



HOW TO

**Wetland:
Water Systems**

2014



How To: Mary Mattingly Studios

Wetland: Water Systems

Why Wetland?

Now more than ever, fostering local connections and collaborations is essential. We need to move away from dependence on global supply chains and address the social and environmental traumas ingrained in production. Climate change urges us to deeply consider the environmental costs of relying on external sources for essential provisions like food, water, and public goods in our cities.

In this context, the sculptural living system known as Wetland emerged. Serving as a submerged sculpture, stage, and floating island, Wetland embodied imagined futures based on participatory design events in Philadelphia. Launched on August 15, 2014, Wetland embodied an urban ecotopia, featuring live, work, and performance spaces alongside sustainable elements like rainwater collection, purification systems, hydroponic gardens, beehives, and composting. Through free events and workshops, it amplified the movements of urban farming and ecological practices, showcasing the transformative potential of individual actions.



WETLAND

Imagining alternative futures through Art

Wetland was a mobile, sculptural habitat, and public space on the Delaware River that explored resource interdependence in urban centers facing sea level rise. It integrated nature with urban spaces, fostering local economies and collective experiences through exchange-based collaborations. Launched in 2014, Wetland served as a stage for stories about shared futures, emphasizing individual impact on the environment. With its rainwater collection, compost systems, gardens, and partnerships with educational institutions, Wetland engaged students and residents alike. This floating sculpture advocated for thriving local ecologically-focus and more justice-oriented economies.



Water is my teacher

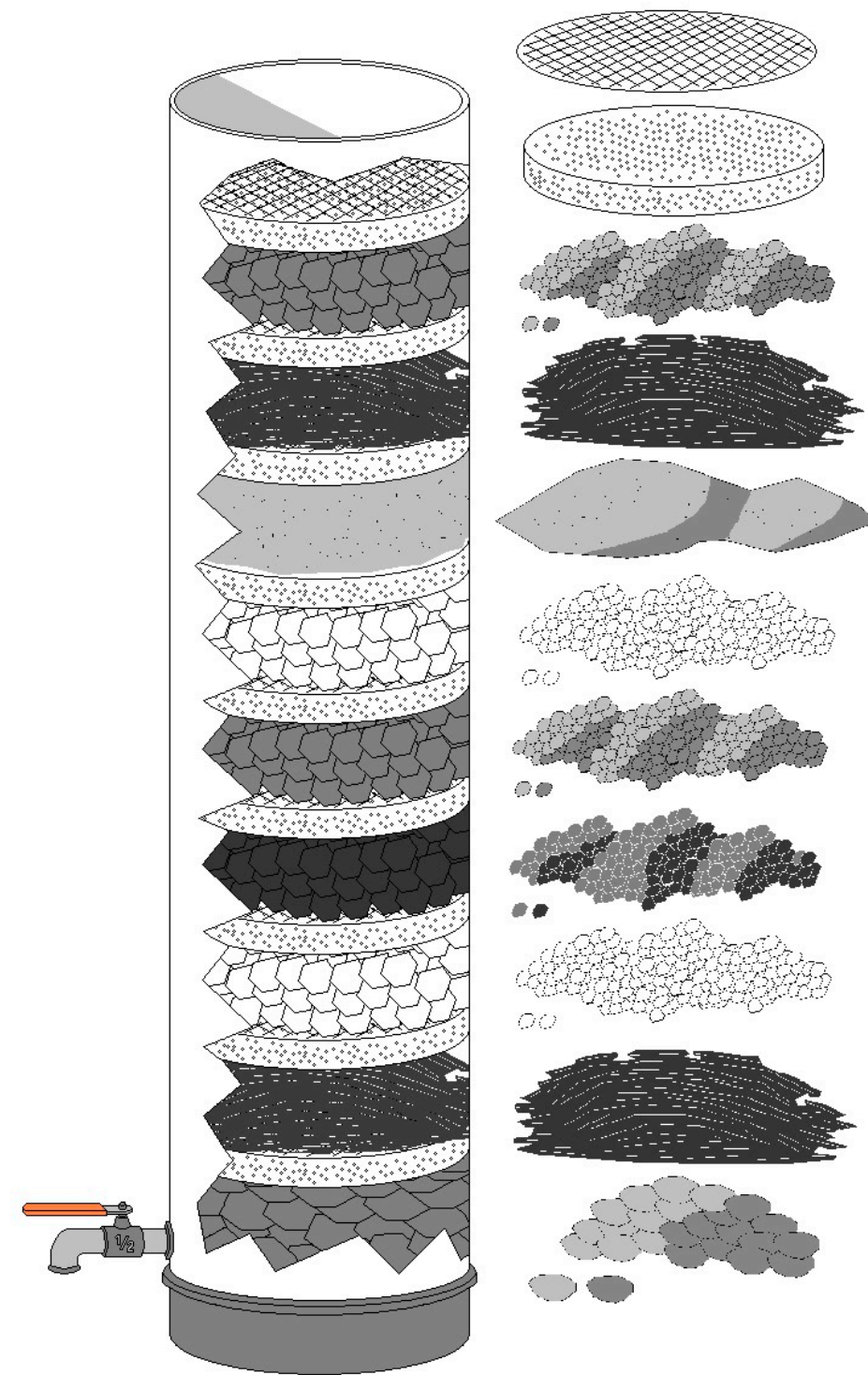
Water

Water is everything. Rainwater harvesting is an effective strategy to reduce domestic water use. I personally embrace this practice, focusing on three potential sources: direct rainfall, street harvesting, and roof harvesting.

For roof rainwater, I have set up a simple water catchment system. Gutters collect the water, directing it through a pipe towards a storage tank. To ensure the water's cleanliness, I implement a "first flush system" where the initial dirty rainwater is diverted away from the tank, allowing only subsequent rainwater to reach it.

Before entering the tank, the rainwater goes through a screen that filters out leaves and debris. The tank itself is designed to prevent algae growth by keeping it dark and screened to keep mosquitoes out. In urban areas, rain barrels are a popular starting point for rainwater harvesting. They are affordable and can be installed along houses, under decks, or in unused spaces. For larger-scale storage, various options such as plastic, ferrocement, metal, or fiberglass cisterns are available in different sizes ranging from 50 gallons to tens of thousands of gallons.

Water Filtration



The following filters can be used to treat water to create potable water systems, but not all filters are needed to create a potable system.

Activated Carbon: treated charcoal creates a porous carbon that absorbs water impurities

- Pros: Removes chlorine, pollutants, organic contaminants, long life, low cost
- Cons:

Reverse Osmosis: pushing water through a semipermeable membrane which will only allow water molecules through

- Pros: Removes all contaminants, low maintenance, removes nitrates
- Cons: Very Expensive, 10% efficiency

Slow Sand Filtration: running water through sand.

- Pros: Removes particulates larger than the sand, removes heavy metals, removes many bacteria, uses local materials, low maintenance
- Cons: Must be cleaned often, can grow algae or bacteria

Water Filtration

Distillation: boiling and condensing water molecules in a separate uncontaminated container

- Pros: Removes bacterium and viruses, reusable
- Cons: Require extra energy, requires extra time, some contaminants transfer

Ion Exchange: use of ion exchange resin beads which will react with contaminants and bind to contaminants

- Pros: Removes nitrates and phosphates and dissolved inorganic compounds
- Cons: Does not remove pathogens, does not remove bacterium, expensive

Ultraviolet Light: the use of ultraviolet light to kill pathogens

- Pros: kills bacteria and viruses, oxidizes organic compounds
- Cons: short life, expensive

Microporous Basic Filtration: uses a filter of certain diameter holes to keep contaminants from passing through.

- Pros: Removes all particles larger than filter diameter, minimal maintenance
- Cons: Does not remove organics or chemicals

Ultrafiltration: similar to microporous filtration but with smaller diameter holes

- Pros: Removes particles above rated size, low cost
- Cons: Does not remove dissolved organics

Appropriate Technology Device	Water Carrying Capacity (Liters)	Initial Cost of Device (US\$)	Cost of Consumables (US\$)	Lifetime of Consumables (days)	Lifetime of total device (years)	Operating cost per year (US\$)	Total cost over lifetime (US\$)	Water produced over lifetime (Liters)	Cost of water (cents/Liter)	References
4.1a Sono 3-Kolshi	50	\$35.50	\$4.50	140	5	\$11.73	\$94.16	73,000	0.1290	Munir et al, 2001 and Hussam, 2007
4.1b 3 Gagri System	4	\$10.50	\$4.50	140	5	\$11.73	\$69.16	73,000	0.0947	Hurd, 2001
4.2a Sono 2-Kolshi Filter	20	\$16.70	\$9.70	365	5	\$9.70	\$65.20	73,000	0.0893	Tabbal, 2003 and Hwang, 2002
4.2b Stevens Institute Method	20	\$9.50	\$2.00	365	3	\$2.00	\$15.50	43,800	0.0354	Hwang, 2002
4.3 Bucket treatment Unit (BTU)	20	\$6.50	NA	NA	3	NA	NA	43,800	NA	Eriksen-Hamel, 2001
4.4 Kanchan Arsenic Filter	20	\$27.50	\$7.50	1095	5.5	\$2.50	\$41.25	80,300	0.0514	KAF, 2001
4.5a Clay Pitcher Arsenic Removal Filter	12	\$14.15	\$9.98	150	5	\$24.28	\$135.57	73,000	0.1857	Tahir, 2004
4.5b Gravity Flow Arsenic Removal Filter	12	\$28.75	\$20.00	25	5	\$292.00	\$1,488.75	73,000	2.0394	Tahir, 2004
4.5c Arsenic Removal Cartridge Filter	10.8	\$26.67	\$10.00	25	5	\$146.00	\$756.67	73,000	1.0365	Tahir, 2004
4.6 Solar Still + CPC (1m2) long life	50	\$277.68	\$0.00	NA	10	\$0.00	\$277.68	146,000	0.1902	Pearce and Denkenberger, 2006
4.6 Solar Still + CPC (1m2) medium life	50	\$277.68	\$0.00	NA	5	\$0.00	\$277.68	73,000	0.3804	Pearce and Denkenberger, 2006
4.6 Solar Still + CPC (1m2) short life	50	\$277.68	\$0.00	NA	3	\$0.00	\$277.68	43,800	0.6340	Pearce and Denkenberger, 2006
4.7 ARUBA	-	0	1.76	365	1	\$80.00	\$80.00	73,000	0.1096	BAAG, 2007b
4.8a Jerry Can System	50	0.5	\$4.50	25	5	\$65.70	\$329.00	73,000	0.4507	Hurd, 2001

Clay Filtration

Clay Filtration: An earthenware clay is mixed with an organic burnout material of proper particle size. The material is then formed into the shape of a pot and fired. In the process of firing the organic material burns away leaving micro-pores in the fired clay body. After firing the filters are often treated with colloidal silver or silver nitrate to prevent bacterial or plant growth inside the pot. Contaminated water is put into the pot, and as it passes through the small pores bacteria and particles are removed. These filters have commonly achieved a 98% success rate in removing coliform bacteria. The pot filters are usually made to fit into a receptacle such as a 5-gallon bucket to capture the filtered water.

How to calculate gallons of rainwater that can be collected from a roof:

In order to figure out the size of the tank you will need to store the rainfall collected in your rainwater harvesting system, it is important to know how large the roof is. Most rain events are 1 inch or less.

Method

1. Measure the length and the width of the roof but check where the downspouts are to find what part of the roof drains to each downspout when there is more than one downspout. For example, if the roof is pitched in 2 directions and you are only able to use the downspout on one side then just measure the part of the roof that drains to the downspout you will use.
2. Every square foot of roof space collects .6 gallons of water in a 1-inch rainfall.
3. To account for losses and inefficiency, you can expect to collect about 75% of the actual rainfall so your calculation should be multiplied by .75

Formula

Length of roof _____feet
 X width of roof _____feet
 X .6 gallons per square ft X .75
 X _____inches of rainfall
 = _____gallons of rainfall collected
 Calculate for: A roof that is 50 feet long by 20 feet wide in a 2-inch rainfall

Length of roof _____feet
 X width of roof _____feet
 X .6 gallons per square ft X .75
 X _____inches of rainfall
 = _____gallons of rainfall collected
 How to calculate gallons of rainwater that can be collected from a roof:

Calculate for: A 30-foot long by 20-foot wide roof in a 1-inch rainfall but you can only collect from half of the roof

Length of roof _____feet
 X width of roof _____feet
 X .6 gallons per square ft X .75
 X _____inches of rainfall
 = _____gallons of rainfall collected
 Calculate for: A roof that is 50 feet long by 20 feet wide for 34 inches of rainfall in a season

Length of roof _____feet
 X width of roof _____feet
 X .6 gallons per square ft
 X .75
 X _____inches of rainfall
 = _____gallons of rainfall collected

Calculate for your roof for a 2-inch rainfall:

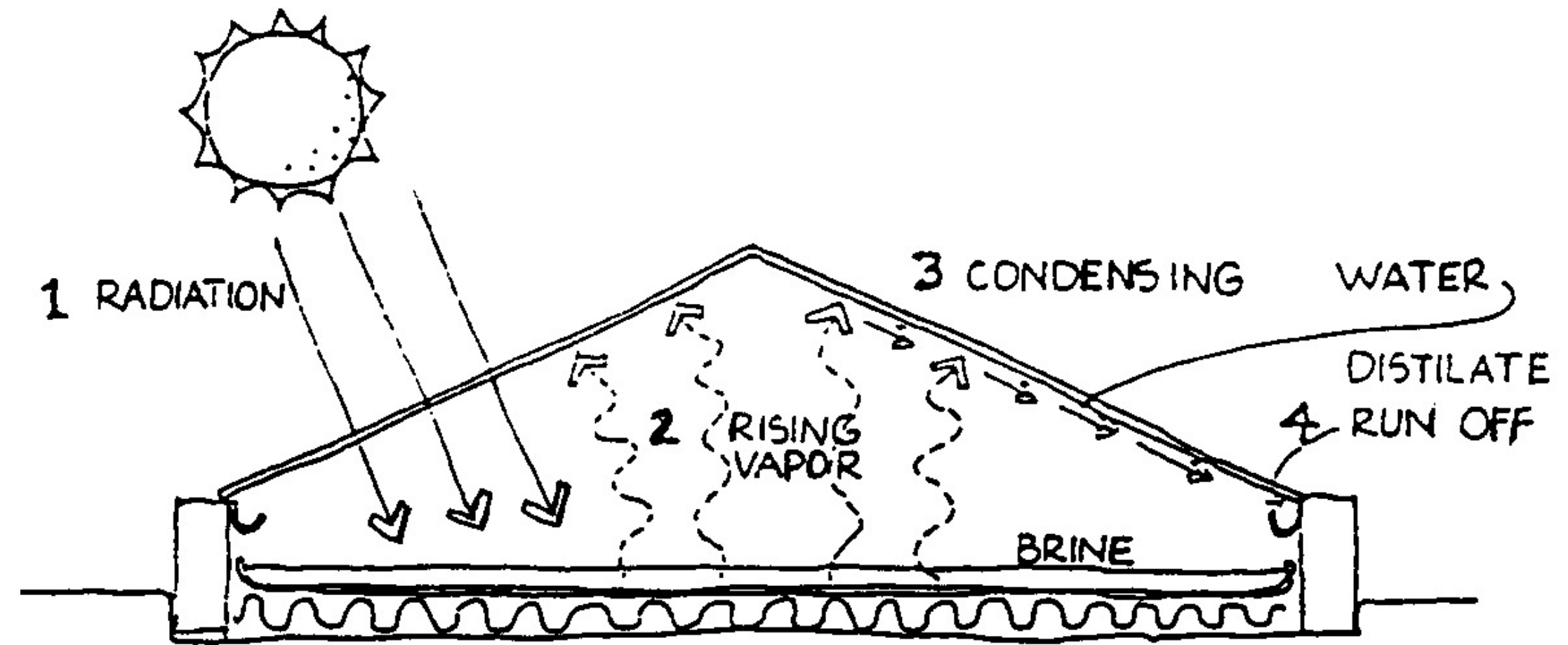
Length of roof _____feet
 X width of roof _____feet
 X .6 gallons per square ft X .75
 X _____inches of rainfall
 = _____gallons of rainfall collected

Thank you:

Water Resources Group

Solar Distillation

Solar distillation uses the heat of the sun directly in a simple piece of equipment to purify water. The equipment, commonly called a solar still, consists primarily of a shallow basin with a transparent glass cover. The sun heats the water in the basin, causing evaporation. Moisture rises, condenses on the cover and runs down into a collection trough, leaving behind the salts, minerals, and most other impurities, including germs.

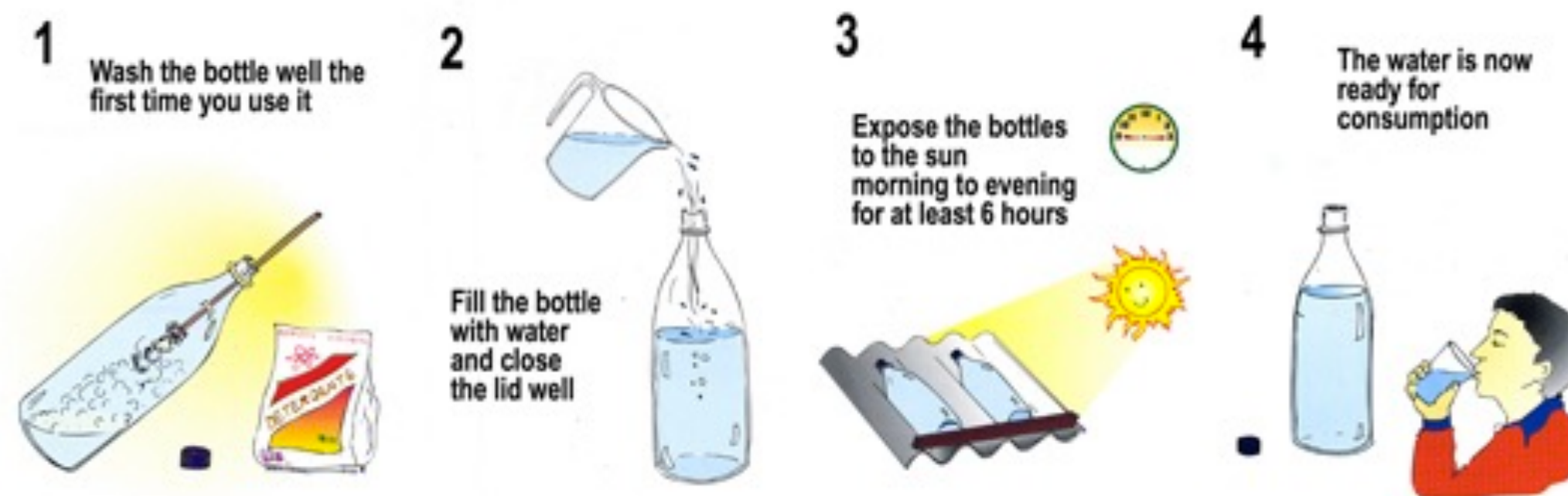


Fresh Water from the Sun, by Daniel C. Dunham, (Washington, D.C., August 1978), p. 16.

Solar Distillation (SODISW)

Solar water disinfection, or SODISW, is a method to disinfect water using sunlight and PET bottles. Water from contaminated sources is filled into transparent water bottles. For oxygen saturation, bottles can be filled three-quarters, then shaken for 20 seconds (with the cap on), then filled completely. Highly turbid water (turbidity higher than 30 NTU) must be filtered prior to exposure to sunlight. Filled bottles are then exposed to the sun. Better temperature effects can be achieved if bottles are placed on a corrugated roof as compared to thatched roofs.

The treated water can be consumed. The risk of re-contamination can be minimized if water is stored in the bottles. The water should be consumed directly from the bottle or poured into clean drinking cups. Re-filling and storage in other containers increases the risk of contamination. Effectiveness can be increased by placing on a dark or reflective surface, e.g. a roof made of corrugated metal, or by painting half the bottle black, such that when laying down the clear half is facing the sky.



The SODIS method is very easy to apply: A transparent PET bottle is cleaned with soap. Then, the bottle is filled with water and placed in full sunlight for at least 6 hours. The water has then been disinfected and can be drunk.

Material, color, and shape of the bottle: The bottles must be transparent and colorless. PET bottles often have a bluish tinge. This is not a problem. Heavily scratched bottles must be replaced. The bottles must not hold more than 3 liters. Concerns about PET leakage is not an issue for this particular use. The temperature for PET leakage must be over 50 degrees celcius or must be left in the bottle for months for this to happen.

Solar Distillation: SODIS Potential Issues

Turbidity: If the water is very turbid, the effectiveness of the method is reduced. It is very easy to determine whether the water is sufficiently clear: The filled PET bottle must be placed on top of a newspaper headline. Now one must look at the bottom of the bottle from the neck at the top and through the water. If the letters of the headline are readable, the water can be used. If the letters are not readable, the water must be filtered. This test corresponds to turbidity of 30 NTU.

Cloudiness: Cloudiness affects the strength of solar radiation and thus also the effectiveness of the method.

Rule of thumb:

- If less than half of the sky is clouded over, 6 hours will be enough to completely disinfect the water.
- If more than half of the sky is covered with clouds, the bottle must be placed in the sun for 2 consecutive days.

Rain: The method does not work satisfactorily during long periods of rain. On these days, we recommend collecting rainwater.

Preventing recontamination: The treated water should be kept in the bottle and used directly from the bottle or poured into a cup or glass immediately before drinking. In this way, it is possible to prevent the treated water from becoming contaminated again.

METRICS FRAMEWORK

Activities

Many studies have shown links between the urban agriculture activities across the top row (such as cooking and nutrition classes, rainwater harvesting, farmers markets) and the health, social, economic, and ecological benefits on the left hand column (such as health eating, stormwater management, and social connections).

● Evidence-based links

Benefits

Health

Benefit	Rainwater Harvesting	Raising Livestock	Composting	Planting Trees	Cooking & Nutrition Classes	Health & Wellness Education	School Programs	Ag./farm Management Training	Women-Focused Programs	Community-Based Research & Organizing	Volunteer Programs	CSA	Farmers Market	Restaurant Sales	
Access to healthy food		●					●	●	●	●	●	●	●	●	●
Food-health literacy	●			●	●	●	●	●	●	●	●	●	●	●	●
Healthy eating					●	●	●	●	●	●	●	●	●	●	●
Physical activity		●		●		●		●	●		●				●

Social

Benefit	Rainwater Harvesting	Raising Livestock	Composting	Planting Trees	Cooking & Nutrition Classes	Health & Wellness Education	School Programs	Ag./farm Management Training	Women-Focused Programs	Community-Based Research & Organizing	Volunteer Programs	CSA	Farmers Market	Restaurant Sales	
Empowerment & mobilization			●	●	●		●	●	●	●	●	●	●	●	●
Youth development & education		●			●	●	●	●	●	●	●				●
Food security		●						●		●	●	●		●	●
Safe spaces		●		●				●		●	●	●		●	●
Socially integrated aging										●					●

Economic

Benefit	Rainwater Harvesting	Raising Livestock	Composting	Planting Trees	Cooking & Nutrition Classes	Health & Wellness Education	School Programs	Ag./farm Management Training	Women-Focused Programs	Community-Based Research & Organizing	Volunteer Programs	CSA	Farmers Market	Restaurant Sales	
Local economic stimulation									●	●		●	●	●	●
Job growth									●	●			●	●	●
Job readiness					●			●	●	●			●	●	●
Food affordability		●									●	●	●	●	●

Ecological

Benefit	Rainwater Harvesting	Raising Livestock	Composting	Planting Trees	Cooking & Nutrition Classes	Health & Wellness Education	School Programs	Ag./farm Management Training	Women-Focused Programs	Community-Based Research & Organizing	Volunteer Programs	CSA	Farmers Market	Restaurant Sales
Awareness of food systems ecology		●	●	●	●	●		●	●	●	●	●		●
Stewardship	●	●	●	●	●	●		●	●	●	●	●		●
Conservation	●	●	●	●			●	●	●	●		●	●	
Storm water management	●													●
Soil improvement			●	●										●
Biodiversity & habitat improvement		●	●	●										●

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NETWORKS

Strengthening preexisting networks is a necessary part of interdependence. Here is a short list of some of Philadelphia's local organizations that focus on Food, water, environmental health, and sharing tools.

ActionPA / Energy Justice Network:

1434 Elbridge St, Philadelphia, PA 19149, 215-743-4884

ActionPA is a state-wide non-profit based in Philadelphia focused primarily on helping communities defend themselves from dirty energy, waste, and toxics-related facilities.

The Blue Green Alliance:

4100 Main St, Suite 403, Philadelphia, PA 19127, P: 215-508-3310

The Blue Green Alliance is a national, strategic partnership between labor unions and environmental organizations dedicated to expanding the number and quality of jobs in the green economy.

Clean Air Council:

135 South 19th Street, Suite 300, Philadelphia, PA 19103, P: 215-567-4004 x 114

A nonprofit Pennsylvania environmental group working to protect everyone's right to breathe clean, healthful air through education, outreach, and advocacy.

Clean Water Action:

1315 Walnut Street, Suite 1650, Philadelphia, PA 19107 P: 215-545-0250 and 100 N 17th St. Philadelphia, PA 19103, P: 215-640-8800

Clean Water Action is a one-million-member organization of diverse people and groups joined together to protect our environment, health, economic well-being, and community quality of life. Our goals include clean, safe, and affordable water; prevention of health-threatening pollution; creation of environmentally safe jobs and businesses; and empowerment of people to make democracy work. Clean Water Action organizes strong grassroots coalitions and campaigns to elect environmental candidates and solve environmental and community problems.

Climate Change Working Group:

606 W. Upsal St. Philadelphia, PA 19119, P: 215-438-2334

A project of the Germantown Friends Meeting in northwest Philadelphia.

Community Recycling:

225 Lincoln Highway, Fairless Hills, PA 19030, P: 215-547-2723

Community Recycling is a community-based textile recycling company that collects and processes second-hand clothing, shoes, accessories, and useable household items. Earn money by helping the environment! Great fundraising idea for schools, nonprofits, churches, synagogues, and businesses. Highly visible, accessible locations are needed to place textile (clothing) bins. Fully insured.

Defenders of Wildlife:

1800 JFK Blvd., Suite 300, Philadelphia, PA 19103, P: 267-238-3840

Defenders of Wildlife's main focus is on protecting endangered species and our secondary focus is on reducing global warming.

Delaware Riverkeeper Network:

300 Pond St., 2nd Floor, Bristol, PA 19007, P: 215-369-1188

The Delaware Riverkeeper Network is the only advocacy organization working throughout the entire Delaware River Watershed. The Delaware Riverkeeper is an individual who is the voice of the River, championing the rights of the River and its streams as members of our community. The Delaware Riverkeeper Network is committed to restoring the watershed's natural balance where it has been lost and ensuring its preservation where it still exists.

Farm to City:

1315 Walnut Street, Suite 1526, Philadelphia PA 19107, P: (215) 733-9599

Farm to City is a Philadelphia- based program whose goal is to unite communities, families, and farmers year-round through good locally grown food.

The Food Trust:

1201 Chestnut Street, 4th fl. Philadelphia, PA 19107, P: 215-568-0830

The Food Trust is responding to the contemporary epidemic of diet-related disease and malnutrition by working to increase access to affordable and nutritious food and helping people to improve their diets. Founded in 1992, the Trust's mission is to ensure everyone has access to affordable, nutritious food.

EAC Network (municipal Enviro. Advisory Councils):

123 Chestnut Street, Suite 401, Philadelphia, PA 19106, P: (215) 592-7020 x103

The Pennsylvania Land Trust Association is pleased to host, in conjunction with the 2014 Pennsylvania Land Conservation Conference, a training and networking program for Environmental Advisory Council (EAC) members and municipal officials. The EAC Network Conference will provide networking and training opportunities and focus on a variety of important topics, including collaborating with municipal boards and committees, conservation referenda, energy, etc.

Bicycle Coalition of Greater Philadelphia:

1500 Walnut Street, Suite 1107, Philadelphia, PA 19102, P: 215 242-9253

Promoting the bicycle as an environmentally friendly, healthy, and economical form of transportation and recreation through advocacy and education.

Fairfoodphilly:

1315 Walnut St Ste 522, Christina Dowd, Philadelphia, PA 19107, P: 2154133790

Fair Food has been uniting local farmers with businesses and consumers for over a decade. We promote the importance of family farms and create a year-round marketplace for fresh, local, and humane food products in the Greater Philadelphia region. We provide an assortment of services that contribute to a strong and sustainable local food system. Supporting farmers, connecting consumers, educating the public, and celebrating the joys of local food.

Greater Philadelphia Commercial Recycling Council:

PO Box 4037, Philadelphia, PA 19118, P: 215-247-3090

Corporate, institutional, and business solid waste planning, economic evaluation, design, research, and program management. We help the business community lead rather than follow. Offering our new Environmental Business Reporting Tool to help document and evaluate greenhouse gas reduction through recycling.

Independence Seaport Museum:

Penn's Landing on the Delaware River, 211 South Columbus Blvd & Walnut St.

Philadelphia, PA 19106, P: 215-413-8630

The Independence Seaport Museum is an anchor attraction on Penn's Landing, attracting visitors to experience both Philadelphia's heritage and current waterfront. The Museum educates area youth groups through interactive programs in its boat shop, presents changing exhibits in its galleries, and hosts visiting ships and events year-round.

The organic mechanics soil company:

PO BOX 272, Modena, PA 19358, P: 610 380-4598

At Organic Mechanics, we're passionate about all-natural, sustainable gardening that provides superior results. That's why our soils are 100% organic, made with locally sourced ingredients, completely peat-free, and used by professional gardeners at arboretums and botanical gardens.

Pennsylvania Association for Sustainable Agriculture:

P.O. Box 419Millheim, PA 16854, Phone: (814) 349-9856

In existence since 1992, the Pennsylvania Association for Sustainable Agriculture(PASA) continues working to bring farmers together to learn from each other, and to build relationships between those farmers and consumers looking for fresh, wholesome, locally and sustainably produced food.

Philadelphia Beekeepers Guild:

St. James School, 3217 Clearfield St., 19132, on the third Thursday of each month. Located in the cradle of American Beekeeping, the Philadelphia Beekeepers Guild works to encourage and promote urban beekeeping through fellowship and education, and to raise awareness of the importance of bees to our environment. The Philadelphia Beekeepers Guild has grown from what began in 2009 as a small, informal group of local beekeepers.

Philly Growing Greener:

Philadelphia, PA 19114, P: 215-966-9976. Philly Growing Greener aims to broaden the horizons of all Philadelphians, but particularly at-risk youth through hands-on science, history and personal development programs.

Schuylkill Center for Environmental Education:

8480 Hagy's Mill Road, Philadelphia, PA 19128

The Schuylkill Center for Environmental Education inspires meaningful connections between people and nature. We use our forests and fields as a living laboratory to foster appreciation, deepen understanding, and encourage stewardship of the environment.

Sharing Backyards:

<http://www.sharingbackyards.com/browse/philadelphia>

Sharing Backyards encourages urban gardening by connecting those who have space to garden with those who would like to garden but don't have yard space.

Student Environmental Action Coalition:

PO Box 31909, Philadelphia, PA 19104, P: 215-222-4711

SEAC is a student and youth run national network of progressive organizations and individuals whose aim is to uproot environmental injustices through action and education. We define the environment to include the physical, economic, political, and cultural conditions in which we live. By challenging the power structure which threatens these conditions, students in SEAC work to create progressive social change on both the local and global levels.

SustainUS is a nonprofit, nonpartisan organization of young people advancing sustainable development and youth empowerment in the United States. Join other young folks (under 35) to push for sustainability in the greater Philadelphia region, through education, advocacy and professional development.

TreeVitalize:

c/o PHS 100 North 20th St. 5th Floor, Philadelphia, PA 19103, P: 215-988-8874

Responding to an alarming trend of the loss of trees in Pennsylvania's metropolitan areas, TreeVitalize is a public-private partnership to help restore tree cover, educate citizens about planting trees as an act of caring for our environment, and build capacity among local governments to understand, protect and restore their urban trees.

The West Philly Tool Library, 1314 South 47th Street, Philadelphia, PA.

The West Philly Tool Library loans tools to community members for simple home maintenance, tending yards and gardens, building furniture, starting projects, and learning new skills in a safe and affordable manner. They aim to be a community resource to provide homeowners, tenants, long-time residents, and newcomers with the tools (and the knowledge to work the tools!) they need.