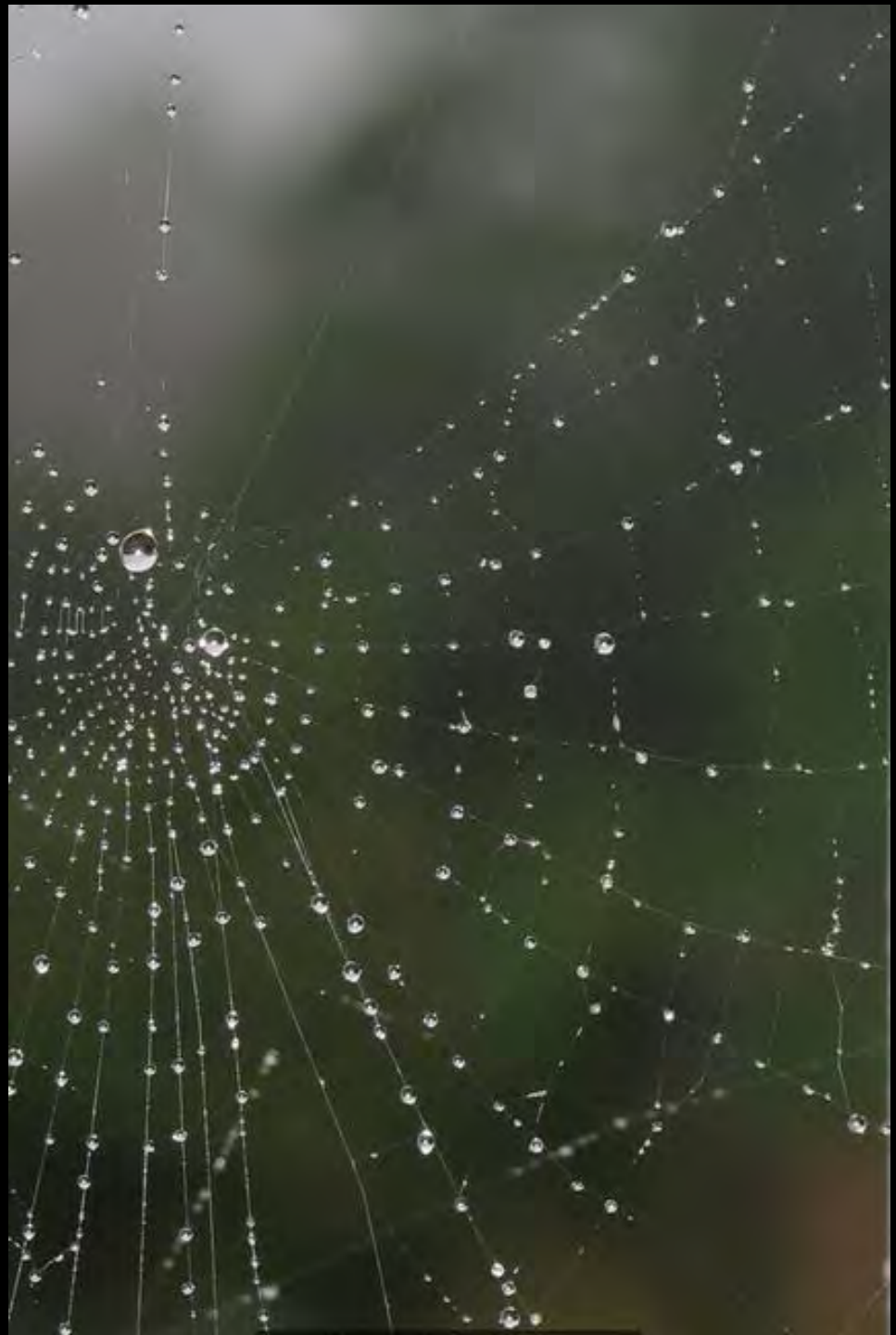
Principles, Practices, and Tips for Water-Harvesting Earthworks and Rain Gardens

by Brad Lancaster

www.HarvestingRainwater.com

www.DesertHarvesters.org



Abundance

Scarcity

sponge

drain

garden garden

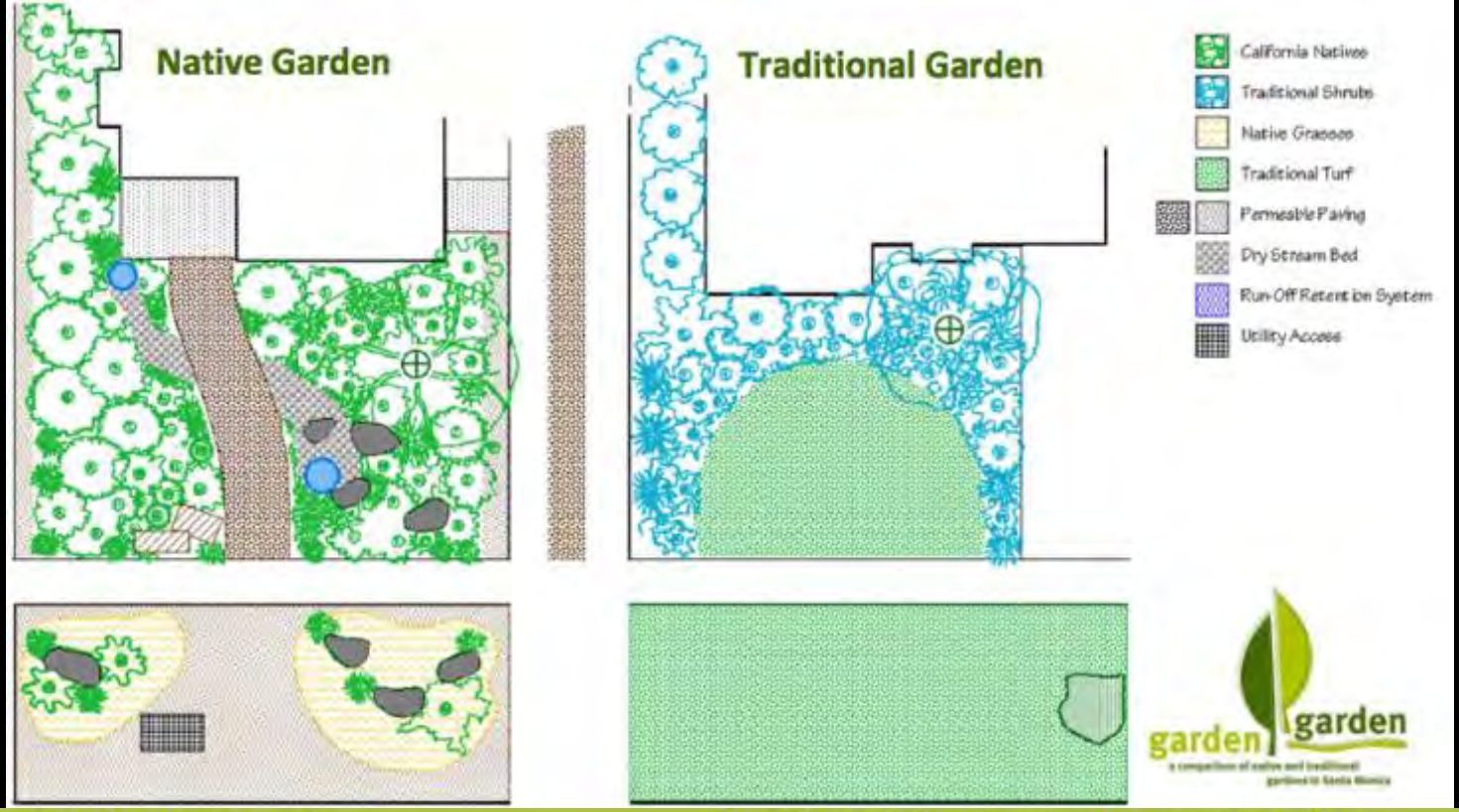
a comparison of native and traditional gardens in Santa Monica

http://www.smgov.net/departments/ose/categories/content.aspx?id=4082

Native (Sustainable) Garden
1724 Pearl St., Santa Monica, CA

Traditional Garden
1718 Pearl St., Santa Monica, CA

Native Garden uses **83% less water**; generates **56% less green waste** and requires **68% less maintenance** than the *Traditional Garden*.



Native Garden Landscape Practices

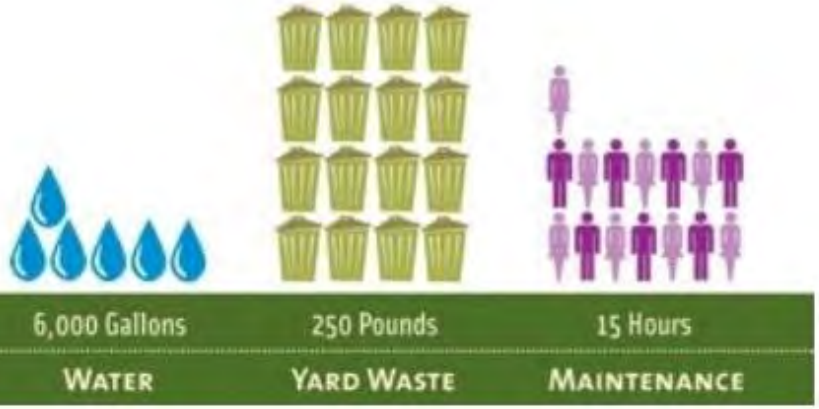
- *No chemical herbicides or insecticides (per Santa Monica City policy)*
- *Native California plant palette with colorful blooms throughout the year designed to replicate the chaparral of the Santa Monica mountain*
- *Weather-based irrigation controller w/ low-volume drip irrigation*
- *Dry creek bed and infiltration pit for infiltrating rainwate into the ground*
- *Wildlife habitat for local and migratory fauna*

Traditional Garden Landscape Practices

- *No chemical herbicides or insecticides (per Santa Monica City policy) but occasional use of blood meal*
- *Commonly used exotic plants from Northern Europe and the Eastern United States*
- *95% of landscaped area is lawn*
- *Standard inefficient sprinkler irrigation system in the lawn and parkway; sub-surface drip used to limit irrigation runoff from the lawn edges bordering the street and sidewalks*
- *Standard automatic sprinkler timer*
- *Weekly maintenance schedule*

The Numbers Speak for Themselves

Sustainable Landscape



6,000 Gallons	250 Pounds	15 Hours
WATER	YARD WASTE	MAINTENANCE

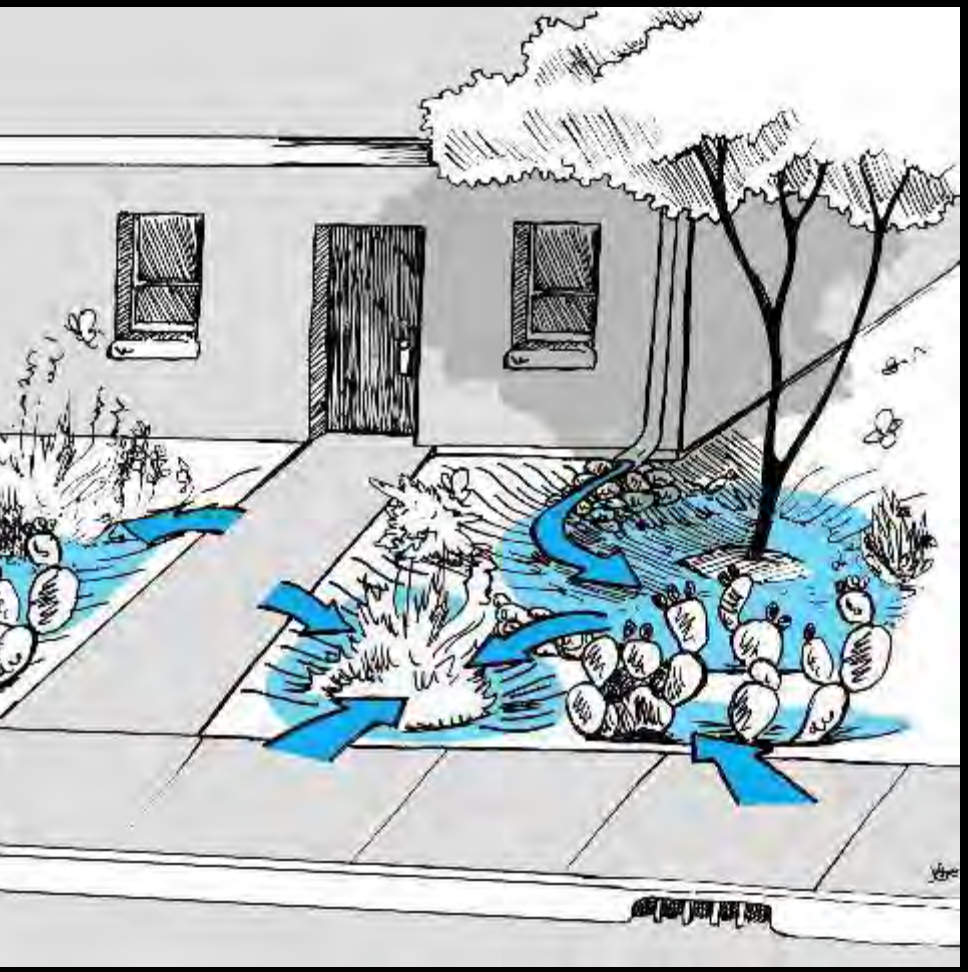
Traditional Landscape

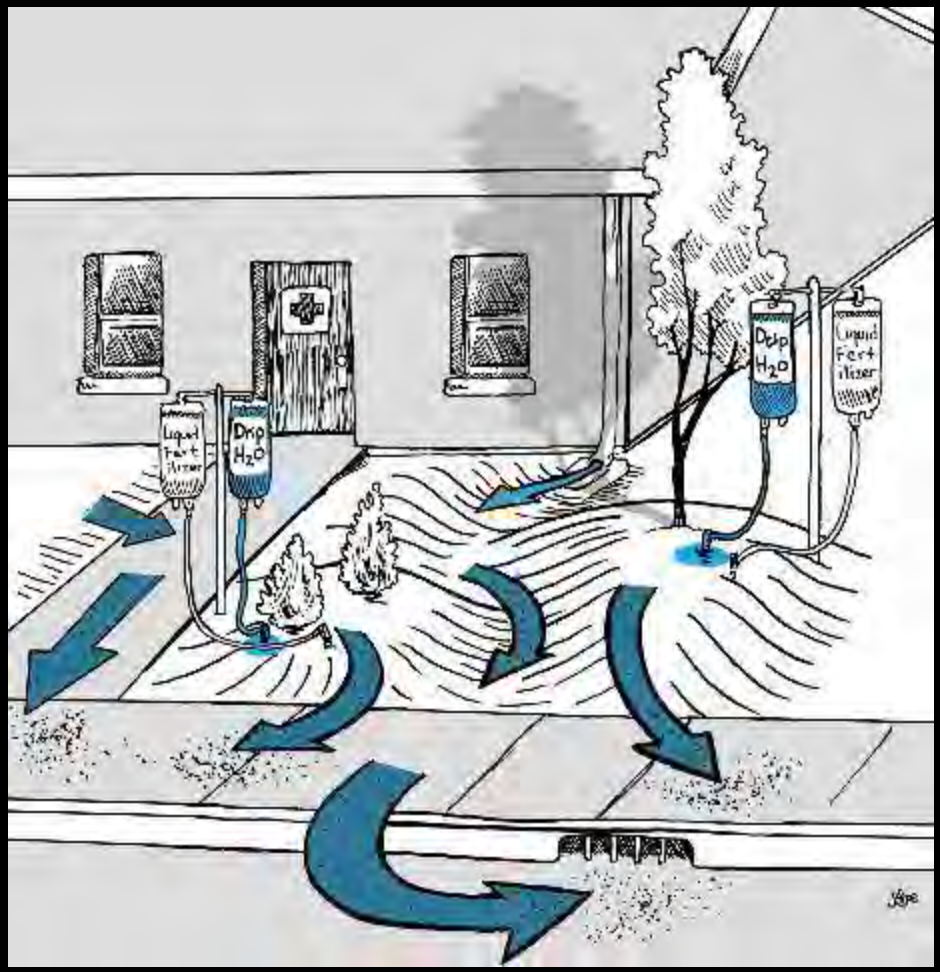
57,000 Gallons	670 Pounds	80 Hours
WATER	YARD WASTE	MAINTENANCE

Consumption for one year based on 2005–2006 data.

Abundance

Scarcity

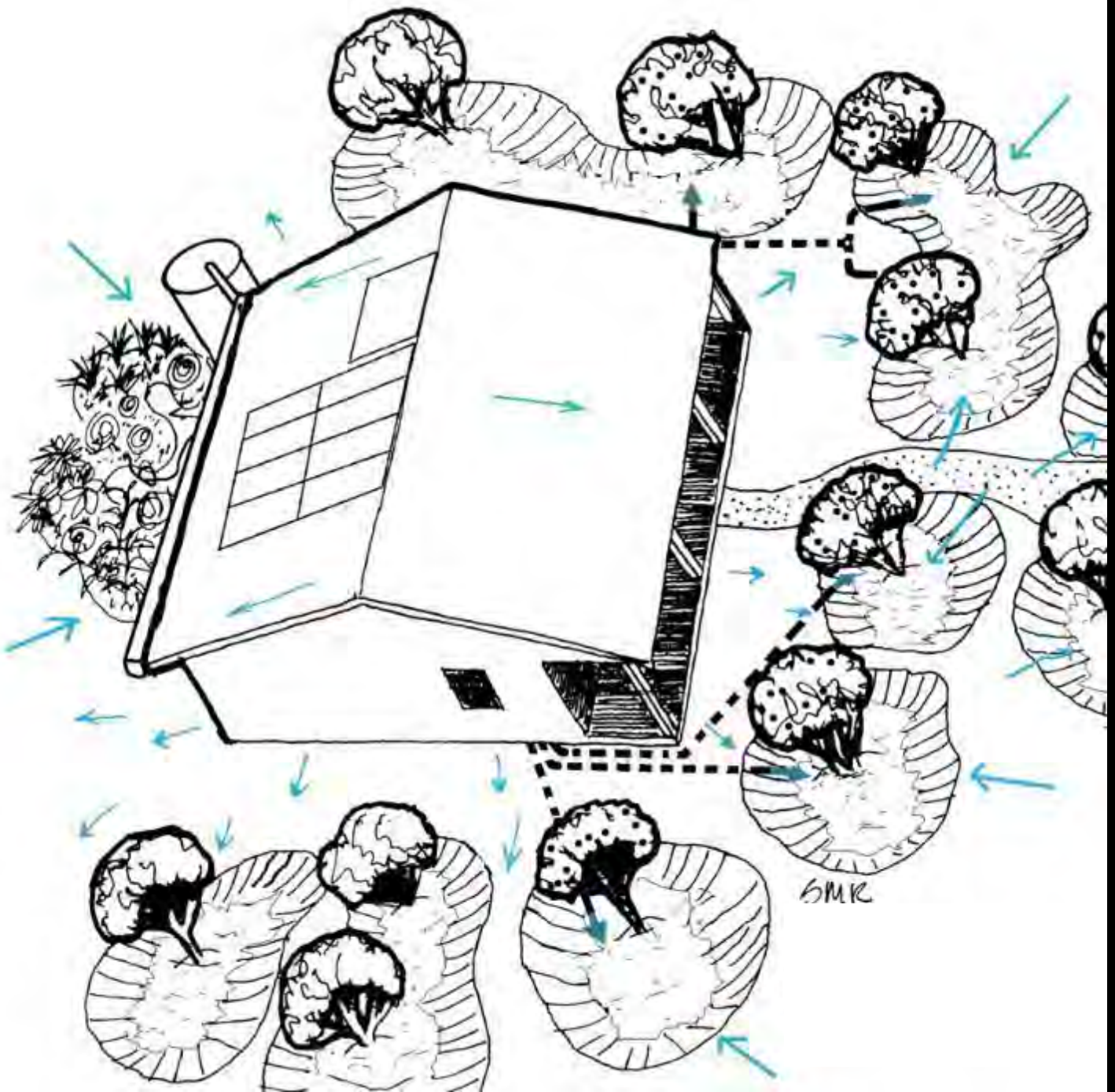




sponge

drain

Plant
the
Rain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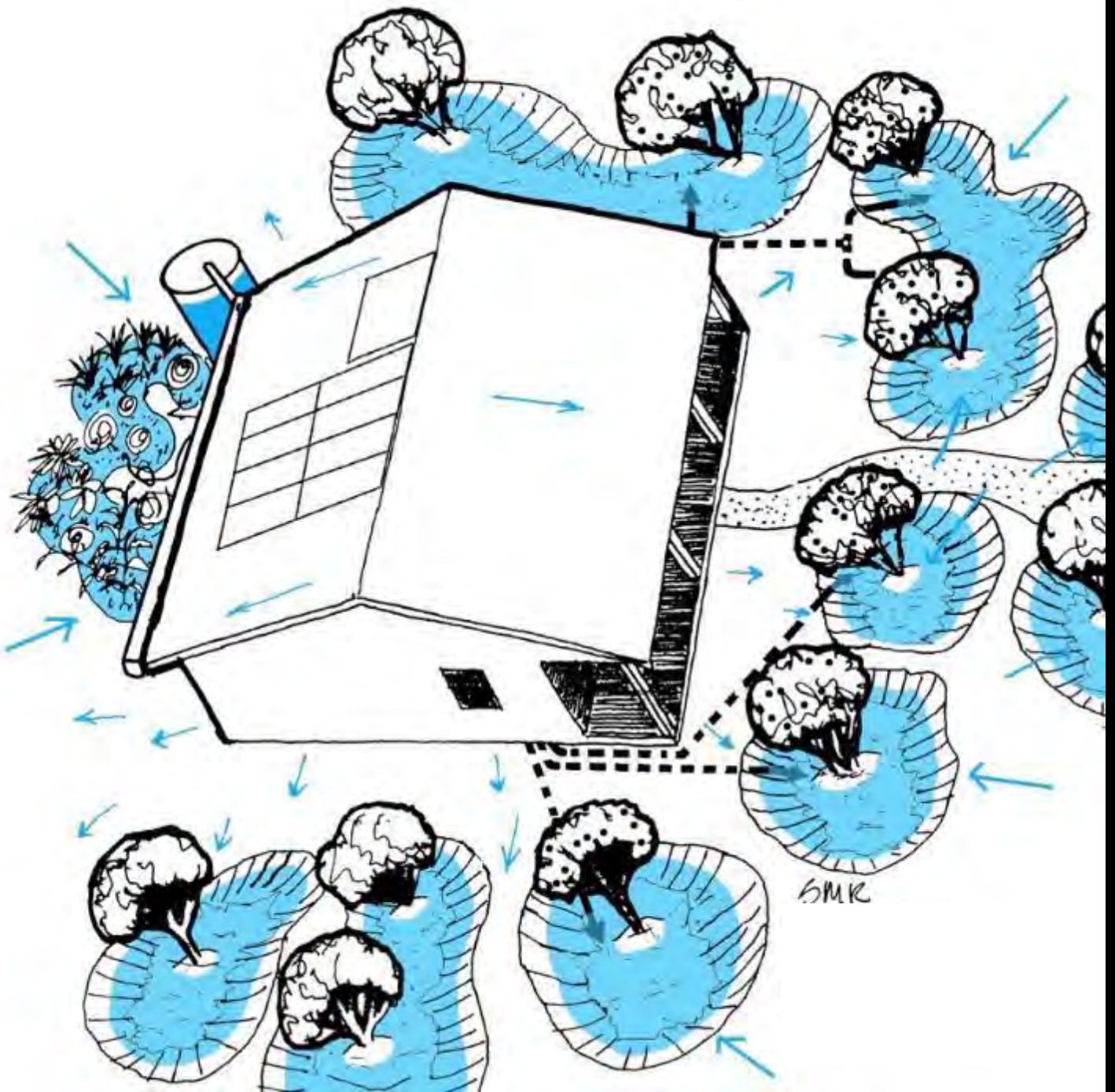
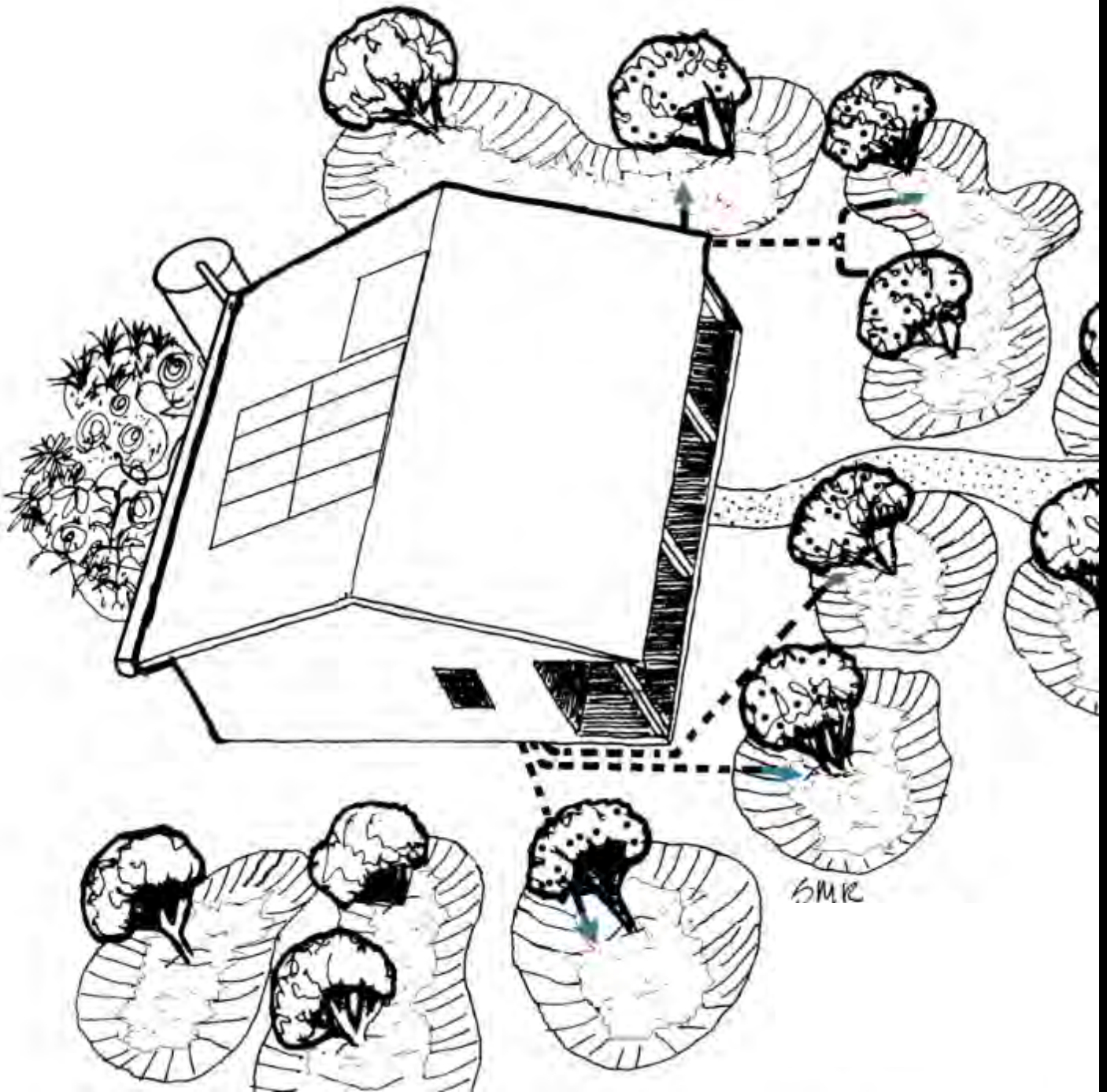

SMK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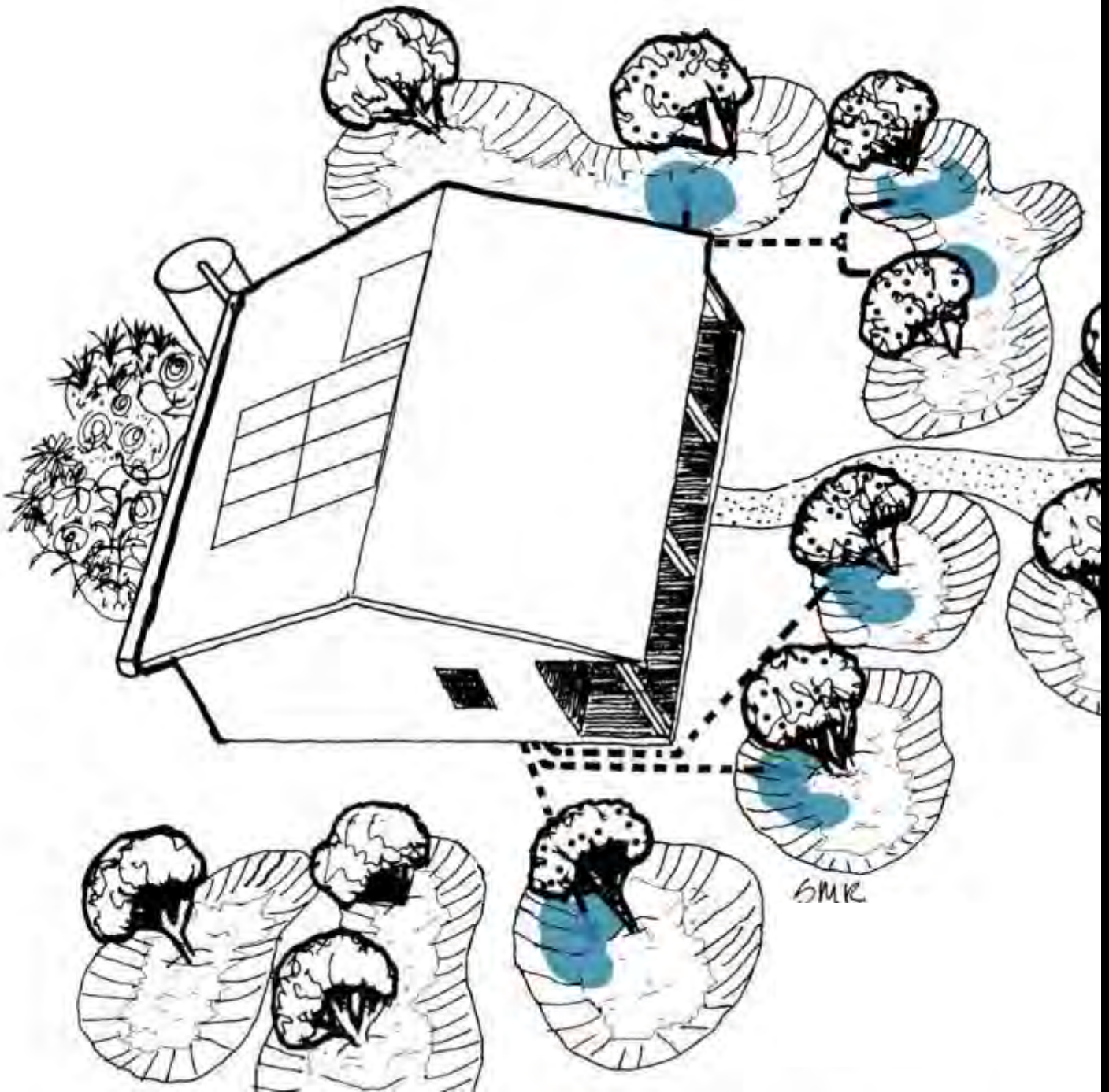
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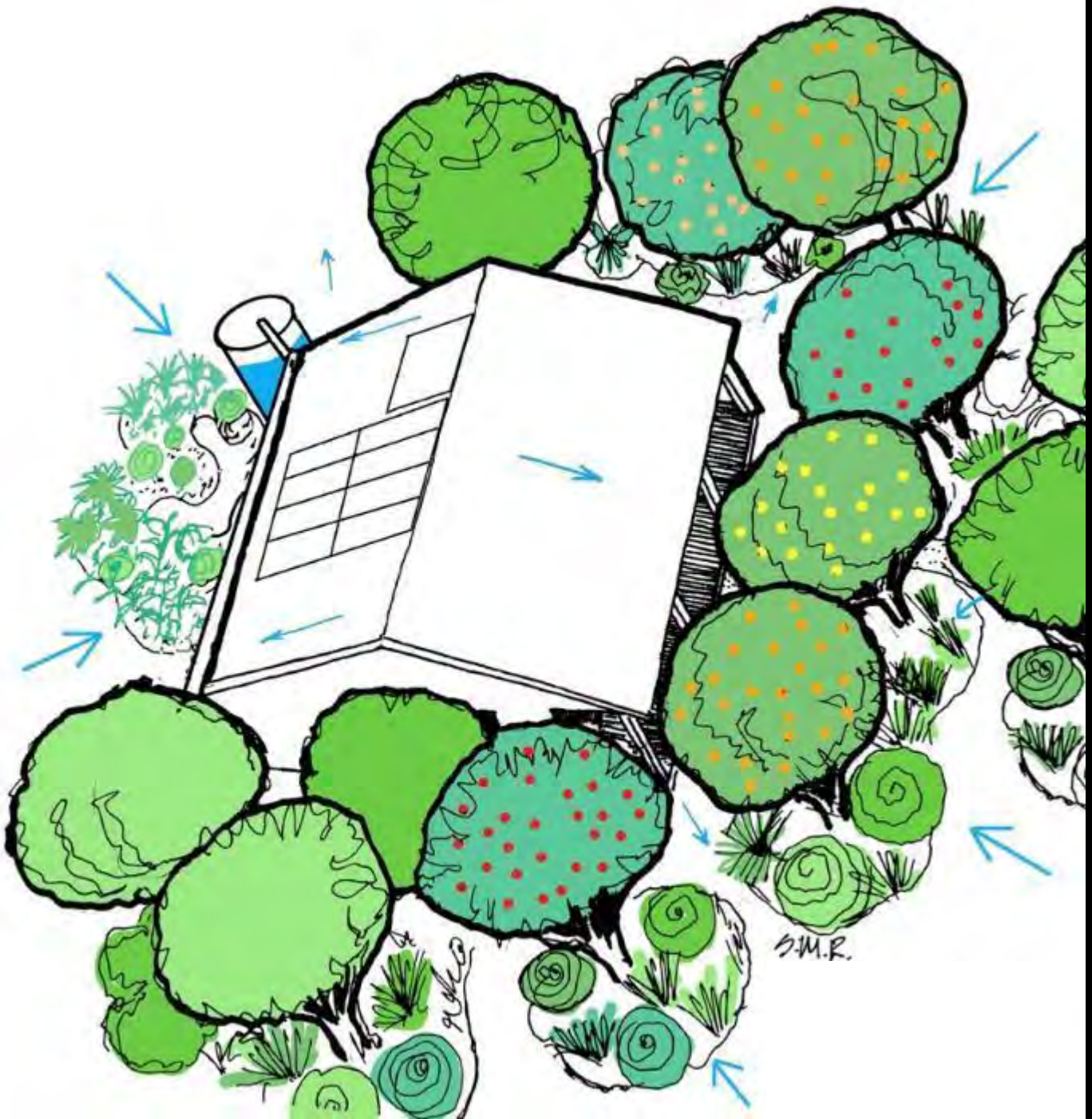
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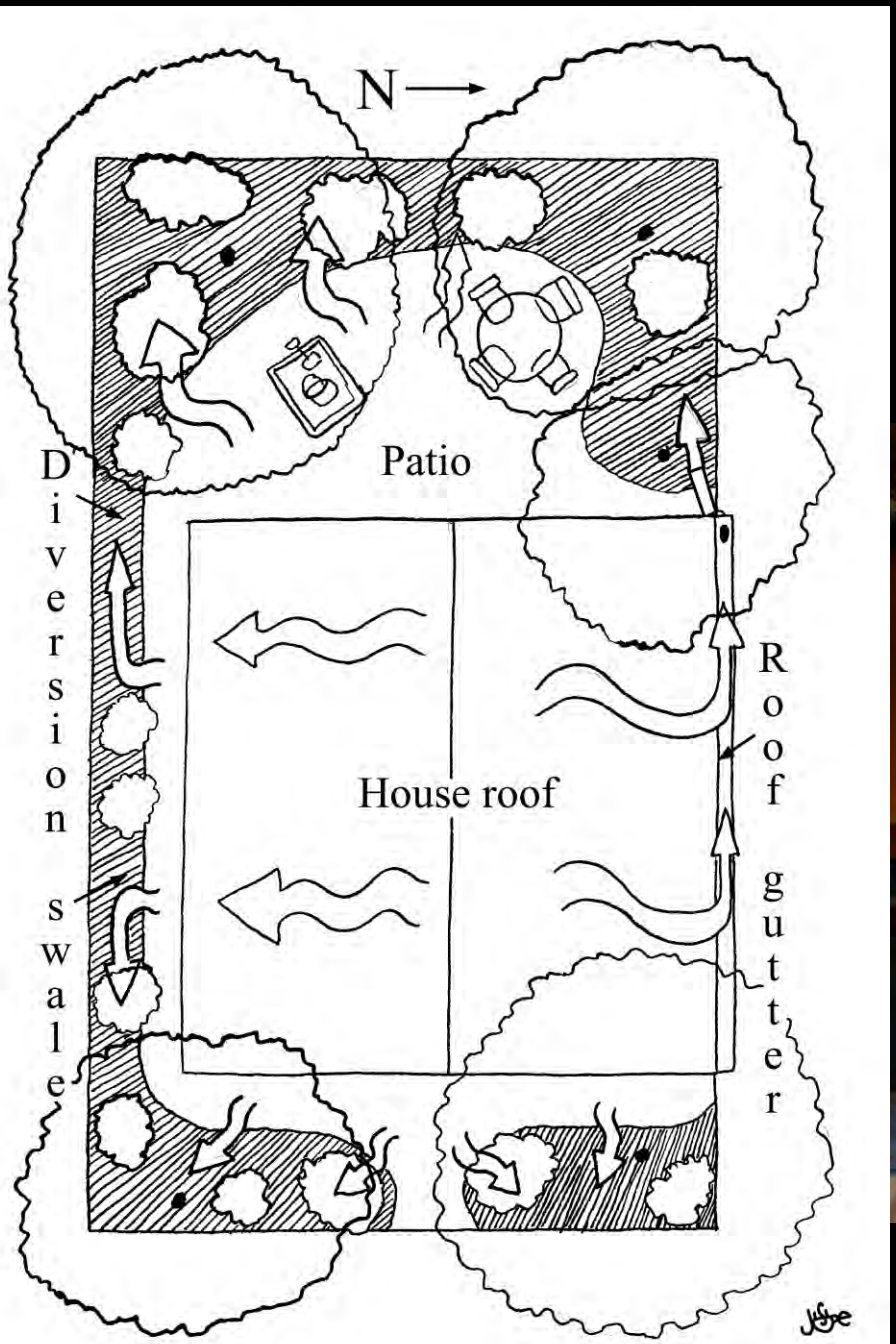
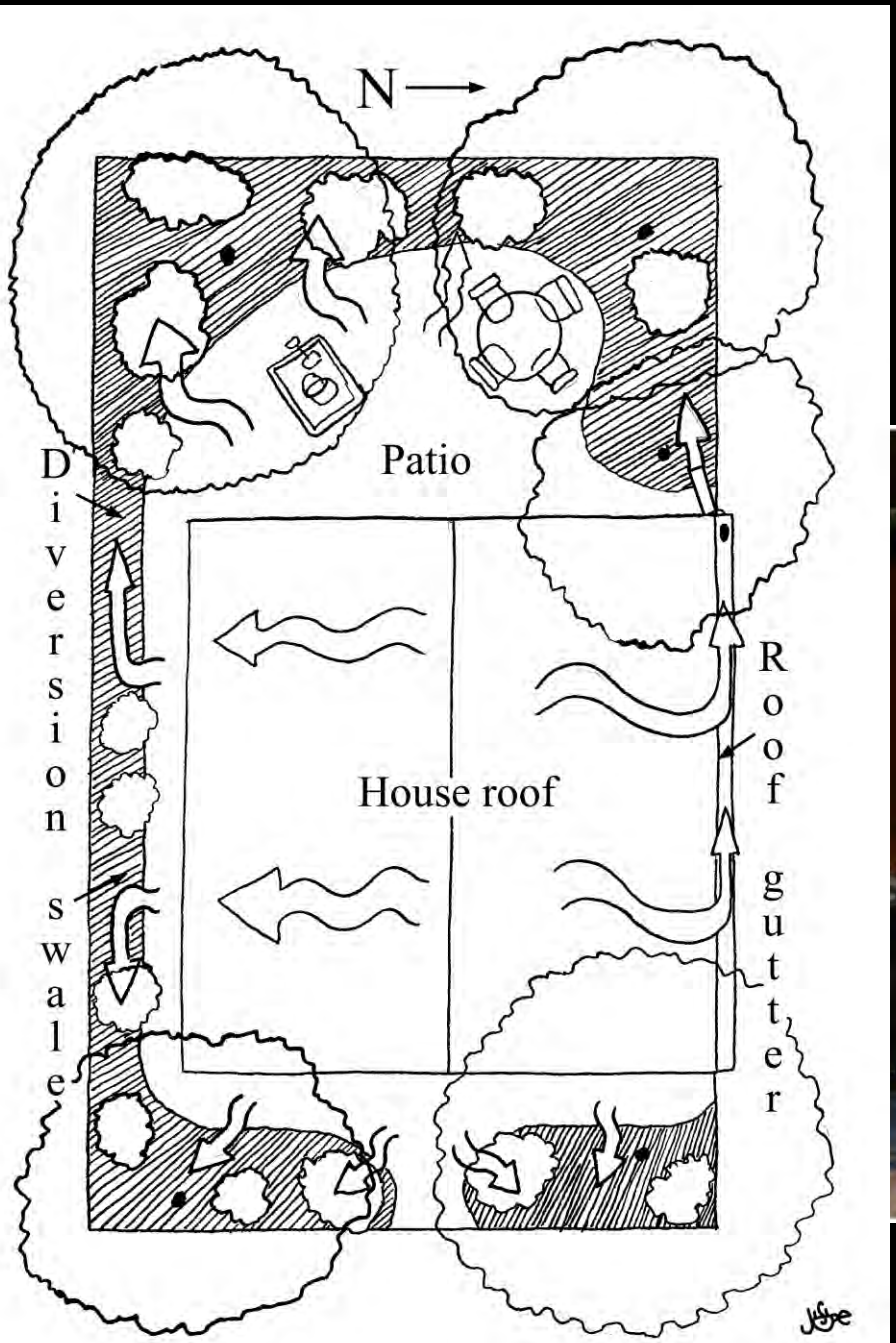

N
Patio
Diversion swale
House roof
Roof gutter


N
Patio
Diversion swale
House roof
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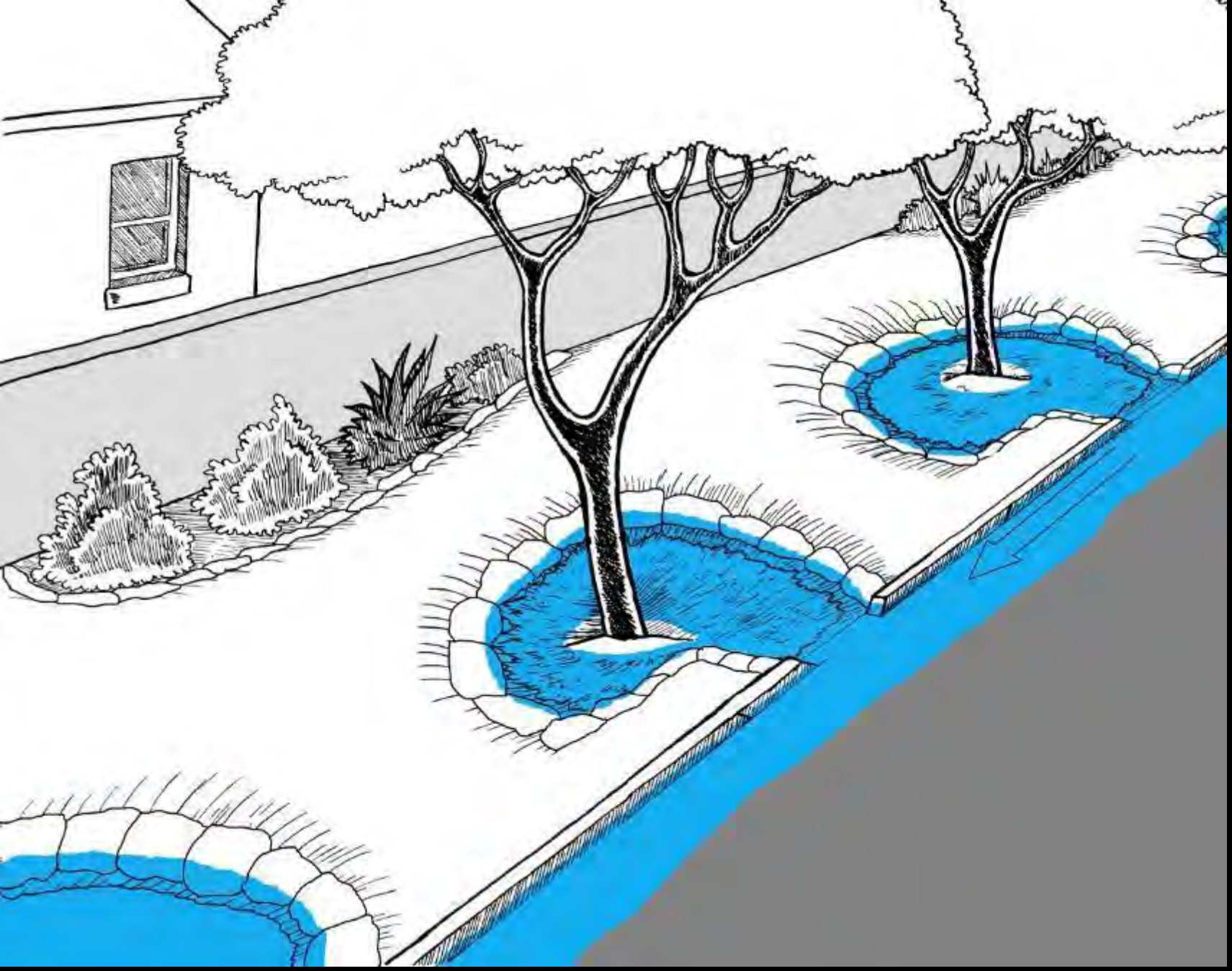
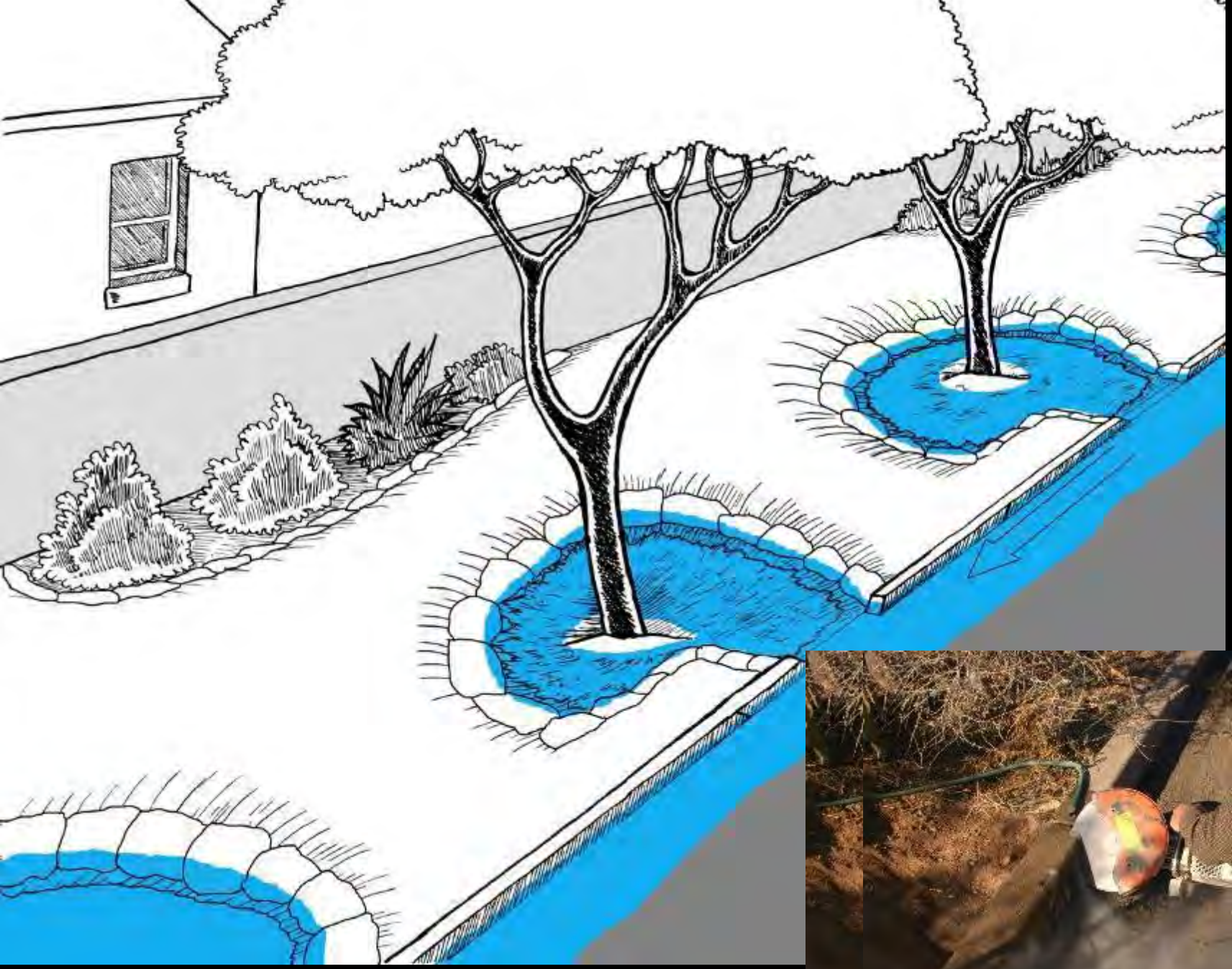
www.HarvestingRainwater.com

Before planting rain and life

After planting rain and life



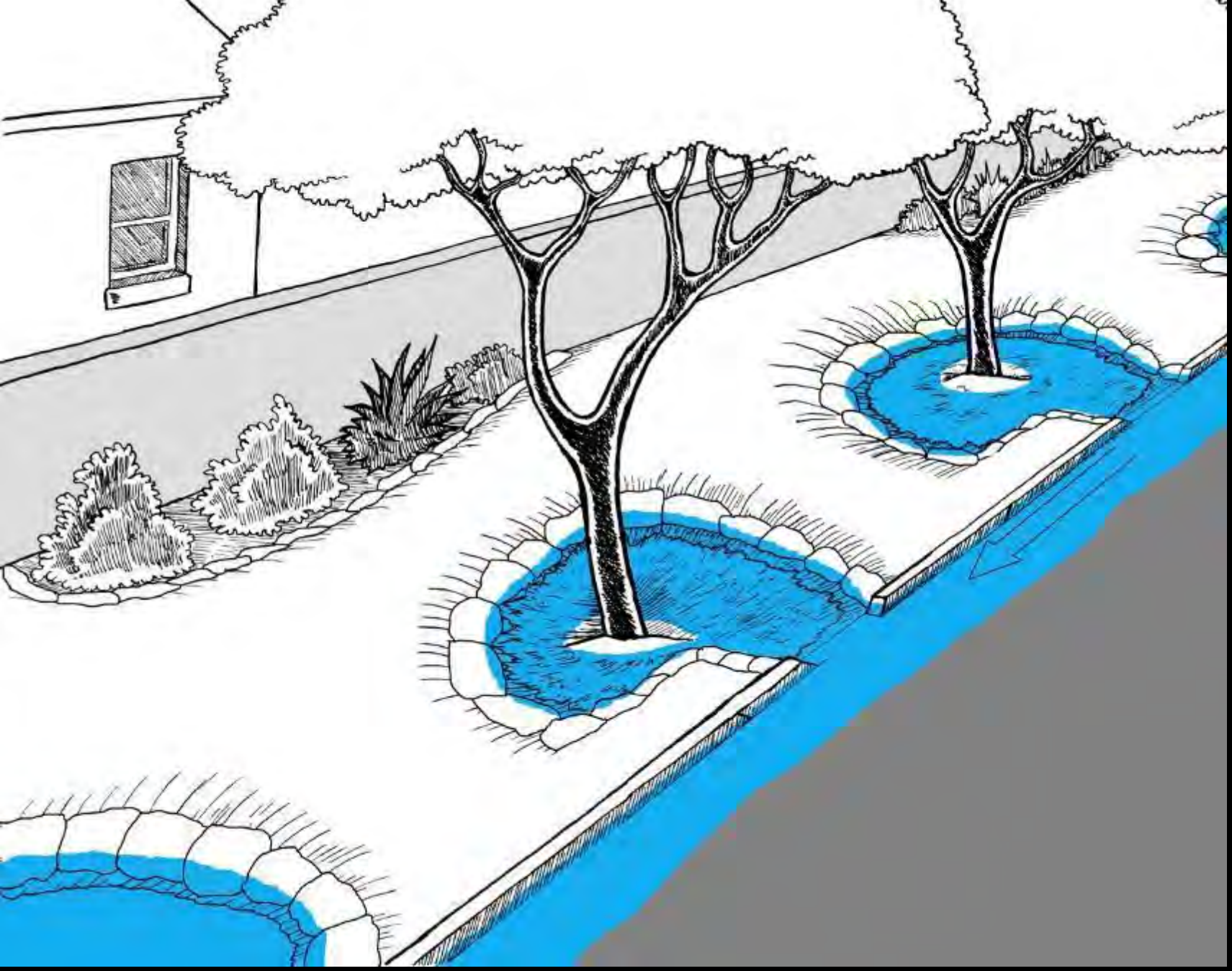
Street runoff irrigating street trees



Street runoff irrigating street trees

See *Harvesting Rain From a 1,000+-Year Storm Event* blog entry at HarvestingRainwater.com

BEWARE!
OF THE DOG!

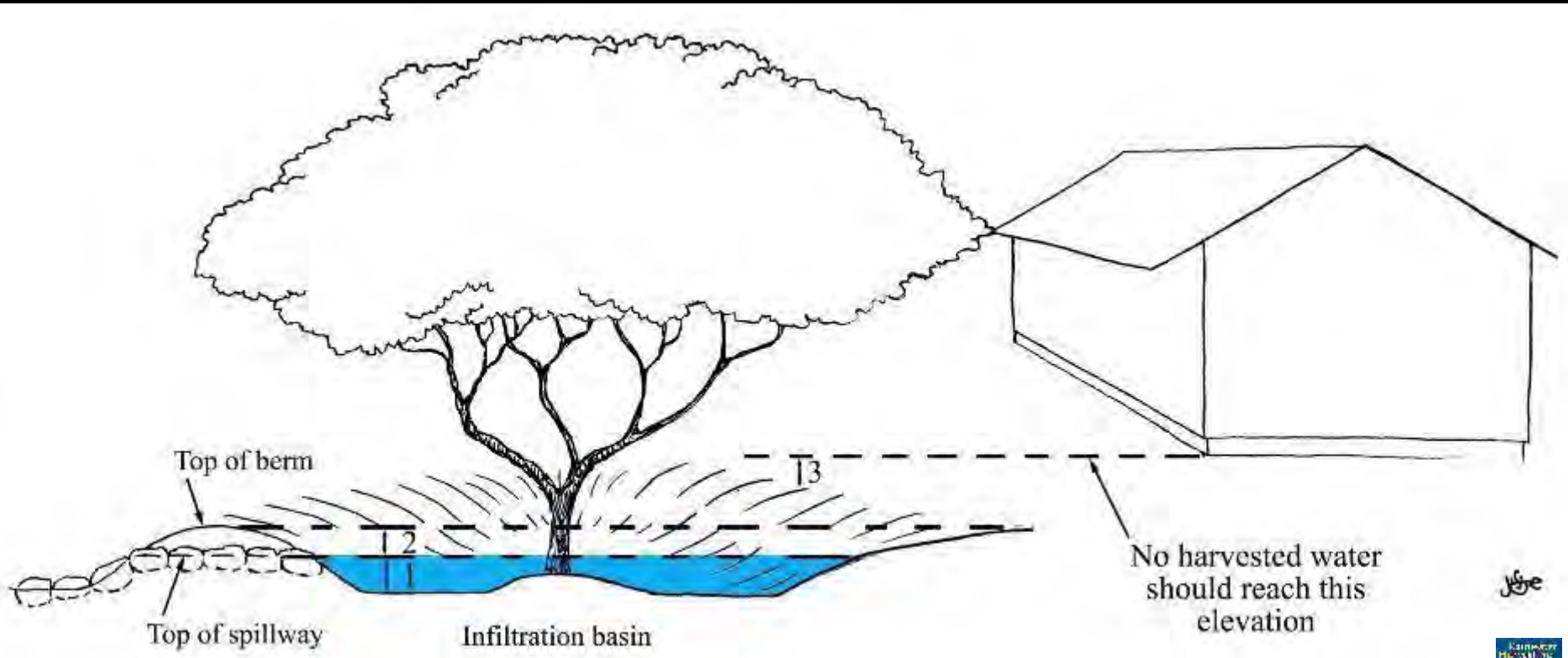


Street runoff irrigating street trees

Always have an overflow and use it as a resource

Key elevation relationships of earthworks

1. Bottom of earthwork to top of overflow spillway
2. Top of overflow spillway to top of earthwork
3. Top of earthwork to precious things



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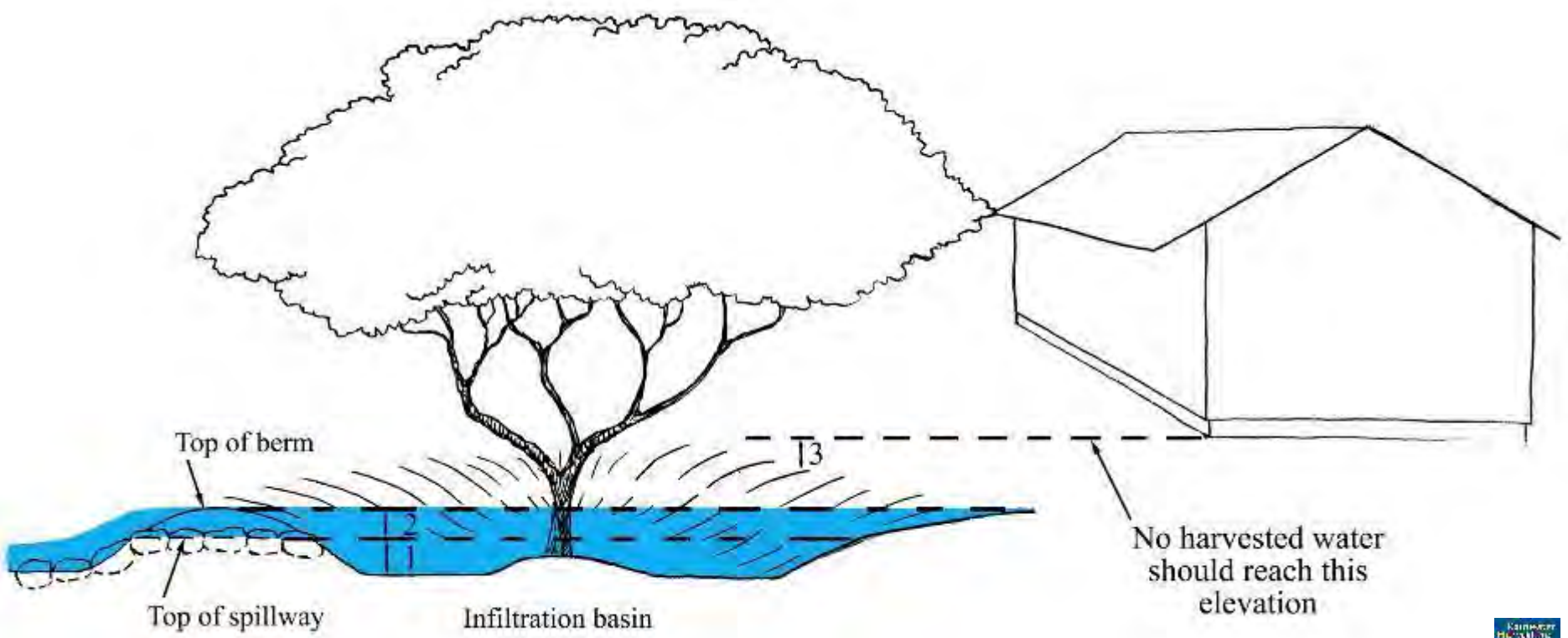

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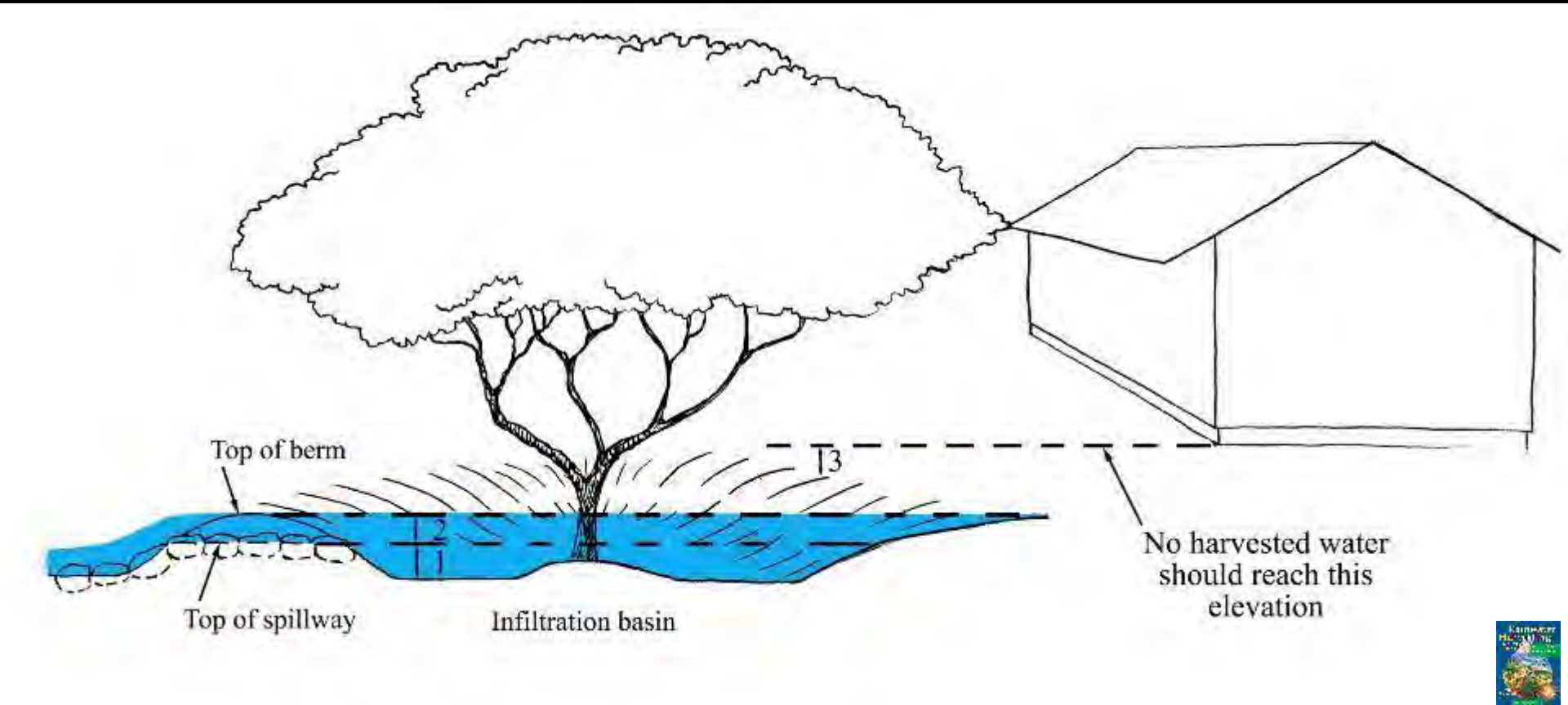

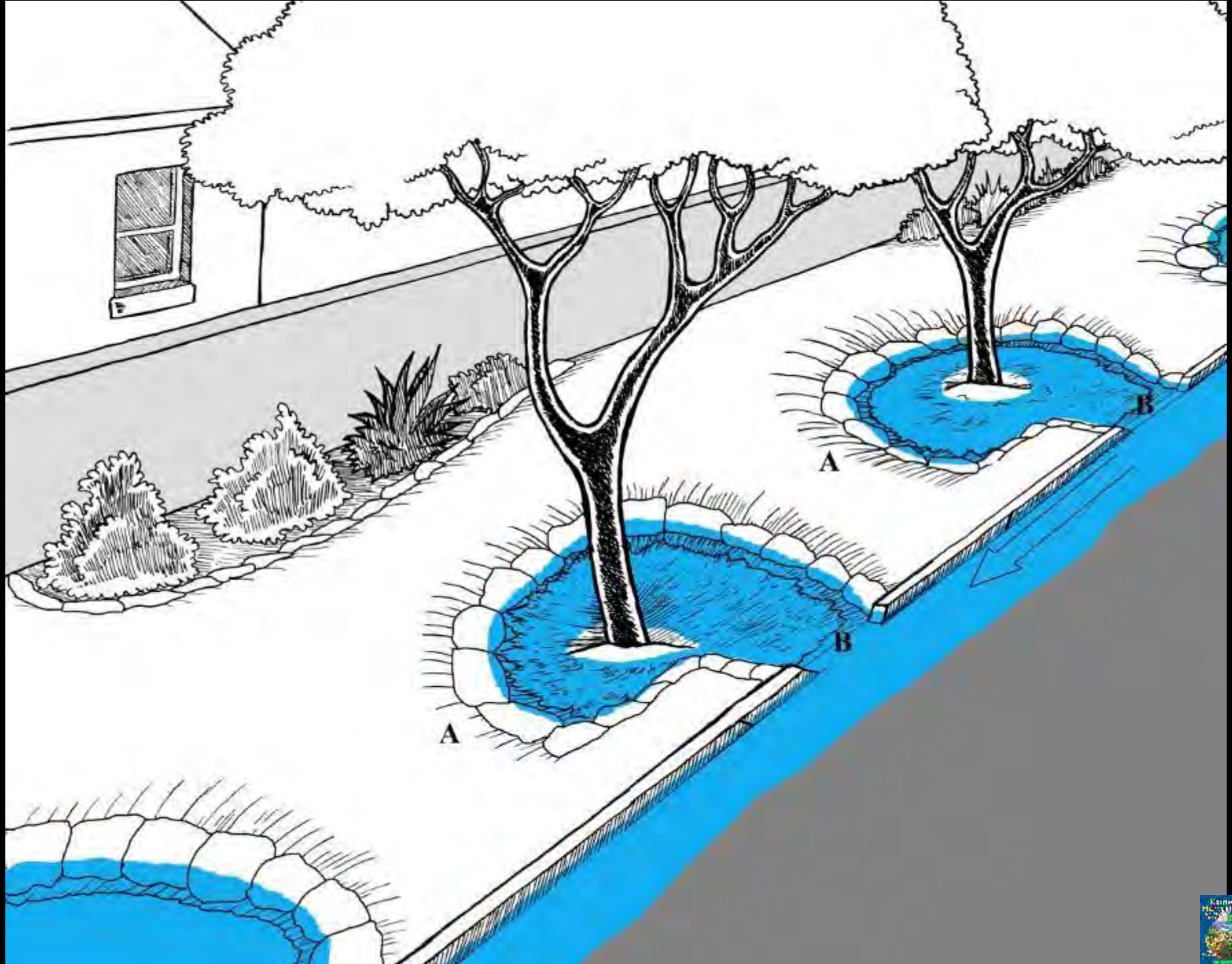
A
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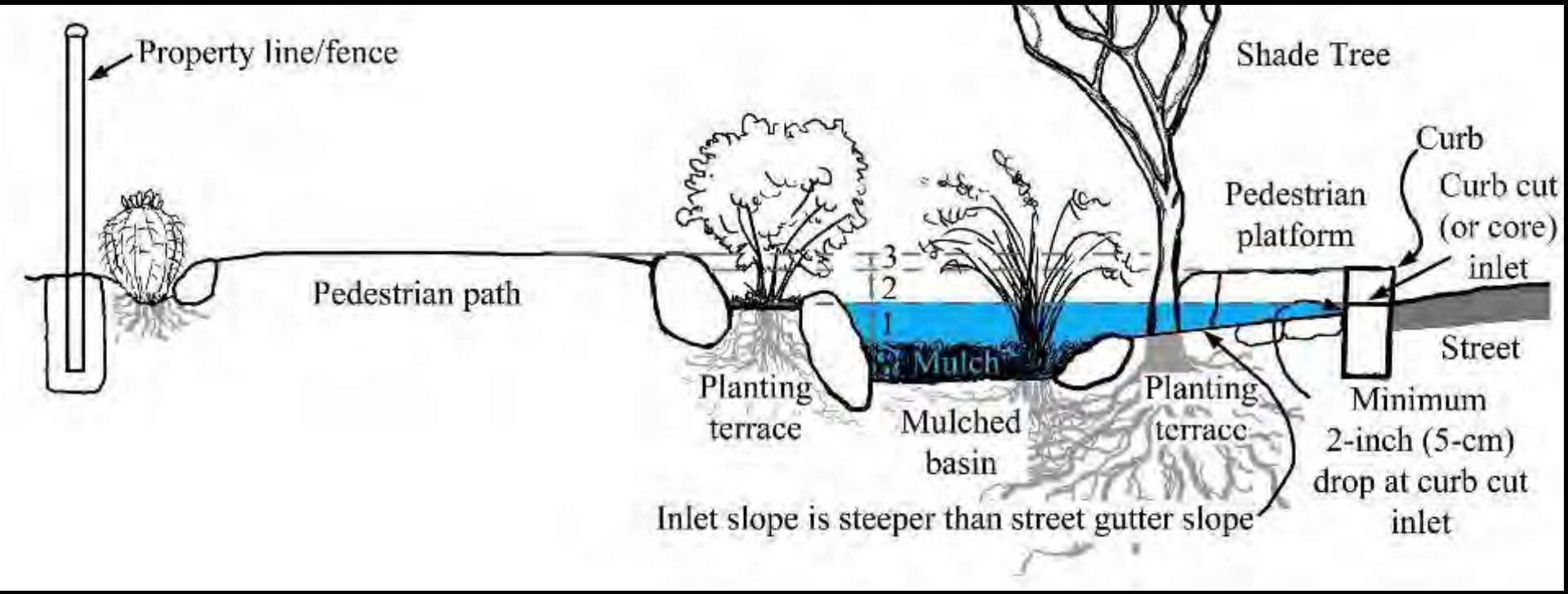
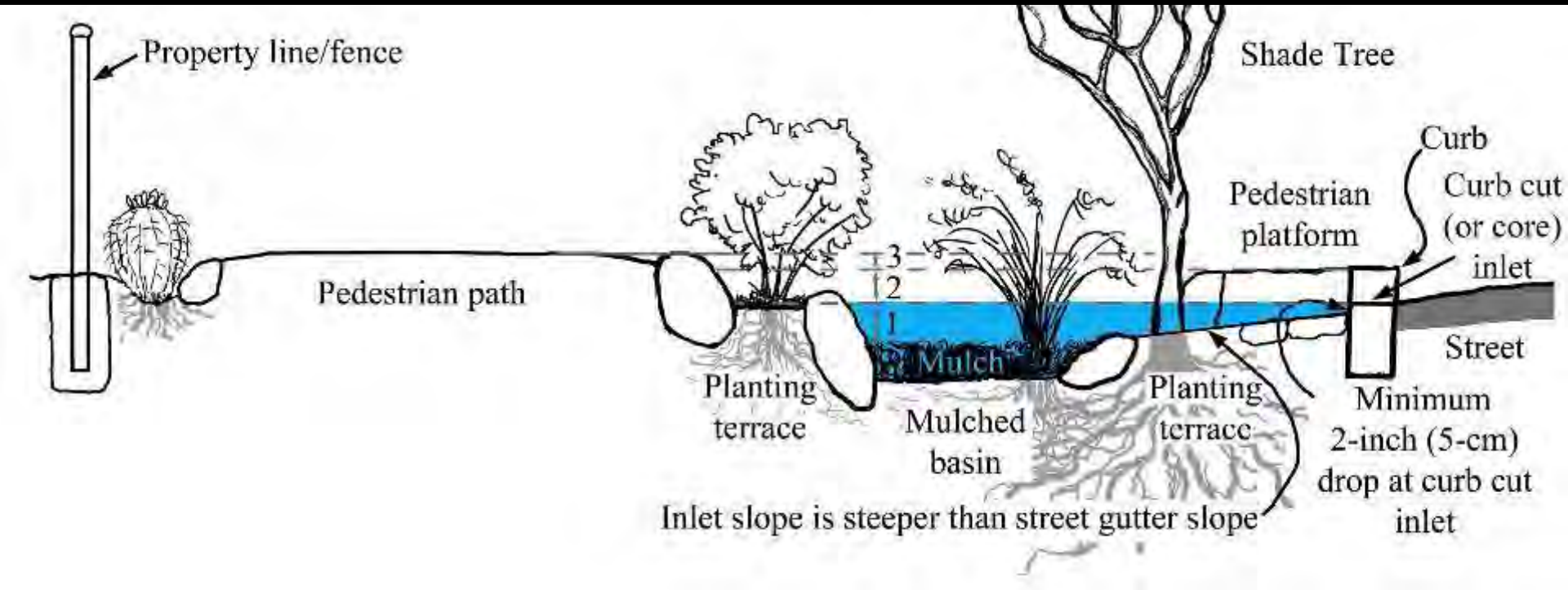
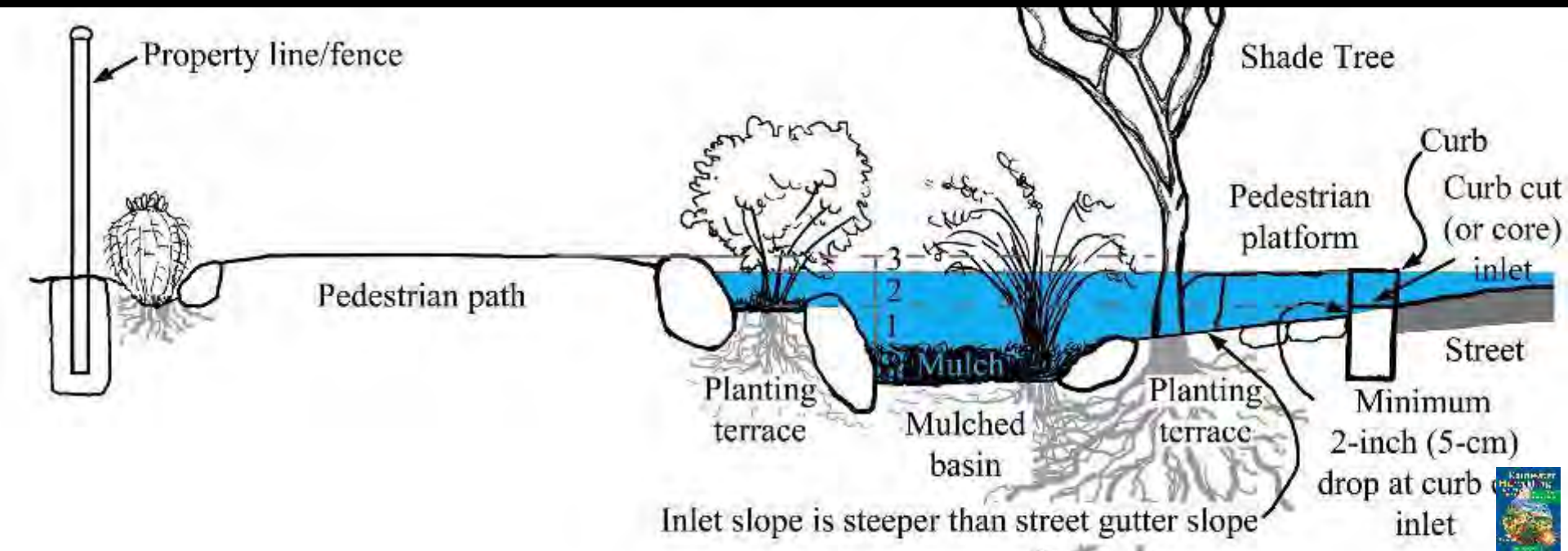


Key elevation relationships in a street-side basin


Property line/fence
Shade Tree
Curb
Curb cut
(or core)
inlet
Pedestrian
platform
Pedestrian path
3
2
1
Mulch
Street
Planting
terrace
Mulched
basin
Planting
terrace
Minimum
2-inch (5-cm)
drop at curb cut
inlet
Inlet slope is steeper than street gutter slope


Property line/fence
Shade Tree
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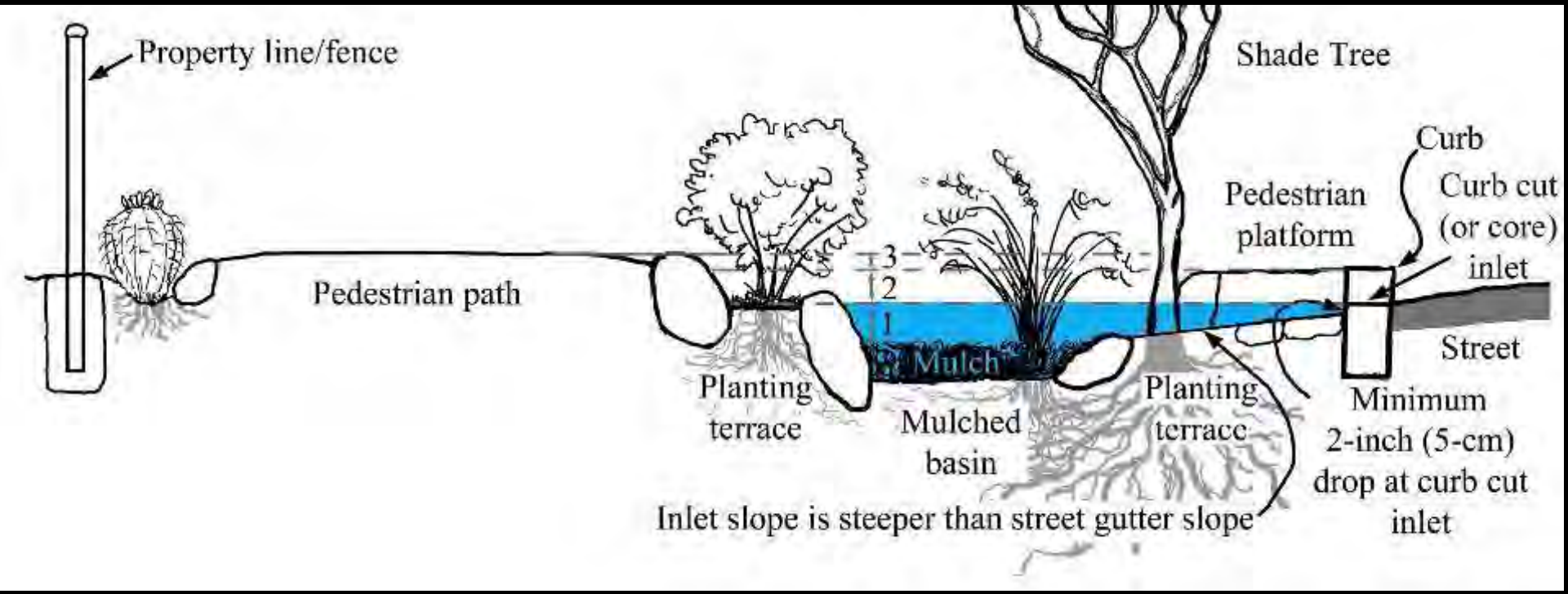
Mulch
Street
Planting
terrace
Mulched
basin
Planting
terrace
Minimum
2-inch (5-cm)
drop at curb
inlet
Inlet slope is steeper than street gutter slope

Curb core hole
4-inch (100-mm) diameter

Speed

/ \

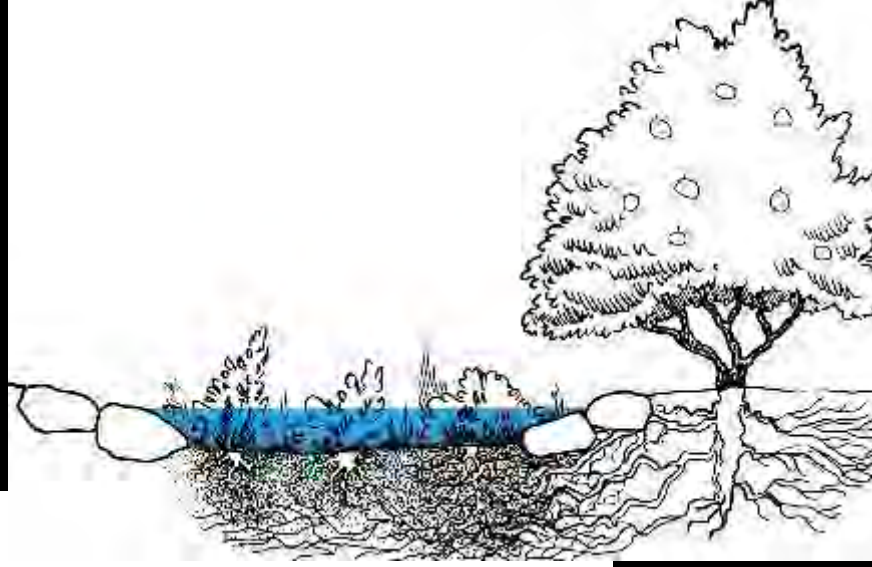
Depth — Volume

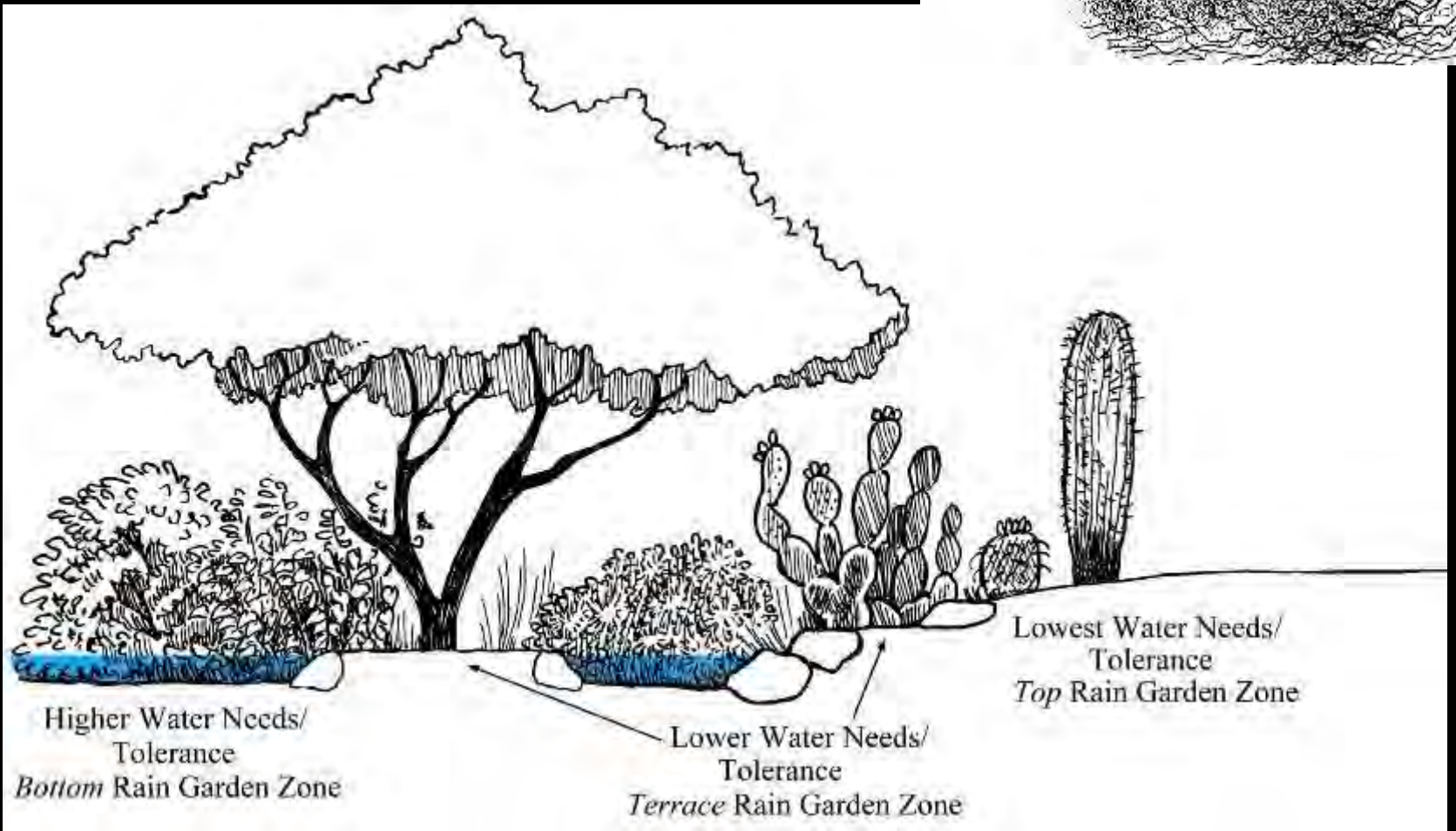


Slope relationships in a street-side basin

Rain Garden Zones

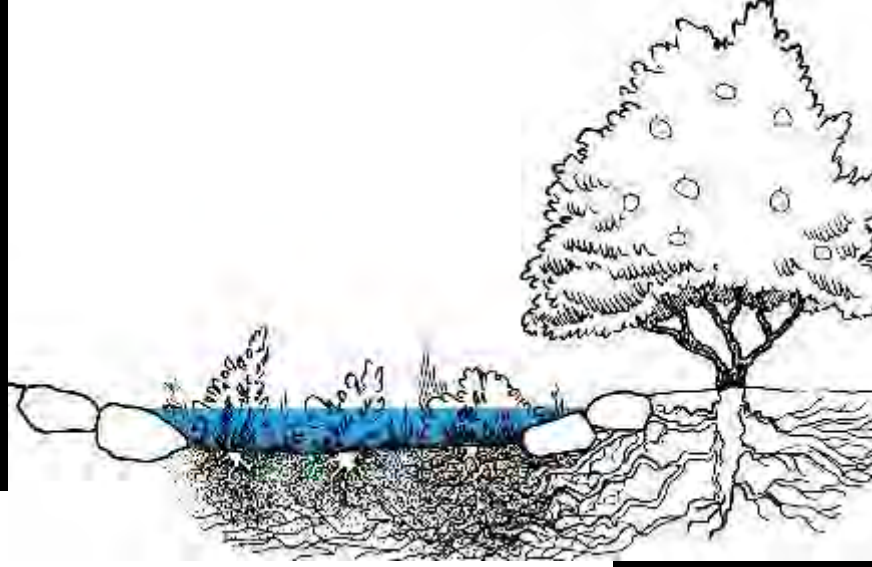
Bottom, Terrace, & Top

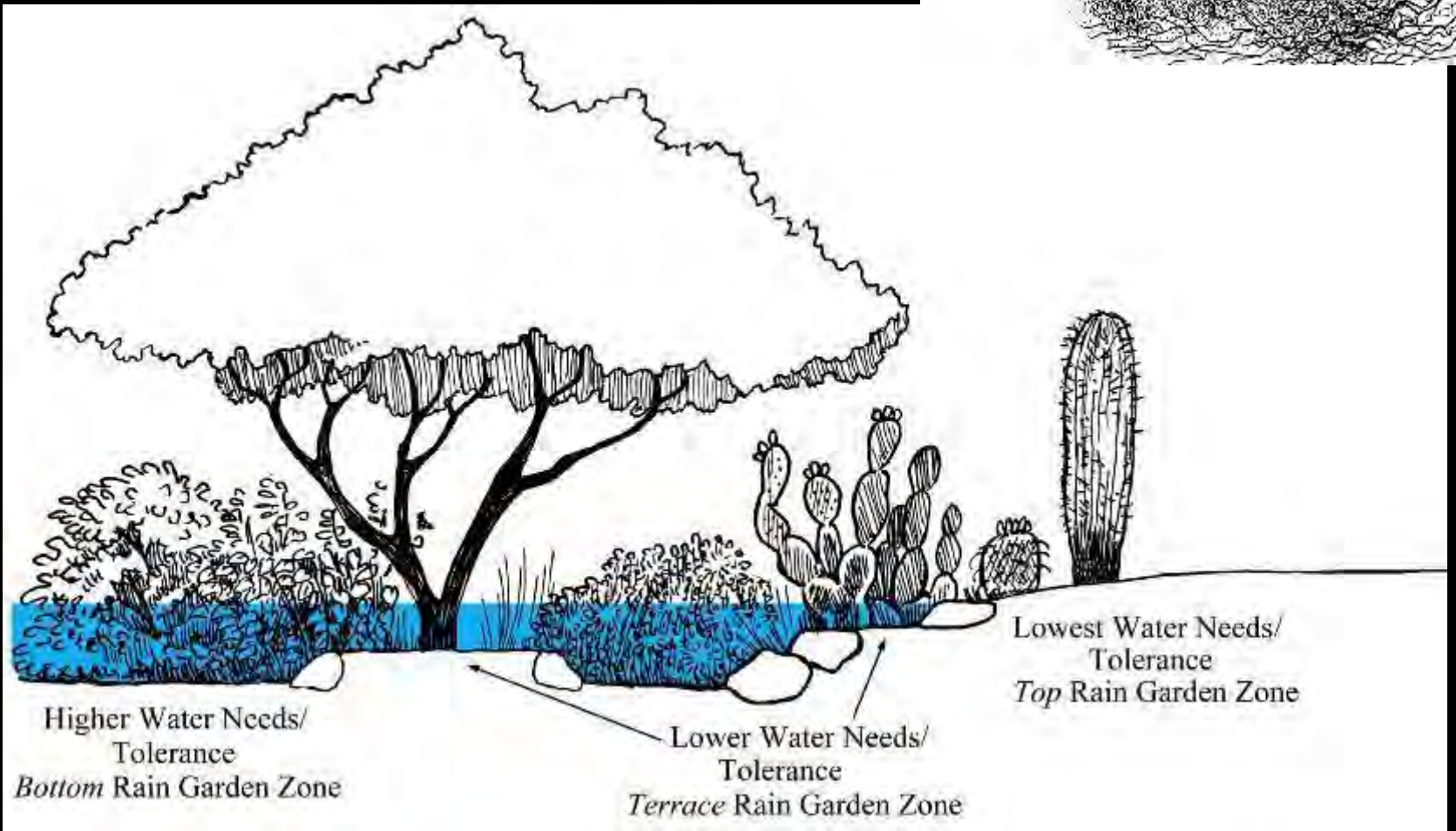




Rain Garden Zones

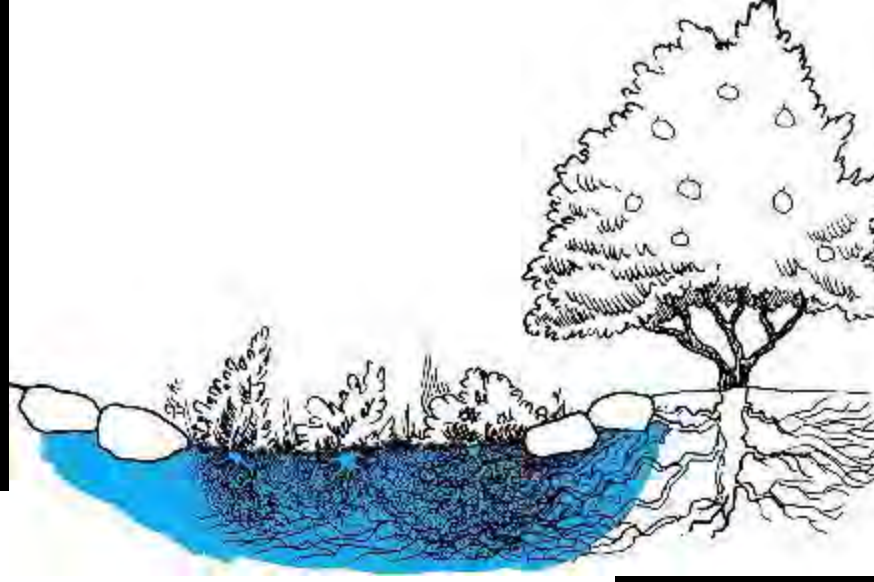
Bottom, Terrace, & Top

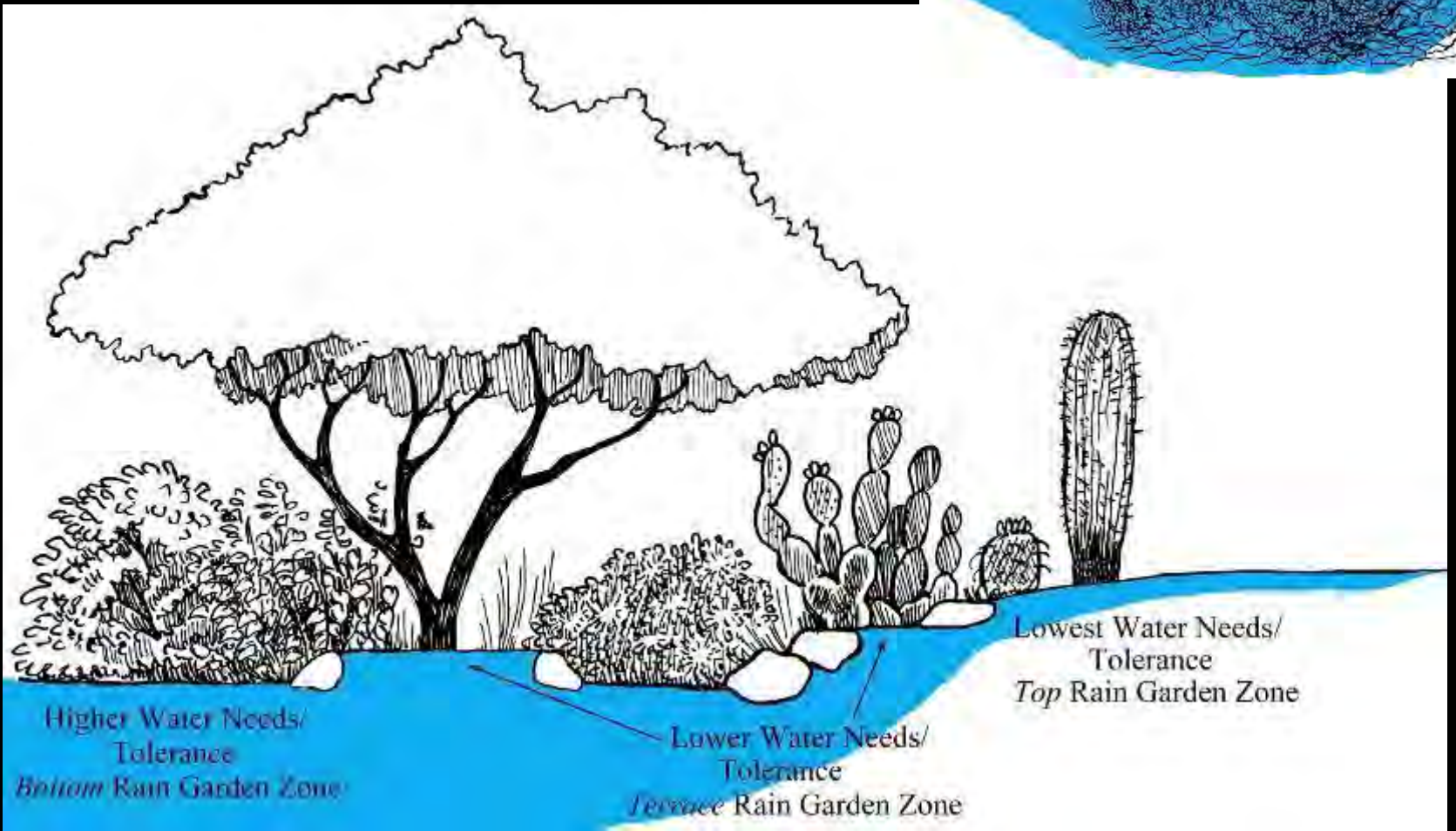




Rain Garden Zones

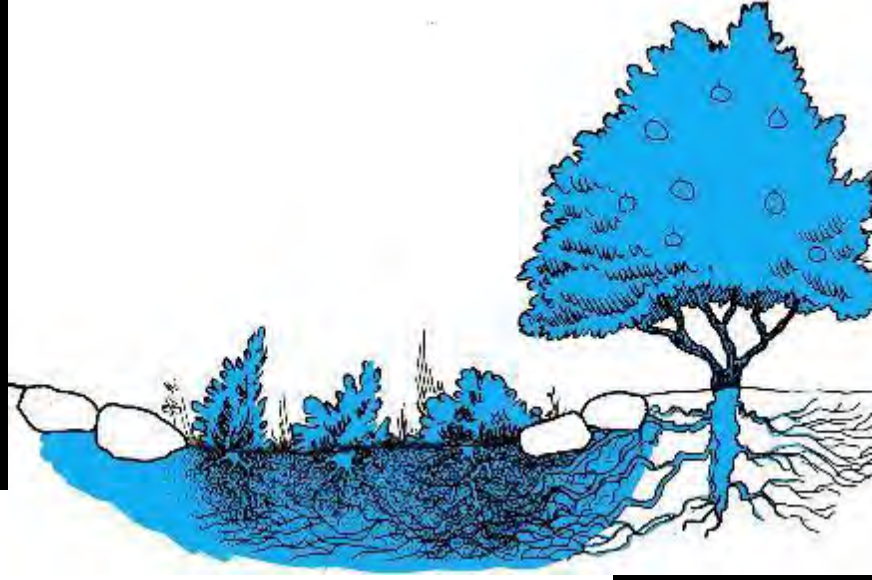
Bottom, Terrace, & Top

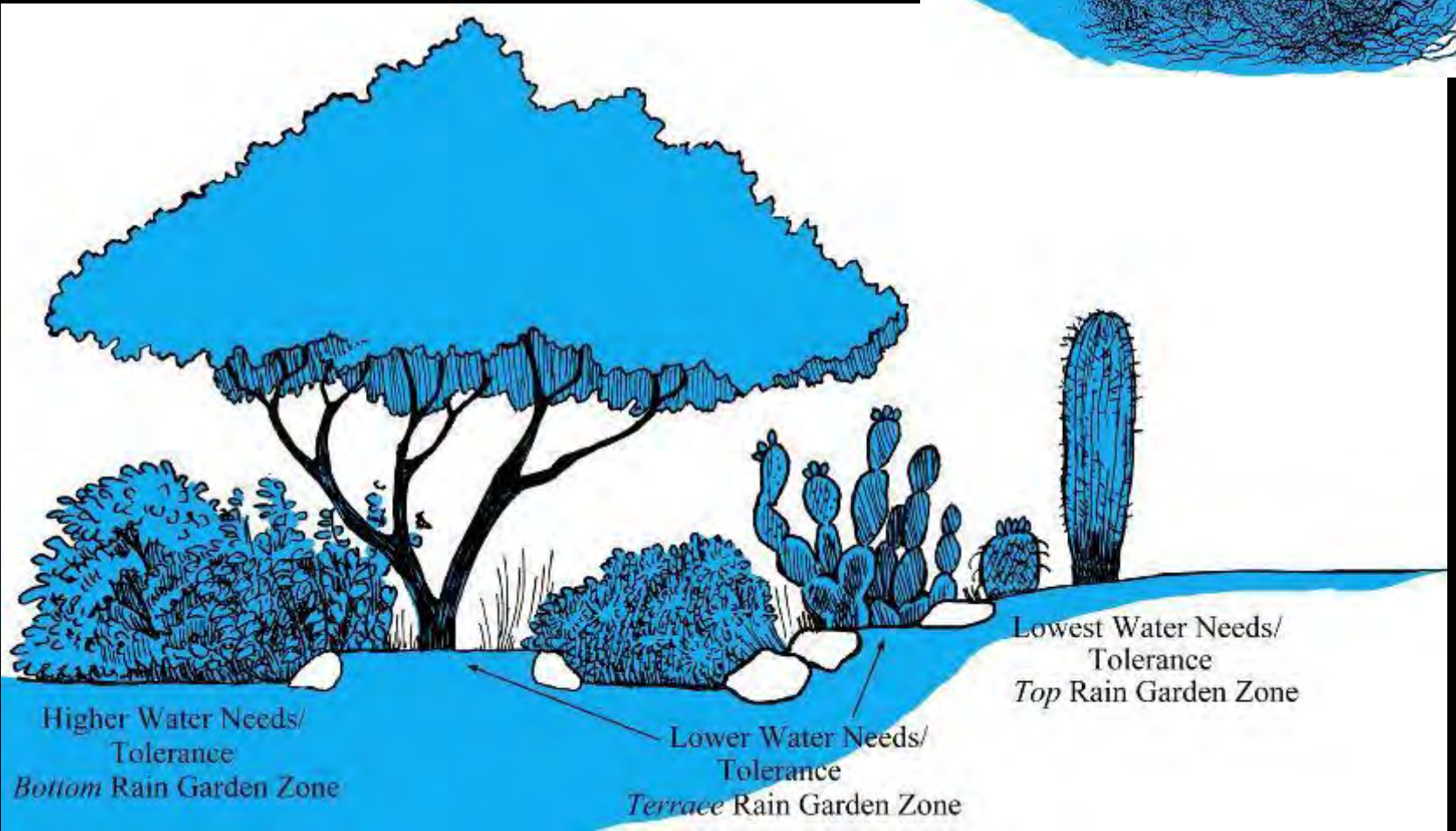




Rain Garden Zones

Bottom, Terrace, & Top





Top ^

Terrace ^

Bottom >

For Multi-Use Rain Garden Plants Lists see:

- *Rainwater Harvesting for Drylands and Beyond, Volume 1*
- Plant Lists & Resources at www.HarvestingRainwater.com

Box A4.2. Native Multi-Use Trees for the Tucson, Arizona Area

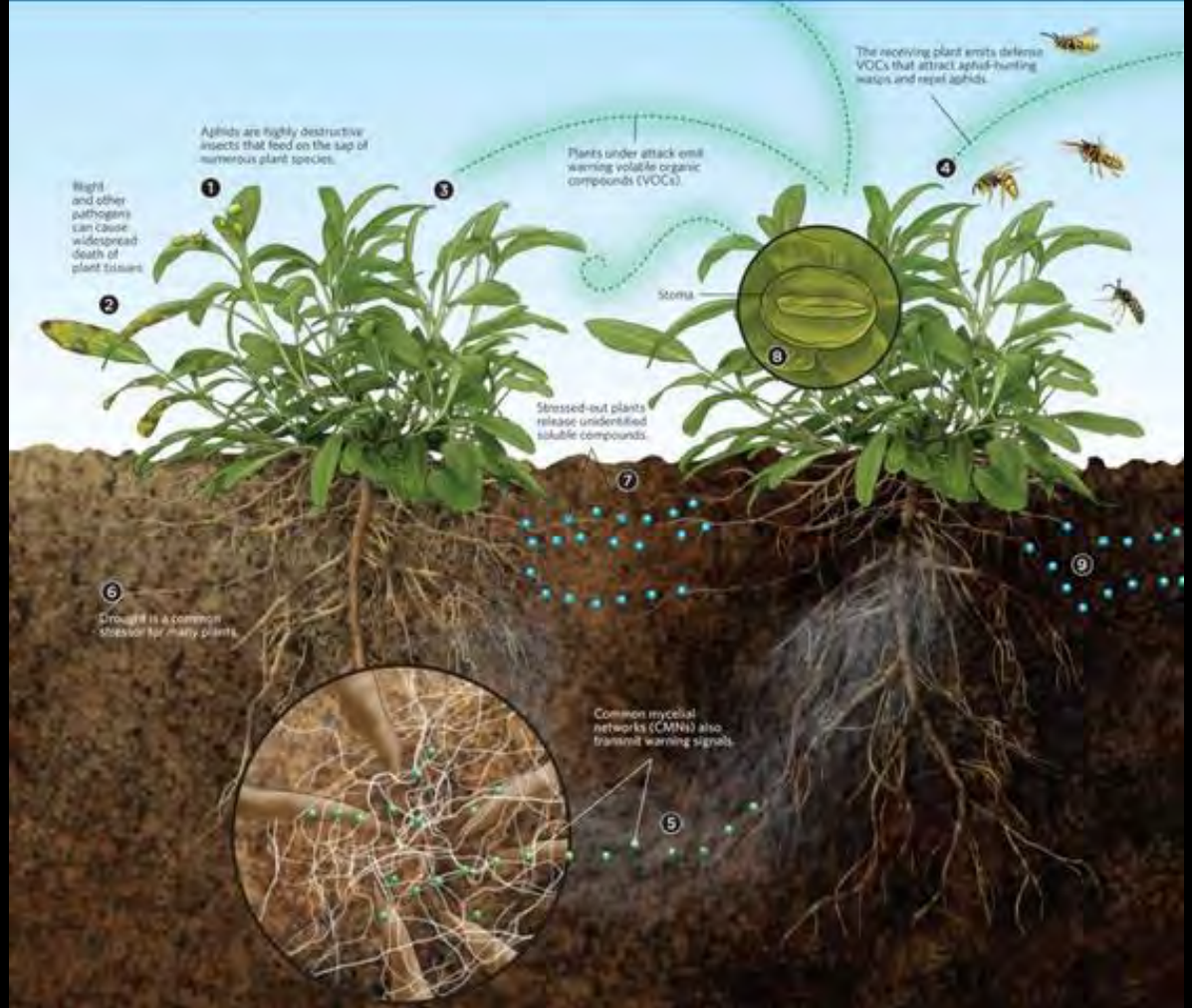
Species	Water Needs	Rain Garden Zone	Size	Cold Tolerance	Elevation Range	Growth Rate	Type of Tree	Human Uses	Wildlife	Domestic Animals That Use plant
Desert ironwood (*Olneya tesota*)	LW (1)	terrace top	25 × 25' (7.6 × 7.6m)	sh 15°f (-9°C)	2,500' (750m) and below	moderate	e	f, m, nf, s, T	Birds, pollinators, large and small mammals	Chickens, goats
velvet mesquite (*Propsopis velutina*)	LW (1)	terrace bottom	30 × 30' (9 × 9m)	h 5°f (-15°C)	1,000–5,000' (300-1,500m)	fast	sD	f, fW, m, nf, P, s, W	Birds, pollinators, large and small mammals	Chickens, goats, cattle, honey bees, dogs
screwbean mesquite (*Prosopis pubescens*)	LW (2–3)	terrace bottom	20 × 20' (6 × 6m)	h 0°f (-17°C)	4,000' (1,200m) and below	moderate	D	f, fW, m, s, W, WB	Birds, pollinators, large and small mammals	Chickens, goats, cattle, honey bees, dogs
Cat Claw acacia (*Senegalia greggii*)	LW (1)	terrace top	20 × 20' (6 × 6m)	h 0°f (-17°C)	Below 5,000' (1,500m)	moderate to fast	D	m, P, s, T, W	Birds, pollinators, large and small mammals	Cattle, honey bees
Whitethorn acacia (*Vachellia constricta*)	LW (1)	terrace top	10–15 × 10–15' (4.5 × 4.5m)	h 5°f (-15°C)	2,500–5,000' (750-1,500m)	moderate to fast	sD	f, G, m, s	Birds, pollinators, large and small mammals	Cattle
Desert Willow (*Chilopsis linearis*)	LW (2–3)	terrace bottom	25 × 25' (7.6 × 7.6m)	h –10°f (-23°C)	1,500–5,000' (450-1,500m)	fast	D	fr, fW, m, s, W, WB	Birds and pollinators	Cattle, honey bees
Canyon hackberry (*Celtis reticulata*)	mW (2–3)	terrace bottom	up to 35 × 35' (10.6 × 10.6m)	h –20°f (-28°C)	1,500–6,000' (450-1,800m)	moderate	D	f, s, W, WB	Birds, pollinators, large and small mammals	Chickens
foothills Palo verde (*Parkinsonia microphyllum*)	LW (1)	terrace top	25 × 25' (7.6 × 7.6m)	h 15°f (-9°C)	500–4,000' (150-1,200m)	slow to moderate	D	f, s, W	Birds, pollinators, large and small mammals, desert tortoise	Cattle, honey bees

Maximize organic and living groundcover

Food-bearing native trees (*Prosopis velutina*) associated with mulched street runoff-harvesting earthworks:

- Do NOT uptake heavy metals into edible plant tissue.
- Grow 33% larger than those without.
- More than double the trees' potential sequestration of atmospheric carbon, passive cooling, and food production
- Enables the soil itself to sequester additional carbon
- Increases the natural pollutant-filtering/bioremediation ability of the soil to ***ten times greater*** than that of rock- or gravel-mulched soil

Mitchell Pavao-Zuckerman, PhD
Biosphere 2 & School of Natural Resources and Environment
University of Arizona mzuckerman@arizona.edu



THE SECRET SOCIAL LIVES OF PLANTS

Contrary to the long-held idea that plants are uncommunicative, recent research has made it clear that many species conduct lively and informative conversations with one another. Scientists have revealed that plants communicate through the air, by releasing odorous chemicals called volatile organic compounds (VOCs), and through the soil, by secreting soluble chemicals into the rhizosphere and transporting them along thread-like networks formed by soil fungi. And this is more than mere gossip: these signals warn neighbors of the many dangers facing plants.

In response to herbivore attacks (1) or infection (2), plants release a blend of volatile organic compounds (VOCs) into the air (3). Neighboring plants respond by activating defense responses or altering expression of defense-related genes to prime themselves against impending stress (4).

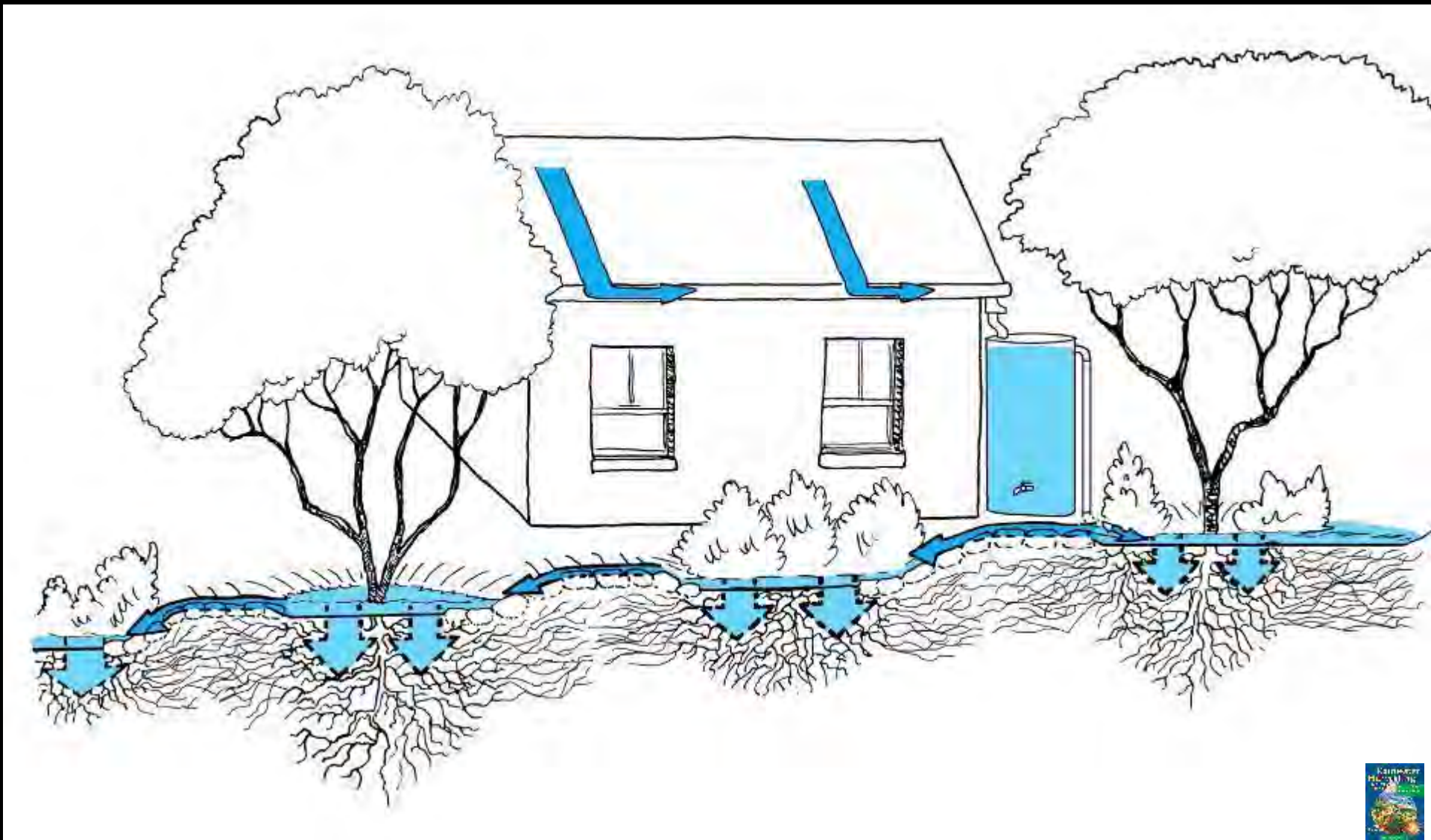
Warning signals about herbivore damage and fungal pathogens are also transmitted via the filamentous hyphae of soil fungi that colonize and connect the roots of different plants in common mycelial networks (CMNs) (5). How compounds zip along these fungal networks in not clear, but researchers have hypothesized that they could travel along the thin layer of water flowing along the surface of the hyphae or through the cytoplasm of the hyphae themselves.

Plants stressed by drought (6) secrete soluble chemicals from their roots that diffuse through the soil to the roots of neighboring plants (7). Receiver plants respond not only by closing the stomata on their leaves (8), but also by relaying the message to other nearby plants (9).

© LOGAN PARSONS

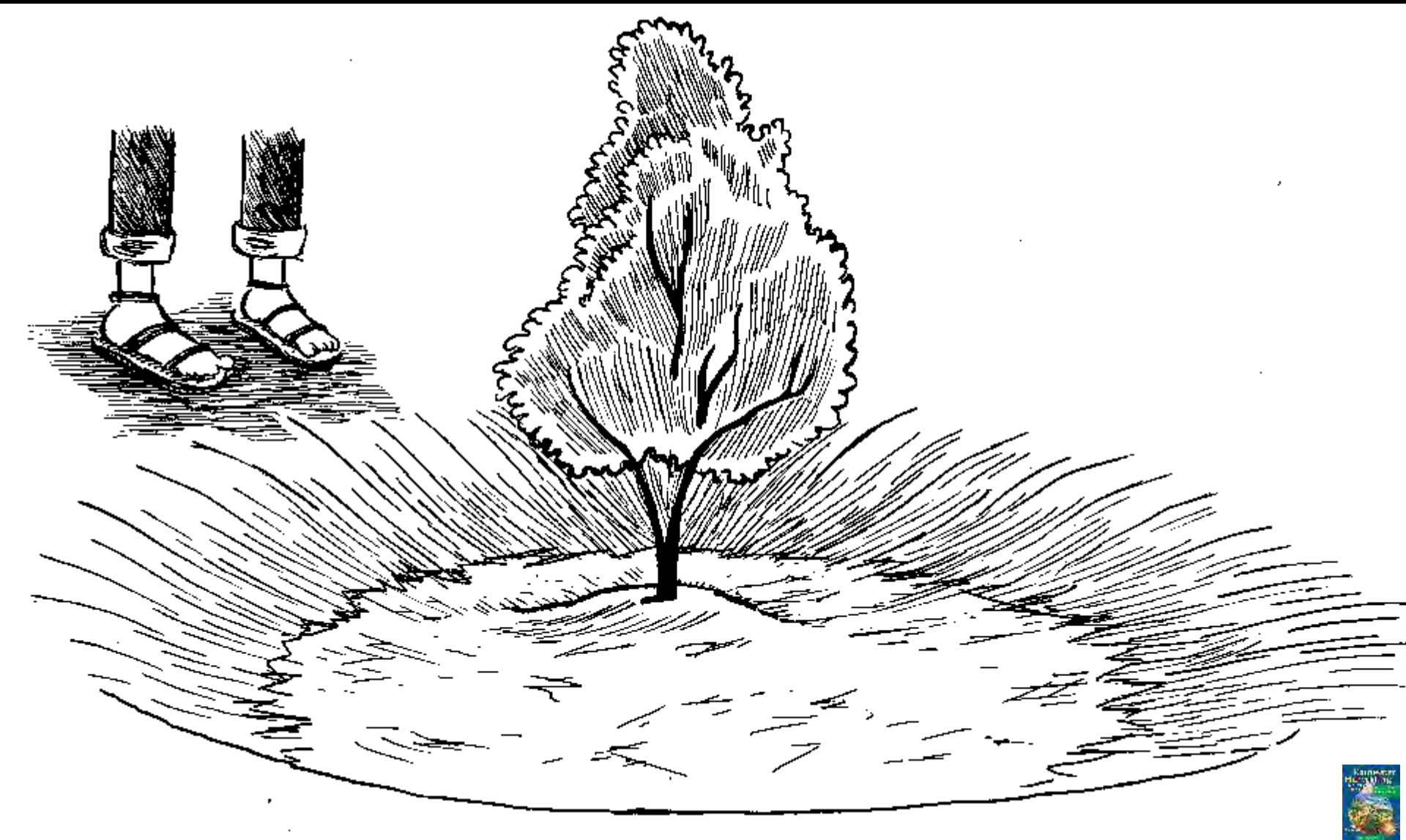
http://www.easy-grow.co.uk/fr/mycorrhizae-fungi-gallery/

Start at the top of the watershed and work your way down

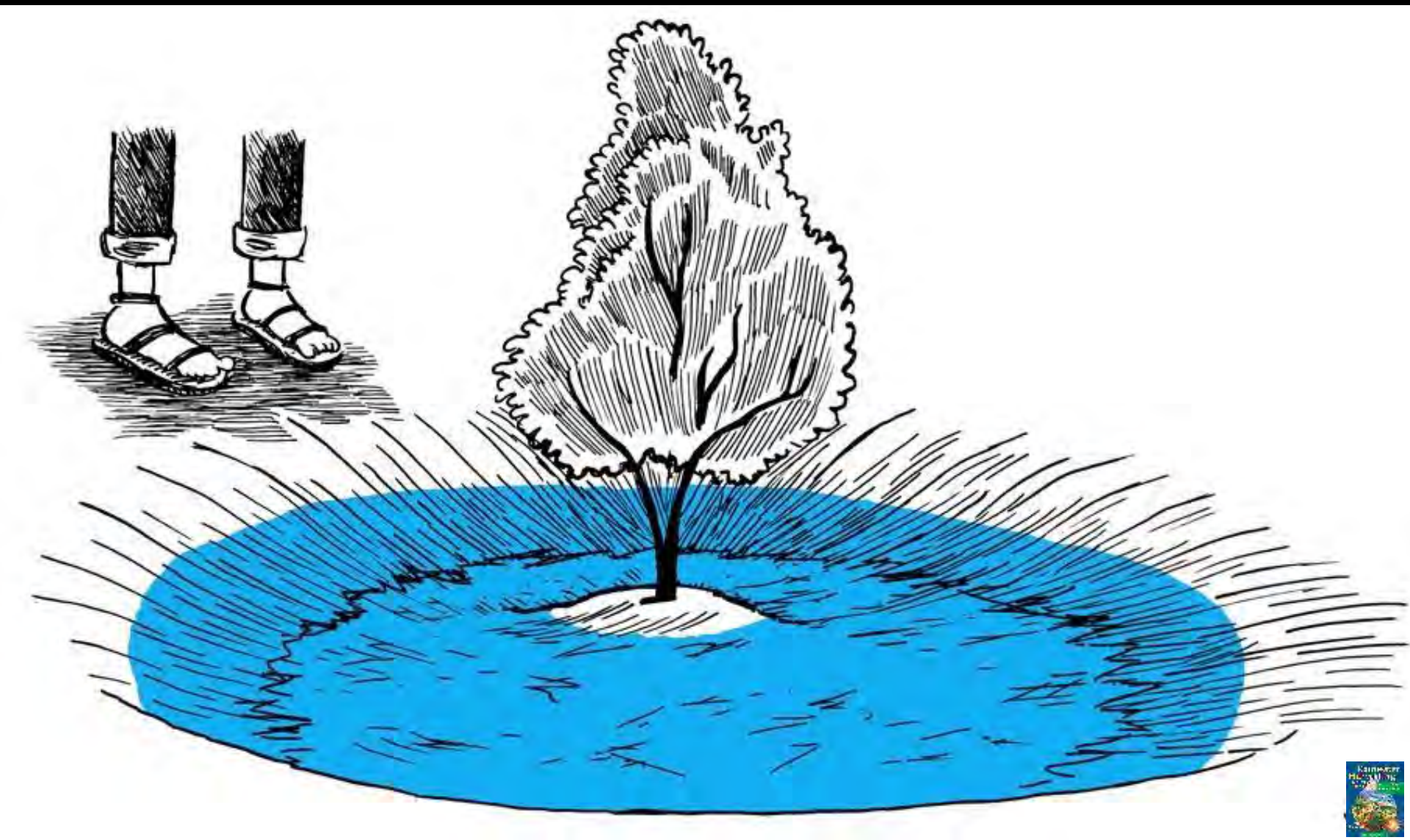


Redbud Center, Austin, Texas

Start small and simple

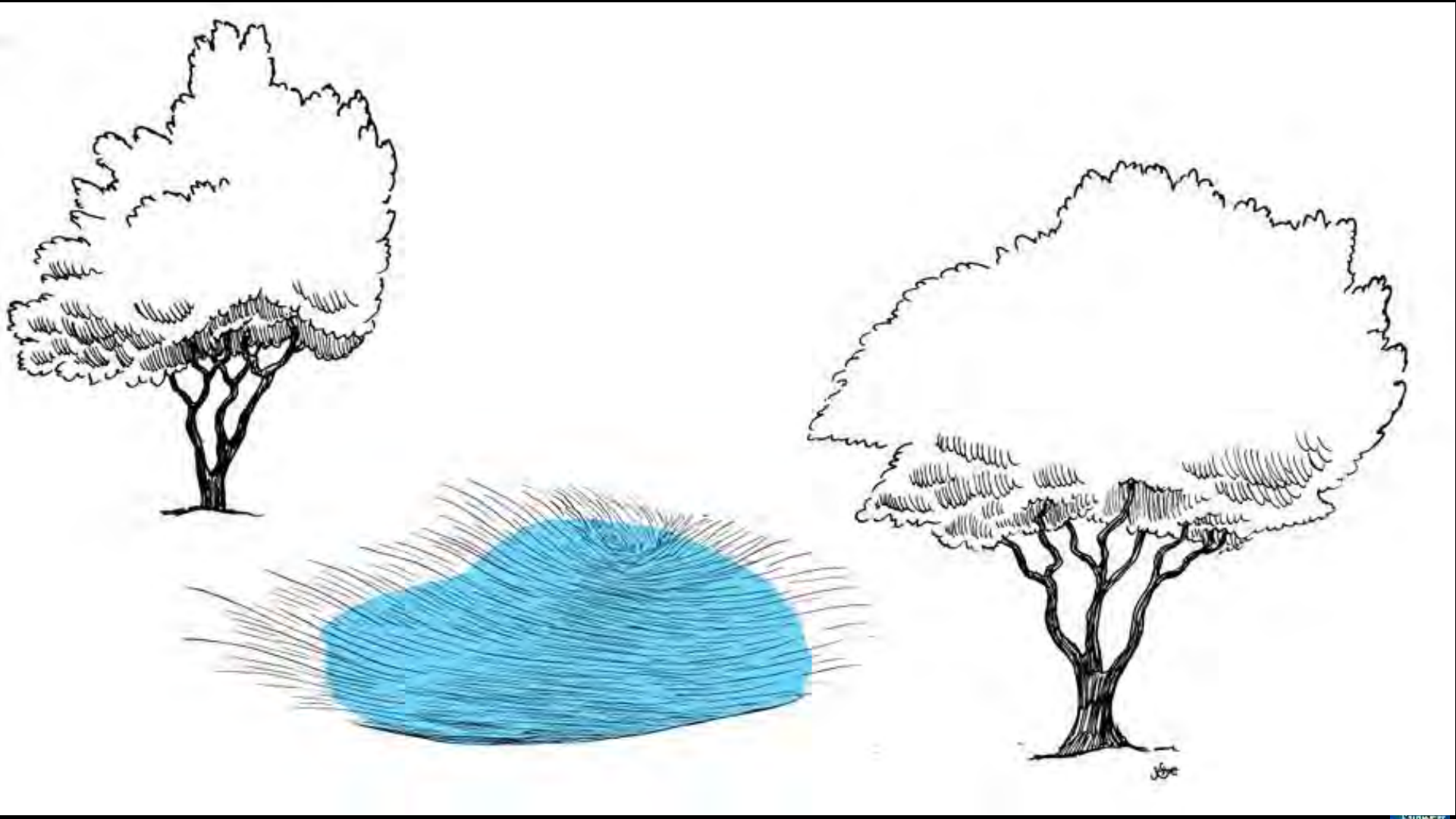


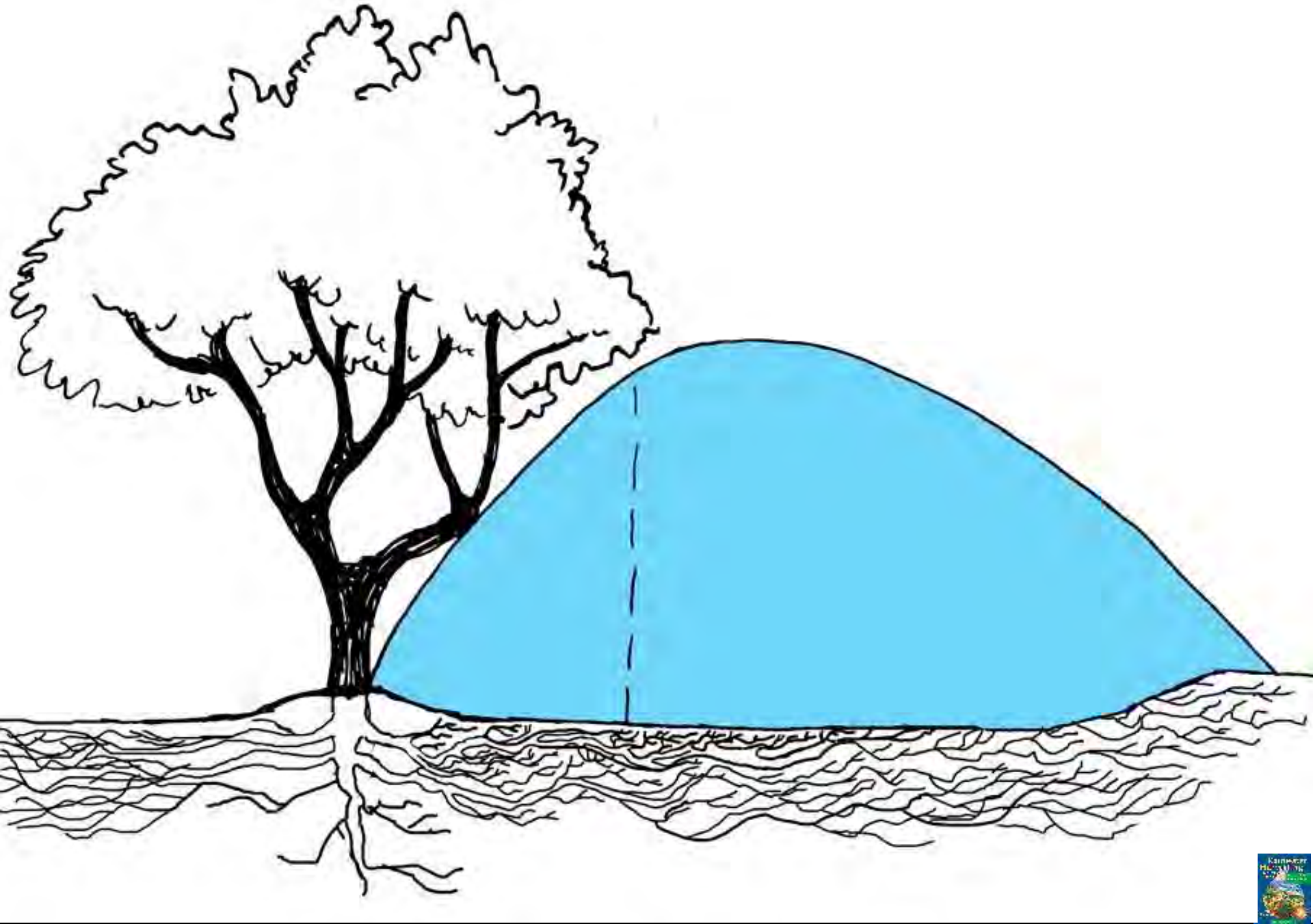
Start small and simple

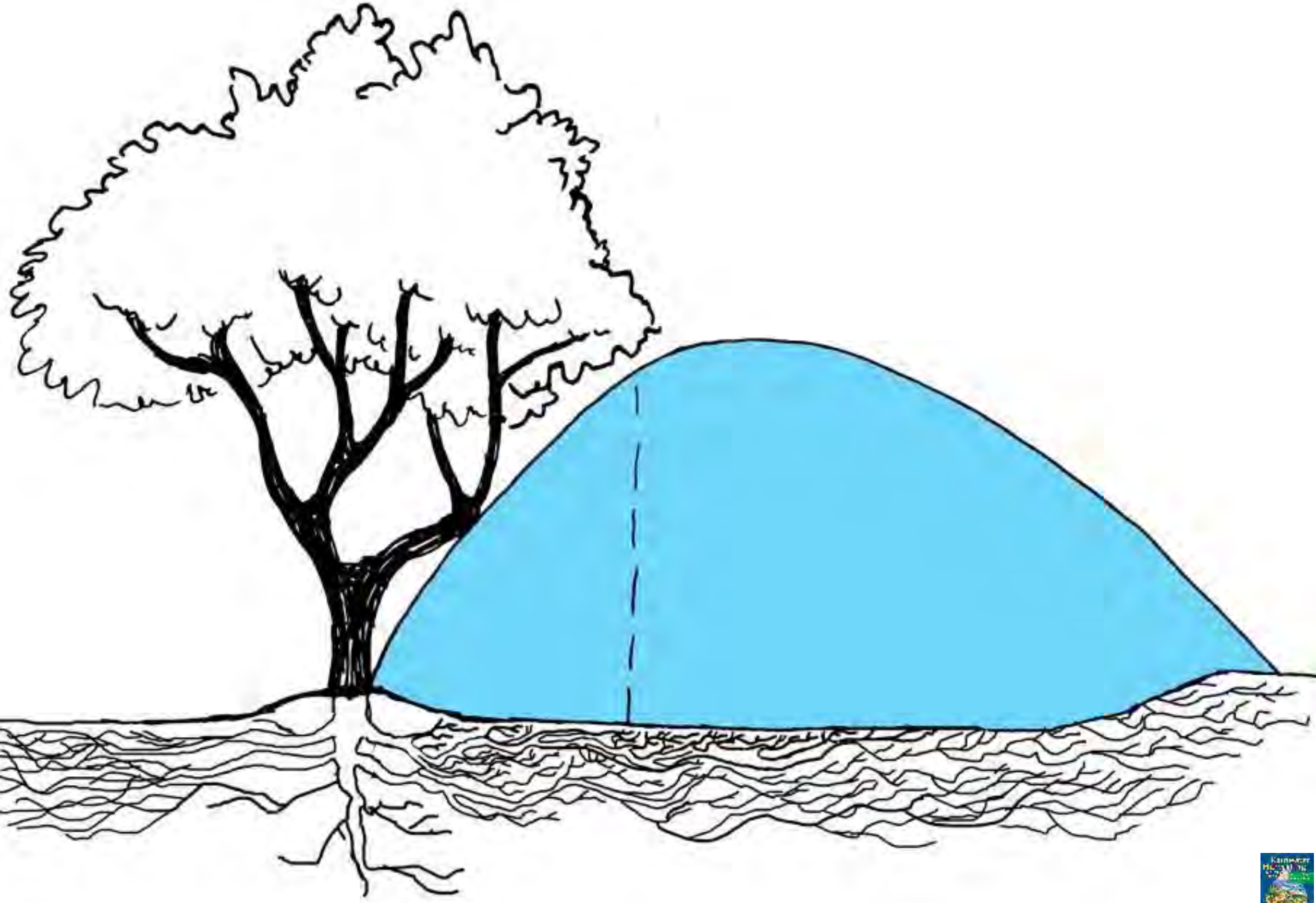


Infiltration basin / rain garden

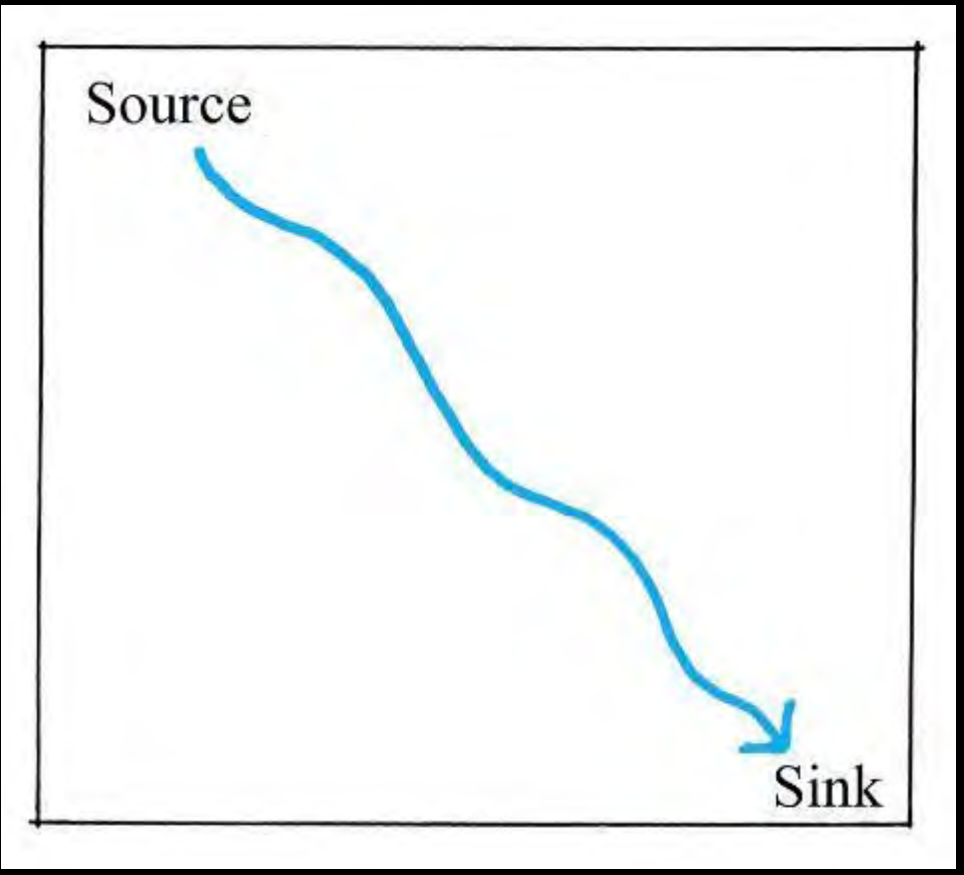
Infiltration basin / rain garden

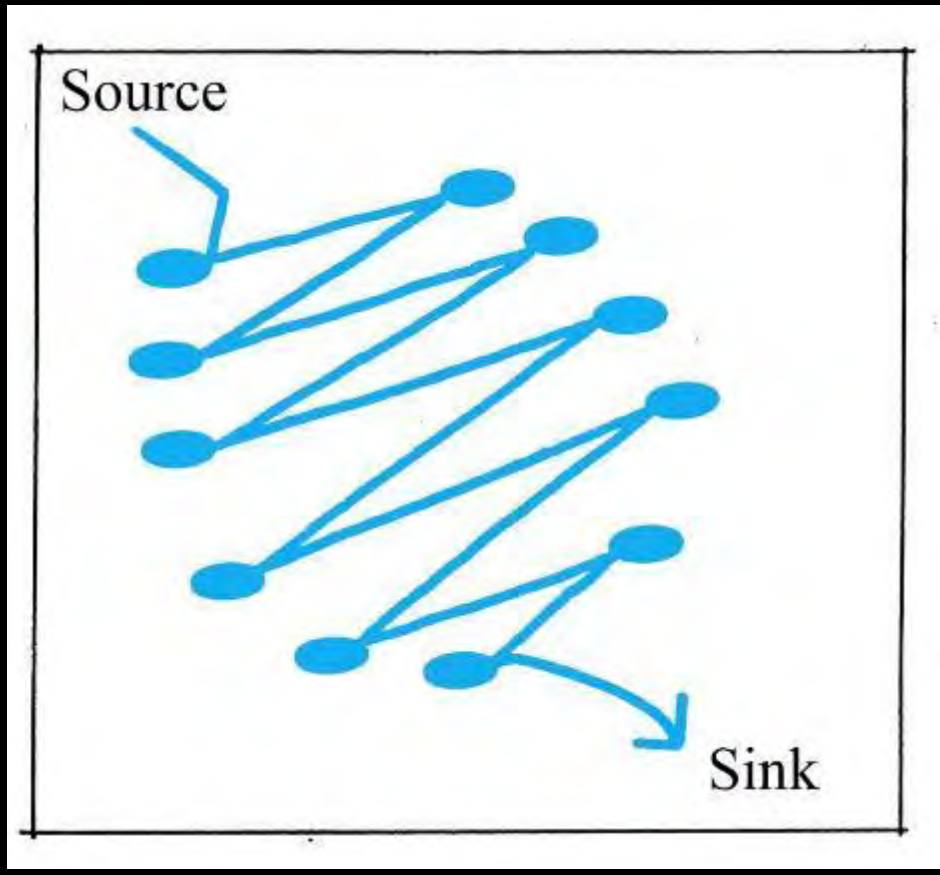


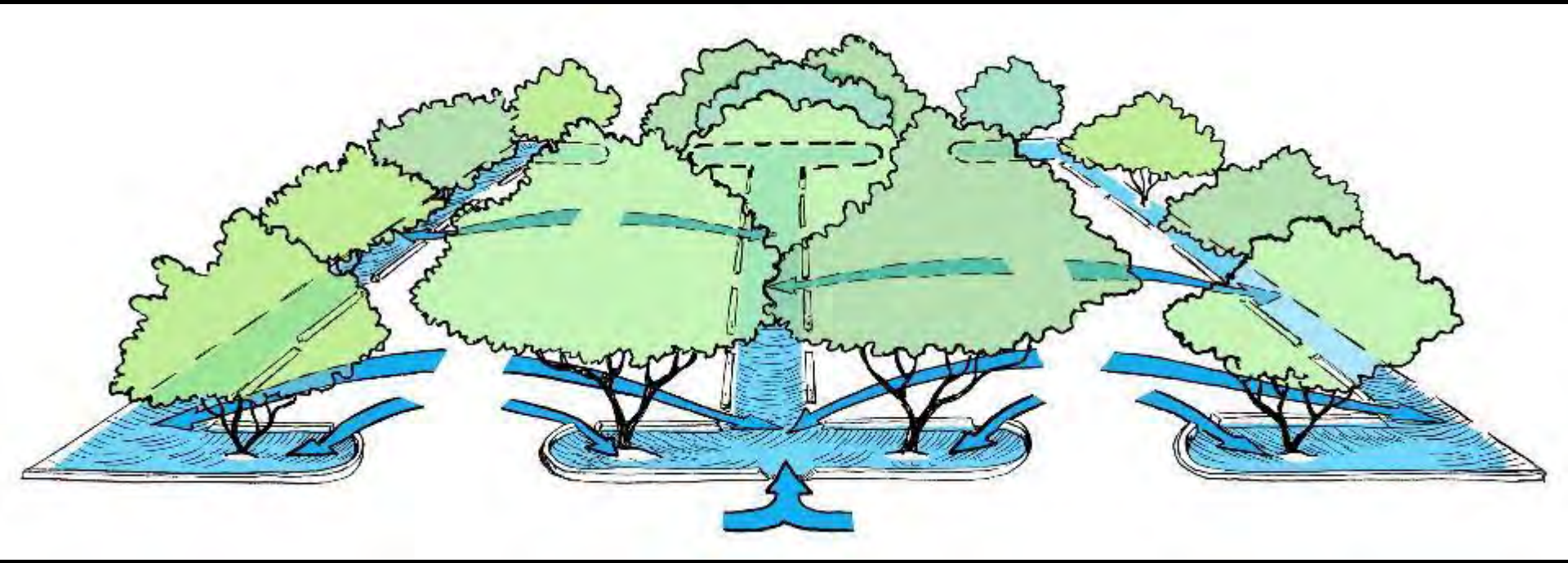




Slow, spread, and infiltrate

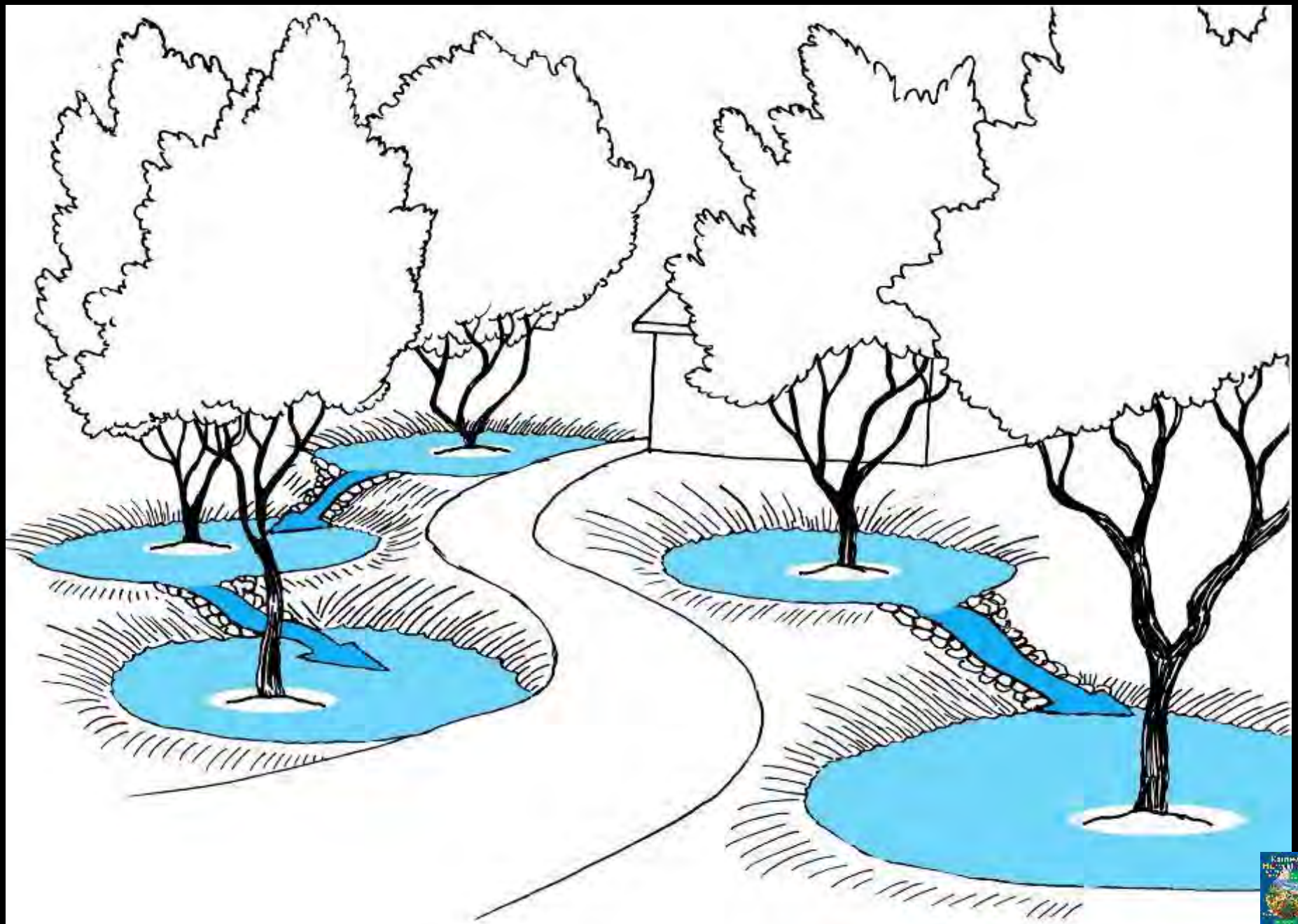




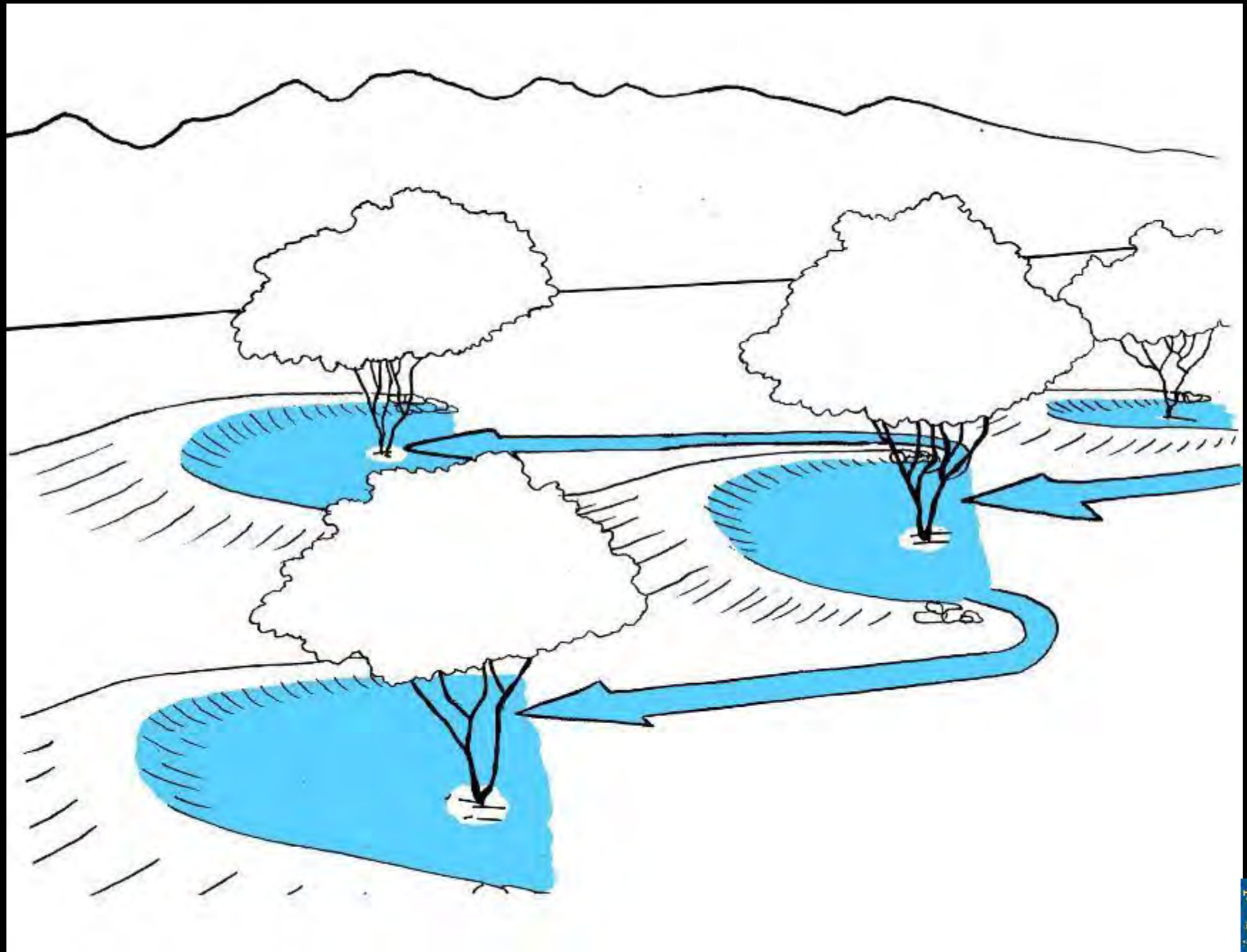


Water-harvesting parking lot

Stepped basin

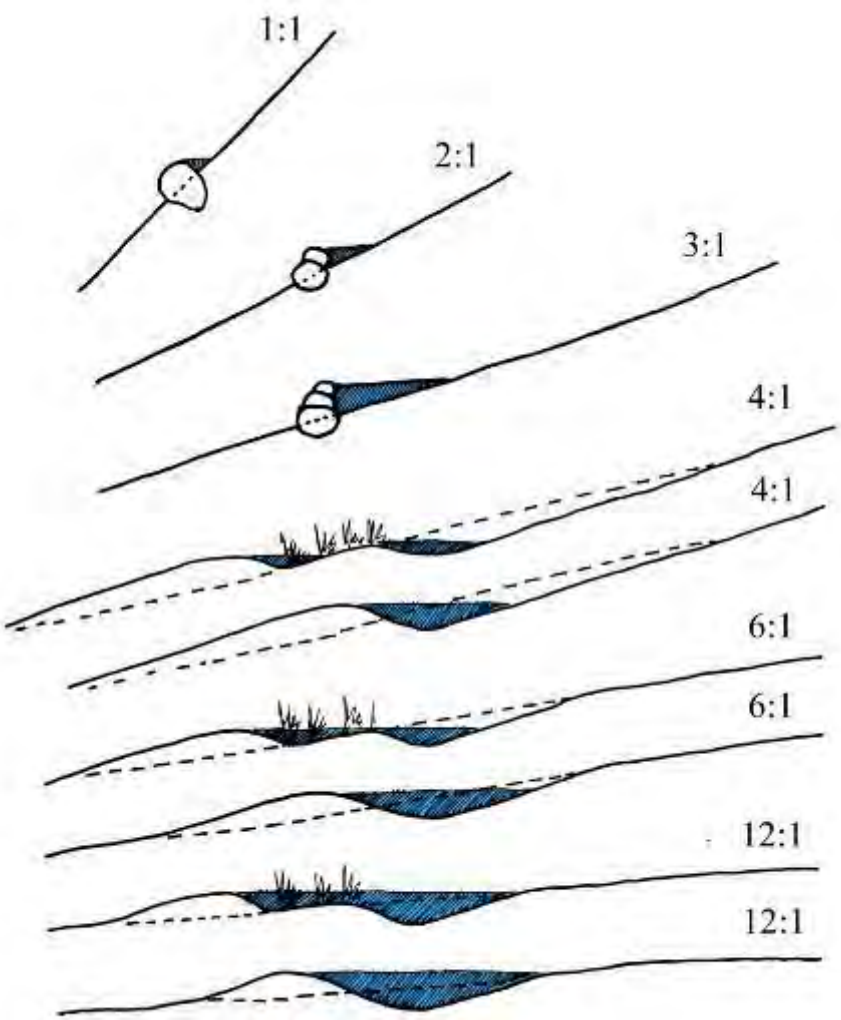


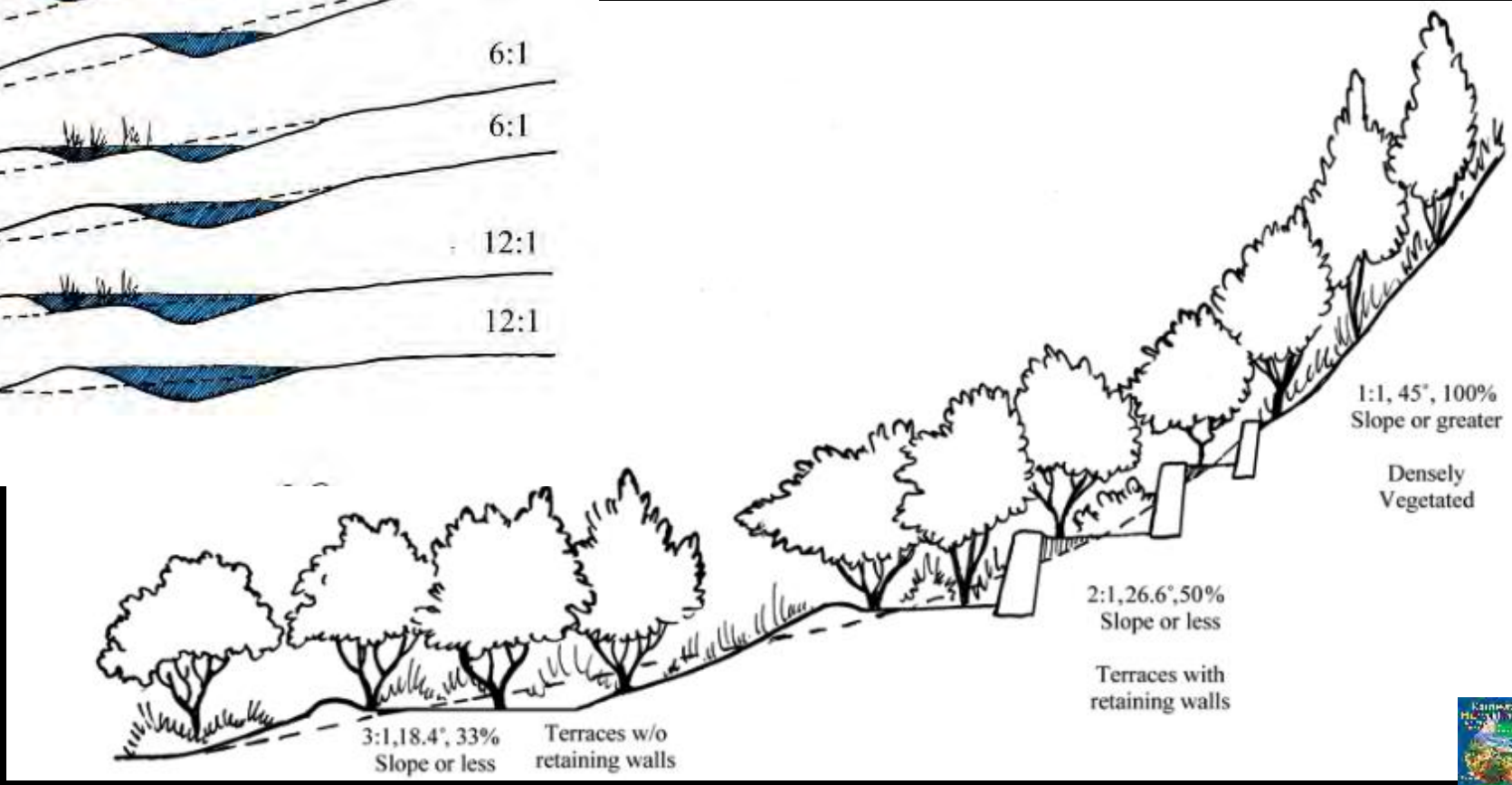
Boomerang berms / smile berms



Contour swales

Terraces





Contour swale or berm ‘n basin

Porous urbanite patio
Blue Agave Designs, Tucson, AZ

Dry-stacked urbanite retaining wall
La Loma Development, Los Angeles, CA

Residential Rain Garden & Street Harvesting Benefit/Cost Ratio Initial Results

Benefit/Cost Ratio:	**$4.4 / $1**	**$2.9 / $1**
Direct benefits only:	**$3.1 / $1**	**$1.9 / $1**

PIMA COUNTY FLOOD CONTROL

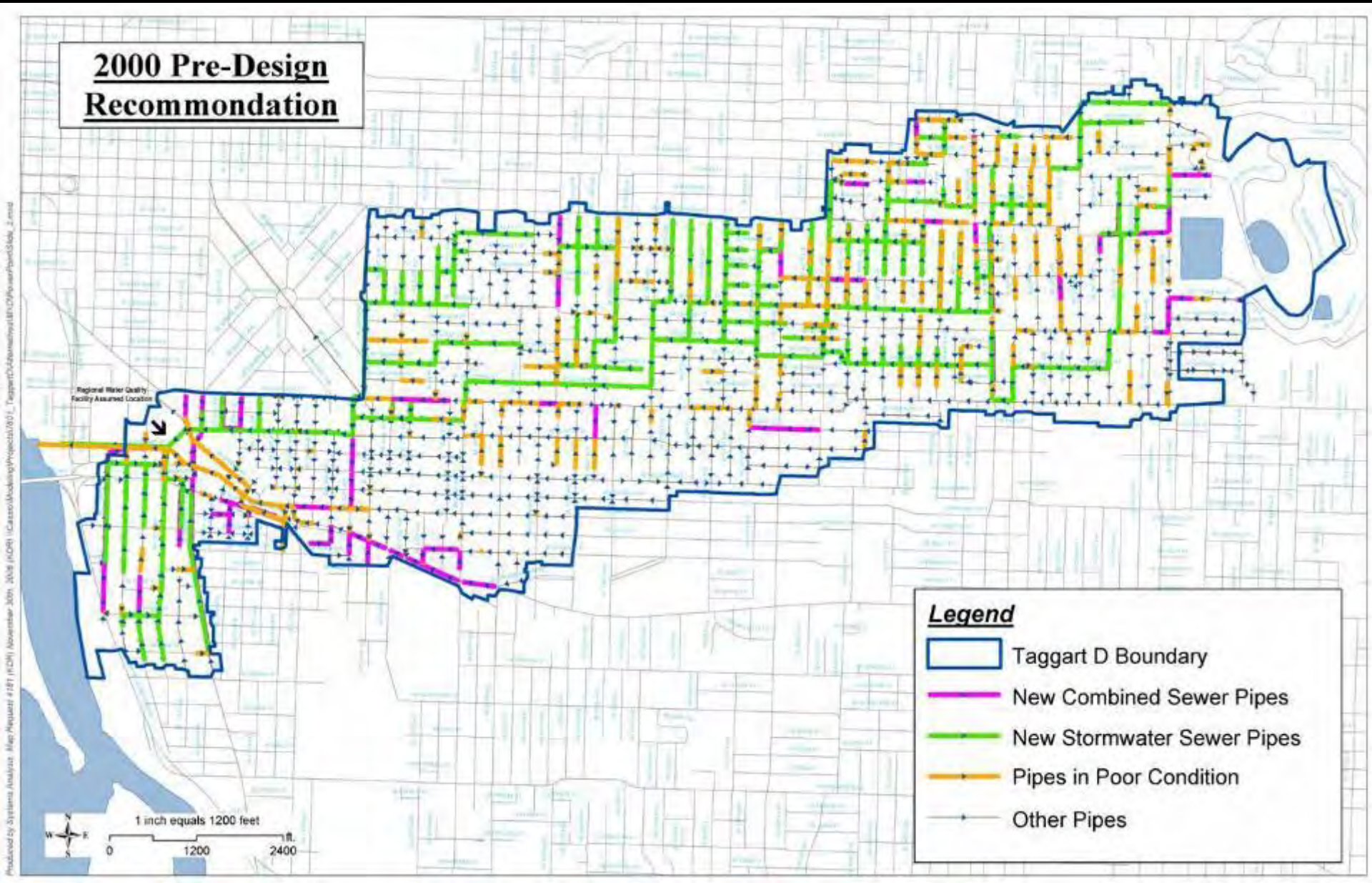
CITY OF TUCSON

WMG

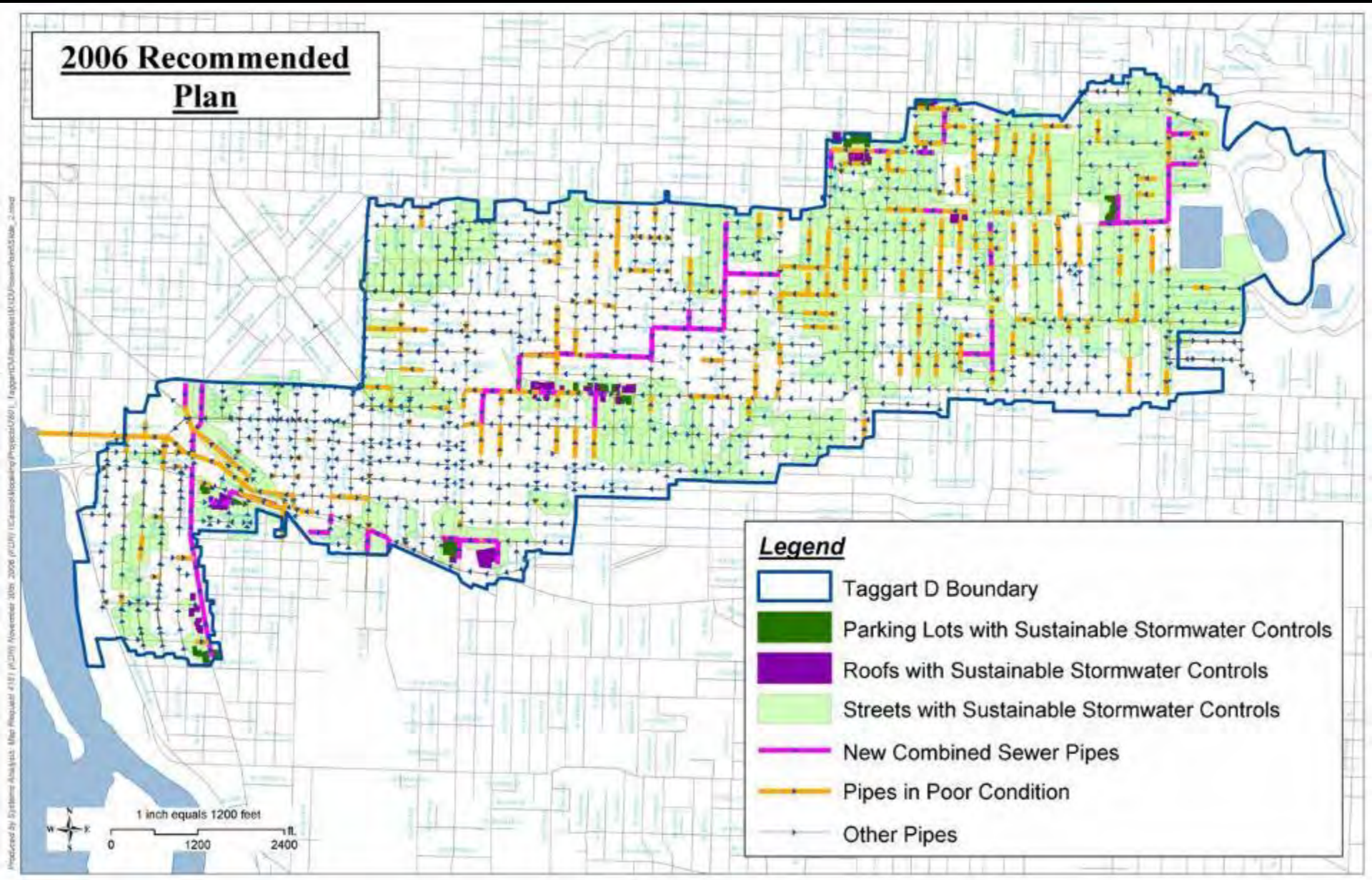
Green Streets
Portland, Oregon

•City is divided up into subwatersheds, and those of highest need are identified.

•Combined Sewer Overflowsand flooding are the typical problem

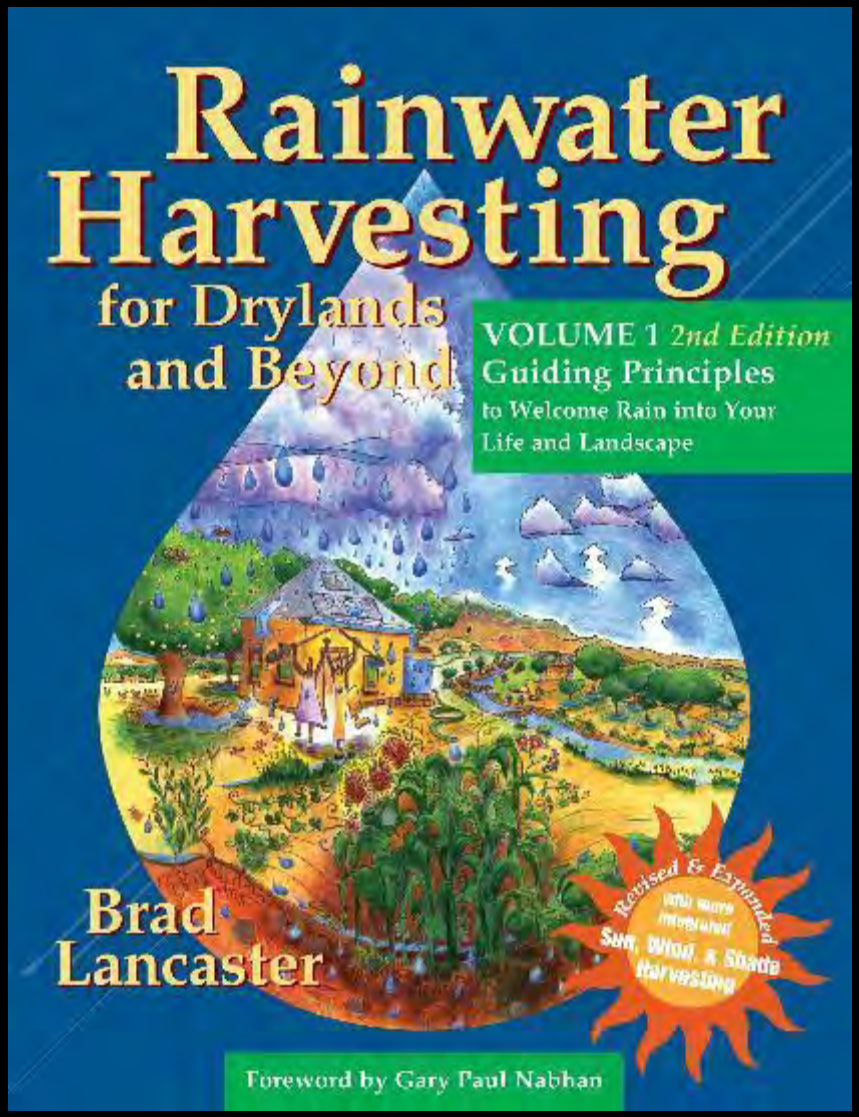


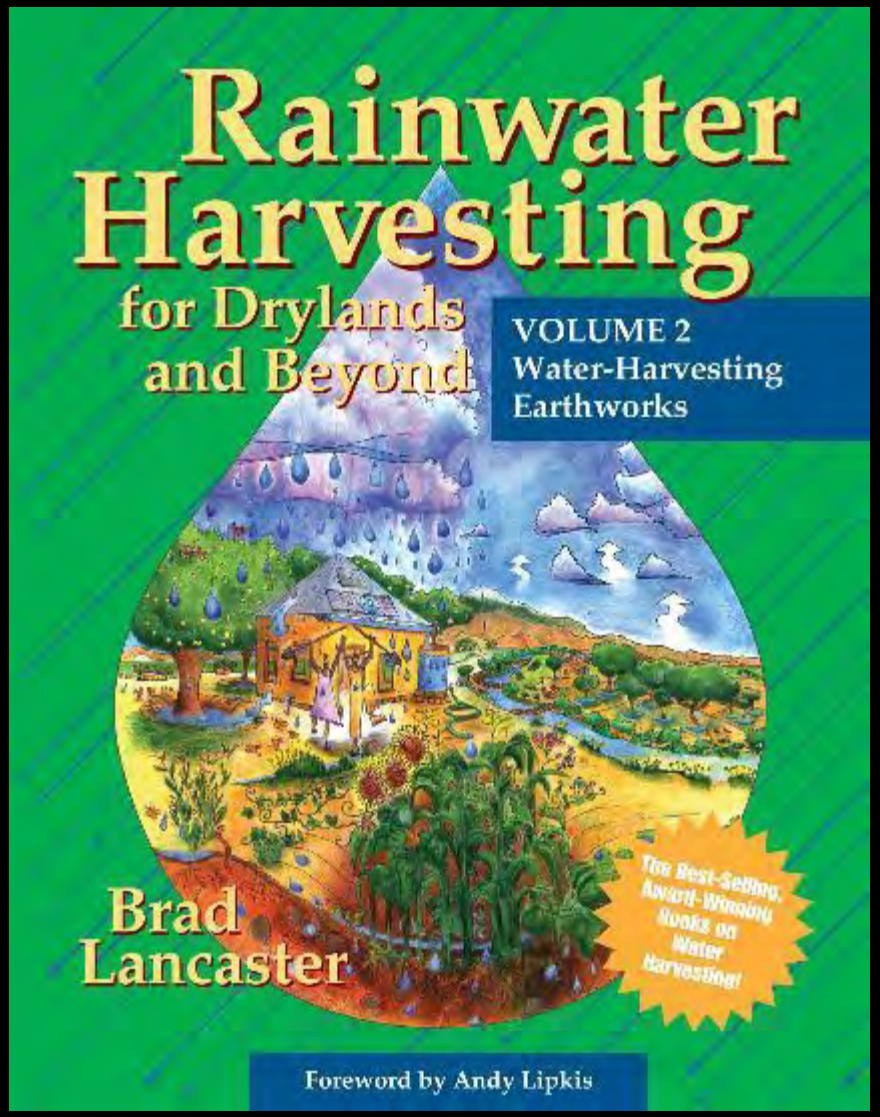
- Conventional drainage design cost $144 million



- Plan with sustainable stormwater strategies cost $86 million.
- $58 million savings due to the reduction of needed pipe replacement

SHOW THE FLOW





www.HarvestingRainwater.com

Speed

/ \

Depth — Volume

Scarcity

Abundance

drain

sponge