A DECENTRALIZED WATER SYSTEM:

Complimenting the Centralized System with a

Rain Harvesting Stormwater Utility

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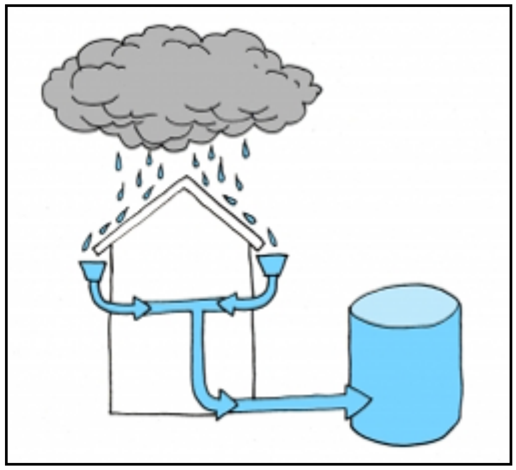
INTRODUCTION

This proposal will explain how using rainwater harvesting as a Best Management Practice (BMP) to reduce flows during rain events and provide the water for non-potable needs can benefit a utility. Water captured from storm events can be **sold** to customers needing non-potable water through the leasing of tanks for a flat fee and access via hydrants to water from larger tanks. If the water rate is high enough the utility **will recoup there cost with in the lifecycle of the system and with an acceptable rate of return.** For example Gwinnett County's in Georgia irrigation rate of $9.70 per 1000 gallons would bring a positive return on the investment of 11 years and Athens/Clarke County rate of $13.50 per 1000 gallons is around 8 years with a life cycle of 20-30 years or more depending on the tank choice.



The idea of a decentralized system came to me in stages after I realized the potential that rainwater harvesting could bring to our area. I witnessed landscaping trucks watering plants, people washing sidewalks and urban gardens trying to supplement irrigation with rain barrels. All were using potable water. If rainwater harvesting systems (RHS) were placed through out a city to supply clean non-potable water, much of our water could be supplied directly from the rain.

The problem of implementing RHS large scale is the upfront cost and lack of short-term payback on the investment. Many commercially installed irrigation RHS may have a payback of 15 years due to seasonal use and the erratic climate patterns; however, once installed, cost and maintenance are minimal. If the utilities had a revenue source from rain harvesting they should embrace the practice. Through my investigation in this project, the lower energy requirements discovered and stormwater management benefits in RHS are the key to making them economical. This led me to realize that this concept could be used as a self funded stormwater utility that provides a product (water) for a fee to pay for the utility cost.

The concept is to bring more sources of water to the watershed and help promote the concept of Rainwater Harvesting to make our society more resilient.

Currently authorities only offer tax credits and rebates in the USA, building code requirements in Australia and Germany through taxes and building codes. Stormwater reduction cost benefits are not added to this plan, because there is no standard for this and authorities use a wide range of methods to calculate fees.

Atlanta rainfall has been historically plentiful with an average 50 inches of rain per year. However, dry periods can last 4-8 weeks allowing the storage of water a necessity. Rain harvesting allows the capture of 0.625 gallons of water per square foot of roof per 1 inch of rain. In reality just over 0.5 gallons of water per square foot is captured. Rain harvesting loses approximately 15-20% during catchment depending on the roof design and weather conditions. A 10,000 square foot building can produce as much as 275,000 gallons of water per year in Atlanta.

Monthly Averages of Rainwater													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Total**
1981-2010 30 yr ave	4.20	4.67	4.81	3.36	3.66	3.95	5.27	3.90	4.47	3.41	4.10	3.90	49.70

Another factor is the quality of water. Rainwater contains virtually no minerals or chemicals. When captured properly the water is of potable quality in the tank. However it should be filtered as per the local authority for potable use. Domestic water from the utility contains chlorine, fluoride and wide range of minerals and chemicals. Water with minerals and chemicals retards plants growth sometimes as much as 20-30 percent and require more water to quench the plant's thirst. Well water can retard plant growth and diminishes the quality of the soil over time. For more information download [Irrigation Water Quality for Agriculture] from the UGA Extension Service.

This plan will explain how water authorities in moderate to wet climates can use rainwater to supply their non-potable water needs, generate revenues from the sale of this water and provide a stormwater utility that funds itself. However marketing it the public may need another title.

Executive Summary

This plan is to develop a decentralized water system through out an authority for non-potable uses such as irrigation, urban farms, parks, washing needs, water features and utility trucks. The authority can install and maintain the tanks allowing a revenue stream to offset the potable water loss. The rainwater harvesting systems can be leased for a monthly fee based on the cost of the system or be connected to violet hydrants to allow vehicles fill their tanks and provide revenue. The fees will be based on the cost of water using current rates. A self-funding stormwater utility is created.

Water use for this project falls into two categories listed below:

- Non-Potable Water Use: This includes a better quality of water used, stored and sold for irrigation, water features, port-a-potties, street sweepers and utility trucks.
- Stormwater Management – Managing the quantity and quality of stormwater. The stormwater that runs off roofs will be directed to tanks for use and during the off season can be released slowly over time to minimize flooding. This will help keep contaminants out streams as well as reduce flooding and erosion.

The Plan

Components of the Plan Include:

- Tanks will be set up in parks, residences and at private businesses to supply water for irrigation and other needs and be charged a flat fee based on cost of the system and current water rates.
- An emergency water reserve will be available through out the city.
- Stormwater management reducing flooding, CSO's and stream pollution.
- New source of revenue for authorities.

Payment would be charged monthly as a flat fee or the same as traditional rates if large tanks were erected with hydrant access. This would allow the customer to budget water costs and offer the authority a simple payment system eliminating the cost of meter installation, maintenance and reading of meters. Using tanks as a finite source of water will help educate customers to the value of

SITES

Sites will vary. Above ground tanks are the easiest to set up and remove allowing versatility. There can also be Public/Private Partnerships created to allow private buildings to allow placement of tanks on private land. Stormwater credits or non-profit donations to the system can compliment the use. One example is [The Mercedes-Benz Stadium, Home of the Atlanta Falcons and Atlanta United] support of a 7300 gallon rainwater system for Trees Atlanta connected to the contractors trailers above during construction.

CATCHMENT AREA

Many types of roofs can be used. Exceptions are wood, roofs using aggregate (rock); roofs with copper flashing or gutters and roofs treated with algae inhibitors if used for food. Roofs should be sloped with no standing water and be smooth. Water testing is available through state and independent labs if quality is important. I have tested four of my systems and they all passed Georgia residential standards for potable water.

Below are models of sites I have assessed for a large-scale project I proposed for the West Side Beltline corredor for Trees Atlanta. Trees Atlanta needs approximately 30,000 gallons of water per week and the existing buildings will provide this and more. The water is currently running off the buildings and into the stormwater drains and adjacent properties unused. Literally millions of gallons are available for non-potable use.

RHS Roof Top Data SW Beltline Cooridor												
Building	**Length**	**Width**	**Roof Area**	**2500 Gallons Tanks**	**Tank Capacity**	**Extra Tanks**	**Tank Capacity**	**Total Capacity**	**Gallons per Inch (Week)**	**Gallons per Month**	**Gallons per Year**	**Growing Season**
Trees Atlanta West Side Office	**260**	**63**	**16,380**	**1**	**15,000**	**0**	**0**	**15,000**	**9,009**	**36,036**	**450,450**	**252,252**
1065 Donnelly - 12 dnspouts												
A	122	145	17,690	1	2,500	3	7,500	10,000	9,730	38,918	505,934	272,426
B	80	145	11,600	0	0	2	5,000	5,000	6,380	25,520	331,760	178,640
C	98	145	14,210	0	0	3	7,500	7,500	7,816	31,262	406,406	218,834
Total			**43,500**	**1**	**2,500**	**8**	**20,000**	**22,500**	**23,925**	**95,700**	**1,244,100**	**669,900**
1320 White Street	**150**	**95**	**14,250**	**3**	**7,500**	**6**	**15,000**	**22,500**	**7,838**	**31,350**	**407,550**	**219,450**
Total			**74,130**	**5**	**25,000**	**14**	**35,000**	**60,000**	**40,772**	**163,086**	**2,102,100**	**1,141,602**

COSTS AND RATES

From my calculations a minimum water rate for all water tiers of $11.00 per 1000 gallons is needed to allow a 10 year ROI with a cot od $4000 per tank with pump. Other tanks are priced at $3000 with no pump. A stormwater utility would also help make this system economically feasible. The minimum price is based on Gwinnett County's rate and Athens/Clarke County rates, which give credibility.

Water use is based on maximum use of the tank. Tanks are sized according to no water availability for 4-5 weeks in a wet climate. Moderate climates may need more storage capacity. Water use for irrigation is erratic, because of climate. However, when needed water becomes invaluable. Stormwater management benefits cannot be included because stormwater utilities vary.

The following table shows the water rates and cost of 2500 gallon leased tanks with pumps comparing water rates and monthly fees. Water fees are based on current fees and the original rate irrigation for Atlanta if used at the high tier rate other utilities use, Gwinnet County and Athens/Clarke County which have progressive stormwater plans and water rate structures. Prices show yearly rates (ROI) and rates based on growing season (GS) use as compared of the same use with water rates. Growing season is estimated at 8 months. Green prices are positive ROI and Red prices area negative ROI. The plan is based on most of the water being used in the tank.

2500 Gallon Tank Leasing Price ROI per Month Public Built for Utility								Atlanta Same Tier Irrigation Rate CCF 748 Gallons			Gwinett County Irrigation Rate 1000 Gallons				Athens/Clarke Irrigation Rate 1000 Gallons			
Tank	w/Pump	w/o Pump	8 Year w/Pump	8 Year w/o Pump	11 Year w/Pump	11 Year w/o Pump	$/Gallon	0-2500 1-3 CCF 1 Tank	5000 4-6 CCF 2 Tanks	7500 7+ CCF 3 Tanks	0-2,500 Gallons 1 Tank	5,000 Gallons 2 Tanks	7,500 Gallons 3 Tanks	10,000 Gallons 4 Tanks	0-2,500 Gallons 1 Tank	5,000 Gallons 2 Tanks	7,500 Gallons 3 Tanks	10,000 Gallons 4 Tanks
Rate per Gallon								$7.47	$7.47	$7.47	$9.70	$9.70	$9.70	$9.70	$13.50	$13.50	$13.50	$13.50
2500 Gallon Tank	$4,000	$3,000	$41.67	$31.25	$30.30	$22.73	$1.60	$24.97			$24.25				$33.75			
Addnl 2500 Gallon Tank		$3,000		$31.25		$22.73	$1.20		$24.97	$24.97		$24.25	$24.25	$24.25		$33.75	$33.75	$33.75
Water Price	Includes Base Charge						TOTAL	$31.47	$56.43	$81.40	$30.75	$55.00	$79.25	$103.50	$42.40	$76.15	$109.90	$143.65
8 Year ROI								$41.67	$72.92	$104.17	$41.67	$72.92	$104.17	$135.42	$41.67	$72.92	$104.17	$135.42
11 Year ROI								$30.30	$53.03	$75.76	$30.30	$53.03	$75.76	$98.48	$30.30	$53.03	$75.76	$98.48
15 Year GS								$29.78	$52.11	$74.44	$29.78	$52.11	$74.44	$96.78	$29.78	$52.11	$74.44	$96.78

Prices include tank, roof washer filter, first flush diverter, plumbing, pump, maintenance, labor and footer pad.

The following table shows the lease price, cost and return of a 38,500 gallon leased tanks with a pump. Water fees are based on current fees and the original rate irrigation. Green prices are positive ROI and Red prices area negative ROI.

Large Tank Lease Price Breakdown ROI per Month Private Built								Atlanta Same Tier Irrigation Rate CCF 748 Gallons	Gwinett County Irrigation Rate 1000 Gallons	Athens/Clarke Irrigation Rate 1000 Gallons
Tank	w/Pump Cost	11 Year w/Pump	15 Year w/Pump	20 Year w/Pump	25 Year w/Pump	30 Year w/Pump	$/Gallon	1-51 CCF	1-38,500 Gallons	1-38,500 Gallons
Rate of Water per Gallon								$7.47	$9.70	$13.05
38,500 Gallon Tank	$65,123.55	$493.36	$361.80	$271.35	$217.08	$180.90	$1.69			
TOTAL							TOTAL	$384.49	$373.45	$502.43
11 Year ROI								$493.36	$493.36	$493.36
15 Year ROI								$361.80	$361.80	$361.80

Prices include tank, roof washer filter, first flush diverter, plumbing, pump, maintenance, labor and footer pad.

SUSTAINABILITY

For more information on the sustainability of rainwater harvesting read the 2 papers linked to on my website The Rainsaver. Lifecycle assessment of a Commercial RHS and Holistic RW on a Watershed Level support rainwater harvesting as a more efficient alternative to domestic water supplies lead by Santosh R. Ghimire, Ph.D. M. ASCE, M. AAAS Global Sustainability and Life Cycle Consultant LLC www.gslcconsultant.com. The papers compare through Lifecycle Assessment of all the products used to build both systems as well as the effect on watersheds.

Also on the page is my interview about this plan on Talk with the Green Guy show with Eric Moncrieff.

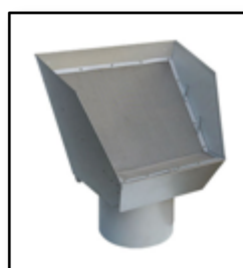
ENERGY

The key component to RHS that may be overlooked is the energy savings. Satisfying the Nation's water needs requires energy for distribution and treatment of water. Electricity costs represents approximately 75 percent of the cost of municipal water processing and distribution (Powicki, 2002) according to the ENERGY DEMANDS ON WATER RESOURCES by the US Department of

Electricity Consumption w/38,500 gallons of storage growing season								
Volts	Amps	kW	Hours	kWh	Price/kWh	Total	Yearly Revenue	% of Use
230	17.5	4.03	340.3	1,369.6	$0.074	$101.35	$4,341.60	2.33%

Energy.[1] The table below shows 2.33% cost for energy for the large tank example.
Energy reduction is a known benefit in water efficiency, but there is little public discussion about the how much energy is used related to water treatment. As mentioned above a key component of this plan is energy savings. The cost of treatment for RHS will only include maintenance of the filters, maintenance of the tanks and the cost of electricity for pumping water with a small pump to transfer the water onsite. No energy is required to treat the water collected, because gravity is used to clean the water as it piped into the tank from the roof as described below in the rainwater filtration section. Not only will this system reduce potable water use, but will save a great deal of energy.

RAINWATER FILTRATION



Rainwater is very clean before and after it lands on the roof if collected properly. To provide clean rainwater the surface of the roof must be cleaned. This is accomplished by filtering the water first through a roof washer (fine stainless steel screen) placed at the bottom of existing downspouts to remove the particulates. There will be two different styles of roof washers one will be an Australian Rain Head that can be used for long-term leases.

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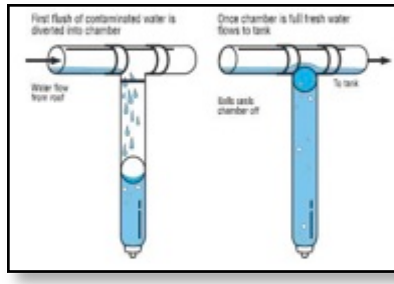
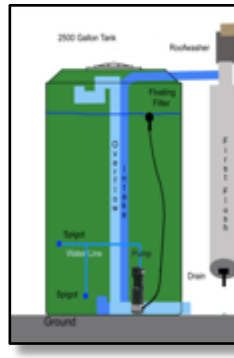
[1] ENERGY DEMANDS ON WATER RESOURCES - REPORT TO CONGRESS ON THE

The next step is to divert the first 5% of the water on the roof to a first flush device. This device will divert the roof contaminants in the water from the tank. When the pipes are filled the device closes and clean water will go into the tanks. The contaminants will drain from the first flush device slowly back into the ground.



Other filters such as the WISY can be used for Systems that may be moved regularly the customers temporary needs. The Wisy can be used for short-term location use. It is easy to install, durable and has a first flush built in to the technology. Other filters maybe used on the larger tanks to provide the same results.



The water then enters the tank through a calming inlet so not to stir any sediment settled on the bottom of the tank. The water is filtered through another fine stainless steel screen attached to a floating filter when pumped out of the tank. The filter collects the water 6-8 inches below the surface. This is the cleanest and most oxygenated water. If this simple design is followed the water in the tanks should be potable. No other filtration is needed. Inlet and outlet pipes are installed internally to minimize damage during transportation and while in use. The system also prevents mosquitos from leaving the tank through piping and screens.

TANKS

Tanks will be 2500 gallon above ground and made from FDA approved UV stabilized polyethylene. Smaller tanks were priced and the return was unfavorable. These tanks are usually green, but are available in a variety colors. To increase capacity 2500 gallon tanks can be linked together or the use of a plastic liner tank can provide a larger storage capacity.

Plastic liner tanks can store up to 800 thousand gallons and are built on site. Tanks can be placed on the ground supported by pavers or gravel for easy installation and removal. These tanks come in corrugated or industrial styles as seen below.

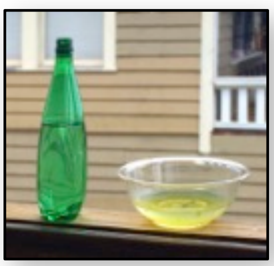
EVAPORATION

The efficiency of storage is something not mentioned when designing reservoirs or comparing rain harvesting to reservoirs. Evaporation from Lake Lanier is about 40 inches per year with an annual average precipitation of 54.8 inches, which calculates to a 73% loss of water according to a US Department of Commerce Technical Paper.[2]

Another story related to water being stored more efficiently in tanks then in lakes, traditional reservoirs, because of evaporation. According to an AJC article Sun Drains .2 Inch of Water Daily from Lanier by Satavy Shelton Published on 06/19/08

> *193.9 million gallons of water evaporated from the lake, the main water source for more than 3 million in metro Atlanta. By comparison, Gwinnett County withdrew an average of 74.2 million gallons a day from the lake in May, or less than half the amount that's disappearing in the sun's rays.*

A 3 year comparison test was initiated with 32 oz. of water in an open bowl (reservoir) compared to a 32 oz. bottle of water (cistern) with a loose cap and the last year an open bottle to simulate the venting system. The green bottle simulates a rainwater cistern, which has only a venting system connecting it to the environment. The bottled contained 32oz of water and only lost 1-2oz each year where the bowl lost 4.75 gallons each year for 2 years. The test for the third year the cap was removed lost 5 oz. in the open bottle and 5.75 gallons for the bowl. Detailed results are available by request.



Evaporation Test

Open Top

Loose Top

AESTHETICS

Many people oppose above ground rainwater tanks as ugly. I have realized this to be untrue. Some manufacturers offer as many a 13 different colors as seen on the next page and incorporate a black layer to completely remove light from entering the tanks. Other choices are wraps and designing the tank into the environment to make a statement. Below are a few examples of pleasing tank designs and there is always the choice to put in on the side of a building that is not viewed.

[2] US Department of Commerce Technical Paper NO. 37, M. A. Kohler, T. J. Nordenson and D. R. Baker Hydrological Service Division, 1959

Maintenance

Quarterly maintenance is usually sufficient. Maintenance consists of cleaning the roof washer screen, the first flush filter and inspecting and cleaning roof and gutters as needed. Each site is different and will have to be monitored. If functioning properly the tanks should remain working/clean for years. Maintenance can be performed by the client, but should also be inspected by local authority twice a year, which is included in the costs.

In Conclusion

This concept will help rainwater harvesting become more accessible to the public and provide them with the quality of water they want with out the large upfront investment necessary to implement rainwater harvesting. As the practice grows others can see the benefits and realize the long-term investment is economically feasible. Information on energy use and evaporation were shared to show how much more efficient and sustainable rainwater harvesting can be when compared to traditional water reservoirs. The system will complement the centralized system and be a revenue stream for the city. The concept is to provide a higher quality water source for non-potable use, which can be priced competitively with domestic water. In fact, this has the potential to be a self-sustaining stormwater utility.

By managing rainwater and stormwater efficiently would insure plenty of water for generations. Expanding the reservoir system with the cost of land, new infrastructure, energy use, environmental issues and the loss due to evaporation seems futile. A decentralized system can be implemented within several years instead of the decades it takes to complete a reservoir. With drought conditions forecast for Georgia in the near future, now is the time to consider implementing this plan.

More data is available upon request. I welcome all comments and suggestions.