Community Gardens:
Rainwater and Solar Harvesting Project

Context:

Problem:

As Toronto continues to grow, increased development and impermeable surfaces continues to strain the City's water infrastructure and pose a threat to the health of our natural ecosystems and infrastructure. A rise in wet weather and intensified rain events as a result of climate change and a growing urban heat island effect, has resulted in increased storm water runoff – entering the City's sewer system and carrying with it debris and pollutants that will enter into our watershed. Mitigating storm water run-off is imperative to building a sustainable city.

Currently, Toronto Water is operating under the Wet Weather Flow Master Plan (WWFMP), to introduce innovative and practical solutions to reducing storm water run-off. Rain harvesting is an important component of this plan. Rainwater harvesting not only manages the path taken by storm runoff to the

lake but also diverts it to on-site non-potable uses such as irrigation and toilet flushing, thereby reducing potable water use, saving energy, operating costs and meeting WWFMP goals.[i]

Rainwater harvesting in community gardens is an achievable and practical way the City can reduce storm water run-off. However, the City does not mandate rainwater harvesting units in community gardens, nor does it provide units for community garden organizations.

Goal: A structure or unit that will provide rain harvesting and solar power generation components for use on Toronto's public lands such as parks and community gardens, and eventually private lands.

Purpose: The purpose of this structure or unit will be to deliver rainwater to Toronto parks for use in community gardens and municipal gardens without access to municipal water, as well as reduce the use of municipal water used to water gardens. In addition, the structure or unit will also provide direct and indirect education on the importance of rainwater harvesting and its ability to reduce the demand on the public water supply system and mitigate rainstorm run-off – which can overload the system and pollute our watersheds.

Policy: The following is a preliminary list of policy programs in which this project can be supported by and administered by, helping to fulfill policy mandates.

- *Wet Weather Flow Master Plan (*WWFMP*):* A long-term plan to protect Toronto's environment and sustain its healthy rivers, streams and other water bodies. The WWFMP aims to reduce the adverse effects of wet weather flow, which is runoff generated when it rains or snows. In addition, the WWFMP places priority on public engagement, involvement and education. The WWFMP works to raise awareness about the issues of efficient sustainable water management through its various projects and programs.[ii]

- *City of Toronto Shade Policy:* A policy program that prioritizes the importance of shade as a component building a healthy city. Through this policy, the provision of shade, either natural or constructed, should be an essential element when planning for and developing new City facilities such as parks or public spaces, and in refurbishing existing City-owned and operated facilities and sites.[iii]

- *Parks, Forestry & Recreation - Community Gardens*: Working in partnership with a wide variety of community groups, the program draws on the collective heritage from Toronto's distinct

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

cultures. Community gardens benefit everyone by creating safe and healthy recreational activity within our parks system, and on other City-owned lands.[iv]

Background: Preliminary research shows that community gardens can play a valuable role in reducing storm water run-off through rainwater harvesting units. In New York City, there are over 140 community garden rainwater harvesting systems, diverting 1.5 million gallons of rainwater a year from nearby roofs, shade structures, and rain barrels, from municipal water infrastructure.[v]

In Ontario, many municipalities, including Toronto, promote the use of rainwater harvesting as a sustainable component of a community garden. However, preliminary research shows that municipalities do not typically provide the rainwater harvesting units to community gardens.

This unique collaboration between Toronto Water, Parks, Forestry & Recreation and Environment & Energy to develop a rainwater harvesting structure or unit to be made available to public community gardens throughout the city will show the city's commitment to building a sustainable water efficient city as well as provide a direct outreach and educational component on the importance of efficient water management to all community garden and park visitors.

The structure envisioned by the City, a combined rainwater and solar harvesting structure or unit is unique. Preliminary research shows that there have been several innovative designs regarding rainwater harvesting units as well as solar harvesting shade units, but independent of each other. Any combination of the two have been designed at a large scale for use by arid communities in developing nations who seek access to potable water. However, there is a unique opportunity being presented for university students across a wide variety of disciplines to design a new structure or unit that could be replicated throughout Toronto and other cities across Canada. These new structures or units can be in the form of a shaded workbench, a garden shed that houses communal work tools, a shade canopy that provides gardeners and visitors a place to sit and relax, or a community gathering place that can house cultural amenities like a wood burning outdoor oven to cook produce from the garden. In addition, the solar harvesting component will allow for the possible installation of a light, an outlet as well as a small water pump if needed. The photos below show possible design inspiration for the structures or units.

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

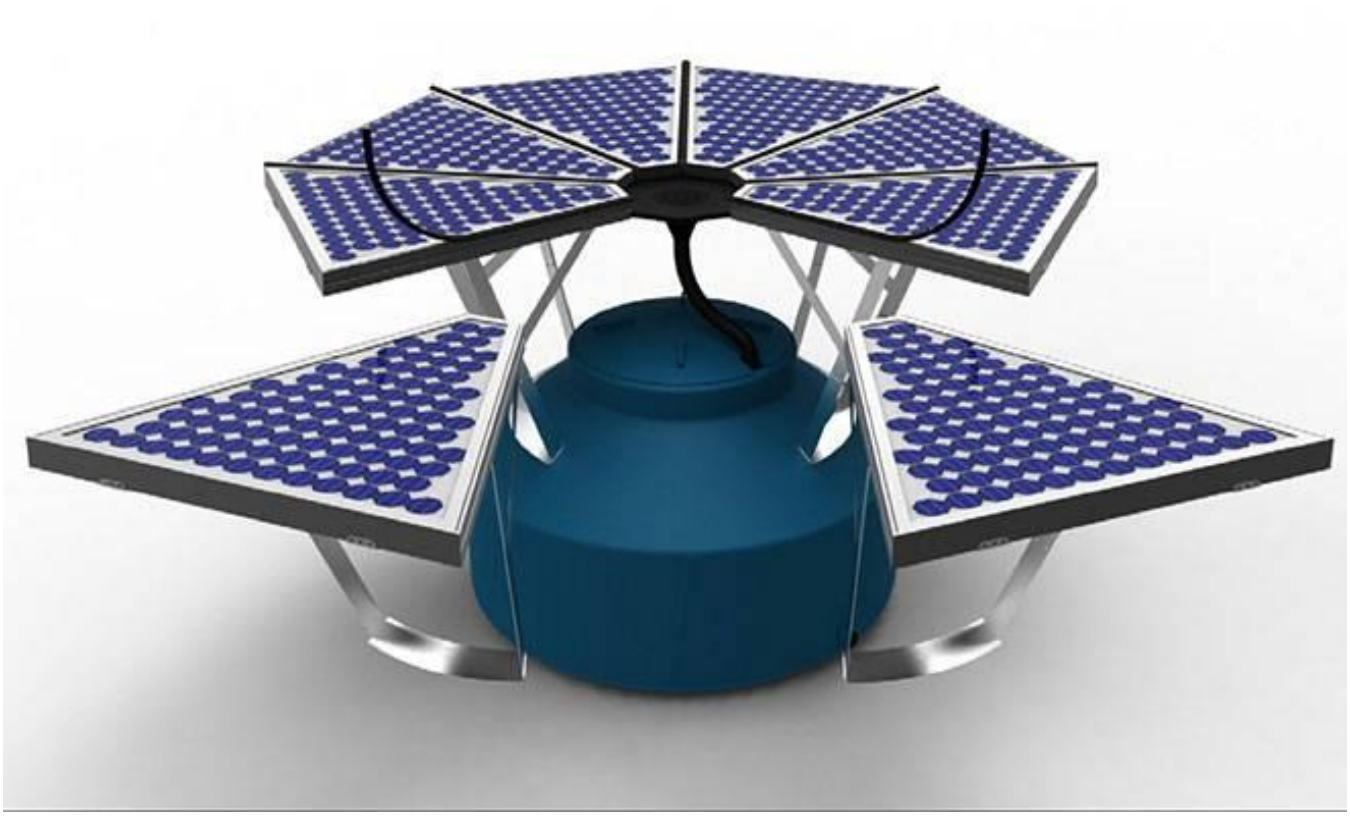

Figure 1 Innovative rainwater and solar harvesting unit for communities with water scarcity (400L capacity).

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Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

Figure 2: Rainwater harvesting unit with wide rainwater collection area that fold for easy transport.

Figure 3: Rainwater harvesting structure in form of shed.

Figure 4: Rainwater harvesting structure with wide rainwater collection area and simple design.

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

Figure 5: Solar shade structure in park with possibility of wide collection area for rainwater harvesting.

Figure 6: Solar shade unit with signage and possibility of wide collection area for rainwater harvesting.

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Project Management and Communications Assistant
Ryerson Urban Water

Figure 7: Innovative solar shade design with possibility of wide collection area for rainwater harvesting.

Figure 8: Smaller solar unit with bike racks, signage and possibility for wide collection area for rainwater harvesting.

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

Figure 9 Private multi-use storage facility with potential for medium size rainwater collection area.

Parameters[vi]:

Scenario one: This scenario is based on the rainwater collection ability of a standard 55-gallon rain barrel, with only the diameter of the barrel for rainwater collection.

Vegetable Garden Area	Water Needs[vii]	Avg. Rainfall[viii]	Natural rain contribution	Water Needs minus natural rainfall	Rainwater collection contribution	Ability for rainwater contribution/garden area
0.9m^2 (1 sq.ft.)	4 gallons/month	~68mm	1.6 gallons/month	2.4 gallons/month	~5 gallons/month	~5 gallons/0.9m^2 (1 sq.ft.)/month

Scenario two: This scenario is based on the rainwater collection ability of a standard 55-gallon rain barrel, with the rainwater collection area of a 1.66m^2 solar panel.

Vegetable Garden Area	Water Needs	Avg. Rainfall	Natural rain contribution	Water Needs minus natural rainfall	Rainwater collection contribution	Ability for rainwater contribution/garden area

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

0.9 m^2 (1 sq.ft.)	4 gallons/month	~68mm	1.6 gallons/month	2.4 gallons/month	~28.5 gallons/month	~28.5 gallons/0.9m^2 (1 sq.ft.)/month

Solar energy production and usage:

Using the above solar panel parameters (1.66m^2) and a 12V 245Ah battery can power a small water pump, to pump water from the bottom of the rain barrel where the gravity fed system is no longer applicable. In addition, but not while the pump is working, the above combination can supply lights and an outlet working simultaneously.

Feasibility:

Component	Cost	Notes
Solar panel:	$258	Specs: Eclipsall 255 Watt Polycrystalline Solar Panel. This is the solar panel that was used in the above parameter scenarios.
Battery:	$605	Specs: Deka Solar 8A8D 12 V 245 Ah This is the battery that was used in the above parameter scenario.
Structure:	~$700 +	This will be determined by the final design and contract. However, existing structures can be retrofitted for this purpose. The cost shown here is based on the lower average cost of a garden shed from Canadian Tire.

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

Component	Cost	Notes
General Labour: **Electrician:**	~$25-35+/hr ~$65+/hr	This cost will depend on the design intricacy.
Additional: **Small Outdoor Spotlight:** **Outlet:** **Pump:**	$15 - $40 $5 - $15 $15-$200	Several different small outdoor lights and outlets can be used. These lights can be purchased at a common hardware store. The pump can vary depending on usage. These pumps come in different sizes and can be purchased at a common hardware store.
Transportation: **(Pick-up truck)**	~$0.66/km	There will be transportation costs involved with regard to moving the units to storage or placement.
Total:	~ $1,918	This total estimates the known costs, using the higher end prices, and based on one hour of labour. This is an estimated preliminary total for feasibility estimates only.
Contingency:	~$383.60	Represents 20% of the total budget.
Overall Total:	$2,301.60	

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

Challenges: During the preliminary research for this project report, three challenges have been identified.

1. Transport and storage: It may be realized that a structure is the most effective and efficient design to reach the goals of this project. Therefore, transport may be difficult and available storage space may become a challenge. Should the City go ahead with a structural design that would remain in the community gardens year round, in an effort to maximize the battery life, batteries would need to be removed from the structure and stored in an all-weather facility.
2. Sustainability and Durability: Weather, material life-span, public preference and technological innovation advancements can all affect the sustainability and durability of the structure or unit selected. It is important that the City select a structure or unit that is made from high-quality materials that will have a longer life-span, but is also able to be retrofitted and adaptable to changing tastes and technology.
3. One size fits all: The final structure or unit design may not fit all community gardens and their needs. As indicated above, the unit or structure has the ability to provide ample water for a vegetable garden. However, Toronto's community gardens vary in size and plot numbers and it is important to note that rainwater harvested from the structure or unit will need to have a supplementary source in case of drought or the inability of the structure or unit to provide enough water for the size of the current garden. In particular, those gardens which currently do not have access, this must be noted and an alternative solution should be provided for users. It is encouraged that as the program moves forward, the City continue to find innovative rainwater solutions that on an independent community garden basis that will help the users use water efficiently

References:

[i] City of Toronto, Wet Weather Flow Master Plan. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=d4e249983587f310VgnVCM10000071d60f89RCRD&vgnextchannel=972bab501d8ce310VgnVCM10000071d60f89RCRD

[ii] City of Toronto, Wet Weather Flow Master Plan. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=f36807ceb6f8e310VgnVCM10000071d60f89RCRD&vgnextchannel=972bab501d8ce310VgnVCM10000071d60f89RCRD).

[iii] City of Toronto, Shade Policy. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=161c7dbbfd510410VgnVCM10000071d60f89RCRD&vgnextfmt=default

[iv] City of Toronto, Community Garden Program. http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=8148dada600f0410VgnVCM10000071d60f89RCRD

[v] City of New York, Grow NYC. http://www.grownyc.org/openspace/rainwater-harvesting

[vi] Rainwater harvesting in Toronto: Research indicates that 0.9m^2 (1 sq.ft.) of vegetable garden requires one gallon of water/week, or 4 gallons/month.[vi] Based on the growing season in the City of Toronto[vi] and the average rainfall during that period[vi], rainwater harvesting collection possibilities, using an average 55-gallon rain barrel, is ~5 gallons of water/month. Subtracting the average number of rain days (rain accumulation of 1.6 gallons/square foot) from the water needs of one square foot of vegetable garden for one month, one square foot of vegetable garden would need 2.4 gallons of water supplemented per month. This indicates that the average 55-gallon rain barrel diameter of 610mm can collect enough rainwater to supplement ~2 square feet of vegetable garden per month.

However, with a larger catch basin area, such as a solar panel (for this scenario a 1.66m^2 panel was used), ~28.5 gallons could be collected/month/panel. Subtracting natural rainfall days from the needs of a square foot of vegetable garden, the solar panel can supply 12 square feet of vegetable garden with water.

Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water

[vii] Sources of Water for the Garden.
http://extension.uga.edu/publications/detail.cfm?number=C1027-11

[viii] Climate Temps, Toronto – Average precipitation/rainfall.
http://www.toronto.climatemps.com/precipitation.php

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Madeline Gibson
Project Management and Communications Assistant
Ryerson Urban Water