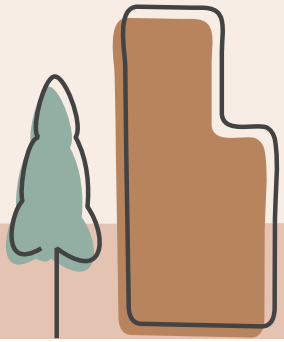
Climate Smart Landscapes

Rainwater Harvesting:
Rain barrels and Cisterns

Patty Gambarini, Chief Environmental Planner

Catalyst for Regional Progress
PVPC



01 – Workshop context

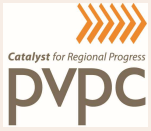
Mill River Watershed

Planning for Flood Resilience

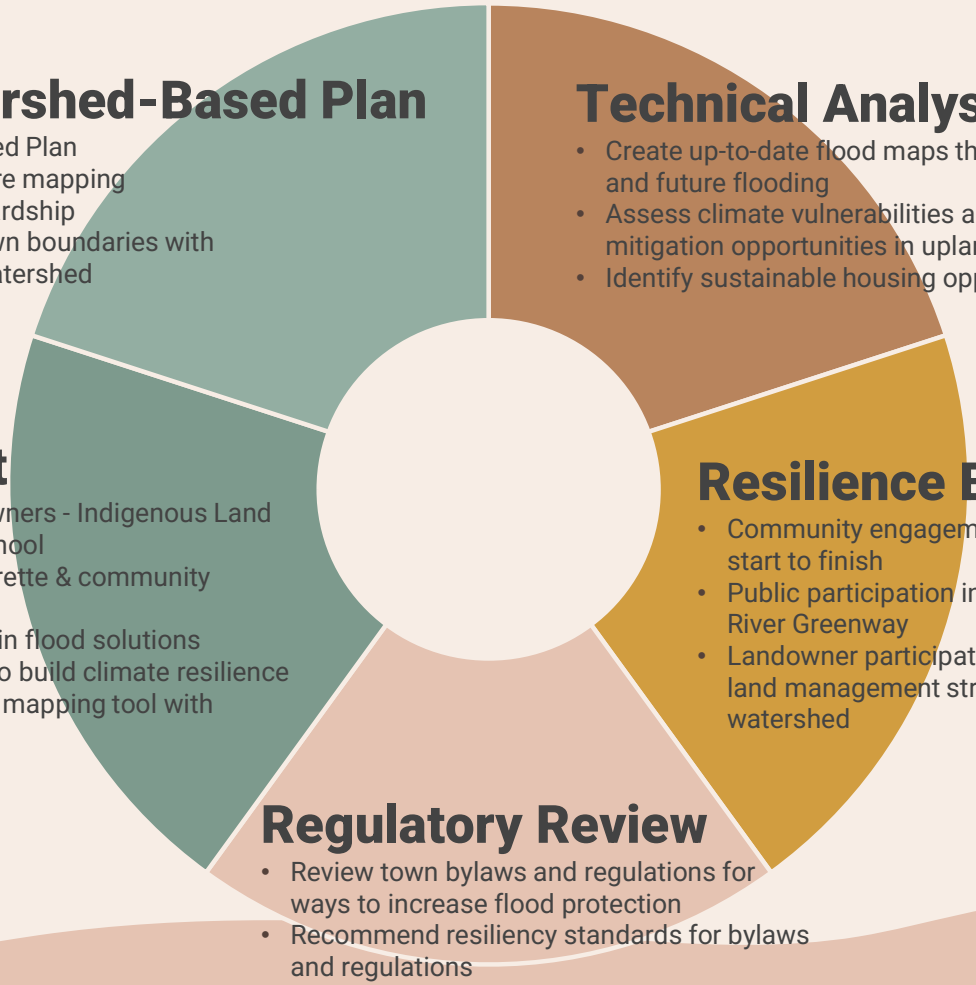
A two-year project made possible by an Action Grant from the Massachusetts Municipal Vulnerability Preparedness Program to the Town of Williamsburg.

DODSON & FLINKER
Landscape Architecture and Planning

No Loose Braids



Project Elements



Holistic Watershed-Based Plan

- EPA 9-Element Watershed Plan
- Stormwater infrastructure mapping
- Upland watershed stewardship
- Collaborating across town boundaries with other stewards of the watershed

Technical Analysis

- Create up-to-date flood maps that show current and future flooding
- Assess climate vulnerabilities and flood mitigation opportunities in upland areas
- Identify sustainable housing opportunities

Engagement

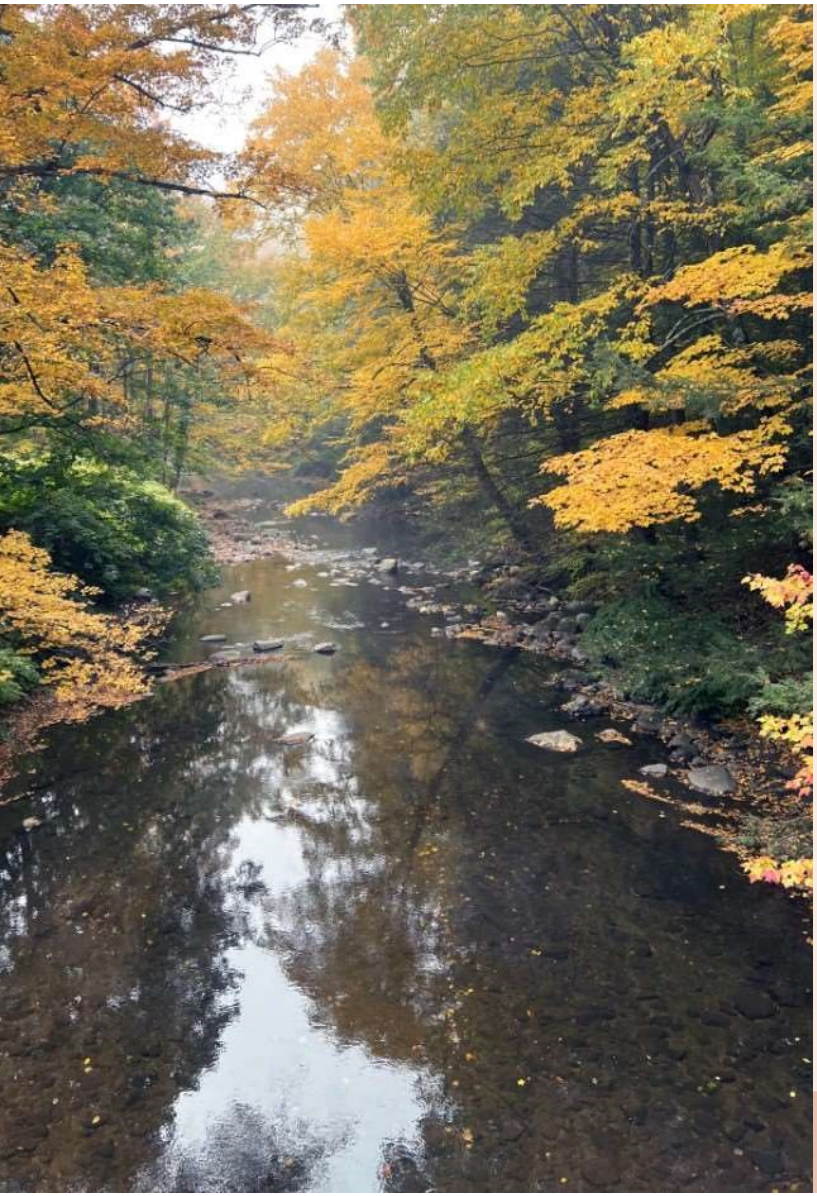
- Town boards - Landowners - Indigenous Land Stewards - Dunphy School
- Greenway Design Charette & community visioning
- Resident involvement in flood solutions
- Backyard workshops to build climate resilience
- Interactive web-based mapping tool with watershed data

Resilience Building

- Community engagement in the project from start to finish
- Public participation in the design of the Mill River Greenway
- Landowner participation in climate-resilient land management strategies throughout the watershed

Regulatory Review

- Review town bylaws and regulations for ways to increase flood protection
- Recommend resiliency standards for bylaws and regulations



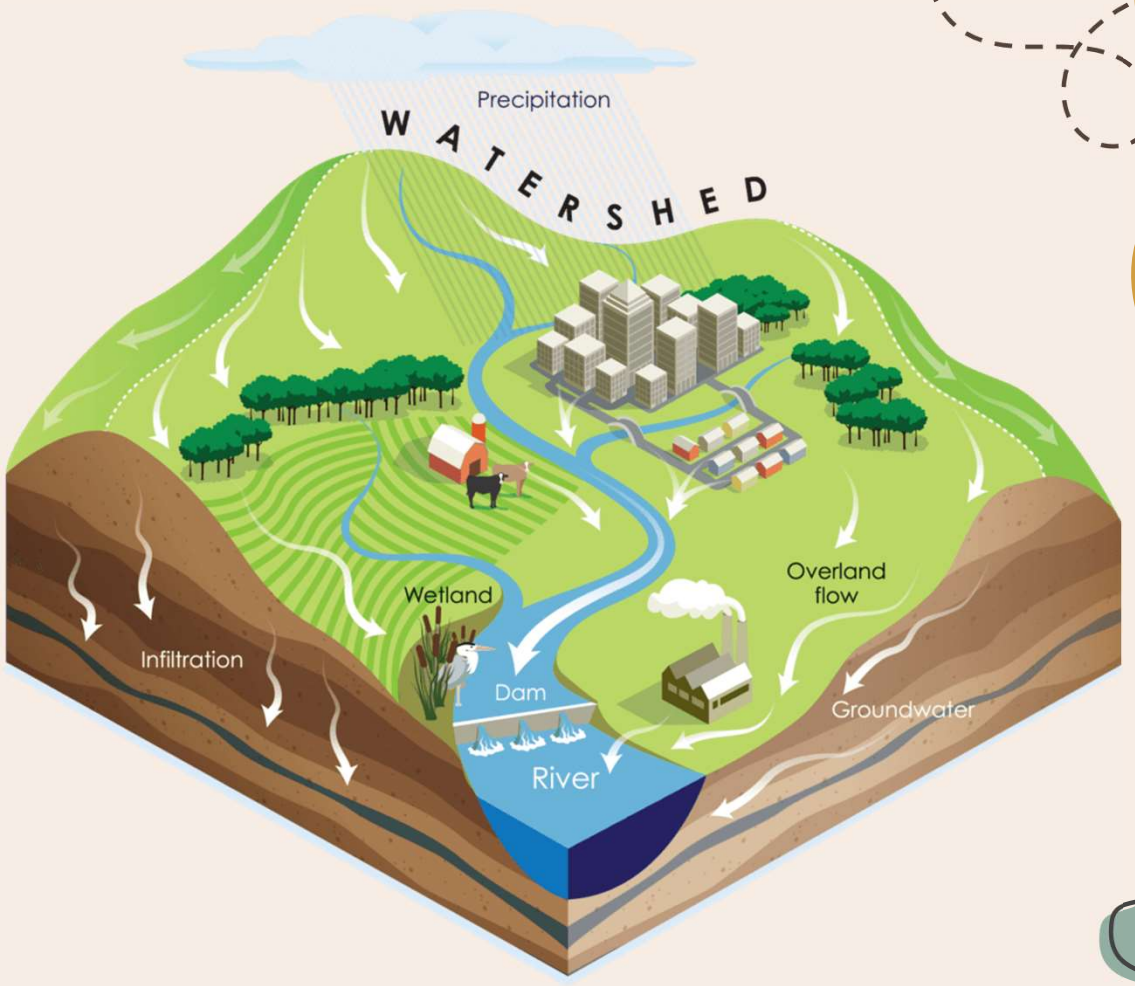
Looking at water

- Including current and future flooding
  - New Flood Maps
  - Regulations Review
  - Areas for Improvement
- Water quality
  - Sources of Pollution
  - Green Infrastructure

and forests

- Benefit of forests for flood mitigation
- Indigenous land practices with No Loose Braids
- Soil analysis of upland areas
- Balancing climate resilient forest conservation with development needs

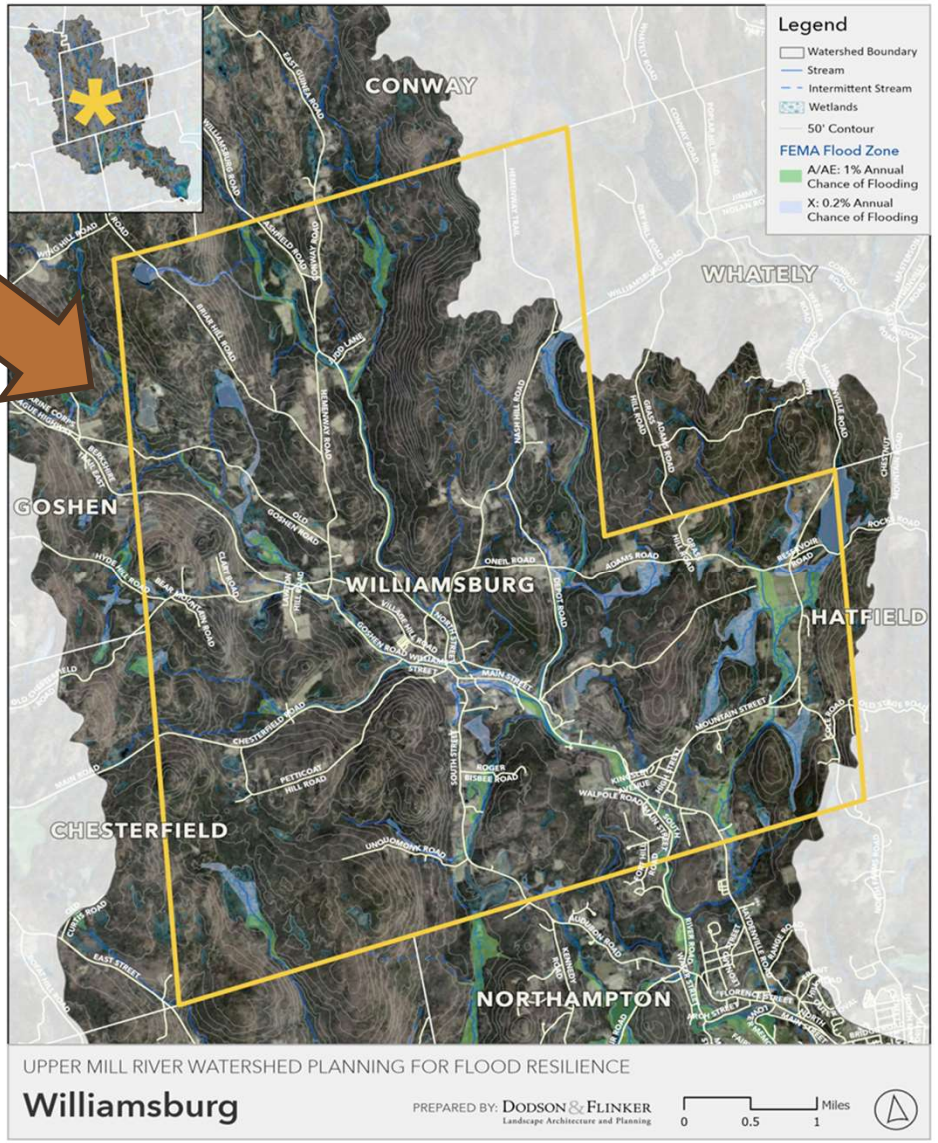
What is a watershed?



Go from thinking about just this

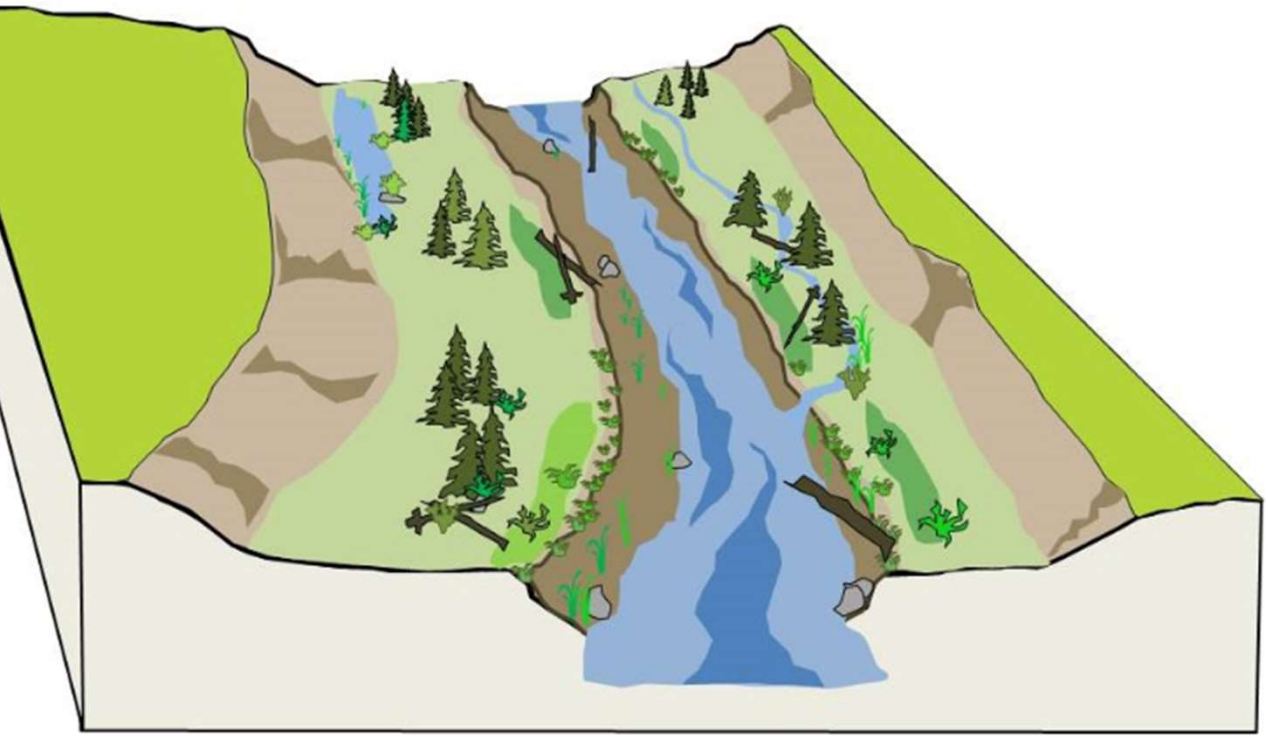
Source: New England Public Media

TO ALL OF THIS



02 – Land development and unintended consequences

Floodplains



Reconnecting Rivers to Floodplains, American Rivers, 2016

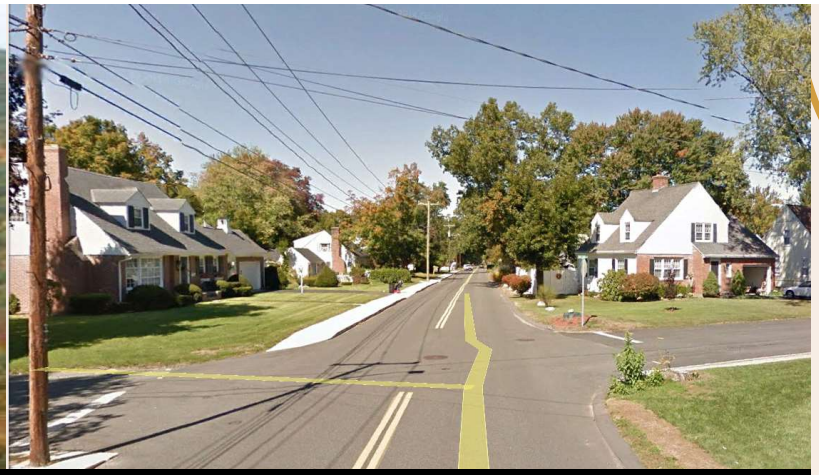
- Lands adjacent to river that are an integral part of the system
- Dynamic land area that regularly disturbed by inundation during high flows
- Form and ecology is shaped over time in response to natural processes driven by periodic flooding

HAYDENVILLE, MASS.

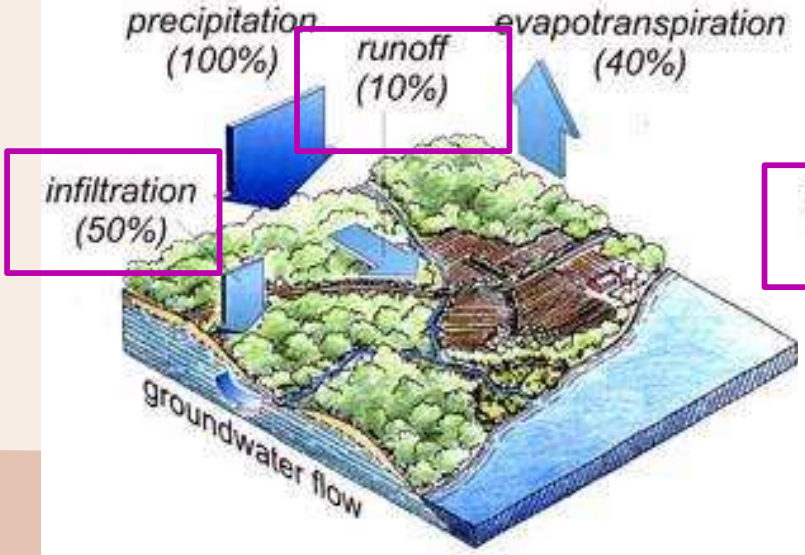
1886.

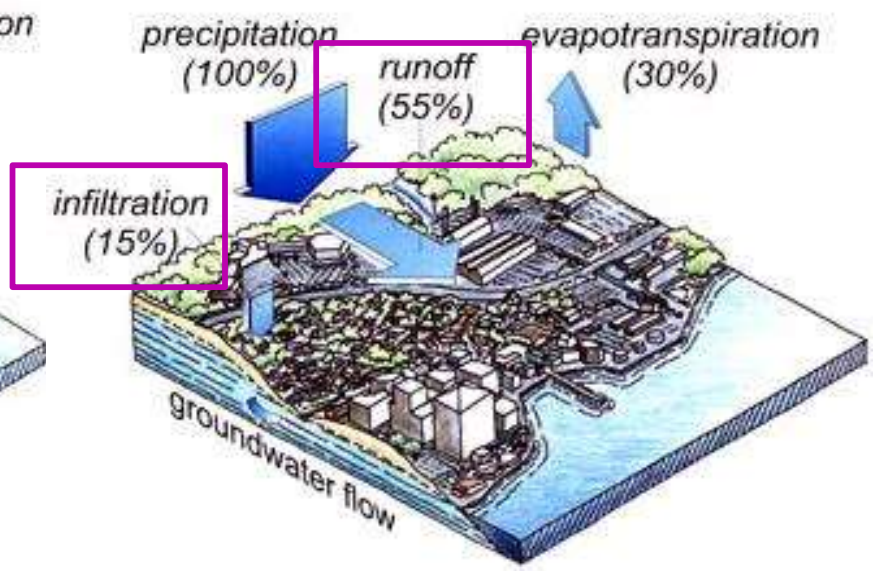

N
1:2,257
30 m
100 ft
42.39354, -72.73268 LAT LON
MassMapper
Leaflet | MassGIS 2021 Aerial Imagery

WWLP, July 2023 flood coverage



Development of land changes the relationship with water, increases surface runoff





Historically approach has been to:

- Convey rainfall away…as if a waste product

- Use drinking water to irrigate lawns and gardens

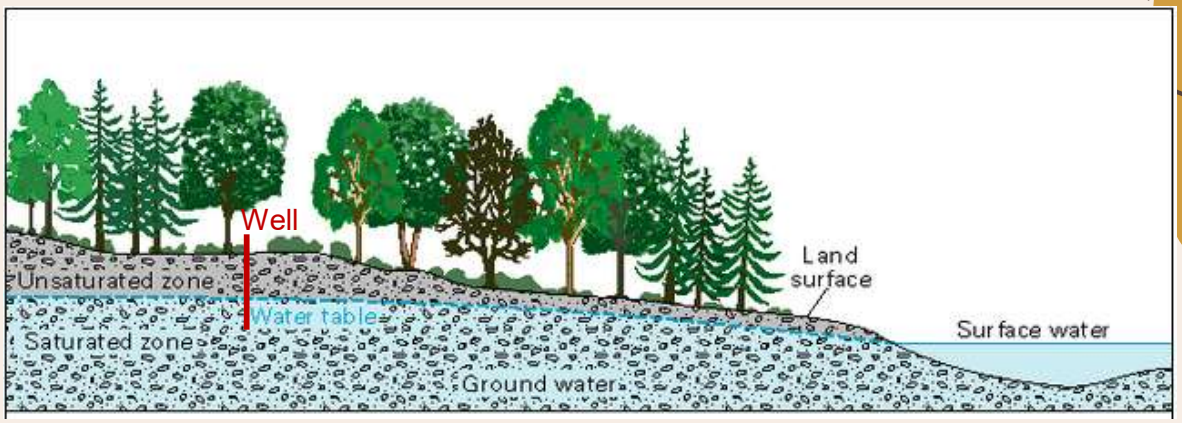
Six impacts associated with impervious and “conveyance” approach to stormwater

Six impacts associated with impervious and "conveyance" approach to stormwater

- Water quantity – moving in larger volumes, causes flooding, streambank erosion, displacement or death of aquatic life
- Water quality – washing accumulated pollutants from impervious surfaces to rivers and streams
- Water temperature – superheating summer rainfall so that flows to local streams can stress or kill aquatic life.

www.willmarmn.gov/departments/stormwater_management_same.php

- Reduced groundwater recharge and baseflow – impacts to local drinking water supply and to aquatic life during dry spells
- Loss of recreational uses – especially in larger parts of the watershed, like Connecticut River, for boating, fishing, and swimming
- Shellfish closures – further downstream in coastal areas where our waters ultimately outlet to the ocean



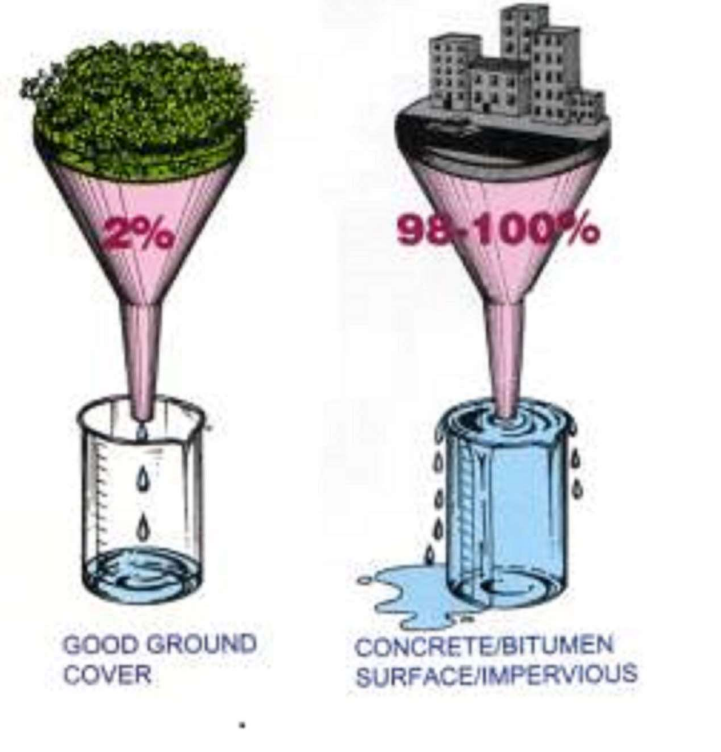
https://water.usgs.gov/edu/earthgwaquifer.html

www.liswaterquality.org/securing-a-safe-and-healthy-future-for-shellfish-in-long-island-sound/

Increased flooding

The greater the impervious cover, the greater the likelihood of flooding.

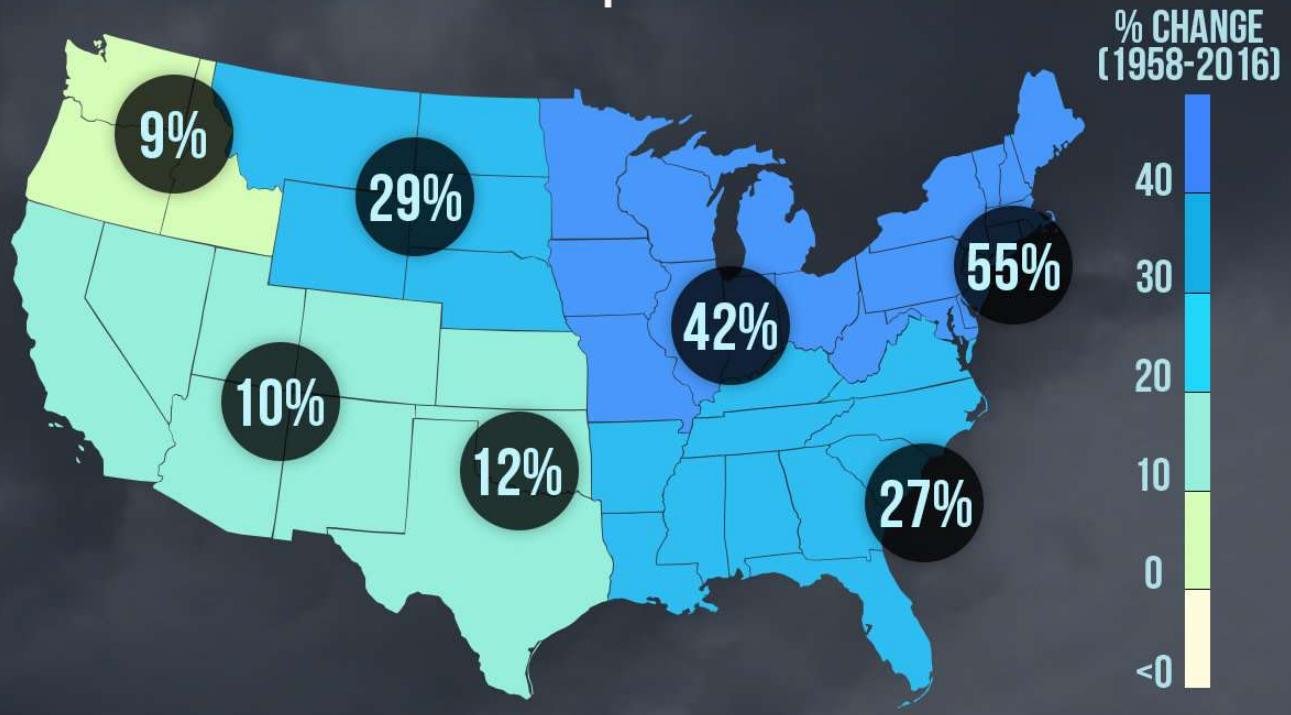
An equation that we are recognizing more and more.



https://beckleysanitaryboard.org/impervious-surface/

MORE DOWNPOURS

Increase in Heaviest Precipitation Events



Heaviest events defined as top 1% of events
Source: USGCRP Climate Science Special Report 2017

CLIMATE CENTRAL

03 – Finding solutions

Shift in thinking about rainfall

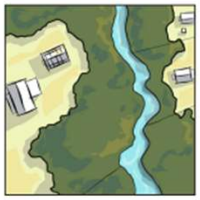
From: Nuisance		**To: Precious Resource**
Pipe and convey	→	Mimic natural processes and integrate management of stormwater with land use
Protect property	→	Protect property **and** habitat
Reactive - solve problems	→	Proactive - prevent problems

Cottages on Green, East Greenwich, RI
Photos courtesy of Jonathan Ford, Horsley Witten Group

This shift is reflected now at varying scales in:

- Single lot and larger developments – distributed systems to capture, treat, soak up rainfall
- Municipalities – green stormwater infrastructure along streets and on public properties
- Watershed – conserving key lands to promote river function; even buy outs in some places to make "room for the river."

WATERSHED SCALE



LAND CONSERVATION

Land conservation is one way of preserving interconnected systems of open space that sustain healthy communities.

Land conservation projects begin by prioritizing areas of land for acquisition. Land or conservation easements can be bought or acquired through donation.

GREENWAYS

Greenways are corridors of protected open space managed for both conservation and recreation.

Greenways often follow rivers or other natural features. They link habitats and provide networks of open space for people to explore and enjoy.

WETLAND RESTORATION AND PROTECTION

Restoring and protecting wetlands can improve water quality and reduce flooding. Healthy wetlands filter, absorb, and slow runoff.

Wetlands also sustain healthy ecosystems by recharging groundwater and providing habitat for fish and wildlife.

STORMWATER PARKS

Stormwater parks are recreational spaces that are designed to flood during extreme events and to withstand flooding.

By storing and treating floodwaters, stormwater parks can reduce flooding elsewhere and improve water quality.

FLOODPLAIN RESTORATION

Undisturbed floodplains help keep waterways healthy by storing floodwaters, reducing erosion, filtering water pollution, and providing habitat.

Floodplain restoration rebuilds some of these natural functions by reconnecting the floodplain to its waterway.

NEIGHBORHOOD OR SITE SCALE

RAIN GARDENS

A rain garden is a shallow, vegetated basin that collects and absorbs runoff from rooftops, sidewalks, and streets.

Rain gardens can be added around homes and businesses to reduce and treat stormwater runoff.

VEGETATED SWALES

A vegetated swale is a channel holding plants or mulch that treats and absorbs stormwater as it flows down a slope.

Vegetated swales can be placed along streets and in parking lots to soak up and treat their runoff, improving water quality.

GREEN ROOFS

A green roof is fitted with a planting medium and vegetation. A green roof reduces runoff by soaking up rainfall. It can also reduce energy costs for cooling the building.

Extensive green roofs, which have deeper soil, are more common on commercial buildings. Intensive green roofs, which have shallower soil, are more common on residential buildings.

RAINWATER HARVESTING

Rainwater harvesting systems collect and store rainfall for later use. They slow runoff and can reduce the demand for potable water.

Rainwater systems include rain barrels that store tens of gallons and rainwater cisterns that store hundreds or thousands of gallons.

PERMEABLE PAVEMENT

Permeable pavements allow more rainfall to soak into the ground. Common types include pervious concrete, porous asphalt, and interlocking pavers.

Permeable pavements are most commonly used for parking lots and roadway shoulders.

TREE CANOPY

Tree canopy can reduce stormwater runoff by catching rainfall on branches and leaves and increasing evapotranspiration. By keeping neighborhoods cooler in the summer, tree canopy can also reduce the "urban heat island effect."

Because of trees' many benefits, many cities have set urban tree canopy goals.

TREE TRENCHES

A stormwater tree trench is a row of trees planted in an underground infiltration structure made to store and filter stormwater.

Tree trenches can be added to streets and parking lots with limited space to manage stormwater.

GREEN STREETS

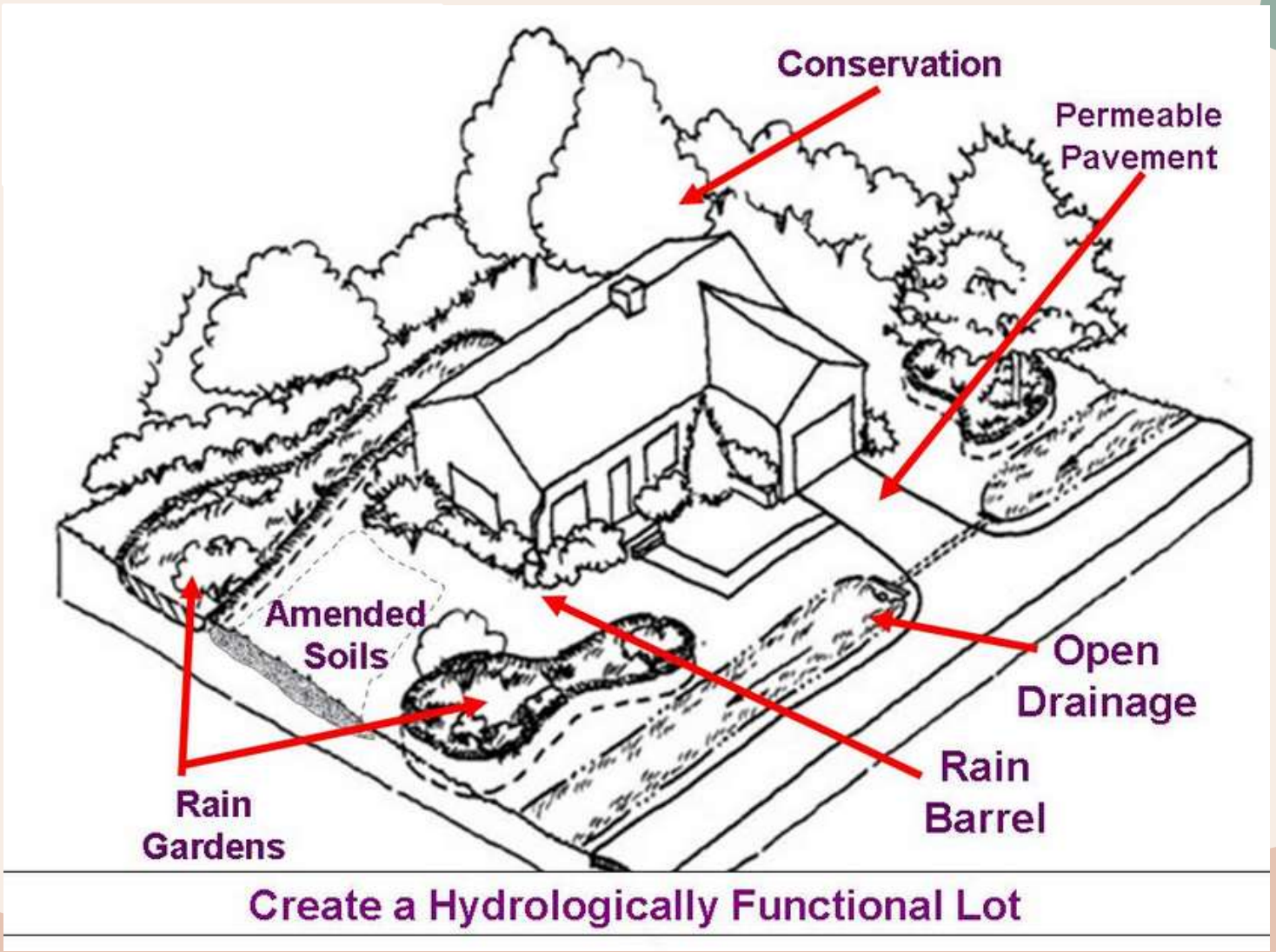
Green streets use a suite of green infrastructure practices to manage stormwater runoff and improve water quality.

Adding green infrastructure features to a street corridor can also contribute to a safer and more attractive environment for walking and biking.

Source: FEMA

Soaking up the rain = facilitating the natural water cycle

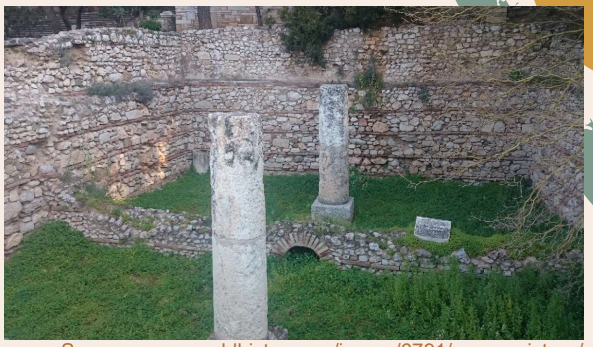
- Protect natural drainage systems and pathways
- Preserve natural areas and native vegetation – trees especially!
- Reduce/remove “impervious” cover
- Find ways to disconnect areas from draining to roadways/municipal storm system/nearby rivers and streams
- Manage rainfall and snowmelt as close to source as possible


Conservation
Permeable Pavement
Amended Soils
Open Drainage
Rain Barrel
Rain Gardens
Create a Hydrologically Functional Lot

04 – Rainwater harvesting

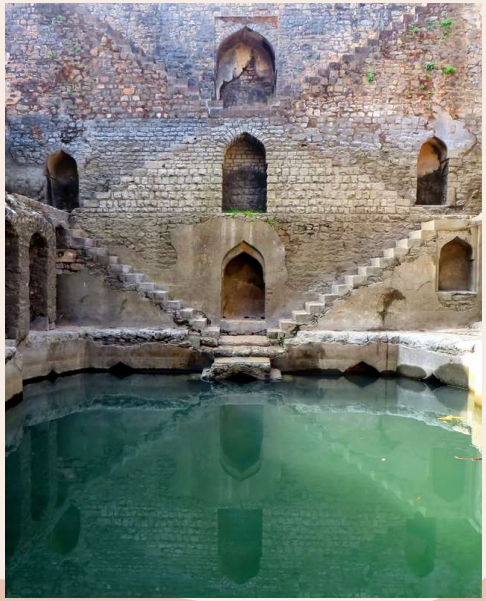
From resource to nuisance to resource

Rain = precious resource



Source: www.worldhistory.org/image/6791/roman-cistern/

Rain = nuisance to convey away

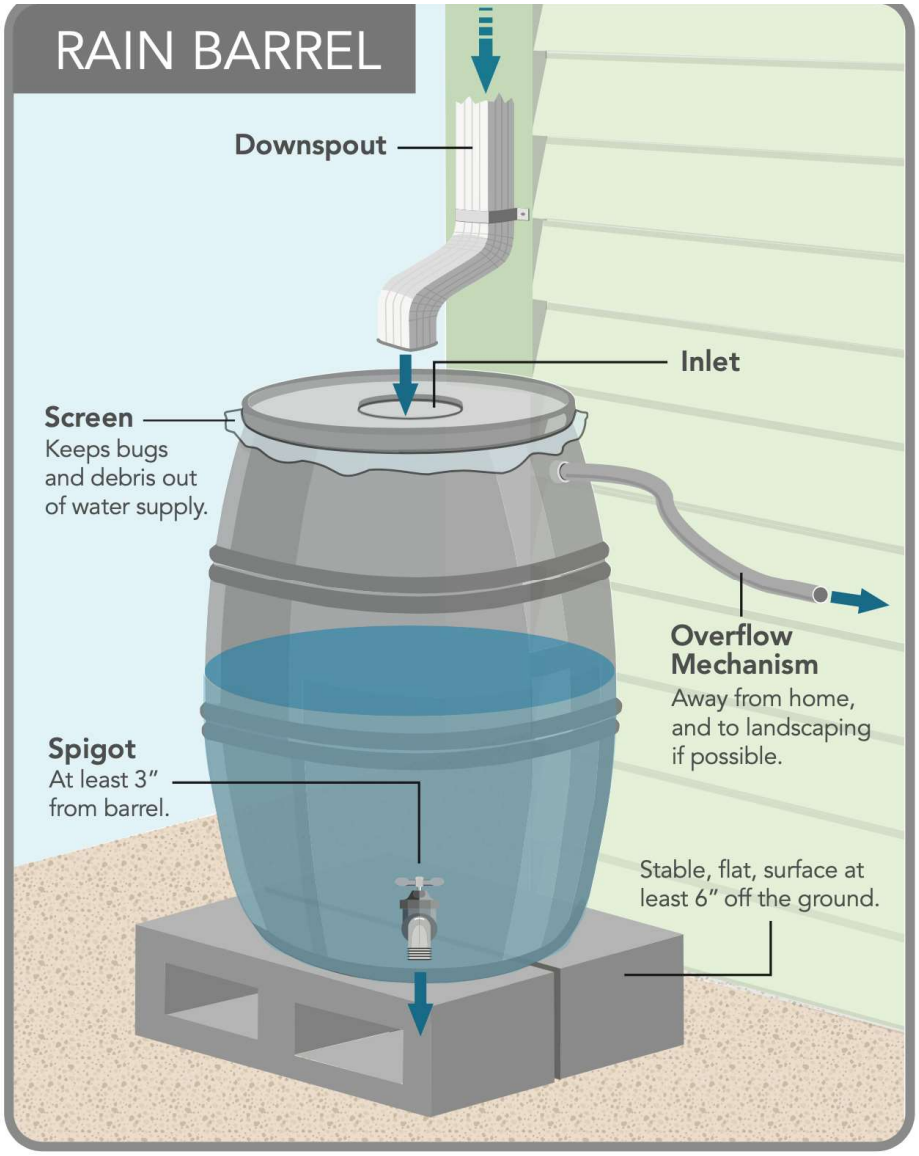


Source: www.bbc.com/future/article/20211012-the-ancient-stepwells-helping-to-curb-indias-water-crisis

https://lifeontheroam.com/ek-balam-mayan-ruins/

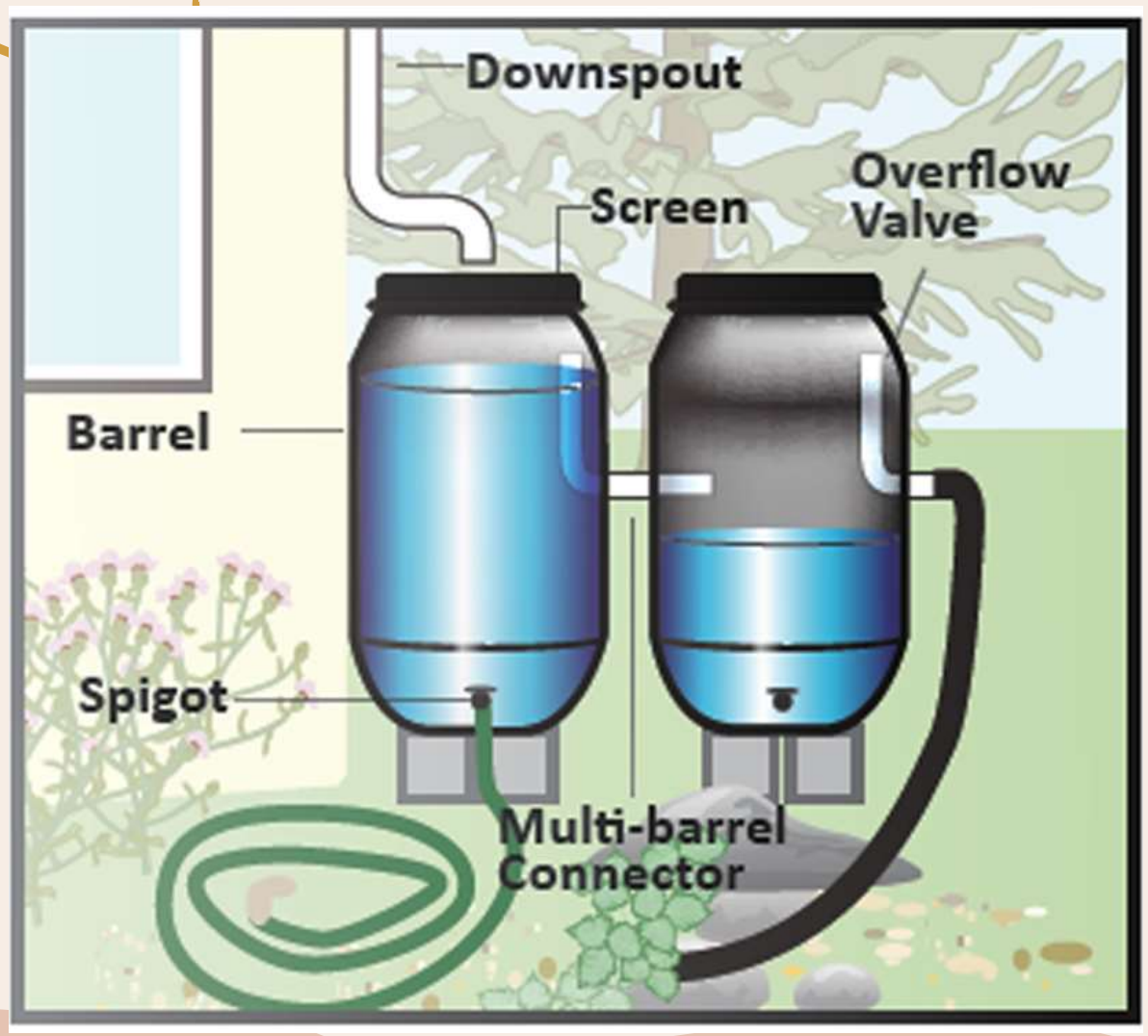
Rain barrels

Basic set up for rain barrel

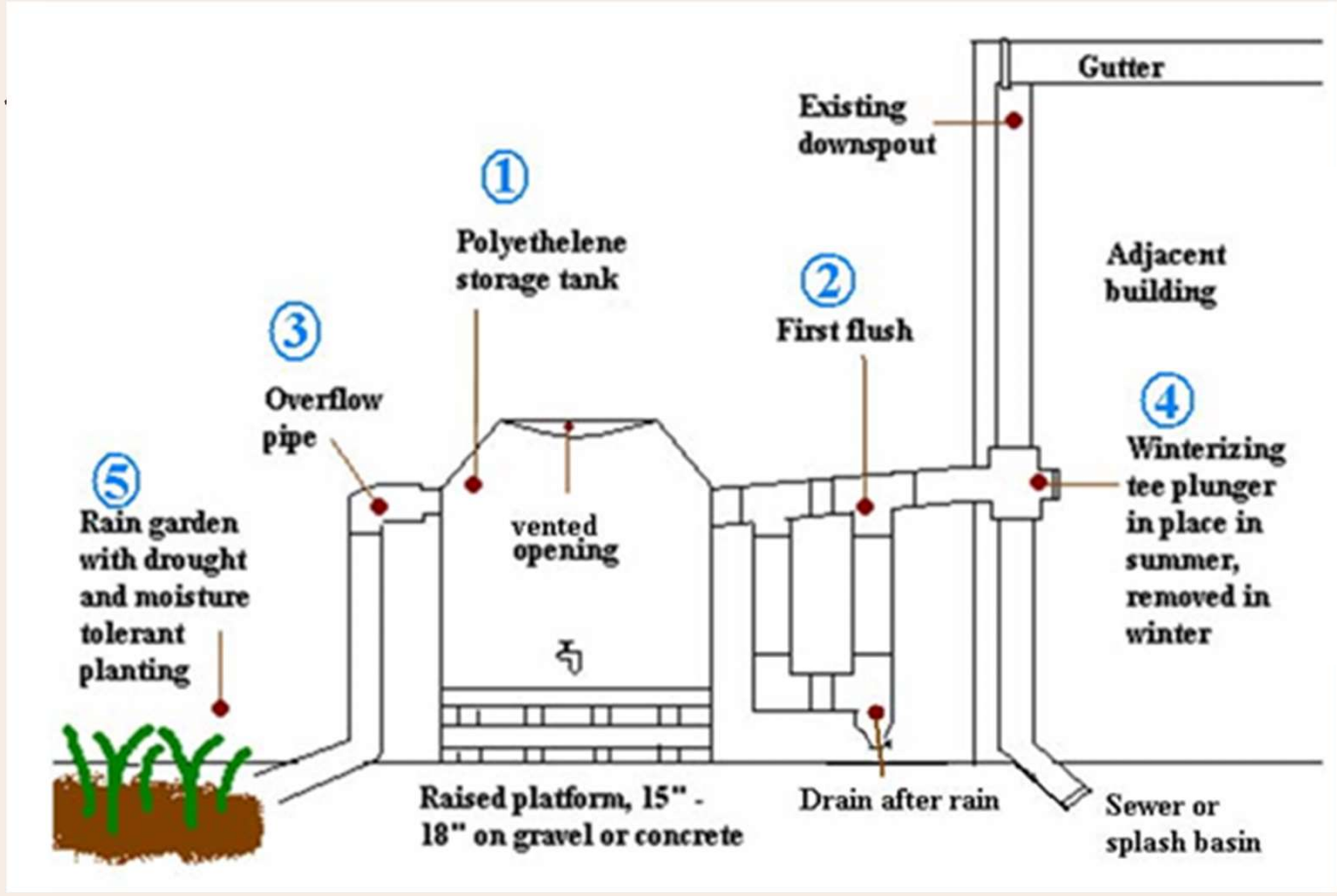


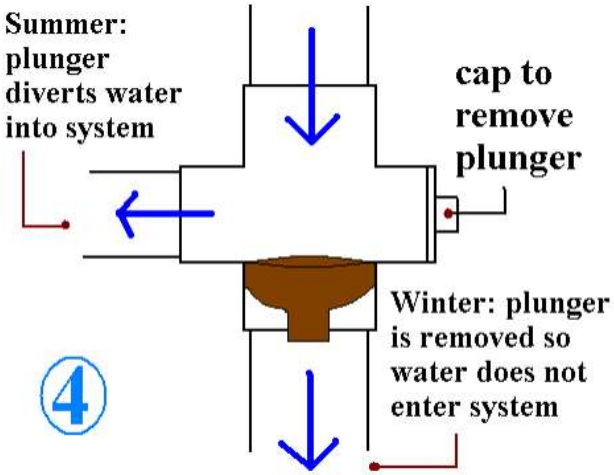
https://www.cityofpaloalto.org/Departments/Public-Works/Watershed-Protection/Stormwater-Rebates


SAVE THE RAIN.


Downspout
Screen
Overflow Valve
Barrel
Spigot
Multi-barrel Connector

Cisterns





Source: Rainwater Harvesting 101, Grow NYC

- 305 gallon food-grade tank
- Roof area ~670 sq. ft.
- Overflow from cistern goes to existing ground level concrete channel that drains to municipal storm system
- Cost: $308 plus $125 delivery = $433

Is roof runoff clean enough to irrigate edibles?

Rutgers Cooperative Extension study (2013)

- 12 rain barrels at homes with asphalt shingle roofs urban/suburban settings
- Collected and tested roof runoff over 4-month period
- Lead and zinc levels below level of concern, suitable for irrigating crops
- Poly aromomatic hydrocarbons (associated with combustion and petroleum products) not detectable

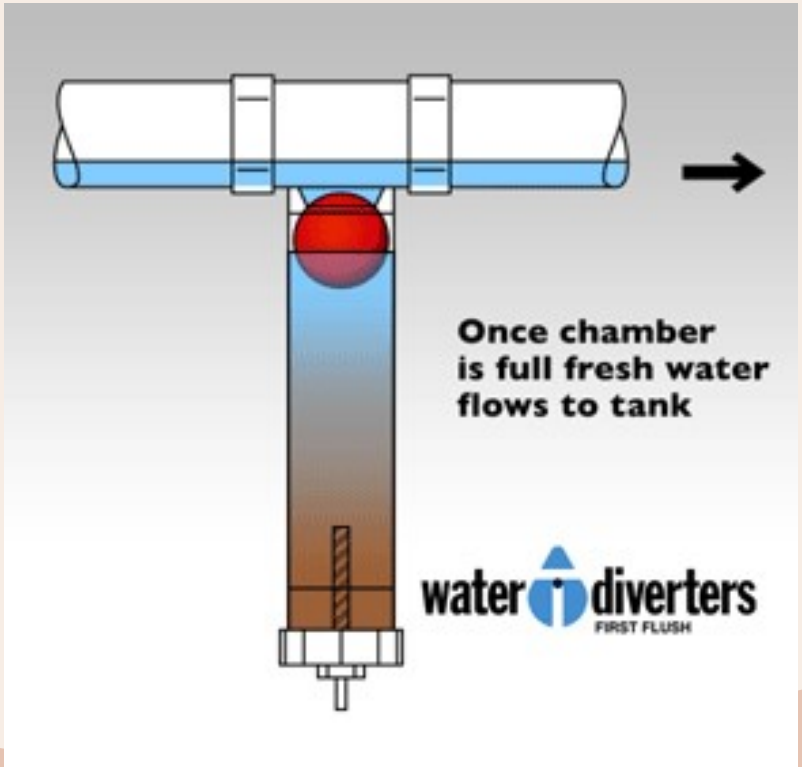
Washington State Dept. of Ecology study (2014)

- Used 18 4x8-foot panels with different roofing materials
- Collected and tested runoff from 10 events in 2013 and 10 events in 2014
- Did not have other components typical to roofs (gutters, flashing, etc.)
- Copper roofs had high levels of copper
- Treated wood shake roofs high levels of arsenic

Consider also bird/other animal waste on roof.

Best practices for rainwater harvesting

- Consider your roofing materials
- Don’t collect 1st flush
- Water the soil; not the food
- Clean rain barrel annually (1/8th cup bleach in 5 gallons of water)



https://www.youtube.com/watch?v=fUuGvpRlKwY

Diversion Recommendations for the Roof

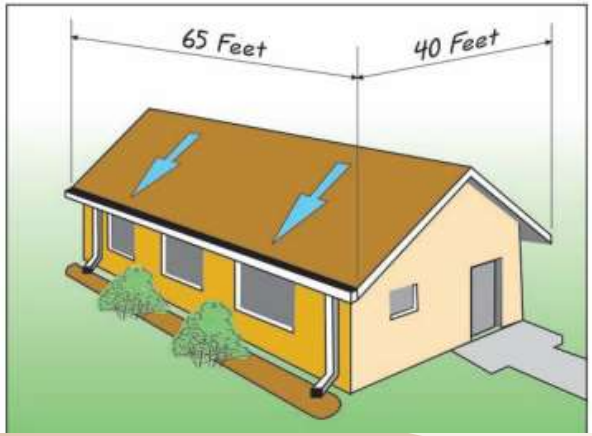
Minimal Pollution: divert 0.0125 gallons per square foot of roof area
Open field, no trees, no bird droppings, clean environment

Substantial Pollution: divert 0.05 gallons per square foot of roof area
Leaves and debris, bird droppings, various animal matter, e.g. dead insects, lizards, etc.

Example for a minimal polluted roof of 1,000 square feet:
1000 square feet X 0.0125 = 12.5 gallons to be diverted

Example for a heavily polluted roof of 1000 square feet:
1000 square feet X 0.05 = 50 gallons to be diverted

Source: Rain Harvest Systems



32.5’ x 20’ = 650 square feet

650 square feet X 0.0125 = 8 gallons

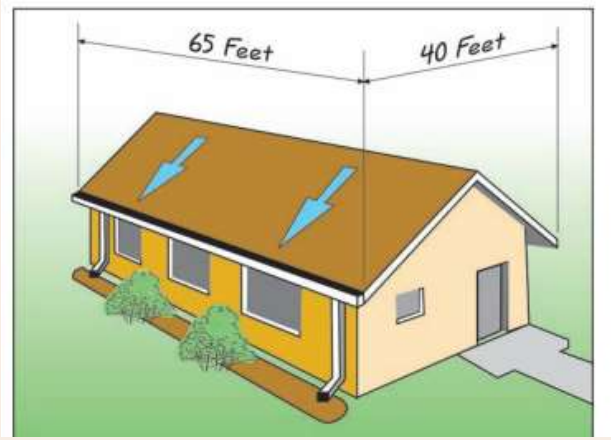
PVC Pipe Specifications
3" Downspout diverters: Use 3" Schedule 40 PVC **(not sewer and drain pipe)** Storage capacity: Each 3 foot section of 3" PVC holds approximately 1.1 gallons of water (0.3840341 gal/ft) **4" Downspout diverters: Use 4" Schedule 40 PVC** **(not sewer and drain pipe)** Storage capacity: Each 3 foot length of 4" PVC holds approximately 2 gallons of water. (0.661312 gal/ft)

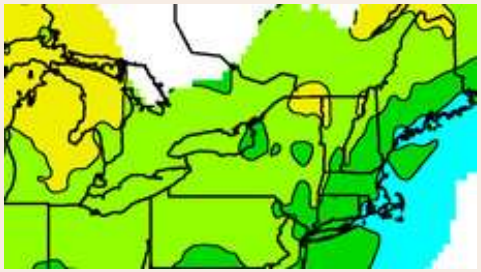
Source: Rain Harvest Systems

Need to capture 8 gallons
with 3” PVC = 8 / 0.3840341 = 20.83 feet of pipe
with 4” PVC = 8 / 0.661312 = 12 feet of pipe

What do you notice in this picture?

Calculating for water harvesting - 1





1. What is roof area?
(account for overhangs)

32.5’ x 20’ = 650 square feet

2. What is annual rainfall depth?
48 inches on average for MA

3. What is runoff coefficient for surface?

metal roof = 0.95; asphalt shingle = 0.90

Average % of rainfall that runs off a particular surface. Roof has higher runoff coefficient than lawn as more rainfall will run off a roof.

Annual runoff from roof

650 sf x 48 inches x .90 x 0.623 = **~17,494 gallons per year**

conversion factor based on cubic foot of water = 7.48 gal, which divided by 12 (inches in a foot) equals 0.623 gallons per inch of water height

Calculating for water harvesting - 2

1. Roof area? – “drainage area”
65’ x 20’ = 650 square feet

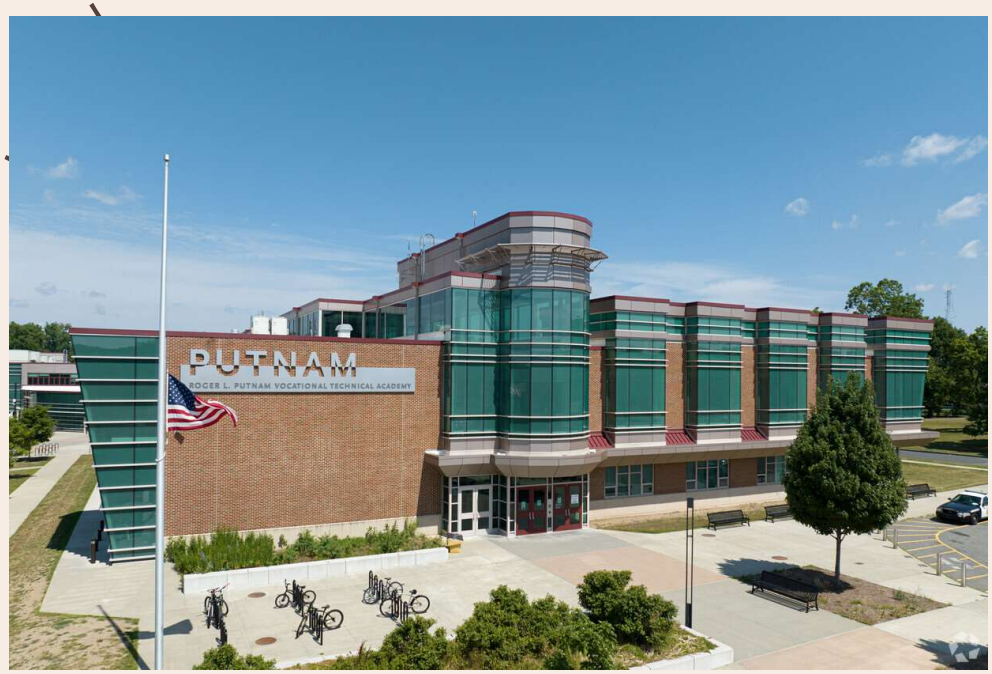
2. Storm event?
1-inch

3. Runoff coefficient for surface?
metal roof = 0.95; asphalt shingle = 0.90

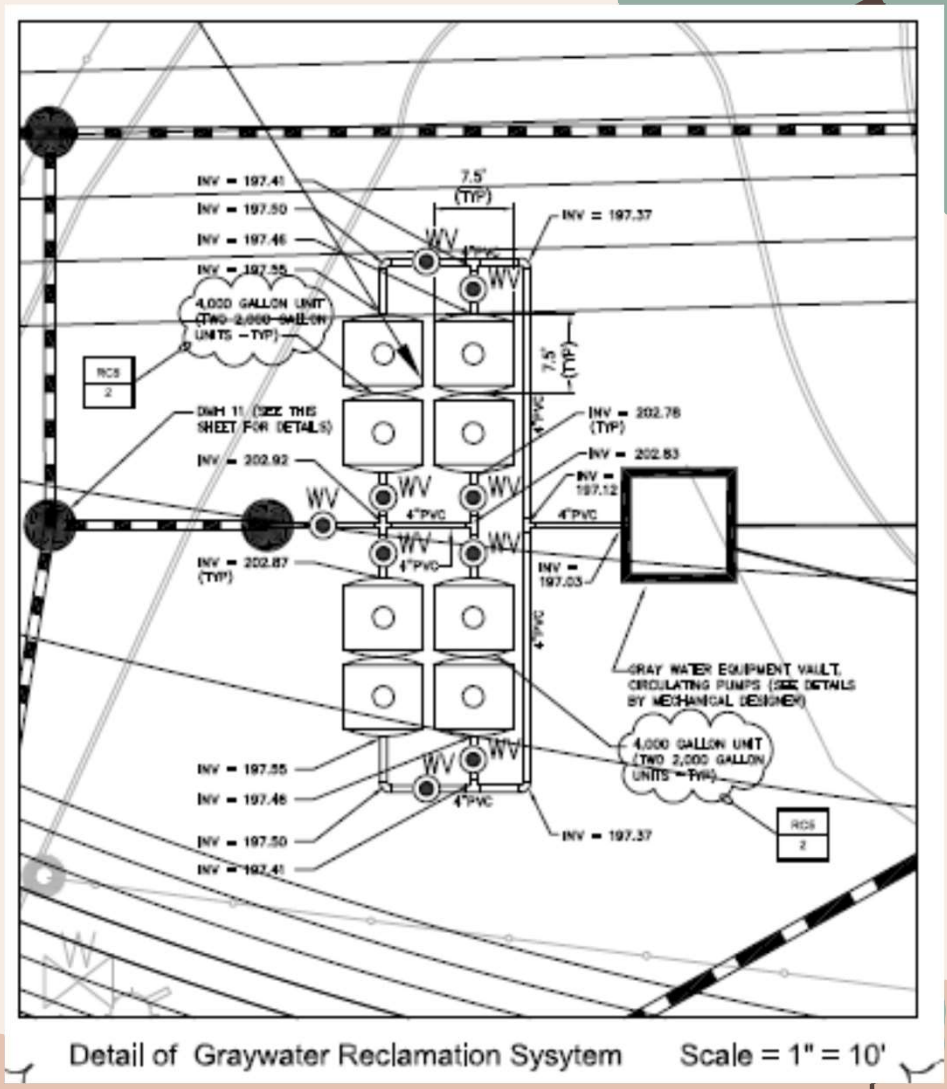
Runoff from 1-inch storm event

650 sf x 1 inch x .90 x 0.623 = **~364 gallons**

Buster Simpson's Growing Vine Street project, Seattle



- Rooftop stormwater flows are collected in underground tanks with total 16,000 gallon capacity.
- Plumbed as a gray water system for flushing all toilets and urinals.
- When tanks are full, water discharged to City stormwater system.
- System not sized for a particular storm event, but rather for the capacity needed to make recycle system work properly.



Upcoming events in this series

Sat April 27: Soak Up the Rain: Rain Gardens and Bioswales
Rachel Lindsay, Regenerative Design Group

Sat. May 4: Soak Up the Rain: Porous Paving
Rachel Loeffler, Berkshire Design Group

www.hilltownlandtrust.org/get-involved/events

05 – Questions and discussion