

Thinking Local: The Role of Health Leadership in Water Capture

by Brad Lancaster

www.HarvestingRainwater.com

www.DesertHarvesters.org



Tucson, Arizona, USA

1904



Sponge

2007



Drain

Evidence of a hydrophobic society

- dehydration infrastructure



Floods that occurred every 100 years
begin to occur every 10 years -
after development paves the watershed and increases the rate
and volume of stormwater running off site





Distance is energy

We ignore, deplete, or pollute our local waters
— then import ever more distant water

The largest consumer of electricity
(and single source producer of carbon)
in Arizona is the pumping of water



Photograph: Pete McBride on the parched Colorado River delta, by Jonathan Waterman





This landscape is irrigated with a combination of imported groundwater and surface water —both relatively high in salt. Over time such irrigation can *increase salt levels* in the soil and *decrease soil fertility*.

Irrigating with on-site **rainwater**, which has almost no salt, *reduces salt levels* in the soil and *increases soil fertility*.

The average annual rainfall in **Tucson, AZ** is 11 inches (280 mm)

Yet more *rain* falls on the surface area of Tucson
in a year of average rainfall,
than the annual consumption of Tucson's *water-utility water*

This situation in **Los Angeles, California** is as follows:

| | | |
|---------------------------------|-----|------|
| RAINFALL INCOME ⁹ | 85 | GPCD |
| | 323 | lpcd |
| UTILITY-WATER USE ¹⁰ | 123 | GPCD |
| | 466 | lpcd |

Path to Scarcity

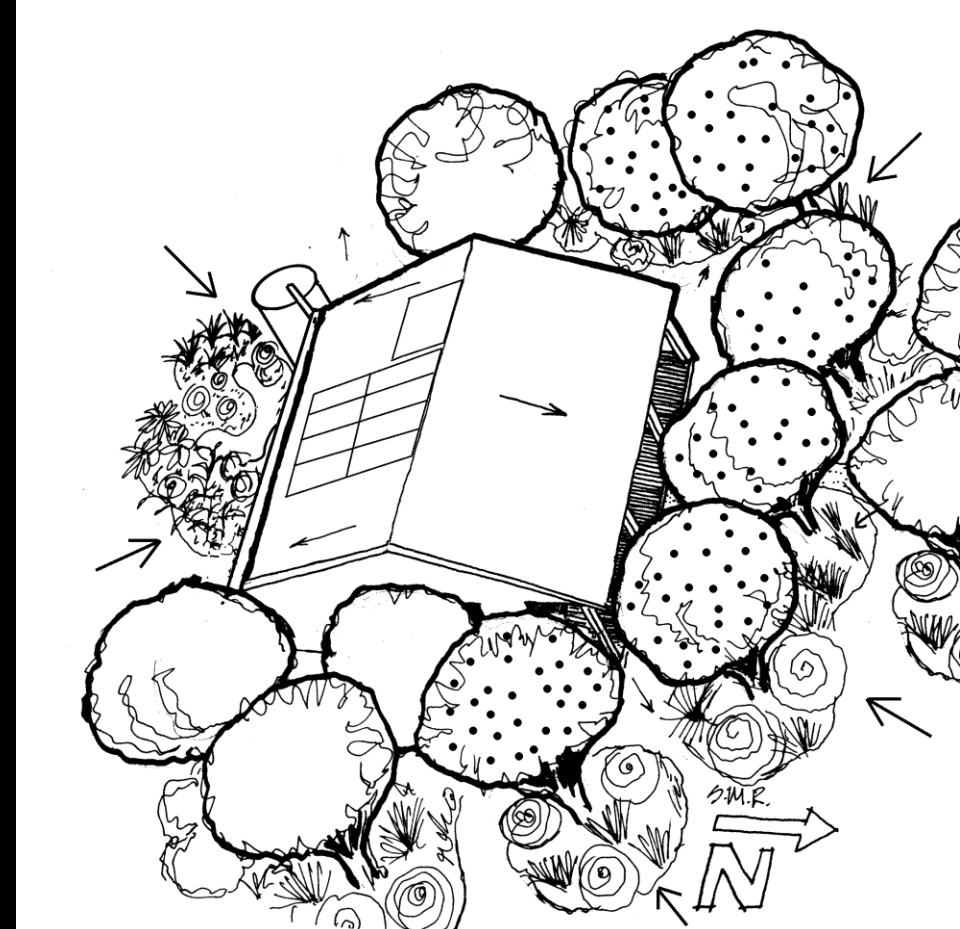
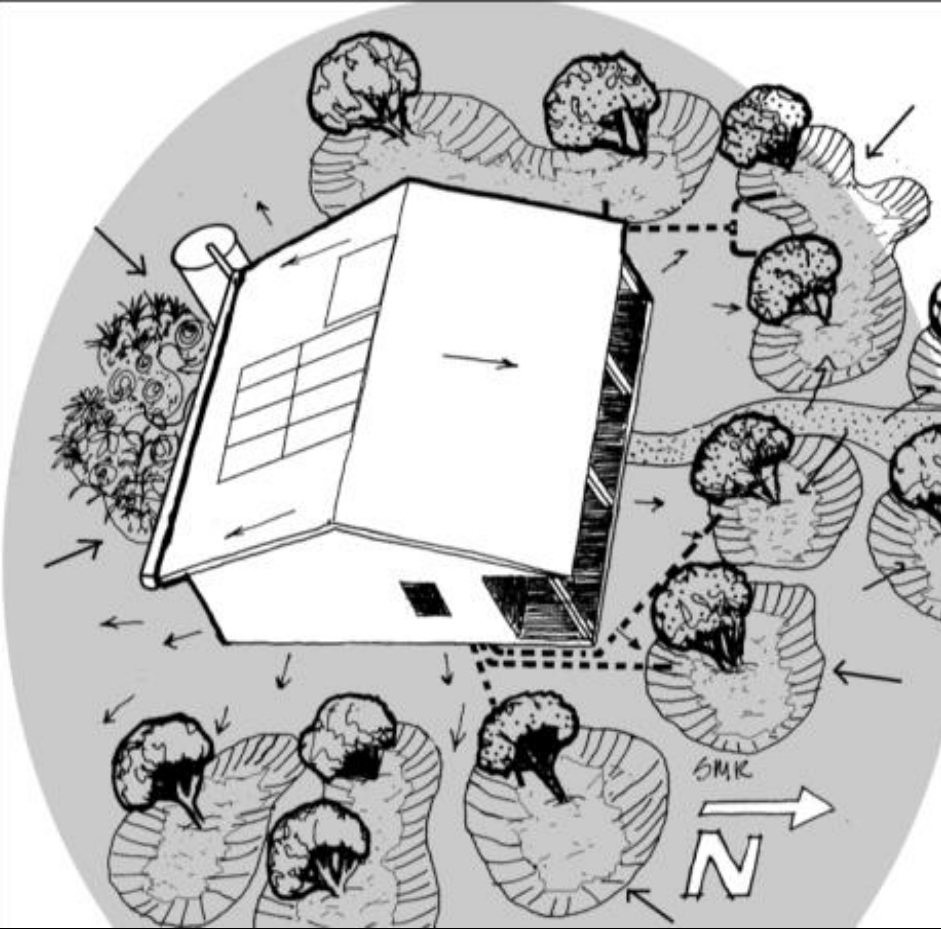


30 to 70% of household's drinking water used to irrigate landscape

Path to Abundance



- Rainwater is *primary* irrigation source
- Greywater and AC condensate are *secondary* irrigation sources
- Drinking water is only a *supplementary* irrigation source



Harvest and utilize on-site water (rainwater, stormwater, greywater, condensate, etc) as close as possible to where it falls

within the **oasis zone**
- within 30' (9 m) of catchment surface



Maximize living and organic groundcover - the sponge





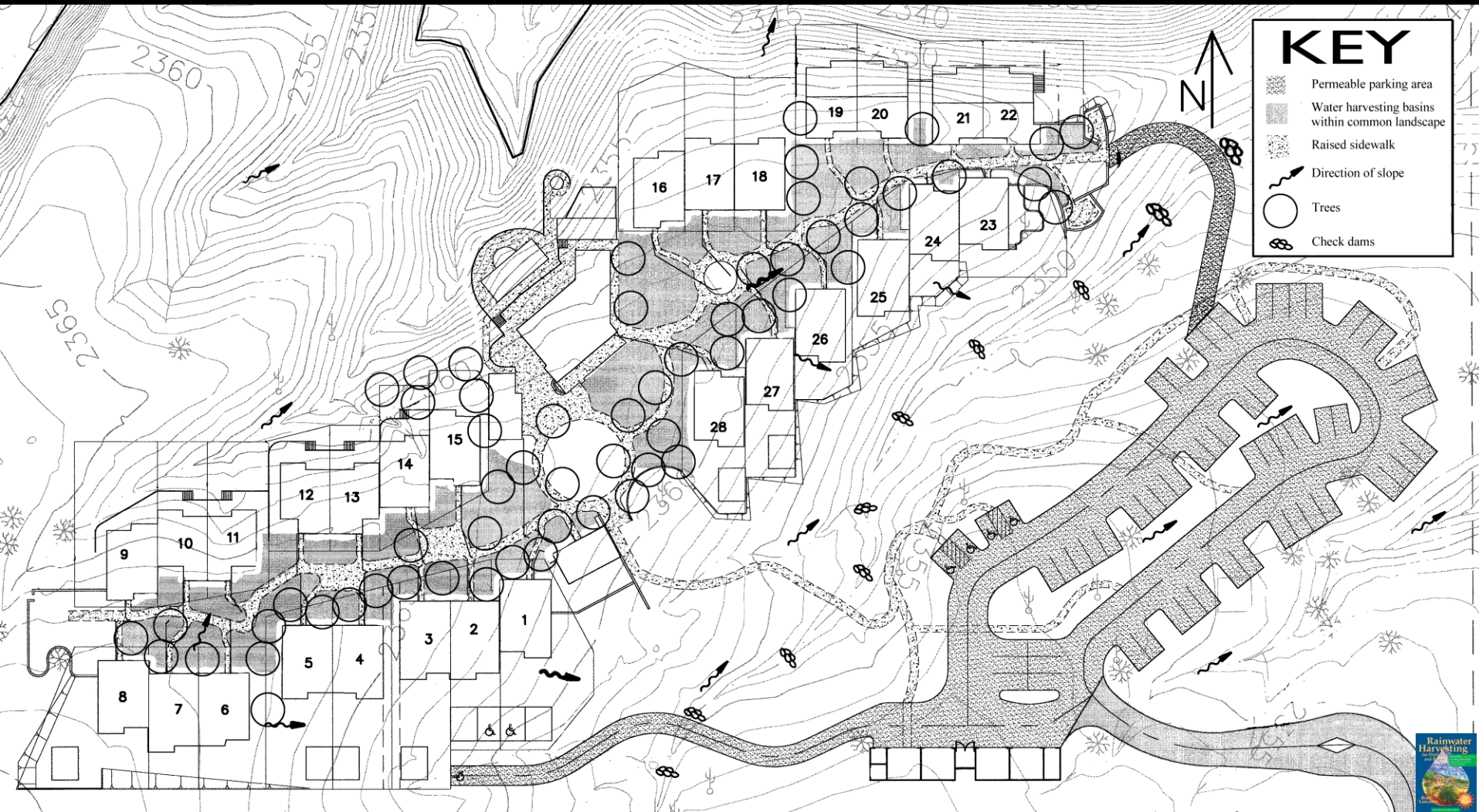
Before sponge:

After 2 inches (50 mm) of rain fell in less than an hour on high clay soils

After sponge: 4 inches (100 mm) of surface mulch and living pumps of vegetation. All rain now infiltrates in less than an hour



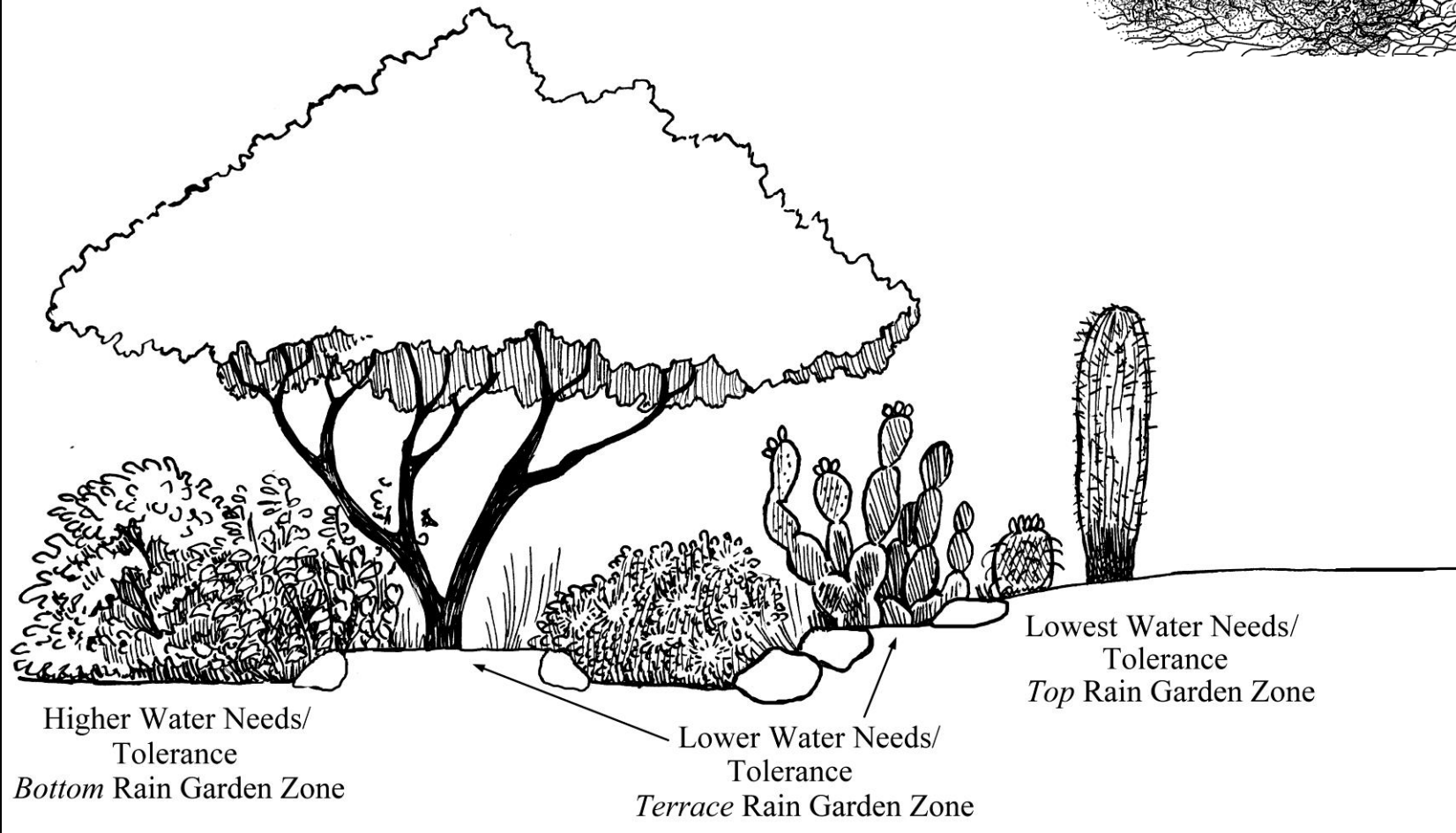
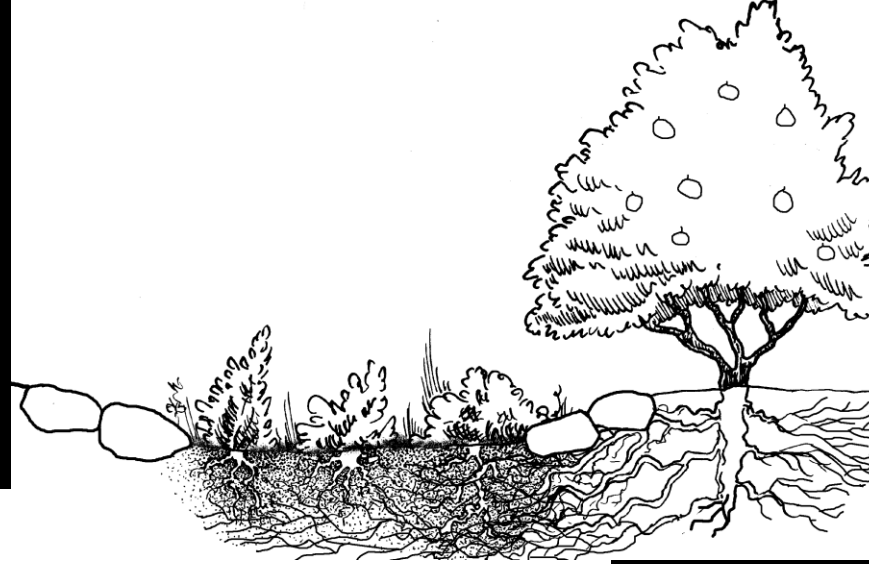
Integrated water harvesting has 10 times the flood-control capacity of a conventional flood-control system



Rain Garden Zones

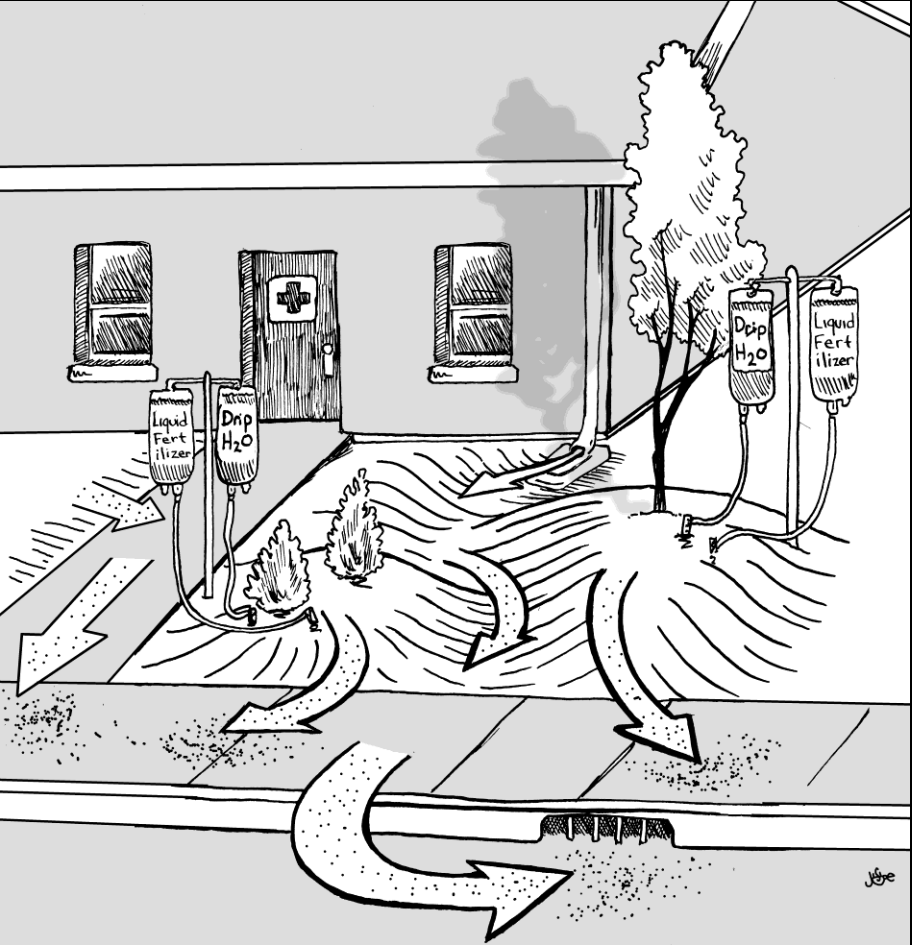
Bottom, Terrace, & Top

Lawn removal programs should incentivize harvesting topography, rather than maintaining drainage topography



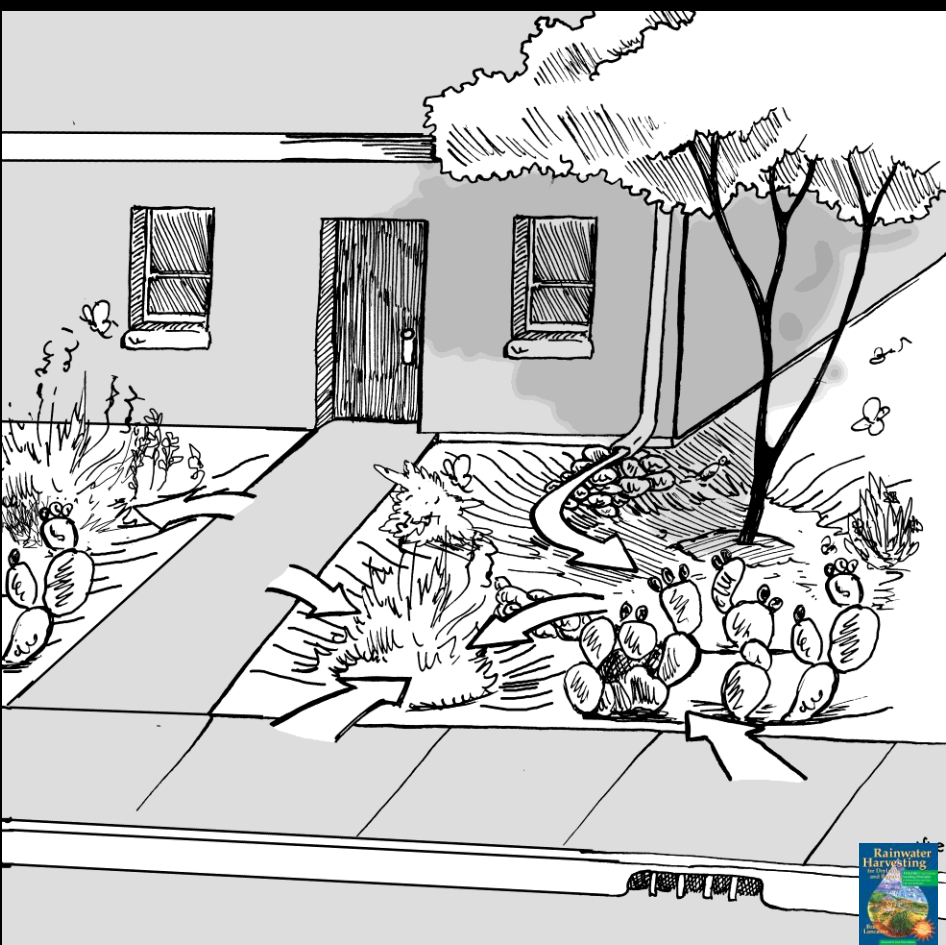
Path to *scarcity* in the landscape:

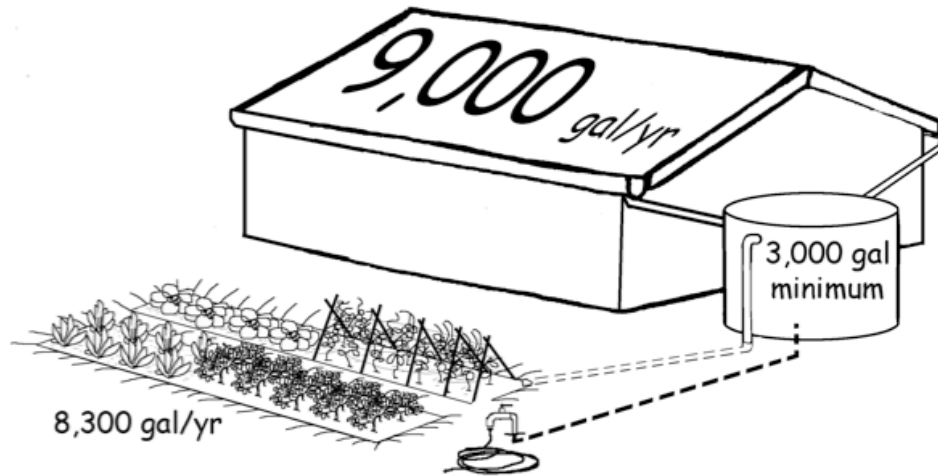
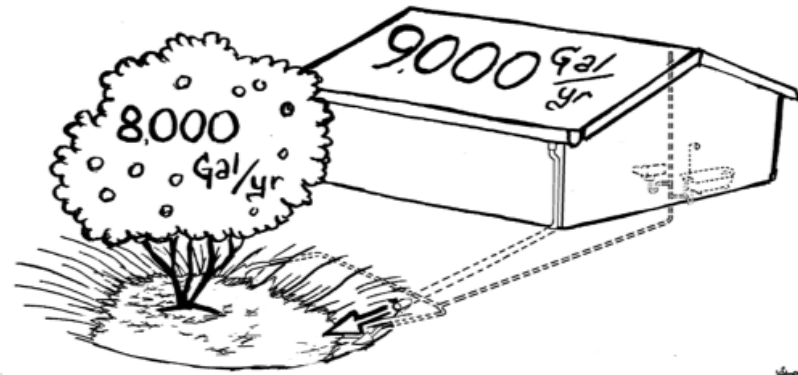
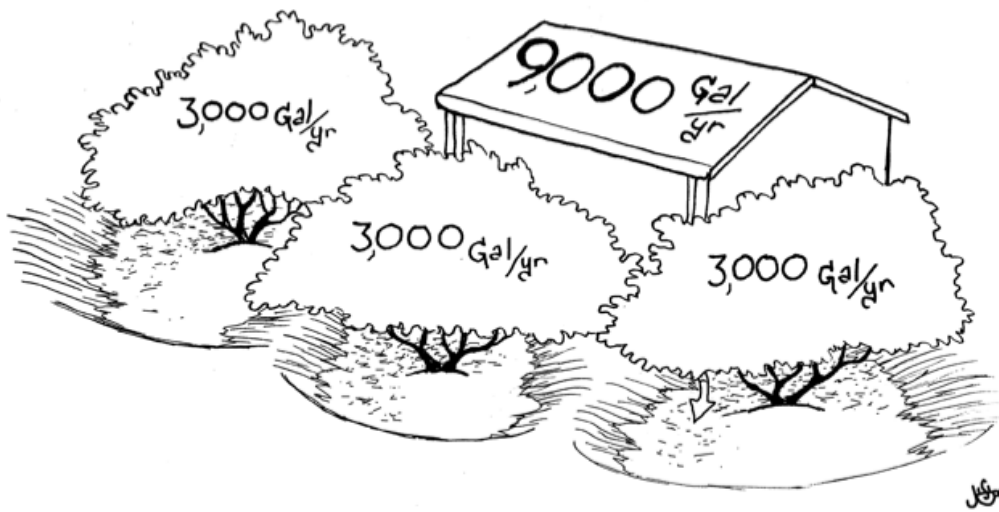
Decrease available rainfall



Path to *abundance* in the landscape:

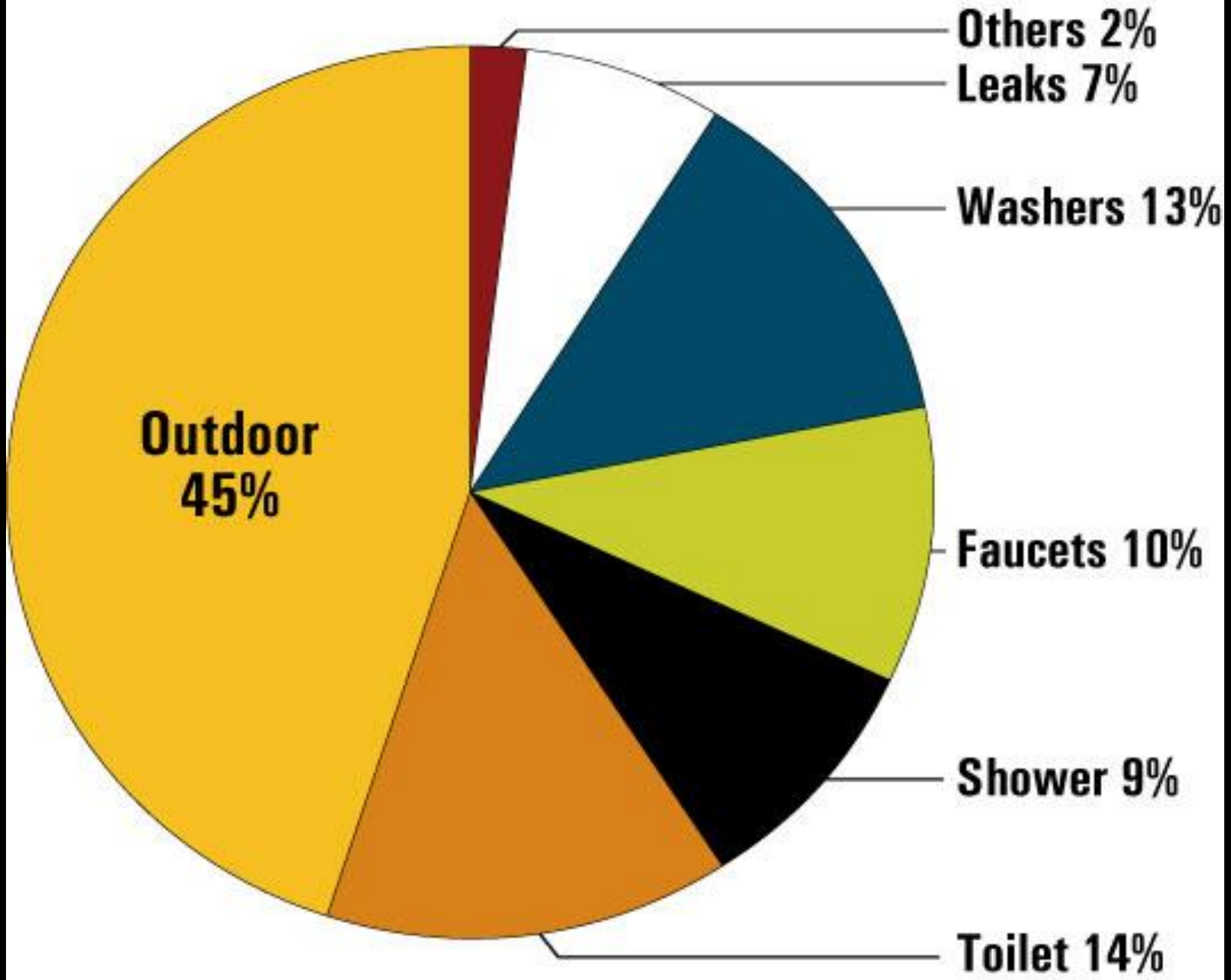
Increase available rainfall





9,000 gallons of water from (1,200-ft² roof) equals:

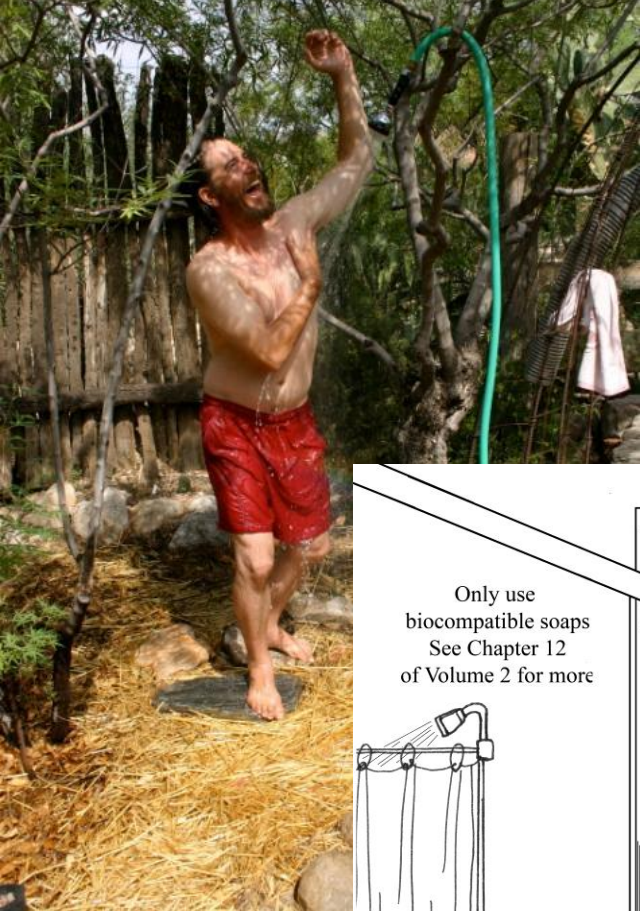
- 5,625 toilet flushes (1.6 gallons per flush)
- 750 loads of clothes washing (12 gallons per load)
- 900 five-minute showers (10 gallons per shower)



Water use in average single-family household in Tucson, AZ

From Tucson Water



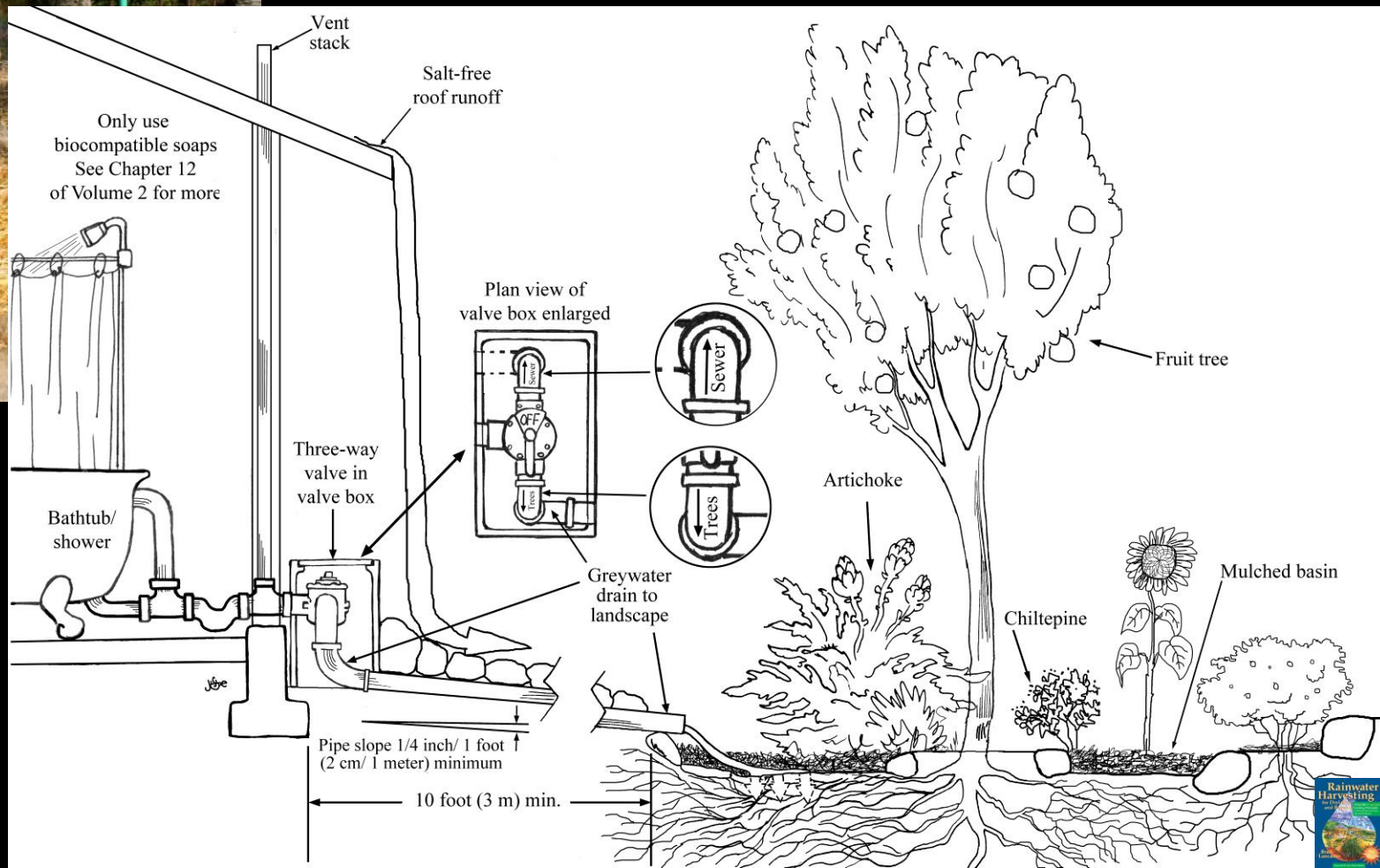


Greywater Harvesting

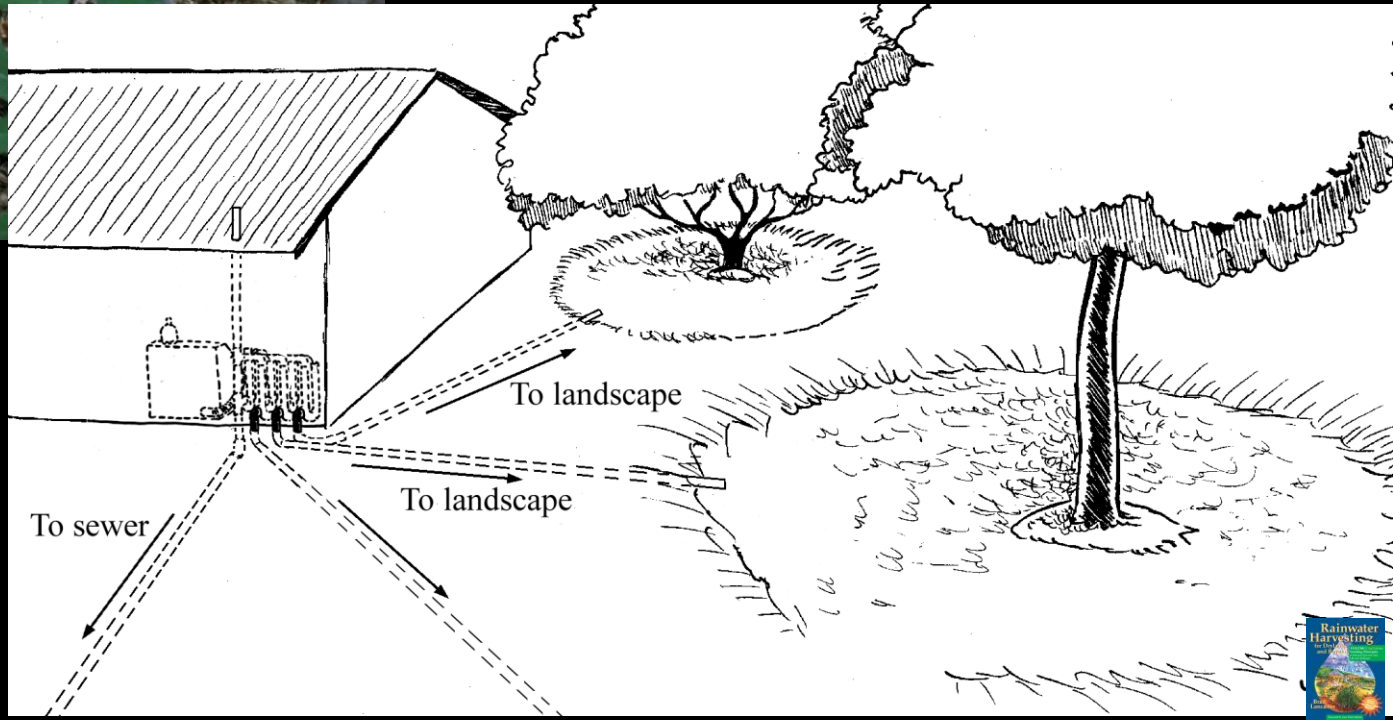
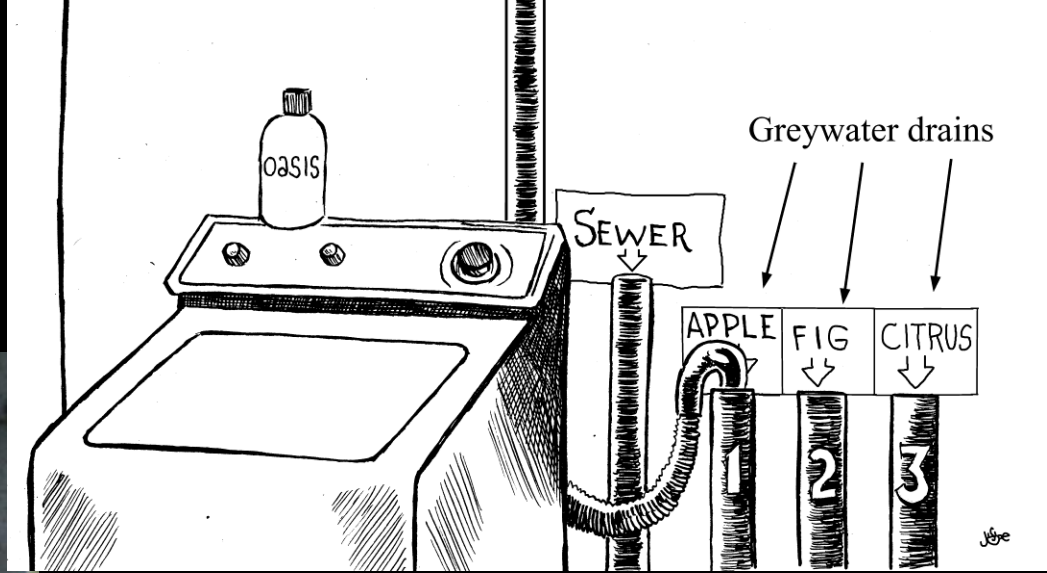
See Greywater Harvesting at

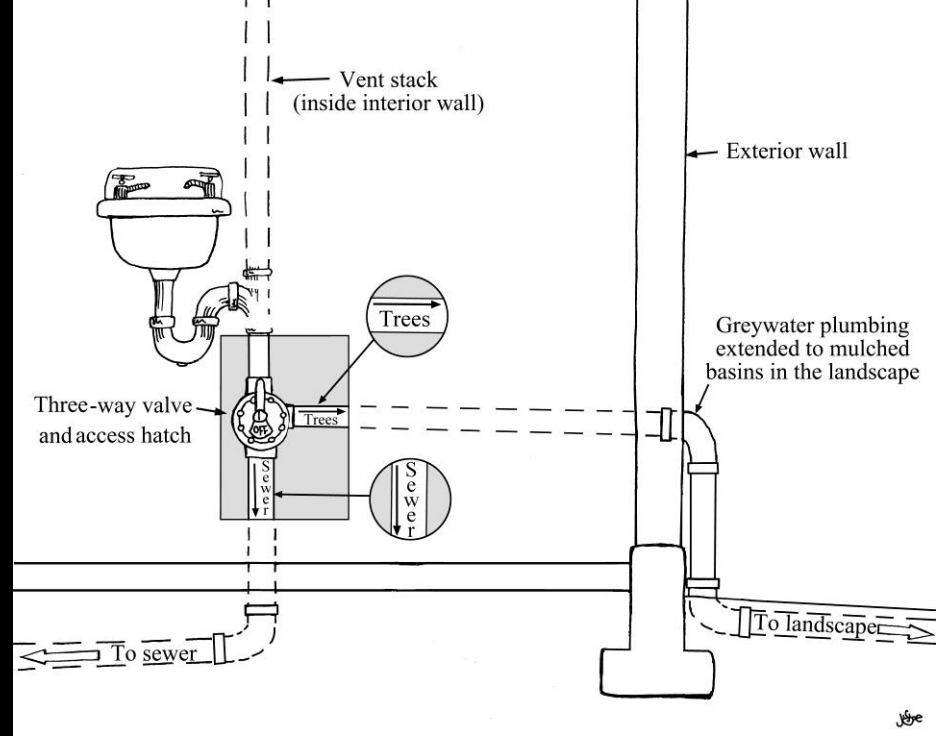
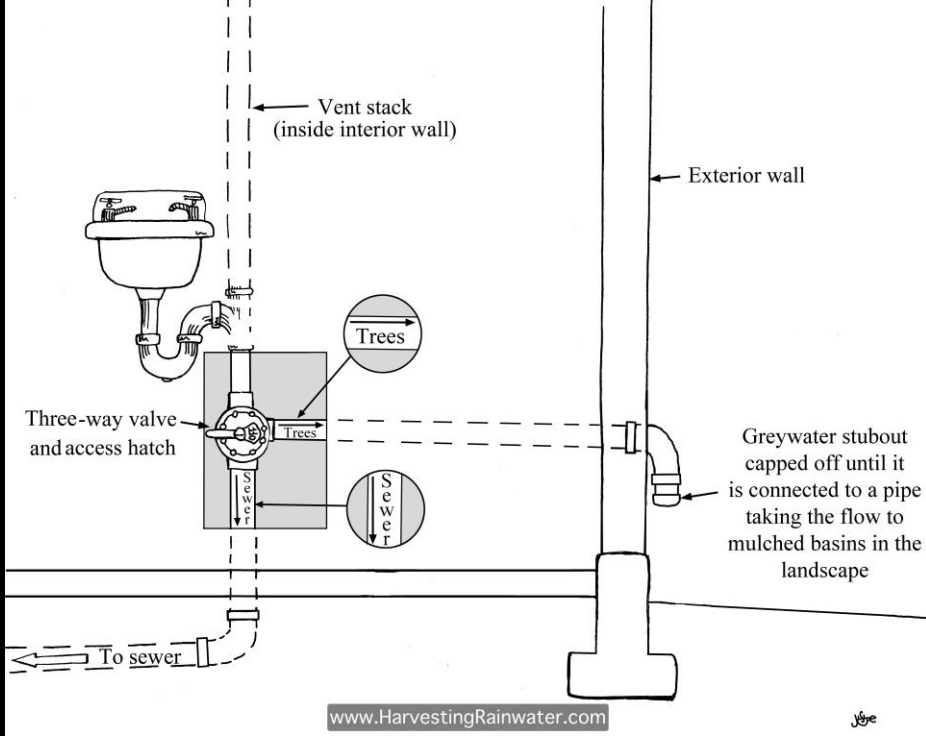
www.HarvestingRainwater.com

for more info including appropriate soaps and detergents, ordinances, & rebates



Multi-standpipe greywater diversion for washing machines





Greywater
stub out
and
3-way valve
plus \$1,000 rebate



Scarcity

30% of household *drinking water* goes down the flush toilet



Abundance

My composted brown gold
- no drinking water used





Air-conditioning condensate harvesting

DRY CLIMATE/SEASON:

a home air conditioner can generate
0.25 gallons (1 liter) of condensate/day

a large commercial air conditioner can
generate 500 gallons (1,900 liters)/day

HUMID CLIMATE/SEASON:

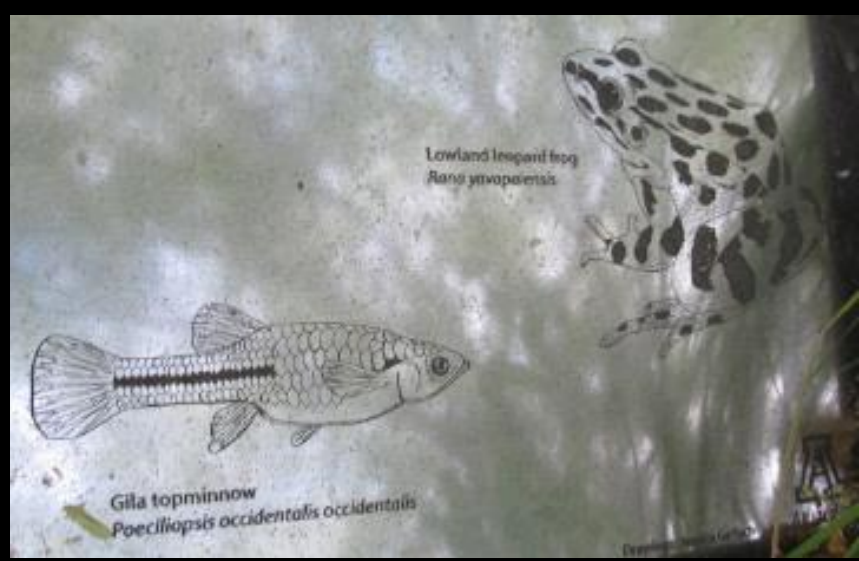
a home air conditioner can generate
18 gallons (68 liters) of condensate/day

a large commercial air conditioner can
generate 2,000 (7,500 liters) gallons



U of A College of Architecture and Landscape Architecture (CALA) Building, Tucson, AZ
www.cala.arizona.edu





Dead *drainageway* to living *infiltrationway*

U of A Architecture and Landscape Architecture Building, Tucson, AZ
CALA landscape tour www.cala.arizona.edu





Scarcity – heat island

Abundance – cool island

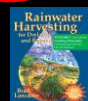


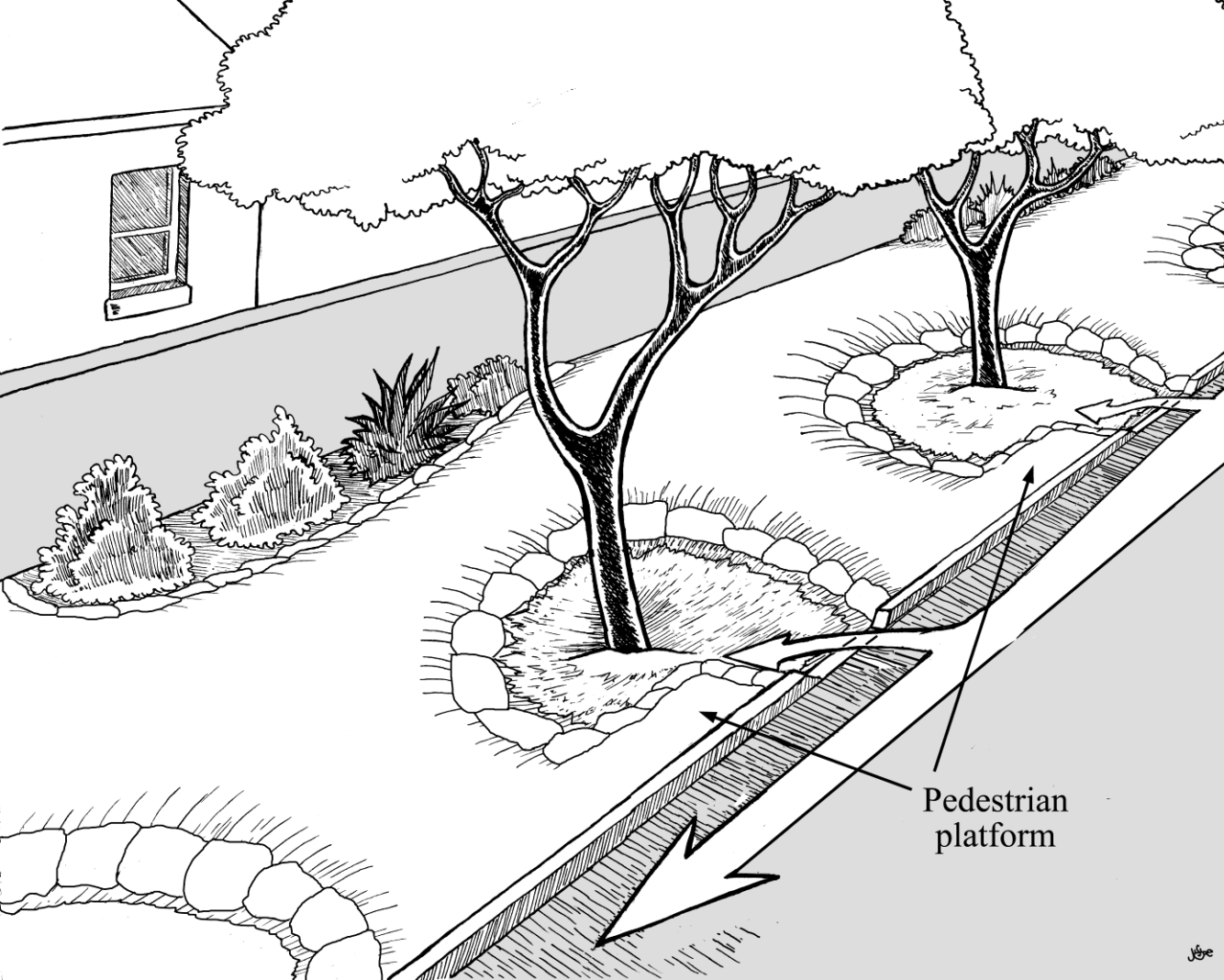
10° F (5.5° C) *increase* in summer

10° F (5.5° C) *decrease* in summer

| WATER | | AVERAGE RAINFALL (GAIN) ¹ | | | | | | | | | | | ANNUAL | |
|--------|--|---|------|-------|-------|-------|-------|-------|-------|-------|-------|------|--------|---------|
| | | 1906–2013 | | | | | | | | | | | | |
| | | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | |
| INCHES | | 3.20 | 3.38 | 2.40 | 1.01 | 0.25 | 0.06 | 0.01 | 0.05 | 0.27 | 0.48 | 1.25 | 2.41 | 14.77 |
| mm | | 81.3 | 85.9 | 61.0 | 25.7 | 6.4 | 1.5 | 0.3 | 1.3 | 6.9 | 12.2 | 31.8 | 61.2 | 375.2 |
| | | AVERAGE PAN EVAPORATION (POTENTIAL LOSS) ^{d,6} | | | | | | | | | | | | |
| | | 1948–2005 | | | | | | | | | | | | |
| INCHES | | 3.32 | 3.59 | 4.86 | 6.28 | 7.33 | 8.59 | 10.88 | 10.28 | 7.84 | 5.85 | 3.81 | 3.03 | 75.66 |
| mm | | 84.3 | 91.2 | 123.4 | 159.5 | 186.2 | 218.2 | 276.4 | 261.1 | 199.1 | 148.6 | 96.8 | 77.0 | 1,921.8 |

Tabled data is for Los Angeles from One-Page Place Assessments at www.HarvestingRainwater.com

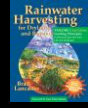




For every *inch* of rainfall...

- A 10-foot wide paved street will drain 27,800 gallons of rainfall per mile
- A 20-foot wide paved street will drain 55,700 gallons of rainfall per mile
- A 30-foot wide paved street will drain 83,500 gallons of rainfall per mile

Green Streets Policy in Tucson, AZ

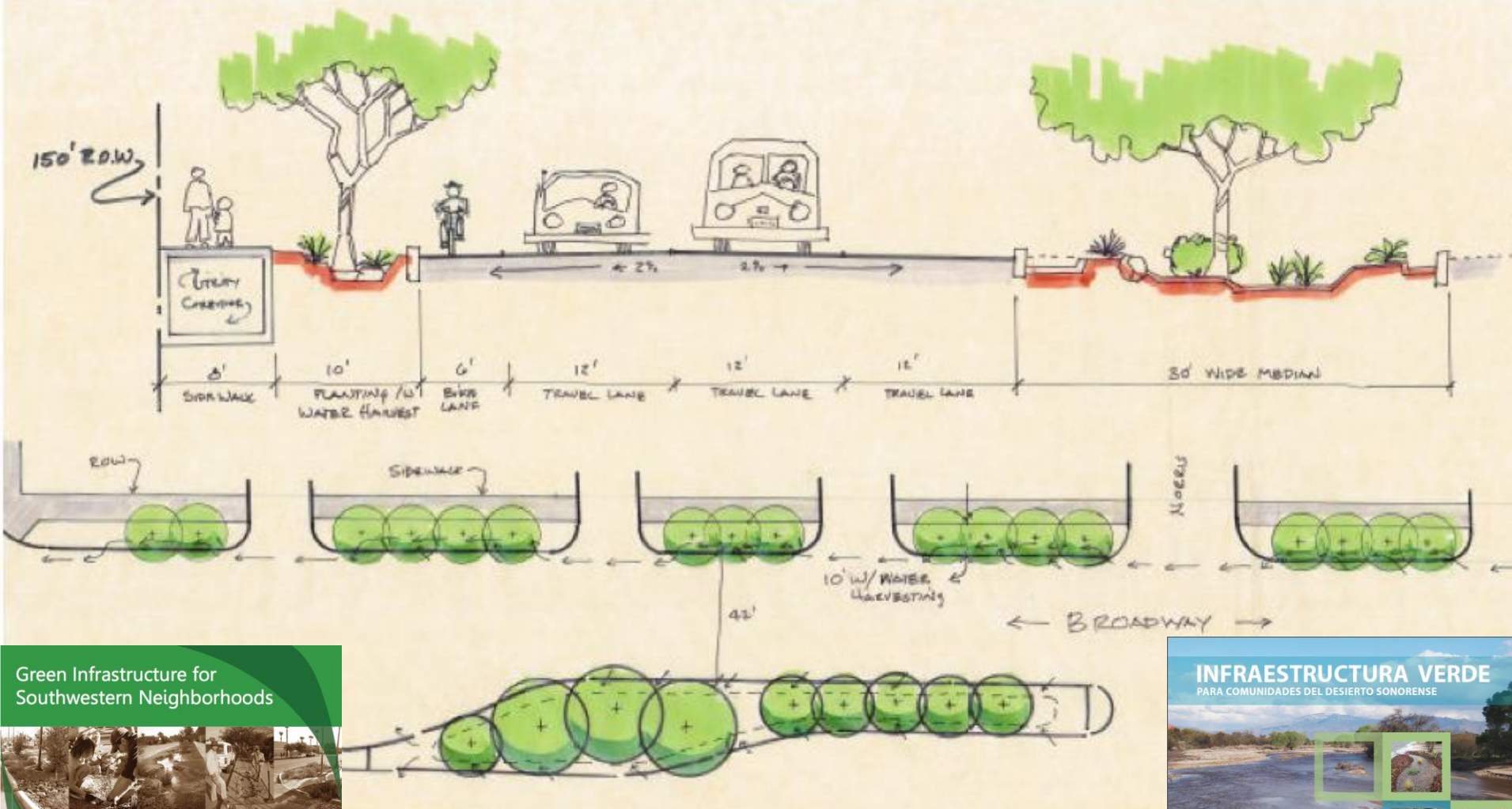


Minimum 1/2 -inch rainfall to be harvested in roadway or adjoining right-of-way

https://www.tucsonaz.gov/files/transportation/Green_Streets_APG_Signed_by_Director.pdf

Commercial landscape policy

At least 50% of commercial landscape irrigation needs must be met by harvested on-site rainwater



Green Infrastructure for Southwestern Neighborhoods

Watershed Management Group
Version 1.2
Revised October 2012

www.WatershedMG.org

INFRAESTRUCTURA VERDE
PARA COMUNIDADES DEL DESIERTO SONORENSE

Watershed Management Group



Prunings from tree used as mulch to fertilize tree and increase soil moisture

12 to 14% of the city's solid waste stream is yard trimmings

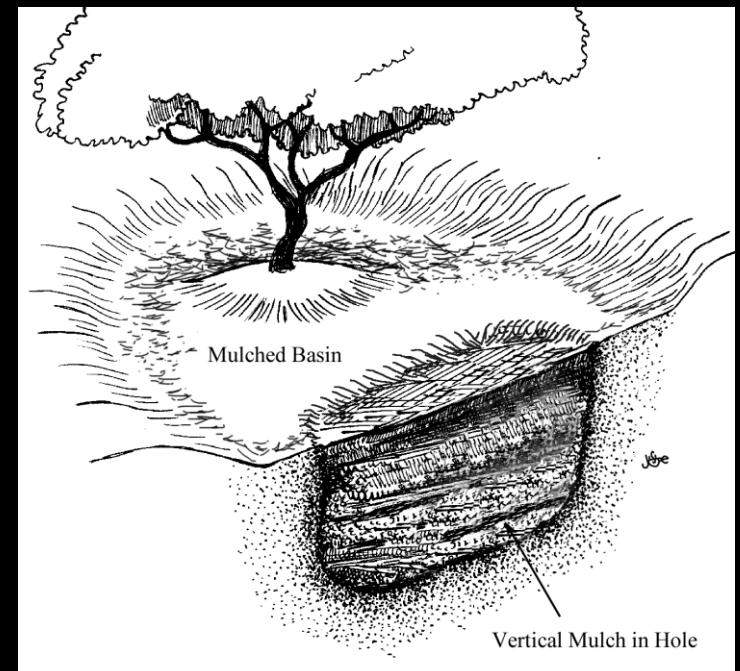
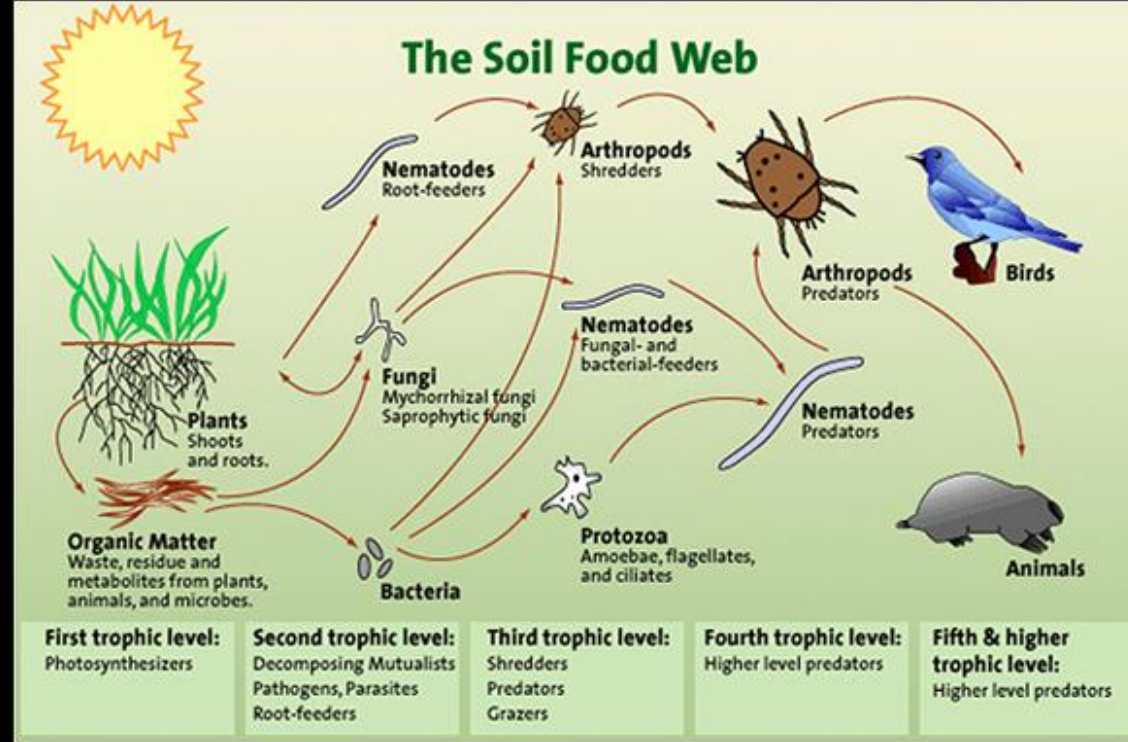


Brush and Bulky transformed into Chipped and Mulchy



Trees associated with mulched water-harvesting earthworks...

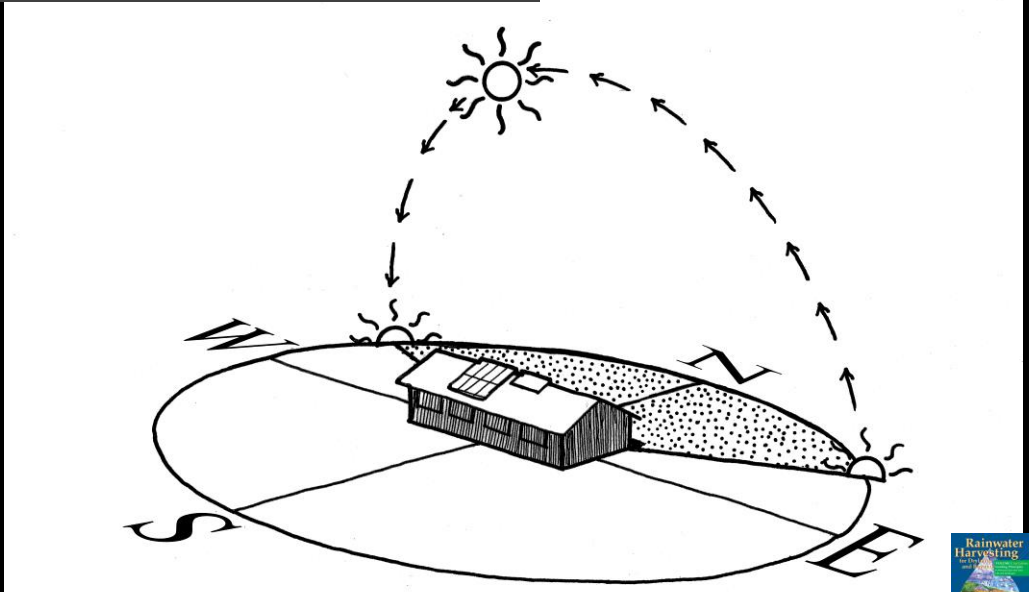
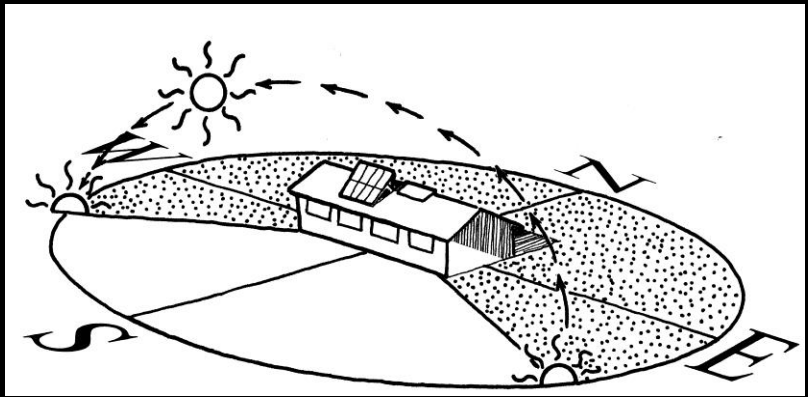
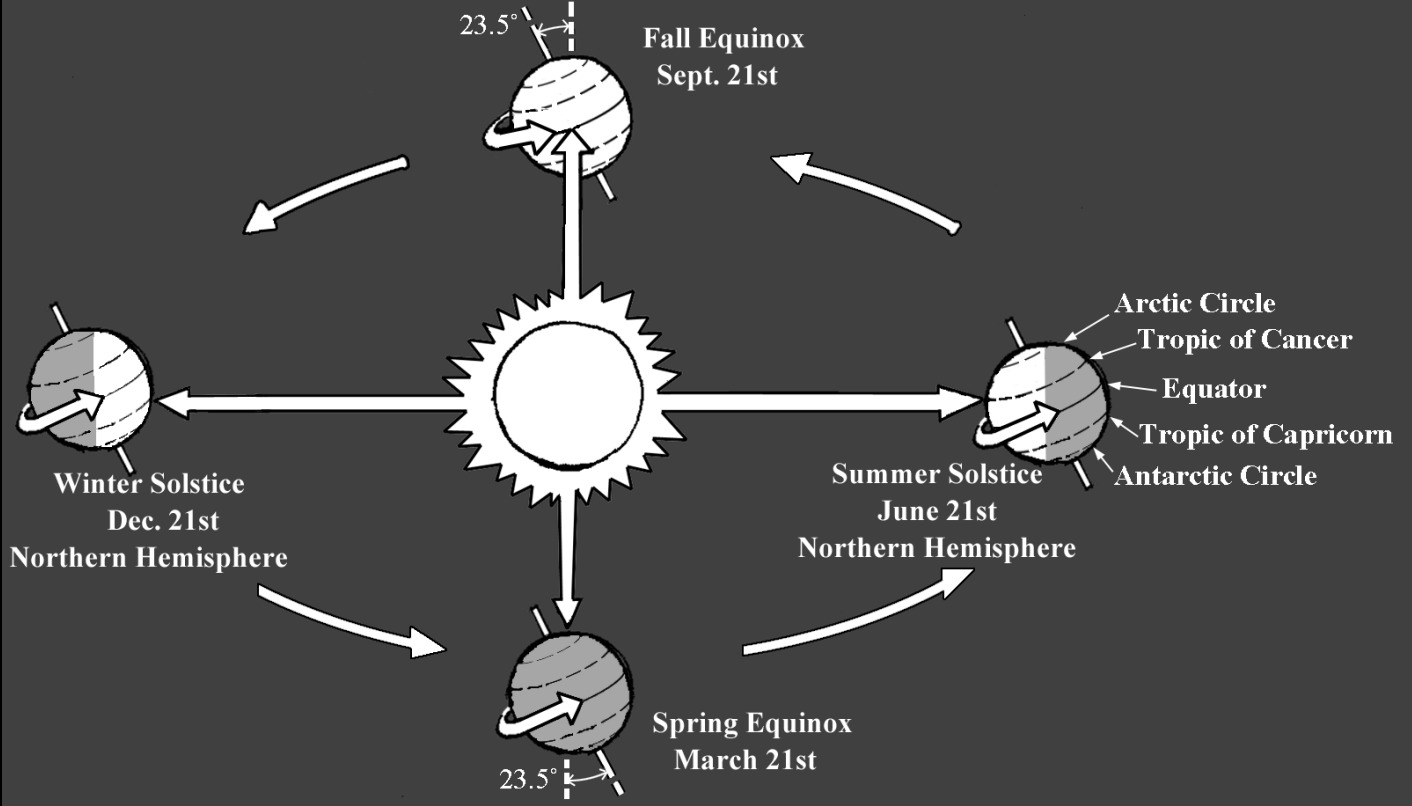
- Grow 33% larger than those without.
- Can more than double the trees' potential sequestration of atmospheric carbon, passive cooling, and food production
- Enable the soil itself to sequester additional carbon
- Increase the natural pollutant-filtering/bioremediation ability of the soil mulched with organic matter to **10 times** greater than rock- or gravel-mulched soil

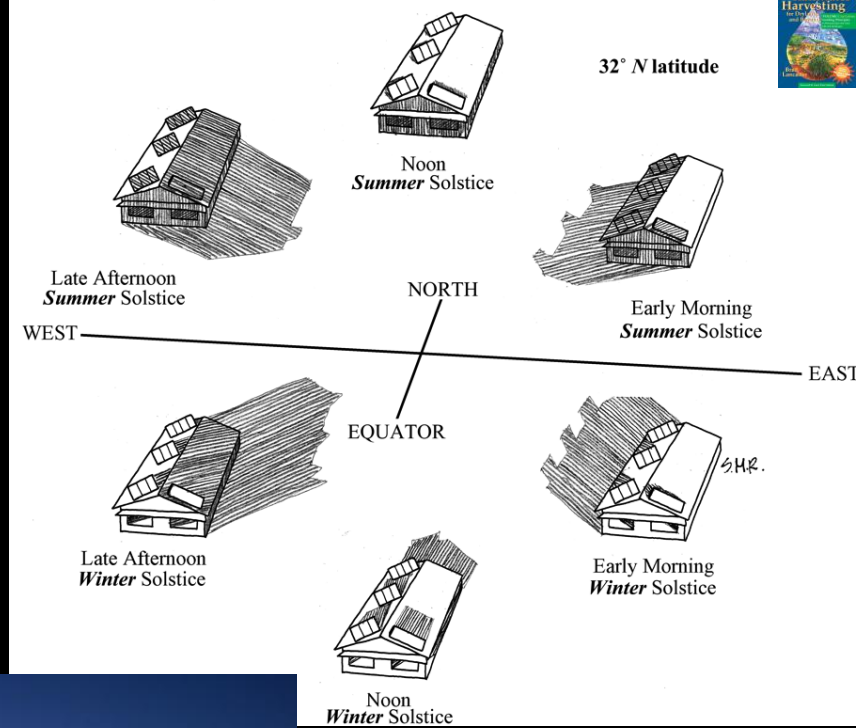
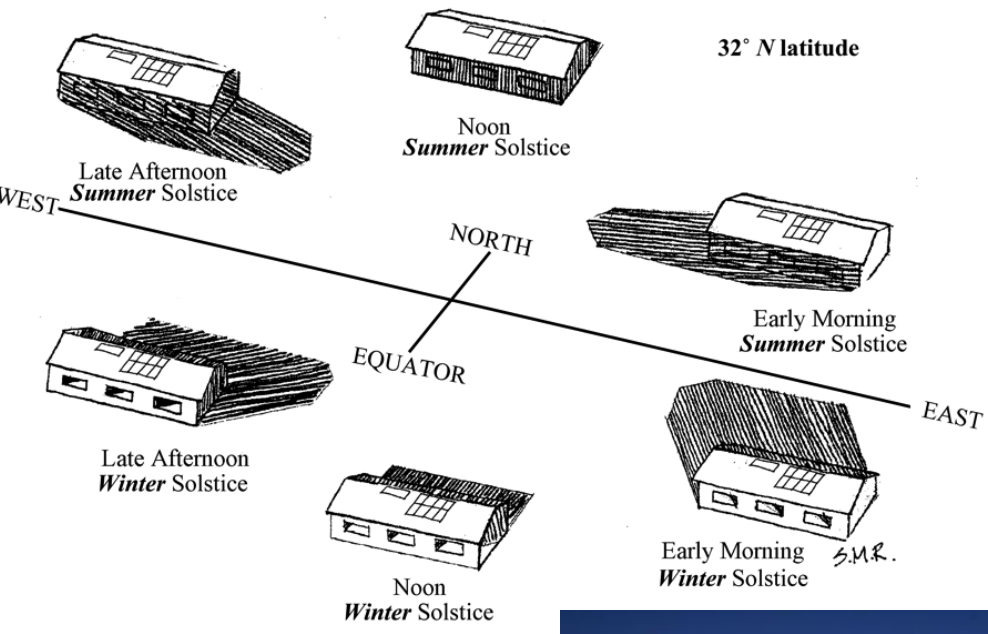


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 Biosphere 2 & School of Natural Resources and Environment
 University of Arizona mzuckerman@arizona.edu



Integrating with the Sun and more using Seven Integrated Design Patterns





Integrated Design Pattern One:

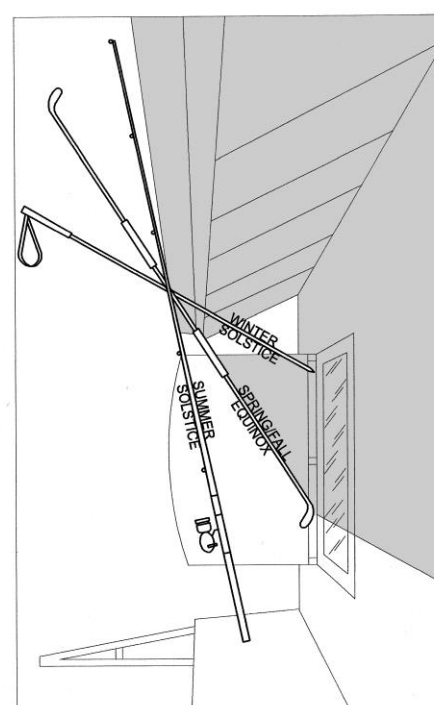
Orienting Buildings and Landscapes to the Sun



| SUN | | P2 | MAR 21 | JUN 21 | SEP 21 | DEC 21 |
|----------|-------|--|--------|--------|--------|--------|
| LATITUDE | 34.1° | DEGREES N or S of DUE EAST THE SUN RISES ³ | 0° | 29°N | 0° | 28°S |
| | | DEGREES N or S of DUE WEST THE SUN SETS ³ | 0° | 29°N | 0° | 28°S |
| | | SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON) ^{3,4} | 56° | 79° | 56° | 33° |



December 21



*Integrated Design
Pattern Two:*

Designing Roof
Overhangs and
Awnings to
Optimize
Winter Sun and
Summer Shade

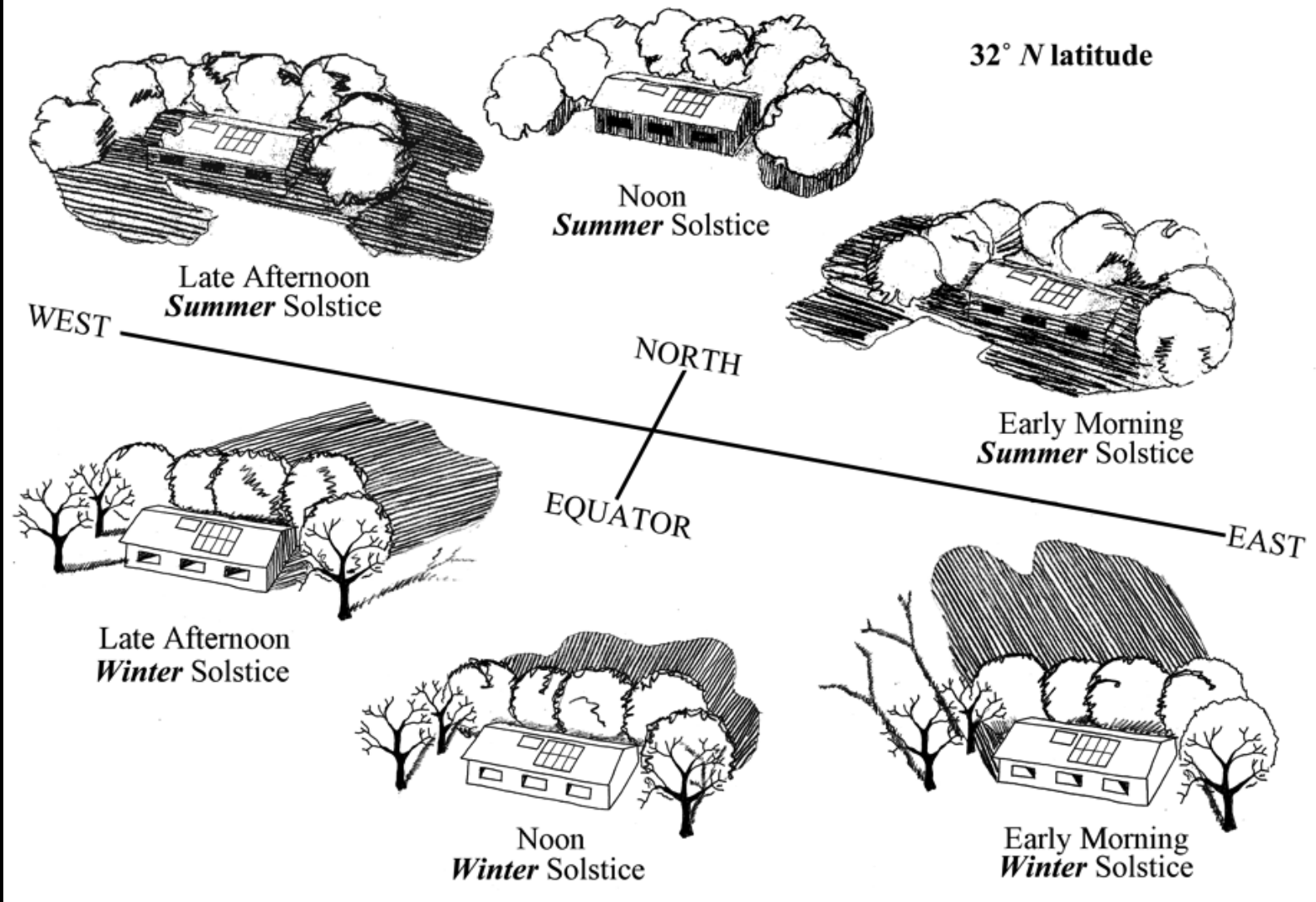


March 21



June 21

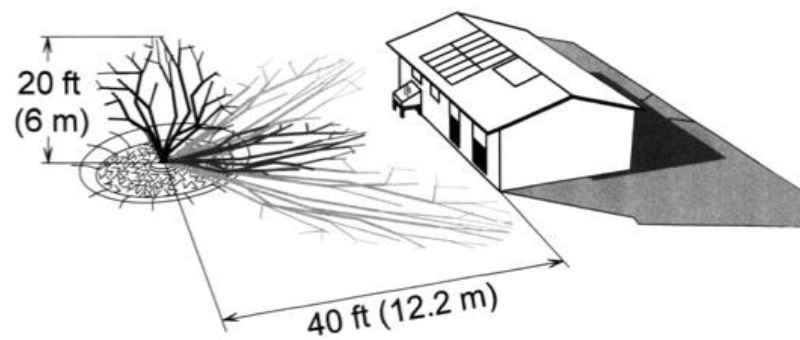
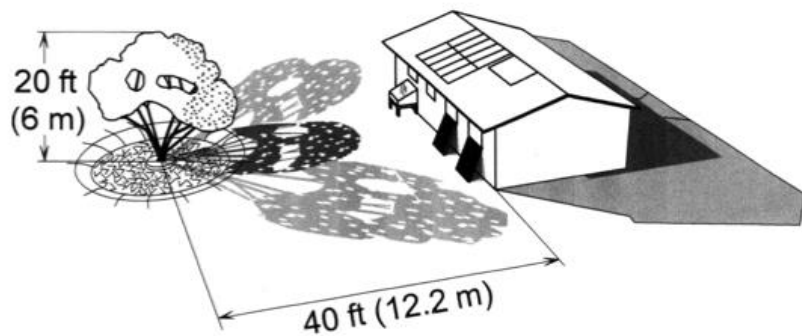
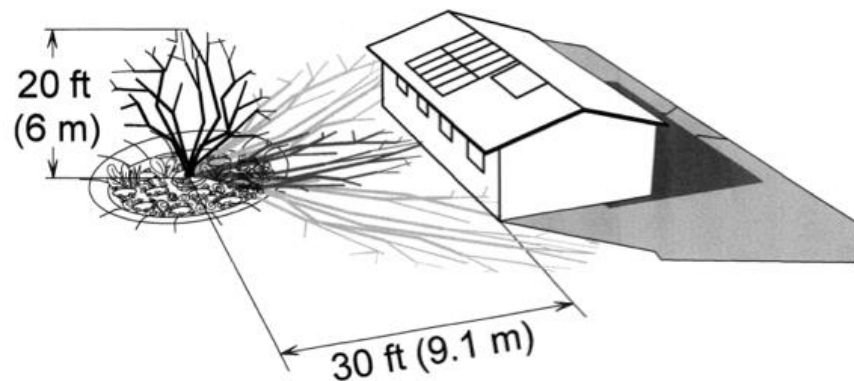
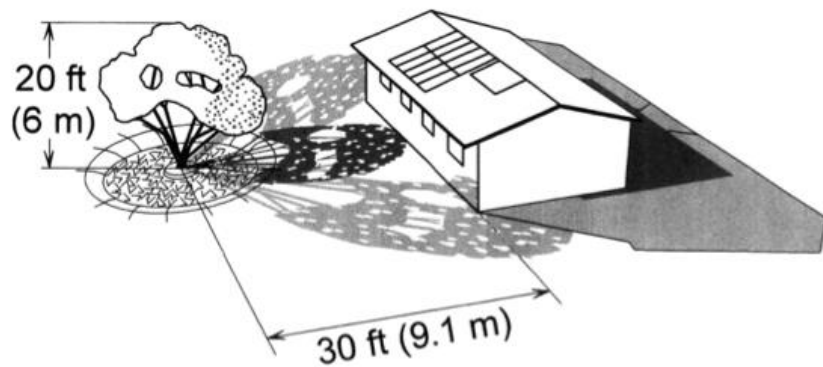
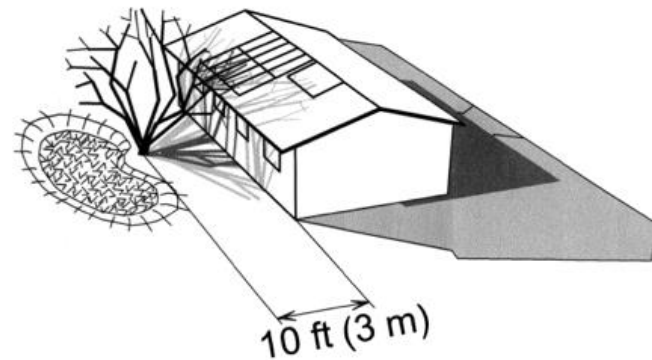
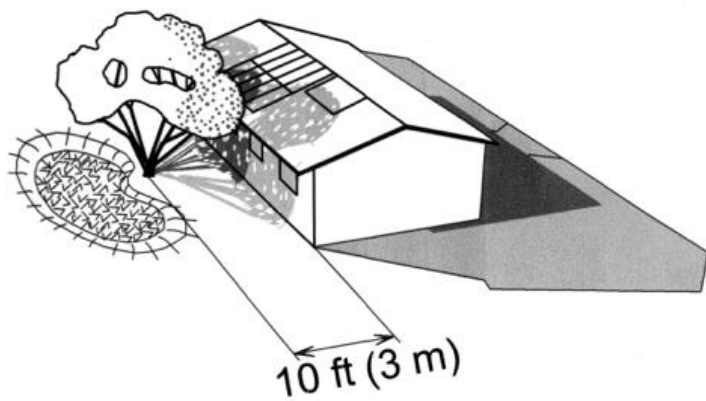




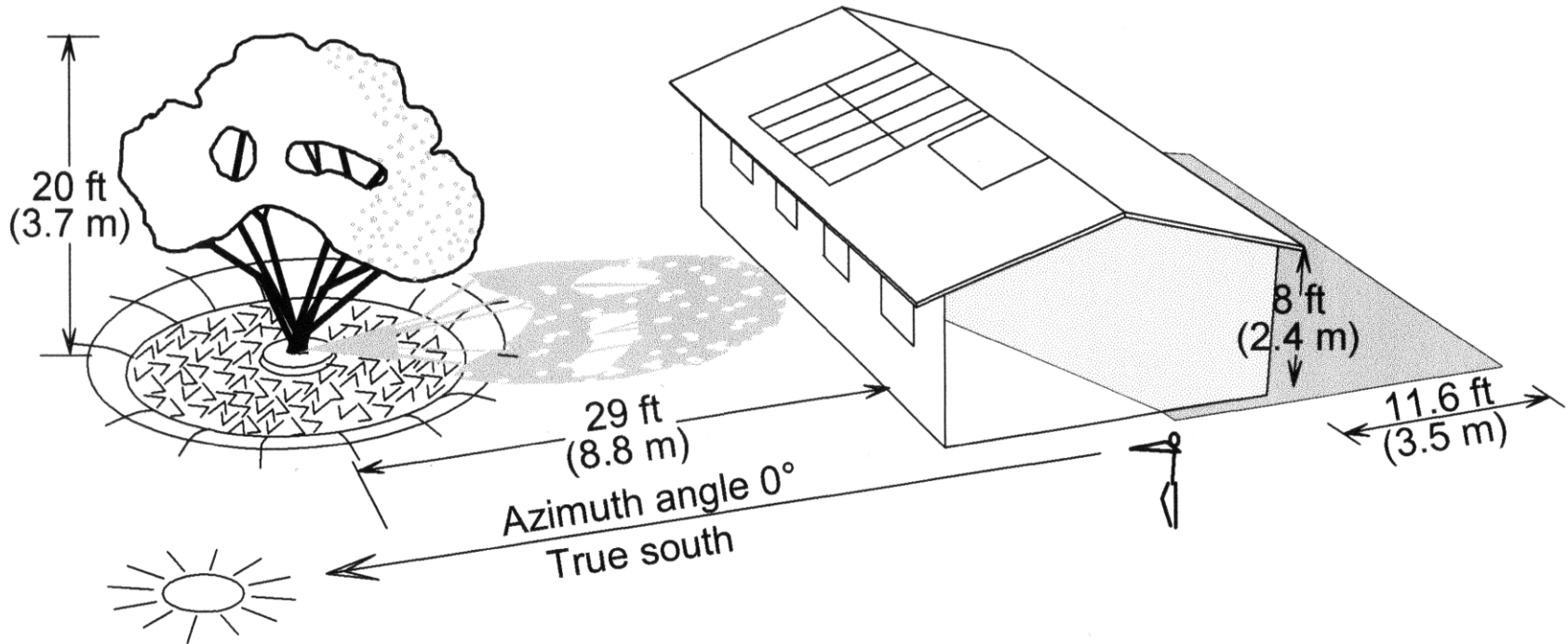
*Integrated
Design Pattern
Three:*
Solar Arcs

| | MAR 21 | JUN 21 | SEP 21 | DEC 21 |
|--|--------|--------|--------|--------|
| DEGREES N or S of DUE EAST THE SUN RISES ³ | 0° | 29°N | 0° | 28°S |
| DEGREES N or S of DUE WEST THE SUN SETS ³ | 0° | 29°N | 0° | 28°S |
| SOLAR-NOON ALTITUDE ANGLE (ABOVE HORIZON) ^{2,3,4} | 56° | 79° | 56° | 33° |

Integrated Design Pattern Five: Maintaining Winter Sun Access

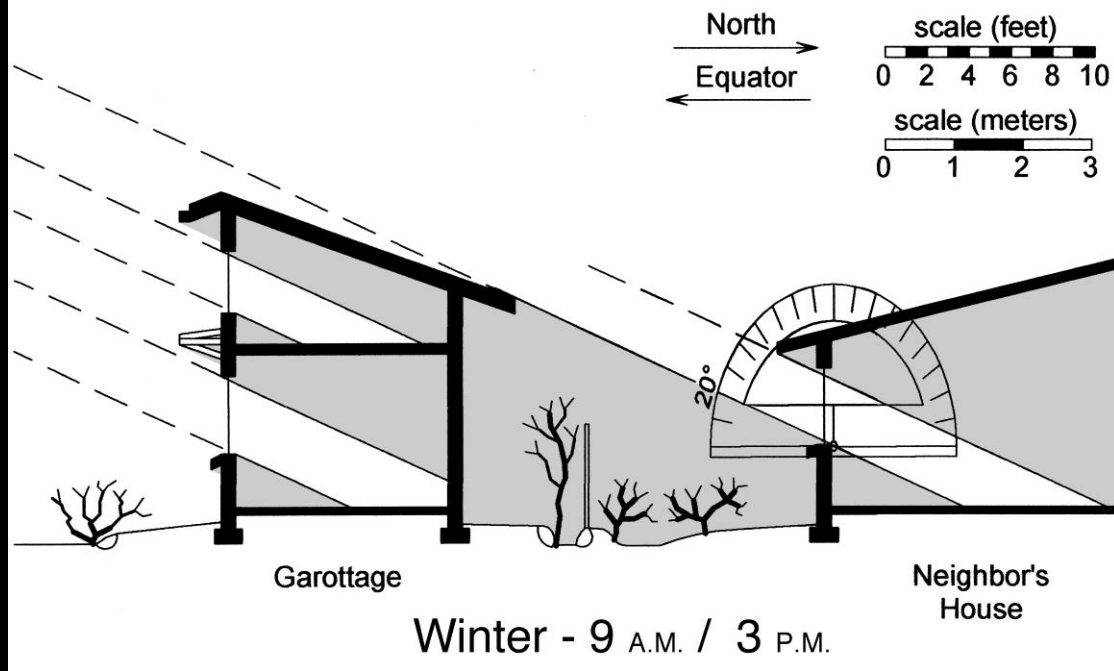


Maintaining *winter* sun access at noon



SOLAR-NOON WINTER-SOLSTICE SHADOW RATIO^b

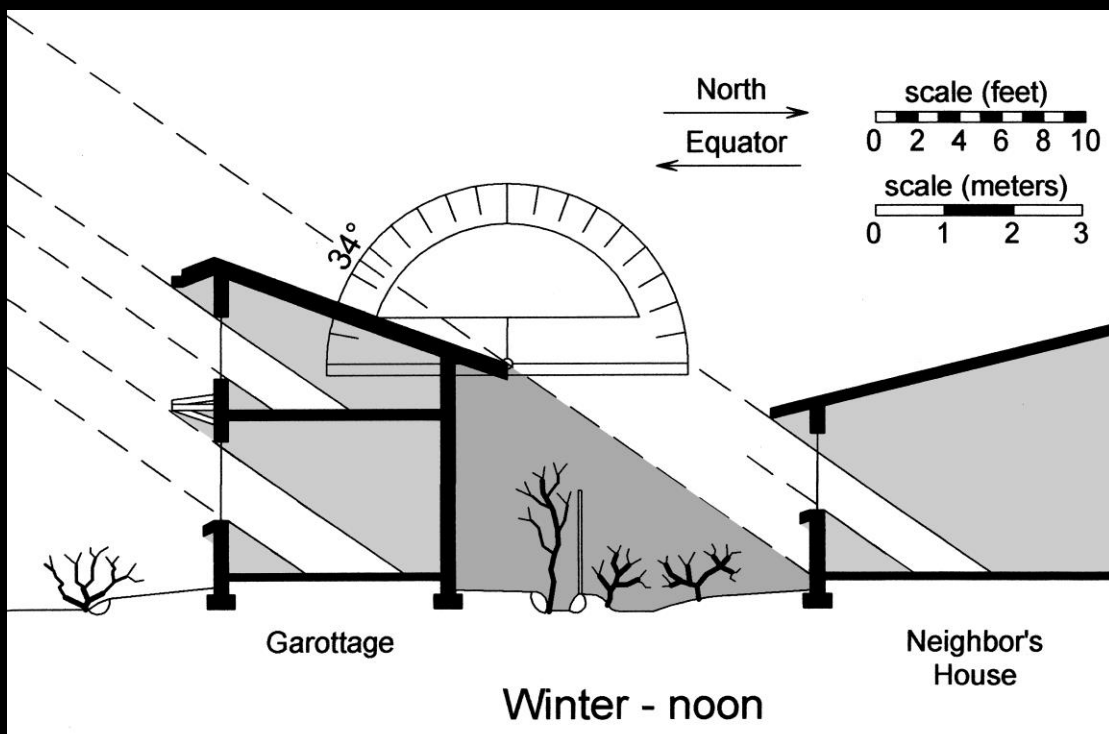
1 : 1.57



Solar Rights

Search “Solar Easements and Solar Rights”
at

www.HarvestingRainwater.com



and make sure you do *not*
choose the wrong
winter-sun-facing windows
that would block out the
warmth from the sun





1994



2004 - 2005 curb cuts and
street runoff harvesting began

For more see

<http://www.harvestingrainwater.com/street-runoff-harvesting/>





Curb cuts legalized in 2007
\$50 permit



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

For more info see
<http://www.harvestingrainwater.com/street-runoff-harvesting/>



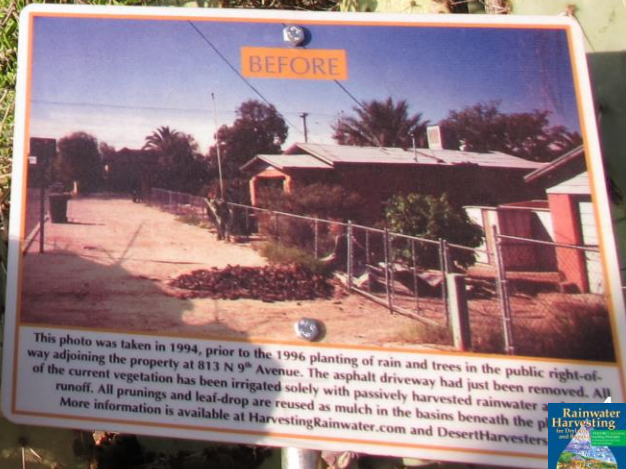


^ 1994

2006

>

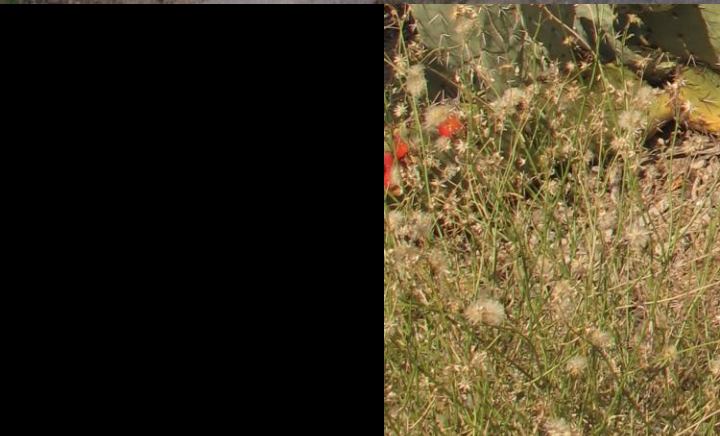


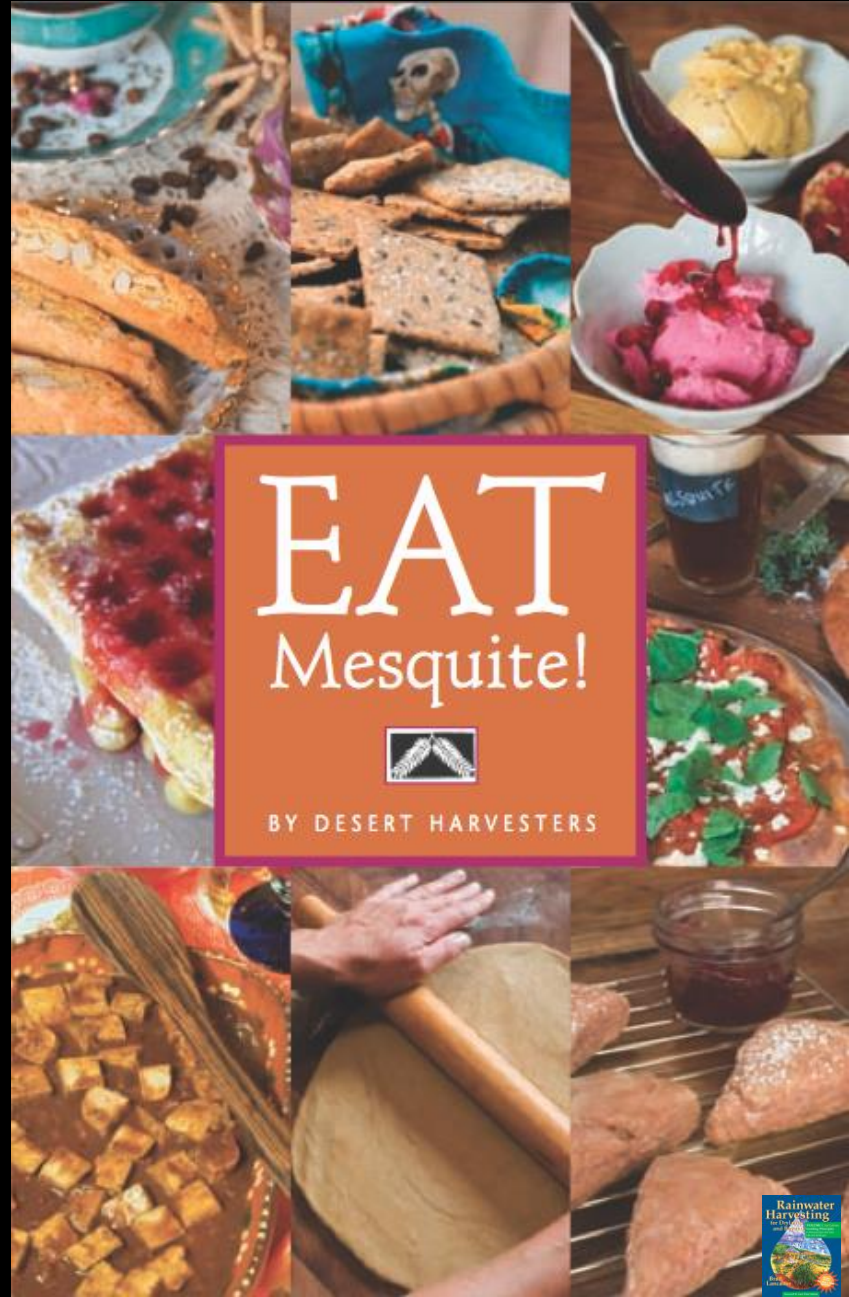


BEFORE

This photo was taken in 1994, prior to the 1996 planting of rain and trees in the public right-of-way adjoining the property at 813 N 9th Avenue. The asphalt driveway had just been removed. All of the current vegetation has been irrigated solely with passively harvested rainwater runoff. All prunings and leaf-drop are reused as mulch in the basins beneath the trees. More information is available at HarvestingRainwater.com and DesertHarvestery.com







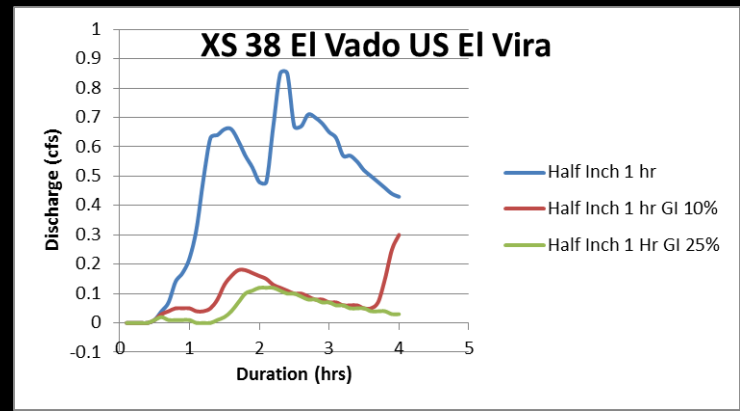
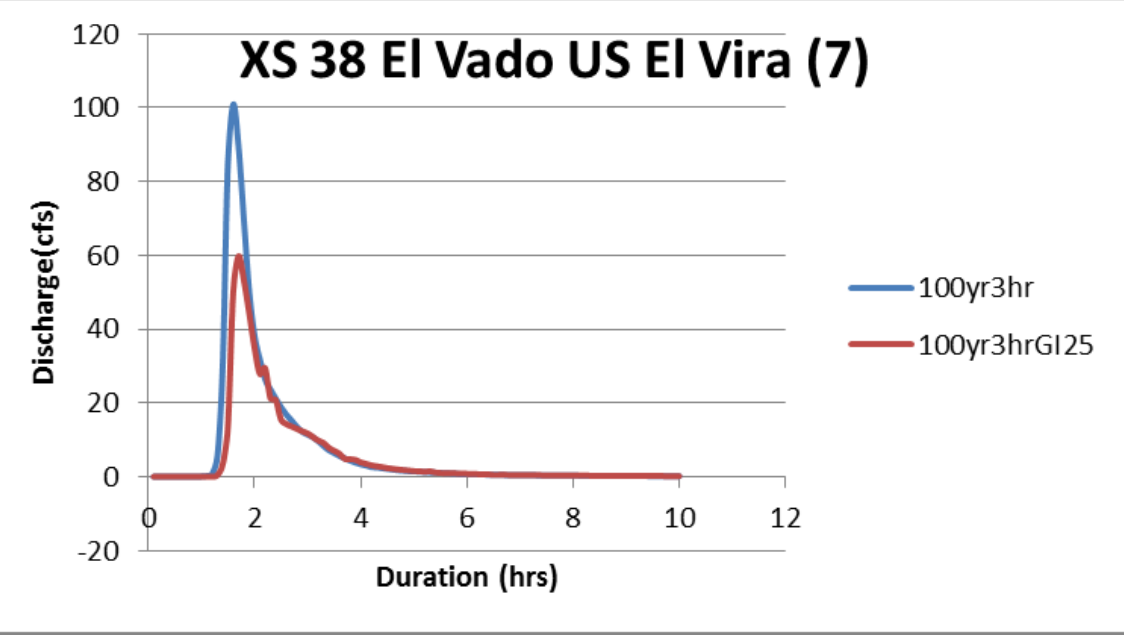
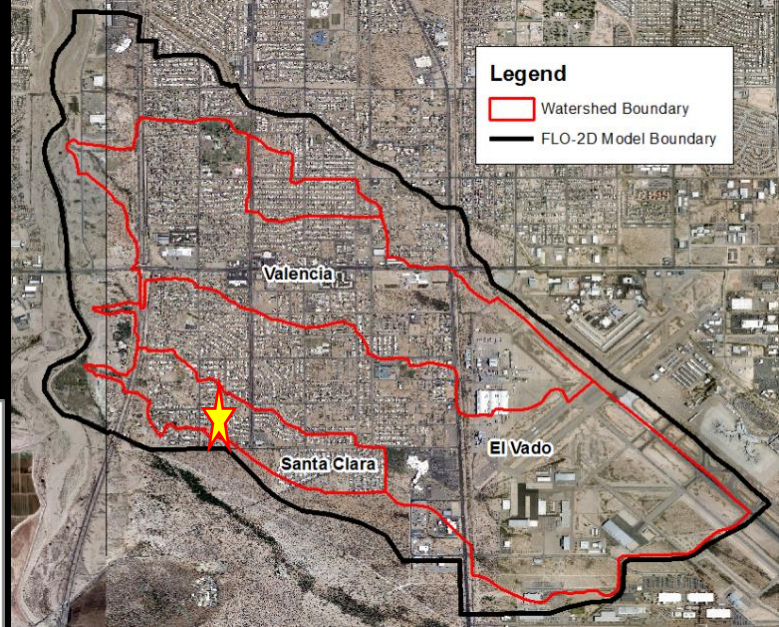


Lost Sonoran Sucker
fish and water-
harvesting Horned
Lizard sculpture
by Joseph Lupiani
in a water-harvesting
traffic-calming chicane



Green Infrastructure installed in 25% of the available unpaved areas of 30-acre El Vado watershed resulted in:

- 40% peak flow reduction
- Over 25% reduction in volume of flow



Solving Flooding Challenges with Green Stormwater Infrastructure in the Airport Wash Area



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

Green Streets Benefit/Cost Ratio Initial Results



Model representation



Benefit/Cost Ratio:

\$2.1 /

Direct Value Only:

\$1.5 /

Parking Lots and In-Street Features: Bustin' Up Asphalt



Model representation

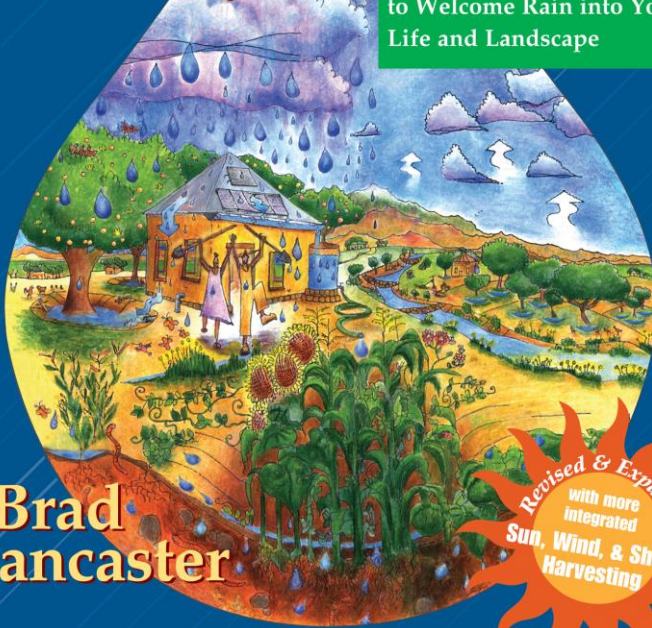
Benefit/Cost Ratio:

\$0.5 / \$1

Rainwater Harvesting

for Drylands
and Beyond

VOLUME 1 *2nd Edition*
Guiding Principles
to Welcome Rain into Your
Life and Landscape



Brad
Lancaster

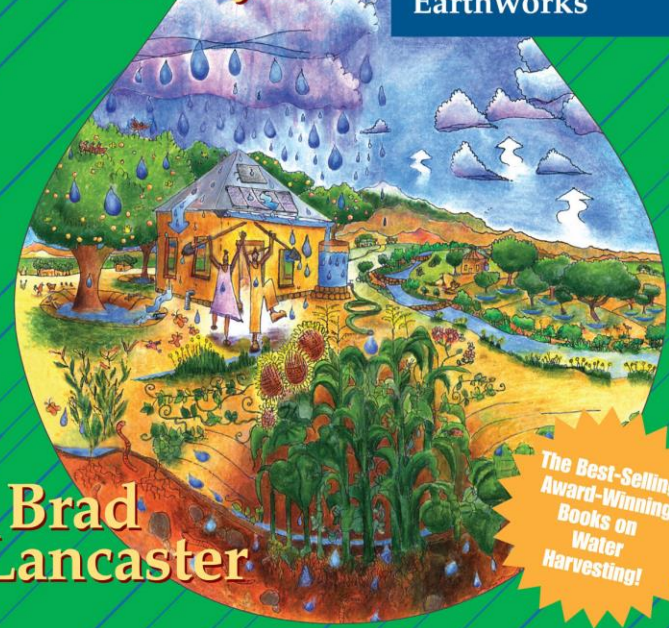
Revised & Expanded
with more
integrated
Sun, Wind, & Shade
Harvesting

Foreword by Gary Paul Nabhan

Rainwater Harvesting

for Drylands
and Beyond

VOLUME 2
Water-Harvesting
Earthworks



Brad
Lancaster

*The Best-Selling,
Award-Winning
Books on
Water
Harvesting!*

Foreword by Andy Lipkis

www.HarvestingRainwater.com

Policy Recommendations

What is the overall desired effect?

A question to ask to ensure we are on the right track, and that we are thinking of the big picture at the same time we look at the details.

I propose the desired effect is to generate policy and actions that simultaneously enhance the health of the ecological systems upon which we all depend as they also enhance the health of all our citizens.

To that aim, let's make it more convenient and joyous for the public to do the right thing by legalizing and incentivizing (rebates, classes/guiding information, policy, ordinances, & demonstration sites at public facilities, schools, plant nurseries, and hardware stores) best actions and evolution.

Sun & Shade Harvesting Policy Recommendations

- **Maintain Solar Rights and Solar Easements**

Search “Solar Rights and Solar Easements” at www.SunandShadeHarvesting.com

- **Incentivize and mandate ideal solar orientation of buildings and landscapes** for free, passive heating and cooling

- Every community should have ideal south-/equator-facing **window to overhang length guidelines/requirements** to maximize summer shading and winter sun access/heating/lighting.

See pages 99 to 106 of *Rainwater Harvesting for Drylands and Beyond, Volume 1, 2nd Edition*.

- Ensure all window manufacturers **carry ideal windows for passive solar heating and cooling**, and that window suppliers are aware of these and inform the public on their use. Currently, most low-E windows available on the market do NOT allow for passive winter heating.

See pages 104 to 105 of *Rainwater Harvesting for Drylands and Beyond, Volume 1, 2nd Edition*.

- Educate designers, planners, and landscapers on **ideal tree placement for passive summer cooling AND passive winter heating**

See pages 106 to 117 of *Rainwater Harvesting for Drylands and Beyond, Volume 1, 2nd Edition*.

Rainwater Harvesting Policy Recommendations

- Increase required tree canopy in the built environment.
- Ensure hardscape drains to planting areas to irrigate the trees for free.
- Use recycled on-site organic material mulch rather than gravel or rock as a groundcover to increase the life, bioremediation ability, and sponge-effect of the soil.

- Tucson Green Streets Policy mandating '½-inch rainstorms' worth of water harvesting in street medians and public right-of-way landscapes
https://www.tucsonaz.gov/files/transportation/Green_Streets_APG_Signed_by_Director.pdf

- Legalize and incentivize retrofit street curb cuts and curb cores
<http://www.harvestingrainwater.com/street-runoff-harvesting/>

- All turf removal programs, must create basin-like, passive rainwater-harvesting topography (rain gardens), before putting in new vegetation. That way the *landscape itself* can harvest and store more water.

- Incentivize use of larger rainwater tanks sized to capture most of the water coming off a roof area in a typical storm. The capacity of rain barrels is too small
- Mandate all new homes install rainwater harvesting tank system for outdoor faucets, laundry, and toilet as is the law in the major cities of Australia such as Brisbane

- Delineate our political and property boundaries by watershed boundaries
<http://www.harvestingrainwater.com/2011/09/22/watershed-maps-are-community-maps/>

Greywater Harvesting / Wastes to Resources Policy Recommendations

What is the most dangerous thing we can do to greywater?

Turn it into blackwater.

- Mandate greywater-harvesting stub-outs in new home construction allowing for inexpensive gravity-fed reuse of the greywater in the landscape.

<http://www.harvestingrainwater.com/greywater-harvesting/greywater-collection-plumbing-and-stub-outs/>

<http://oaec.org/our-work/projects-and-partnerships/ca-decentralized-water-policy-council/>

- Offer greywater-harvesting rebates with educational classes on best practices

<https://www.tucsonaz.gov/water/gray-water>

- Educate public on correct soaps and detergents to use with greywater systems.

<http://www.harvestingrainwater.com/greywater-harvesting/greywater-compatible-soaps-and-detergents/>

- Incentivize soap and detergent manufacturers to produce truly greywater-compatible soaps and detergents. Currently, most biodegradable soaps are not appropriate for greywater use because they contain too many soil and plant harming salts.

- Legalize use of compost toilets, including affordable site-built options.

<http://www.recodenow.org/portfolio/legalized-site-built-composting-toilets/>