

Appendix 4

Example Plant Lists and Water Requirement Calculations for Tucson, Arizona

This Appendix contains estimated water needs for vegetable gardens and three multi-use perennial plant lists specific for Tucson, Arizona (water needs will fluctuate depending on planting density, soil type, placement, and exposure). There is a far more diverse array of suitable plants and cultivars available for this area than the lists suggest. These lists are meant simply as both a partial introductory guide for Tucsonans, and as a template for people elsewhere to create plant lists specific to their location and climate.

Estimated annual or monthly water requirements can be easily calculated for plants by looking up their mature size, water needs (low, medium, high), and evergreen or deciduous nature on the plant lists, and then using the simple calculations that follow the lists. These estimates are very helpful in determining what plants, and how many, can be sustained within a Tucson, Arizona site's rainwater budget (calculated in

chapter 2) and potential supplementary water from household greywater (estimated from box 2.6).

The vegetation section of the resources appendix of volume 2 of *Rainwater Harvesting for Drylands* lists some of the books from which I compiled the information. Local gardening groups, herbalists, primitive skills enthusiasts, native plant societies, locally owned plant nurseries, and my own direct observations then fleshed out the lists, and can help you form your lists too. Chapter 4 in this book, and the chapter on vegetation and the planting section of the chapter on infiltration basins in volume 2 offer still more tips.

The first table in box A4.1 shows, for various size vegetable gardens (square feet or square meters), approximate yearly water needs. Note that these gardens are mulched and in sunken basins, in conformance with the principles and strategies of water harvesting.

Box A4.1. Approximate Annual Water Requirements for Mulched Vegetable Gardens in Tucson, Arizona, Planted in Sunken Basins

Based on "Economic Value of Home Gardens in an Urban Desert Environment" by David A. Cleveland, Thomas V. Orum, and Nancy Ferguson, *HortScience* 20(4):694-696.1985

50 ft ² 3,180 gallons	100 ft ² 6,360 gal.	150 ft ² 9,540 gal.	200 ft ² 12,720 gal.	250 ft ² 15,900 gal.	300 ft ² 19,080 gal.
4.5 m ² 12,080 liters	9 m ² 24,160 liters	13.5 m ² 36,250 liters	18 m ² 48,080 liters	22.5 m ² 60,420 liters	27 m ² 72,500 liters

In the plant list tables that follow (boxes A4.2–A4.4), APPROXIMATE WATER NEEDS are listed as:

LW = low water use of 10 to 20 inches of water per year

MW = medium water use of 20 to 35 inches of water per year

HW = high water use of 35 to 60 inches of water per year.

The numbers 1, 2, 3, or 4 in parenthesis signify the approximate irrigation needs of the plants once they become established (this often takes 2 to 3 years).

(1) = no supplemental irrigation,

(2) = irrigation once a month in the growing season,

(3) = irrigation twice a month in the growing season,

(4) = irrigation once a week in the growing season.

Ratings based on Arizona Department of Water Resources Low Water Use/Drought Tolerant Plant Lists and direct observation.

Abbreviations signify: D=deciduous, E=evergreen, EO=essential oil, EPS=earth plaster/pigment stabilizer, F=food, FB=firebreak species, FR=fragrant, FW=fiber/basketry/weaving material, G=glue, H=hardy, HC= hair conditioner, LF=living fence, M=medicinal, NF=nitrogen-fixing, P=pigment or dye, S=shelter/shade, SC=screen, SD=semi-deciduous, SH=semi-hardy, SP=soap, T=tanning hides, W=wood/timber, WB=windbreak.

“Pollinators” can include: butterflies, native solitary bees, beneficial predatory wasps.

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

Species	Water	Size	Cold Tolerance	Elevation Range	Growth Rate	Type of Tree	Human Uses	Wildlife	Domestic Animals That Use Plant
Desert Ironwood (<i>Olneya tesota</i>)	LW (1)	25 × 25'	SH 15°F	2,500' and below	moderate	E	F, M, NF, S, T,	Birds, pollinators, large and small mammals	Chickens, goats
Velvet Mesquite (<i>Prosopis velutina</i>)	LW (1)	30 × 30'	H 5°F	1,000–5,000'	fast	SD	F, FW, M, NF, P, S, W	Birds, pollinators, large and small mammals	Chickens, goats, cattle, honey bees, dogs
Screwbean Mesquite (<i>Prosopis pubescens</i>)	LW (2–3)	20 × 20'	H 0°F	4,000' and below	moderate	D	F, FW, M, S, W, WB	Birds, pollinators, large and small mammals	Chickens, goats, cattle, honey bees, dogs
Cat claw Acacia (<i>Acacia greggii</i>)	LW (1)	20 × 20'	H 0°F	Below 5,000'	moderate to fast	D	M, P, S, T, W	Birds, pollinators, large and small mammals	Cattle, honey bees
Whitethorn Acacia (<i>Acacia constricta</i>)	LW (1)	10–15 × 10–15'	H 5°F	2,500–5,000'	moderate to fast	SD	F, G, M, S	Birds, pollinators, large and small mammals	Cattle
Desert Willow (<i>Chilopsis linearis</i>)	LW (2–3)	25 × 25'	H –10°F	1,500–5,000'	fast	D	FR, FW, M, S, W, WB	Birds and pollinators	Cattle, honey bees
Canyon Hackberry (<i>Celtis reticulata</i>)	MW (2–3)	Up to 35 × 35'	H–20°F	1,500–6,000'	moderate	D	F, S, W, WB	Birds, pollinators, large and small mammals	Chickens
Foothills Palo Verde (<i>Cercidium microphyllum</i>)	LW (1)	25 × 25'	H 15°F	500–4,000'	slow to moderate	D	F, S, W	Birds, pollinators, large and small mammals, desert tortoise	Cattle, honey bees
Blue Palo Verde (<i>Cercidium floridum</i>)	LW (2)	30 × 30'	H 15°F	500–4,000'	fast	D	F, S, W	Birds, pollinators, large and small mammals, desert tortoise	Sheep, honey bees

Box A4.3. Native Multi-Use Shrubs, Cacti, And Groundcover for the Tucson, Arizona Area

Species	Water	Size	Cold Tolerance	Elevation Range	Growth Rate	Type Of Plant	Human Uses	Wildlife	Domestic Animals That Use Plant
Oreganillo (<i>Aloysia Wrightii</i>)	LW (2)	5x5'	H 15°F	1,500–6,500'	moderate	D shrub	F, FR	pollinators	Honey bees, livestock
Quail-brush (<i>Atriplex lentiformis</i>)	LW (1)	Up to 8x12'	H 15°F	Below 4,000'	fast	E shrub	F, FB, M, NF, SC, SP	Birds, large mammals	Honey bees, livestock
Chiltepine (<i>Capsicum annum</i>)	LW (2)	Up to 3'	Frost sensitive	Below 4,000'	Slow to moderate	E shrub, D w/ frost	F, M	Birds	Chickens
Desert hackberry (<i>Celtis pallida</i>)	LW (2)	Up to 10'	H 20°F	1,500–3,500'	Slow to moderate	SD shrub	F, M, SC, W	Birds, pollinators, mammals	Chickens, Honey bees, cattle
Brittlebush (<i>Encelia farinosa</i>)	LW (1)	3'	SH 28°F	Below 3,000'	fast	E shrub	M, G	Pollinators, birds, large mammals	
Mormon Tea (<i>Ephedra trifurca</i>)	LW (2)	3–12'	H	Up to 4,500'	Slow	E shrub	E, M, P, T	Pollinators, birds, large mammals	Honey bees
Ocotillo (<i>Fouquieria splendens</i>)	LW (1)	Up to 15' tall	H 10°F	Below 5,000'	slow	D "shrub"	E, M, LF	Pollinators, birds	
Chuparosa (<i>Justicia californica</i>)	LW (2–3)	4'	SH 28°F	1,000–2,500'	Moderate to fast	D shrub	F	Birds, pollinators	
Creosote (<i>Larrea tridentata</i>)	LW (1)	Up to 11'	H 5°F	Below 4,500'	Slow to moderate	E shrub	G, M, W	Birds, pollinators, mammals	
Wolfberry (<i>Lycium fremontii</i>)	LW (1)	3–5'	H	2,500' and below	Moderate to fast	D shrub	F, M, SC	Birds, pollinators	Chickens, honey bees, livestock
Penstemon (<i>Penstemon parryi</i>)	LW (1)	Up to 3' tall	H 15°F	1,500–4,500'	Moderate	E ground cover	M	Birds, pollinators	
Jojoba (<i>Simmondsia chinensis</i>)	LW (1)	Up to 7'	H 20°F	1,000–5,000'	Slow to moderate	E shrub	FB, M, SC, SP, WB	Large and small mammals	Cattle
Saguaro (<i>Carnegiea gigantea</i>)	LW (1)	Up to 40' tall	SH 21°F	600–3,600'	slow	E cactus	F, G, M, W, T	Birds, bats, pollinators	Chickens
Barrel Cactus (<i>Ferocactus wislizenii</i>)	LW (1)	4–8' tall	H 15°F	1,000–5,600'	slow	E cactus	F, HC, M, P	Birds, pollinators, mammals	Pigs
Staghorn Cholla (<i>Opuntia versicolor</i>)	LW (1)	3–10' tall	H	2,000–3,000'	Moderate to fast	E cactus	F, M, SC	Birds, pollinators, mule deer	
Prickly Pear (<i>Opuntia Engelmannii</i>)	LW (1)	Up to 5' tall	H 10°F	1,000–6,500'	moderate	E cactus	EPS, F, LF, M, P	Birds, pollinators, mammals, tortoise	Sheep, cattle (when thorns burned off)

Box A4.4. Exotic Multi-Use Fruit Trees, Vines, and Cacti for the Tucson, Arizona Area

Species	Cultivars	Water	Size	Cold Tolerance or Needs	Growth Rate	Type of Plant	Human Uses	Wildlife	Domestic Animals That Use Plant
Apple (<i>Malus pumila</i>)	Anna, Ein Shemer	MW (3)	15-20' X 15-20'	150–250 chill hours	moderate	D tree	F, S	Birds, pollinators, deer	Chickens
Apricot (<i>Prunus armeniaca</i>)	Royal or Blenheim, Katy	MW (2–3)	25 X 25'	300–400 chill hours	moderate	D tree	F, FB, S, WB	pollinators	Chickens
Carob (<i>Ceratonia siliqua</i>)	Casuda, Santa Fe, Sfax	MW (3)	25 X 25'	SH 23°F	moderate	E tree	F, FB, S, WB,		Honey bees, sheep, goats, pigs, cows, horses
Chinese Jujube (<i>Ziziphus jujuba</i>)	Lang, Li	LW (2)	20–30 X 10–20'	H 0°F	moderate	D tree	F, M		Chickens
Citrus – grapefruit	Duncan, Ruby Red, Marsh	MW (3)	14–20'	SH 27°F	moderate	E tree	EO, F, FB, M, S	pollinators	Honey bees
Citrus – lemon	Improved Meyer, Lisbon	MW (3)	Up to 20 X 20'	SH 31°F	moderate	E tree	EO, F, FB, M, S	pollinators	Honey bees
Citrus – Sweet orange	Valencia, Trovita, Marrs, Sanguinelli Blood	MW (3)	12–20 X 12–20'	SH 27°F	moderate	E tree	EO, F, FB, FR, M, S	Pollinators, hummingbirds	Honey bees
Date palm (<i>Phoenix dactylifera</i>)	Medjool, khadrawy, halawy, zahidi, maktoom. Only females produce fruit	MW (3–4)	Up to 40' tall	SH 22°F	moderate	E tree	F, FW, M, S, W, WB	birds	Chickens, dogs, camels, horses
Grape (<i>Vitis spp.</i>)	Flame, Ruby, Lomanto, Black Manukka, Thompson	MW (4)	5-90' long	H 0–10°F	moderate	D vine	F, FW, S (on trellis)	Birds, pollinators, small mammals	Chickens, Honey bees
Fig (<i>Ficus carica</i>)	Black Mission, Conadria	MW (3)	15–30 X 15–30'	H 15°F >100 chill hours	fast	D tree	F, FB, M, S	Birds, bats, pollinators	Chickens
Loquat (<i>Eriobotrya japonica</i>)	Big Jim, Tanaka, Champagne, Gold Nugget	HW (4)	20 X 20'	Tree H 10°F, fruit & flowers SH 28°F	moderate	E tree	F, S, WB		Chickens, honey bees
Nopal (<i>Opuntia ficus-indica</i>)	Burbank, Quillota, Papaya, Honey Dew, Florida White	LW (1–2)	Up to 10' tall	H 20°F	moderate–fast	E cactus	EPS, F, FB, LF, M, SC	Pollinators, desert tortoise, javalina	Chickens, pigs, sheep, cattle
Olive (<i>Olea europaea</i>) *	Ascolano, Barouni, Haas, Manzanillo, Mission	MW (2–3)	Up to 30 X 30'	Trees H 15°F, Green fruit SH 28°F	moderate	E tree	F, FB, M, S, W, WB	Birds	Chickens
Peach (<i>Prunus persica</i>)	Desert Gold, Mid Pride, Rio Grande	MW (3–4)	15–25'	H –15°F, 250–350 chill hours	moderate to fast	D tree	F, FB, M, S	Birds, pollinators	Chickens, honey bees
Pomegranate (<i>Punica granatum</i>)	Wonderful, Fleishman, Papago, Sweet	LW (2–3)	12–15'	H 15°F, 100–200 chill hours	moderate	D shrub to tree	F, FB, M, P, SC, T	Birds	Chickens, honey bees

* Order fruiting olives from Peaceful Valley Farm Supply (www.groworganic.com).

How to Estimate the Water Requirements in a Given Month for a Listed Plant in Tucson, Arizona

Based on the “How To Develop A Drip Irrigation Schedule” handout from the LOW 4 Program of the Pima County Cooperative Extension/University of Arizona Water Resource Research Center 350 N. Campbell Ave., Tucson, AZ 85719. Ph. 520-622-7701.

A similar “plant water requirement estimator” can be created for other areas according to local evapotranspiration rates.

For an additional resource, see the Arizona Department of Water Resources for their Drought Tolerant/Low Water Use Plant Lists <http://www.water.az.gov/adwr/Content/Conservation/LowWaterPlantLists/default.htm>

They have plant lists specific to Tucson, Phoenix, and the Pinal, Prescott, and Santa Cruz Active Management Areas (AMAs)

1. Identify the plant as evergreen or deciduous, and as high, medium, or low water requirement.

For example, a Velvet Mesquite is deciduous with a low water requirement.

2. Determine the canopy diameter of the plant (the diameter of the leafy part of the plant). This can be the plant’s current canopy or its potential canopy at maturity. *Let’s say our example mesquite has a 20-foot canopy.*

3. Determine the plant’s water requirement in inches for a given month. See the tables in boxes A4.5A and A4.5B, which show how many INCHES of water the plant needs to receive beneath its canopy to maintain its health. *According to the table in box A4.5B, the June water requirement of our deciduous, low water requirement mesquite is 3 inches.*

4. Convert the plant’s water requirement from inches to gallons. Find the plant’s canopy diameter in Box A4.5C. Then find the corresponding # of gallons per inch of water beneath the canopy, and multiply it by the number of inches required in June to get the total GALLONS of water required in that month.

For example, the number of gallons in an inch of water under a 20-foot diameter Velvet Mesquite is 196 gallons. The tree needs 3 inches of water in June, so multiplying $196 \times 3 =$ a June water requirement of 588 gallons.

Box A4.5A. Monthly Water Requirement in Inches–Evergreen Plants

Water Requirement	J	F	M	A	M	J	J	A	S	O	N	D	Annual Total
Low	0	0	2"	2"	3"	3"	3"	2"	2"	2"	1"	0	20"
Medium	0	0	3"	4"	5"	5"	5"	4"	4"	3"	2"	0	35"
High	0	3"	5"	6"	8"	9"	7"	6"	6"	5"	3"	0	58"

Box A4.5B. Monthly Water Requirement in Inches–Deciduous Plants

Water Requirement	J	F	M	A	M	J	J	A	S	O	N	D	Annual Total
Low	0	0	0	2"	3"	3"	3"	2"	2"	0	0	0	15"
Medium	0	0	0	4"	5"	5"	5"	4"	4"	0	0	0	27"
High	0	0	0	6"	8"	9"	7"	6"	6"	5"	0	0	47"

Box A4.5C. Conversion Table: Canopy Diameter vs. Gallons/Inch under Canopy

Canopy Diameter in Feet	2	4	6	8	10	12	14	16	18	20	25	30
# of Gallons per Inch of Water beneath Canopy	2	8	18	31	49	71	96	125	159	196	306	441

How to Estimate the Annual Water Requirements for a Listed Plant in Tucson, Arizona

Use the tables in box A4.5A or A4.5B to find the plant’s estimated ANNUAL water requirement in INCHES. Multiply that number by the number of gallons per inch of water beneath the canopy (table in box A4.5C), and the plant’s canopy diameter. *For example, the 20-foot diameter Velvet Mesquite needs 15 inches of water annually, and from Table A4.5C we see that there are 196 gallons per inch of water beneath a 20-foot canopy. So multiplying $15 \times 196 =$ an annual water requirement of 2,940 gallons.*

Note 1: Annual water requirement estimates are likely all you will need to consider when designing a landscape of local native plants based on natural wild plant densities and sizes. Such vegetation is naturally adapted to the local rainfall patterns and, once established, can survive the dry periods between rains.

Monthly water requirement estimates are better suited for designing landscapes of exotics or native plants that are planted at a higher than normal density or are irrigated for larger than normal plant sizes. These estimates give you a better idea of what seasons or months require more water so that you can better plan for needed water storage and the timing of supplemental irrigation with cistern water or greywater.

The water requirements for all plants will increase as they grow, since the amount of water they transpire through their leaves increases with the increase in cumulative leaf surface area. Therefore, it is important to plan for the water needs of your plants at their mature size. However, by minimizing the amount of water available to native plants you can reduce their mature size—reducing the need for more water. For example, a Velvet Mesquite receiving approximately 6,600 gallons of water per year can grow to be 30 feet tall and wide, but if only 2,940 gallons of water per year is available to the tree, it will likely not grow to be taller and wider than 20 feet.

Note 2: For another method of estimating landscape water needs and tables of information allowing you to do so for many locations in Arizona see the free publication, *Harvesting Rainwater for Landscape Use*, 2nd Edition by Patricia H. Waterfall and Christina Bickelmann, 2004. The document may be ordered from the Arizona Department of Water Resources, Tucson Active Management Area, 400 W. Congress, Suite 518, Tucson, AZ 85701, Phone 520-770-3800, Website www.water.az.gov. This document is also available online: www.cals.arizona.edu/pubs/water/az1344.pdf