Native Trees for Tucson

# 10 Tips to Grow Native Desert Trees with Harvested Water

A PROJECT OF

TUCSON CLEAN & BEAUTIFUL

Its getting hotter and drier

- Tucson is 3rd fastest warming US city
- 2019 and 2020 set heat records
- Heat Island effect is raising city temperatures both day and night
- Parking lots and other bare "hardscapes" are especially hot
- Average temperatures could increase by 10 degree by 2100
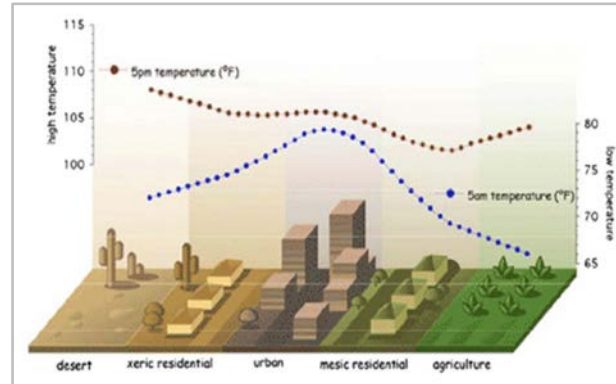
Source: Figure 1. Typical profile of Phoenix urban heat island using five predominant land cover types in the metropolitan area (Harlan, et al, 2007) in International Journal of Biometereorology, by D. Ruddell, P Dixon, published online, October 22, 2013

U.S. Drought Monitor
Arizona

February 9, 2021
(Released Thursday, Feb. 11, 2021)
Valid 7 a.m. EST

Intensity:
- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Brad Rippey
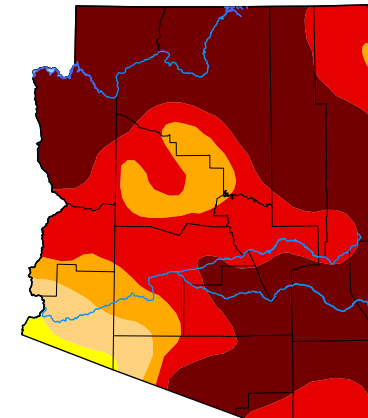U.S. Department of Agriculture

droughtmonitor.unl.edu

We need more shade

- Greatest concerns for increased heat: neighborhoods with <10% shade
- Average shade, eastern Pima Co., 8%
- Average shade, Tucson, <6%
- Average shade in some wards, <4%

We must conserve drinking water

- We get drinking water from CAP water that originates in the Colorado River
- Colorado River flows are expected to decrease 7.7% due to earlier snow melts in Colorado
- Headline April 19, 2021, *"West prepares for possible first water shortage declaration"*

Projected average annual temperatures in Pima County through 2100
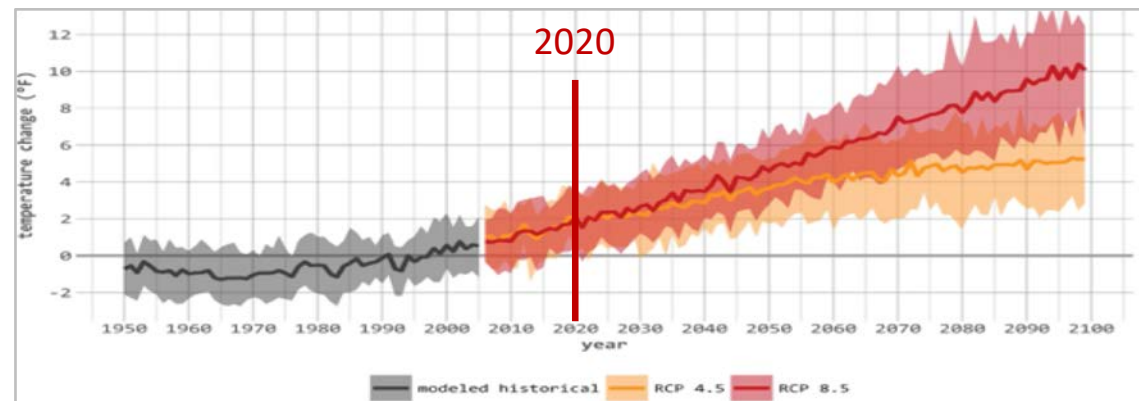
Source: Presentation by Dr. Ladd Keith given at the 2020 On-line Desert Horticulture Conference, Tucson, AZ

Native trees increase shade, improve climate resiliency and save drinking water

Native trees are adapted to heat and drought

- They grow in natural habitats on rainfall and runoff alone
- Small leaves deflect UV rays
- Broad multitrunk canopies cool branches, trunks and soil below
- Native trees respond naturally to intense heat and drought
  - Yellowing, dropping leaves
  - Self pruning branches
  - Skipping flowering-seeding cycles

How to increase shade while saving drinking water

- Tucson produces abundant free, harvestable water
  - Rainfall and rainwater runoff
  - Stormwater runoff
  - Graywater from homes
  - Condensate water from cold-producing machines
- In the hot city, native trees given harvested water
  - Grow faster and larger
  - Create deeper shade
  - Avoid natural drought responses
  - Meet urban shade and aesthetic standards

The natural draping shape of a desert ironwood tree shades branches and trunk and shelters wildlife

Ancient ironwood tree in natural setting with a canopy around 45-foot in diameter

10-year old well-pruned urban ironwood thriving on street runoff alone

13-year old well-pruned urban ironwood thriving on rooftop runoff and potentially water from septic leach field

## Native trees provide many benefits in addition to shade

- Serve as shady "nurse plants" for small saguaros and other native plants
- Have edible fruits, seeds and pods, increasing local food
- Feed and shelter native insects, birds and other wildlife
- Grow well in low-nutrient desert soils
- Add nitrogen to improve soil quality
- Screen wind, dust and noise
- Thorny trees serve as security barriers
- Provide shade, food and beauty for hundreds of years
- Honor our cultural and historic traditions
- Yield valuable wood for traditional and modern uses

What native trees don't do

- Typically don't require soil amendments
- Roots typically don't heave pavement and foundations
- Aren't prone to blowing over

Saguaros "nursed" by foothills palo verde tree
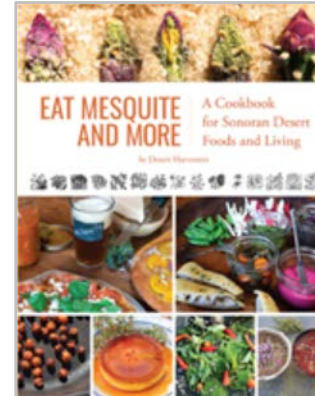
Cookbook for using mesquite and other native edibles

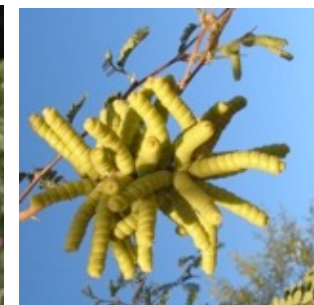Bird nest in berry-rich canyon hackberry tree

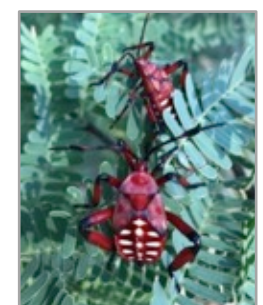Magnificent blooming blue palo verde, Arizona's state tree

Traditional Tohono O'odham wato built from mesquite wood

Butterfly sipping nectar from desert willow blooms

Edible screwbean mesquite tree seed pod

Colorful, harmless nymphs of native giant mesquite bug

1. Grow native trees using harvested rainwater, stormwater, graywater and condensate water

2. Learn native tree needs and characteristics

3. Plant native trees and native understory plants together

4. Plan where to plant to meet your needs and the tree's needs

5. Start with healthy young plants

6. Shape your tree's water harvesting area

7. Plant your tree carefully

8. Add mulch when you plant to keep moisture in the ground

9. Provide establishment watering and on-going watering using harvested water

10. For good shade and tree health, prune native trees right

Native trees providing abundant shade

BEST PRACTICE 1

Grow native trees using harvested rainwater, stormwater, graywater and condensate water

RAINWATER · STORMWATER RUNOFF · GRAYWATER · CONDENSATE WATER

Why talk about water first?

We need water to grow native trees in hot urban areas
Fortunately there's plenty of harvestable water in Tucson

- Rain falls on homes and yards and runs off residential roofs, driveways and patios
- Hundreds of thousands of gallons of stormwater flows off large building roofs, streets, parking lots and other "hardscapes"
- Graywater is available every day from washing machines, showers and bathroom sinks
- Water that condenses on cold air conditioners, ice machines and other cold-producing machines is widely available and especially abundant when its humid
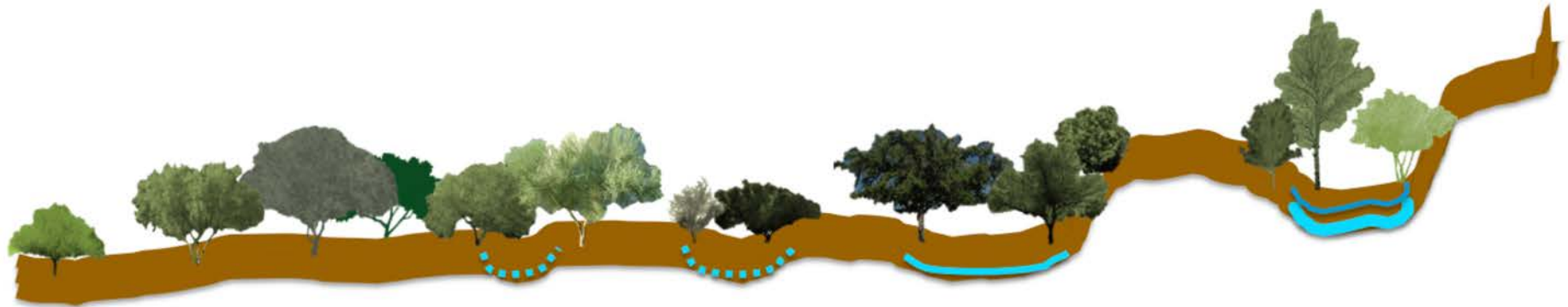
How do native trees get water in their natural habitats?
How much water do they need in urban areas?

Natural habitats of low water-use native trees | Natural habitats of medium water-use native trees

LOW WATER-USE NATIVE TREES:
Hardy trees for hot streets and parking lots

- Low water-use native trees grow naturally on desert flats, slopes and dry washes at lower elevations
- They meet urban needs for heat- and drought-tolerant trees that grow well along hot streets and in hot parking lots
- In urban areas they need 12 to 20 inches or more of water per year

MEDIUM WATER-USE NATIVE TREES:
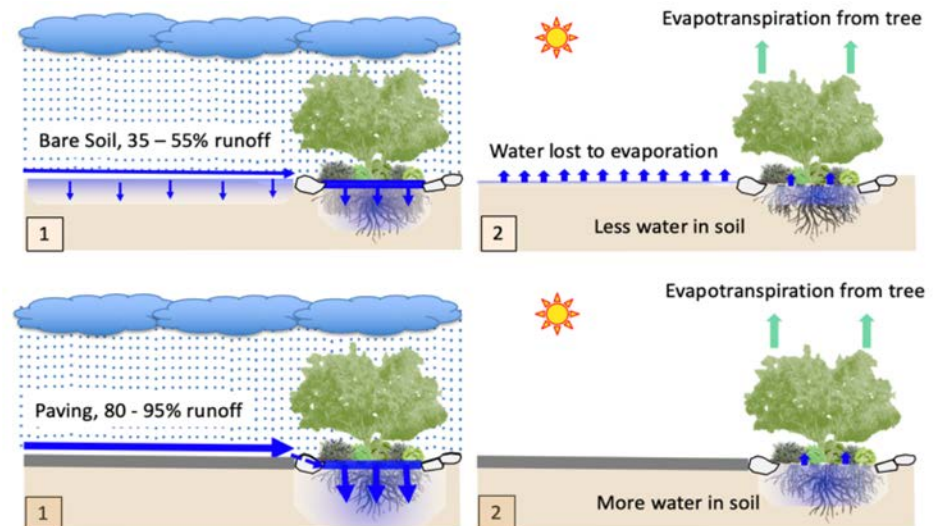**Heat tolerant trees that meet special urban needs**

- Medium water-use native trees grow naturally in large washes and canyons at higher elevations supported by rainfall and runoff water
- They meet urban needs for single trunk trees, small-stature trees and dense hedge-like trees
- In urban areas, they need 30 inches or more of water per year

How much rainfall runoff can be harvested?

- Rainwater flows down sloped land
- Basins placed at the bottom of slopes can capture this water to support trees
- Very small rainfalls don't usually result in runoff
- In moderate and large rainfalls,
  - 35 – 55% of rain runs off sloped bare soil, while the rest infiltrates into the soil or evaporates
  - 80 – 95% or rain runs off sloped paving, while the rest gets caught in crevices in the paving or evaporates

Bare Soil, 35 – 55% runoff | Evapotranspiration from tree | Water lost to evaporation | Less water in soil

Paving, 80 - 95% runoff | Evapotranspiration from tree | More water in soil

What is a catchment ratio?

- A catchment ratio is the ratio of the area of land (called the catchment area) whose rain and runoff is captured in a water harvesting basin, compared to the full-grown canopy area of the tree that will use that water
- This illustration shows a 4:1 catchment ratio

1 UNIT OF TREE CANOPY AREA

3 UNITS OF ROOFTOP CATCHMENT AREA

BASIN
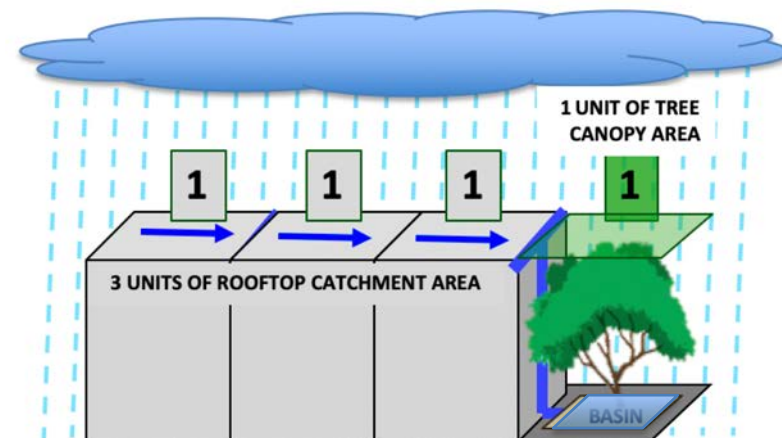
1 + 1 + 1 + 1 4 units of catchment area

compared to 1 1 unit of tree canopy area

This is a 4 to 1 (or 4:1) catchment ratio

Minimum recommended catchment ratios

- The larger the catchment ratio, the more water is harvested for trees
- Minimum recommended catchment ratios will meet tree needs most months if Tucson receives its average rainfall of 12 inches
- Rainfall varies year-to-year—in 2020 Tucson received less than 5 inches of rain
- To grow larger trees, create larger catchment ratios to provide more runoff
- Roofs, streets, parking lots, driveways and other hardscapes supply ample runoff

PAVED: 3:1 CR   EARTH: 7:1 CR
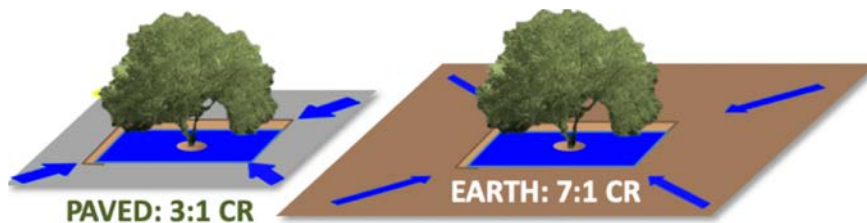
**Minimum recommended catchment ratios (CR) for
LOW WATER-USE NATIVE TREES**

PAVED: 4:1 CR   EARTH: 10:1 CR
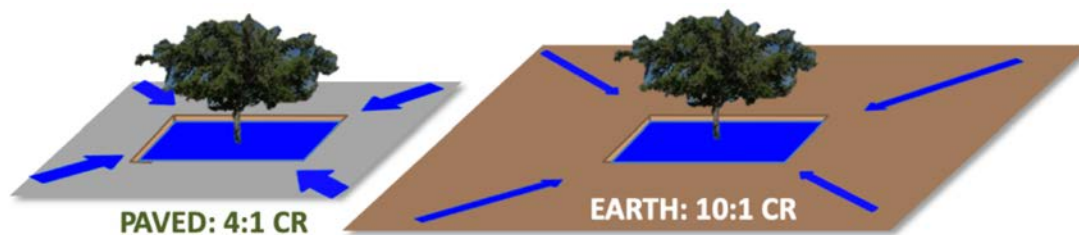
**Minimum recommended catchment ratios (CR) for
MEDIUM WATER-USE NATIVE TREES**

NOTE: Catchment ratio calculations assume trees receive 100% of direct rainfall over mature canopy area, plus 50% runoff from paved catchment area or 13 % runoff from bare earth. These conservatively low runoff estimates are used to take spatial and temporal rainfall variability into account. Estimated native tree water demand needed to meet urban aesthetic standards is based on plant water-use coefficients for a range of low and medium water-use plants in *Harvesting Rainwater for Landscape Use* by Patricia H. Waterfall, 2006.

Catchment Ratios can't meet all water needs for native trees in urban areas

**Paved 3:1 catchment ratios meet
LOW WATER-USE TREE NEEDS
around 9 months in an average rainfall year**

RAINFALL-RUNOFF DEFICIT
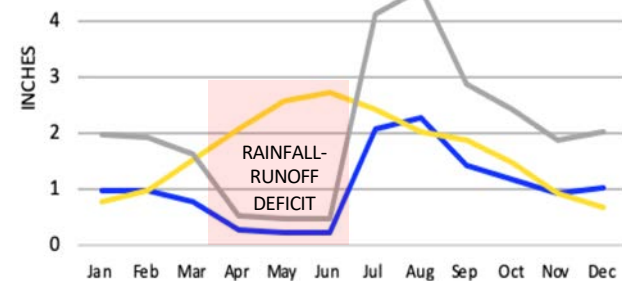
BLUE LINE: AVERAGE MONTHLY RAINFALL (12 INCHES/YR TOTAL)
YELLOW LINE: AVERAGE MONTHLY LOW WATER-USE TREE WATER NEEDS
GRAY LINE: AVERAGE MONTHLY WATER HARVESTED FROM PAVED 3:1 CR

**Paved 4:1 catchment ratios meet
MEDIUM WATER-USE TREE NEEDS
around 8 months in an average rainfall year**

RAINFALL-RUNOFF DEFICIT
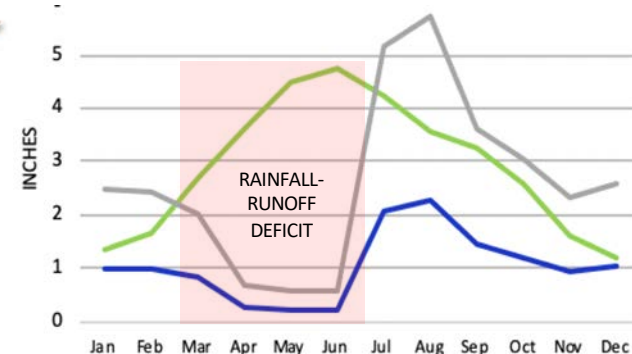
BLUE LINE: AVERAGE MONTHLY RAINFALL (12 INCHES/YR TOTAL)
GREEN LINE: AVERAGE MONTHLY MEDIUM WATER-USE TREE WATER NEEDS
GRAY LINE: AVERAGE MONTHLY WATER HARVESTED FROM PAVED 4:1 CR

Rain falls right where you need it—on your land. "Passive water harvesting" captures and infiltrates large volumes of rainwater, and all you need to do it is a shovel.

How to get started passively harvesting rainwater

- At your site, harvest rainwater from rooftops and higher land areas, working your way down slope
- Zigzag water flow down your site through multiple basins
- On sloping land, add berms on downhill sides to harvest and infiltrate more water
- On flat land, dig simple depressions to harvest direct rainfall
- Raised curbs help hold more direct rainfall in parking lots

www.HarvestingRainwater.com

Construction tips for building earthworks

- Its easier to dig when soil is moist—not when it's dry and hard
- Build berms wider than they are tall
- Compact the soil of the berm
- DO NOT compact the bottom of basins
- Make the slope into basins gentle
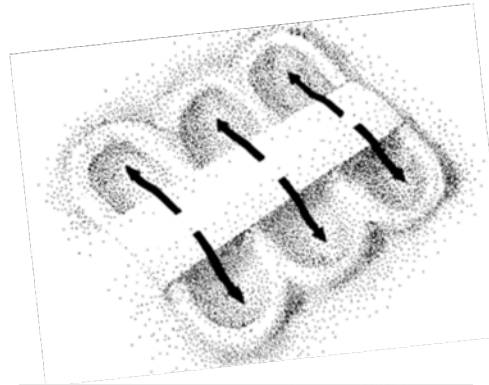- You can add rock to the top and outside of berms to stabilize them

www.HarvestingRainwater.com

10
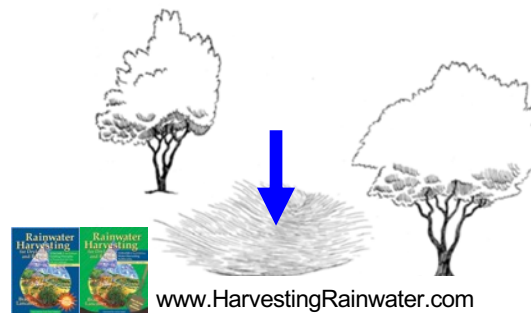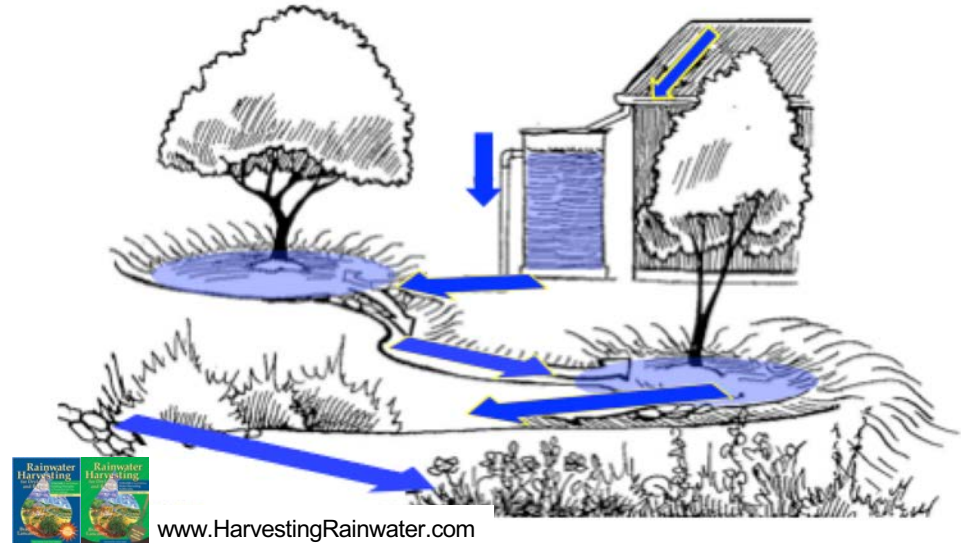
Raise paths, sink adjacent basins

- Raise paths and sidewalks and slope them toward adjacent basins to supply runoff water to plants
- Make wide paths next to deep basins for the safety of pedestrians

Move water down slopes in steps

- On longer slopes, construct multiple basins going down the slope so water can flow from one basin down to the next
- You can place rocks across berms for water to flow over to the next lower basin, or cut shallow "overflow spillways" into the berms to direct overflow water down a particular route. Line spillways with stabilizing rock.
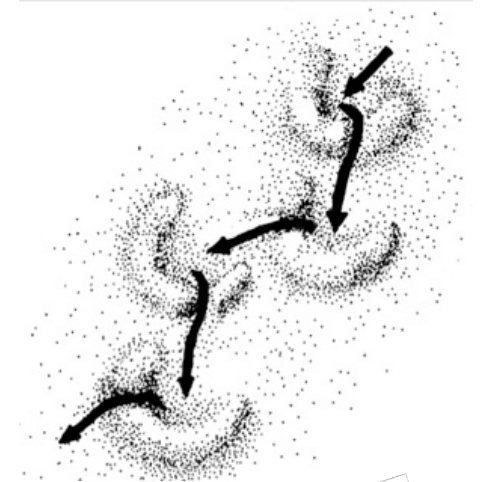
Collect water in swales constructed on slopes

- Swales are linear basins built along a land contour (a line of equal land elevation)
- Swales collect more water than small basins since runoff from more land (the catchment area) flows into them
- Place berms on the downstream side of swale depressions to increase the amount of harvested water
- Construct spillways along the berms to discharge overflow water in large storms
- Spillways should be several inches below the top of the berm, and constructed wide and level
- Armor the spillways with rock to reduce erosion
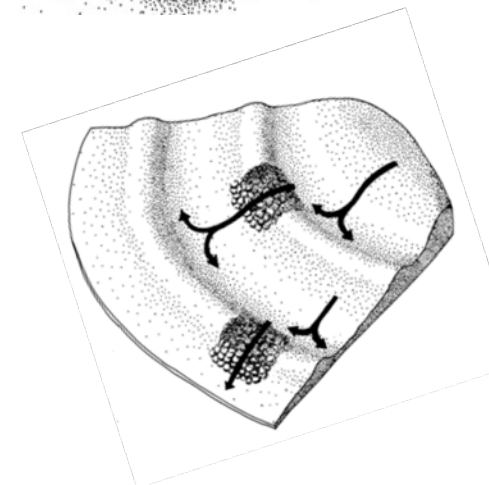
Consider rainwater tanks

- After you develop passive water harvesting earthworks, consider adding a tank to store rainwater for use in the dry season
- This is called "active water harvesting" because it requires construction of a permanent structure and ongoing operation and maintenance
- Tanks come in all shapes, sizes and materials
- Tucson Water customers can apply for a rebate to construct rainwater tanks at https://www.tucsonaz.gov/water/rainwater-harvesting-rebate

Native Trees for Tucson

Stormwater runoff is rainwater that flows off large "hardscapes"

- Hardscapes include large roofs, parking lots, streets, sidewalks and other large areas of concrete and asphalt
- Runoff is harvested to support trees within and next to the hardscape
- Curb cuts in parking lots lead stormwater runoff to tree planting basins that grow trees to increase shade
- Curb cuts along streets lead stormwater runoff to street-side tree basins that grow trees to increase shade
  - Water from street-side curb cuts must remain in the public right of way (ROW) easement—you cannot direct it onto private property
  - Check your jurisdiction's rules and find out what permits are needed to construct curb cuts
- "Permeable paving" is a paving material that provides a hard walking and driving surface while allowing water to infiltrate to soil below. Examples include
  - Porous concrete made with gravel, cement and water, but no sand
  - Specially designed paving blocks with built-in gaps

Roof runoff from a large public building
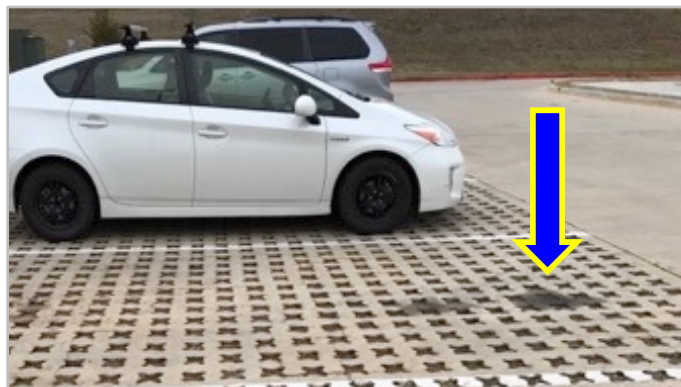

Valuable parking lot runoff

Curb cuts in a commercial parking lot

Curb cut on public street leading runoff to ROW basin

One type of "Permeable paving" consists of paving bricks with large gaps that allow water to infiltrate into soil
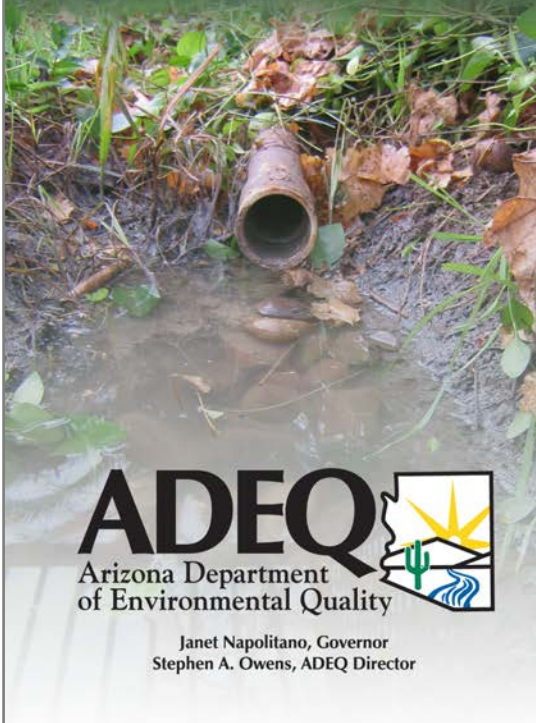
Using Gray Water at Home

Arizona Department of Environmental Quality's Guide to Complying with the Type 1 General Permit

ADEQ
Arizona Department of Environmental Quality

Janet Napolitano, Governor
Stephen A. Owens, ADEQ Director

Graywater is a predictable year-round water supply to support trees

The Arizona Department of Environmental Quality regulates the use of graywater. Graywater is wastewater that originates from bathroom sinks, showers, bathtubs and clothes washers that is collected separately from sewage flow. Dishwasher and toilet water are NOT graywater and must be discharged to septic/sewer. Kitchen sink water requires additional treatment before use in soil.

www.HarvestingRainwater.com

To landscape

To sewer

To landscape
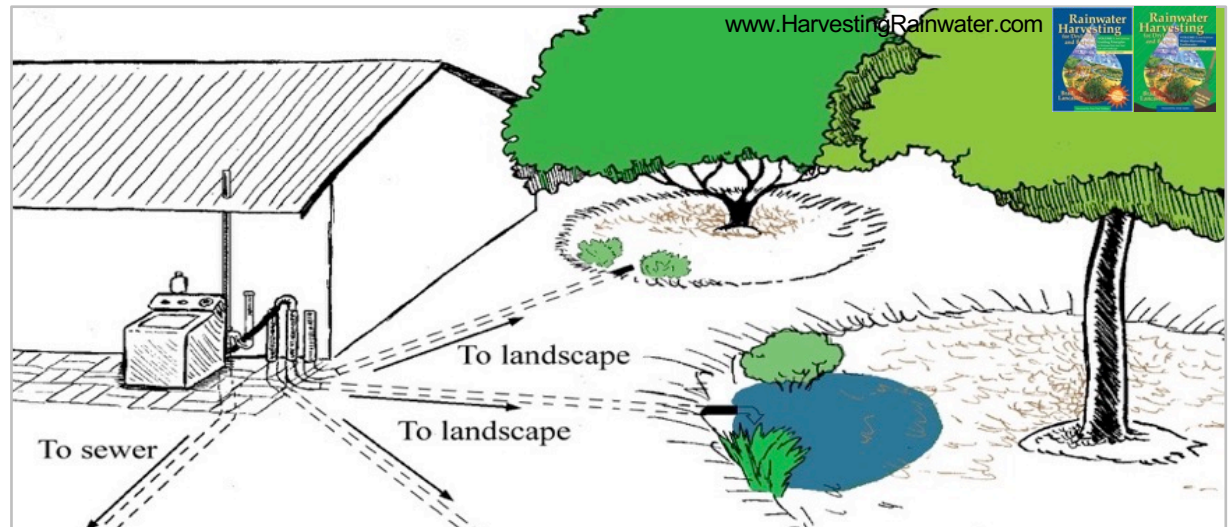
Applying graywater to native trees

- Graywater can be piped outside and delivered at the base of trees via drip or flood irrigation. Keep surface accumulations of graywater to a minimum
- Avoid human contact with graywater and graywater-irrigated soils
- Use special soaps and detergents that are designed to be safe for plants
- While native desert trees tolerate the salts in graywater, collect rainwater in graywater basins to dilute these salts
- DO NOT spray graywater
- DO NOT apply graywater to leaves or edible parts of of trees
- DO NOT use graywater if your house has a water softener
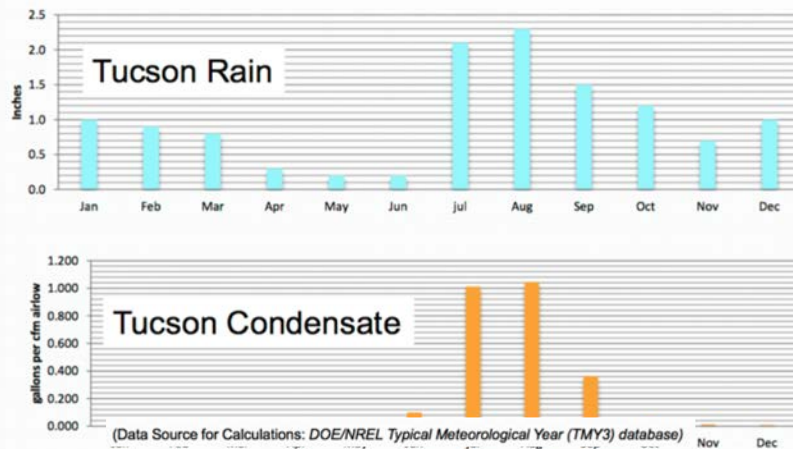- DO NOT use washing machine water if you are washing diapers

Condensate is the water produced when moisture in air condenses on cold surfaces

Monthly Tucson rainfall and air conditioning condensate supply

Tucson Rain

Tucson Condensate

(Data Source for Calculations: DOE/NREL Typical Meteorological Year (TMY3) database)

Moisture in humid air condenses on the cooling coils inside air conditioners. This water must be discharged.

Condensate water discharge is greatest in July, August, and September—hot, humid months when air conditioners are heavily used.
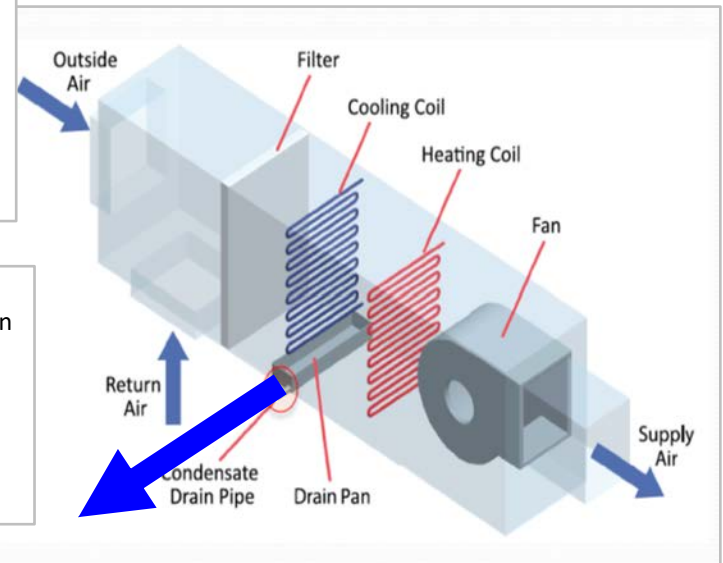
Source: San Antonio Condensate Collection and Use Manual for Commercial Buildings © 2013 San Antonio Water System

Commercial scale system: Air conditioning condensate + rooftop runoff + graywater are harvested In 11,000 gallon tank at University of Arizona. Tanked water supports lush native garden at Underwood Family Sonoran Landscape Laboratory

Residential scale system: AC condensate pipe yields over 30 gallons every 24 hours in Tucson's monsoon season

Native Trees for Tucson

See the difference water harvesting has made!

In side-by-side multifamily housing complexes, the shady, abundant landscape below is supported by rainwater, stormwater and graywater use
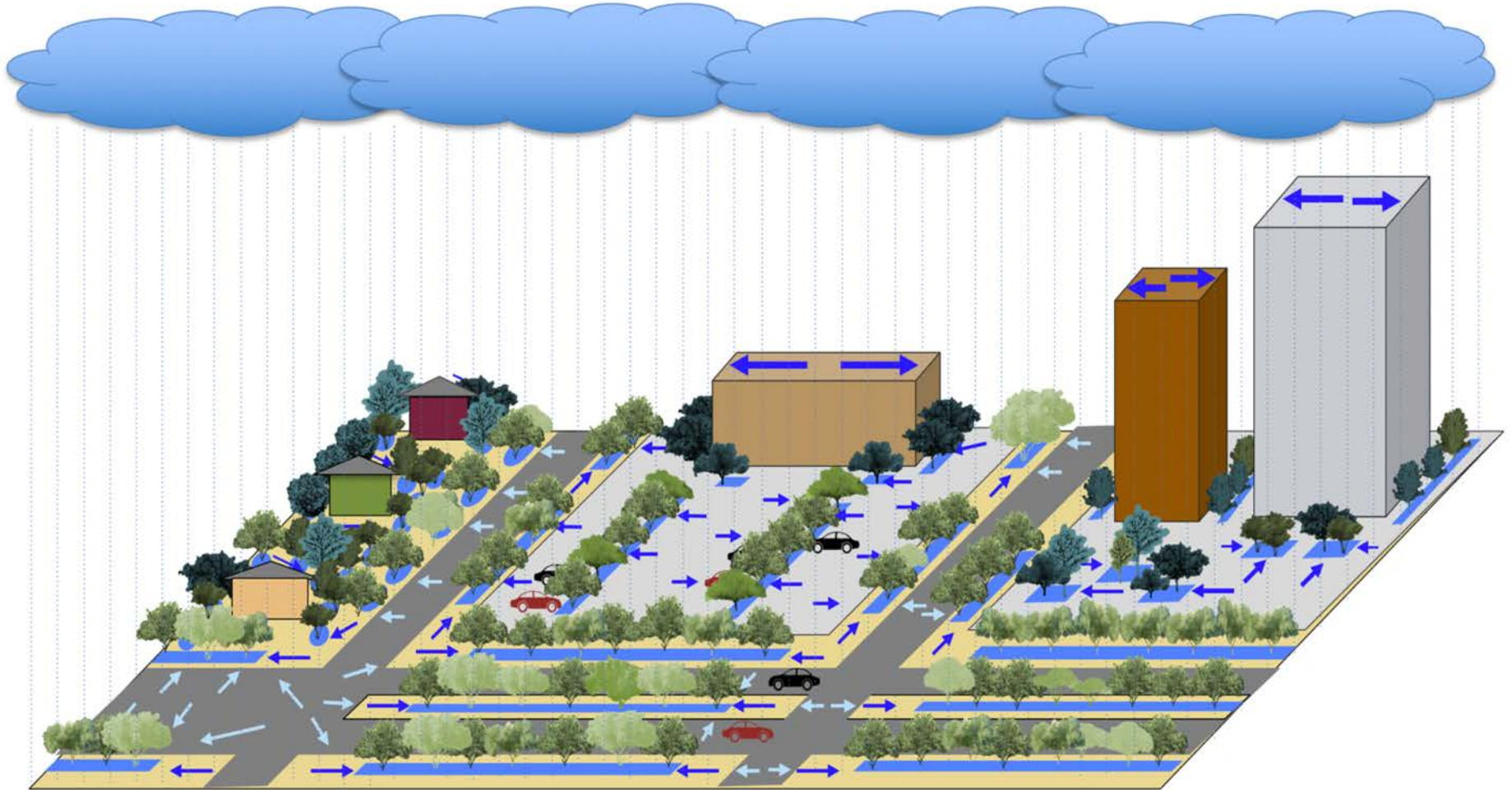
The landscape below has more roof and pavement from which water could be harvested but has conventional irrigation, far fewer trees and less shade

Roger Road, Tucson, Arizona, photo dated 8/19/2018

See the difference water harvesting could make!

Low water-use trees (lighter colored) are planted throughout the landscape where they can be supported primarily by harvested rainwater and stormwater

Medium water-use trees (darker colors) are placed close to houses and buildings where they can be supported by harvested rainwater, stormwater, graywater, condensate, and tanked rainwater

BEST PRACTICE 2
Learn native tree needs and characteristics

Desert Ironwood
(Olneya tesota)

Velvet mesquite
(Prosopis velutina)

Foothills palo verde
(Parkinsonia microphylla)

Blue palo verde
(Parkinsonia florida)

Catclaw acacia
(Senegalia greggii)

Palo brea
(Parkinsonia praecox)
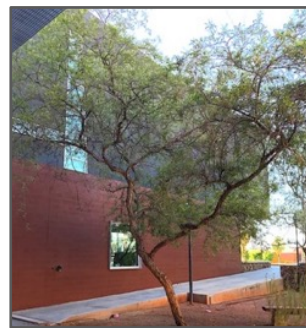
Whitethorn acacia
(Vachellia constricta)

Desert willow
(Chilopsis linearis)

Canyon hackberry tree
(Celtis reticulata)

Screwbean mesquite
(Prosopis pubescens)

Kidneywood tree
(Eysenhardtia orthocarpa)

Arizona rosewood
(Vauquelinia californica)

Feather tree
(Lysiloma watsonii)

Little leaf ash
(Fraxinus greggii)

INFORMATION PROVIDED ABOUT TREES

WATER NEEDS: Water needs are based on type of native tree, and its drought hardiness. Catchment Ratios are recommended for urban planting.

GROWTH RATE: Growth rates shown are based on natural conditions. Additional water generally increases urban growth rates.

SIZE RANGE: Utility pole and human figure provide scale and show if tree is "utility friendly." The more water trees receive, the larger they grow..

CLIMATE RESILIENCE: Place trees in appropriate microclimates according to their heat, cold and wind tolerance

NATURAL RANGE: The natural range of native trees in Arizona indicates their general preferred habitats, elevations and rainfall conditions.

CHARACTERISTICS: Listed tree characteristics help you determine which trees will meet meet your needs and suit your site

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Desert Ironwood *(Olneya tesota)*
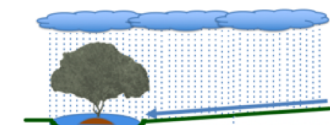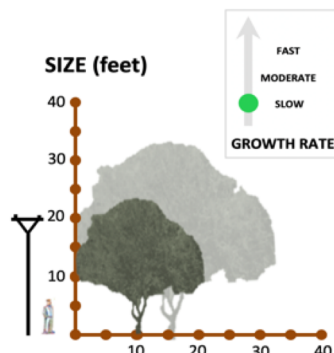
SIZE (feet)

GROWTH RATE: FAST / MODERATE / SLOW (SLOW)

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

- VERY DROUGHT TOLERANT; DROUGHT DECIDUOUS
- ADAPTED TO EXTREME HEAT
- GROWS IN STRONG SUN; HAIR ON LEAVES PROTECT FROM HARSH UV RAYS
- COLD TOLERANT TO 20° F
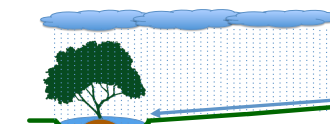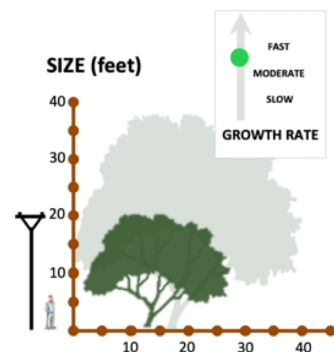- WITHSTANDS HOT DESSICATING WIND
- SELF SEEDS

Characteristics: Multitrunk, thorns, evergreen, fixes nitrogen in soil, casts dense shade, edible seeds, supports native pollinators and wildlife, lives 1000+ years

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Velvet mesquite *(Prosopis velutina)*

SIZE (feet)

GROWTH RATE: FAST / MODERATE / SLOW (FAST)

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

- EXTREMELY DROUGHT TOLERANT
- ADAPTED TO EXTREME HEAT
- GROWS IN STRONG SUN. VELVETY LEAVES SHIELD UV RAYS
- COLD TOLERANT TO 15°F
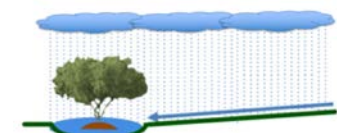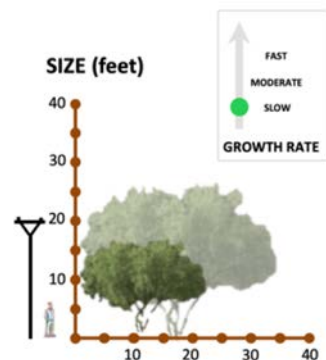- WITHSTANDS HOT DRY WIND
- SELF SEEDS

Characteristics: Multitrunk, thorns, deciduous, fixes nitrogen in soil, casts dense shade, edible pods and seeds, supports native pollinators & wildlife, lives 200+ years

Native Trees for Tucson

Foothills palo verde (*Parkinsonia microphvlla*)

SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- VERY DROUGHT TOLERANT, SELF-PRUNES LIMBS IN DROUGHT; PHOTOSYNTHETIC BARK
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
- ADAPTED TO EXTREME HEAT
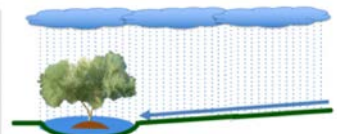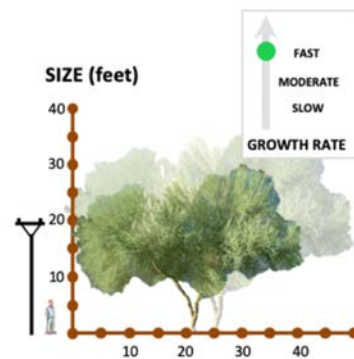- COLE TOLERANT TO 15°F
- SELF SEEDS

Characteristics: Multitrunk, thorns at end of branches, casts moderate shade, edible seeds, supports native pollinators and wildlife, lives 200+ years

Blue palo verde (*Parkinsonia florida*)

SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- VERY DROUGHT TOLERANT; DROUGHT DECIDUOUS
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 15°F
- SELF SEEDS

Characteristics: Multitrunk, thorns, winter deciduous, casts dense shade, edible seeds, supports native pollinators and wildlife, lives 150+ years

Catclaw acacia (*Senegalia greggii*)

SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- VERY DROUGHT TOLERANT, HIGH WATER-USE EFFICIENCY
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 0°F

Characteristics: Multitrunk, curved thorns, winter deciduous, fixes nitrogen in soil, casts dense shade, supports native pollinators and wildlife, lives 100+ years

Palo brea *(Parkinsonia praecox)*

SIZE (feet)

GROWTH RATE — FAST (●), MODERATE, SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- DROUGHT TOLERANT
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
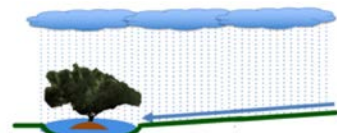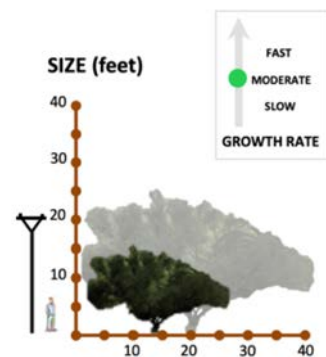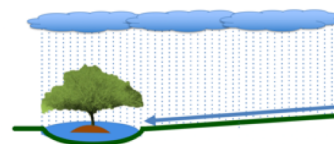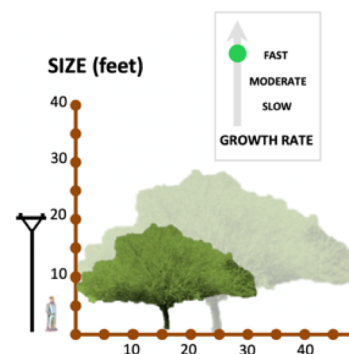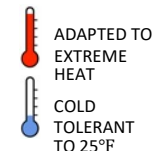- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 25°F

Southern Sonoran Desert

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Multitrunk, thorns, semi-evergreen, casts filtered shade, supports native pollinators and wildlife, showy flowers, striking bark, lives 150+ years

Whitethorn acacia *(Vachellia constricta)*
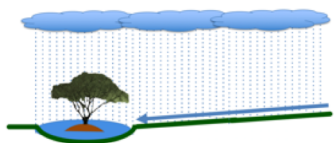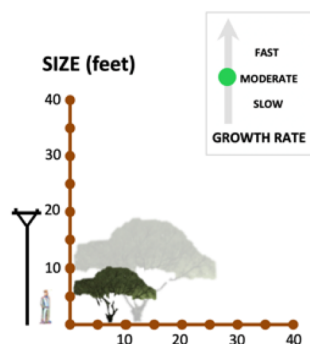
SIZE (feet)

GROWTH RATE — FAST, MODERATE (●), SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- VERY DROUGHT TOLERANT, READILY SPROUTS AFTER FIRE
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 5°F

Southern Arizona

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Multitrunk, thorns, winter deciduous, fixes nitrogen in soil, casts light shade, supports native pollinators and wildlife, useful security barrier, lives 50+ years

Desert willow *(Chilopsis linearis)*
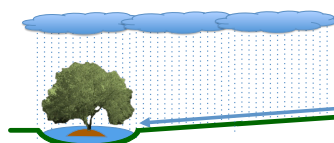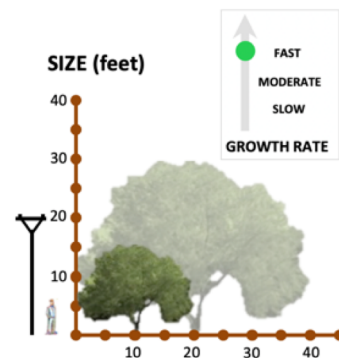
SIZE (feet)

GROWTH RATE — FAST (●), MODERATE, SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- DROUGHT TOLERANT; UNDER EXTREME DROUGHT MAY NOT PRODUCE SEED
- GROWS IN STRONG SUN
- WITHSTANDS HOT DRY WIND
- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 10°F
- SELF SEEDS

LOW WATER USE TREE
Use 3:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Multitrunk,, winter deciduous, casts dense shade, supports native pollinators and wildlife, abundant beautiful flowers, adaptable shape, lives 150 years

BEST PRACTICE 2. Learn native tree needs and characteristics

Canyon hackberry (Celtis reticulata)
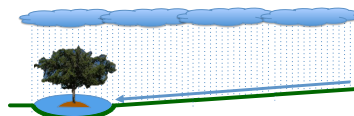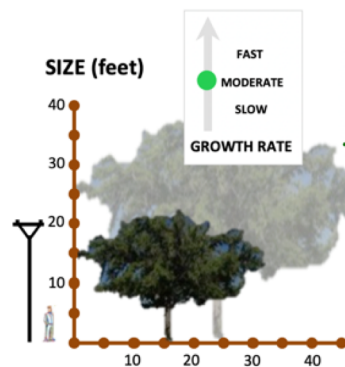
SIZE (feet)

GROWTH RATE — FAST / MODERATE / SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

DROUGHT RESISTANT
GROWS IN STRONG SUN
ADAPTED TO EXTREME HEAT
COLD TOLERANT TO 20°F

MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Single trunk, winter deciduous, fixes nitrogen in soil, dense shade, edible berries, supports native pollinators & wildlife, interesting branch and trunk patterns, lives 200 years

Screwbean mesquite (Prosopis pubescens)

SIZE (feet)

GROWTH RATE — FAST / MODERATE / SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

VERY DROUGHT TOLERANT
GROWS IN STRONG SUN
WITHSTANDS HOT DRY WIND
ADAPTED TO EXTREME HEAT
COLD TOLERANT TO 0°F
SELF SEEDS
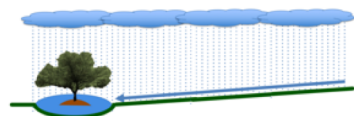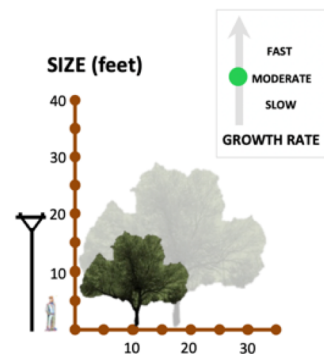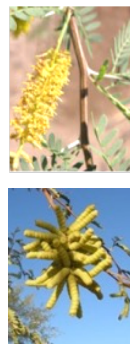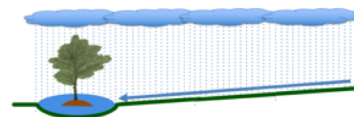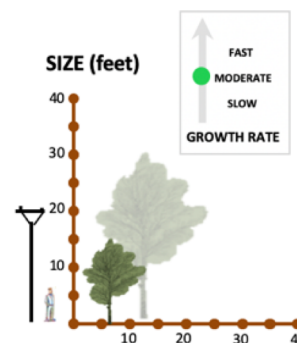
MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Multitrunk, thorns, winter deciduous, fixes nitrogen in soil, moderate shade, edible pods and seeds, supports native pollinators and wildlife, interesting pod and trunk patterns, lives 100+ years

Kidneywood tree (Eysenhardtia orthocarpa)

SIZE (feet)

GROWTH RATE — FAST / MODERATE / SLOW

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

DROUGHT RESISTANT; DROUGHT DECIDUOUS
GROWS IN FULL SUN OR PARTIAL SHADE
ADAPTED TO EXTREME HEAT
COLD TOLERANT TO 15°F

MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

Characteristics: Single trunk, winter deciduous and drought deciduous, moderate shade, draws butterflies and other pollinators, fragrant flowers, lacy foliage, good patio tree, lives 50 years

BEST PRACTICE 2. Learn native tree needs and characteristics

Arizona rosewood (*Vauquelinia californica*)
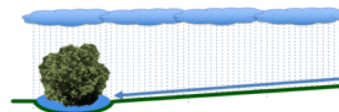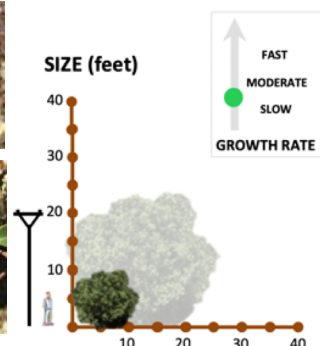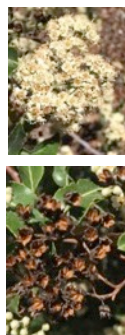
SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank
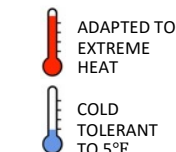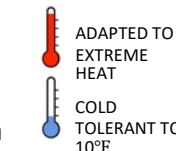
CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- DROUGHT TOLERANT
- GROWS IN FULL SUN OR PARTIAL SHADE
- WITHSTANDS STRONG WINDS; GOOD WINDBREAK
- ADAPTED TO HIGH HEAT
- COLD TOLERANT TO 10°F

Characteristics: Multitrunk, large evergreen shrub, casts dense shade year round, good windbreak and visual barrier—replacement for oleander, lives <50 years

Feather trees (*Lysiloma watsonii*)
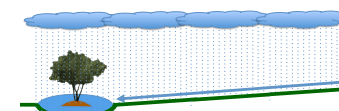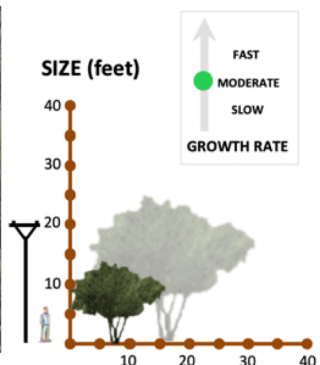
SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- DROUGHT RESISTANT
- GROWS IN STRONG SUN
- ADAPTED TO EXTREME HEAT
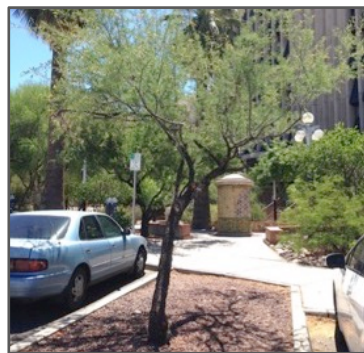- COLD TOLERANT TO 25°F

Sonoran Desert foothill areas east of Tucson

Characteristics: Multitrunk, semi-deciduous, fixes nitrogen in soil, casts filtered shade, supports native pollinators and wildlife, lacy foliage, good patio tree, lives < 50 years

Little leaf ash (*Fraxinus greggii*)
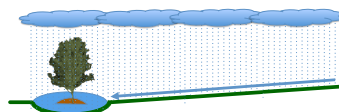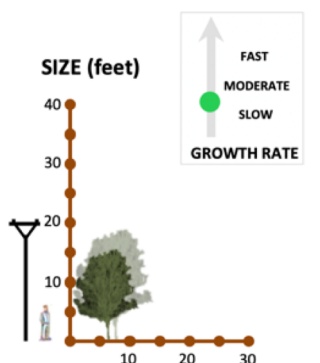
SIZE (feet)

GROWTH RATE
- FAST
- MODERATE
- SLOW

MEDIUM WATER-USE TREE
Use 4:1 or more catchment ratio
If needed, supplement with graywater, condensate, rain tank

CLIMATE RESILIENCE & NATURAL RANGE IN AZ

- DROUGHT RESISTANT; DROUGHT DECIDUOUS
- GROWS IN STRONG SUN
- ADAPTED TO EXTREME HEAT
- COLD TOLERANT TO 10°F

Southern Arizona

Characteristics: Multitrunk shrub or can be pruned to small single trunk tree, winter deciduous, moderate shade, good patio tree, lives 50 years

BEST PRACTICE 3

Plant native trees and native understory plants together

Plant 3 native understory plants the same time you plant your native tree to:

- Cool the soil
- Add color and texture
- Provide edible native foods
- Support native pollinators & wildlife
- Encourage vital soil life

Blooming chuparosa

Fruiting wolfberry

Desert ironwood's natural relationships with understory along a desert wash

Urban desert ironwood with abundant understory plants along a local street

Native Trees for Tucson

Place understory plants in native tree basins that harvest the listed catchment ratio or greater. Place cacti at the top of basins.

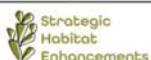| Latin name	Common name	Type	Water harvesting catchment ratio	Pollination Calendar: Bloom color and bloom months											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hesperaloe parviflora	red hesperaloe	Shrub	2:1		red	red	red	red							
Justicia candicans	jacobina	Shrub	4:1			red	red	red	red	red			red	red	
Anisacanthus thurberi	desert honeysuckle	Shrub	2:1			red	red	red	red				red	red	
Justicia californica	chuparosa	Shrub	3:1			red	red	red	red						
Calliandra eriophylla	fairy duster	Shrub	2:1	pink	pink	pink	pink	pink				pink	pink	pink	pink
Penstemon parryi	Parry's penstemon	Shrub	2:1		pink	pink	pink	pink							
Maurandya antirrhiniflora	snapdragon vine	Vine	2:1				pink	pink	pink	pink	pink	pink	pink	pink	
Jatropha cardiophylla	limberbush	Shrub	2:1							pink	pink	pink	pink		
Gossypium thurberi	desert cotton	Shrub	2:1								pink	pink	pink		
Lycium fremontii	Fremont's wolfberry	Shrub	2:1		purple	purple	purple	purple	purple	purple	purple	purple	purple	purple	purple
Glandularia gooddingii	Goodding's verbena	Shrub	4:1		purple	purple	purple	purple	purple	purple	purple	purple			
Dalea pulchra	Santa Catalina prairie clover	Shrub	3:1		purple	purple	purple	purple							
Sphaeralcea ambigua	globemallow	Shrub	2:1	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange
Bebbia juncea	chuckwalla's delight	Shrub	2:1	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange	orange
Ferocactus wislizeni	fishhook barrel cactus	Cacti	None							orange	orange	orange			
Encelia farinosa	brittlebush	Shrub	2:1	yellow	yellow	yellow	yellow	yellow	yellow				yellow	yellow	yellow
Trixis californica	trixis	Shrub	2:1		yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow			
Larrea tridentata	creosote	Shrub	2:1		yellow	yellow	yellow	yellow					yellow	yellow	
Senna covesii	desert senna	Shrub	2:1			yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow		
Psilostrophe cooperi	western paperflower	Shrub	2:1			yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow		
Agave murpheyi	Hohokam agave	Succulent	2:1			yellow	yellow	yellow							
Chrysactinia mexicana	damianita	Shrub	2:1			yellow	yellow	yellow	yellow	yellow	yellow	yellow	yellow		
Opuntia engelmannii	Engelmann's prickly pear	Cacti	None				yellow	yellow							
Cucurbita digitata	coyote gourd	Vine	2:1						yellow	yellow	yellow	yellow	yellow		
Eriogonum fasciculatum	Mohave buckwheat	Shrub	3:1			white	white	white	white	white	white	white			
Asclepias subulata	rush milkweed	Shrub	2:1			white	white	white	white	white	white	white			
Carnegiea gigantea	saguaro	Cacti	None				white	white	white						
Aloysia wrightii	oreganillo	Shrub	2:1				white	white	white	white	white	white			
Simmondsia chinensis	jojoba	Shrub	2:1		green	green	green	green	green	green	green				green
Dodonea viscosa	hopbush	Shrub	2:1			green	green	green	green	green	green	green	green		
Celtis pallida	desert hackberry	Shrub	2:1			green	green	green	green	green	green	green	green	green	
Ziziphus obtusifolia	graythorn	Shrub	2:1				green	green	green	green	green	green			
Sporobolus wrghtii	giant sacaton	Grass	2:1							green	green	green	green		

Native Trees for Tucson

BEST PRACTICE 4

Plan where to plant to meet your needs and the tree's needs

What do you want and need from native trees?

- Year-round shade? Seasonal shade?
- Trees you can walk under?
- Windbreak trees to reduce strong dry winds?
- Trees that produce edible fruits, seeds or pods?
- Trees that fit into small yards?
- Thorny trees that act as security barriers?
- Bushy trees that provide visual barriers?
- Shady, thornless trees for child play areas?
- Trees to buffer traffic and fit in right of way?
- Trees that attract native birds, insects & wildlife?
- Beautiful flowers, leaves, bark and pods?

Beautiful blooms on thornless desert willow tree
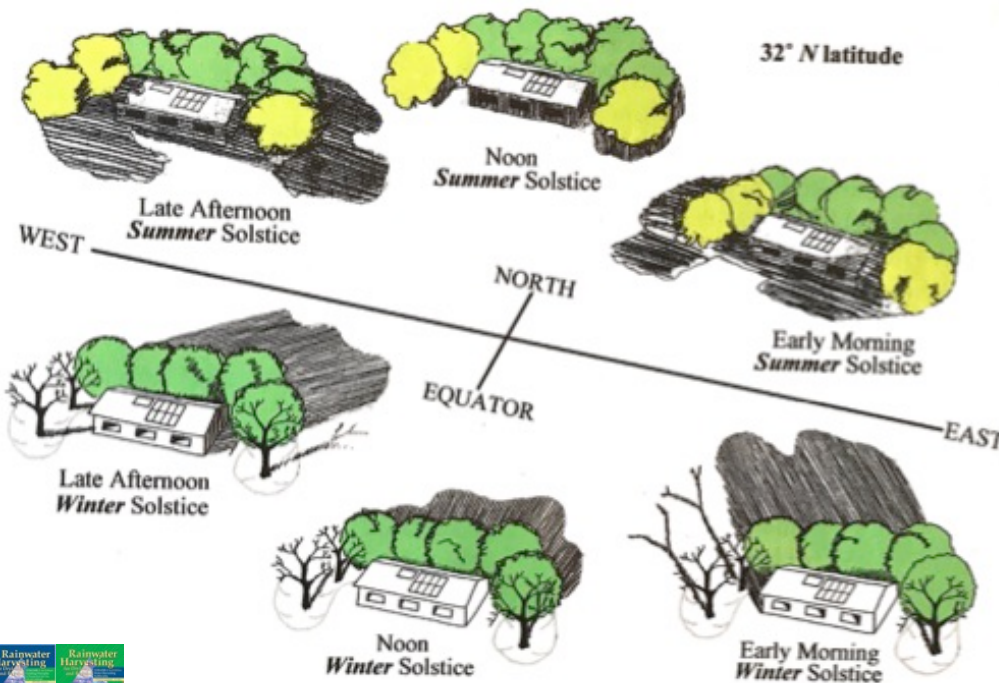
Place trees to provide summer shade and winter warmth

- Shading your home can save 20-30% energy costs
- For maximum summer shade, plant trees in an arc on east, north and west sides of the house
- Place deciduous trees southeast and southwest of the house to shade in summer and let sun provide warmth in winter
- If you want sun's warmth in winter and electricity from rooftop solar panels, don't plant trees outside south-facing windows

www.HarvestingRainwater.com

Give trees the harvested water they need

- Observe where rain falls, flows and pools to decide where to harvest water
- Take advantage of existing slopes and low spots to create natural-shaped basins
- Place multiple basins starting from the "top" (highest elevation) and going to the "bottom" (lower elevations) of your site to harvest as much rain as possible
- Basins can interconnect, one overflowing to the next
- Be creative, basins don't have to be square, round, or long and straight
- Place basins to harvest runoff from roof, driveway, sidewalk, patios and other hardscapes
- Access graywater from washing machine, tub, bathroom sink
- Access condensate from air conditioners, ice machines, and other sources
- Place basins to support medium water-use trees near buildings for easy access to graywater, condensate and tank water
- Can place low water-use trees farther from the house since they need less water

Basins harvest water from sidewalk, provide shade

Give trees the space they need

- Find out how big trees will grow and give them sufficient room to do it
- Its OK for native tree canopies to touch one another to create continuous shade if they have enough water

Keep trees away from overhead and buried utility lines

- Don't plant under overhead power lines—if trees grow into lines, their canopies will need major cutting, distorting the tree
- Don't plant over buried utility lines—roots might damage buried lines and utility work might damage roots
- Call 811 to locate buried lines leading up to your site
- Hire private companies to locate buried lines on your site

Plant a safe distance from corners for traffic safety

- Don't plant trees where they will block traffic signs or signals—trimming to increase visibility will distort trees. Keep trees 8 feet or more from intersections.

Heavily pruned desert willow under power line

BEST PRACTICE 5
Start with healthy young plants

Be selective when purchasing trees from nurseries
- Some native trees cross-pollinate with other species, creating hybrids
- Ask for true native velvet mesquite (feel for "velvety leaves"), blue palo verde, foothills palo verde and palo brea trees to get true native tree characteristics
- Large trees in small pots may have coiled tap roots that need to be straightened when planted

When to plant
- Ideally, plant when trees naturally germinate—often the monsoon season
- Avoid planting in the hot dry period before monsoons, but if you must, water frequently
- Container plants "hardened" out in full sun and cold winters will be hardier when planted
- Don't plant if there is freeze danger. Protect cold-sensitive trees from hard freezes
- Plant trees and understory plants at the same time to get shade and cooling faster

Nurture native plant "volunteers"
- Many trees and understory plants readily self seed
- If plants "volunteer" in good locations, add water harvesting basins and mulch to encourage growth

This blue palo verde "volunteer" sprouted from a seed

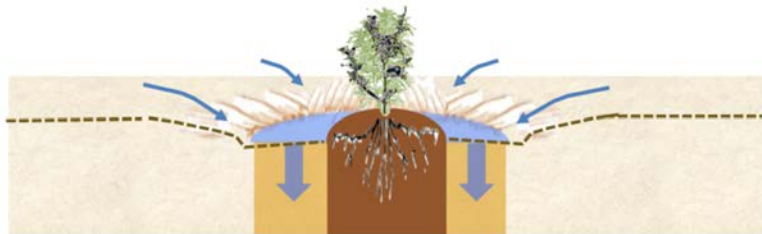Young Arizona Rosewoods growing in 5-gallon pots

Native catclaw acacia trees grown in tall pots have straight root growth (photo courtesy of Nighthawk Nursery)
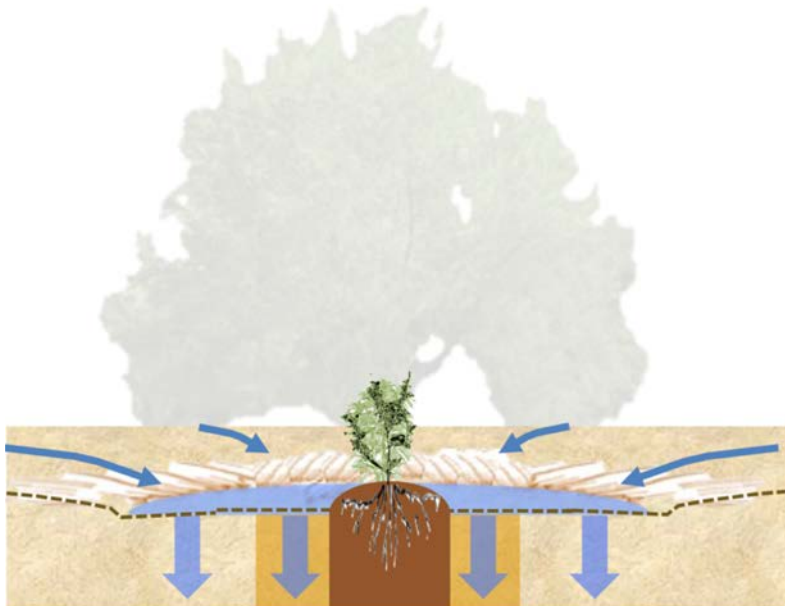
CAUTION: BEFORE YOU DIG water harvesting basins and tree planting holes **CALL 811** to located buried utility lines in the right-of-way next to your property. Hire a private utility locating service to mark buried lines on your property. Always dig slowly and carefully, and stop if you encounter any buried utility lines.

Build a small basin sized for the young tree then add additional basins farther out from the tree to infiltrate more water for the growing roots

Or build a large basin to start that is big enough to support the mature tree and slope the basin bottom to focus water on the small, newly planted tree

Be careful digging around existing trees

- If you must dig near existing trees, make sure they are well watered and not stressed at the time of year you dig
- Avoid disturbing existing tree roots as much as possible—these roots will likely extend well beyond the outer edge of the tree canopy

Basin width and depth

- Wide basins around 12 inches deep typically store ample rain and runoff
- Well-developed roots will take up the majority of moisture beyond the drip line of their canopy, so the wider the basin the better
- Make basin slopes gradual
- You can dig deeper, narrower basins if needed due to limited space
- Place rocks along steep basin sides to stabilize slopes and to mark basins for people walking by them
- DO NOT compact the bottom of basins—compaction slows infiltration

Number of basins

- Build a small basin sized for the young tree then add additional basins farther out from the tree to infiltrate more water for the growing roots
- Or build a large basin to start that is big enough to support the mature tree and slope the basin bottom to focus water on the small, newly planted tree
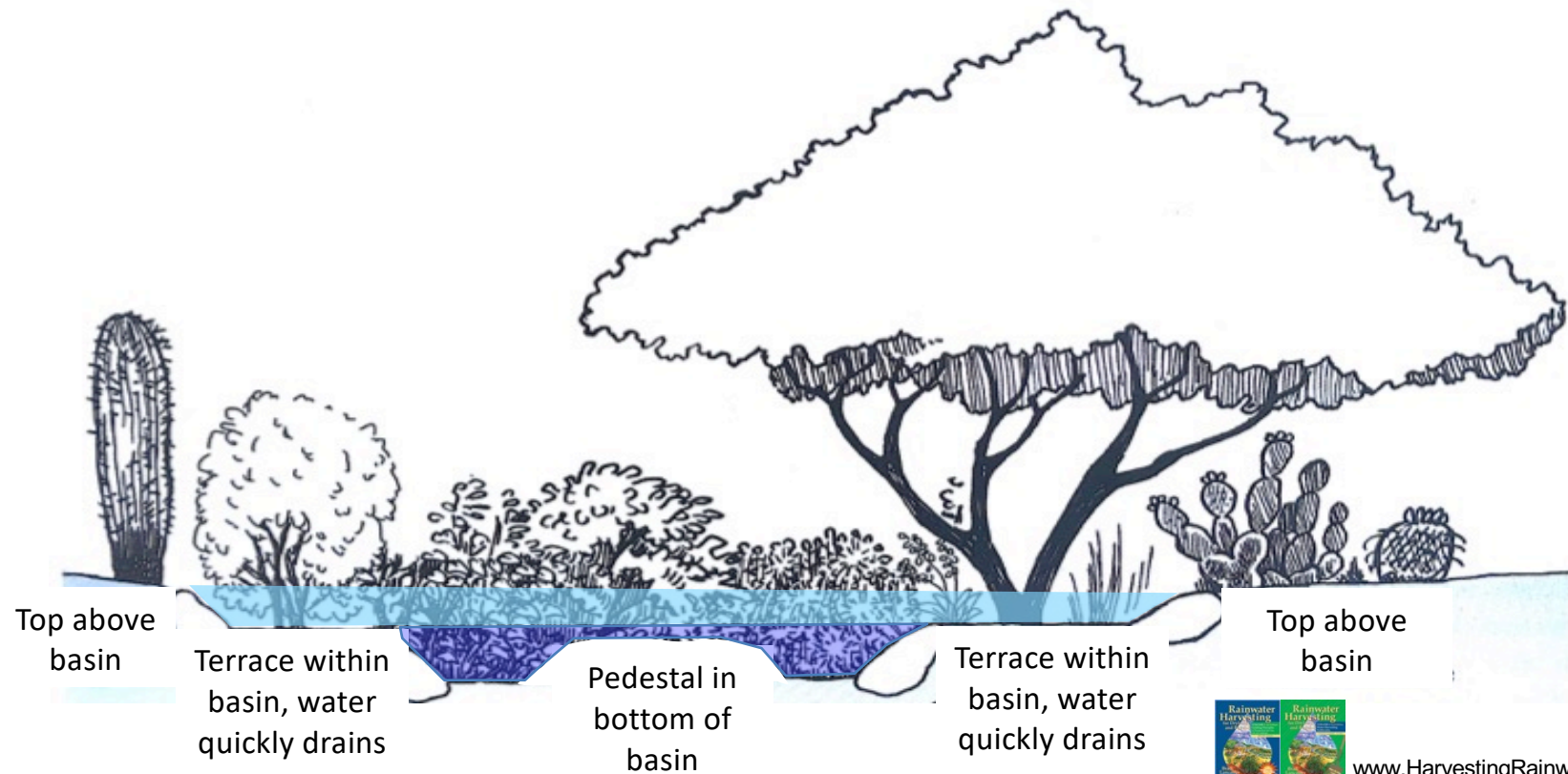
How to place trees relative to the basin to avoid inundation

- To avoid inundating the trunks of desert trees, plant trees on built-up pedestals within the bottoms of basins or on raised terraces at the sides of basins
- Desert trees that need very well-drained soil (Arizona rosewood and foothills palo verde) should be placed on the land surface above basins where roots can access the moist soil under the basins without being inundated

Basins should drain within 12 hours

- To avoid attracting mosquitos (they take 3 days to reproduce in standing water), construct basins that drain within 12 hours
- If a basin is slow to drain, try these strategies:
  - Reduce the catchment area flowing to the basin
  - Enlarge the basin to spread the water over a larger infiltration area
  - Dig down to punch through any impeding caliche or clay layer
- As tree and understory roots grow, infiltration should improve

Top above basin

Terrace within basin, water quickly drains

Pedestal in bottom of basin

Terrace within basin, water quickly drains

Top above basin

www.HarvestingRainwater.com

Illustration adapted from above source

BEST PRACTICE 7

Plant your tree carefully

Dig the planting hole

- Dig the planting hole in the chosen position relative to the basin
- Dig the planting hole no deeper than the depth of the root ball
- The hole can be up to twice as wide as the root ball

### Take the tree out of its pot and check the root ball

- Gently squeeze the sides of the tree pot to loosen the soil
- If soil is very loose, cut down the side of the pot to release the tree
- If the root ball is sturdy, ease the tree out of the pot
- Check the root ball for signs of disease—don't plant if unhealthy
- If roots tightly bind the root ball, loosen roots gently by hand or slice along one side of the root-ball to unbind the roots
- If the main root is coiled in the bottom of the pot, try to stretch it downward. If needed, cut off the coiled portion so remaining root can grow downward

Place the tree in the ground and water it

- Position the tree in its planting hole so the tree will grow straight up
- If tree is in the bottom of basin, raise the base of the tree several inches above the basin bottom and create a pedestal with native soil
- Back fill the planting hole with native soil, removing any rocks
- Compress soil slightly to remove big air pockets
- Water the soil during and just after planting
- If the watered soil sinks below the root ball, add more native soil
- The final soil level should just cover the roots
- Avoid staking small trees—let the tree sway and bend in the wind to strengthen the trunk for a long life in strong desert winds
- Native trees typically do not require soil amendments

Potted agave plant with tightly coiled roots, similar to root coiling in potted trees
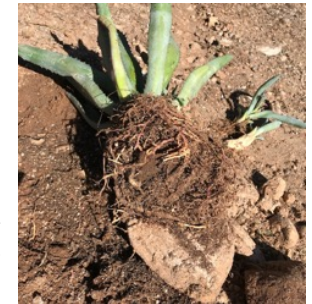
Agave roots loosened gently by hand to allow healthy root growth

dunbarspringneighborhoodforesters.org

Tree planting event at by Dunbar/Spring Neighborhood Foresters includes planting a tree along with understory plants in a street-side water harvesting basin. Photo: Brad Lancaster

BEST PRACTICE 8

Add mulch when you plant to keep moisture in the ground

Blue palo verde "self mulch"   Foothills palo verde "self mulch"

Organic mulch reduces evaporation and builds soil

- Organic mulch builds soil, encourages soil life, increases infiltration, cools soil and suppresses weeds
- Use chipped/composted leaves, wood or straw placed 3 - 6 inches deep for newly planted trees
- Leave a 3- to 6-inch ring around tree trunk free of mulch to prevent rot
- Allow growing trees and understory to "self-mulch" by dropping leaves, twigs, pods and seeds into their basins
- Rake up nearby leaves, twigs, pods and seeds to add more mulch
- Cut prunings into 4-inch long sticks and drop them into basins below to add mulch
- Small plants, insects and wildlife add organic nutrients to mulch

Inorganic mulch reduces evaporation

- Inorganic mulch reduces evaporation from soil
- Use rocks, cobbles, gravels placed 3 inches deep leaving gaps between rocks for water to infiltrate through
- Rock can be hard to weed around, gets cold in winter and very hot in summer
- Rock does not add organic material to basins to help support plants
- Do not put decomposed granite (DG) in basins—it sheds clay that can clog soil pores, reducing water infiltration

BEST PRACTICE 9

Provide establishment watering and on-going watering using harvested water

### Water newly planted native trees to get them established

- Water new native plantings for one to three years to get them established
- Native trees do not require continual high soil moisture
- To establish new plantings, in hot months water every other day for the first three weeks after planting, then cut back to a good watering once a week
- Eventually water once a month until trees are well established.
- To avoid installing a drip irrigation system, you can water by hose, or fill a drip bucket (5-gallon bucket with a small hole punched at its base) and place it next to the plant

Provide on-going watering for well-established native trees in hot dry months, if needed

- Inspect tree for signs of drought stress such as wilting leaves, yellowing or dropping leaves and branch die-back
- If plants are showing stress, provide supplemental water to soak two to three feet of soil below the mulch layer, if possible
- See the next page for a watering strategies using harvested water supplies

Water your tree at and beyond the canopy "dripline" rather than at the tree's trunk

- Apply water to soil at and outside the tree's "dripline"—the outer edge of the tree canopy where rainwater drips off the leaves
- The roots primarily responsible for water intake reach to the drip line and often far beyond it

DRIP LINE   DRIP LINE
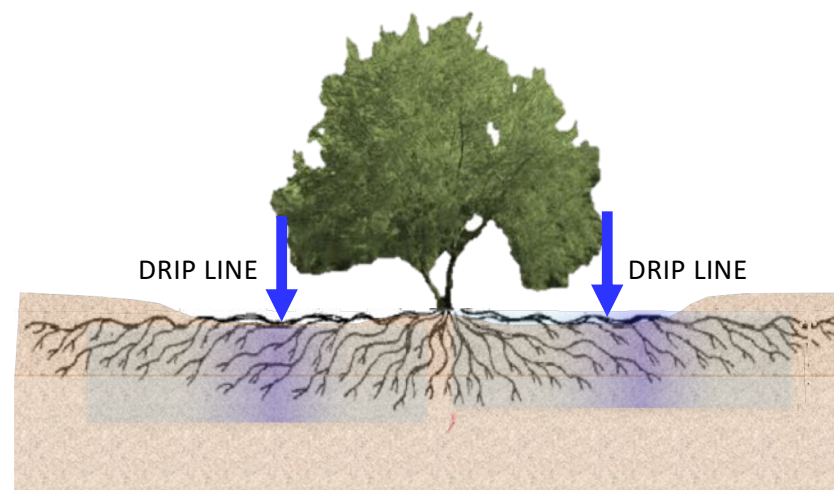
Tree root zone may be 1-1/2 to 4 times as wide as the tree canopy. Root depth is 1 to 3 feet below land surface. Stabilizing tap roots may extend deeper.
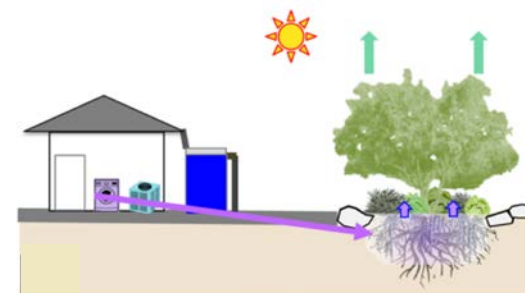
If native trees need to be watered, use condensate water, graywater and tanked rainwater first. Use drinking water (potable water) only in necessary


Let natural rainfall and runoff fill your tree basin (and rainwater tank if you have one)

Use AC condensate (light blue hose) if it is available—the more humid it is, the more condensate is available
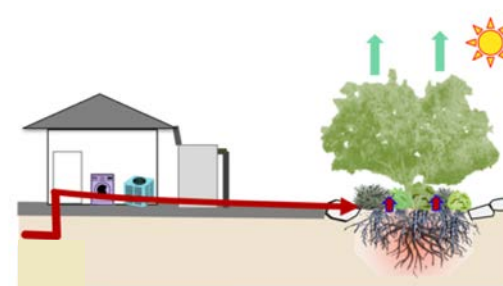

If condensate isn't available, use graywater (buried purple pipe)—an important water source for medium water-use trees. Harvest rainwater in the same basin to dilute salts found in graywater
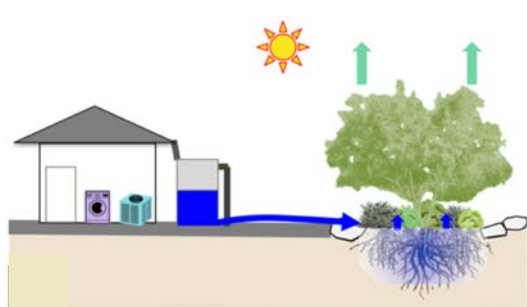
Use rainwater in tank (dark blue hose) if other nonpotable supplies aren't available. An empty tank is ready to refill the next time it rains
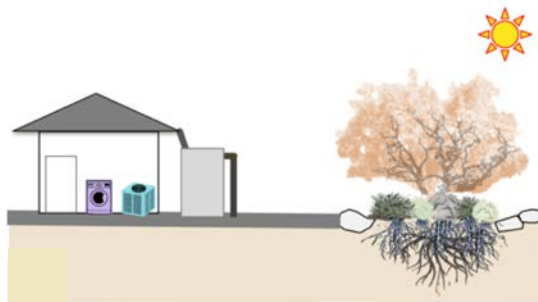
If no nonpotable water is available, you can allow low water-use native trees to adapt naturally by dropping leaves and small branches. Or, if necessary, water with potable water (red pipeline) to maintain essential shade, keep medium water-use trees healthy, meet necessary aesthetic standards and meet other urban tree needs

<div style="background-color: #fff9c4">

BEST PRACTICE 10

For good shade and tree health, prune native trees right

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Well pruned native trees in right-of-way provide a shady walk for pedestrians, shade for parked cars, and survive entirely on stormwater runoff from the street. This is 10 years of growth.

Nine Pruning principles for native trees

1. **Prune for maximum shade for you and to provide sun energy for trees.** Maintain the tree's natural form to provide maximum shade for people. Leave plenty of leaves for the tree to turn the sun's energy into food to fuel it's growth. Essential reasons to prune include traffic safety, managing thorns, making room along paths, making room along streets, creating views through trees for security, wildfire safety, pruning limbs that are prone to natural limb-drop, and making it possible for people to walk under trees for shade.

2. **Wait three years before pruning newly planted trees.** Small branches protect and strengthen the trunk as it grows. Plant growth hormones in branch tips relate to root growth—pruning in early years slows root establishment

3. **Do not prune more than 20-25% of the tree at any one time**

4. **Make sure tools are sharp.** Use scissor-action hand pruning shears, loppers and pruning saws

5. **Start pruning at the bottom.** Start at the bottom and make your way up the tree from there so you prune only what's essential

6. **Start with small branches.** Start by pruning branches less than 5/8 inch in diameter and work your way to larger branches from there

7. **Turn prunings into mulch.** Cut prunings into lengths 4-inches or less and leave them under the tree to serve as mulch

8. **Prune at the right time for the health of the tree**
   - Best pruning time is late winter (February) when the tree is dormant. This is the right time for structural pruning because you can see branches and remove mistletoe and the tree will have time to recover before spring growth
   - You can prune in late spring and summer to remove recent rain-induced growth
   - You may need to prune at other times to remove obstructions

9. **Wear gloves.** Native trees can be very thorny, especially when young

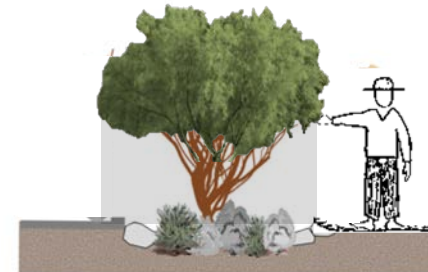# The right way to prune native trees
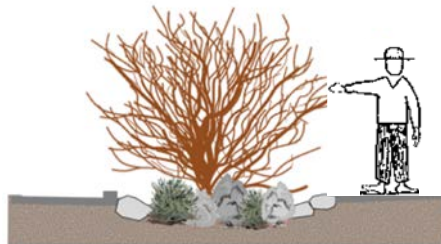
Small multitrunk urban tree
- Planted between street and sidewalk, needs to be pruned
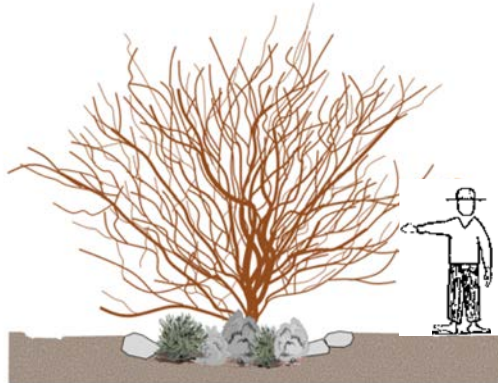- Only prune a side if access is needed

Small multitrunk urban tree showing cuts
- Start small, prune from bottom up
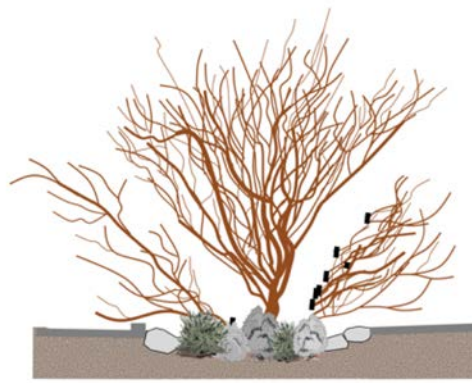- Remove enough for needed urban shape
- Retain multiple trunks

Small multitrunk urban tree, now pruned
- Final pruning has prepared the tree for long-term tree health and access
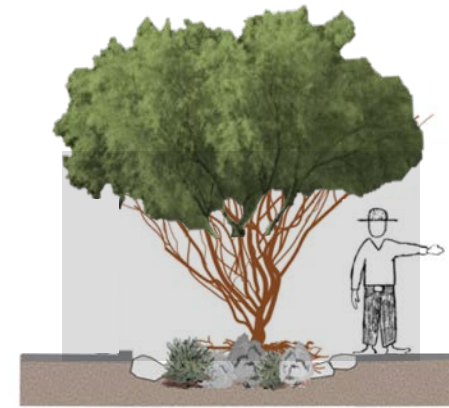- Will grow to produce more shade

Medium sized multitrunk tree in open space
- Fine for now, but development is coming....

Medium multitrunk tree, urbanized
- Need to prune both sides for access
- Start small, prune from bottom up

Medium multitrunk tree, now pruned
- Finished prune allows immediate access
- Produces needed shade

Pruning Methods

Branches < 5/8 inch—Use scissor-action hand pruning shears
- Cut close to the branch, leaving the branch collar intact
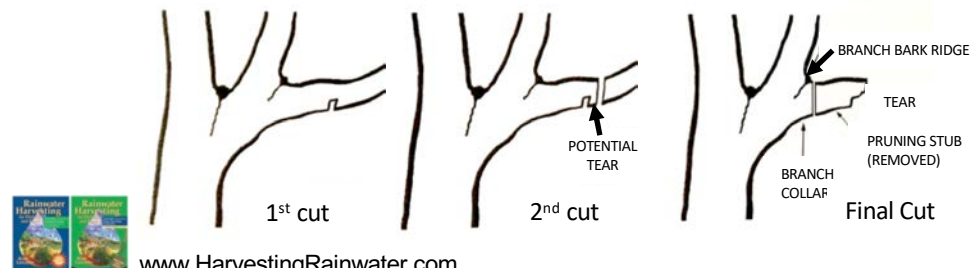- Remove whole limbs or branches. Do not leave a stub.

Branch > 5/8 inch—Use lopper or pruning saw
- 3-cut method is useful if limb could potential tear—use pruning saw
  1st cut: Place saw under branch 3-5 inches from branch collar then cut ¼ way into branch
  2nd cut: Place saw on top of branch and finish the cut downwards
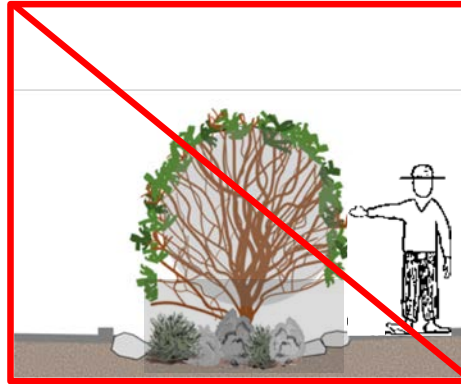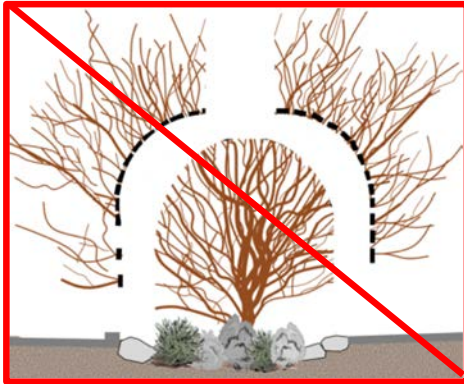 *Final cut:* **Cut off the stub**

3-cut method

1st cut

2nd cut
POTENTIAL TEAR

Final Cut
BRANCH BARK RIDGE
TEAR
PRUNING STUB (REMOVED)
BRANCH COLLAR

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DO NOT SHEAR THE TOP AND/OR SIDES OF NATIVE TREES

- Shearing vastly reduces shade for pedestrians and vehicles
- Shearing turns native trees into distorted shrubs
- Growth after shearing creates a dense mass of leaves at the ends of cut branches, eliminating light and stressing and weakening the plant's interior structure

Foothills Palo Verde   Unpruned

Well-pruned, maintaining natural form

Extreme pruning

DO NOT do extreme pruning of native trees!

Extreme pruning weakens tree health, exposes trunks to harsh sun and heat and drastically reduces needed shade

Velvet Mesquite   Unpruned

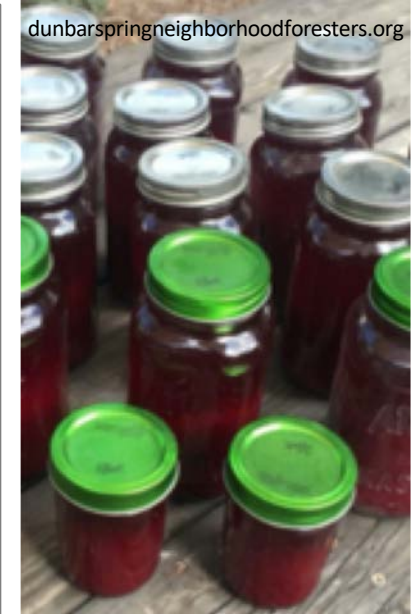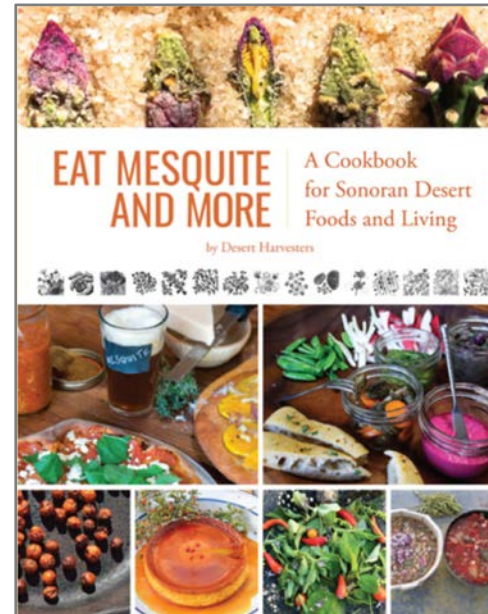Pruned, maintaining natural form

Extreme pruning

Harvest native trees, and enjoy many other native tree benefits

- Native trees that provide edible fruits, seeds and pods include:
    - Velvet mesquite
    - Screwbean mesquite
    - Foothills palo verde
    - Blue palo verde
    - Desert ironwood
    - Canyon hackberry
- Many understory species produce edible foods as well
- This food is free, local, fresh and nutritious
- Harvesting food locally increases food security and saves the energy and water needed to import foods
- **Before harvesting any native plant, research safe practices on how and when to harvest and how to process the food**

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by Desert Harvesters

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Plant Tucson's beautiful, climate resilient, shade-producing native trees

More information at tucsoncleanandbeautiful.org