



# KEEP SAFE

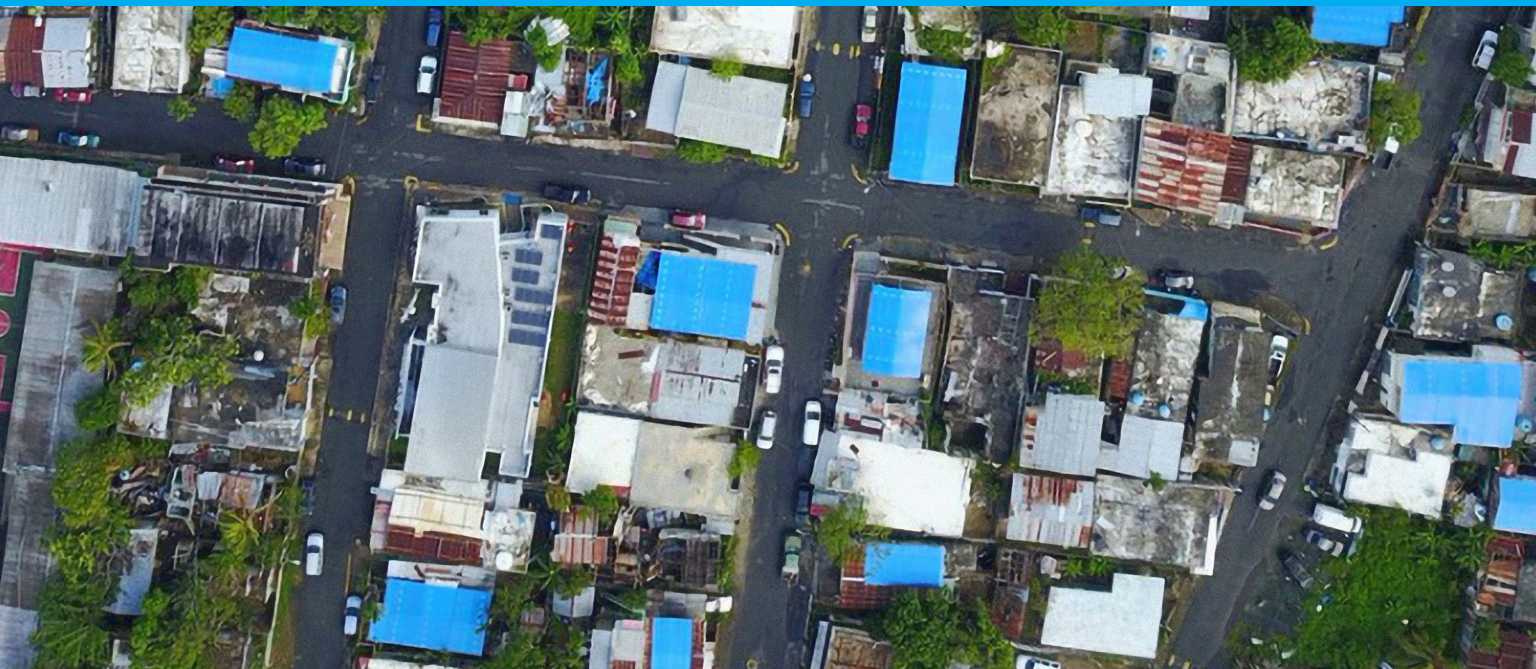
**A GUIDE FOR RESILIENT  
HOUSING DESIGN IN  
ISLAND COMMUNITIES**



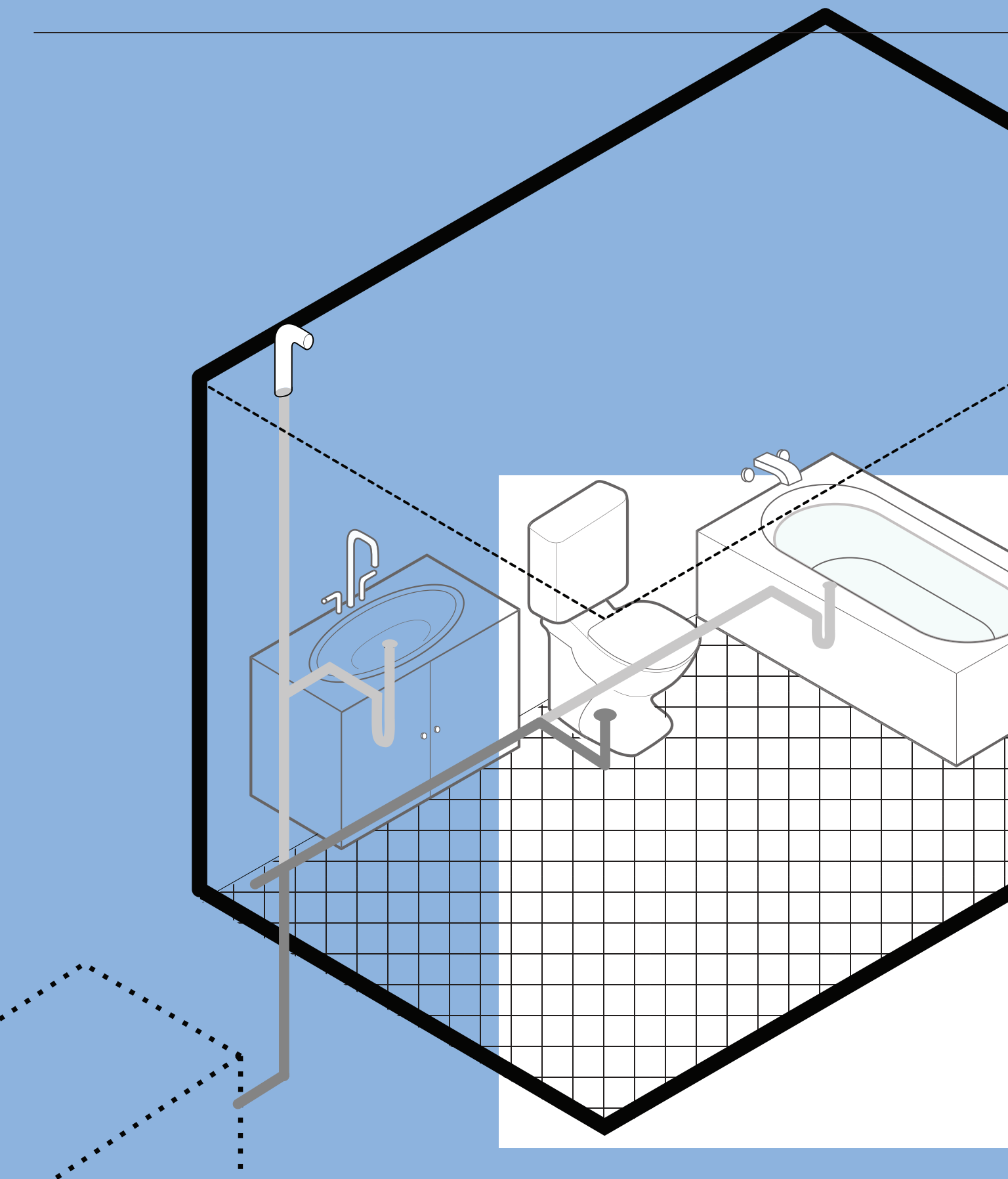
**Enterprise®**



**ASOCIACIÓN DE  
CONSTRUCTORES  
DE PUERTO RICO**







## WATER MANAGEMENT AND STORAGE

Strategies that provide critical needs for water when a facility loses power or other services.

TYPES OF STRATEGIES LISTED IN THIS SECTION

STRATEGY #	19	20	21	22
STRATEGY NAME/TITLE	REDUCE YOUR WATER CONSUMPTION	COLLECT AND USE RAINWATER	IMPROVE SEPTIC WASTE DISPOSAL SYSTEM	PREVENT WASTEWATER BACKFLOW IN HOMES
DESCRIPTION	As with electricity, reducing your water consumption will not only save you money, but it can also make you less dependent on the central water supply. Being in the habit of using less water means you can get by more easily if there is a shortage. This strategy identifies ways to use water efficiently.	This strategy shows how to harness stormwater on site for household use.	This strategy explains the basic components of a septic system, the design considerations for each part of the system, and an overview of how to build each part.	This backup can create unsanitary conditions for occupants by exposing them to bacteria contaminating potable water reservoirs, which may leave people without safe drinking water. This strategy identifies ways to mitigate these risks.
	\$	\$\$\$	\$\$\$\$\$	\$

INTRODUCTION

During storms and other natural hazard events, drinking water -or “potable” water- can become scarce or contaminated, and non-potable water such as waste from sinks and toilets may have nowhere to go. Managing water resources to create a resilient household or residential building is critical to supporting household, building and community resilience.

Puerto Rico has some of the most abundant water resources on earth, with 1200 freshwater bodies

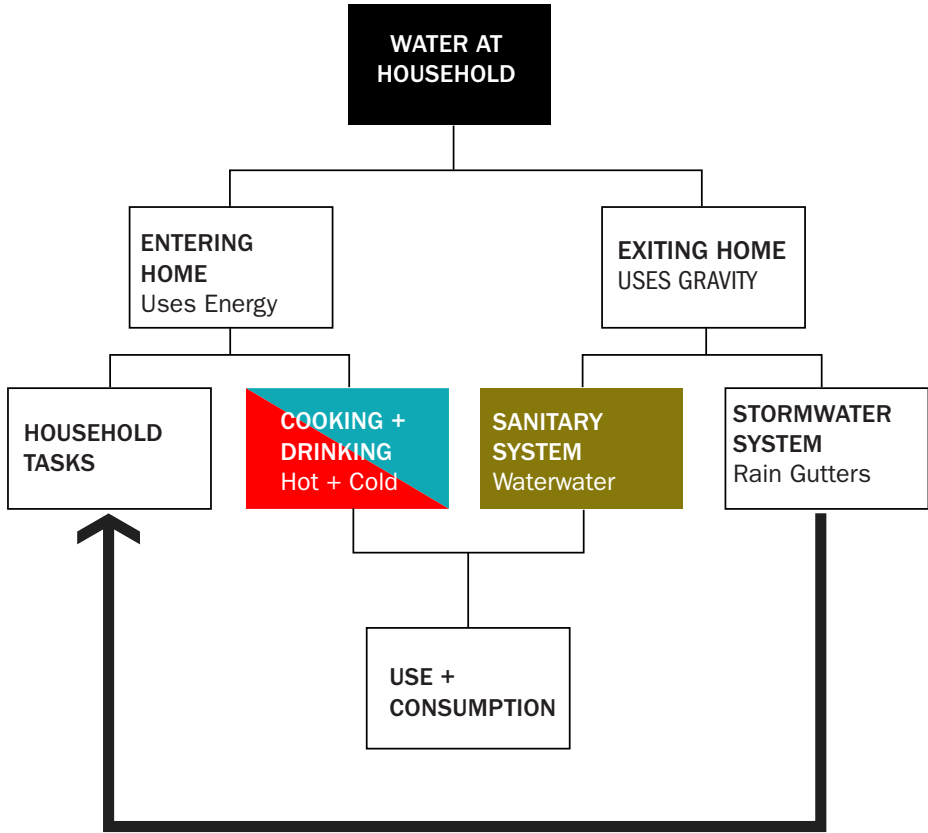
irrigating it from mountain to coast, andan average of 30 to 170 inches of rainwater annually, depending on the area. However, there is not yet enough water treatment infrastructure to purify or distribute this water. This can leave homes and housing vulnerable to interruptions in potable water supply. Additionally, an interruption of electrical service, a fractured distribution pipe or a contaminated reservoir can jeopardize water security during a natural hazard event - which drives home the importance of taking resilient water management into our own hands.



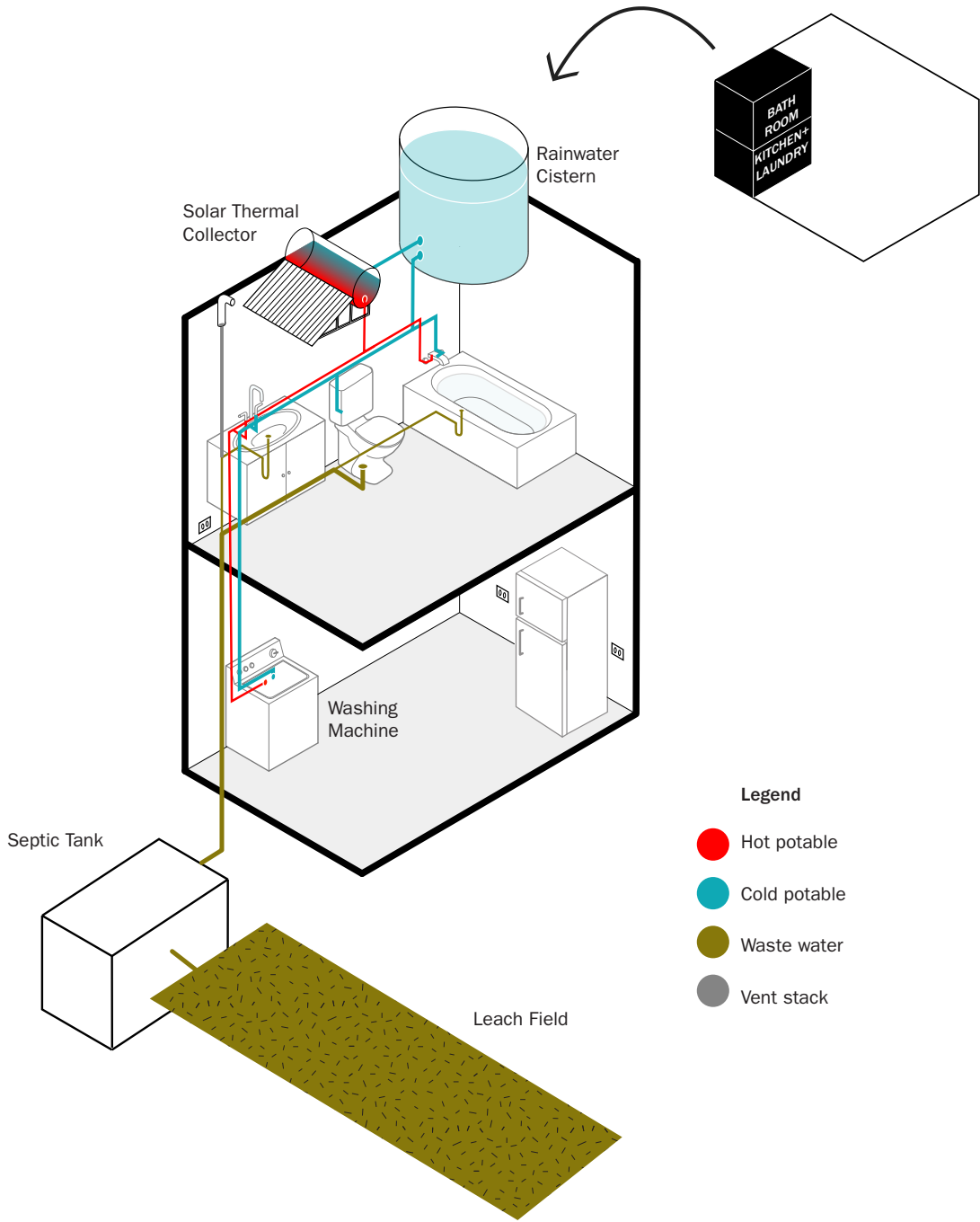
HOW DO WE USE WATER

Residential buildings manage water in two ways: "intake," or supply of potable water, and "outtake," or discharge of non-potable water.

- **SUPPLY:** Water is usually distributed to buildings from a large treatment facility after it is made safe for drinking. In the majority of cases, the systems that deliver water to a household faucet are pressurized - which means they need energy in order to operate.
- **DISCHARGE:** There are two types of water that leave our homes: rainwater, which can collect at the roof and at our site's surface, and wastewater, which comprises waste draining out of toilets, urinals, lavatories, sinks and washing machines. In the majority of cases, these systems use gravity to operate, not electricity.
- Understanding these components and how they work at our homes will enable us to improve them. The strategies outlined in this chapter support conservation and management of both potable and wastewater on sites to ensure access to clean and safe water in the face of a natural hazard.



WATER SYSTEMS





STRATEGY

19

REDUCE YOUR WATER CONSUMPTION

\$

As with electricity, reducing your water consumption will not only save you money, it can make you less dependent on the central water supply. Approximately 98% of Puerto Rico's houses depend on the public water system operated by the Puerto Rico Aqueduct and Sewer Authority (PRASA)/Autoridad de Acueductos y Alcantarillados de Puerto Rico (AAA). Nearly everyone is at risk of losing access to drinkable water if pipes in the system break, pumps stop working, or water becomes contaminated. Being in the habit of using less water means you can get by more easily if there is a shortage. This strategy identifies ways to conserve and use water efficiently.

- Strategy in Action
- 1. Calculate your household water use
  - 2. Conserve water
  - 3. Repair leaks
  - 4. Install water-efficient fixtures
  - 5. Incorporate graywater

WHAT YOU NEED TO KNOW

- Understanding how much water your household uses now is important for measuring your progress. Simple changes in the way you use water on a daily basis can reduce your water consumption by 50%.
- Updating your plumbing fixtures will lower water use.
- Keeping your plumbing systems in good working order saves water and protects your house from damage.
- Modifying your water supply system gives you new sources of water for certain uses.

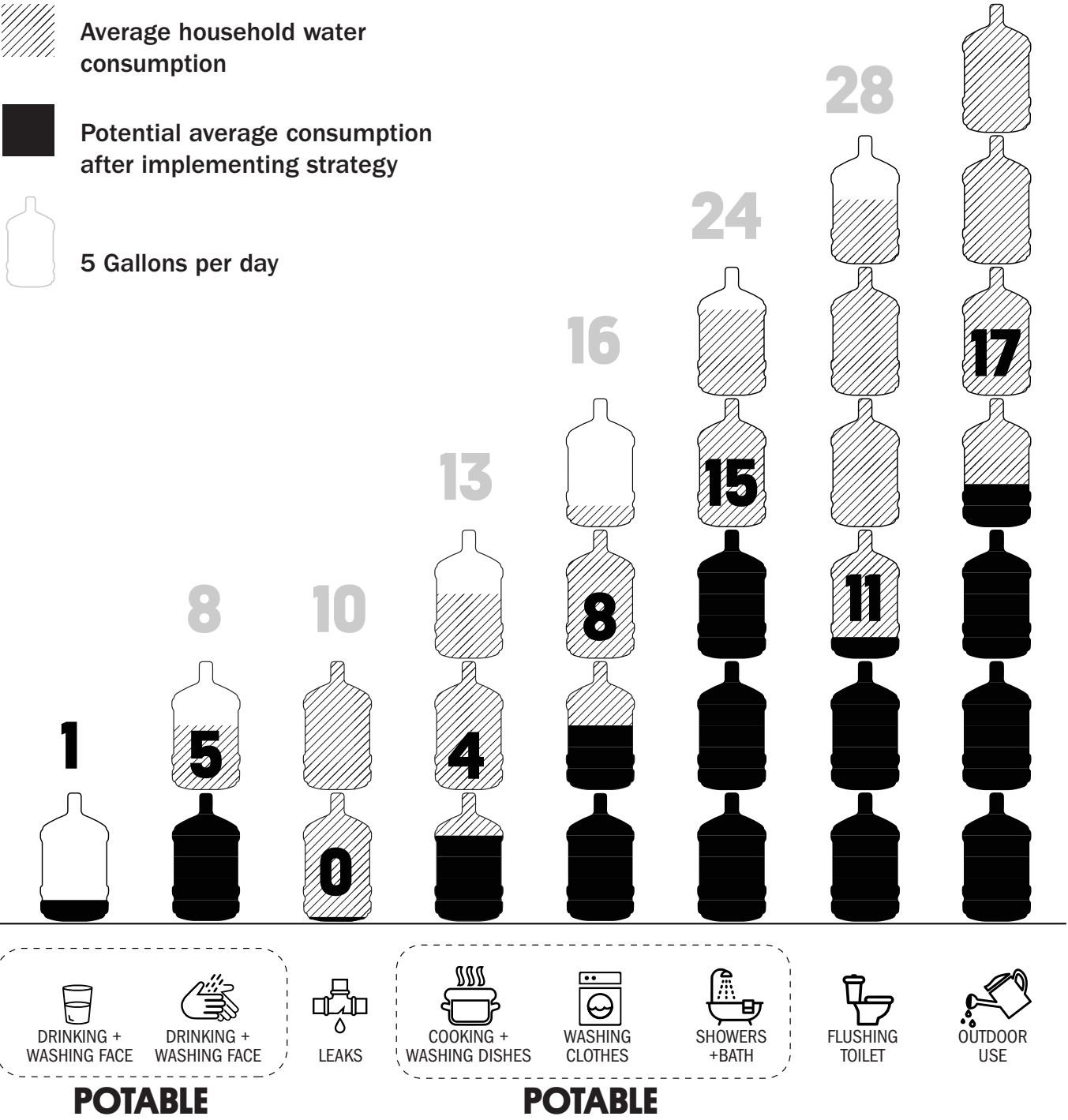


SUPPORTING STRATEGIES

01	02	14
Reinforce Site	Reinforce Site with Vegetation	Manage Pests

YOUR AVERAGE WATER USE

Based on average household water consumption habits.



# REDUCE YOUR WATER CONSUMPTION

## STEP 1 - CALCULATE HOUSEHOLD WATER USE

Analyze your water bill to see how much water you are using, and how much you are saving as you conserve. Try to reach far below the Autoridad de Acueductos y Alcantarillados average of 62.5 gallons per person per day.

### WATER USE

Use the equation below to calculate your water use.

#### GALLONS PER DAY

gallons per month

×

days in the month

=

gallons per day

#### GALLONS PER PERSON PER DAY

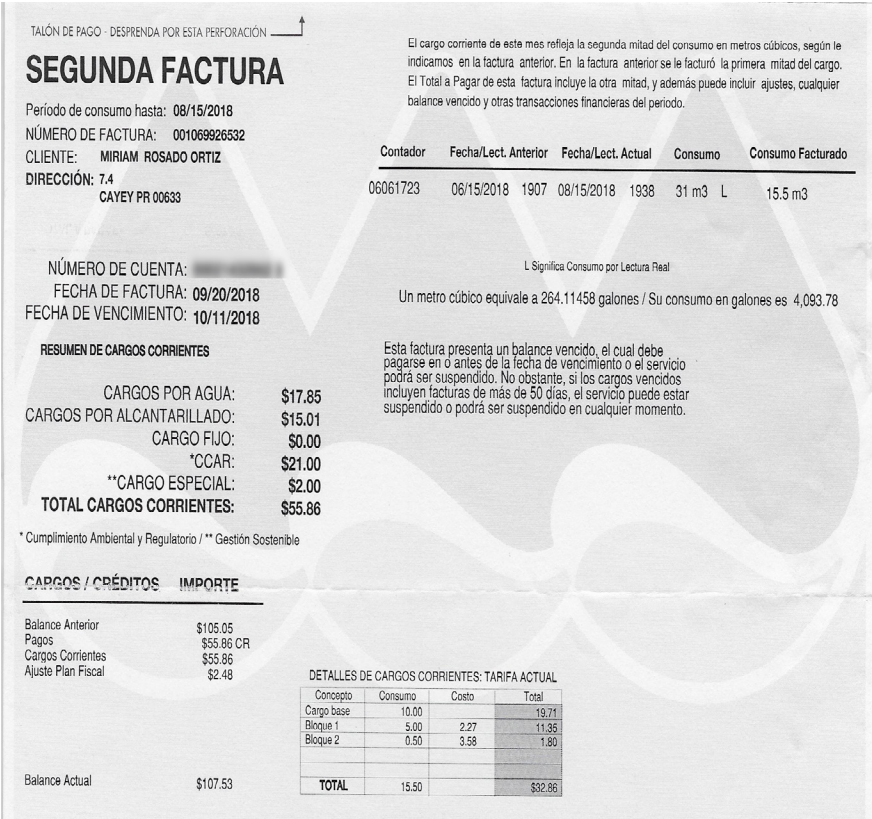
gallons per day

×

# family members

=

gallons per person per day



## STEP 2 - CONSERVE WATER

Consume less water to save money and help the environment.



### BATH

▶ GALLONS / DAY

36

▶ CONSERVATION PRACTICES

Take a shower instead of a bath.



### SHOWER

2-5

Shower quickly with a low-flow showerhead.



### BRUSHING TEETH

1-2

Turn the faucet off when brushing.



### WASHING FACE/HANDS

▶ GALLONS / DAY

1

▶ CONSERVATION PRACTICES

Turn the faucet off soaping hands and face.



### SHAVING

1

Turn the faucet off when shaving.



### WASHING DISHES


8-27

Scrub first, then wash dishes while turning off faucet. Only run a dishwasher when it is full.



REDUCE YOUR WATER CONSUMPTION

STEP 2 - CONSERVE WATER




WASHING CLOTHES

GALLONS / DAY

8-14

CONSERVATION PRACTICES

Wash clothes




TOILET FLUSH

GALLONS / DAY

3

CONSERVATION PRACTICES

- Use toilets that are as “low flow” as possible ranging from 1.5 gpm to .6 Use toilets that are dual flush separating liquid and solids.
- Check toilet for leaks.




DRINKING AND COOKING

GALLONS / DAY

2

CONSERVATION PRACTICES

- Reuse water where possible.
- Measure water absolutely needed for cooking.
- Steam food when possible to conserve water.



IRRIGATION

GALLONS / DAY

2

CONSERVATION PRACTICES

Prioritize functional landscape to fortify site, retain stormwater, encourage shading and other functions and use native plants whenever and wherever possible.

CALCULATE HOW MUCH WATER YOU SPEND YEARLY PER ACTIVITY

# of gallons

×

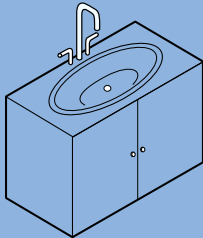
365

=

gallons in activity per year


STEP 3 - REPAIR LEAKS

- ▶ Leaks can make you lose 40% of the potable water you pay for.
- ▶ Regularly check for leaks or monitor your bill or water meter for spikes in use, particularly for multifamily buildings. Hire a plumber to find leaks you can’t see. - Repair leaks quickly. Even slow drips can waste a lot of water over time.



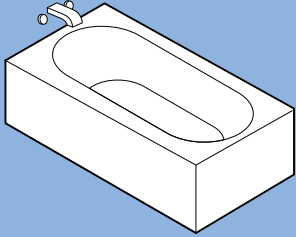
SINK

- Kitchen or bathroom
- Can leak due to open faucet or faulty gasket



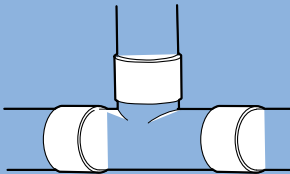
TOILET

Can leak due to open valve, faulty buoy or gasket




BATHTUB FAUCET

Can leak due to open faucet or faulty gasket



PLUMBING

Water will leak through any connection that is not completely sealed. Look for humidity marks on the walls and keep an eye out for a trickling sound coming from “inside” the wall.



# REDUCE YOUR WATER CONSUMPTION

## STEP 4 - INSTALL WATER-EFFICIENT FIXTURES

- ▶ Replace old standard fixtures for more efficient models, or retrofit existing ones with aerators.
- ▶ Install a pre-rinse valve.
- ▶ Look for fixtures that have the Environmental Protection Agency’s Water Sense label. WaterSense products use up to 20% less water than the regular models.
- ▶ Install Aerators in the Faucet which are various devices used mixing air and water. These devices allow you to use less water and maintain pressure.

### BATHROOM



TOILET

- Convert a 5-10 gallon toilet to a 1.28 one using a WaterSense Fixture.
- Convert to a dual flush toilet
- Install low flush flushometer to existing toilet.
- Consider installing a first flush water diverter, which helps reduce solids.



FAUCET

- Convert to a WaterSense of 1.5gpm or less.



SHOWER HEAD

- Convert to a WaterSense .5 gpf “low flow” showerhead.



AERATOR

- An WaterSense aerator increases water pressure while decreasing water used.

### IRRIGATION



#### IRRIGATION

- Water efficient fixtures for irrigation:
  - Irrigation Controller
- Spray Sprinkler Bodies that include:
  - Drip system for planting beds
  - Separate zoning for turf and plantings
  - Timer
  - Rain delay controller
  - Available in WaterSense

#### OPERATIONS AND MAINTENANCE TIPS

- ▶ Check regularly for leaks through a visual inspection of pipes and quality of water.
- ▶ Replace gaskets and rubber parts when needed.
- ▶ Use non-toxic cleaning supplies for water that goes into the graywater supply.
- ▶ Never expose occupants to Blackwater

### KITCHEN / LAUNDRY



KITCHEN / SINK

- Convert to a WaterSense of 2.0gpm or less.
- Install a WaterSense aerator to increase pressure and decrease amount of water used.
- Install a recirculating pump to existing hot water system to reduce the time hot water arrives to fixture.



WASHING MACHINE

- Convert to an ENERGY STAR certified washer.



DISHWASHER

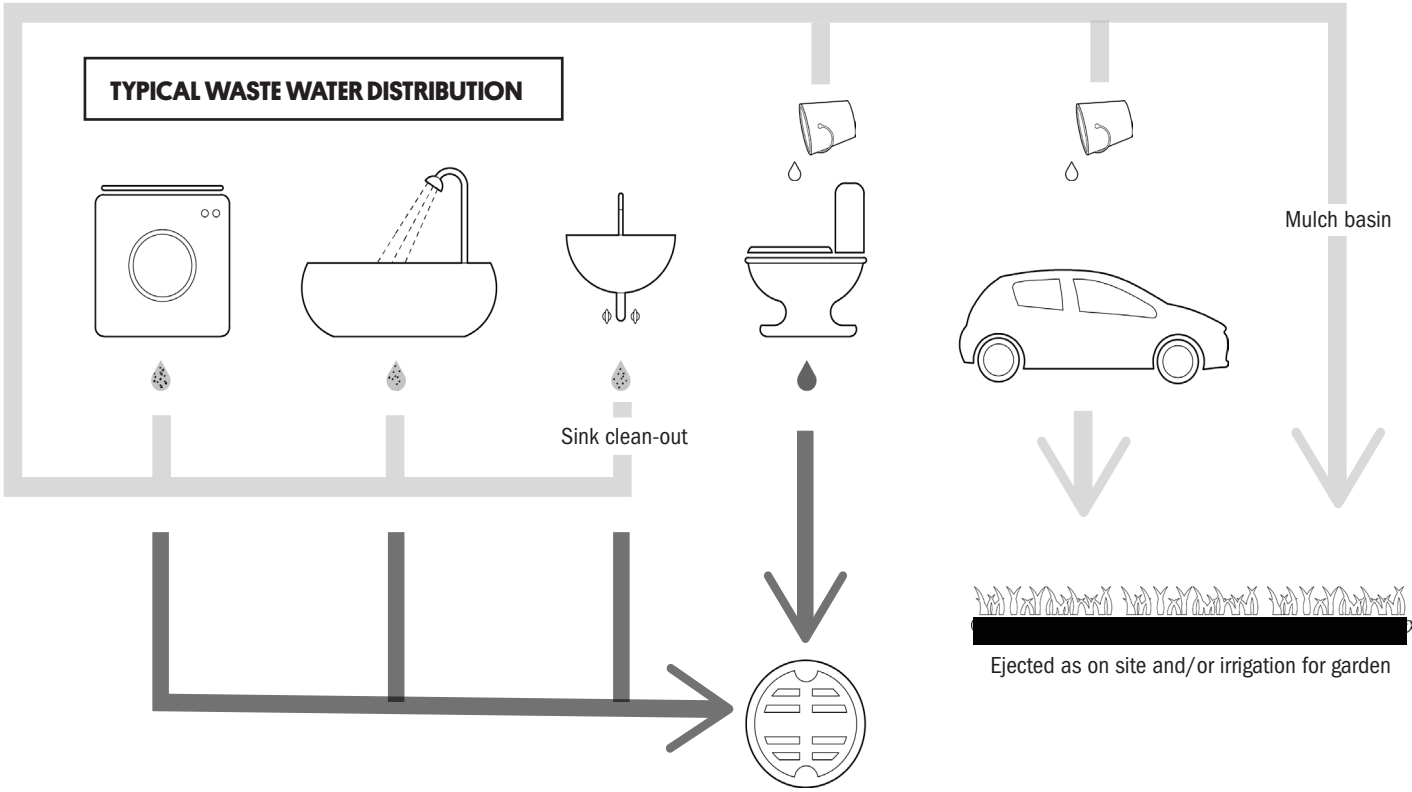
- Convert to a water efficient ENERGY STAR certified dishwasher.



# REDUCE YOUR WATER CONSUMPTION

## STEP 5 - INCORPORATE GRAYWATER

- ▶ **GRAYWATER:** Only 30% percent of household water needs to be safe for drinking. A graywater system allows you to reuse water in certain fixtures, and can reduce the amount of water you draw from the water supply by as much as 50%.
- ▶ Graywater is water that drains from bathroom sinks, washing machines, and bathtubs. It can be used instead of drinking water to flush toilets, irrigate plants, or for anything except drinking or bathing. In tropical locations, graywater must be used that same day to prevent bacterial contamination.
- ▶ Blackwater is wastewater from toilets, and contains dangerous bacteria. People should not be exposed to it.

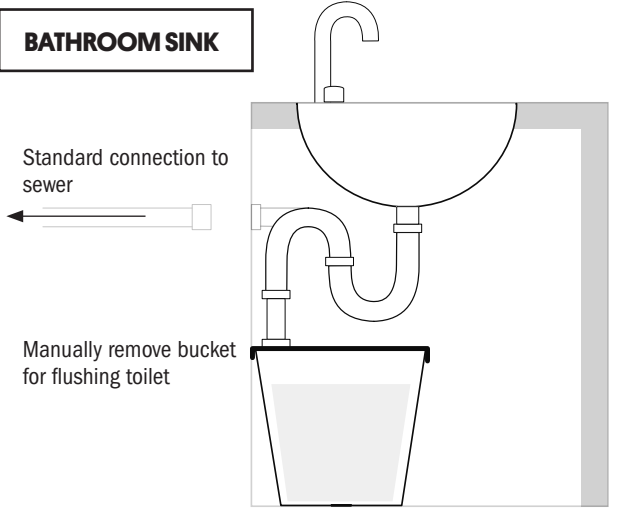
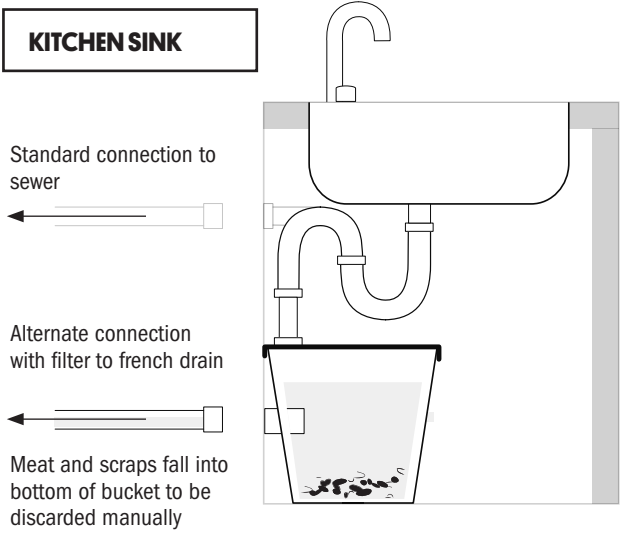


▶ **CODE**

Per the IPC 2018 - Graywater used for flushing water closets and urinals shall be disinfected by an on-site water reuse treatment system complying with NSF 350.

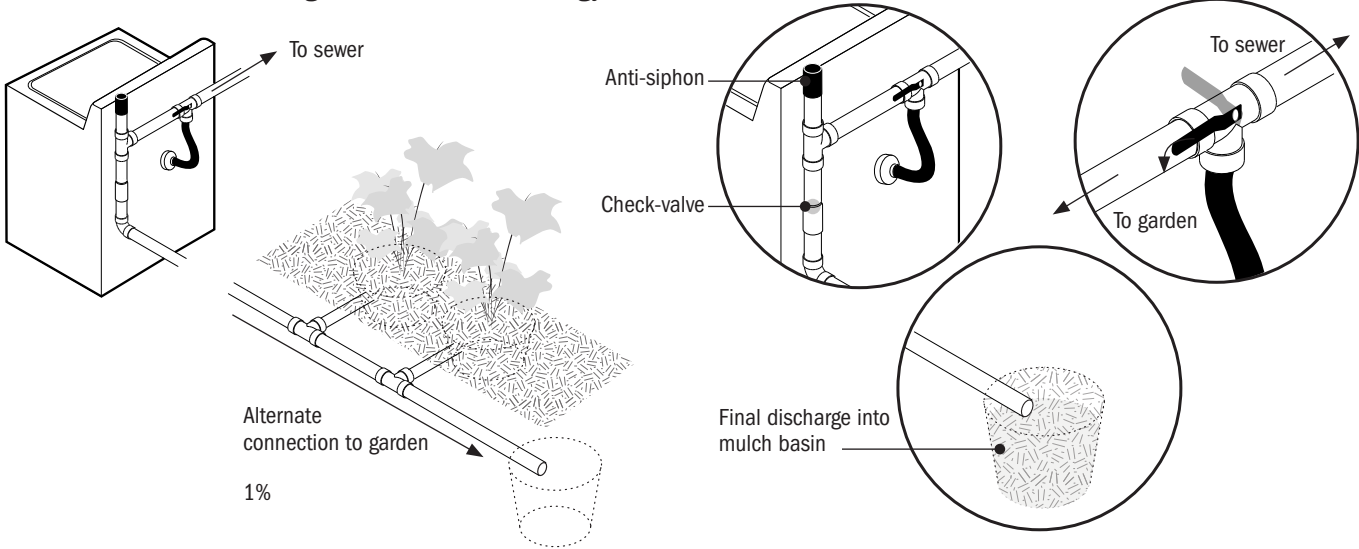
## BATHROOM AND KITCHEN SINK WATER

- ▶ **Option #1:** Adapt your plumbing system to use graywater. Water from kitchen sinks needs filtration.
- ▶ **Option #2:** Manually remove the J-Trap and place a bucket underneath. This water can be directly poured into the toilet.
- ▶ If using to water plants, do not use harsh soaps or detergents.



## LAUNDRY WATER

- ▶ Switch to a detergent that does not contain harsh chemicals (phosphates or chlorine).
- ▶ Remove the discharge hose from the washing machine and connect it to a hose long enough to reach the garden.
- ▶ Create a mulch basin to absorb the water.
- ▶ This method has a risk of creating a backwater flow into the washing machine. See Strategy 18.



COLLECT AND USE RAINWATER

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Rainwater harvesting is the collection and storage of rainwater for reuse on-site through irrigation. Regularly harvesting rainwater makes your home resilient by reducing the dependency on the system, minimizing storm water run-off, and preventing the septic system from overloading. This strategy focuses on showing how to harness storm water on-site.

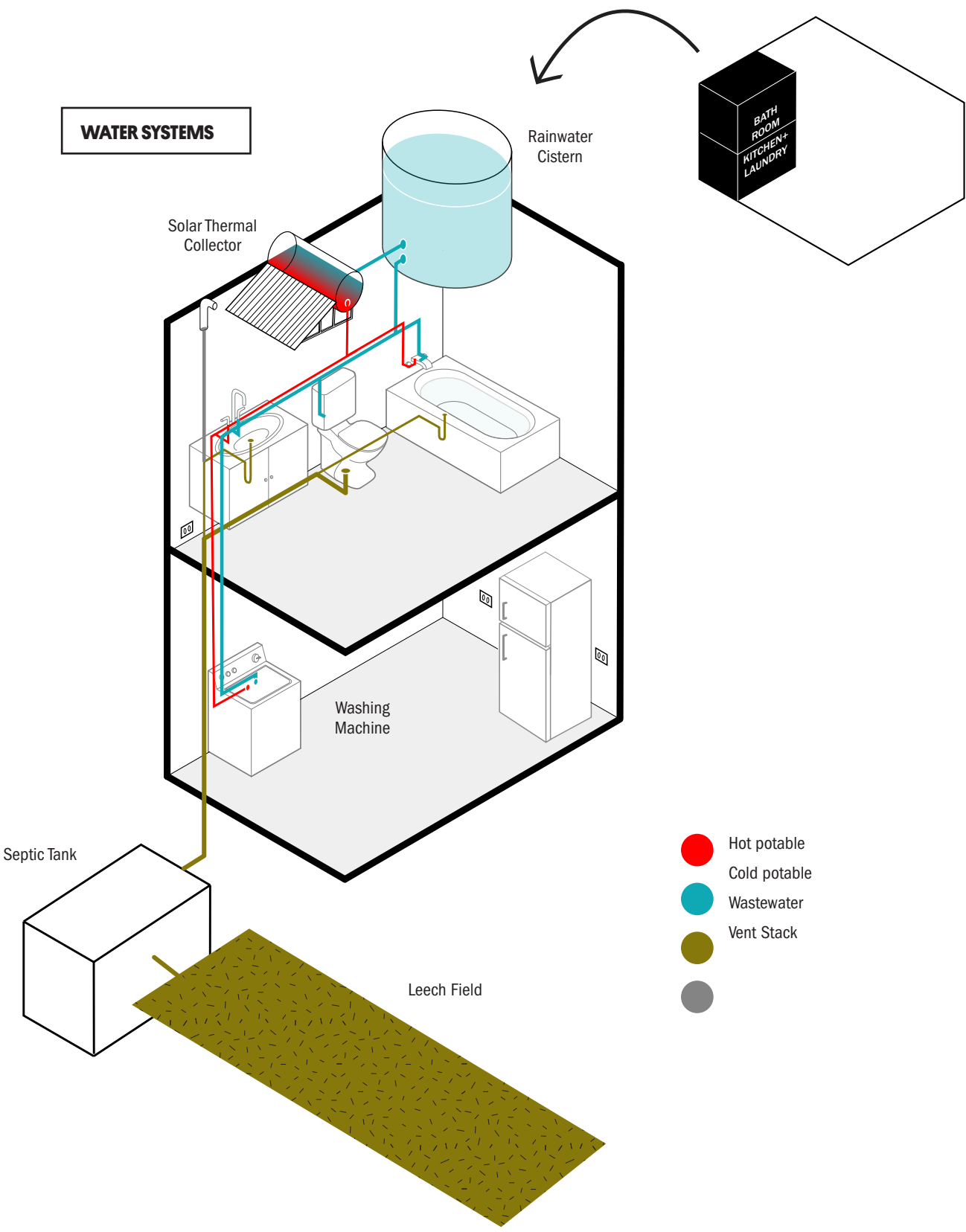
- Strategy in Action
- 1. Identify Soil Type and Properties
  - 2. Choose and Plant Vegetation
  - 3. Implement Resilient Sitescaping

WHAT YOU NEED TO KNOW

- ▶ Rainwater is not naturally potable. To turn rainwater into drinking water, you must treat it and filter it so that it meets local health regulations and codes.
- ▶ Your entire roof assembly is surface to support rainwater catchment. Therefore, be considerate of the paints, materials, and slope of the roof to support maximum water capture.
- ▶ The water quality coming off a roof during a rainstorm tends to improve as the rain continues. The first inch of rainwater can contain the highest percentage of contaminants and should be filtered and flushed out of system before use.



SUPPORTING STRATEGIES		
03	02	18
Plant an Edible Garden	Reinforce Site with Vegetation	Install Energy Backup
19	21	22
Reduce Your Water Consumption	Improve Septic Waste Disposal System	Prevent Waste-water Backflow in Homes





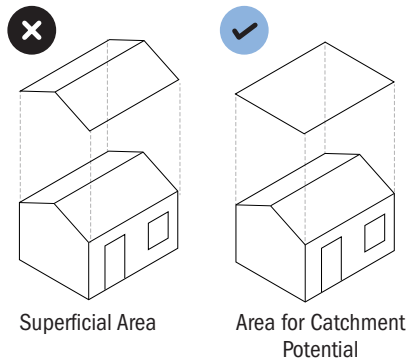
# COLLECT AND USE RAINWATER

## STEP 1 - CALCULATE ROOF WATER COLLECTION POTENTIAL

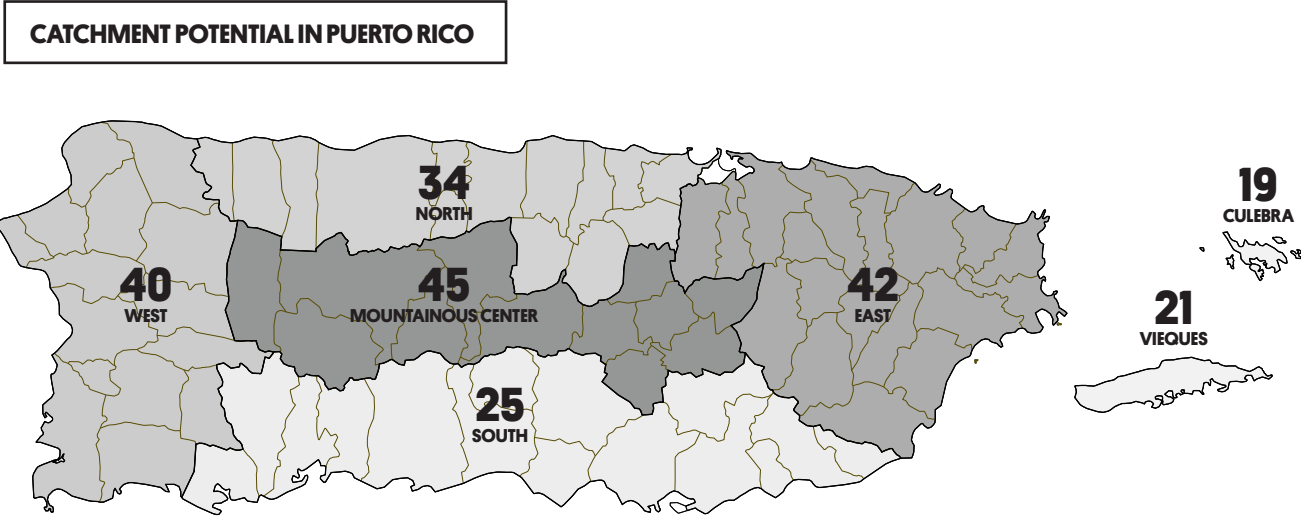
An average Puerto Rican single family home can collect up to 28 gallons of water per square foot. For a 1,000 sq. ft. home, this is equivalent to 2,800 gallons a year. Assuming a cost of \$1 per gallon, this means almost \$3000 in savings.

### A. CALCULATE YOUR ROOF AREA IN FEET

**Roof's Area:** Make sure to measure area by multiplying length times width of roof's span (foot-print), not its superficial area.



### B. IDENTIFY ANNUAL RAINFALL IN YOUR AREA USING THE MAP BELOW



### C. PLUG IN RESULTS FROM PARTS A AND B TO DETERMINE YOUR POTENTIAL RAINWATER COLLECTION.

Use a co-efficient of .85 when measuring how much water will be harvested from your system for your household needs.

**A:**  
ANNUAL CATCHMENT POTENTIAL

gallons/sq.

×

**B:**  
ROOF AREA (LENGTH X WIDTH)

square feet

=

**C:**  
YOUR ROOF'S CATCHMENT POTENTIAL

gallons per year

COMPARE WITH: Water consumption calculated on STRATEGY 19\*

**WATER CONSUMPTION**

gallons per year



# COLLECT AND USE RAINWATER

## STEP 2 - OPTIMIZE + SLOPE YOUR ROOF AND GUTTER FOR WATER COLLECTION

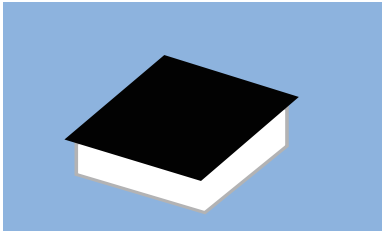
- Slope, Materials, and Finishes, affect a roof's catchment potential.

► Water must be transferred and stored quickly; stagnant water may be too heavy for the roof.
- Regularly maintain the roof. Materials deteriorate over time and the loose roofing finishes can contaminate water.

► Use the appropriate filters in the tank coming off the roof.

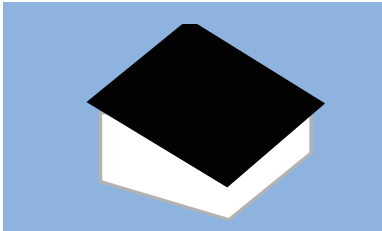
### A. SLOPE

The ideal slope for catchment is 2%.

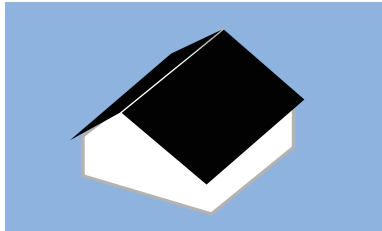


FLAT

Pooling water puts additional load on the structure and can damage it. Pooling water can also lead to pests like mosquitos that can cause health issues. See Strategy 14.



SINGLE PITCHED



MULTIPLE PITCHED

Ensure roof is sloped in every direction

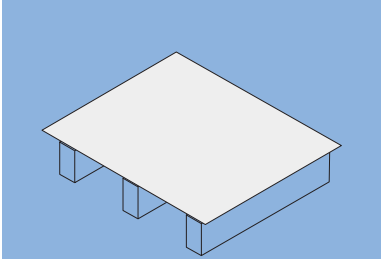


### B. MATERIALS

Materials used as catchment surface area and gutter should be free of pollutants like airborne chemicals that can leach into water.

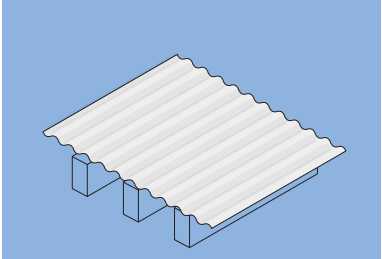
REMEMBER

If you wish to use water from rivers or wellspring, test for bacteria. Most surface water sources are contaminated with deadly bacteria.



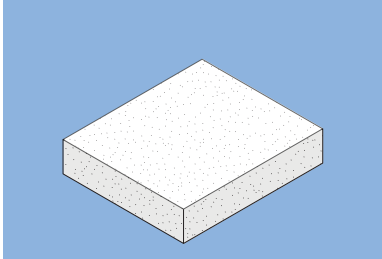
METAL ROOF

- Low porosity prevents it from absorbing water.
- Can become very hot and that could lead to water loss.
- Requires an additional finish to prevent rusting and corrosion.



CORRUGATED METAL ROOF

- Gutters help direct water for collection.
- Clean gutters regularly to prevent sediment build up.
- Place perpendicular to water flow to reduce its flow speed.
- Requires an additional finish to prevent rusting and corrosion.

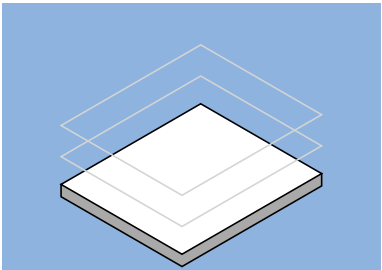


CONCRETE ROOF

- High porosity can create sediment build up.

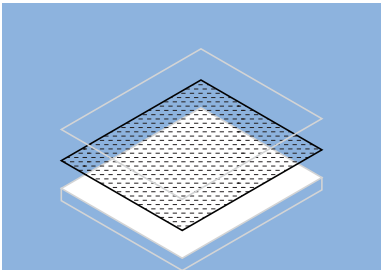
### C. FINISH

Finishes used on catchment surface area and gutter should not have zinc or lead that can leach into water.



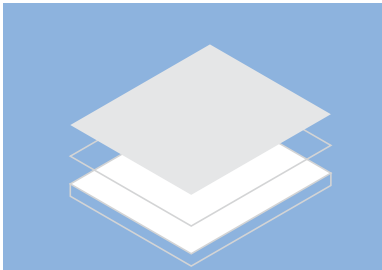
INSULATION

- Apply a protective layer to prevent chemicals from roof from contaminating harvested water.



SEALANT

- Seal with FDA approved sealants like Danosa. These elastomeric sealants are made with silicone, an elastic polymer that seals cracks and waterproofs surfaces.
- Maintain sealant as directed.



PAINT

- Apply an epoxy coat to prevent metal from rusting and contaminating harvested water.

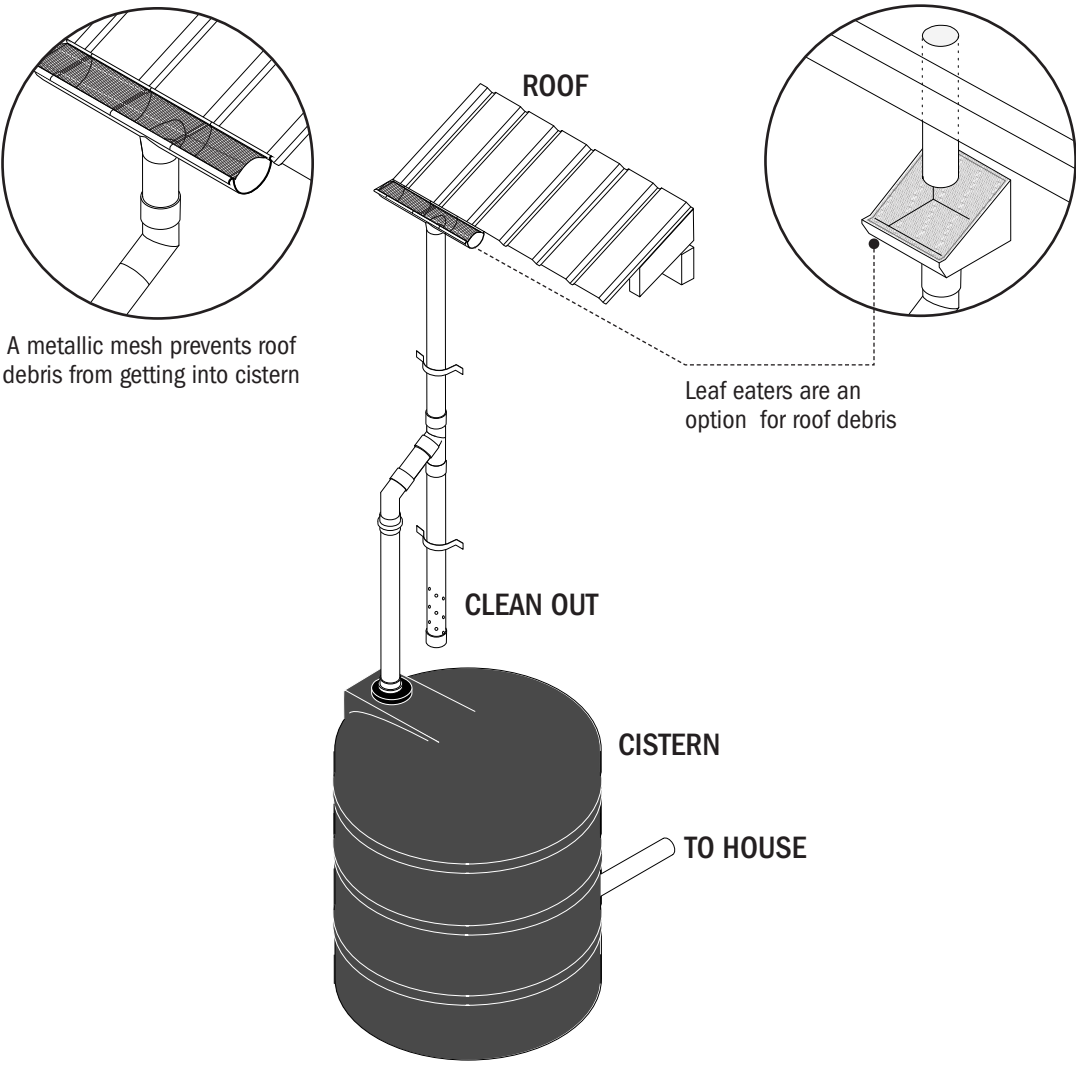


# COLLECT AND USE RAINWATER

## STEP 2 - OPTIMIZE + SLOPE YOUR ROOF AND GUTTER FOR WATER COLLECTION

### OPTIMIZE GUTTERS AS COLLECTION ELEMENTS

- ▶ Use a leaf catcher to prevent clogging and prevent large organic matter from entering your system.
- ▶ Anchor gutters to the structure during strong winds or a hurricane.
- ▶ Flush out the first 5 minutes of stream, using a clean-out device, to eliminate debris and dirty water with minimal loss.



## STEP 3 - SELECT A CISTERN

### A. SIZE

- ▶ Use the number calculated on Strategy 19 to determine water needs.
- ▶ Have a redundant system — use multiple cisterns in case one fails. This is a higher upfront investment.

### DAILY USE — STRATEGY 19

gallons/day

×

14 days

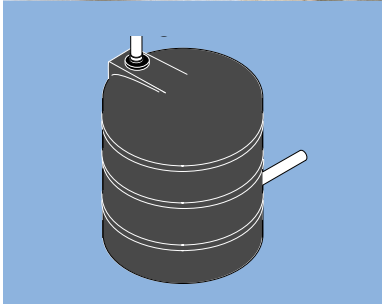
=

gallons per day

### EMERGENCIES - 2 WEEKS

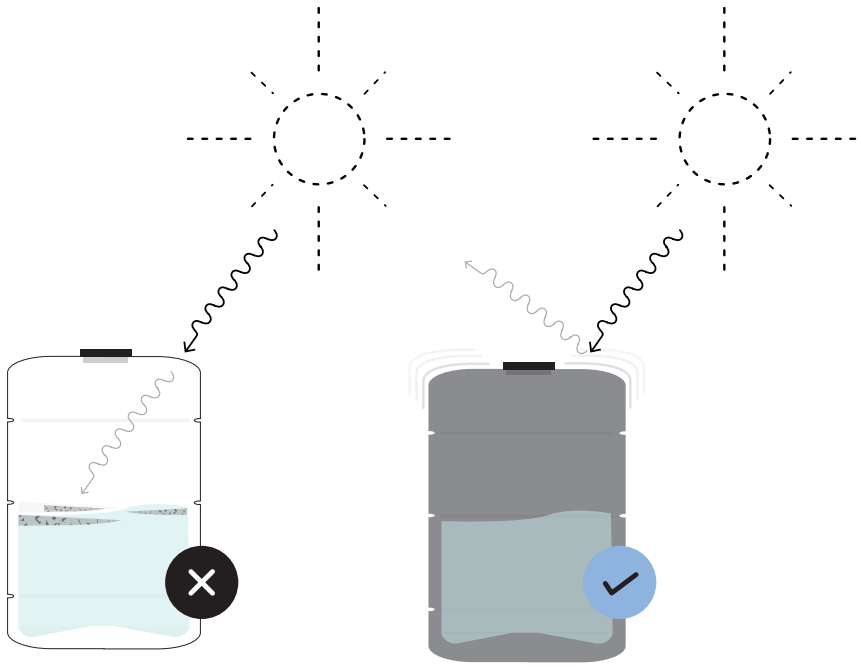
gallons per day

### B. TYPE



#### PLASTIC

- Usually cylindrical, made of polyethylene plastic.
- Choose a tank with a curvature at the bottom to maximize water usage.
- Dark plastic tanks block sunlight and UV radiation, which protects your water from developing bacteria and algae.
- Support local brands, like Vassallo.



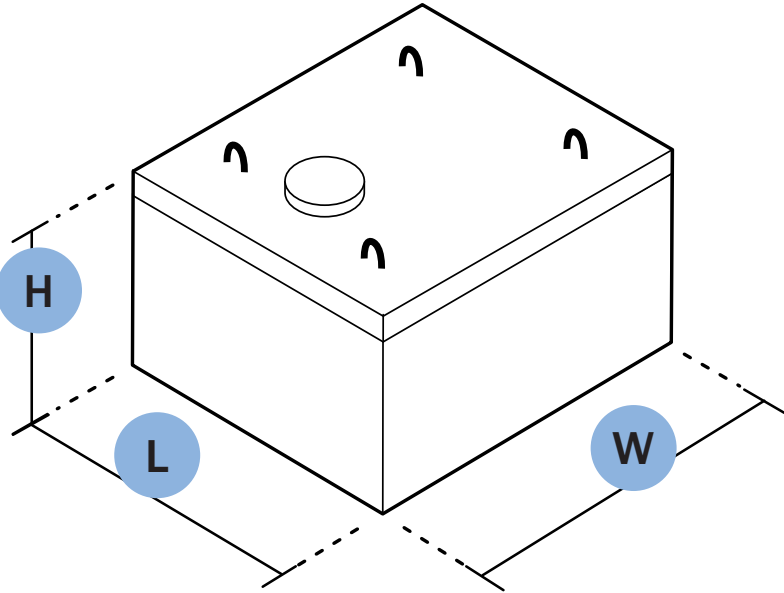
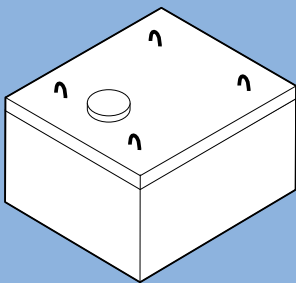
✗ Sun rays pass through light color plastic and creates a favorable condition for algae growth

- ✓ Protection against sun rays
- ✓ Reflects heat

# COLLECT AND USE RAINWATER

## STEP 3 - SELECT A CISTERN

### B. TYPE



height

×

length

×

width

=

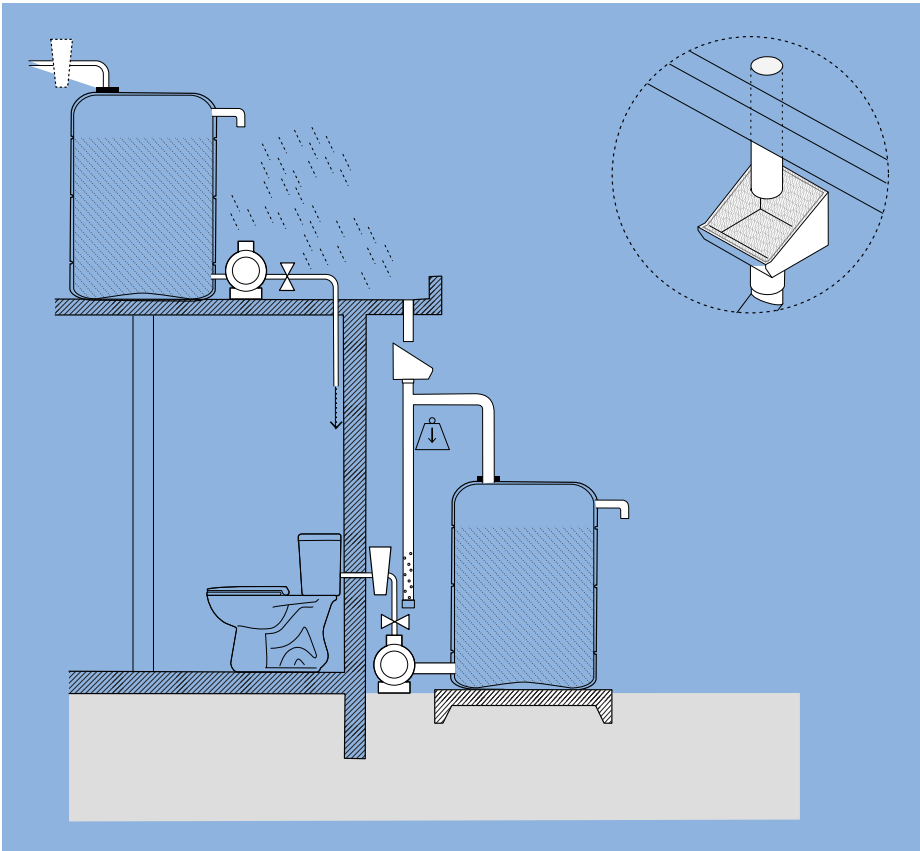
gallons \ 7.5

#### CONCRETE

- Gutters help direct water for collection.
- Clean gutters regularly to prevent sedimentations building up.
- Place perpendicular to water flow to reduce water flow speed.
- Requires an additional finish to prevent rusting and corrosion.

### C. LOCATION

- ▶ Water is heavy. A cubic foot of water weighs approximately 62 pounds.
- ▶ If the roof is not strong enough to support water weight, place the tank on the ground.
- ▶ Locate the tank higher than the home plumbing intake to create pressure for your fixtures.



#### ON ROOF

#### PROS

- Works by gravity
- NO pump needed

#### CONS

- Need a structural engineer to study load on roof.
- Higher cost

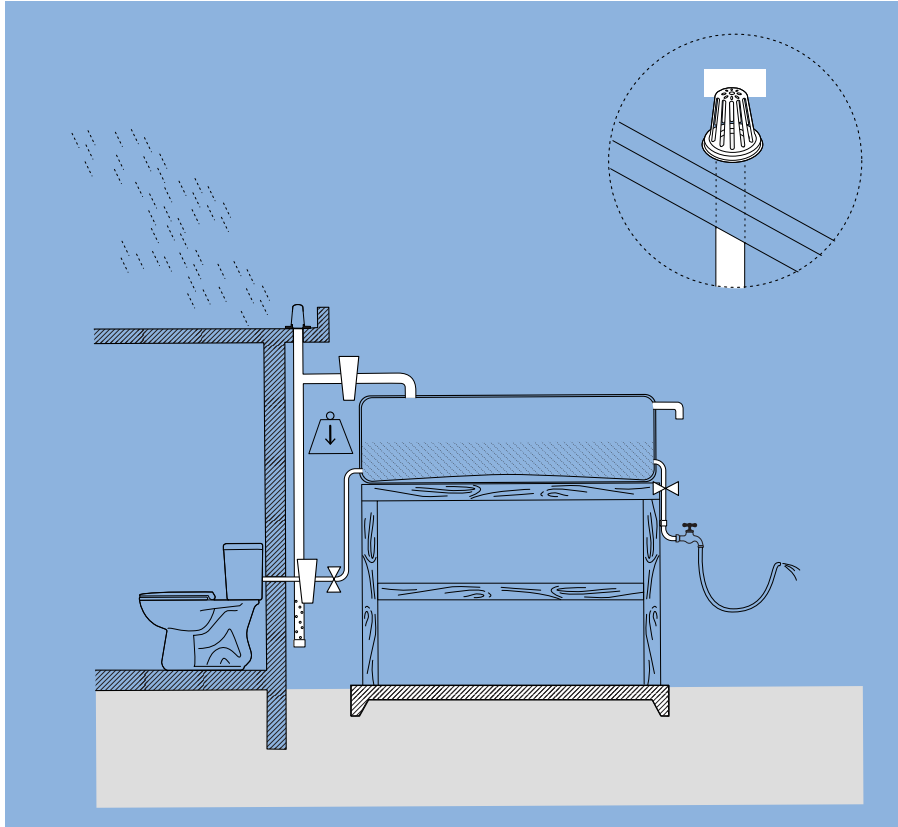




COLLECT AND USE  
RAINWATER

STEP 3 - SELECT A CISTERN

C. LOCATION



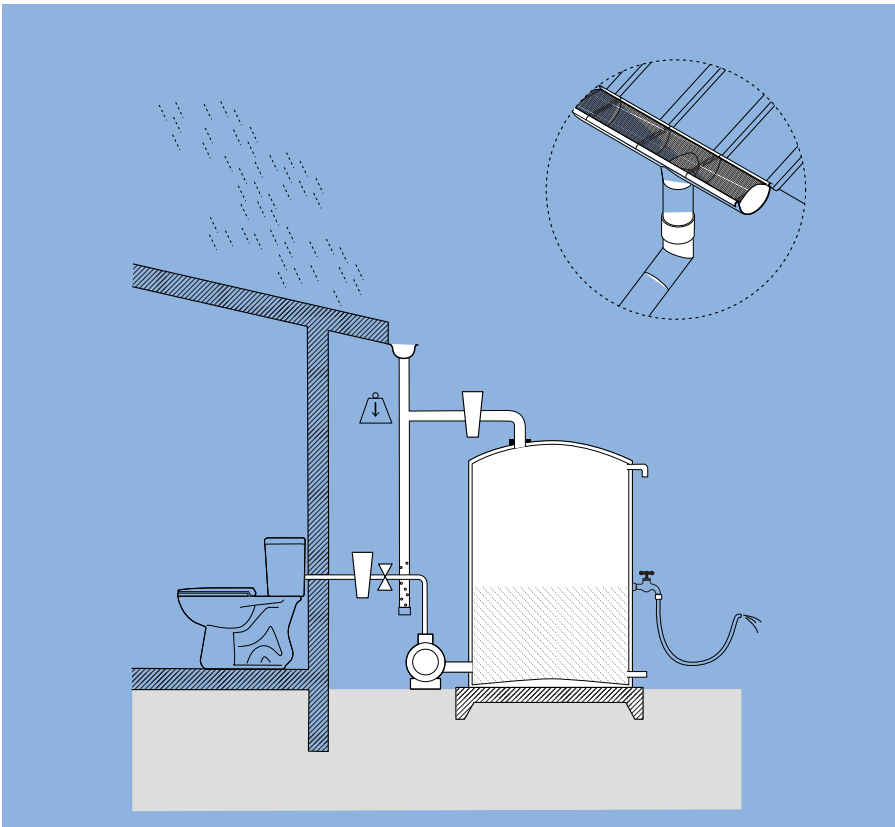
ELEVATED ABOVE GROUND

PROS

- Works by gravity
- NO pump needed
- NO additional load on home

CONS

- Requires a stand-alone structure
- Higher cost



ON GROUND

PROS

- Easy access for maintenance
- Easier to install
- NO additional load on home
- Cheapest option

CONS

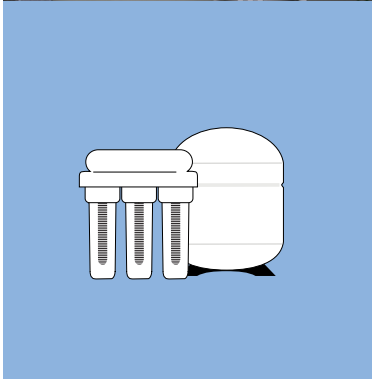
- Requires pump for most indoor uses



# COLLECT AND USE RAINWATER

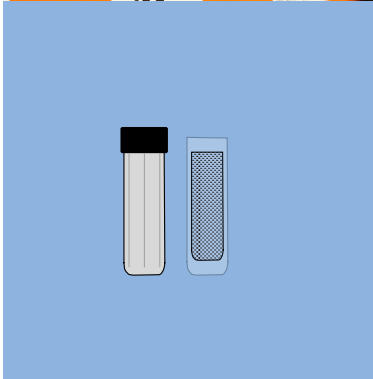
## STEP 4 - FILTER AND TREAT HARVESTED WATER

- ▶ Water for drinking, washing and plumbing fixtures needs to be treated. Water for landscaping does not.
- ▶ When in doubt, boil for 3 minutes to kill any bacteria. This water must be free of organic matter or solids.



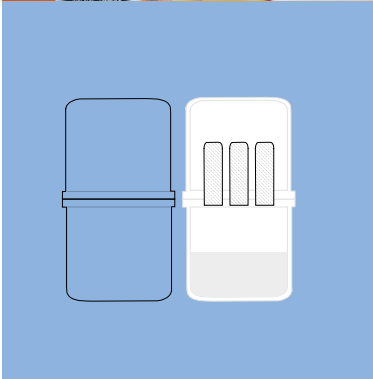
### REVERSE OSMOSIS

Passes water through a permeable membrane to remove unwanted ions.



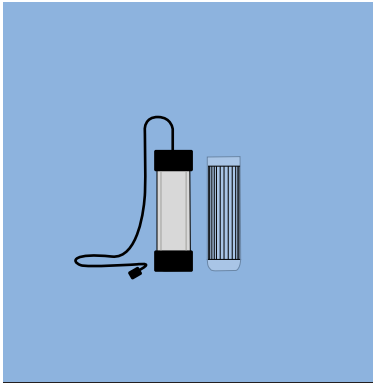
### ACTIVATED CARBON

Removes some inorganic compounds and heavy metals.



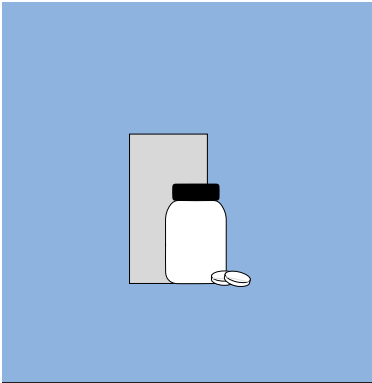
### CERAMIC WATER FILTER

Porous nature of ceramic filters small particles and microorganisms. It is an inexpensive method and can be combined with passive filtration



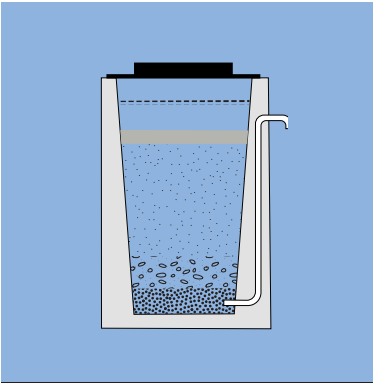
### MICROFILTRATION

Filters water through a fine mesh membrane to remove particles and microorganisms.



### PURIFICATION TABLETS

Kill pathogens in water, offer an easy purification option for emergencies and can be combined with passive filtration.



### SLOW SAND FILTRATION SYSTEM

Removes particles as water passes through the different layers of gravel and sand.

## OPERATIONS AND MAINTENANCE TIPS

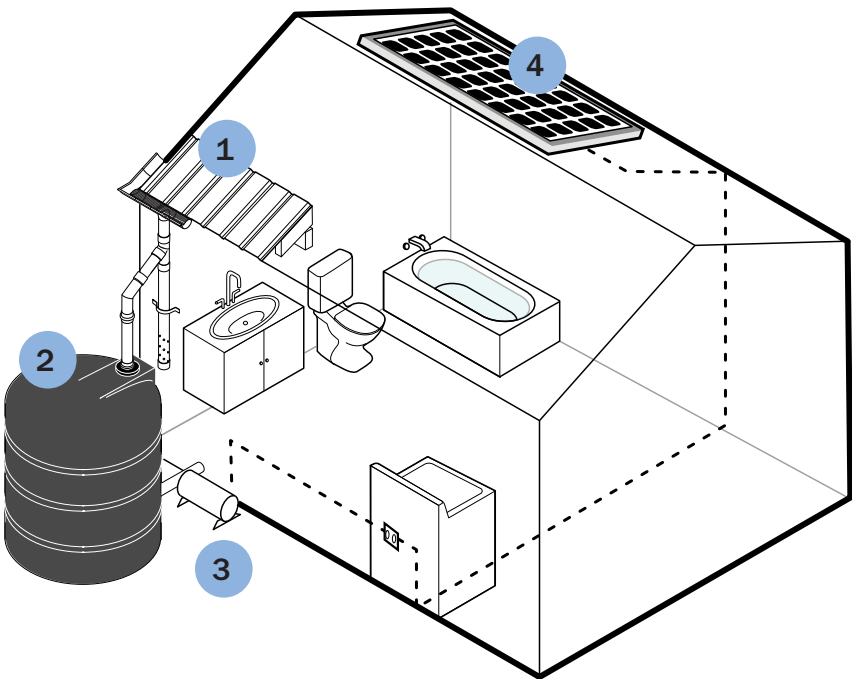
- ▶ The storage tank components should be visible and easy to access for regular maintenance and visual inspection.
- ▶ Apply FDA food grade approved roof sealants as indicated.
- ▶ Track dates to change filter and system components.
- ▶ If you want to distribute water for the toilets, revise the PRASA agreement, and install a sanitary water meter.
- ▶ The quality of harvested water depends on the maintenance of the catchment system surfaces and cistern. Humidity, including piping, helps bacteria develop and contaminates water.
- ▶ Clear roof of sediments regularly, especially after rain. Inspect the roof at least twice a year, during spring and fall.
- ▶ Flush out sediments that fall on the bottom of the tank.



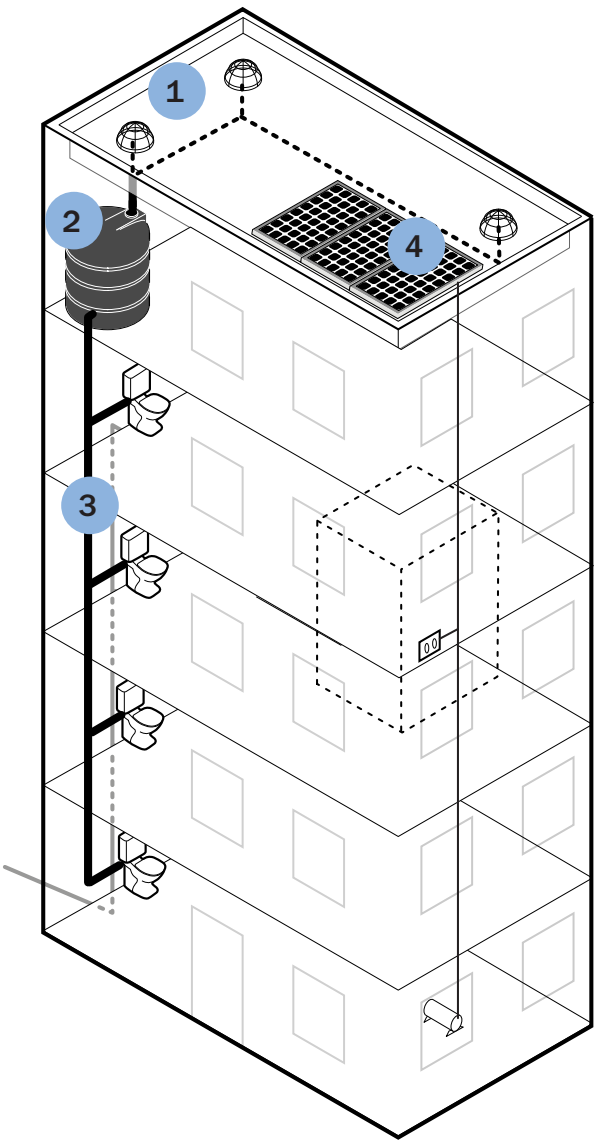
# COLLECT AND USE RAINWATER

## STEP 5 - DISTRIBUTE HARVESTED WATER

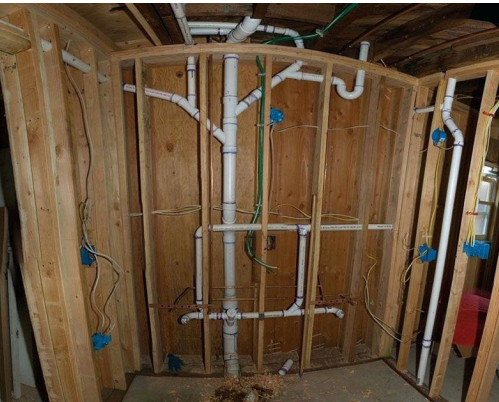
- ▶ Harvested water can be distributed by gravity or by a water pump system.
- ▶ 1-2 solar panels can be used to operate water pump system. See Strategy 17.
- ▶ On pitched roofs, a gutter at the lowest points of the roof will direct water into pipes.
- ▶ On flat roofs, the parapet will hold the water and regular drains will flush it out. The drains need to be connected to the catchment system.



- 1 ROOF**
- 2 CISTERN**  
Roof slope directs water to roof drain
- 3 DISTRIBUTION FIXTURES**  
Can supply by gravity or pump according to cistern location and appliances. Distribution and filtering will vary on use.
- 4 OPTIONAL**  
Supplemental PV system can operate pump if cistern is on below appliances and can serve for critical load.



- 1 ROOF**
- 2 CISTERN**  
Rainwater cistern on upper floor distributes to floors and gravity.
- 3 DISTRIBUTION OF PLUMBING & FIXTURES**  
Rainwater supplies appliances not dependable on potable water by gravity.
- 4 OPTIONAL**  
Supplemental PV system can operate pump if cistern is on ground floor and can also operate an Emergency Hub.





# IMPROVE YOUR SEPTIC SYSTEM

\$\$\$\$

In most of Puerto Rico, urban area homes are connected to a main sewer line owned and operated by the Puerto Rico Aqueduct and Sewer Authority (PRASA) that collects and treats household wastewater. Septic design is regulated by the 2018 International Building Code (IBC). On-site septic systems are a suitable form of wastewater treatment in rural and suburban areas where there is space to build them, where the site conditions are considered (including soil type and terrain), and where connections to the central system are not feasible or cost-effective. This strategy explains the basic components of a septic system, the design considerations for each part of the system, and an overview of how to build each part.

- Strategy in Action**
- 1. *Identify Soil Type and Properties*
  - 2. *Choose and Plant Vegetation*
  - 3. *Implement Resilient Site scaping*

## WHAT YOU NEED TO KNOW

- ▶ A septic system is a mechanism for sewage to exit the home, be stored temporarily, and go back to the soil to inject nutrients and kill bacteria. Every step of the process should be considered as a treatment mode, with particular attention to leach field of design and maintenance such as ensuring adequate plants are used for nutrient uptake, that no heavy weights are placed on the field, and soil has the appropriate absorption and saturation capacity.
  - ▶ Damaged septic systems can contaminate nearby water bodies and aquifers, leading to diseases that affect your home and community.
  - ▶ Consult with a professional before installing a system and ensure that the local municipal health department allows it and provides you with all the necessary regulatory input.
- ▶ Septic systems fail because:
    - Old age, low or lack of maintenance, overloading the septic system above the design limitations, and poor soil conditions or damage to drainfield.
    - Septic tanks, particularly concrete or precast, are susceptible to leaks and cracks in landslides and seismic events if built without taking precautionary measures.
    - Drainfields can be damaged if heavy weight is placed over the lines or the field is flooded and lacks saturation capacity.
    - Solids from the septic system clog the small holes in the drainfield pipes.
    - Flushing fats, oils, greases, chemicals, solvents, paint, and other improper substances down the drain that can kill the bacteria that treat waste in the tank and in the drainfield.
    - Improperly positioned drainfield in a floodable area of the site.
    - They are overloaded by adding too much waste. This can happen in the case of garbage disposal use or adding additional occupants that exceed the system’s design limitations.
    - Tree roots uplift drainfield lines.

### SUPPORTING STRATEGIES

02

Reinforce Site with Vegetation

22

Prevent Wastewater Backup in Home



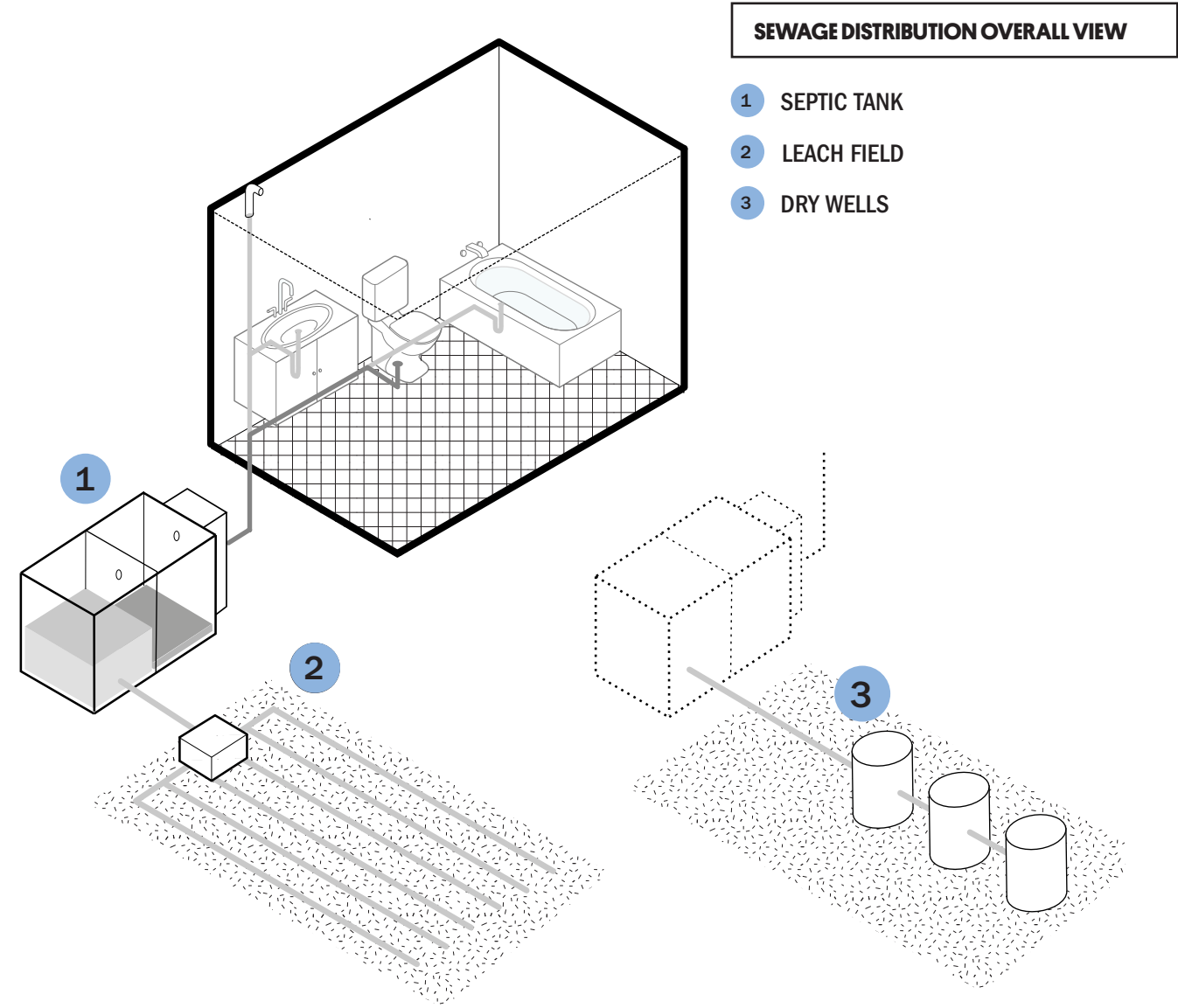
Huertas, Evelyn



IMPROVE YOUR SEPTIC SYSTEM

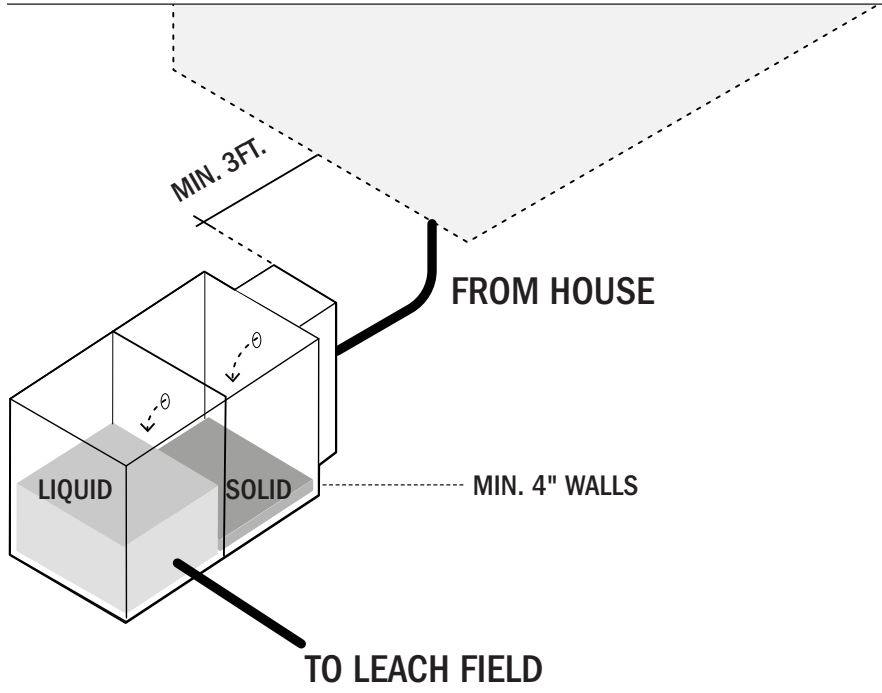
STEP 1 - DISTRIBUTE HARVESTED WATER

Review Your Home Water Use and Create Water Efficiency and Conservation. Do this where possible. The less wastewater you produce or consider “effluent,” the less water will need to be disposed and treated. See Strategy 19 for reducing your water consumption.



STEP 2 - SIZE AND CHOOSE A SEPTIC TANK

A septic tank is a container comprised of two chambers that separate solid from liquid waste. The solids stay in the tank until they are pumped out by a septic company, and the liquids drain into a leach field or dry well that injects them safely into the soil. Place the tank underground. Do not locate it in a high-water table since this could cause the tank to float.



SEPTIC TANK CAPACITY FOR ONE AND TWO FAMILY DWELLINGS

# BEDROOMS	SEPTIC TANK (GALLONS)
1	750
2	750
3	1,000
4	1,200
5	1,425
6	1,650
7	1,875
8	2,100

FOR SI: 1 GALLON = 3.785 L

# IMPROVE YOUR SEPTIC SYSTEM

## STEP 2 - SIZE AND CHOOSE A SEPTIC TANK

### SIZE

- ▶ The size of the septic tank depends on the number of people, and the amount of waste producer per person each day.
- ▶ Install a larger tank if you envision your home expanding.
- ▶ Larger tanks need to be emptied fewer times than a smaller tank.
- ▶ Follow guidelines from the local municipality, the Health Department, and the Junta de Calidad Ambiental.
- ▶ Work with a professional on designing and installing the tank, as it can become a health hazard for your home and community.
- ▶ Consider adding a septic effluent filter to the septic tank to catch suspended solids, smaller particles of debris which, as they pass out to the soil absorption system, or drainfield, which can create clogging of the drainfield lines and reduce absorption and treatment.
- ▶ Alarm septic tanks to warn of an operating problem with the system that could risk a sewage backup into the building.

### OPERATIONS

- ▶ Hire specialized companies to pump out solids that may clog the small holes in the each field pipes.
- ▶ Never use bleach in tank.
- ▶ Check alarm systems regularly.
- ▶ Check regularly for any cracks or leaks, especially after a natural disaster.
- ▶ If the tank requires constant pumping or experiences continuous backups and overflows, it may be failing.
- ▶ Place a septic waste water filter in the tank to filter large particles from entering the leach field and clogging the system.
- ▶ Do not throw fats, oils, greases, chemicals, solvents, paint, and other substances down the drain. These may clog the system, kill the bacteria that treat waste in the tank, or contaminate the environment around the leach field.
- ▶ Use lightweight, septic-system safe toilet paper and do not flush bulky cotton items like paper towels or hygiene products.

### REGULATORY AND CODE

- ▶ The 2018 IPSDC (International Private Sewage Disposal Code) provides tables with the minimum sizes for the septic tanks, pumping chambers and holding tanks, based on the number of bedrooms for one and two-family dwellings, and per bedroom for Apartment buildings and condominiums.
- ▶ 2018 International Private Sewage Disposal Code
- ▶ Regulations as established by Environmental Quality Board.

### MATERIAL



#### PLASTIC

- Last longer, less maintenance required
- Higher cost



#### CONCRETE

- Can be custom built
- Inexpensive
- Gets damaged more easily

### OPERATIONS AND MAINTENANCE TIPS

- ▶ **Document your system**  
Document every component of the septic system and keep these organized as a set of “as-builts” for current and future operations.  
Take photos of:
  - Septic tank location
  - Leach field layout or location of dry well
  - Layout of the drain field lines and the position of your tank in regards to the house plumbing
  - Layout of the drain field in regards to plantings
  - Electrical components
- ▶ Reduce putting any loads on leach field such as parking or heavy objects which can disrupt lines and compact soil preventing treatment from occurring.
- ▶ Don’t place bleach or chlorine down the drains because it can destroy critical bacteria colonies that treat wastewater in your septic tank.
- ▶ If possible, drain your septic system before any major climatic event. A good rule of thumb is to drain it around August, right before hurricane season is at its peak.
- ▶ **Septic Tanks**
  - Hire specialized companies to pump out solids.
  - Never use bleach in the tank.
  - Check that alarm systems are in working order.
- ▶ **Leach Field**
  - Maintain soil porosity and ensure that no significant weight is placed on the drainfield, such as parking or structures.
  - Ensure lines are properly buried and unclogged.
- ▶ **Keep an eye out for the following signs of septic system failure:**
  - Wastewater backing up into household drains.
  - Bright green, spongy grass on the drainfield, especially during dry weather.
  - Pooling water or muddy soil around your septic system or in your basement.
  - A strong odor around the septic tank and drainfield.
  - If the drainfield is overloaded with too much liquid, it can flood, causing sewage to flow to the ground surface or create backups in toilets and sinks.
  - Septic tanks that require constant pumping or that experience continual backups and overflows during normal use may be in the first stages of septic system failure.



# IMPROVE YOUR SEPTIC SYSTEM

## STEP 3 - SITE AND BUILD A TREATMENT SYSTEM FOR WASTE DISPOSAL

A leach field or drainfield is the final stage of the septic system and provides additional treatment of wastewater. A drainfield is arrangement of perforated pipes over a series of trenches on site filled with appropriate soil, sand or gravel. The liquid wastewater in the septic tank exits by gravity or pumps into the leach field and percolates into the soil, naturally injecting nutrients and removing harmful bacteria.

Using drain field is a best practice management for onsite treatment systems. The liquid wastewater in the septic tank exits by gravity or pumps into the leach field and percolates into the soil, naturally injecting nutrients and removing harmful bacteria.



LEACH FIELD

PERFORATED PVC PIPE  
“Weepholes” allow liquid waste to flow into surrounding gravel and percolate slowly

SEPARATION LAYER  
2” of saw dust or hay between gravel and top soil

GROUND COVER  
Nutrient-rich soil appropriate for growing lawn

COARSE GRAVEL  
3/4 inch to 2 1/2 inch in diameter

ROCKS

TRENCHES  
Filled with gravel, lined with perforated pipes that carry liquid waste

PERFORATED PIPES  
Min. of 3 feet between pipes between 1.5 feet and 3 feet deep

20 ft. max



# IMPROVE YOUR SEPTIC SYSTEM

## STEP 3 - SITE AND BUILD A TREATMENT SYSTEM FOR WASTE DISPOSAL

SIZE

- The size of the leachfield needed can range depending on the number of bedrooms, soil percolation rate, depth of field and composition of soil and use of aggregate like gravel .

OPERATIONS

- Maintain soil porosity and ensure no weight is placed on the leach field, like parking or structures.
- Ensure lines are properly buried and unclogged.
- Keep an eye out for:
  - Bright, green, spongy grass on the leach field, especially during dry weather
  - Pooling water or muddy soil around the system. If the leach field is overloaded it can cause sewage to flow to the ground, surface or create backups in plumbing fixtures.
  - A strong odor around the septic tank or leach field

SITE

- Place far away from habitational areas.
- Identify which soil is appropriate for the land plot.
- The soil percolation rate is a measurement of how much water a type of soil can absorb in a particular amount of time. It is recommended that the soil neither retain water nor let it pass through too quickly. Sandy loamy soil or sand have good draining capacity.
- Consult a soil engineer for a thorough percolation test and comprehensive soil analysis.
- Soil on top of the tank must be sloped downwards to allow surface water to flow away from the system.
- Set aside an area the same size as the primary drainfield for use as a replacement drainfield if something happens to the primary one.
- - Consult with the Puerto Rico Office of General Permit (OGPe) guidance on construction requirements and minimal distance from the water body.

FIELDWORK

- Fence off or mark up the leach field to alert of its location.
- Cover the whole system with a layer of topsoil to prevent animals and surface runoff from reaching wastewater.

VEGETATION

- Plant vegetation and locate mounds of soil around the leach field so it absorbs excess water and nutrients from the septic tank.
- Choose a native plant species with a shallow root system that can uptake water and nutrients from effluent but will not clog the drain pipes.
- Do not plant trees or shrubs within 25 feet

SITE AND BUILD A DRY WELL

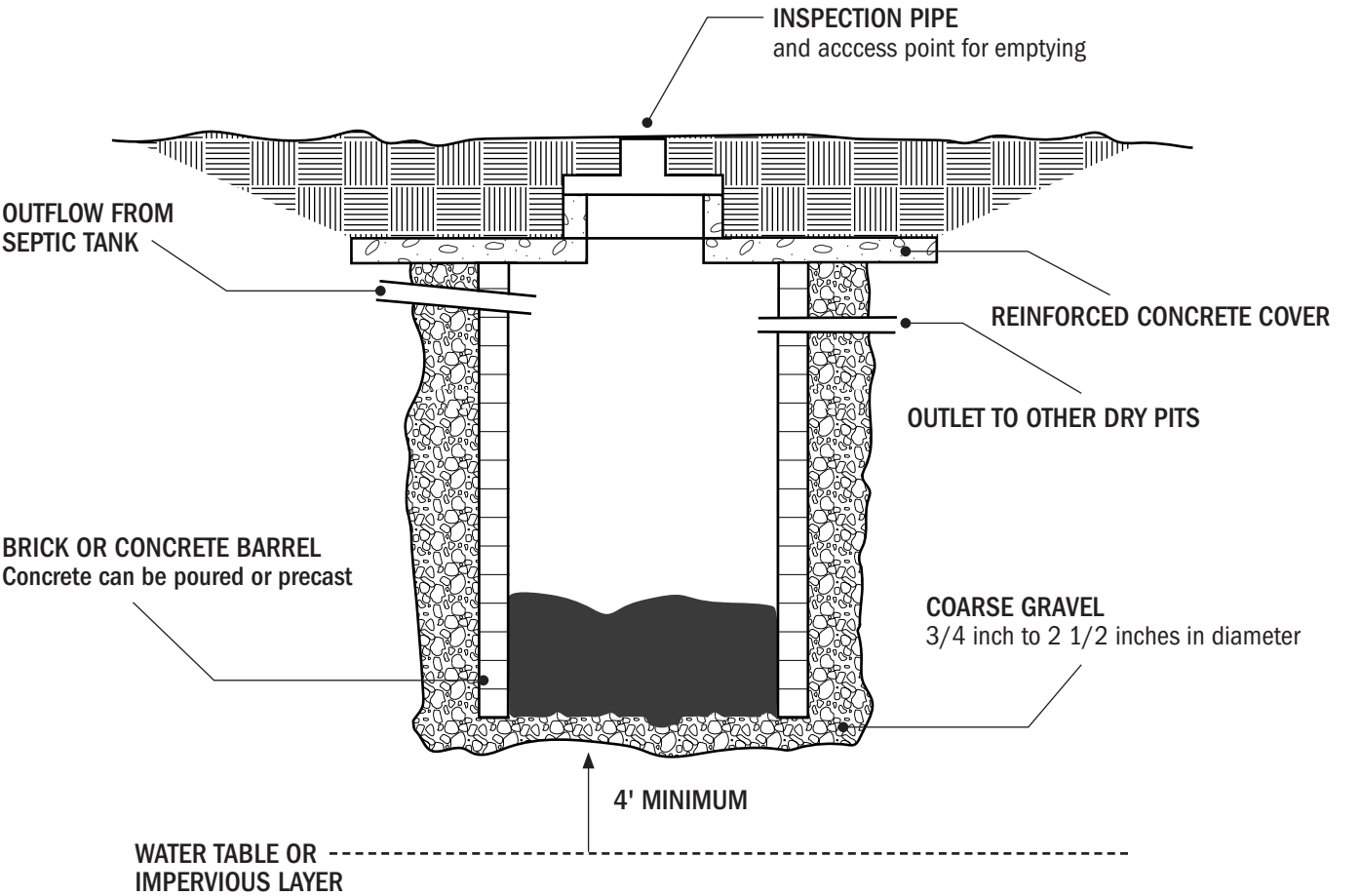
- Use in zones with inadequate soil absorption capabilities, limited space, or steep slopes.
- A dry well is a type of leaching mechanism which is an alternative to a traditional leachfield when conditions don't permit. It consists of a bottomless tank with holes on the side, and uses stone or aggregate material to control the injection process into the soil.

- Add gravel around it at the bottom of the well so wastewater percolates into the soil while solids will remain in place for later disposal.



DRY WELL

A dry well utilizes gravel and other permeable materials to slow the injection process into the surrounding earth. It is an alternative to traditional leaching systems on lands with inadequate soil absorption capabilities.





STRATEGY

22

PREVENT WASTEWATER BACKFLOW IN HOMES

Flooding from Stormwater, Coastal surge or a high water table, can overwhelm a home’s waste treatment system, and it can cause wastewater and sewage to flow back into the home. This backup can create unsanitary conditions for occupants by exposing them to bacteria contaminating potable water reservoirs, which may leave people without safe drinking water. This strategy identifies ways to mitigate these risks.

- Strategy in Action
- 1. Install a backflow preventer valve
  - 2. Install a backwater alarm
  - 3. Maintain pipes and sanitary vents
  - 4. Deal with backflow in the leach field

WHAT YOU NEED TO KNOW

- ▶ Wastewater backflow is when water flows through sewage pipes in the wrong direction and backs up into the house or building, contaminating spaces as well as potable water.
- ▶ In urban areas, the biggest risk associated with backflow is contamination of water reservoirs.
- ▶ In rural areas, the biggest risk associated with backflow is failure of a leach field, which leads to flooding and health risks.



SUPPORTING STRATEGIES

19	20	21
Reduce Your Water Consumption	Collect and Use Rainwater	Improve Septic Waste Disposal System

REMEMBER

**DO NOT MIX STORMWATER AND SEWAGE WATER!**  
Design the site to prevent storm water from going into the sewer. During a flood, holes may open and cause wastewater to overflow into water bodies, streets, or other homes.

STEP 1 - INSTALL A BACKFLOW PREVENTER VALVE

WHAT IS IT?

A backflow preventer valve is a cost-effective device that protects water from getting contaminated from wastewater overflow.

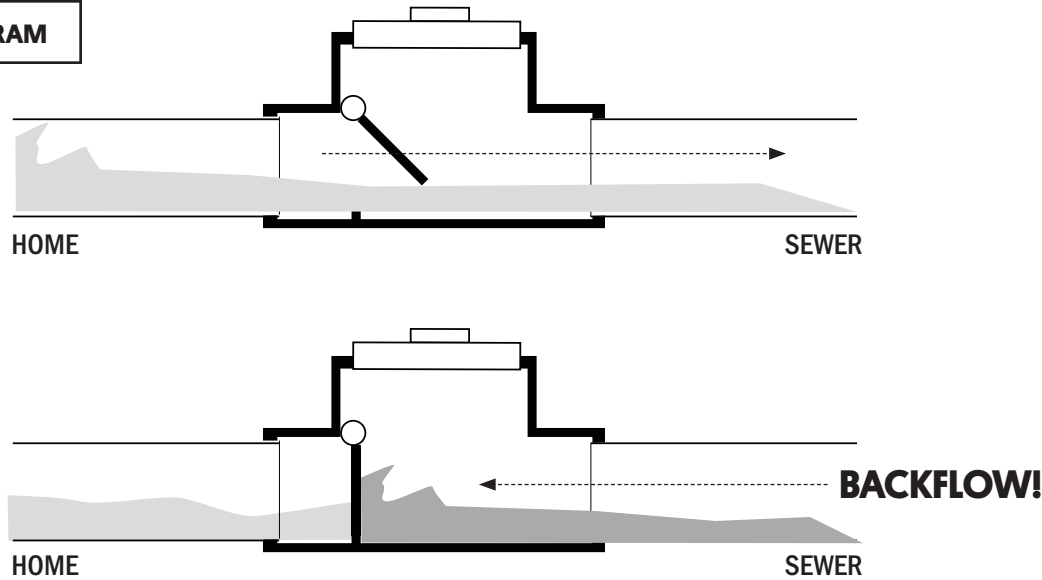
WHO NEEDS IT?

Install a backflow preventer valve if your home is in a flood zone or in a flood prone area.

WHY DO YOU NEED IT?

To ensure water is not backing up into household pipes from the septic system.

BLACKFLOW DIAGRAM



WHERE DOES IT GO?

- Install it where the water pipes exit so sewage only flows outward.
- A backflow preventer valve is typically installed inside a concrete pit with a waterproof cover that can be removed for easy access for maintenance.

HOW DOES IT WORK?

It works with a flapper that opens in the direction of home to sewer line but closes if water flows in the other direction. If the valve is closed, wastewater cannot enter or exit the building. If the valve is closed, the water collected from the roof and site cannot exit the pipes, so you must redirect it to gravel or grass. Failure to do this will result in the pipes flooding your home.



# PREVENT WASTEWATER BACKFLOW IN HOMES

## STEP 2 - INSTALL A BACKWATER ALARM

WHAT IS IT?

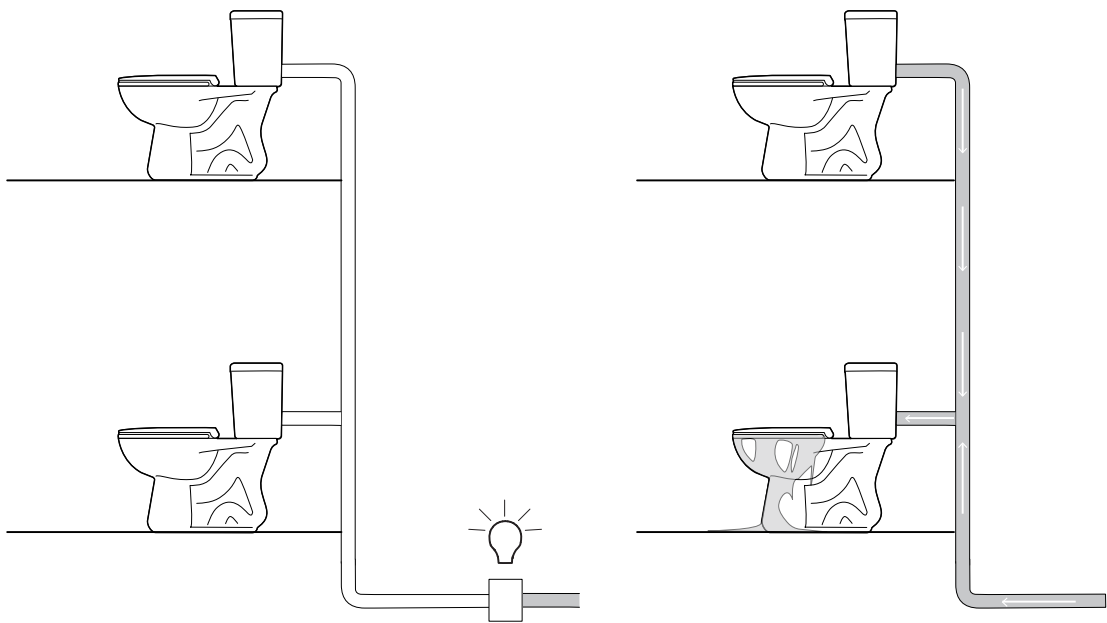
A backwater alarm is a device that alerts occupants that a backflow is happening, and they should not use fixtures until it settles.

WHO NEEDS IT?

Install a backwater alarm if your home is in a flood zone or in a flood prone area.

WHY DO YOU NEED IT?

To ensure you do not use contaminated water.



BACKFLOW!

WHERE DOES IT GO?

Sanitary plumbing lines, next to the backflow preventer valve.

HOW DOES IT WORK?

The device consists of an alarm box that runs a sensor to verify pipes are clean. If it detects that there is a water influx, the box emits a loud sound.

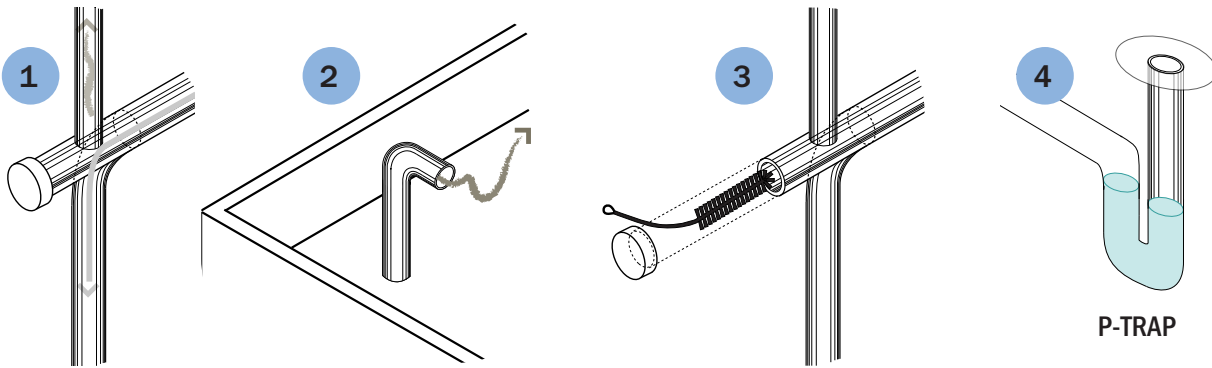
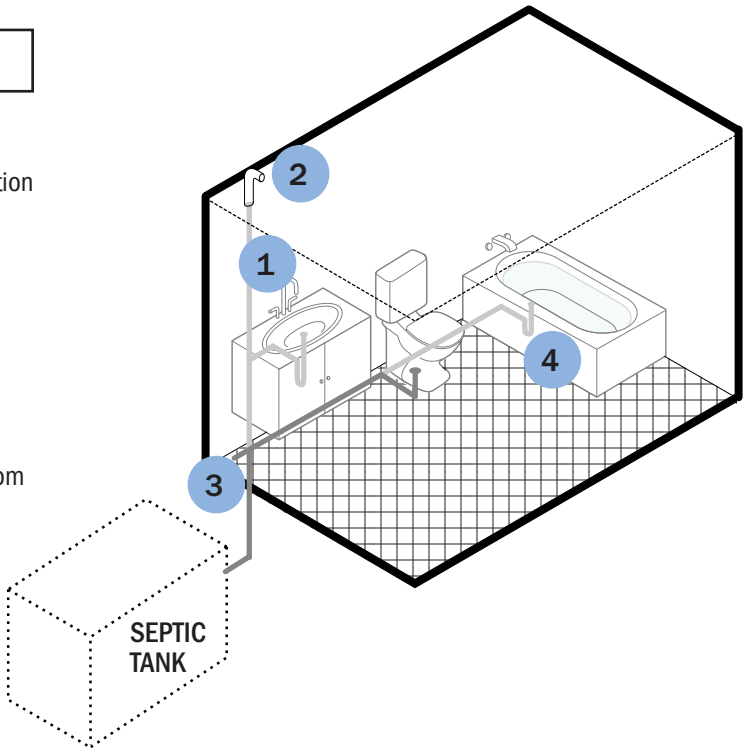


## STEP 3 - MAINTAIN PIPES AND SANITARY VENTS

- ▶ Connect every plumbing fixture to a pipe that carries wastewater out of the home.
- ▶ Connect every water pipe to a vent pipe to allow air involved in the sewage movement process to exit.
- ▶ Connect every vent pipe to a vent stack, a vertical pipe that goes to the exhaust point at the roof.
- ▶ Ensure that all vent pipes (and soil lines in septic systems) are clear of any blockage. Do this by creating “cleanouts”, access points along waste lines that allow professionals to unclog or insert cleaning devices.
- ▶ Seal all pipes to prevent cockroaches, rats and other from entering the house or contaminating water.

SEWAGE DISTRIBUTION SYSTEM COMPONENTS

- 1 VENT PIPES  
expel gases that form during waste decomposition through stack vent.
- 2 STACK VENT
- 3 CLEANOUT  
located at every pipe turn, allows access for cleaning waste that might block the line.
- 4 WATER SEAL  
prevents cockroaches, rats and other critters from getting into your house.





# PREVENT WASTEWATER BACKFLOW IN HOMES

## STEP 3 - MAINTAIN PIPES AND SANITARY VENTS



### OPERATIONS AND MAINTENANCE TIPS

- ▶ Examine backwater valve once a year to monitor obstruction, rust and corrosion. Cast-iron valves can become rusted or corroded in areas where there is a lot of salt water. Prevent this by utilizing a rust-proof paint or sealant.
- ▶ Ensure sanitary vent discharge points are clear of debris and verify sanitary line cleanouts whenever the system seems sluggish.

### CODE AND REGULATIONS

- ▶ The International Mechanical Code has a chapter that establishes all pertinent regulations for this type of system.

## STEP 4 - DEAL WITH BACKFLOW IN THE LEACH FIELD

- ▶ Ensure you maintain your leach field appropriately to avoid flooding.
- ▶ Avoid contact with the sewage, as it may contain harmful bacteria.
- ▶ Contact the local health department or regulatory agency for guidance.
- ▶ Cleanup personnel should wear protective clothing (e.g., long rubber gloves, face splash shields).
- ▶ After cleanup is complete, thoroughly wash all equipment, tools, and clothing used during cleaning.
- ▶ Disinfect all items or areas exposed with a mixture of 90% water and 10% household bleach.
- ▶ Thoroughly dry out the affected area and do not use for at least 24 hours.
- ▶ See Strategy 21: Prevent Wastewater Backflow in Homes.





## SAN JUAN BAY ESTUARY



**Description:** The San Juan Bay Estuary Program is a 501(c)(3) non-profit corporation that designs, implements, and monitors the recovery measures taken to improve the quality of water and the associated ecosystems within the San Juan Bay Estuary system and its basin. The Estuary system spans eight municipalities: Bayamon, Carolina, Cataño, Guaynabo, Loiza, San Juan, Toa Baja, and Trujillo Alto. This program involves citizens, visitors, and tourists. It is also associated with the government, scientific, private, academic, and community sectors.





# ENLACE OF CAÑO MARTIN PEÑA PROJECT

**Interviewee:** ENLACE, Lyvia Rodriguez

For more information, visit <http://cano3punto7.org/nuevo/index.html>

**Description:** the ENLACE del Caño Martín Peña Project is the corporate umbrella of organizations that work together to complete dredging works along the 3.7 miles of expanse of the Martín Peña Channel, as well as the redevelopment of the eight communities bordering it, thus contributing to the transformation of the city as well. The ENLACE del Caño Martín Peña Project Corporation is an independent government entity whose mission is to coordinate and implement public policy related to dredging and channeling this body of water. This would also ensure the continuity, urban development, and socioeconomic growth of its eight neighboring communities. This project involves the active and effective participation of their residents, their community-based organizations, and the partnerships between communities, the public sector, and the private sector.

ENLACE is driven by the ENLACE del Caño Martín Peña Project Corporation, the G-8, Inc., and the Caño Martín Peña Community Land Trust. It is also supported by a large group of strategic partners including universities, foundations, companies, and government institutions. The corporation works towards achieving its vision of a united, safe, and prosperous community through a self-managed cohabitation model in the heart of San Juan.

## INTERVIEW

Before the event, we prepared fact sheets about



its hazards to warn the community that this was something real and very dangerous. Since the Martín Peña Channel has always been a flood-prone area during heavy rainfalls, we prompted some of the residents to move to a shelter. Our fact sheet, which we delivered from house to house in the Channel's communities, provided all residents with suggestions on what to do before and after the hurricane. During this period, community leaders were very actively involved.

After the hurricane, we first walked through the streets to inventory structural damages and document the reach of the flood waters. The database and tools we previously had, such as documentation systems, were essential for this. We already had maps that showed us the streets and structures as they were before the event, which helped us document the state of the streets and buildings damaged by the floods. This helped us determine that the most pressing need at that moment was the tarps to cover home roofs; more than a 1,000 families had lost the roof of their homes. Once we identified this need, we started looking for a space with Internet service so we could contact our partners in the diaspora. As a result, our offices

became collection centers; two weeks later, we had collected about 400 tarps.

We had a team in charge of coordinating and contacting our partners and collaborators. This team also made sure that the supplies made it safely from wherever they were (e.g., the airport) to our facilities. The distribution team, composed by community leaders, was in charge of delivering supplies to community residents. On the other hand, one of our biggest accomplishments was obtaining permission from the federal government to fill out FEMA assessment forms with the information we had already gathered about damages in the community. The agency provided the forms, and we went from house to house helping residents fill out the forms. This was crucial to speed up the process, since many people were unable to leave their homes and visit our centers, for whichever reason.

For the community to plan for and face similar situations, it is critical that the following exist:

- A subject or issue that is essential and relevant to every member of this organization.
- Acknowledgment of the community's weaknesses and strengths, as well as the extent of its vulnerability.
- Knowledge of the public policies implemented by the current central government and participation in the island's important processes to reduce its vulnerability.
- The establishment of a decision-making structure for situations involving key decision-making processes.
- Implementing communication methods for community involvement.
- A self-assessment process for community growth and to identify what works, what doesn't, and how to improve as a group.

We worked on different things after the hurricane, and we are still working on others. For example, as we were documenting the damages, we noticed that

rats and mosquitoes were going to be a major public health problem. Consequently, donations allowed us to install rat traps and distribute two types of kits (one to repel mosquitoes and the other to treat mold). Aside from that, we also carried out awareness campaigns because, just three days after the hurricane, we had a few building owners starting to evict their tenants. This prompted us to counsel tenants as to their rights. Additionally, we developed a communication structure for each street in every community, leaving someone in charge to report any issues that came up there. In terms of rebuilding efforts, we provided popular self-build workshops for residents, where they were taught how to make the necessary alterations to their homes. This helped them fix their own homes safely, since these structures were built by the residents themselves. Therefore, this was a way for us to make sure to reduce home vulnerability. By distributing educational materials and providing step-by-step guidance in layman's terms, residents acquired the knowledge needed to do it themselves.





# COMMUNAL AQUEDUCT, RIO CHIQUITO, INC



Communal Aqueduct Río Chiquito, Inc.  
Bo. Río Chiquito Ponce  
Contacts  
    José Álvarez Jiménez, Presidente  
    Gumersindo Torres, Director Ejecutivo

**Vision and Mission:** Acueductos Río Chiquito, Inc. has the purpose of fulfilling the will of the community, facilitating a supply of potable water ordered to all members of the community, protecting the aqueduct facilities, safeguarding public health and establishing the corresponding rights and obligations of the subscribers or users of this service. This organization was created with the purpose of promoting and promoting the welfare of the Río Chiquitos Community in the Municipality of Ponce, guaranteeing potable water for our community for more than forty years. Among the services offered by the Communal Aqueduct is the extraction of water resource, storage, disinfection processing, water distribution, pipe repair, billing, system maintenance, analysis and water testing required by all regulatory agencies like those of the Department of Health of the Department of State, among others.

