pools and spas

5. **Transition to Alternative Sources of Potable and Non Potable Water**

We are all the *"guardians of the planet"*. Reducing "water scarcity" can be done by improving technologies and policies in fresh water management and by leading the transition of our communities to increased use of harvested rainwater for potable and non potable uses. Public education, technical training, certification of installers, government incentives and approval of regulations will help in the transition.

Canada Mortgage and Housing (CMHC) has developed an excellent set of resources and handbooks about transitioning to rainwater harvesting. These include:

- *CMHC Make Your House "Alternative Water Ready"*
- *CMHC Guidelines for Residential Rainwater Harvesting Systems Handbook*
- *CMHC Feasibility Study Large Scale Rainwater Harvesting*

6. **Rainwater Use Policies and Regulations**

In Canada, legislation exists for alternative water supplies such as rainwater harvesting and grey water reuse (water from laundry, showers and sinks) and varies between provinces. For example, Ontario, Alberta and BC have added rainwater harvesting systems to their Provincial Building Code for both potable and non potable use. Check with local authorities to determine what rainwater uses are permitted in your area. Encourage all levels of government to approve the use of rainwater for potable and non potable water use.

Once you know which applications are permitted, determine which ones are right for you. You could choose a seasonal system for outdoor-only use to water your garden or lawn and to wash your car or a year-round indoor system to flush toilets, fill your pool and do laundry with rainwater collected in an underground cistern. With approved water treatment, the collected rainwater could meet all of your household's needs in both potable and non potable water.

If you are a Municipality, make the adoption and approval of rainwater potable and non potable use a high priority for your council.

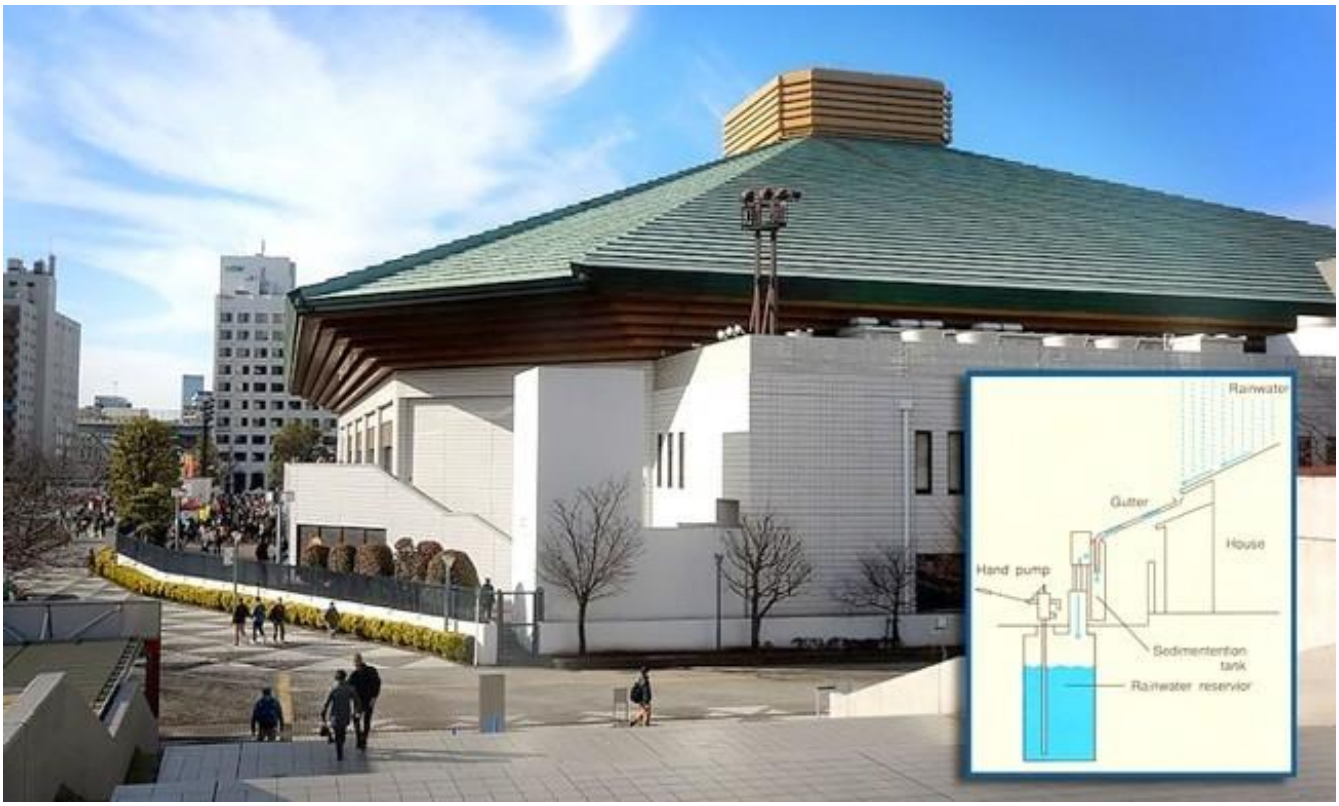
Performance Evaluation of Rainwater Harvesting Systems, Toronto, Ontario Study

"Results indicate that rainwater harvesting systems on commercial properties have the potential to provide significant water conservation and storm water management benefits. Model simulations under 'normal' precipitation conditions (798 mm) showed that the RWH systems monitored in this study would supply between 59 and 79% of total demand for non potable water supplies, and reduce storm water runoff by between 18 and 43%.

Toronto Conservation Authority, Sustainable Technologies Evaluation Program, 2010

7. **Municipal Rainwater Harvesting - Examples from around the world**

The Ryogoku Kokugikan Arena in Tokyo uses its full 8,000 m² roof to serve as a rainwater harvesting system, draining into a massive 1,000 m^3 tank below the building. Japan has embraced rainwater harvesting technology on a large scale, introducing it to all its main buildings.



*The roof of Ryogoku Kokugikan arena in Tokyo collects rainwater to be used in the building's toilets. The Ryogoku Kokugikan Arena in Tokyo uses its full 8,000 m² roof to serve as a rainwater harvesting system, draining into a massive 1,000 m^3 tank below the building. Japan has embraced **rainwater harvesting technology** on a large scale, introducing it to all its main buildings. The inset shows a similar system for residential use. Photo credit: Facebook*

- The majority of the Singapore's population lives in high-rise apartment buildings due to scarcity and cost of owning land. Many of these apartment buildings have been converted to support rainwater harvesting. Individual collection systems are installed to use rain as potable water.

- The Millennium Dome, U.K., uses a water collection system to catch run-off water from its curved structure. With a surface area of 90,000 m², water is collected through a gutter and is passed through a series of hoppers to reach the main storage system.

8. **Industrial and Commercial Rainwater Harvesting Systems**

Rainwater harvesting now makes financial sense because companies can lock in funding for water efficient technologies. Rainwater is better for industrial machinery because rainwater is kinder than a treated main supply of 'harder' water. Most industrial and commercial premises have a large amount of roof space that can easily be converted to improve rainwater harvesting. For commercial rainwater harvesting, larger sites tend to enjoy a quicker return on investment from savings on their water bill.

Image courtesy of Stormsaver Ltd

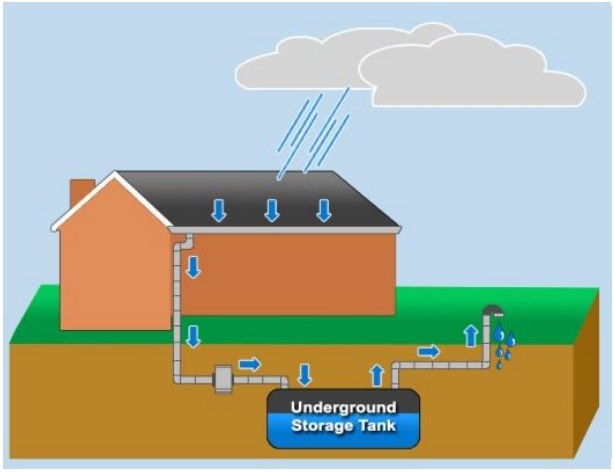
Examples of commercial building rainwater harvesting solutions:

- Non Pressurised;
- Gravity fed system;
- Pressurised system; or
- A Combination High Level Collection system which can be installed in your roof area.

9. **Rainwater Harvesting for Agriculture and Livestock - Water Silos**

Many farms in North America are experiencing water shortages and rising water costs. Water silos, underground storage tanks or retention ponds are effective ways to store rainwater. Connecting the roof gutters on barns and greenhouses is a simple way to collect rainwater for irrigation. Once your water is stored, you have control over your irrigation. For colder climates, underground cisterns can be installed near barns to store rainwater.

Livestock owners tend to have large catchment areas already constructed on their property due to the housing requirements of managing livestock. Leveraging the surface area of existing structures such as houses, barns, stables, and sheds gives farmers a comparative advantage in rain water collection. The long-term result save money and resources by self-sourcing the most inelastic commodity. The implementation of rainwater collection systems should be a top priority for farmers and ranchers world-wide. Dr. Gene Simpson, Alabama Cooperative Extension System specialist, estimates that a typical poultry farm with four houses uses between 1.8 and 2 million gallons of water every year. It is estimated that this Alabama poultry farm's system for harvesting rainwater could pay for itself in 4 to 5 years just with the money saved from no longer having to purchase municipal water.



John Deer

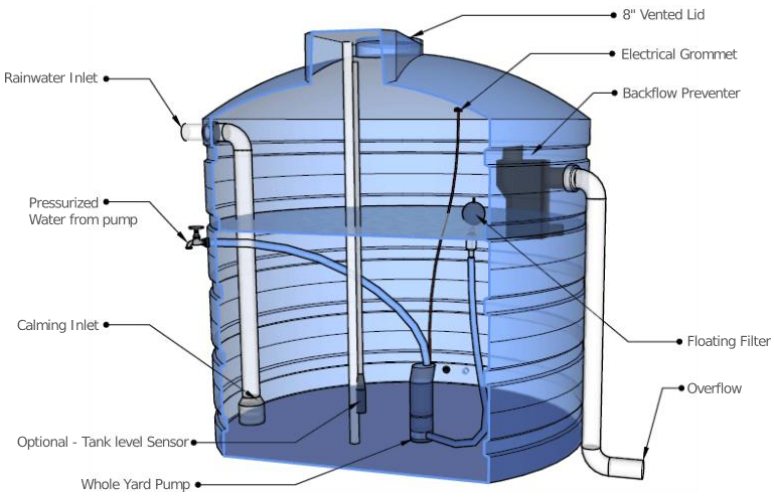
10. **Integrated Rainwater Systems - Residential/Commercial (Canada)**

Clean Flo Water Technologies

- Both potable and non potable rainwater systems;
- Above and below ground rainwater systems are designed so the tank does not have to be cleaned;
- Can be fully integrated into existing building systems;
- Specializes in rainwater harvesting systems that are used for irrigation, toilet, laundry, potable drinking water, fire suppression, and storm water retention.

Above Ground Tanks

Made of virgin polyethylene and of food grade quality. Manufactured in Canada making them the most economical rainwater storage solution.



Below Ground Tanks

Made of fibreglass and resin for strength while buried up to 10 feet.

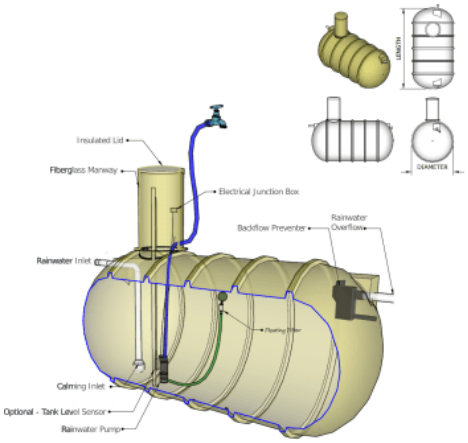
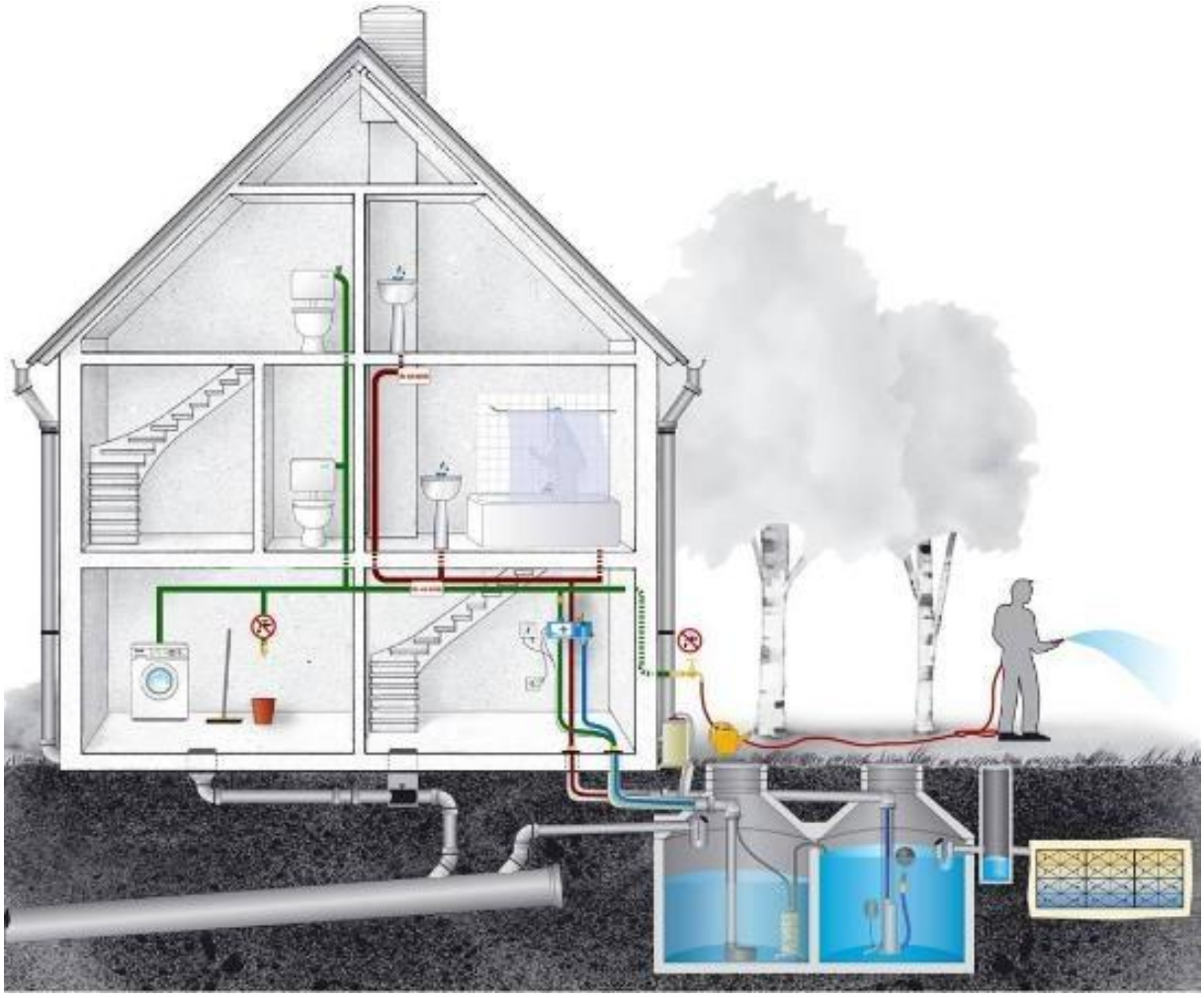


Diagram credit: Clean Flo Water Technologies - Atlantic Canada Office
https://harvestingrainwater.ca

11. Greywater Recycling and Rainwater systems - Examples

Oasis greywater and rainwater harvesting system



A sustainable water collection, storage and supply system to help reduce the demand for mains water from domestic and commercial buildings. The greywater system uses ultra filtration membrane ISB technology to treat bath, shower and hand basin waste water which is then used to flush toilets and watering the garden. Approximately 70 litres of drinking water and 44 litres of waste water can be saved per person per day in domestic households and significantly more in hotels. This system is also available as a combined rainwater harvesting and greywater recycling system. The systems can be used for domestic, industrial, commercial and hotel applications.

Diagram credit: http://www.cpm-group.com

Beetham Water Recycling Plant

CST Industries Inc. has erected two 5,300,000- gallons water storage tanks at the Beetham Water Recycling Plant in Point Lias, Trinidad, as part of the Caribbean's largest water reuse project. The Point Lisas Industrial Estate is one of the largest consumers of water, using approximately 23 million gallons of water per day. Any disruption to this water supply could have had a significant adverse economic impact.

The tanks were part of an upgrade to the Beetham Wastewater Treatment Plant to allow up to 10 million gallons per day of wastewater to be recycled to industrial standard and used to supply industrial facilities in their region, thereby diverting 10 million gallons of good quality potable water per day to the community, supplying drinking water for 150,000 people. Waste water was previously being recycled and pumped into the sea. This project was the Waste and Water Digest's 2015 Water Project Winner!

SCAFCO water tanks were installed at the University of California, Teaching and Research Winery and Jess. S. Jackson Sustainable Winery Building. SCAFCO supplied this winery with four model 2105 water tanks with an approximate total storage capacity of 180,000 gallons (681,375 liters) of water. The rainwater collection and water cleaning system reuses 90 percent of the water.

12. **Rain Saucers - Open Field or Remote Collection**

Rainwater Saucers - Upside down cone shape object made out of hard or soft materials that can be used to collect and direct rainwater into collection barrels when no roof catchment area is available such as in open fields. The inverted cone shape can also be incorporated to future roof designs for larger rainwater harvesting systems.

Photo: Heather Kinkade-Lavario

13. Community Gardens - Rainwater Collection and Storm Water Management

Community gardens can easily obtain all of their needed water through rainwater collection. The hundreds of community gardens throughout Canada and New Brunswick have an amazing opportunity to provide environmental education to the public by demonstrating the techniques of rainwater collection, hosting workshops and collection system seminars. Rainwater is free of chemicals, it is warm and it is better than municipal chlorinated water for garden plants.

Simple slanted wooden structures, roofs of sheds or nearby buildings, rain saucers or even tarps or tires in a tree can be used to direct rainwater into collection containers throughout the garden. Rainwater storage bins must be covered with either a solid lid or, at a minimum, with a screen cover and bungee cord to prevent mosquitoes from laying their eggs on top of the water and to prevent small animals or children from drowning in the standing open water.

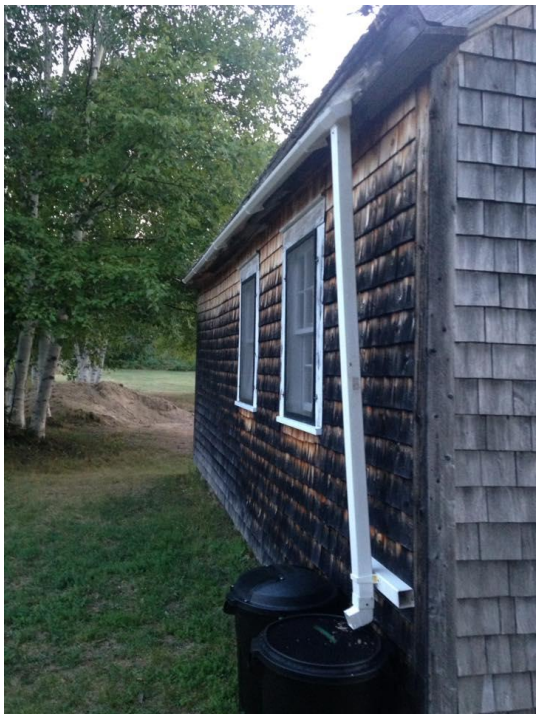
Community gardens can also play a valuable role in reducing storm water run-off through rainwater collection units. In New York City, there are over 140 community garden rainwater harvesting systems collecting over 1.5 million gallons of rainwater a year from nearby roofs or shade structures, making water collection convenient for gardeners, and reducing demand on the public water supply system. They also help mitigate rainstorm runoff, which can overload storm drains and pollute the waters surrounding the city.

If rain barrels are elevated, a gravity fed supply of water can be diverted to your garden through a system of weeping or drip garden hoses.

14. Rainwater Harvesting in New Brunswick Community Gardens

Doaktown Community Garden, N.B.

In 2017, the Doaktown Community Garden, along with BSD, participated in a Rainwater Collection Project with support from the NB ETF. The garden committee attached gutters and a downspout to the roof of an existing structure so they could begin to harvest rainwater. Next season, they plan to attach more rain barrels and connect them together with overflow tubes to provide additional rainwater storage capacity for the garden.



Peter McKees Community Garden, Moncton, N.B.

In 2017, the Peter McKees Community Garden **and the Food Depot Alimentaire, along with BSD, participated** in a Rainwater Collection Project. Next spring, they would like to build a raised platform, put two or three rain barrels on the platform, interconnect them with overflow tubes, move all of their existing other barrels beside the platform and have them overflow to all of their other large water collection barrels so that they have adequate rainwater for almost 100% of their garden needs for the season. They would also like to design a way to cover each barrel.

St. Mary's Community Garden, Fredericton, N.B.

The St. Mary's Community Garden in Fredericton has an impressive rainwater collection system with six interconnected 1,000 litre capacity "totes" which are used to hold commercial soap. The totes were placed on built raised platforms and are used to store rainwater harvested from the roof and existing gutter of a building at the St. Mary's church. Rainwater is gravity-fed to the garden down the hill through a system of underground tubes.

Parkwood Heights Elementary School Garden

Uses a shed, gutter and downspout to harvest rainwater for their school garden.

Hodge Podge Community Garden, Bridgewater, N.S.
Rainwater Collection System

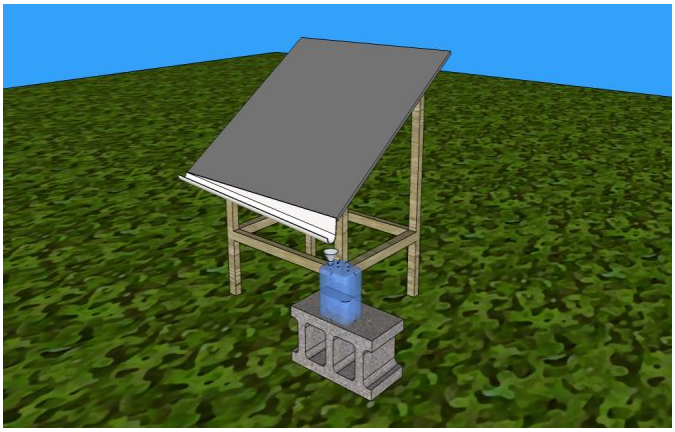
Marysville Community Garden Rainwater Collectors, Fredericton, N.B.

Rotary Community Garden, Coronation Park
Bathurst, 2017

Open field rainwater harvesting diy.org

Open field rainwater structure

More Ideas!



Slanted board design structure to harvest rainwater.

https://engineerzero.blog/page/58/

Rain Saucers used to direct rainwater into rain barrels in areas with no roof structures or in remote settings.

Rainwater collector designed by BSD,
built in 2009 for the Bathurst Community Garden,
Victoria Park, Bathurst, N.B.

This 2,000 litre rainwater system cost $7,000 to build in 2009.
Additional totes can be attached for extra storage capacity.

14. **Tips about Totes**

Totes: Totes are recycled plastic containers with a capacity of 500 to 1,000 litres or more. To help the container keep its shape and to prevent punctures during use and transport, totes are often found inside a metal frame and come with a tap or spout, and metal feet.

Know What Was In Your Tote: Make sure you know what was originally in your tote or rainwater collection barrel and that it is safe. Avoid using tanks that held harsh chemicals. Choose a tote that held commercial or industrial soap.

Taps: Most tanks come with a 6" threaded cap on top and a 2" threaded outlet valve at the bottom. You can convert the bottom 2" valve to accept a standard garden hose with a few adapters found at your local hardware store.

Draining your tote: Before totally draining your tote, open the top cover so that air remains inside the tote to support the walls. Leave the tap open during winter and disconnect the downspout. Melting snow or winter rain may freeze inside the tote and damage the tap and tote.

Keep It Dark: You will want to keep the water from getting direct sunlight to keep algae from growing in the stagnant water. Algae can only grow if there is light. If your tank is translucent, cover it or place it in the shade or under a roof overhang.

Keep It Covered: No matter what system you use to store your water, you will want to keep it closed. Still water is an open invitation to mosquito larvae. Totes come with 6" caps and lids on the top. Cut out the hole for the downspout and seal the edges with some inexpensive foam or attach screen around the opening to keep mosquitoes away.

Know What To Use The Water For: Rainwater collected at community gardens is used for watering plants, washing off equipment, etc. Since it is not treated it in any way, it is not to be used or drinking.

1,000 litre tote

Removable cover

Rain Saucer for Open Field Rain Water Collection

Select a patio umbrella manufactured with a small flap opening at the top of the canopy fabric. When the umbrella is inverted over the top of the tote it will act as a rain saucer and will harvest rain water which will flow through the flap opening and into the tote. Funnels or drain pans can also be mounted onto of the tote and used to guide rain water into the tote.

Attach nylon tent ropes onto the frame of tote and umbrella frame

Remove the tote cover. (cover may be red or black)

A large funnel may also be used instead of an unbrella.

Drain pan for top of totes

A tap and tube can be inserted into the tote to replace the manufacturers tap to allow for a garden hose to be attached.

Attach a filter screen to the top opening of the tote by placing a zip tie over a piece of screen, under and around the bottom thread of the opening. Before tightening the zip tie, attach four additional zip ties to the top frame bars of the umbrella and attach them to the zip tie around the thread. Pull all zip ties tight to secure the screen and hold the center of the umbrella over the tote opening.

Place empty tote on stacked wooden pallets to allow space for hose attachment and gravity fed watering through drip hoses or irrigation system.

Tip: *Empty the tote before winter to prevent water from freezing and breaking the tote. Always keep cover off when draining to prevent contraction of tote walls. If you live in a cold climate, remove the umbrella and put the cover on the tote opening for winter storage.*

Design by Brenda Kelley, Bathurst Sustainable Development

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2. Rainwater Harvesting
3. Collecting Rainwater Saves You Money
4. Collecting and Using Rainwater at Home: A Guide for Homeowners
5. About Your House: Collecting and Using Rainwater at Home
6. Guidelines for Residential Rainwater Harvesting Systems Handbook
7. Rainwater Harvesting and Greywater Reuse
8. Make Your House "Alternative Water Ready"