

## WANT TO CHANGE YOUR YARD, BUT DON'T KNOW WHAT TO DO?

Discover how to have a Southern California yard that saves water, improves the environment, and provides beauty.

It's not as hard as you think once you discover...

- What is the Santa Ana Watershed?
- How do you design your yard?
- What is the importance of getting to know your soil and the life within it?
- Should you change your landscape or work with what you have?
- What are the proper ways to select, install, and maintain your plants?
- Why are native plants important—even a small patch?
- What are the proper ways to use irrigation and why?
- Tying it all together as a sustainable landscape.

SoCal Yard Transformation | A STEP-BY-STEP GUIDE TO GET THE YARD YOU WANT



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A STEP-BY-STEP GUIDE TO GET THE YARD YOU WANT

Edited by Pam Pavela

WESTERN MUNICIPAL WATER DISTRICT . RIVERSIDE

Second Edition

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Pam Pavela, Editor  
Western Municipal Water District







# SoCAL YARD TRANSFORMATION

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Most people would like to have an attractive yard, and even better, one that doesn't use a lot of water or require us to get off the sofa more than a couple of times a month. However, most people have no clue how to create such a yard, let alone maintain it. There are endless resources available, but many are either too technical, inaccurate, or simply don't provide enough meaningful information to put to use. That's where this book comes in.

The intended audience of this book is the majority of residents who have a yard in the Santa Ana Watershed of Southern California. Although, the basic principles will apply to most landscapes.

Some will argue that this book creates more questions than answers. After having read the book, at least the reader will have a foundation from which to ask the right questions. Some will argue that this book gets a bit technical; for example, "Why do you prefer to give us those weird hard-to-pronounce botanical names for plants instead of simple common names?" Because, if I told you to go to a nursery and purchase a mimosa, you will either end up with one of several completely different plants, or an unintentional date. ("Mimosa" is also the name for a cocktail.) Regardless of your arguments, I'm positive you will find this book to be of benefit to you.

Enjoy!

*Pam*

Pam Pavela, Editor



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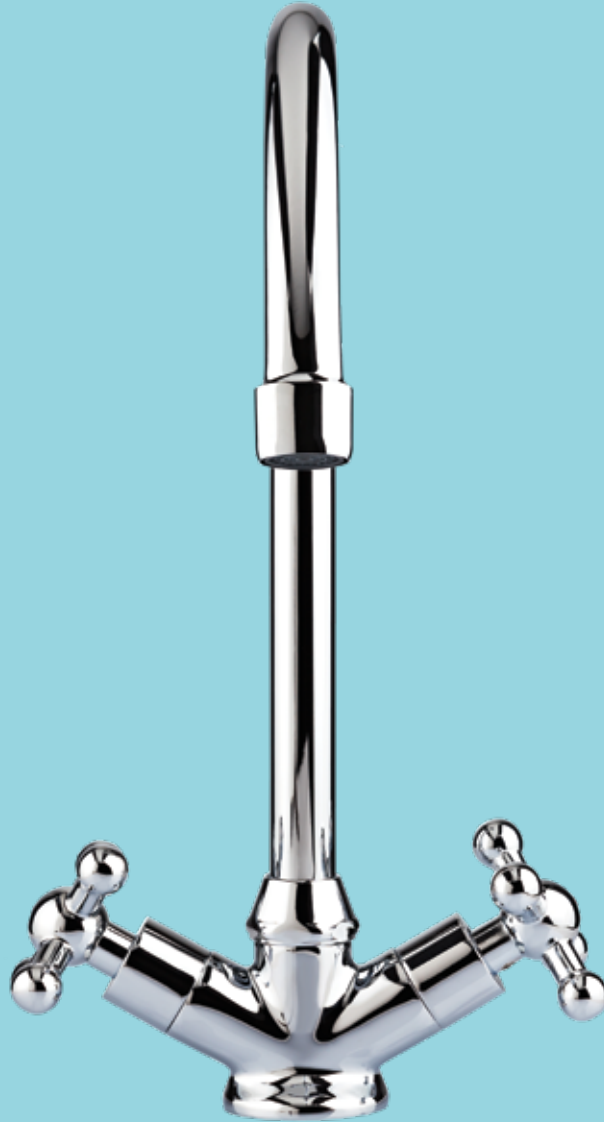
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WHAT IF YOU TURNED ON YOUR FAUCET  
AND NO WATER CAME OUT?

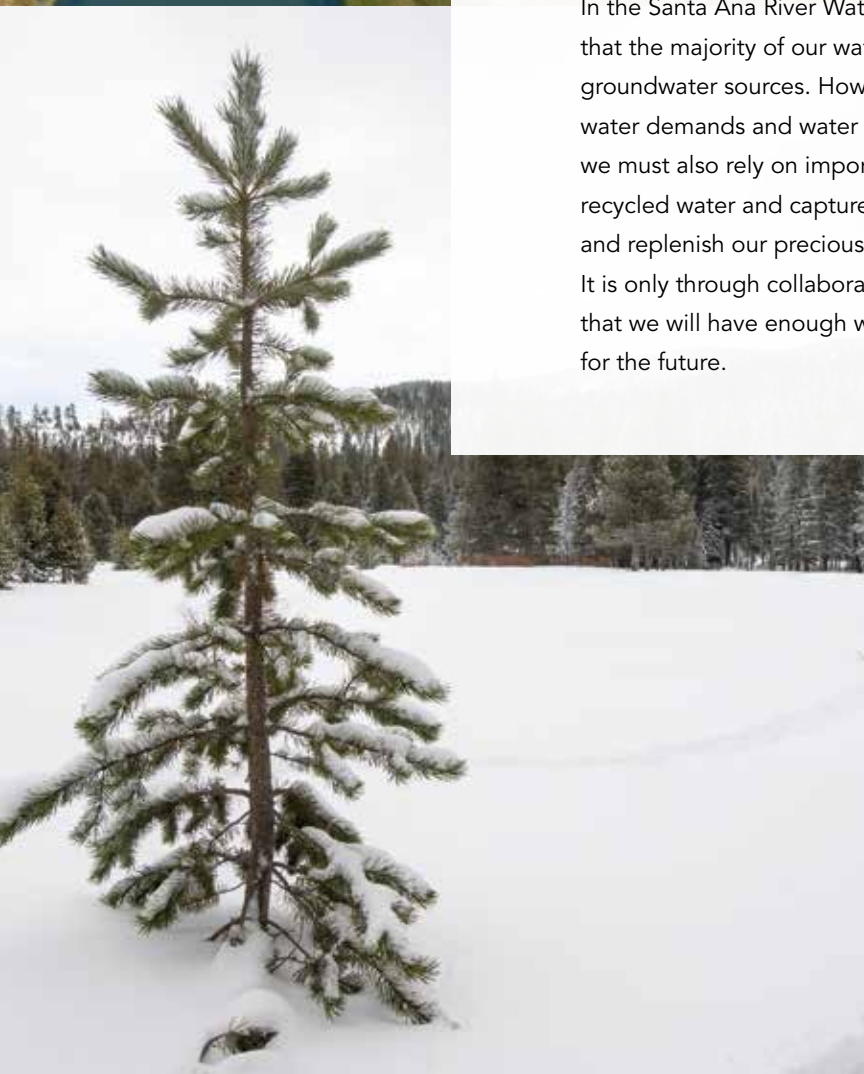
THINK ABOUT IT. HAVE YOU EVER HAD A “WATER OUTAGE”?  
PROBABLY NOT. WATER PROVIDERS WORK HARD EVERY  
DAY TO MAKE SURE YOU HAVE CONSISTENTLY RELIABLE  
AND SAFE WATER AT ALL TIMES. MOST PEOPLE DON’T REALIZE  
THE JOURNEY THAT WATER TAKES TO GET TO THEIR TAP.

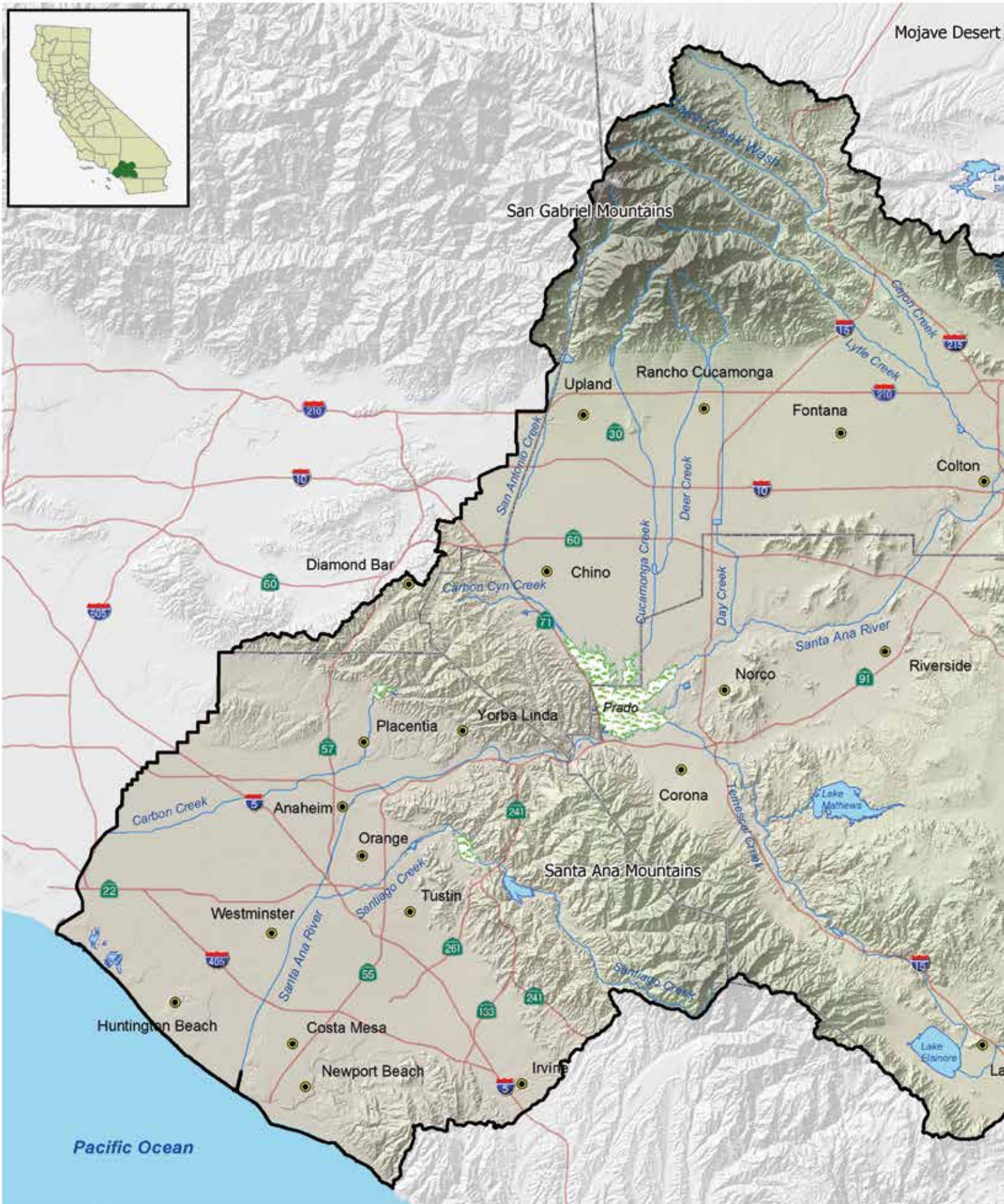
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## WHERE DOES YOUR WATER COME FROM?

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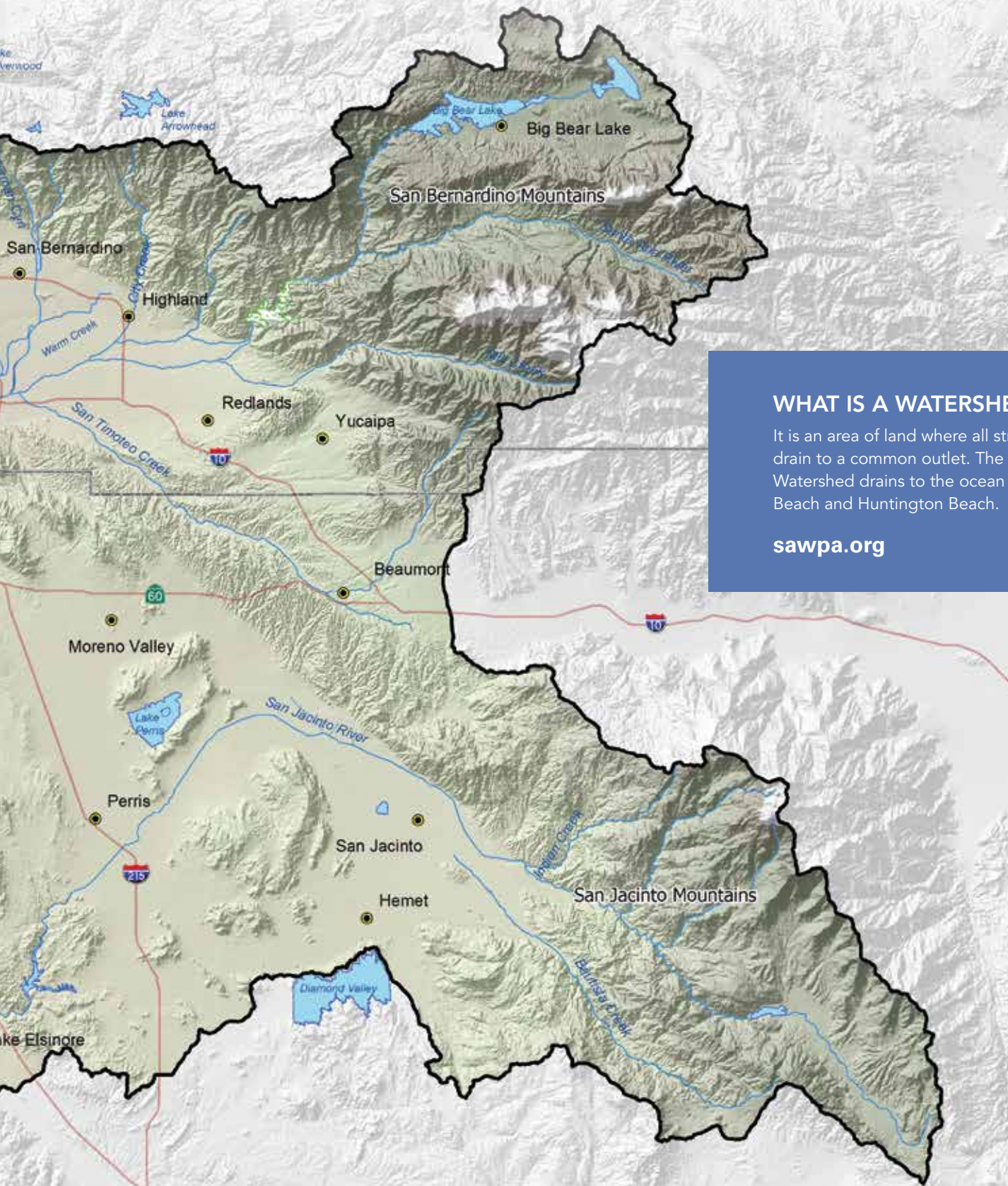
In the Santa Ana River Watershed, we are fortunate that the majority of our water supply comes from local groundwater sources. However, with ever-increasing water demands and water quality protection needs, we must also rely on imported water deliveries, recycled water and captured stormwater to supplement and replenish our precious local groundwater sources. It is only through collaborative projects and programs that we will have enough water to meet the demands for the future.





# THE SANTA ANA RIVER WATERSHED

# WATER



## WHAT IS A WATERSHED?

It is an area of land where all streams and rainfall drain to a common outlet. The Santa Ana River Watershed drains to the ocean between Newport Beach and Huntington Beach.

[sawpa.org](http://sawpa.org)



## GROUNDWATER

# 55% – 60%

Our largest groundwater sources are at the base of the San Bernardino Mountains and the alluvial areas of Orange County. Snowmelt and rainfall are the primary sources of water that supply these large groundwater sources. Supplemental water from Northern California or the Colorado River is artificially added to these groundwater sources to prepare for long dry periods, which the Santa Ana River often experiences.



## IMPORTED WATER

# 25% – 30%

Currently, this is our most expensive water source. Two-thirds of this water travels over 400 miles in an aqueduct from the Sacramento Bay Delta area, down along Interstate 5, over the Tehachapi Mountains, and into the greater Los Angeles area to storage reservoirs such as Lake Perris. One-third comes from the Colorado River through an aqueduct from the Parker Dam/Lake Havasu area of the Colorado River to storage reservoirs, such as Lake Mathews and Diamond Valley Lake.

# CURRENT WATER SUPPLY

## RECYCLED WATER

# 10% – 15%

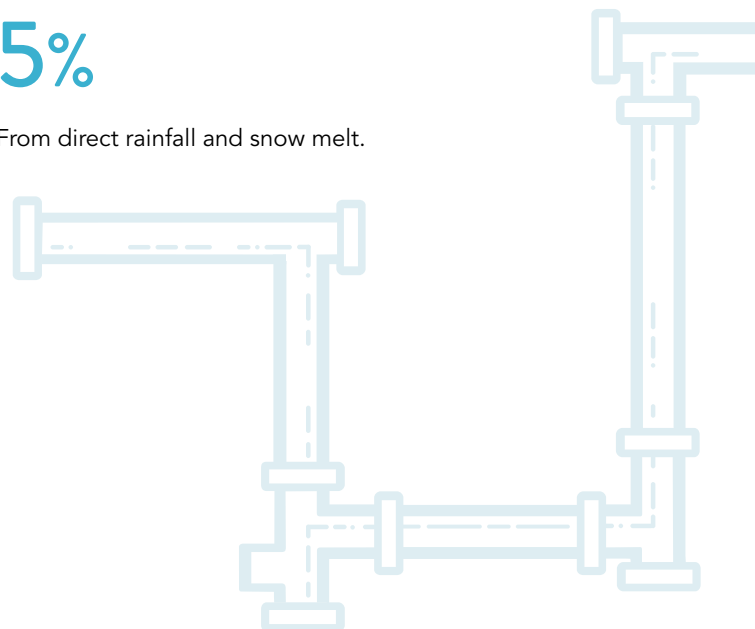


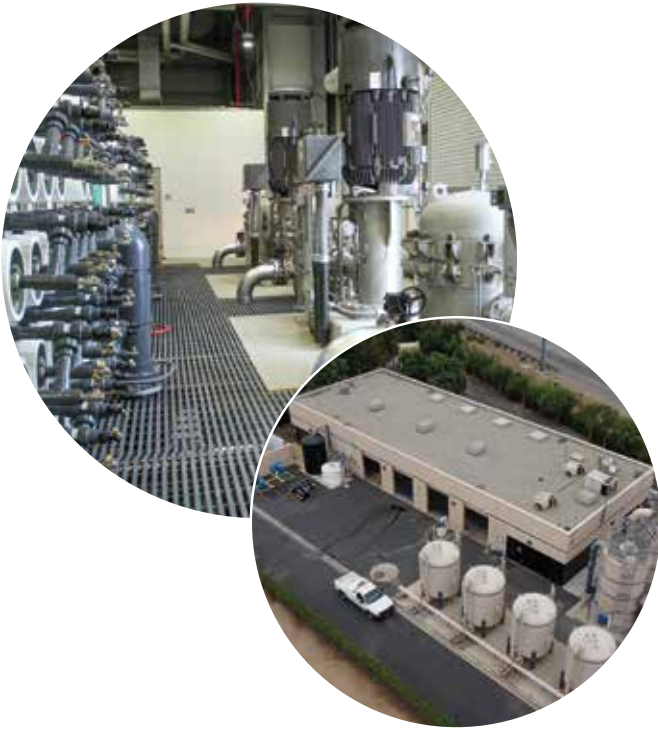
Here's an interesting fact: Did you know that most of the summer flow in the Santa Ana River is recycled water from wastewater treatment plants? Treated wastewater (recycled water) is typically used for irrigation or various industrial and commercial activities. However, many water suppliers in the Watershed, such as the Orange County Water District, perform advanced wastewater treatment (i.e., reverse osmosis and ultraviolet disinfection) which allows direct replenishment of the groundwater sources with this highly treated, recycled water.

## SURFACE WATER

# 5%

From direct rainfall and snow melt.





## OTHER SOURCES

**Water conservation.** Yes, conserving water now effectively extends the life of our water supply. This in turn helps avert the need to develop costly new water sources and large infrastructure projects.

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**New major pipelines** allowing water transfers between basins

---

**Increased groundwater storage** (groundwater recharge basins)

---

**Increased recycled water capacity or facilities**

---

**Increased desalting capacity or facilities**

---

## FUTURE WATER SUPPLY



DID YOU KNOW THAT **19%** OF ALL ELECTRICITY USED IN THE ENTIRE STATE OF CALIFORNIA IS WATER-RELATED? IT IS USED PRIMARILY FOR THE TRANSFER, TREATMENT, HEATING, AND COOLING OF WATER.

---

As you can see, water is moved, pumped, treated, and reused many times over. Most of this requires a lot of water infrastructure and electricity. Once water has gotten to your local water provider, it is—on a daily basis—rigorously tested, treated, and moved through hundreds of miles of pipe to where it is needed. It goes through valves, pump stations, meters, and fire hydrants.



# WATER IN THE LANDSCAPE

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Most people use about 50 to 55 gallons per person, per day, indoors. However, when you add irrigation for landscape, the average water consumption per person or per household takes quite a jump. It can add 200 gallons or more per person, per day. This is especially true in hotter inland areas, and during the warmer months.

When we add water to the landscape, it has two destinations: one intentional, and one not so intentional. Intentionally, we add water to the soil to provide for our plants. Water that goes in the soil can be taken up by plant roots, act as storage for future use, or it can end up replenishing groundwater supplies. Unintentionally, we allow water to run off our property. The water ends up traveling through the watershed via gutters, storm drains, and ultimately, out to the ocean. Unfortunately, it often contains or picks up contaminants along the way. If it can be captured, it can be restored to a clean state once more.

By far, what are the most common contaminants that leave a residential landscape and enter the watershed?

Misapplied fertilizers and pesticides: one of the most common being ant poison.



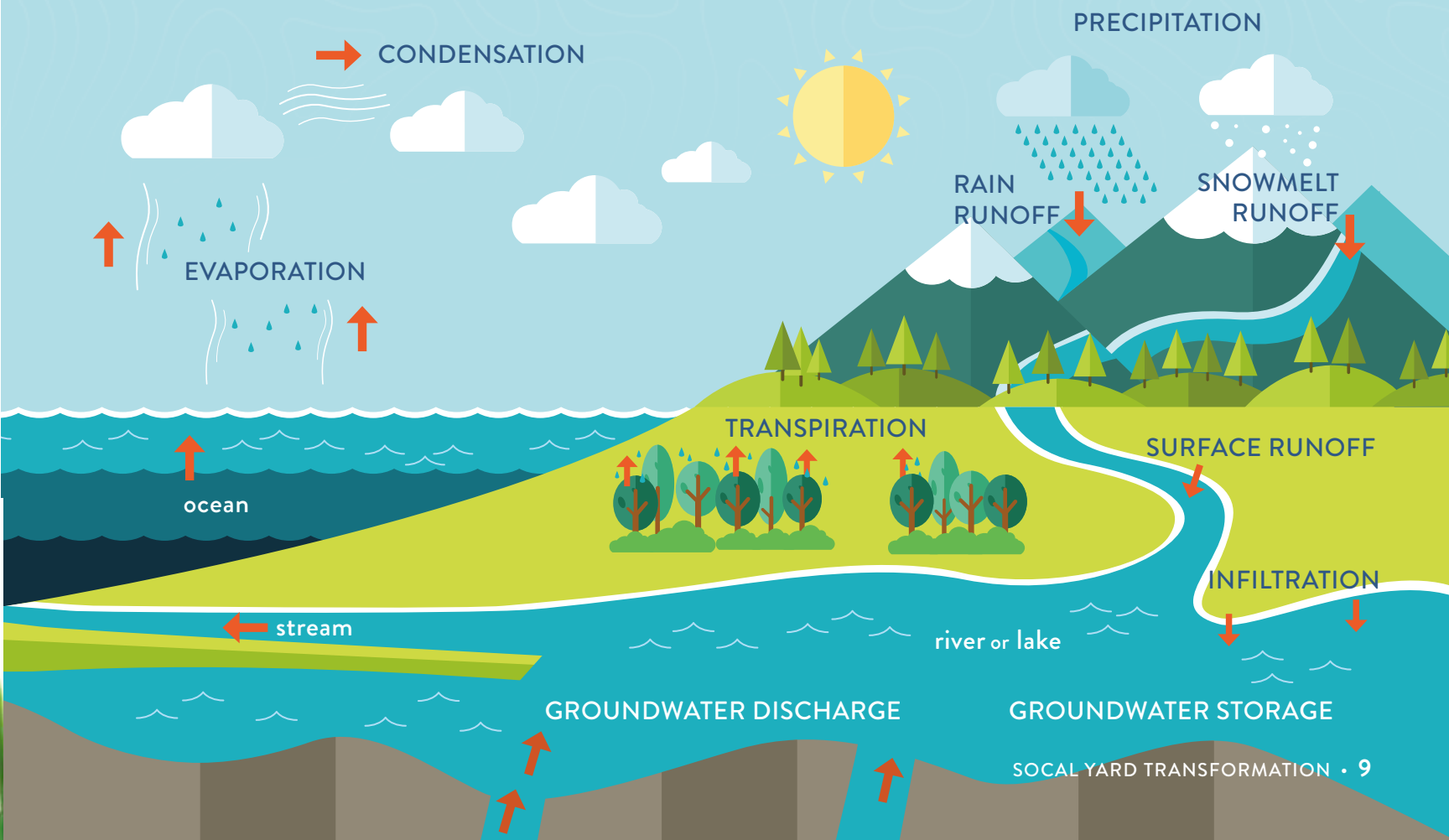
Automobile oil, fluid leaks, and heavy metals

---

ON AVERAGE IN OUR WATERSHED, **60%** OF ALL RESIDENTIAL  
WATER USED GOES TO LANDSCAPE WATERING.

# WATER ON EARTH

Believe it or not, there is a finite amount of water on Earth. We are drinking the same water that the dinosaurs drank. How can this be? Water is constantly being recycled and changing its state (ice, liquid, vapor) through what is called the "water cycle." Therefore, all water is recycled.



# WATER IS INEXPENSIVE!

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The actual cost of your water is very low; however, getting it to you safely and reliably requires a lot of infrastructure, procedures, and regulatory compliance.

Take a look at your last water bill. Most bills show the quantity of water used in a unit of measure called a "CCF." It is defined as "Centum Cubic Feet" or 100 cubic feet. "Centum" is Latin for "one hundred." Each of these units equals 748 gallons. Some water agencies use a less commonly used unit of 1,000 gallons of water. Multiply your units by the number of gallons per unit to see your total water use in gallons.

It will likely be in the thousands of gallons per month. Divide your water bill dollar amount by the gallons of water used to get the price per gallon. You will see the price of water is actually quite a bargain.

Let's say you used 20 units of water in one billing period (approximately 30 days), and the bill for this period was \$130.

20 units x 748 gallons/unit =  
14,960 gallons used for the month

---

If your total  
WATER BILL = \$130

and you used

14,960 GALLONS

each gallon

IS LESS THAN 1¢ PER GALLON

and that includes fixed system costs.

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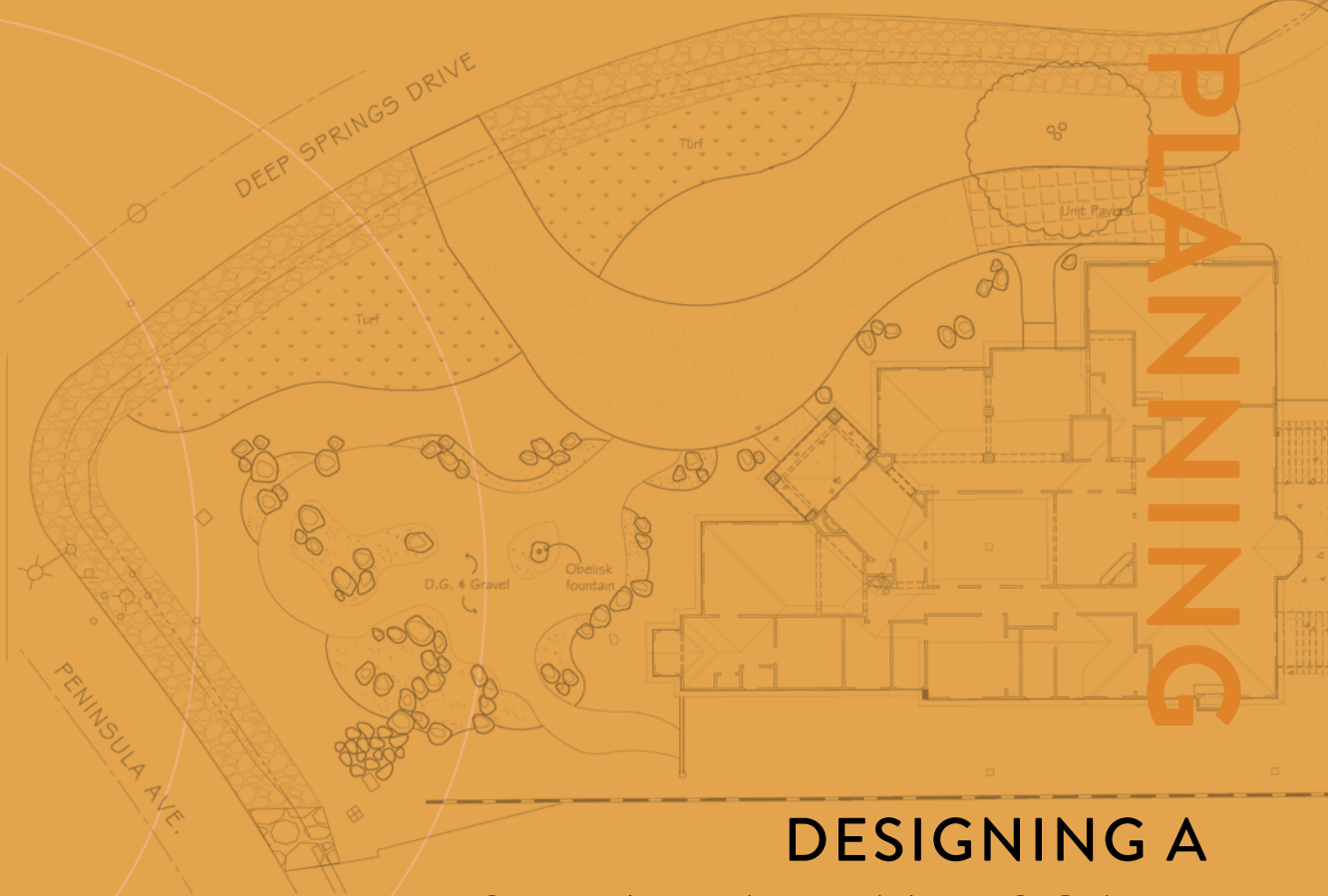
HOPEFULLY, BY FOLLOWING THE INFORMATION IN THIS BOOK, YOU WILL HAVE A NEW APPRECIATION FOR YOUR LANDSCAPE AND THE WATER IT USES, AND YOU WILL BE INSPIRED TO CREATE THE YARD YOU WANT.

---



# PLANNING:

The Key to Success \_\_\_\_\_



# DESIGNING A RESIDENTIAL LANDSCAPE

## A step-by-step example

Designing your landscape involves a series of thoughtful and creative steps. These steps will help you achieve a beautiful and water-efficient landscape.

A step by step example of designing a landscape is shown on the next series of pages to help you visualize how to plan and plant your new landscape. These steps are listed below:

### Step 1. **OBSERVE**

the conditions and needs of your property

### Step 2. **LIST**

your ideas and outcomes based on your observations

### Step 3. **SKETCH**

ideas and outcomes

### Step 4. **INSTALL**

grade, soil prep, boulders and paths, irrigation, plants, and mulch

### Step 5. **REVIEW**

your work

# 1.

## OBSERVE THE CONDITIONS AND NEEDS OF YOUR PROPERTY

MEDITERRANEAN STYLE ARCHITECTURE:  
Pick plants that fit

Western exposure, hot summer sun:  
Home needs shade and framing

Sloped, uninteresting topography

POTENTIAL TO CAPTURE AND INFILTRATE RAIN

No Separation from Street:  
Some privacy needed



A SUCCESSFUL LANDSCAPE depends upon knowing your property, lifestyle choices, and preparing an overall program before thinking of specific plants. Like a successful home, landscapes have spaces and circulation that need to be designed to fulfill certain functions and style, so they will flow and connect together.

When it comes to landscapes we look at our climate for sun and shade patterns, seasons of heat and cold, and we study our topography to understand drainage and enclosure. We also look at how our property is organized and faces our neighbors and streets, and where there are opportunities for different outdoor activities and uses.

## CREATE STRONG LANDSCAPE INTEREST AT ENTRY

Capture roof runoff:  
Use water for plants

Select shade adapted plants

Tree Needed:  
Shade and Entry Marker

ROCKY,  
WELL-DRAINING  
SOIL



Create bioswales to hold  
and infiltrate rainfall on site

Whether you have moved into a new home or have lived for many years in your current one, the success of your landscape reflects how well you make observations and see the opportunities and constraints you want to address.





## LIST IDEAS & OUTCOMES

**IS A LAWN NEEDED?** A small entry lawn or low groundcover is needed in the front yard to face the neighbors, but creating an outdoor garden room is most important.

---

**WHERE IS SHADE NEEDED?** Near the driveway entry, garden room and South and West facing walls. Trees can significantly reduce cooling costs.

---

**WHAT TYPE OF WATER-EFFICIENT PLANTS FIT OUR HOME AND PROPERTY?** Many Mediterranean and California native plant species (see Resources)

---

**HOW DO WE PREPARE THE SOIL FOR HEALTHY PLANTS?**  
(see Soil chapter)

---

**WHERE CAN WE APPLY MULCH?** Almost everywhere, including organic, decorative gravel and stone, and decomposed granite (see Soil chapter)

---

**WHERE CAN WE CAPTURE AND INFILTRATE RAINFALL?** Near each of our roof downspouts and off larger slopes in the front yard

---

**WHAT'S THE BEST WATER-EFFICIENT IRRIGATION SYSTEM?**  
(see Irrigation chapter)

---

**WHAT ARE THE MONTHLY AND ANNUAL MAINTENANCE NEEDS?**  
Monthly trimming, weed removal, replacing mulch, checking irrigation system coverage and schedule. Every six months deep cleaning and detailing garden to remove debris, trash, and trim plants.

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“  
Don't reinvent the wheel! There are many good ideas in your community and at local demonstration gardens.  
”

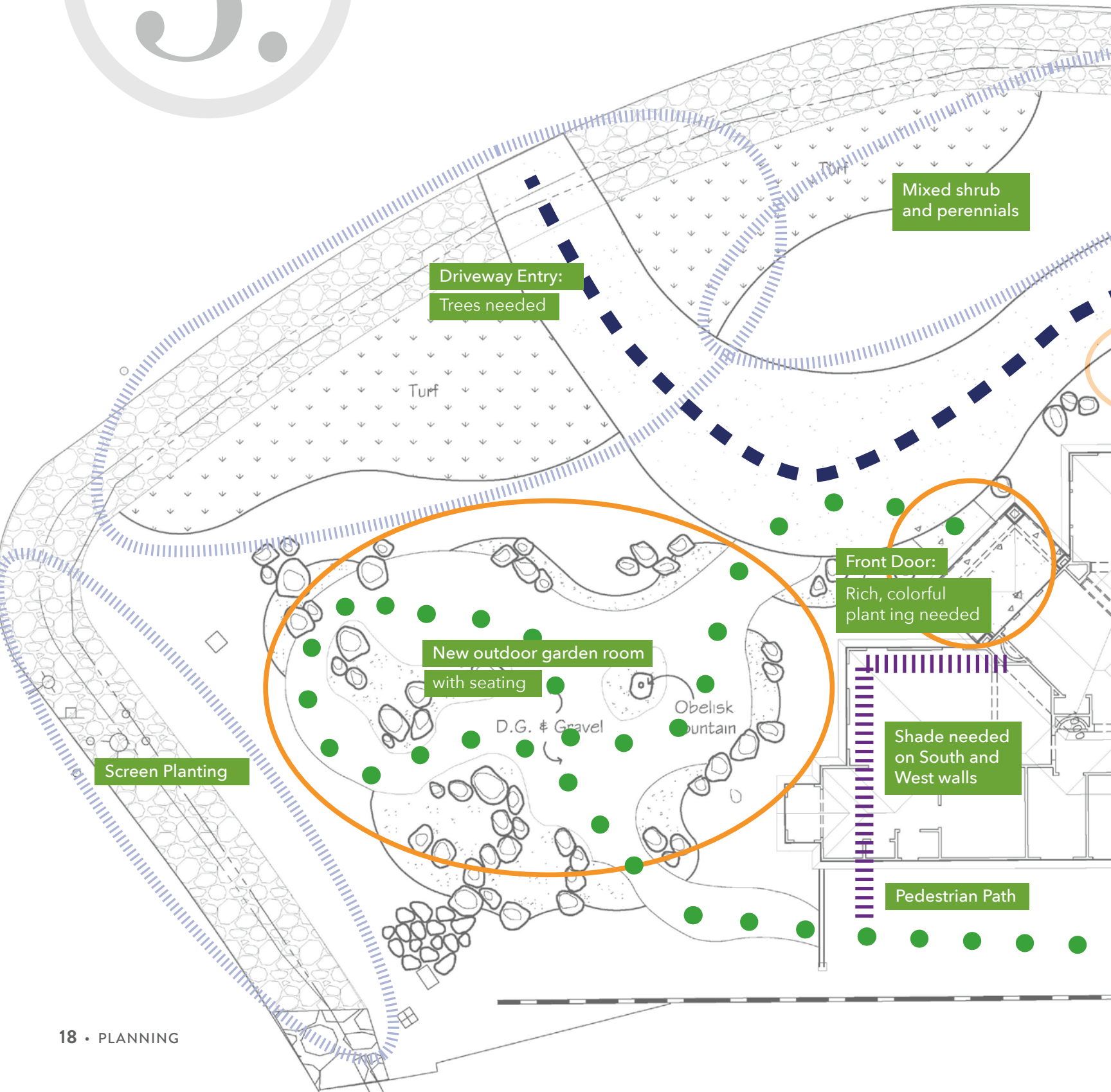


- 
1. Mid-century modern garden
  2. Native bioswale planting
  3. Abundance of flowering perennials
  4. The pleasure of butterflies



# 3.

## SKETCH IDEAS & OUTCOMES



Mixed shrub and perennials

Driveway Entry:  
Trees needed

Turf

Front Door:  
Rich, colorful  
planting needed

New outdoor garden room  
with seating

D.G. & Gravel

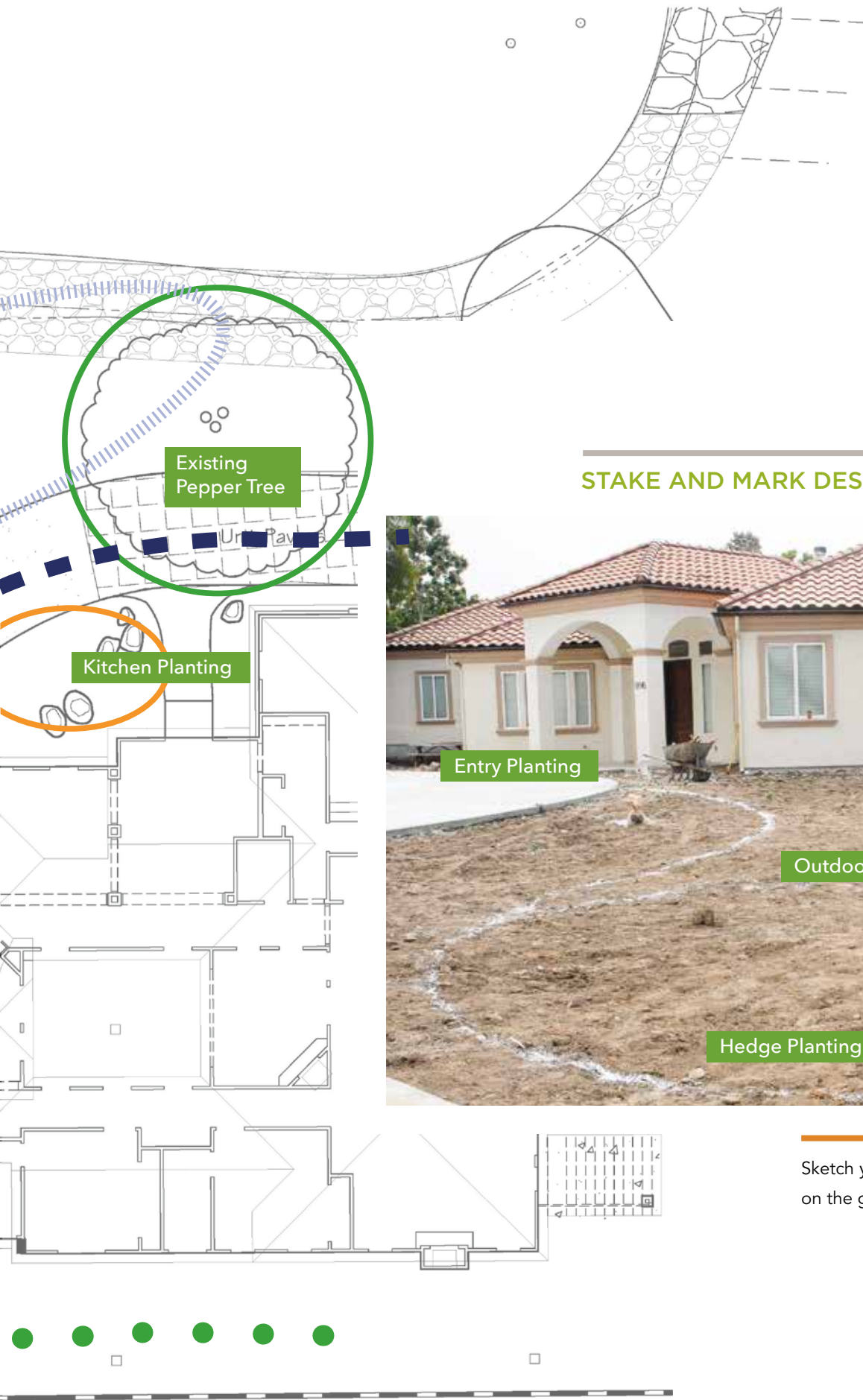
Obelisk  
fountain

Shade needed  
on South and  
West walls

Screen Planting

Pedestrian Path

# PLANNING



## STAKE AND MARK DESIGN ON SITE



Sketch your ideas on paper and mark them on the ground. Make a map.

# 4.

## INSTALL BOULDERS & PATHS IRRIGATION, PLANTS, AND MULCH



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Grade property, prepare soil, and install irrigation



---

Continue irrigation work, place boulders and trees. Be sure to partially bury the boulders so their placement looks natural and not plopped in place.

# 4.

## INSTALL BOULDERS & PATHS IRRIGATION, PLANTS, AND MULCH

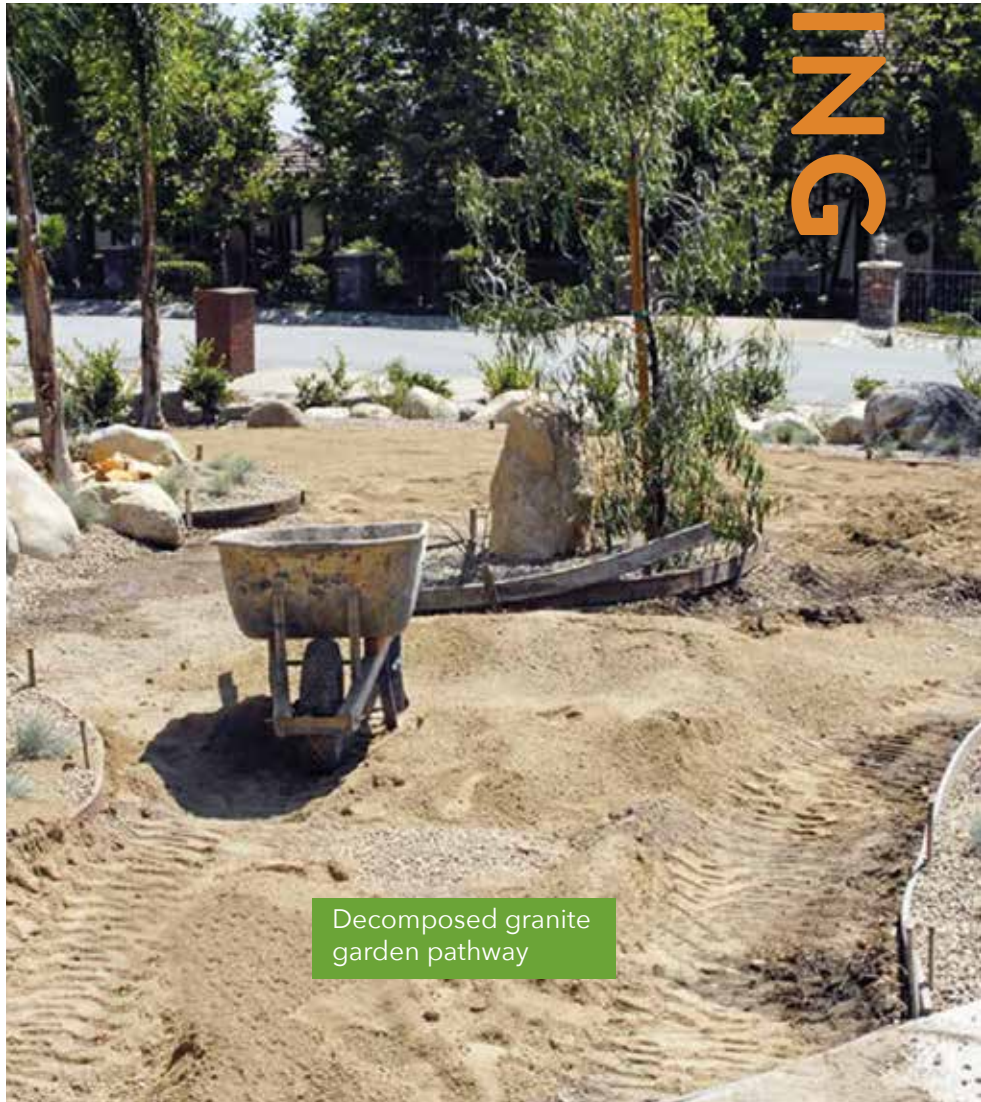
MID-FALL PLANTING SEASON



# PLANNING



Drip tubing:  
To be covered with  
4-6" of organic mulch



Decomposed granite  
garden pathway



# 5.

## REVIEW YOUR WORK



# PLANNING





WHAT'S SO IMPORTANT ABOUT

# Soil?

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## THE HEALTH OF YOUR PLANTS DEPENDS ON IT!

Most people think of bugs and disease as the major problems with plants, when it is actually the soil.



*What makes soil healthy?*

## LIFE

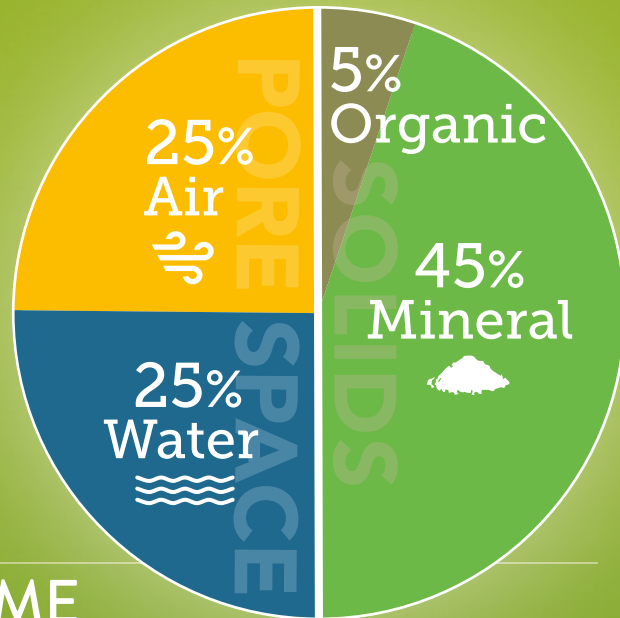
Soil is more than dirt! It is not only made up of minerals (the dirt part), but also water, air, and organic material—dead and alive—and critters. Yes, critters. Soil is teeming with life! Did you know that a teaspoon of healthy soil contains more critters than there are people on earth? These critters consist of bacteria, fungi, protozoa, yeasts, algae, nematodes, and worms, to name a few. They live in a “soil food web” where energy and nutrients pass from one organism to another in a network. Without these critters in the soil, we would not have life on earth. They participate in many activities that assist in soil formation, plant health and growth.

---



*What makes these little guys happy?*  
**A GOOD HOME AND TASTY FOOD!**

HEALTHY SOIL CONTAINS:



**HOME**



**SOIL PARTICLES**

Minerals, the "dirt"



**WATER**

All life needs water



**AIR**

Yes, soil needs air. When soil does not get the air it needs, it begins to stink and turns black and gooey. This is what can happen with extreme overwatering. This condition is called "anaerobic" meaning "no oxygen."

**FOOD**



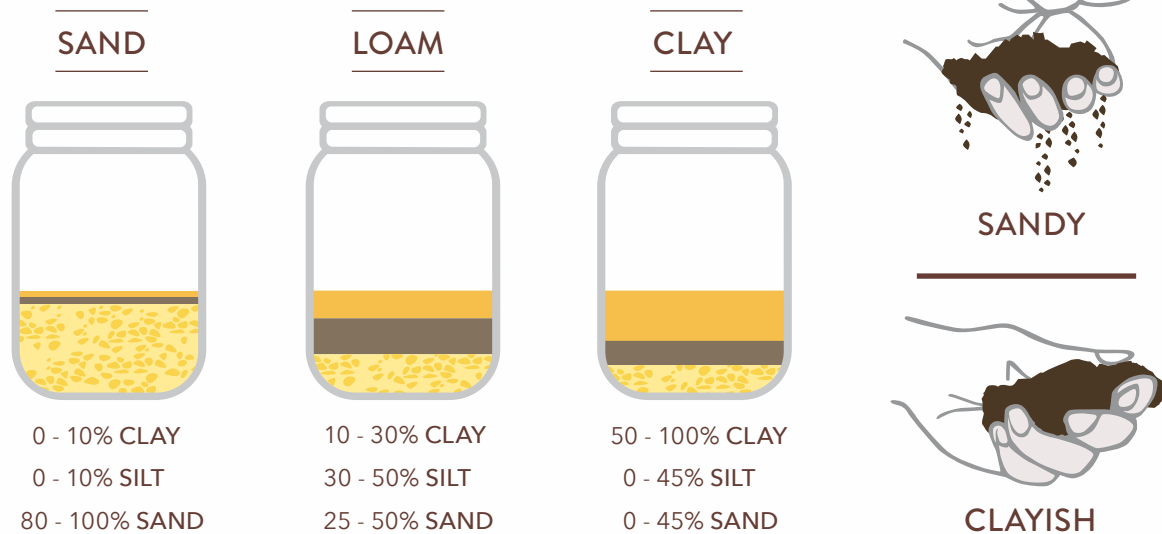
**ORGANIC MATTER**

This consists of root exudates, byproducts of decaying plant material, microorganisms, waste products, humus, etc. Soil critters like a high-carb diet! Even though typical healthy soil contains only 5% organic matter by weight, it provides a base for the life in soil. It acts as a sponge to store water, it retains and provides nutrients, and it glues and binds soil particles into stable aggregates.

# SOIL TYPE & MODIFICATION

The ideal soil is called "loam." It is made up of various mineral particle sizes ranging from fine clay to sand—not too sticky-gooey and not too sandy.

## Jar testing for soil type



### SOIL TESTING FACILITIES IN THE SAWPA REGION:

**Riverside Corona Resource Conservation District**  
 Riverside  
 (951) 683-7691  
[rcred.com](http://rcred.com)

**Waypoint Analytical, Inc.**  
 Anaheim  
 (714) 282-8777  
[waypointanalytical.com](http://waypointanalytical.com)

**Test America, Inc.**  
 Irvine  
 (949) 261-1022  
[testamericainc.com](http://testamericainc.com)

# WHAT'S SO GREAT ABOUT LOAM?

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It provides a structure that readily supports plant roots, while allowing for water and air movement around the soil particles. It supports water and nutrient storage, as well as soil life.

Few people are lucky enough to have loamy soil. In addition, they may have compacted soil, especially if they live in a housing tract.

## WHAT TO DO

Find out what you are working with. Use the methods from this chapter for basic information, or get a soil test; they only cost about \$25. The soil test will tell you what type of soil you have, the nutrient levels, and the pH. Many reports will provide helpful recommendations based on your results.

It is not easy to change your soil type. If you are so inclined, in extreme cases you can remove the top two to three feet of soil and replace it with imported loamy topsoil—not an easy or inexpensive method!

Let Mother Nature create your mulch by allowing fallen leaves to decompose in place. Or, you can

apply a three-inch layer of wood chip mulch to the top of your soil. (Be sure to keep the mulch a few inches away from the base of any plants.) As the mulch decomposes, it provides food to the soil critters, which in turn create beneficial physical and chemical changes in the soil where soil particles stick together creating aggregates. This creates better pore space and water drainage (think sugar cubes) that invite new life to the soil. Replenish the mulch as it decomposes and you will be amazed at the transformation in your soil.

Do not use landscape fabric or plastic sheeting. It inhibits decomposition.



**Good soil structure allows water, air and plant roots easy entry into the soil**



## MULCH vs. AMENDMENT?

Mulch is applied to the top of the soil. It can be either organic, like wood chips, or inorganic, like gravel and rocks. Unless you are landscaping with a palette of desert plants, or plants native to rocky soils, you are better off using organic mulch. An amendment is mixed into the soil. Typical amendments include compost or manure.

### ORGANIC



### INORGANIC



### AMENDMENTS



## WHAT NOT TO DO

Don't add amendment to permanent landscape areas or California native plant landscapes. Amendments are fine for areas that are harvested or replanted frequently, like vegetable or flower gardens. But in a landscape, it can do more harm than good by destroying existing roots and soil food web networks created by the beneficial soil critters. Additionally, amendments contain nutrients that your soil may or may not need.

*Should you add soil amendment to planting holes?*

*No.*

When you dig a hole for a new plant, and add soil amendment around the roots of the new plant, you have created a "glorified pot." This is because the soil of the root ball and the amendment are typically light and airy (large pore spaces) while the existing soil in which the hole has been dug is more dense and tight (smaller pore spaces). When water is added to the new plant and amendment, it will get sucked into the surrounding soil. This is because water is attracted to surfaces. Tighter, smaller pore spaces have greater surface areas in which to attract the water. If your surrounding soil is dry, the root ball of your new plant will dry out faster than if it were in a plastic pot! Additionally, the added amendment creates an environment that keeps roots from penetrating the landscape soil, ultimately causing the plant to become root-bound. The goal is to get the new plant's roots established in the existing soil so the roots will grow beyond the planting hole.







# WHAT IS COMPOSTING, AND IS IT WORTH IT?

Most definitely! Composting is nature’s way of recycling. It is a process of taking organic matter, both green and dry, such as grass clippings, manure (NOT from meat-eating animals), vegetable peels, and dry leaves, twigs etc., and putting them in a pile to decompose. With proper air, moisture, and time,

the pile will yield a pleasant, earthy smelling, dark brown, crumbly material that looks nothing like the original components. Compost provides a rich source of soil microorganisms that can greatly benefit your soil. Use it as an amendment in vegetable and flower gardens, or as a mulch in permanent landscapes.

## COMPOST CHECKLIST

Use this checklist to help you compost organic materials for yourself or deliver your trimmings to a commercial organics recycler.

- Compost piles or bins are located in an area with easy access that is aesthetically acceptable. ....
- Compost ingredients are added and blended to balance nitrogen and carbon ratios. The right mix is equal parts “green” and “brown.” .....
- The compost is kept sufficiently moist, like a wrung-out sponge. ....
- The compost pile is turned, fluffed, or aerated to provide oxygen to microbes and prevent odor. ....
- The finished compost is used as a soil amendment to return nutrients to the landscape and save money on amendment purchases. ....
- Diseased plant material and mature weeds with seeds should not be added to a pile. ....
- Large-scale composting must be performed in a responsible, good-neighborly manner. ....
- State and local laws require permitting or licensing of larger composting facilities. ....
- Take excess material to local, commercial-scale composters. They accept clean landscape trimmings and sell quality organic soil amendment for landscaping uses. ....

## SHOULD I FERTILIZE?

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If you have the optimal 5% organic matter in your soil, you probably don't need to add additional fertilizer to your landscape. A soil report will indicate if your soil is deficient in any nutrients. Intensive gardening, like growing vegetables, may require additional fertilizer.

**Not all fertilizers are the same.** A plant cannot tell if a fertilizer comes from a manufactured or natural source. However, natural or organic fertilizers, even though they are slower to react, provide benefits to the soil life—manufactured fertilizers do not.

**Be careful not to overdo it.** Over-fertilization can actually cause certain nutrients to become “tied up” and unavailable to plants. It can cause salty or even toxic conditions—both of which can harm plants. Even compost used as an amendment can become toxic if it is overused.

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## WANT TO SEE HOW WATER MOVES?

**Try these experiments:** Hold a paper towel vertically. Dip the edge of a paper towel in water and watch the water climb up the towel; or, put a drop of water on a flat impervious surface. Note how the water drop stays in a roundish “bump.” Now take your finger (or just about any object) and just barely touch the edge of the droplet. Notice how the droplet is pulled toward the object.



What you are witnessing is capillary action. It causes water to move without gravity. In addition to soil, this is one of the ways water moves through plants from roots to shoots. (The other way is through osmosis.)

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# WHAT CAUSES THE MOST PROBLEMS IN A LANDSCAPE?

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## 1. SOIL COMPACTION

## 2. OVERWATERING

Both of these problems are caused by a reduction of air and water space in soil which in turn decreases the soil critter population.



**WATER SPACE**  
25%

*Remember, air space and water space should each take up about 25% of a soil's volume.*



**AIR SPACE**  
25%

Soil compaction squishes these spaces, and overwatering fills the spaces up with water. Symptoms include increased disease incidence, shallow rooting of plants, nutrient deficiencies, and wasteful water runoff. In other words, a sick and wasteful landscape!



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OVERWATERING ACTUALLY  
CAUSES MORE DAMAGE THAN  
UNDERWATERING! IT ALSO  
ENCOURAGES WEED GROWTH.



## Remedies:

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### OVERWATERING

**Easy! Cut back on watering.** You'll have a healthier landscape if you cut back on the days you water rather than reducing the watering time each day of watering. Soil needs a period of time to dry down (thus creating those important air spaces). Refer to the irrigation chapter for recommended watering schedules.

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### SOIL COMPACTION

**Not so easy.** If you have a new landscape of bare soil, you can successfully add organic soil amendment to the top six to eight inches. (Three cubic yards covers 1,000 square feet approximately one inch deep.) If your landscape is established with plants, you can aerate the soil with spikes or tines (basically poking holes in the soil), but this can damage soil critter networks and the soil aggregates they have formed. Tilling the soil is even worse. **The best thing to do is periodically add mulch to the surface of your soil.** It will take time (many months), but it will greatly enhance the soil without destroying the soil critters and their networks. To prevent compaction, avoid walking on soil, especially when wet. The soil can squish and stay that way.



“Hmm.

I think I’ll buy that one,  
and that one. Oh, and that  
colorful one over there!”

Isn’t it fun to visit a nursery or garden department and wander the aisles of beautiful plants and flowers? It’s so easy to buy things that are pretty in the store and three weeks later they are dead in your yard.

What happened?



## THREE THINGS TO KNOW

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Plants are living things that have unique requirements for survival and vigor. You might be able to get away with poufy floral chintz curtains in your mid-century modern home, but the wrong plant in the wrong place won't last long, and can be a lot of work trying to keep it alive.

### BEFORE YOU PURCHASE ANY PLANTS, INVESTIGATE A FEW THINGS FIRST:

**1. Know your soil.** There is no sense in purchasing a lovely azalea when you have heavy clay, and alkaline soil conditions. You will be in a constant battle while the azalea dies a slow death. Purchase plants that thrive in your conditions. Yes, there are plants that thrive in clay, alkaline conditions. If you must have an azalea and you live in an environment with compatible temperature extremes, then build a raised bed, or use a large pot, where you can manipulate the soil to the azalea's liking.

**2. Know your environment.** Will the plant be growing in shade, full sun, or somewhere in between depending on the time of year? What are the temperature extremes? Do your winter temperatures get below freezing? Do you have hot summers? Do you live in a windy area? Will the plant's ultimate size be appropriate?

**3. Know the water needs of the plant.** Different plants have different water needs. Group plants with the same water needs together so that when you water you will not have to overwater some plants to meet the needs of others or vice versa.

Careful selection and placement of plants  
cannot be stressed enough!



The number of plant choices may seem completely intimidating, but don't worry. The limiting factors of your yard will actually be a benefit for a change.

### WHAT ARE TWO THINGS THAT CAUSE MAJOR PROBLEMS IN A LANDSCAPE?

1. Overwatering

2. Wrong plant in the wrong place

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# SHOULD YOU CHANGE YOUR LANDSCAPE OR KEEP WHAT YOU HAVE?

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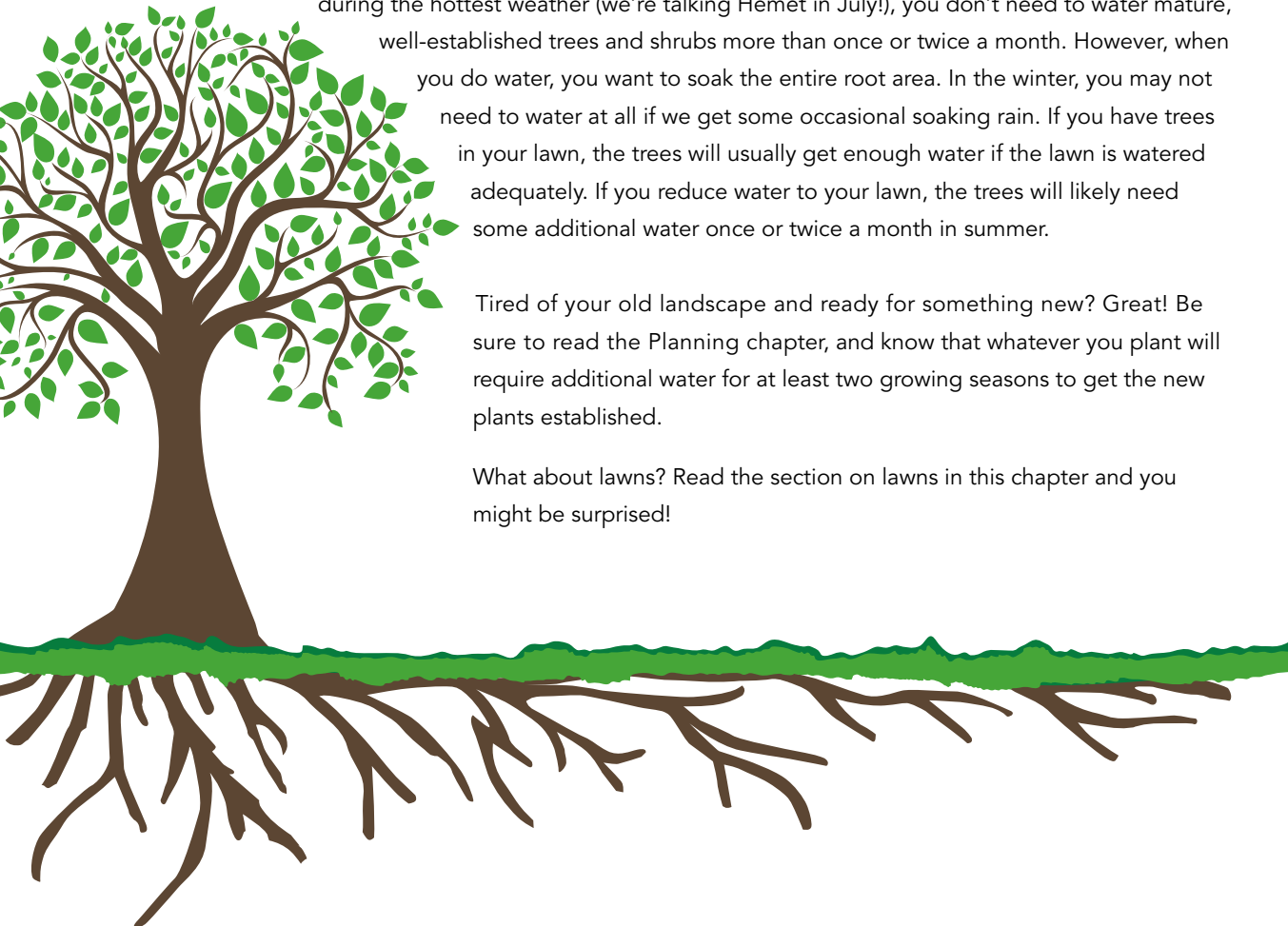
You don't have to rip out your landscape to save water! There are things you can do to a conventional landscape to significantly reduce water waste. Conventional landscapes get a bad rap because most people overwater them or water them incorrectly.

## BEFORE YOU THINK YOU **HAVE TO** RIP OUT YOUR LANDSCAPE, CONSIDER THE FOLLOWING:

Established trees and shrubs do not need frequent watering, even those that are not native. In fact, frequent and too much watering causes more problems than any other factor in the landscape. Most trees have roots in the top three feet of soil and extend in width well beyond the tree canopy. Shrubs are similar, but on a smaller scale. It is best to soak the soil when watering, then let it dry down. How long should you let the soil dry down? In the hottest areas, during the hottest weather (we're talking Hemet in July!), you don't need to water mature, well-established trees and shrubs more than once or twice a month. However, when you do water, you want to soak the entire root area. In the winter, you may not need to water at all if we get some occasional soaking rain. If you have trees in your lawn, the trees will usually get enough water if the lawn is watered adequately. If you reduce water to your lawn, the trees will likely need some additional water once or twice a month in summer.

Tired of your old landscape and ready for something new? Great! Be sure to read the Planning chapter, and know that whatever you plant will require additional water for at least two growing seasons to get the new plants established.

What about lawns? Read the section on lawns in this chapter and you might be surprised!



## SO HOW MUCH WATER DO YOUR PLANTS NEED?

It depends on a number of things:

**Origin** of the plant species (rainforest, desert, etc.)

**Tissue type** – Is it woody like a tree or shrub (you need a saw or clippers to prune it), or herbaceous like a geranium (you can squish it with your foot)? Woody plants of all origins can go weeks without water. Most mature trees can thrive on monthly deep watering.

**Structure** – Plants with small, narrow, and tough foliage can survive without water the longest. Plants with big, soft, thin leaves will require the most water. However, there are always exceptions.

**Maturity** – Older established plants do not require the frequency of watering that young plants require. But when you *do* water, soak 'em good!

**Soil Type** – Plants use water at the same rate and amount regardless of soil type, but heavier soils stay wet longer and need to be watered less frequently than sandier soils.

**Weather** – Temperature, wind, humidity, solar radiation (sun intensity). Guess which factor will dry a plant out faster: high temperature or high solar radiation? It's solar radiation. Air temperature is indirectly dependent on solar radiation.

**Microclimate** – Plants in full sun or reflected heat from walls will require more water than those in full or partial shade.

**Bottom line: Don't be afraid to experiment.** Skip watering for a week and see what happens (nothing will happen unless it is super hot). Then try two weeks, three weeks or more, until you see signs of stress (pale leaf color, wilting). You will be shocked at how long your plants can go without water. When you do water, soak the heck out of your soil so all roots get some water.



# WHAT SHOULD YOU LOOK FOR WHEN YOU BUY NEW PLANTS?

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- 1. Vigor.** Don't buy a droopy-looking, insect-infested, sick plant. Unless the plant has naturally yellow or variegated foliage (you can tell by the name, "Golden" or "Variegated"), the leaves should not be yellowing or mottled.
- 2. Small Size.** Do you think a big plant in a small pot is a deal? Think again. Pull the plant out of its container and be sure roots fill the soil, but check for circling or large bent roots. Several circlers are okay if they are small, but a lot of them can create a problem that the plant will never outgrow. Small is better.



Also consider...

- 3. Environmental Needs.** What are the water, soil, and shade requirements for the plant? Does it tolerate wind and frost (if you live in areas prone to these factors)? Do you have enough room to accommodate the ultimate size of the plant?
- 4. Maintenance Needs.** Do you have the manpower to maintain it properly? Often, people buy plants that get too large for their area. They either have to be trimmed frequently or ripped out.
- 5. Functional Needs.** For what purpose will the plant be used? Eye candy (flowers), neighbor barrier (thorns and dense screen), foundation planting (sturdy low-growing evergreen), accent (unique growth pattern, foliage, or flowers), edible (home grown food), etc.?

Plants are usually sold by the container size: one gallon, five gallon, 15 gallon, 24-inch box, etc. If you can wait a year or two, planting smaller sized plants allows for better rooting, easier planting, and you can save yourself some money. Typically, the younger and/or smaller the plant, the faster its growth rate. If you were to plant a one gallon and a five gallon of the same species at the same time, the one gallon will "catch up" to the five gallon in size in a matter of one to three years for most plant species.

Resist the urge to overplant! Your landscape may look sparser than you want for the first couple of years, but in the long run this will save you time and money.



*Cortaderia selloana*



*Arundo donax*



*Nassella tenuissima*



*Pennisetum setaceum*



*Cytisus scoparius*



*Vinca major*

## ARE THERE SOME PLANTS YOU SHOULD AVOID?

### YES!

Some plants just don't know how to behave. They are known as "invasive plants" because they thrive and spread aggressively outside of their native range creating \$120 billion in economic impacts nationwide. What may be invasive in one area is not necessarily invasive for another. Take, for example, butterfly bush (*Buddleja davidii*). It behaves here in Southern California, but is very invasive in the cool humid climate of Washington. Here are some examples of invasive species in our region. Please don't plant these pests. They often reseed too easily.

Pampas grass (*Cortaderia selloana*)

Giant reed grass (*Arundo donax*)

Green fountain grass (*Pennisetum setaceum*)

Mexican feather grass (*Stipa tenuissima* or *Nassella tenuissima*)

Spanish broom (*Cytisus scoparius* or *Genista monspessulana*)

Large periwinkle (*Vinca major*)



Note: What looks like lawn is actually *Myoporum parvifolium*.

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## WHAT SHOULD YOU PLANT?

You will have the most success with plants that have origins from the Mediterranean regions of the world: California, southern Australia, southern Europe, central Chile and South Africa. These plants are adapted to warm, dry summers, and cool wet winters. You do not have to use California native plants in order to create a water-efficient landscape. However, using them, even in a portion of your yard, provides important habitat.

The Santa Ana Watershed Project Authority (SAWPA) service area has a lot of diversity when it comes to local climates. You will need to consider temperature minimums and maximums, elevation, aspect, and degree of marine influence. *Landscape Plants for California Gardens* and *The New Sunset Western Garden Book* have detailed descriptions of the features of different climate zones across the SAWPA service area. (See Resources.)

Some plants are bred and selected for particular characteristics. They have a special name called a “cultivar.” The cultivar names of many plants can give you a hint about where they thrive. For example, ‘Point Reyes’ manzanita grows much better along the coast but will need more irrigation and shade further inland.

See RESOURCES for plant list recommendations.

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## WHEN SHOULD YOU PLANT?

With careful watering (see Soil chapter), most containerized plants can be planted any frost-free time of year. However, the best time of year to plant is in the autumn when the temperatures are cooling off and the landscape soil is still warm. This encourages root establishment before winter in order to take full advantage of winter rains, and roots will have a head start in the spring as growth increases dramatically.

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## HOW SHOULD YOU PLANT?

Prepare your planting hole as suggested in the Soil chapter. Most plants come in plastic containers or pots. Water the plant well, then give the pot a little squish on three or four sides and gently pull the plant out of the pot. If you see a lot of roots and hardly any soil, put it back—chances are it will never grow as a healthy plant! The most important thing to do once you have your plant in the ground is to water it immediately after planting!!! Keep the root ball moist the first few weeks after planting. Once roots start to penetrate the landscape soil, then watering frequency can be cut back. Don’t forget to add a few inches of wood chip mulch (see Soil chapter). Just keep it away from the stem or trunk of the plant.

For a helpful garden planning checklist see Natives chapter.

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## SHOULD YOU ADD FERTILIZER?

In most cases, established landscape plants other than lawns don't need fertilizer; not even at planting. But there are always exceptions:

- **Fruit trees, veggies, and flowers** – These have variable fertilizer needs depending upon what you want to produce and the timing for fruit, veggies, and annual flowers.
- **Sick looking plants** – Plants can sick be due to unhealthy roots, poor soil conditions, or improper watering. Check your watering practices to be sure you are not over- or underwatering. If no adjustments seem needed in watering, it is best to get a soil analysis done to get an idea of what is going on before deciding to fertilize or add anything to the soil. Most soil analyses come with recommendations. (See Soil chapter. A soil test is inexpensive.) Sometimes it is just a matter of having the wrong plant in the wrong place which creates a more vulnerable plant. For example, an acid-loving plant in an alkaline soil.

If you need fertilizer, "slow-release" types are better for the soil and the environment. They add plant nutrients in a form that makes chemical runoff far less likely to enter our watershed (your neighborhood!).

### TIPS:

- Don't over-fertilize! Plants will grow excessively, crave extra water, and foliage can be burned. In other words, you'll create a monster plant.
- If you fertilize trees, do so at the drip line area, not near the trunk.



# DOES YOUR PLANT NEED A HAIRCUT?

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**PRUNING (A “HAIRCUT”) IS DONE FOR THREE MAIN REASONS: SAFETY, PLANT HEALTH, AND AESTHETICS. IT CAN ALSO STIMULATE FRUIT PRODUCTION IN SOME PLANTS IF DONE CORRECTLY.**

What does pruning do? It can stimulate new growth, and if done severely enough or at the wrong time of year, it can stunt growth.

Should you top your tree? Absolutely not!!! Many people think topping a tree will help keep the tree shorter and safer when actually the exact opposite is true. When a branch or trunk is cut (note that most trunk pruning kills trees), the hidden buds below the cut start to grow and create lots of new branches that are usually weakly attached. These new branches will attempt to replace what was cut. Now, after several growing seasons, you have a tree that is almost the same size as before the topping, but with branches that have a greater chance of breaking off and falling. Plus, the architecture of the tree has been permanently ruined. If a tree is genetically determined to grow tall and wide, it's going to grow tall and wide no matter how much it gets butchered. This is why you need to select and locate trees so that their mature size will not cause problems.

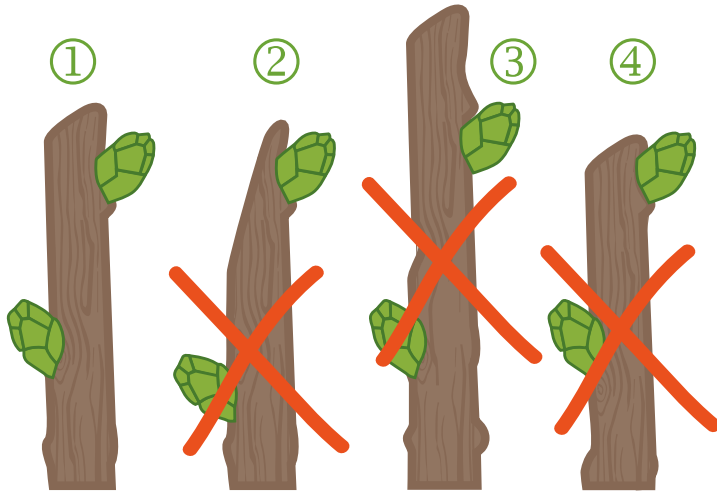


FIGURE 1: Proper pruning at an angle just above the bud

FIGURE 2: Cutting the branch at too sharp an angle

FIGURE 3: Cutting too high above the bud

FIGURE 4: Cutting too close to the bud

Pruning cuts should be made above a bud or branch that is pointing in the direction of the desired new growth.

### THE BEST TIMES TO PRUNE:

- After a plant has finished flowering, unless it is late autumn
- When it is dormant. This is typically in winter when all leaves fallen, or summer for many California native plants.
- Hedges can be pruned almost any time since you are forcing them to stay small with frequent pruning. Be sure to prune them so their sides are straight up and down or slightly tapered at the top so sunlight can reach lower leaves.

### THE WORST TIMES TO PRUNE:

- Autumn. This is when most plants want to slow down and take a snooze for the winter. If you prune them, they will push out new growth; some of which will be more sensitive to frost.
- When nighttime temperatures get near or below freezing (unless the plant is completely dormant)
- Before flowering (unless you don't want flowers or fruit)
- Exception: Some California native plants and perennials do better with autumn pruning.



## What's bugging your plant?

Critters, weeds, diseases, and other assorted disorders can damage or even kill your plants. Go to [ipm.ucanr.edu](http://ipm.ucanr.edu) for an incredible wealth of information from a most definitive source: the University of California.

# WHAT'S THE MOST VALUABLE ASSET IN YOUR LANDSCAPE?

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No, it's not your pizza oven. Here are a few hints:

- It takes years to mature and can be difficult and expensive to replace.
- It captures stormwater runoff and protects water quality.
- It filters the air of pollution while producing oxygen.
- It increases property values.
- It can improve social interaction by lowering crime rates, creating privacy, providing a sound barrier, and adding beauty.
- It can cool a surface 20 to 45 degrees!

**THE ANSWER IS A TREE.** Don't believe it? Find a large tree in a planter next to an asphalt parking lot on a hot summer day. Stand on the sunlit asphalt. Now stand under the tree. Think of how this can be cooling your house.



# PLANTS



Trees should never be topped or wacked. This can create a dangerous situation, and one ugly tree.

When planting a young tree, remove any stakes. If it stands on its own, and tolerates some wind, it does not need to be staked. If it needs some help standing up, provide two stakes for about one year. You want the tree to be allowed to move and bend as it is growing (like a fishing pole), so place the stakes just outside the planting hole and use a flexible material to attach the tree trunk to the stakes. Otherwise, the tree will not grow up to be able to stand on its own in a hard wind.

Mature trees don't need frequent or routine pruning. Prune them only to remove dead or pest-infested branches, branches that interfere with people or block important views, or branches that have poor structure. If you need a tree trimmer, please be sure to hire one who is certified by the International Society of Arboriculture. Find a pro at [treesaregood.com](http://treesaregood.com).



Stake Placement



# LAWN IS NOT A BAD WORD!

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LAWNS ARE MADE UP OF TURFGRASS PLANTS. AND, YES, A TURFGRASS LAWN CAN USE A LOT OF WATER; BUT IT DOESN'T HAVE TO IF IT IS USED FUNCTIONALLY, IRRIGATED APPROPRIATELY, AND THE CORRECT TYPE OF TURFGRASS IS SELECTED.

**What is turf?** It is an even, mowed surface made up of densely planted turfgrass plants that are used in non-crop settings such as lawns and sports fields.

There are two types of turfgrasses: cool-season and warm-season.



TALL FESCUE



**COOL-SEASON TURF:** Tall fescue is the most popular species of cool-season turf. Others include perennial rye, Kentucky bluegrass, and fine fescues. Cool-season turf stays green all year and has a deep green color. It requires less maintenance than some of the warm-season grasses. However, it requires **A LOT** of water.

**WARM-SEASON TURF:** This type of turfgrass lost its popularity when tall fescue came along as a lawn turf. Warm-season lawns like it hot. When winter and cold temperatures come along, they can go dormant (brown). Warm-season turfgrasses are tough. They form “runners” and can fill in dead spots easily which makes warm-season grasses great for pets and play. This also means they easily invade areas of the landscape or garden where they are not wanted. The more common species are Bermuda grass, St. Augustine grass, zoysia, seashore paspalum, even the weedy kikuyu grass. Bermuda grass can be quite drought-tolerant, as much or more than most “drought-tolerant” plants. Stay tuned: There are warm-season grass varieties being bred right here in our watershed that will hold green color throughout the winter.



ST. AUGUSTINE



BERMUDA



There are those who think all lawns should be banned. In many situations, lawns makes sense in areas of a landscape that need the functions it provides. Before you rip out all of your lawn, consider the pros and cons:

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## Pros

- Significantly cools the environment. A lawn surface can be 30 degrees cooler than a paved area
- Improves air quality by releasing oxygen and trapping junk from the air
- Makes a great walk-on or playing surface for activities
- Can be very attractive
- Can absorb sound
- Protects the soil from wind and water erosion
- In sports applications, Mother Nature rids a natural turfgrass surface of blood, sweat, bacteria and other gross bodily fluids.
- Can be used as a vegetative filter to treat stormwater runoff

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## Cons

- Difficult to irrigate without wasting water if the edges of the lawn are not surrounded by other planted areas
- Requires a lot of water if cool-season turf is used
- Needs frequent grooming (mowing) and periodic fertilization
- May require pesticide use

# THE ULTIMATE LOW-WATER USE LIVING LANDSCAPE: CALIFORNIA NATIVE PLANTS

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## What is a California native plant?

IT IS A PLANT THAT HAS EVOLVED AND ADAPTED NATURALLY IN A LOCAL ECOSYSTEM OR LOCATION WITHOUT DIRECT OR INDIRECT HUMAN INTERVENTION.

All plants are native to somewhere on Earth. Here in California, we have more than 2,100 species that are ours alone, and almost 7,000 species, subspecies, and varieties that occur here naturally. Applied to the Santa Ana River Watershed, a native plant is one that grows within the watershed from Big Bear to Huntington Beach. A few plants will grow happily in salty air, snow, and the hot inland areas of Riverside, but most plants are native to a limited set of conditions. Some plants may need an ocean breeze to thrive, while others will need hot, dry conditions and clay soil. However, not all native plants make good landscape plants. Using a little common sense, and the tools mentioned in this chapter and the native plants chapter, you will be able to select native plants for your garden that provide habitat for birds, butterflies, and other animals, and grow in balance with your time and resources.







# California Native Plants

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THE ULTIMATE LOW-WATER LANDSCAPE FOR  
BUTTERFLIES, BIRDS AND BEAUTY





Everyone knows that, most of the time, we are in a water crisis. Not everyone knows we are also in an extinction crisis. Since 1970, the world has lost 52% of its vertebrate wild animals—birds, mammals, fish, reptiles and amphibians.<sup>1</sup> Landscaping with native plants helps mitigate the water and extinction crises, providing dramatic water savings (about 80%!) and essential habitat for butterflies, birds and other wildlife, which give us ecosystem services such as pollination and natural pest control. In addition, native gardens require NO soil amendments, fertilizers or pesticides; all of which can harm watershed and ecosystem health. Native gardens are positive local environmental action with a multitude of benefits!

The Earth is undergoing a sixth mass extinction mainly due to habitat destruction. We can be a force for good by protecting the wildlands that remain and creating native habitat in our urban and suburban areas. **Even just a scrap of land with a few native plants can make a difference** for support of birds, insect pollinators and other wildlife, which give us so much more than beauty. We can show our appreciation by planting the native plants that provide them with the insects, nectar, fruit, leaf, nut or berry foods they need in order to survive. Imagine how our neighborhood landscapes could be transformed into places that

are not just decorative, but places that hum and buzz with life! Let's bring songbirds and clouds of butterflies back to Southern California! How? Native plants!

We must remember that, to create sustainable communities, "green" buildings, renewable energy and decreased water use are not enough; we need healthy food webs and functioning ecosystems as well. These require biodiversity, which, on land, requires native plants.



# SOME WIDESPREAD MISCONCEPTIONS

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## Myth:

Drought-tolerant non-native plants are just as good for the environment as drought-tolerant native plants.

## Fact:

Non-native plants very rarely provide the habitat our Native pollinators, birds and other insects and animals need. Native plants are the foundation of healthy food webs and functioning ecosystems.

## Why?

Native insects and animals specialize on native plants due to co-evolution. Up to 90% of native leaf-eating insect species (such as caterpillars of butterflies) can eat **ONLY** native plants.<sup>2</sup> Insects are the protein that fuels the food web. For example, 80% of a hummingbird's diet is insects, and caterpillars are the main food of baby birds. Native plants produce 35 times more caterpillars than non-native plants. Therefore, we need to garden with caterpillar forage plants to help baby birds survive! In addition to supporting insects, native plants also produce seeds, nuts, fruit or berries that adult birds and other animals need for survival. Habitat loss is the main cause of extinction. We make habitat by landscaping native to sustain nature where we live.<sup>2,3</sup>





# NATIVES

## Fact:

Only 1-2% of California's nearly 7,000 species, subspecies and varieties of native plants are cacti.

**Myth:**  
*Most California native plants are cacti.*

## Why?

Only about a quarter of California is desert. California's varied geography of coastal plains, inland valleys and mountain ranges has made California one of the most botanically rich places in the world. Geographic richness = botanic richness. California has a vast array of native plants that are useful in the garden as shade trees, hedges, privacy screens, groundcovers, borders, etc., and many species are suitable for containers as well. Over a third of California's native plant species are found nowhere else in the world. California is a biodiversity hotspot, a place rich in native plant, insect and animal life threatened by development and population pressure. We support biodiversity by landscaping native.

**Myth:**  
*California native plants don't make flowers.*

## Fact:

Yes, they do! California native gardens can produce flowers throughout the year!

## Why?

In the late 19th and early 20th centuries, California was known as "the country of flowers" through the work of renowned gardener and writer William Robinson. For an idea of California's beautiful variety of flowers in different seasons, look at manzanita (*Arctostaphylos* species), California lilac (*Ceanothus* species), Cleveland sage (*Salvia clevelandii*), matilija poppy (*Romneya coulteri*), monkeyflower (*Diplacus*, or *Mimulus*, species) and California fuchsia (*Epilobium* species). And don't forget California's spectacular array of wildflowers!



MANZANITA



CALIFORNIA LILAC



CLEVELAND SAGE



MATILIJA POPPY



MONKEYFLOWER



CALIFORNIA FUCHSIA





## Myth:

Native gardens require more maintenance.

## Fact:

Native gardens require 68% less maintenance than a traditional garden.<sup>4</sup>

## Why?

In addition, the native garden generates 56% less green waste. Native gardens also reduce carbon emissions because of their decreased water use; one-fifth of California's energy use is for transporting and treating water. The less water we use, the fewer emissions we make, which decreases contributions to climate change.

## Why, exactly, are native, rather than exotic, plants essential for sustaining biodiversity and supporting the food web?

Native plants are essential because they support specialization—relationships in nature that have been established over tens of thousands to millions of years. For example, caterpillars of Monarch butterflies specialize on milkweed. No milkweed, no Monarchs. There are more than 150 species of butterflies in Southern California, and the caterpillars of most of the species specialize on native plants.<sup>3</sup>

Scientists know that, in nature, specialization is the rule. Specialization is illustrated by the fact that up to 90% of leaf-eating insect species (such as caterpillars of butterflies) can eat *only* native plants.<sup>2</sup> These insects turn leaf matter into protein and feed the food web. There are about 10% of leaf-eating insect species that are generalists and can eat exotic plants, but planting exotics eliminates habitat for the 90% of specialists, and makes places virtually sterile but for a handful of generalist species. Native plants are essential for biodiversity because of the specialized relationships between plants, insects and animals that have developed over time.



In North America, 96% of terrestrial bird species rear their young on insects—mostly caterpillars. We need native plants to support native caterpillars that become the food source for our native birds. Over 430 species of North American birds are at risk of extinction, and there are 50% fewer songbirds today than 40 years ago, mainly due to loss of habitat.<sup>5</sup> Birds need native plants for the insects they support, the shelter and nesting material they provide, and the seeds, nuts, fruits or berries they produce.

The relationship between native plant habitats and support for birds holds true for terrestrial food webs in general. In California, for example, native oaks support more than 5,000 species of beneficial insects and animals.<sup>6</sup> By contrast, the non-native ginkgo supports very few species. In our urban and suburban areas, we support healthy food webs and functioning ecosystems by landscaping with native plants.



## NATIVE PLANTS SUPPORT BENEFICIAL INSECTS WHICH SUPPORT IMPORTANT NATIVE BABY BIRD DIVERSITY

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## Are there particular native plants that are especially important for wildlife?

Yes! Particular native plant species—core species, such as oaks (*Quercus* species) – create what Professor Douglas Tallamy terms “foraging hubs.” These hubs are key sources of food for wildlife. For example, foraging hubs are made of 5% of local native plant genera (*Quercus*, for example) that support 73% of the local butterfly species. When the caterpillars are eaten, they supply essential protein, lipids and carotenoids to other insects and animals in the food web. (Birds, for instance, need carotenoids for immune system support, anti-oxidant protection for DNA, attractiveness for mating, improved color vision, and sexual vitality. Carotenoids are only made by plants, so birds have to eat things that eat plants—caterpillars!— to obtain the carotenoids birds need. And most species of caterpillars can eat ONLY native plants, so...) Foraging hubs exist everywhere across the world. To help support biodiversity in our gardens, we need to plant foraging hubs of native plants.

### TOP FORAGING HUB **TREE** SPECIES FOR OUR SANTA ANA RIVER WATERSHED:

For dry environments:

- *Quercus* (oak)
- *Prunus* (hollyleaf cherry)

For moist environments (like a swale where water collects):

- *Salix* (arroyo willow, Goodding’s black willow, red willow, sandbar willow)
- *Populus* (cottonwood, poplar, and aspen in the mountain areas)
- *Alnus* (white alder)

### TOP FORAGING HUB **SHRUB** SPECIES FOR OUR SANTA ANA RIVER WATERSHED:

- |   |  |
|---|--|
| • <i>Acmispon</i> (deervetches)         | • <i>Lessingia</i> (lessingia)             |
| • <i>Arctostaphylos</i> (manzanita)     | • <i>Lupinus</i> (lupine)                  |
| • <i>Atriplex</i> (saltbush)            | • <i>Malacothamnus</i> (bush mallow)       |
| • <i>Baccharis</i> (coyote bush, broom) | • <i>Malosma</i> (laural sumac)            |
| • <i>Ceanothus</i> (California lilac)   | • <i>Penstemon</i> (beardstongue)          |
| • <i>Dudleya</i> (chalk plant)          | • <i>Peritoma</i> (bladderpod)             |
| • <i>Encelia</i> (brittlebush)          | • <i>Prosopis</i> (mesquite)               |
| • <i>Epilobium</i> (hummingbird flower) | • <i>Ribes</i> (currants and gooseberries) |
| • <i>Eriodictyon</i> (yerba santa)      | • <i>Salvia</i> (sage)                     |
| • <i>Eriogonum</i> (buckwheat)          | • <i>Yucca</i> (yucca)                     |
| • <i>Frangula</i> (coffeeberry)         | • Wildflowers                              |
| • <i>Juniperus</i> (juniper)            |  |



*Quercus*



*Penstemon*



*Salix*



Wildflowers

## What is a native plant?

According to The United States National Arboretum:

“A NATIVE PLANT IS ONE THAT OCCURS NATURALLY IN A PARTICULAR REGION, ECOSYSTEM, OR HABITAT WITHOUT DIRECT OR INDIRECT HUMAN INTERVENTION.”

In other words, a native plant is one that occurs naturally in a particular place (i.e. wasn't brought there by people) and evolved there over time. Native plants are adapted to the climate, rainfall, soil, insects, animals, microbes and fungi of a particular place.



## What is a CALIFORNIA native plant?

California native plants are those that were found in California before the 1500s, when Spanish explorers arrived and brought exotic plants into California. For example, from the fossil record we know that oaks (*Quercus* species) are native to California, having been in California for about 56 million years. This long residence means that oaks have not only adapted to California's climate, soils, and rainfall, but have also formed relationships with the native insects and animals. A native plant, therefore, supports much more life in a landscape than a non-native plant, because the native plant shares an evolutionary history with the microbes, fungi, insects and animals of that place.

To find out which plants are native to your area of California, visit the California Native Plant Society's Calscape website: [calscape.org](https://www.calscape.org). On the home page, enter your zip code to yield the names of local native plant species for sun, part shade, low water, groundcovers, and other conditions or categories.



FIND OUT WHICH PLANTS  
ARE NATIVE IN YOUR AREA  
OF CALIFORNIA, VISIT:

[calscape.org](https://www.calscape.org)



## Are “California friendly” plants native?

Sometimes. “California friendly” is a name that has been coined to represent the plants that are adapted to grow in California’s Mediterranean-type climate. All California native plants are California friendly, but not all California friendly plants are native! French lavender is a good example of a non-native California friendly plant. California friendly plants reduce water use in the garden but, unless they are native, they will not support our ecosystems and biodiversity.



## Is a native plant any plant found in the wild?

**No!** Many plants now found in the wild are non-native plants that escaped from cultivated areas or were introduced by people. The introduction of non-native plants into wildlands was often done with the best of intentions but has yielded ecologically and economically disastrous results. For example, California taxpayers spend nearly \$100 million dollars annually to remove invasive, non-native plants from our wildlands because these plants increase wildfire and flooding danger and displace the native plants that provide habitat for our native insects and animals, among other negative effects. See the Plants chapter for common invasive plant species in our watershed.

For more information about invasive plants in California, visit the websites of the Cal-IPC (California Invasive Plant Council) and Plant Right: [cal-ipc.org](http://cal-ipc.org) and [plantright.org](http://plantright.org).

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ALL CALIFORNIA NATIVE PLANTS ARE CALIFORNIA FRIENDLY, BUT NOT ALL CALIFORNIA FRIENDLY PLANTS ARE NATIVE!



## Will any California native plant do well in any California garden?

**No**, because the geography of California is extremely varied. Different parts of the state are at different distances from the equator and Pacific Ocean, which affect the growing conditions for plants. For example, California redwoods are native to the coastal fog belt in the northern portion of the state; redwoods would die in the Mojave Desert. Because of geography, garden conditions vary, so it is important to choose species adapted to the conditions of your location (soil, sunlight, elevation...). For the most success, plant your local native plant species. Local species—the ones that evolved in your area—will be most suited to thrive in your garden. Visit the Calscape website at [calscape.org](https://www.calscape.org).

The geography of the Santa Ana River Watershed also varies, from cool coastal areas with clay soil, such as Huntington Beach, to high elevation mountain areas with fast-draining soil, such as Big Bear. The location of where you live should determine the kinds of plants you choose for your landscape. For example, a coastal sand dune plant that evolved in the relatively mild temperatures of Huntington Beach will not do well in the hot, dry conditions of Riverside. Similarly, a plant that evolved below the snow line will not be able to withstand the freezing temperatures and snow of Big Bear. Landscaping becomes so much easier if the natural character of the land and local native plant species are used as a guide. Work with the nature of your site. Embrace the nature of where you live.

## What type of climate does California have?

**CALIFORNIA HAS A MEDITERRANEAN-TYPE CLIMATE OF COOL WET WINTERS AND HOT, DRY SUMMERS.**

Our native plants have adapted to our climate and rainfall patterns. Like native plants worldwide, California natives have evolved to be able to survive just on rainfall. This makes landscaping with native plants particularly water efficient. In the garden, once established, native plants can survive without supplemental irrigation, but look their best with infrequent, deep soaks during the dry season. There are, however, a few genera of California native plants that tolerate no summer water, such as flannel bush (*Fremontodendron*) and bulbs.



## Are all Mediterranean-climate plants native to California?

**No.** California is one of five Mediterranean-type climate areas in the world: the Mediterranean Basin, southwestern Australia, California, the Cape Region of South Africa, and central Chile. The native plants of all of these regions have similar adaptive characteristics. For example, some shed their leaves during the summer to cope with drought stress; others have aromatic oils in their leaves to retain moisture. However, the native plant communities and species of each Mediterranean-type climate area are different.

People often assume that French lavender, despite its name, is native to California because it is a Mediterranean-climate plant. French lavender shares adaptive characteristics with many California native plants, such as Cleveland sage (*Salvia clevelandii*); both species are aromatic with light-colored leaves. However, French lavender supports biodiversity in France but supports much less biodiversity in California. Both plants will give water savings, since they are both Mediterranean-type climate plants, but only the native plant will provide optimal support for biodiversity. The native plant will also deliver water savings because it co-evolved with the soil's mycorrhizae—a fungus that grows thread-like strands that attach to the roots and deliver supplementary water to the plant.



## What about microclimates?

Buildings, walls, and other objects at your site create microclimates. For instance, the south side of a wall will be much warmer and will receive more sunlight than the north side of a wall; plant accordingly. In the afternoon, the east side of a house will shade that portion of the garden; plant accordingly. Before you purchase any plants, do a site analysis and map the soil, sun and shade characteristics of the garden. Resist impulse buys; do your site analysis so that you purchase plants that will work with the conditions of your site. And remember, you are not a failure if a plant dies. It happens, even to the best of gardeners. Just try again, and have fun! Gardens are meant to be life-enhancing in more ways than one!

## GARDEN PLANNING

- ① Sunlight: What is the sun exposure for each part of the garden — morning, afternoon, or full-day sun? How does the exposure change at different times of year?
- ② Soil: Does water drain quickly or slowly? Do a drainage test to find out: Dig a one-cubic-foot hole; fill it with water; time how long it takes to drain. If it takes more than an hour, plant clay-adapted species or those whose soil preference is adaptable.
- ③ Size: What are the measurements of the site? Draw a map on graph paper, one grid space per square foot. Include existing or planned hardscape and shade areas of trees.
- ④ Determine the function of each area of your site: Where are pathways, seating areas, shade and privacy screens needed?
- ⑤ Determine your garden style and follow basic landscaping principles: repetition; variation of color, texture and form; staggered bloom periods; evergreen anchor and foundation plants; and sightlines.
- ⑥ Coupled with style and function, choose plants based on the sunlight, soil and size of the area. Match the plant to the area. For example, if the area has clay soil and full sun, plant a native that is adapted to those conditions. For greatest success, choose species from your area – work with the nature of where you live.
- ⑦ Design the garden based on each plant's width at maturity. For example: black sage (*Salvia mellifera*) is 5'H x 5'W at maturity; in a 25-foot-long by 5-foot-wide space, five black sages are sufficient because  $5 \times 5 = 25$ .
- ⑧ On the graph-paper map, draw a circle for each plant based on its width at maturity. This will help avoid overplanting, one of the most common mistakes. Overplanting leads to root competition and added work for trimming. Let the plants assume their natural size and shape.

See Resources for plant list recommendation.

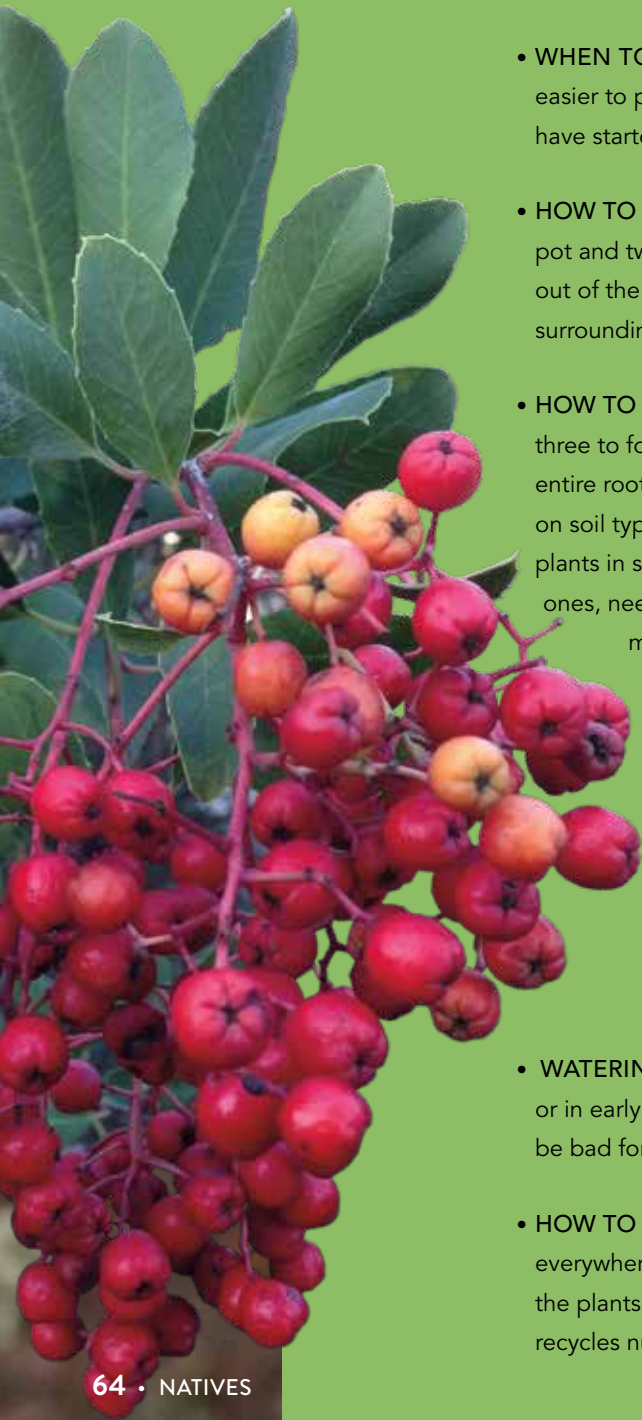




# GARDEN ESTABLISHMENT AND CARE

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- **DON'T FERTILIZE:** California native plants are adapted to so-called nitrogen-poor soil.
- **DON'T AMEND THE SOIL:** Plant a native species that is adapted to the site's soil.
- **WHEN TO PLANT:** California native plants may be planted year-round, but it is easier to plant in the autumn and winter, when the weather has cooled and the rains have started.
- **HOW TO PLANT:** Dig a hole slightly less deep (one-quarter inch) than the soil in the pot and twice as wide. Soak the hole several times; let the water completely drain out of the hole before planting the plant slightly higher (one-quarter inch) than the surrounding soil level; this prevents water from sitting around the crown and stem.
- **HOW TO WATER, ESTABLISHMENT PERIOD:** For a one-gallon plant, give the plant three to four gallons of water each time the top three to four inches of soil is dry; the entire root ball and nearby soil should be saturated. How often you will water depends on soil type: Plants in fast-draining soil will need to be watered more frequently than plants in slow-draining soil. Remember: Baby native plants, even drought-tolerant ones, need frequent deep watering to become established; shrubs and perennials may take a year, and trees may take more than two years. You should mimic a rainy El Niño for the first year, including the first two summers. After the plant is established, elongate the dry periods between the deep watering.
- **HOW TO WATER, POST-ESTABLISHMENT PERIOD:** In general, California native plants prefer deep and infrequent water rather than shallow and frequent. Once established, though adapted to survive on rainfall, most native plants look their best in the garden with deep infrequent supplemental water. Riparian plants will require more water while others may require NO summer water; group plants accordingly.
- **WATERING IN THE HEAT:** Try to water *before* a heat wave hits, below 85°F, at night or in early morning. *Why?* Water plus heat promotes the growth of fungus, which can be bad for plants.
- **HOW TO MULCH:** The garden should have a three- to four-inch layer of mulch everywhere except around the plant stem, crown, or trunk. No mulch should touch the plants. Mulch keeps moisture in the soil, discourages weeds, cools the roots and recycles nutrients into the soil.



- **IRRIGATION METHODS:** Overhead spray or drip irrigation may be used. With either method, make sure the system runs long enough to deliver three to four gallons of water to the roots of each plant during the establishment period. If using drip, be sure the emitters do not clog. If using 1/4" tubing, be sure to keep moving the tubing out to the drip line of the plant as the plant grows. Once plants are established (which is when they have been in the ground for two summers or have tripled in size), begin to lengthen the dry periods between deep soakings.
- **PRUNING:** Should be the exception rather than the rule. In general, do not prune at bird nesting time. Prune on dry, not wet, days. To avoid stressing the plant from water loss, do not prune on hot days. California lilac (*Ceanothus* species) do not like pruning of branches larger than a pencil diameter.
- **DEADHEADING:** All pollinated flowers turn into something: seeds, nuts, fruit or berries that are food for wildlife! Be compassionate: Do **NOT** immediately deadhead old flowers; let flowers fulfill their destiny and nurture wildlife. Then, once the food has been consumed and before the next season of growth starts, cut back the flower stalks of some species to where leaves start near the end of the branch. Examples: buckwheat (*Eriogonum*), penstemon (*Penstemon*) and sage (*Salvia*). Most California native species need no deadheading at all.
- **HOLES IN LEAVES:** Native plants are adapted to native insects; the plants have coping mechanisms for not getting eaten down to nothing. So don't worry! Do not use insecticides. Celebrate those holes—there's life in your garden! That life is protein for birds, lizards, and other animals. To help mitigate the extinction crisis, we need to adjust our notion of beauty away from "perfect" leaves in sterile gardens to gardens that are humming and buzzing with life.
- **GARDEN ECOSYSTEM:** By planting natives, you will be creating a garden ecosystem of insects and animals for pollination, natural pest control, and other ecosystem services. Native gardens, in contrast to non-native gardens, are usually self-regulating. Typical human intervention with non-native gardens, such as the use of pesticides, is usually not needed in native gardens. Plant native species of foundational genera, such as oak (*Quercus*), cherry (*Prunus*), manzanita (*Arctostaphylos*), sage (*Salvia*) and buckwheat (*Eriogonum*) (and more) to create foraging hubs for wildlife in your garden. 5% of native plant genera support 73% of caterpillar species!<sup>2</sup>
- Above all, take time to enjoy your new garden. Find out what works, and do more of that. It's a process!

FOR VERY INFORMATIVE INFORMATION ON HOW TO GARDEN WITH NATIVE PLANTS AND NATIVE PLANT LISTS, GO TO:

Rancho Santa Ana Botanic Garden, [rsabg.org](http://rsabg.org)

Theodore Payne Foundation, [theodorepayne.org](http://theodorepayne.org)





Let's face it...

# Irrigation

is just not a subject most people spend time studying.

However, by learning a few principles about plant water requirements and irrigation scheduling you can beautify your yard and save water! It's a win-win situation.

## PERSPECTIVES

**FROM A PERSON:** Where do I begin? How much should I water? When should I water? Should I replace my whole yard with natives? Why do I have dry areas in my lawn? How do I program my timer or controller? Why does my valve make funny sounds? How do I fix this #\$\$@\*! broken head? Should I install new or different sprinklers or a new controller?

**FROM THE SOIL:** Don't overwater me! I need oxygen just like you. But if you overwater me, I can become waterlogged, and I will lack the oxygen needed to keep the plants and soil organisms alive.

**FROM THE PLANT:** I need water, but just like the soil, I also need air. Depending upon my plant type, I may need frequent water or maybe only rainwater (if there is enough). Therefore, I need to be grouped with my comrades that require the same amount and frequency of water that I require.



## THE TOP TEN WAYS TO CONSERVE WATER IN YOUR YARD

1. **SELECT WATER-EFFICIENT PLANTS THAT GROW WELL IN YOUR CLIMATE.** Use Sunset® climate zones for detailed local information, or the USDA zones for cold hardiness (see Resources).

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2. **PLACE PLANTS WITH SIMILAR WATER NEEDS TOGETHER AND IRRIGATE THEM ACCORDINGLY** (high, medium, low, and very low water use zones). This is called "hydrozoning." In other words, don't water your lawn and shrubs with the same valve. They have different water needs.

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3. **MAKE SURE YOUR IRRIGATION SYSTEM IS FUNCTIONING OPTIMALLY.** Are the sprinklers all working properly, and are they spaced the proper distance apart? Are drip emitters clogged? Are weeds growing around pop-up heads keeping them from working?

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**4. FOR PLANTS THAT HAVE BEEN IN YOUR YARD A SEASON OR MORE, WATER THEM LESS FREQUENTLY THAN NEWLY PLANTED ONES.**

Water them to a depth of slightly below the root zone to encourage extended root growth. Water newly planted plants as often as needed to keep them from wilting; which, in some cases, may be every day. Use the “feel test” described in the soils chapter to determine when it is time to water again.

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**5. AVOID SUMMER PLANTING.** Converting a thirsty yard to a drought-tolerant one should be done in autumn (preferably) or spring rather than during the heat of summer. New transplants need frequent and shallow irrigation until roots extend into native soil.

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**6. IF YOU NO LONGER ENJOY OR USE YOUR LAWN, CONSIDER REPLACING YOUR LAWN WITH MORE WATER-EFFICIENT PLANTS.**

If you decide to keep your lawn, water it based on the *UC Lawn Watering Guide* specific for your locale (see Resources). For you scientists out there, the ET used in the watering guide charts is 0.8 for cool-season grasses, and 0.6 for warm-season grasses.

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**7. SPREAD AND MAINTAIN A 2 -3" LAYER OF MULCH ON TOP OF SOIL AROUND GARDEN PLANTS AND TREES** (wood chips, pebbles, etc.). Keep it away from tree trunks though!

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**8. WATER EARLY IN THE MORNING WHEN EVAPORATION IS LOW.**

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**9. CONTROL WEEDS.** They are just waiting to compete with your plants for all the water they can get!

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**10. FERTILIZE ORNAMENTALS ONLY IF YOU NOTICE SYMPTOMS OF NUTRIENT DEFICIENCY.**

Adding too much fertilizer, particularly nitrogen, creates weak growth and requires more water. Surely a vicious cycle to avoid!

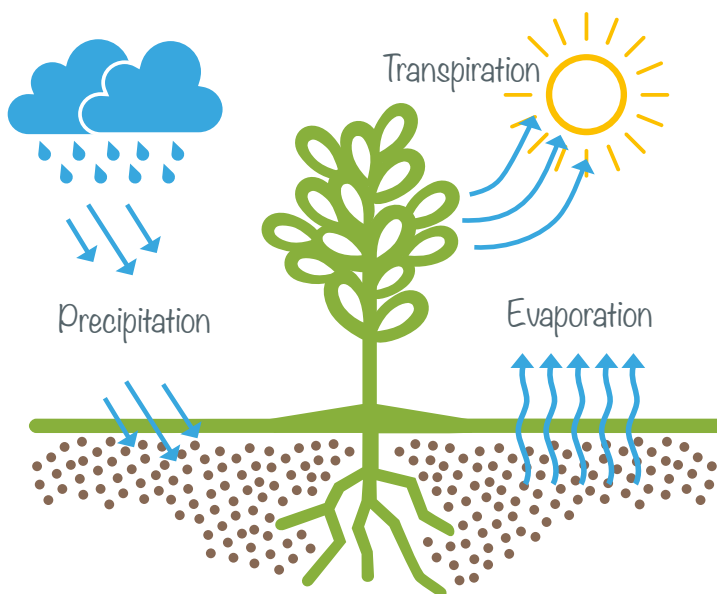
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## PLANT WATER USE

### How much water do your plants need?

It depends upon the plant type and where you live. For example, a cactus needs a lot less water than a lawn; and the same type of lawn will need a lot more water in Hemet compared to Newport Beach. Fortunately, researchers have determined the various water needs of plants based on the plant type along with your local climate.

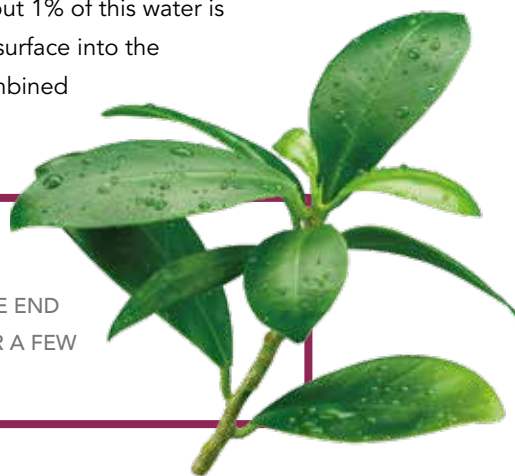


### Factors that affect plant water use - Evapotranspiration

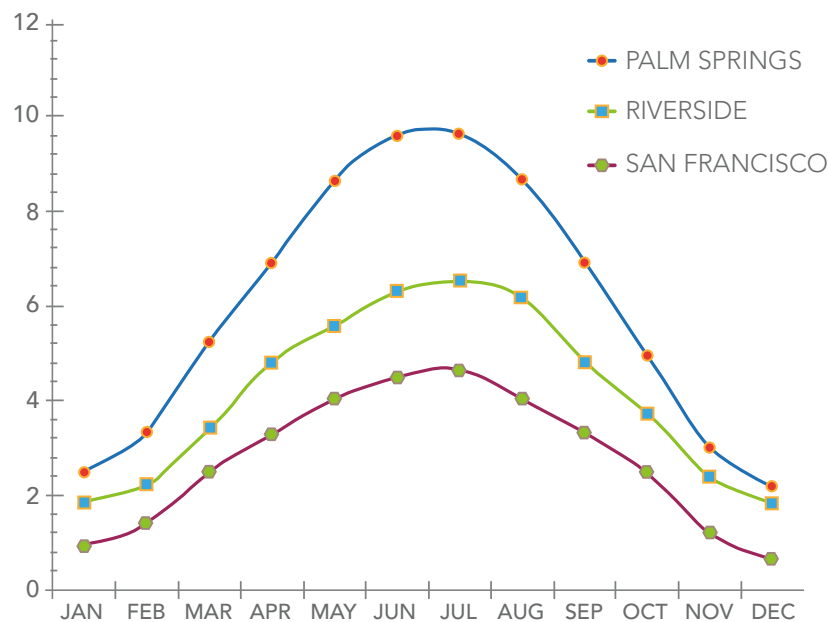
Imagine yourself sitting in the sun on a hot day. Your body sweats to cool itself. Throw in some wind and high humidity and you are really going to sweat! This is very similar to what a plant experiences. However, instead of sweating, the plant loses water through a process called *transpiration*. Water enters a plant through its roots. It then gets transported through the plant up the stem and exits through the leaves as water vapor. (Interestingly, only about 1% of this water is retained by the plant!) Water also evaporates off the soil surface into the atmosphere through *evaporation*. The two processes combined are called *evapotranspiration*, or ET for short.

#### WANT TO SEE A PLANT TRANSPIRE?

TAKE A BAGGIE AND PUT IT OVER SOME LEAVES AT THE END OF A BRANCH EARLY IN THE DAY. TIE IT CLOSED. AFTER A FEW HOURS YOU WILL HAVE A WET BAGGIE.



In California, cool-season grass (specifically tall fescue) is used as a benchmark to compare the water needs of other plants. Why cool-season grass? Because it uses more water than most other plants. Simply put, the maximum amount of water healthy tall fescue needs over a given period of time is thus referred to as "reference ET," written as "ET<sub>o</sub>." ET<sub>o</sub> is a rate that can be measured (with a bewildering equation), and is reported as inches over a given area, like inches of rain (see [cimis.water.gov](http://cimis.water.gov)). As you might guess, the highest ET<sub>o</sub> in the state is in the deserts, and the lowest is along the foggy central and northern coast. In July, during an average year, the average ET<sub>o</sub> is over 9 inches in Palm Springs but only slightly over 4 inches in San Francisco. About half way between the two is Riverside.



## What makes ET change?

- solar radiation (sunshine)
- temperature
- vapor pressure (similar to relative humidity)
- wind speed

Solar radiation has the most influence. The higher the rate of ET, the faster a plant uses water, and the faster water evaporates from the soil. Simply put, your plants will require about half of their annual water needs in summer and a lot less water in the winter months (except for native plants); the actual amount depends on where you live. The good news is, established plants (that are at least a season or two old) do very well when irrigated below the maximum amount of water they would take up if unlimited water was available! In other words, there is no need to replace all the water lost through ET. Many landscape plants do well between 20% and 50% of ET<sub>o</sub> (0.2 and 0.5 of ET<sub>o</sub>).



## WHAT FACTOR AFFECTS PLANT WATER USE THE MOST?

NO, IT'S NOT TEMPERATURE,  
IT'S SOLAR RADIATION  
(SUNSHINE)

---

### Why do you need to know about ET? Three reasons:

1. You can use it to get a pretty good idea of how much water your plants will require.
2. More and more water districts are adopting water rate structures with budgets that vary throughout the year depending upon ET. If you can irrigate according to the rate of your local ET, you will be very efficient, and your yard will thank you.
3. "Smart" or "weather-based" irrigation controllers irrigate according to your local ET. Note: Many water districts provide rebates on these types of controllers.

### What month of the year do most people overwater?

## October.

The ET drops significantly in the autumn due to less hours of daylight and less solar radiation. Don't forget to adjust your controller to less watering days in the autumn.

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## How to determine how much water your plants need

The percentage of  $ET_0$  required by different types of plants to perform well is shown in Table 1. Most plant types will survive with somewhat less water than these estimates but they will not meet yield, growth, or appearance expectations. It is also important to understand that most plants will use more than they need if it is available, even those plants deemed low-water-using or drought-tolerant. They are opportunists! Thus, it is easy to waste water and overwater many plants without realizing it.

Keep in mind that one of the best ways to monitor the water needs of your plants is to watch for these signs of stress and take action before irreversible damage occurs!

- Wilting or drooping leaves that do not return to normal (without adding additional water) by morning
- Curled or yellow leaves that may fold or drop, along with potential twig drop
- Leaves that lose luster and become grayish or bluish

**Table 1. Percentage of reference ET ( $ET_0$ ) for established landscape plants, turfgrasses, and home garden crops to provide acceptable performance in California <sup>1,4</sup>**

Plant Type	Percentage of $ET_0$
Tree, Shrubs, Vines, Groundcovers (woody plants) & Non-woody Perennials	0.5
Desert Native Plants	0.2
Annual Flowers & Bedding Plants	0.8
Lawns, cool-season (fescues, ryegrass, bluegrass, bentgrass)	0.8 <sup>2,3</sup>
Lawns, warm-season ( Bermuda, zoysia, buffalo, St.Augustine)	0.6 <sup>2,3</sup>
Fruit Crops, Deciduous (apples, apricots, peaches, berries, etc.)	0.8 <sup>2</sup>
Fruit Crops, Evergreen (citrus, avocado, etc.)	1.0
Vegetable Crops	1.0 <sup>2</sup>
Mixed Plantings	Percentage of the planting is that of the plant type present with the highest percentage

By using the table you can see that trees need only half as much water as a cool-season grass lawn.

*But there is more to it than that!*

Most plants, other than turfgrass, annuals, and most edible crops, do best with less frequent watering days, not less frequent watering time. For example: If a lawn needs water four days a week, we would assume a typical tree will need water two days a week. However, a tree typically has deeper roots than a lawn, so it would actually be better to water the tree once a week at double the amount of water.

## THE MATH

(DON'T BE SCARED!)

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If you are not afraid to try a formula or two, you can use ET to figure out how many inches of water or gallons of water your plants need. You'll need to know the following:

$ET_o$ : Your local  $ET_o$  in inches for the time period you specify (day, week, month, year). See Table 2 for monthly ET values.

%: The percentage of  $ET_o$  for your chosen plant type from Table 1

A: The area, in square feet, that your plants occupy

0.623: The factor to convert to gallons of water

$$\text{Inches of Water (think rain)} = ET_o \times \%$$


---

**EXAMPLE:**

How many inches of water will I need to apply to my cool-season grass lawn for the month of April in Irvine? **3.8 inches**

$$3.8 \text{ inches} = 4.8 \text{ inches (from Table 2)} \times 0.8$$

OR

$$\text{Gallons of Water} = ET_o \times \% \times A \times 0.623$$


---

**EXAMPLE:**

How many gallons of water will you need to apply to your 2,000 square-foot warm-season grass lawn for the month of July in Hemet? **5,906 gallons**

$$5,906 = 7.9 \times 0.6 \times 2000 \times 0.623$$

*Dang! That's a lot of water.*

If this were for a cool-season lawn, it would be even more! **7,875 gallons**



**Table 2. Historical monthly average ET<sub>o</sub> for two different climates in the watershed<sup>5</sup>**

	JANUARY	APRIL	JULY	OCTOBER
Irvine	2.4	4.8	6.2	3.6
Hemet	2.3	5.3	7.9	4.2

Note: ET<sub>o</sub> values are available for many areas throughout the state at [cimis.water.ca.gov](http://cimis.water.ca.gov). Values will differ slightly year-to-year.

By knowing the answers to the formulas above, and the rate of water that is delivered through your sprinklers, you can calculate how to program your irrigation controller.

*This sounds like too much work!*

Not to worry—we've done the work for you. See the appendix for sample watering schedules based on ET.



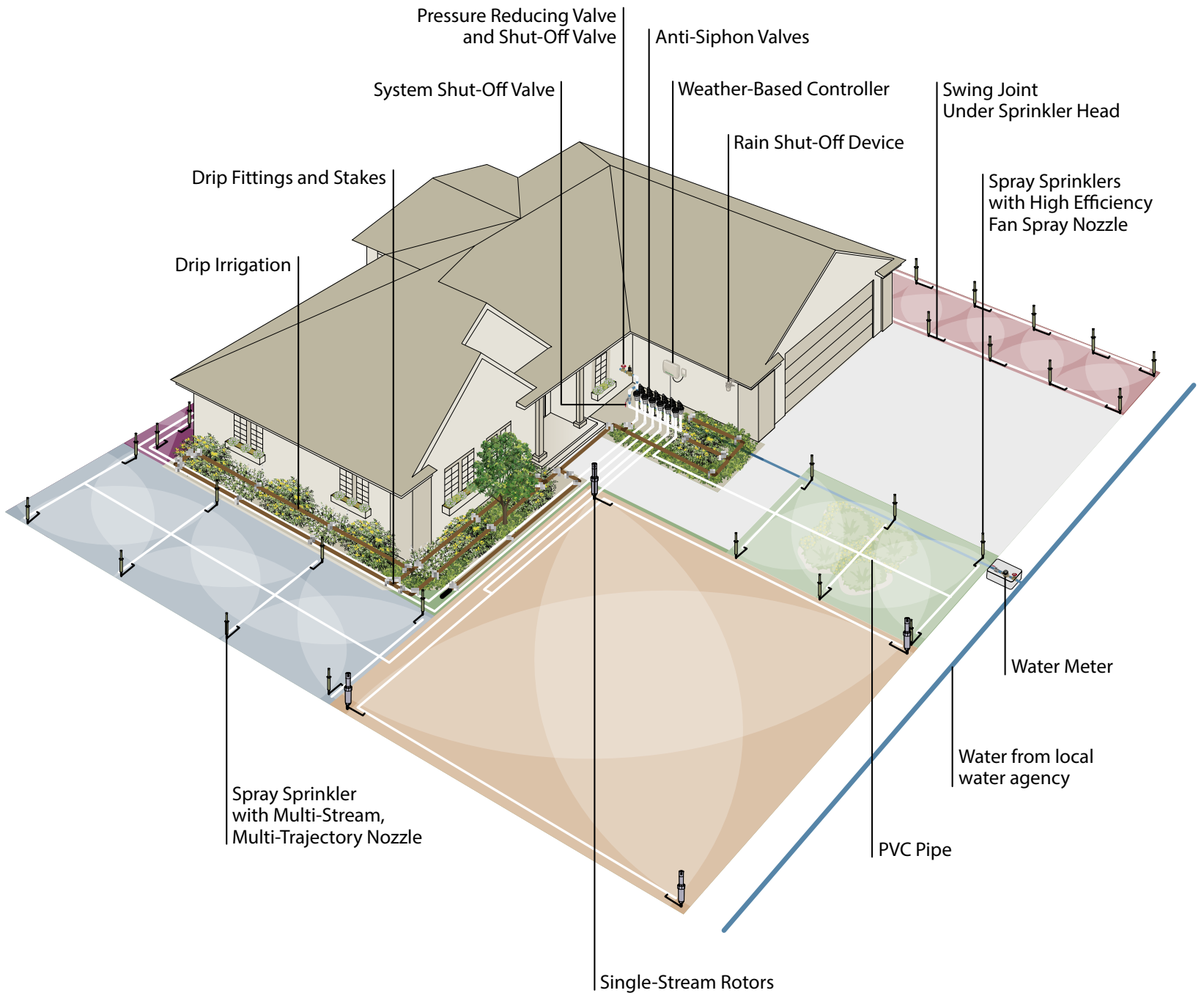
MORE THAN HALF OF A  
PLANT'S ANNUAL WATER  
NEEDS OCCUR DURING  
THE SUMMER (EXCEPT  
FOR NATIVE PLANTS)!

## THE HUNT FOR WATER SAVINGS

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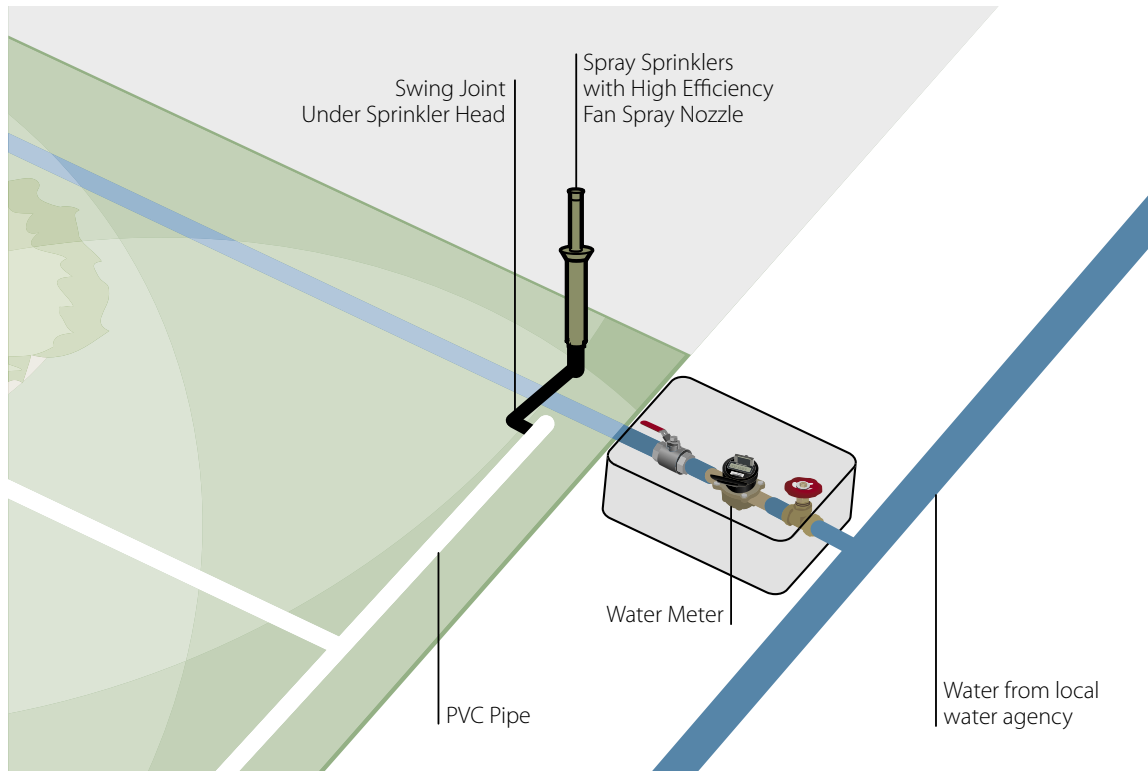
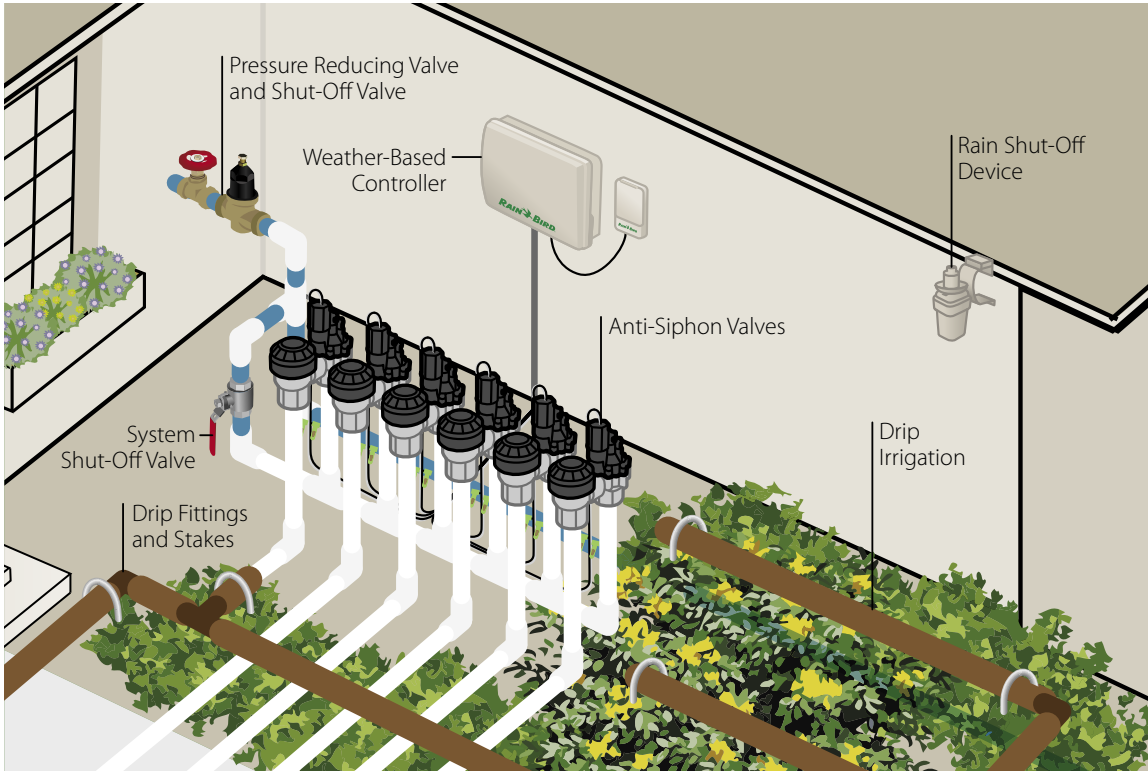
The good news is that you can reduce most water use by following a few simple guidelines. It isn't necessary to replace your entire yard to save water! Let's take a look at an irrigation system and see where savings can be achieved.

# ANATOMY OF AN IRRIGATION SYSTEM



Illustrations created by Rain Bird Corporation

# IRRIGATION



## Controllers

An irrigation controller can also be referred to as a *timer* or *clock*. It is the brains of your irrigation system. It controls when, and how long, each valve operates. If valves are not watering when they should, or not working at all, it is likely a problem with the controller. If areas are overly wet or dry, it is not the controller's fault.

---

## SMART Controllers

Is your controller a "smart" or "weather-based" irrigation controller? These types of controllers change their programming automatically to adjust to changes in weather and season using ET data. They offer one of the best ways to save water in your yard. Many water districts offer rebates to help cover the cost.

A smart controller has the same controls as a standard controller, as listed above, but some or many of the controls are automatically programmed for you depending upon the controller model and the set-up information you have programmed into it.

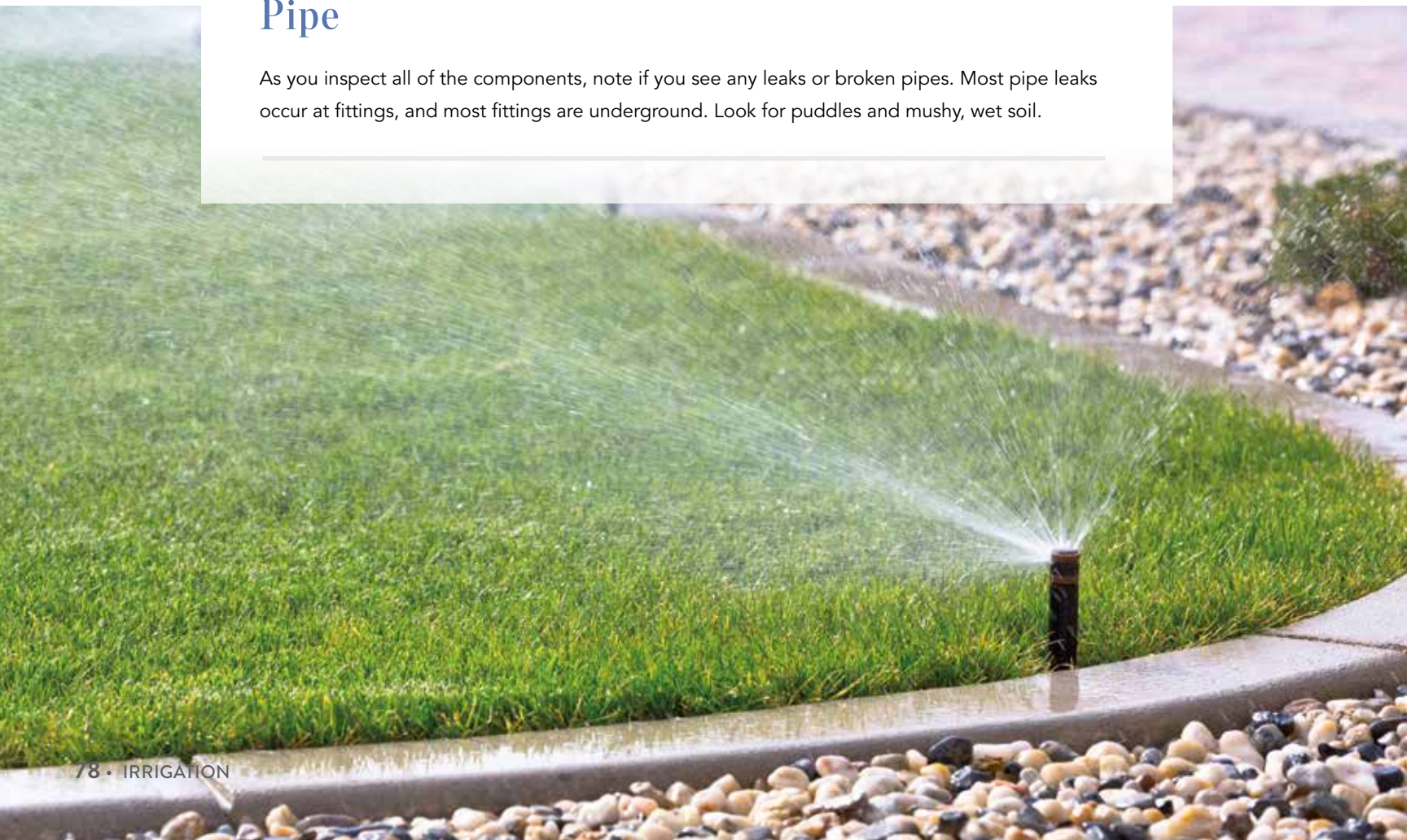
If there is a problem with a smart controller, it will have an alert that will be displayed on the controller panel. Some models also have an audible beep.

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## Pipe

As you inspect all of the components, note if you see any leaks or broken pipes. Most pipe leaks occur at fittings, and most fittings are underground. Look for puddles and mushy, wet soil.

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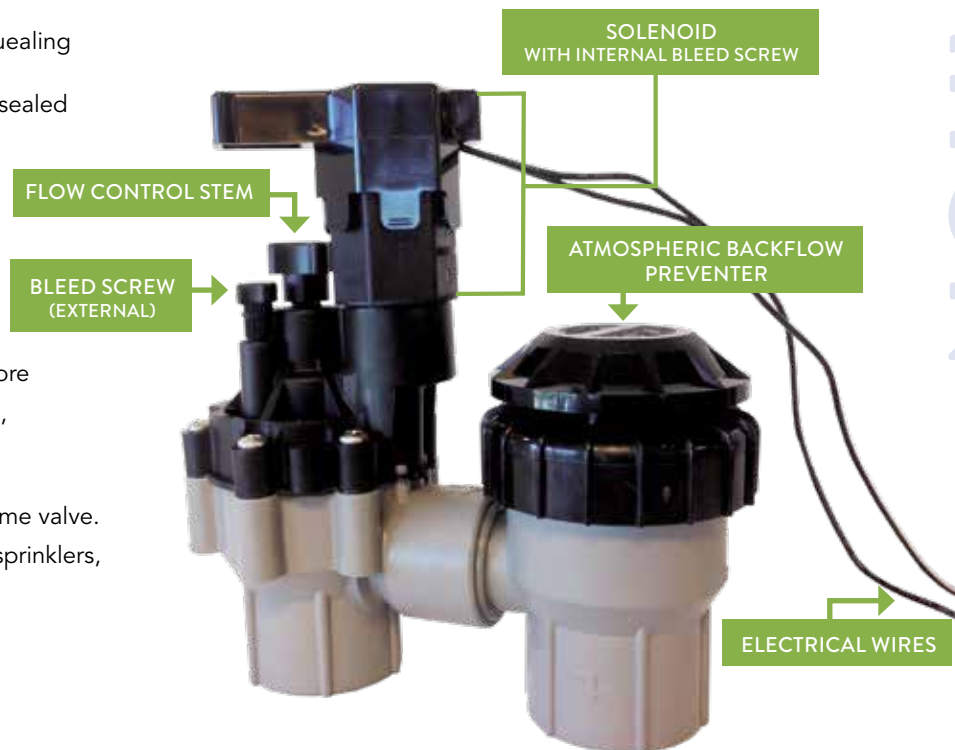


## Valves

Valves are the heart of the irrigation system. They can be turned on manually at the valve or automatically at the controller. The area that is watered by one valve is called a “zone” or “station.”

As you turn on each valve, look and listen for the following problems:

- Non-operation
- Sounds such as buzzing, thumping, and squealing
- Disconnected wires or wire ends not water-sealed
- Leaking at the valve or pipe fittings near the valve
- Water gushing out of the atmospheric backflow preventer
- One valve that waters plants with two or more different levels of water needs; for example, turf and shrubs.
- Mixed sprinkler types operated from the same valve. For example, spray sprinklers and rotating sprinklers, or spray sprinklers and drip irrigation.



### *What if you don't know how to turn the darn thing on?*

There are two ways to operate a valve: manually at the valve, and automatically from the controller. Test both ways.

**Manual operation** at the valve can vary depending upon the type of valve.

- Traditional valves will have a screw near the top of the valve. Start turning it to the left until a little stream of water squirts out. This relieves the pressure inside the valve and allows the valve to open. The stream will flow for as long as the valve is operating. Turn the screw to the right to shut the valve off.
- Newer valves can be operated by turning the solenoid a quarter turn. There will be arrows on the solenoid indicating which direction to turn it on or off. No stream of water will come out of the valve if it is operating correctly.

**Automatic operation** is performed at the controller. Depending upon the irrigation manufacturer, find the manual setting for individual valves. Typically, this requires turning a dial to MANUAL, tapping an arrow button to the zone number you want, and tapping START.”



# Sprinklers

There are a number of different types of sprinklers.



SPRAY SPRINKLERS



MULTI-STREAM, MULTI-TRAJECTORY



SINGLE-STREAM ROTORS



BUBBLERS



IMPACT

As you operate each zone, look for and note the following:

- Broken sprinkler heads. Usually quite obvious when you see a small geyser. A common place for a head to break is at the bottom of the head which is usually buried, or at the top of the head where a nozzle has blown off.
- Tilted or sunken sprinklers
- Sprinklers blocked by plants or lawn ornaments
- Misting or fogging – This is caused by high pressure.
- Hissing or other weird noises
- Rotating nozzles that are stuck and not rotating – Caused by debris in nozzle or simply a malfunctioning nozzle.
- Mixed nozzles – Causes overly wet and dry areas.
  - Same type of nozzle (all spray, all rotor), but different manufacturers
  - Different types of nozzles (a few spray nozzles mixed with a few rotary nozzles or even drip)
- If on a slope, or even a slight elevation change, the lowest head or heads drool after the valve is shut off.
- Sprinkler water is not reaching adjacent sprinkler heads. Each sprinkler should throw water far enough to reach the sprinklers adjacent to it. This is called “head-to-head” coverage.

## Bubblers

Bubblers put out a lot more water per time than drip irrigation, essentially flooding an area with water. As long as the area is level, and you are not trying to completely saturate a large area like a lawn, bubblers have advantages. They work well for small or narrow planters where you don't want water hitting windows, fences, and sidewalks. They are easier to maintain than drip irrigation because they are very sturdy, rarely clog, and they don't need a drip irrigation valve set-up with a filter and low-flow pressure-regulated valve. Their output type can be either flood (as pictured) or stream.



## Drip Irrigation

Drip irrigation is the most efficient way to deliver water to plants. However, it needs to be monitored and expanded as plants grow. Otherwise, you will end up with super saturated spots surrounded by dry soil. This is not an optimal environment for plants (see Soils chapter).

Drip irrigation is typically installed in one of two ways: **point-source** or **dripline**. We highly recommend you use pressure-compensating emitters with either method. Otherwise, it is easy to get overwatered areas and dry areas on the same line, even if the area appears to be level.

New installations or conversions should contain a screen filter and a pressure regulator right after the valve. Drip emitters have very small holes that can easily clog. Because drip systems operate at a low volume of water, you want to be sure your pressure is not too high or it will blow up your system. Pressure regulation is a must!

# Drip Valves



## Point-Source

Point-source drip can consist of either  $\frac{1}{4}$ " tubing (sometimes referred to as spaghetti tubing) or standard  $\frac{1}{2}$ " tubing. (There are other, less common sizes.) Because  $\frac{1}{4}$ " is so narrow, limit the length to 10 feet or less for each use. If you have  $\frac{1}{4}$ " tubing going to each plant, this will need frequent inspection.  $\frac{1}{4}$ " tubing tends to get moved out of place by critters, people, equipment, and even strong wind. It can be unknowingly cut by garden tools. It also tends to detach itself easily from its water source (typically connected to a larger drip tube or multi-port device). Landscapes provided with this type of drip irrigation will need additional drip tubing and emitters added as plants grow. The goal is to apply water within the root zone and a little beyond. Therefore, you will want to add enough emitters to irrigate a little beyond the current roots to encourage new extended root growth.



## PLANT ROOTS DO NOT SEARCH FOR WATER!!!

Roots grow where there is available water. All plants have a limit to their root growth; however, people don't realize trees and shrubs in optimal environments have root growth that extends two to three times the width of their canopies! You will find many recommendations to water just under the canopy. But for optimum growth and health, you want to water where most of the roots grow, and this is at, and slightly beyond, the canopy.



## Linear or Grid

Typically, ½" tubing is used for this method. Tubing can be purchased with built-in emitters at regular spacing such as 12, 18, or 24 inches, and with a choice of flow rates. This is called dripline or in-line drip tubing. (We will refer to it as dripline.) If you want to install your own emitters, you can purchase blank tubing and insert emitters where desired. A grid layout provides the most uniform application of water for optimum plant growth.

There are many manufacturers of drip emitters and a wide range of flow rates. The most common flow rate is one gallon per hour. Please be sure to do the following:

- Use pressure compensating emitters to get the most even application of water.
- Use the same manufacturer for all tubing and fittings because they vary in size between manufacturers.



# IRRIGATION SCHEDULING

---

**WARNING:** If you find this stuff to be absolutely boring or just too technical, you can cut to the chase to the appendix for your irrigation schedule!

## Scheduling Tips

Before you schedule your irrigation, you should first review the following tips and factors:

### Don't water the same all year long.

Change your irrigation schedule throughout the year. Do you honestly think a plant needs as much water in January as it does in July? Plant water needs change throughout the year due to weather and daylight length.

The best time to water is in the early morning hours to minimize evaporation and wind drift.

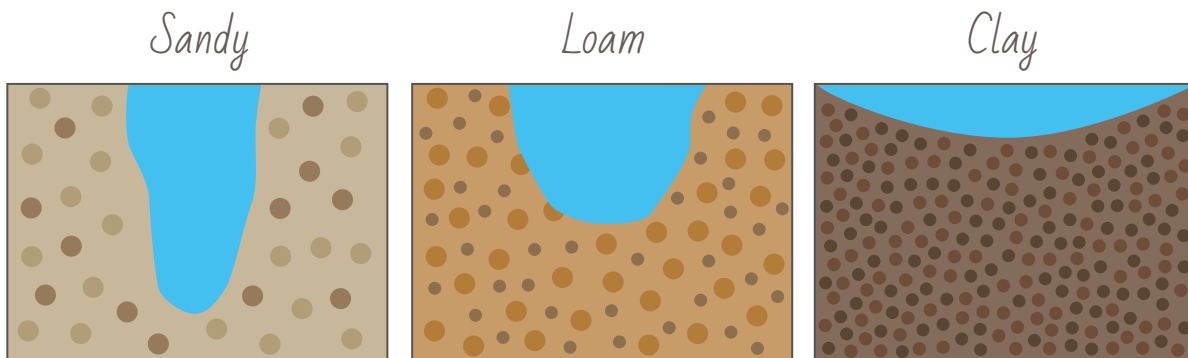
Plus, there may be a mandated watering time frame from your local water district (consult their website).

If you need to cut back on watering, it is in the best interest of the plants to cut back on watering **days**, not watering **time** (run time).

This allows the soil to dry down between watering days. Believe it or not, unless you have bog plants, a plant's root system needs some gaseous oxygen in addition to water.

### Know your soil (see Soil chapter).

Clay soils absorb water more slowly and hold the water longer than sandy soil. Therefore, if you have clay soil, you can get away with watering a lot fewer days than if you have sandy soil. When you do water, you will probably have to break up your watering time into several intervals to allow the water to soak in. Otherwise you will get runoff.



## UP TO 80% OF ALL PLANT ILLNESS IS A RESULT OF OVERWATERING!!!<sup>6</sup>

### Know your plants.

The type of plant (tree, shrub, lawn, etc.), origin (desert, temperate, or tropical), and root depth affect the amount of water needed.

---

### Know your sprinklers.

Different types of sprinklers put out water at different rates per area. This is called the precipitation rate. It is measured in inches per hour. For example, a traditional spray sprinkler nozzle has a precipitation rate of 1.5-1.6 inches per hour while a multi-stream, multi-trajectory sprinkler nozzle has a precipitation rate of 0.4-0.6 inches per hour. Think of precipitation rate as rain. If we had a rain storm dumping 1.5 inches of rain an hour, that is what a spray sprinkler nozzle puts out. **WOW! THAT'S A LOT OF WATER!** No wonder we see so much water running down the street! However, it is not the sprinklers' fault. Sprinklers need to be scheduled properly in multiple, short run times to give the water a chance to soak in.

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### Know your maximum run time for each zone

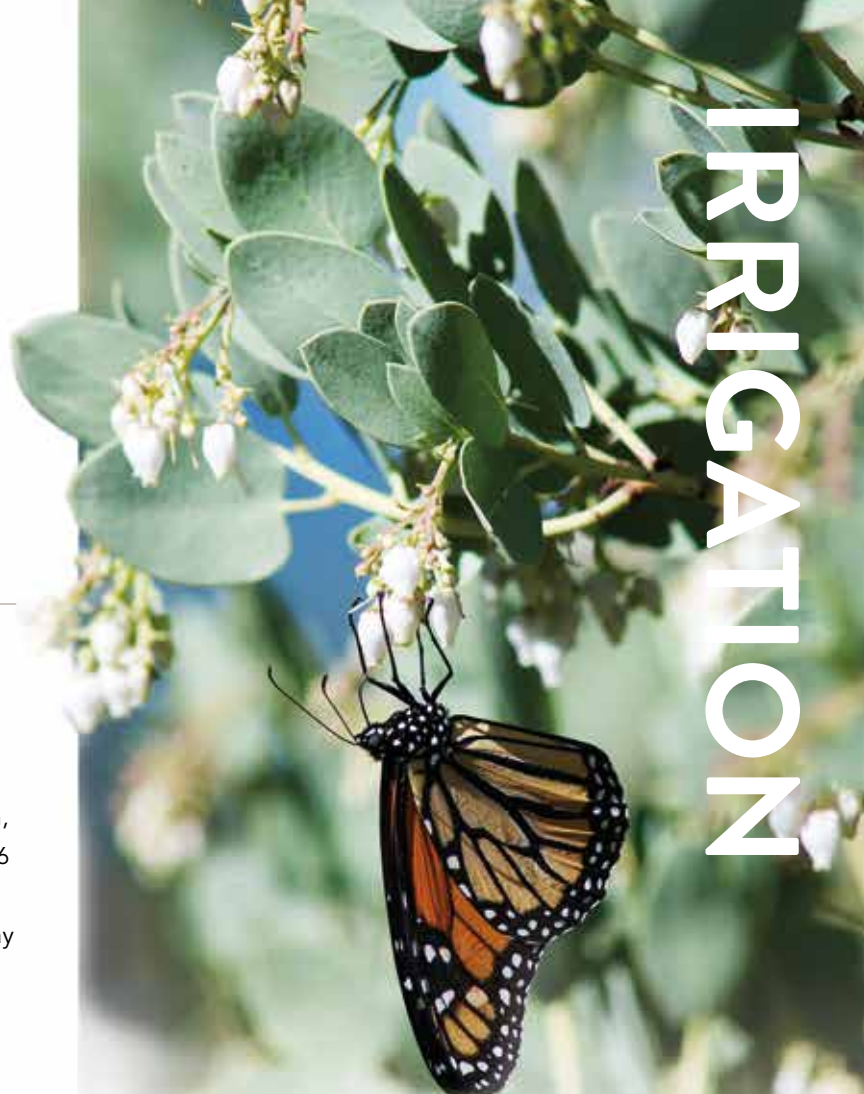
*This is the easiest way to reduce water waste!*

The best way to determine the optimal run time for each valve is to conduct a "runoff" test. In other words, turn on a valve and time how long it takes to see water starting to runoff your yard and onto non-target areas such as the sidewalk, driveway or other hard surfaces. Do this for every valve. If you have sloped areas or clay soils and are using spray sprinklers, this could be as little as 3-4 minutes. If you have a flat surface and sandy soils, it could be 10-12 minutes using spray sprinklers. Set your run time for one minute less than the time it takes to see runoff.

What does this tell you? Regardless of how hot it is, the maximum you can run a particular zone will always be the same. If your plants need more water, add multiple start times about an hour apart.

---

# IRRIGATION



## PREPARING AN IRRIGATION SCHEDULE

**PERFECTION** – There is no such thing as a perfect irrigation schedule. We can only estimate with the knowledge we have. Even then, plants have an innate buffering capacity. Most plants can go without water for a lot longer than you might realize. Conversely, some plants will gladly accept water beyond their needs; although this can lead to problems. **Bottom line:** If you don't water perfectly, your plants will survive.

**SCHEDULING** – See the appendix for sample scheduling guidelines for your area.

# CONTROLLER PROGRAMMING

---



## How do you program an irrigation controller?

It is not as intimidating as it looks when you understand each of these basic settings.

**ON/OFF OR RUN/OFF** – This allows you to shut your controller off in case of rain or cool weather. The information you programmed into the controller will not be deleted.

---

**DATE/TIME** – Every controller needs to know the current date and the current time.

---

**STATION** – Either with the buttons or a dial, select the station (zone) you want to schedule.

---

**PROGRAM** – Years ago, controllers operated all valves on the same watering schedule. You could not have, for example, zone #1 water every other day, and zone #2 water just on Thursdays. Now you can group individual zones together to match their common watering needs. For example, all your turf zones could be in Program A and water every three days while a shrub bed could be in Program B and water once every seven days. The only limit is that most controllers will not let you run more than one or two zones at a time in order to prevent too much water flowing too fast through your pipes.

---

**RUN TIMES OR STATION TIMES** – This setting may also be called *Station* or *Zone Run Times*. This is the amount of time you want each zone to run each time it turns on.

---

**START TIMES** – This setting may also be called *Water Start Times*. This is the time you want the controller to start watering. It's best to water during the night and early morning hours between approximately midnight and 8 a.m.

---

**WATERING DAYS** – This setting is for the specific days of the week that watering will occur. If you have watering restrictions, it is recommended that you find a controller that can accommodate watering on odd or even days, or every number of days, like every third day.

---

**WATER BUDGET %, ALSO CALLED SEASONAL ADJUST** – This setting allows you to change the overall percentage of water output. For instance, if you set your water budget to 50%, it will cut the run time on each zone by 50%. From a plant health standpoint, this is **NOT** the best way to reduce your watering. It is better to eliminate watering *days*. Plants prefer a dry-down of the soil between watering days. If you cut the percentage, you will still be applying water frequently and this can create shallow, less drought-resistant roots and possible rot. See the Soil chapter. We recommend keeping the percentage at 100%.

---

**RAIN DELAY OR DELAY WATERING** – Not all controllers have this feature, but it is very convenient. If your landscape gets some rain, you can delay the operation of your controller by up to 14 days. If significant rain falls in the winter, you easily won't need to water for a week or more.

---

**PROGRAM ERASE** – Don't like what you have programmed? Enter program erase and you can start all over.

---

**MANUAL OPERATION** – This allows you to operate a valve or valves immediately, independent of what is programmed into the controller.

**Single Zone or Station** – Operates one zone that you have identified. Some controllers allow you to enter a time duration. Others will water the amount of time that is programmed into the regular watering cycle. It can be stopped at any time.

**Program Cycle** – This setting will run through all valves that are programmed into one particular program of your choosing. It will either water each zone for one minute, or for the amount of time that is programmed for each zone.

---



**RAIN SHUT-OFF DEVICE** – If your controller has a shut-off device (and we highly recommend that you have one), be sure to clean it at least once a year before the rainy season begins. Even dust accumulation can alter its performance.

If you have an old controller that does not have most of the controls above, consider getting one with a minimum of the following:

- At least three programs or an independent programming feature
- Four start times per program
- A shut-off setting that interrupts irrigation without losing the programmed settings during rain events
- Odd/even, weekly and interval program capability up to 31 days
- Water budgeting adjustment feature that increases or decreases existing run times of all zones in 10% increments
- Non-volatile memory – If your power goes out, the controller will not lose what you have programmed into it



*A very common old-type controller.*

## Smart Controllers

Smart controllers, or “weather-based” controllers take a lot of guess work out of when and how much to water. There is potential for significant savings. Smart controllers are able to adapt their watering schedules based on weather data that is obtained either remotely through a daily or hourly signal, or on-site via a weather station. This results in a controller that adapts watering to the most recent weather. It will water more in the summer, and less or not at all in the winter. You can go on a long vacation and not have to worry if you are over- or underwatering!

A smart controller will take extra time to program initially due to a number of factors that will need to be programmed into the controller for each and every valve. You will need to enter the sprinkler type, plant type, root depth, sun exposure, soil type, slope, and sprinkler location (top of hill vs. bottom of hill). Some controllers make it easier with guidance questions. Once the controller is operational, a few tweaks to some of the factors will likely need to be made initially, and as the landscape changes.

# COMMON IRRIGATION PROBLEMS DEMYSTIFIED

With just some small improvements to your irrigation system, you can reap BIG water savings. In this section, we will discuss some of the common problems with an irrigation system and explain what improvements can be made.



**PROBLEM:  
LEAKS IN YOUR IRRIGATION SYSTEM**

Check your system for leaks by reading the water meter. Turn off all of the faucets and water-using appliances inside and outside the house. Go to the meter and look to see if the indicator is spinning. (Most meters are typically located at the curb in front of your house.) Verify with family members that no water is running. If the meter is still spinning, this means you may have a leak. You should also review your water bill to look for trends. Most water bills show a history of water use where you can see if there has been excessive use.



**PROBLEM: WATER SEEMS TO BE DROOLING OUT THE LOWEST HEAD IN A ZONE**

If the sprinkler zone has some kind of slope, even with a slight elevation change, the water from the zone collects at the lowest head then drools out. We call this “low head drainage” and it is easy to fix. Just like fixing pressure problems, if you can change a light bulb, you can change the sprinkler guts with a “check valve” feature installed into the sprinkler stem. All sprinkler head guts within a zone should be changed. If your heads are very old, you may need to upgrade to newer sprinklers.



## PROBLEM: SPRINKLERS MISTING OR FOGGING, OR LAWNS THAT HAVE GREEN DONUTS

### Too much pressure

Other than a big leak, sprinklers operating above their recommended pressure can cause big water losses that are not very obvious. Sprinklers will spray in a fine mist or fog that is easily blown away by the slightest breeze. A valve zone of 10 spray sprinklers operating at 20 psi higher than it should can put out an extra 100 gallons a week or more, on average, with a good portion of the water drifting off site.

The solution is simple. If you can change a light bulb, you can replace the guts of the sprinkler with a type that regulates pressure. All sprinkler head guts within a zone should be changed so that the pressure will be even throughout the zone. If your heads are very old, you may need to upgrade to newer sprinklers. If the pressure is not too high, a few turns of the valve flow control stem can help reduce the pressure, but this is not ideal. It is better to install a pressure regulator or pressure regulating heads.

### Too little pressure

Operating at pressures that are too low cause poor spray patterns, thus increasing the need to apply more water. If low pressure is occurring in a lawn, there will be dark green donuts of lawn surrounded by very dry lawn near the sprinkler.

To correct the problem, either split the zone that is operated with one valve into two zones operated by two separate valves, or retrofit the sprinkler nozzles with high-efficiency nozzles that have a lower flow rate.



IMPROPER INSTALLATION –  
No flexibility



PROPER INSTALLATION –  
Allows flexibility while  
maintaining the head  
in a vertical position.



## PROBLEM: EXCESSIVELY WET OR DRY AREAS

A very common problem is having excessively wet or dry areas; this is especially noticeable in a lawn. Here are a number of situations that can cause uneven watering along with some remedies:

**1. BLOCKED HEADS** – Various things can block sprinkler heads. Usually it is a plant that has grown larger, but sometimes it can be a lawn ornament unknowingly placed near a hidden pop-up head. Either the plants can be trimmed, or the sprinkler can be raised with the addition of pipe. In lawns, a common problem is pop-up sprinklers that don't pop up high enough to clear the grass. We recommend installing 6" pop-ups. Unless you have a lawn such as hybrid Bermuda grass, 4" pop-ups will not always clear the height of your grass. Then you have to dig ugly moats around each sprinkler head so they will be unimpeded.

**2. MISALIGNED OR SUNKEN HEADS** – These are easy to see, but can be a hassle to fix. When sprinkler heads are installed, they should include a flexible tube or fittings that create a swing joint under the sprinkler head. This allows easy adjustment of head height and alignment, and allows some defense against mower damage. Many do-it-yourselfers either don't know or don't bother with installing flexible fittings under the head. This makes later adjustments impossible.



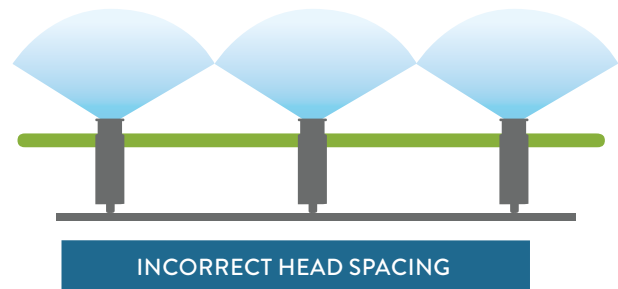
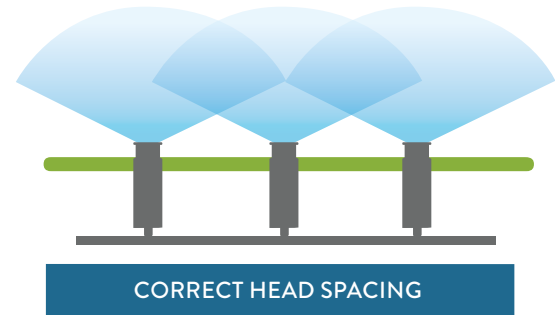
There's no need to cut a moat around your sprinkler head if they pop up high enough. Use 6" pop-up heads in this situation.

### 3. ADJUSTING SPRINKLER NOZZLES TOO SEVERELY –

When water is hitting the sidewalk or just simply reaching too far, there is a screw in the sprinkler nozzle that can be turned right to shorten the sprinkler's throw. However, if the reduction is more than 25%, the spray pattern will be distorted. In this case, a smaller nozzle (shorter radius) is called for.

### 4. MISMATCHED NOZZLES AND SPRINKLER HEADS –

If possible, always try to have the same manufacturer and model of sprinklers and nozzles within a valve zone. Never mix different types of heads or nozzles in the same zone (like spray and rotor heads). Use the same manufacturer for all nozzles in a zone. Generally, different head and nozzle types have different rates of applying water, and have different pressure requirements.



**5. INCORRECT PRESSURE** – This is far more wasteful than it appears. Read above, "Problem: Sprinklers misting or fogging..."

**6. IMPROPER HEAD SPACING** – When sprinkler heads are operating, their spray or stream of water should reach all adjacent heads. This is called "head-to-head" coverage. Many do-it-yourself sprinkler installations are installed incorrectly with gaps and crowded spacing which totally ruins any chance of uniform water application.

## PROBLEM: RUNOFF

Unless you have a sandy landscape soil, most soils will not allow water to soak in as fast as the water is being delivered by the sprinklers. Therefore, runoff will occur and you will be paying for water running across sidewalks and down the gutter. There is a simple remedy: cycle and soak. Program your controller to water in short durations with about 45 to 60 minutes in between each start time. For example, let's say your yard needs a total of nine minutes of water from spray sprinkler heads on the day you need to water. Set three start times of three minutes each, 45 minutes apart: 4:00 a.m. for 3 minutes, 4:45 a.m. for 3 minutes, and 5:30 a.m. for three minutes.

Another option is to change your sprinkler nozzles to rotating sprinkler nozzles which apply water at a much slower rate. Make sure you replace the current nozzles with rotating nozzles that throw the same distance. You want the water from one sprinkler to reach each adjacent sprinkler. Additionally, you will need to change all of the nozzles in the same zone or you will end up with very dry and wet spots. How long can you water at one time with rotary nozzles? It depends on your soil type. Turn on the rotary zone and time how long it takes to see runoff. Subtract one minute; this is the maximum run time. If you need more minutes, take the total minutes needed and divide between two start times. Allow 45 to 60 minutes between the times the sprinklers are watering.



#### PROBLEM: THE SPRINKLERS ARE THROWING TOO FAR, HITTING THE SIDEWALK

If you just need to reduce the distance a little, you can use an adjustment screw in the sprinkler nozzle. Please note that you should reduce the throw by only a few feet (or 25%) otherwise the pattern will become distorted. The other method would be to replace the nozzle with a shorter throw nozzle to better cover the area without watering the walkway or driveway.

#### PROBLEM: WATERING DURING RAIN

Install a rain shut-off device. They are inexpensive, simple to install, and come in both wired and wireless models.



## WHEN TO HIRE A PRO

When your irrigation is inefficient and several problems need to be addressed, it may be time to contact a professional contractor that specializes in irrigation renovations. Here is an example: You operate a valve and all the sprinkler heads do not pop up completely. You referred to the Troubleshooting Guide at the end of this chapter and have determined that you have too many sprinklers on the zone. In this situation another valve is needed. This will result in each zone having fewer sprinklers, more flow, and better pressure. We call this “splitting the zone.” This requires running new pipe, adding a new valve, and running new controller wires from the new valve to the controller.

A variation to this problem is having different sprinkler types on the same valve or zone. For example, you might have six spray sprinklers covering a smaller area, four rotating sprinklers covering a larger area, and all operated by one valve. Different types of sprinkler heads or nozzles should never be operated on the same zone or valve. The spray sprinkler area will always get too much water compared to the rotor area. Therefore, the valves need to be split as described above so that all spray sprinklers are on one valve, and all rotors are on a separate valve. Drip irrigation should always be operated from its own dedicated valve. Not only does it deliver water at a much slower rate than sprinklers, the valve should have a filter that is not necessary for sprinkler irrigation.

# DIVE DEEPER INTO WATER SAVINGS

THERE ARE FOUR MAIN THINGS YOU CAN DO  
TO GET DEEPER WATER SAVINGS.

1. Sprinkler improvements
2. Converting to drip irrigation
3. Upgrading to a smart controller and/or soil moisture sensing
4. Rainwater capture

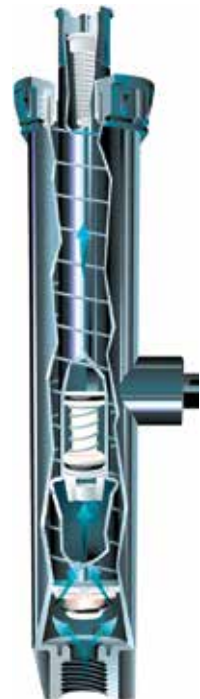
# 1.

## WATER SAVINGS BY SPRINKLER IMPROVEMENTS

Many homes have high water pressure. In a recent study<sup>7</sup>, the average home saw 70 pounds per square inch (psi) for their outdoor irrigation. Yet, many manufacturers recommend that spray sprinklers operate at 30 psi and rotating sprinklers operate at 40-45 psi. In another study, just having pressure 20 psi over the manufacturer's recommended psi resulted in up to a 1 gallon per minute of water wasted for each sprinkler. That means if you had 10 sprinklers on a zone, you would waste 10 gallons per minute for each minute the system operated. If the zone ran for 10 minutes, **100 gallons would be wasted every time it watered!** There is an easy fix for this: Replace the guts or inner components of the sprinkler with pressure regulating guts in the stem.

Another problem that can cause wasted water is having the lowest sprinkler head on a zone drool out onto the sidewalk or driveway. There is an easy fix for this as well: Replace the guts or inner components of each sprinkler in the zone with those that incorporate a check valve.

Take the dive for huge potential water savings just by fixing or upgrading your current irrigation system!





### Want more water savings with your sprinklers?

Consider replacing your sprinkler nozzles with high-efficiency nozzles. These nozzles are tested to a standard and must meet a performance threshold. These nozzles can be spray sprinkler nozzles, multi-stream-multi-trajectory nozzles, or nozzles installed into a rotating sprinkler. The difference between these nozzles is the distance of throw.

- **15 feet or less** – spray sprinkler nozzles are the most common
- **12 to 25 feet** – multi-stream-multi-trajectory nozzles
- **Greater than 20 feet** – nozzles for a rotating sprinkler that typically has one rotating stream of water

Make sure that *all* of the nozzles in a zone are from the same manufacturer. Check with your water agency to see if high-efficiency nozzle rebates are available.

### BUILT-IN PRESSURE COMPENSATION

+

BUILT-IN CHECK VALVES

+

HIGH-EFFICIENCY NOZZLES

=

**EASY  
WATER SAVINGS**





## 2.

## WATER SAVINGS BY CONVERTING TO DRIP IRRIGATION

Many landscapes have planter areas with shrubs that are currently irrigated with spray sprinklers. The sprinklers can easily be converted to drip irrigation which can result in 20% to more than 50% water savings. There are two ways to convert spray sprinklers to drip. First, look for conversion kits that have a filter and pressure regulator as well as a way to cap off most existing sprinklers by using special caps. The sprinklers don't have to be removed. The second way is to remove the existing sprinklers and to cap them off at their risers using ½" PVC caps.

Now you can easily install the drip tubing. If the shrub area is sparsely planted, you can use the point-source method of watering by adding emitters on either side of the shrub. For denser plantings, using the dripline method would be the fastest and most beneficial for the plants and soil. Just lay out the dripline in a grid pattern. It can be buried for subsurface applications (like a lawn), or it can be left on top of the soil. (We recommend covering it with mulch.) With either method, use fittings to connect the pieces of tubing and stakes to keep the tubing in place. Be sure to use tubing and fittings that are from the same manufacturer. Once the drip is installed, add mulch. Mulch adds extra water savings because there is less evaporation of water from the soil. An added benefit is that mulch reduces weed growth. And, if organic, mulch enhances the soil environment.



# 3.

## WATER SAVINGS BY UPGRADING TO A SMART CONTROLLER OR SOIL MOISTURE SENSOR

It's important to adjust your irrigation schedule at least monthly throughout the year since weather changes directly impact water requirements of a plant. More than half of a plant's annual water needs occur during the summer, except for native plants! Just by remembering to reduce the days you water during autumn and winter can increase the health of your plants and greatly reduce water waste. Whether you hand water or use a conventional controller, remember to make these adjustments. Using the "feel method" or a soil moisture sensor can help out a lot, too!

### SMART CONTROLLERS

A smart or weather-based controller will adjust your controller for you based on temperature, hours of daylight, humidity, wind and rainfall, among other factors. Then it will schedule the controller to operate accordingly. Most likely, the controller will operate most days in the summer but the real water savings will occur during the autumn, winter, and spring when the controller will go days before watering.

How do you know which smart controller to choose when there are so many models available? You can look for a third-party validation such as EPA WaterSense® (like EnergyStar®, except for water-using products). However, not all certified controllers are equal. Look for a smart controller that not only adjusts the schedule based on weather conditions, but adds the concept of deep, infrequent watering. The controller logic should look for ways to eliminate watering days rather than adjusting the run time. Not all smart controllers on the market do this. You want one that has a "soil moisture depletion factor." In other words, it will take into account how much water has been depleted from the soil. This builds in a dry-down time between watering days so your yard will not get watered too frequently. It promotes deep, infrequent watering which is healthier for plants.

### SOIL MOISTURE SENSORS

Agriculture has used soil moisture sensors with great success for many years. In landscapes, soil moisture sensors can be tricky to use because there are so many variables in a landscape compared to a homogeneous crop. However, if your controller allows a soil moisture sensor for each program, and you have an accurate representative location for each sensor, this can be the most accurate way to monitor a landscape's water needs.

If you want to go "low-tech," purchase an inexpensive soil moisture meter probe (about \$10 to \$20 dollars). Use it to see the moisture content in various places in your yard.



# 4.

## WATER SAVINGS BY CAPTURING RAINWATER AND CREATING RAIN GARDENS

Have you ever noticed how vibrant and healthy a landscape looks after a good soaking rain? Even with our relatively low rainfall averages, capturing rainwater for landscape use has advantages. Rainwater is good for plants. In addition to providing water, think of it as a cleanser. It does not contain harmful salts and other minerals that can harm root growth. Rain can actually flush salts and minerals below the root zone.

In order to use rainwater, it must be captured, diverted, and stored. The simplest system can be a **rain garden** that collects water from a roof surface where all rainwater is diverted into a catchment area for holding in the soil. It takes planning. As the rainy season ends, nearby plants utilize what is stored in the surrounding soil. This obviously won't provide enough water for the entire summer in some areas, but it will certainly help. Sophisticated systems can be created with large cisterns connected to an irrigation system.

### ADVANTAGES OF USING RAINWATER:

- Retains water on site
- Reduces or eliminates runoff of contaminated water entering storm drains and local bodies of water
- Removes salt accumulation in the soil which can harm roots
- Acts as a natural filter, slowing the flow of water so it soaks into the soil where microorganisms can do their job in removing pollutants
- Recharges groundwater
- The water is free!

For in-depth rain garden information, see UC ANR Publication 8531 at [anrcatalog.ucanr.edu/pdf/8531.pdf](http://anrcatalog.ucanr.edu/pdf/8531.pdf)



IRRIGATION

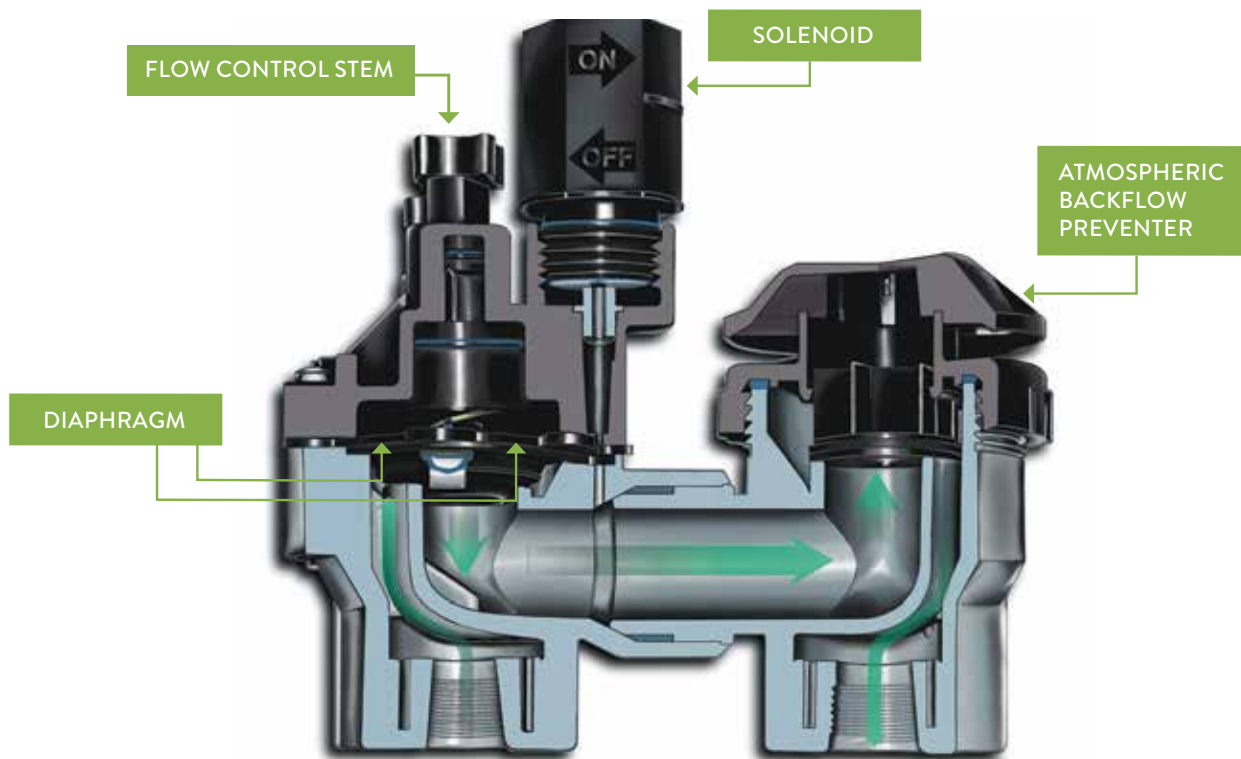
# TROUBLESHOOTING

## MAJOR PROBLEMS

PROBLEM	CAUSE	SOLUTION
<b>Water won't turn on</b>	Something is turned off. It could be the water meter, main gate valve to irrigation system, or an individual valve's flow control stem.	Make sure system is on. Check each of the causes.
	Controller program or current day/time is incorrect.	Check controller settings.
	Wiring between the valve and controller not connected or making contact.	Check the wire connections at the valves and at the controller. Use waterproof wire connections.
	Solenoid may be defective.	If the valve can be turned on manually but not electrically, replace the solenoid.
	There is debris in the valve.	Use the external bleed screw to flush the valve. If debris is significant, the valve may need to be disassembled and cleaned.
	When some valve diaphragms tear, they do not allow watering.	Open the valve and replace the diaphragm.
<b>Water won't shut off</b>	The controller may be programmed incorrectly.	Check the controller schedule.
	When some valve diaphragms tear, water will not shut off.	Open the valve and replace the diaphragm.
	There is a damaged or cracked valve bonnet (valve top) and/or body.	Look for cracks in the valve and replace as needed.
<b>Puddling in the yard</b>	Could be a broken pipe.	Remove dirt and plant material to expose the broken pipe, then repair.

## VALVES

PROBLEM	CAUSE	SOLUTION
Valve makes buzzing sound	Faulty solenoid	Replace solenoid.
Valve makes thumping sound	Pressure is too high.	Install a pressure regulator.
Water gushes out of the atmospheric backflow preventer at valve	Atmospheric backflow preventer is likely cracked.	Replace the atmospheric backflow preventer.
Misting sprinklers/hear hissing sound	Pressure is too high.	The flow control stem enables you to restrict flow by 10% which could bring the pressure down a little or you may need to install a pressure reducer at the house or a pressure regulator in the sprinklers (review sprinkler section).



# SPRINKLERS

PROBLEM	CAUSE	SOLUTION
<b>Sprinkler not popping up all the way</b>	Missing nozzle	Replace nozzles.
	Dirt is jamming the riser.	Remove cap and guts and flush out.
	There is not enough water pressure.	Change to smaller flow nozzles/check the sprinkler nozzle for debris. May need to consider adding another valve.
	Valve or system has a flow restriction.	Ensure the valve and the system is fully open.
<b>Sprinkler is stuck up and does not retract after watering</b>	There is a damaged riser or riser seal.	Replace sprinkler inner components.
	There is a damaged retraction spring.	Replace sprinkler inner components especially the retraction spring.
	Dirt is jamming the riser.	Remove cap and guts and flush out.
<b>Watering pattern not matching the landscape</b>	There is a shorter than desired throw.	Check the filter and clean. Replace the nozzles with the correct nozzle distance.
	Does not water in the desired pattern.	Spray: Replace the nozzles with high-efficiency variable arc nozzles. Rotor: Adjust the pattern.
	Sprinkler is tilted, sunken.	Fix or replace.
<b>Watering pattern creates a green donut in turf</b>	Pressure is too low.	Either reduce the flow rate out of every sprinkler in the zone by replacing the nozzles with those with a lower flow rate, or install a new zone to split the existing zone.
<b>Excess water from the lowest sprinkler head</b>	There is low head drainage especially on sloped areas.	Replace sprinkler inner components with "check valves" in the stem of each sprinkler within the zone.
<b>Excess misting/hear hissing</b>	Pressure is too high.	Replace sprinkler inner components with pressure regulation in the stem.
<b>Uneven coverage</b>	Verify with a catch can test.	Fix or replace.
	Spray sprinklers and rotors/multi-stream rotating nozzles on the same zone.	Replace so that all nozzles are the same type and from the same manufacturer.

## DRIP IRRIGATION (Drip)

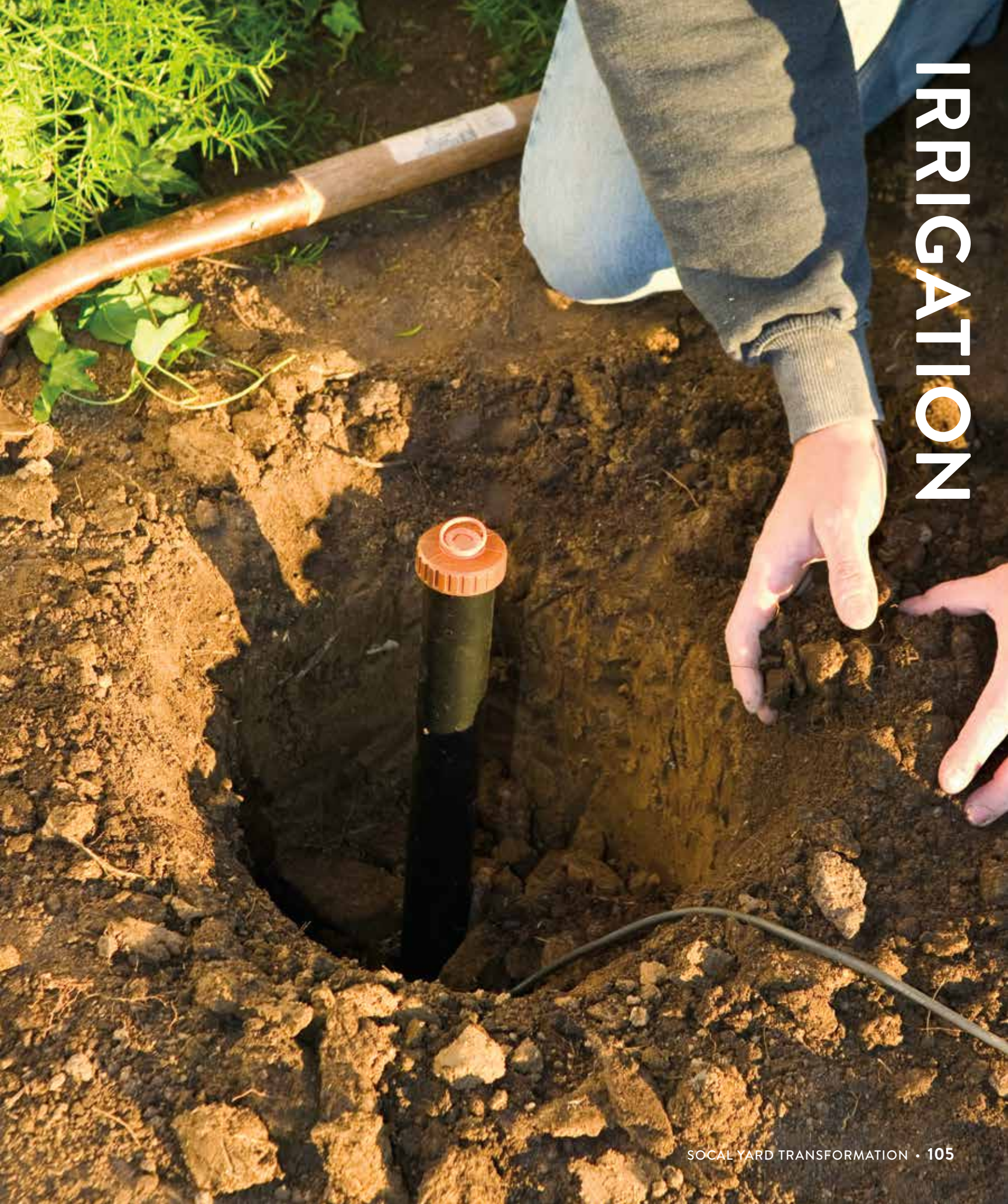
PROBLEM	CAUSE	SOLUTION
Plants look unhealthy	Not enough water getting to the plants due to plants having grown since the drip was installed.	Watch the system run then add additional emitters.
Entire section of plants look unhealthy	Water is not getting to a section of the yard.	Check for, and repair, leaks and breaks.
Plants look unhealthy in the entire zone	Check to see that the valve is open and able to operate.	Ensure that the entire system is operational.
	Check to see that the filter is clean.	Clean the filter.
	Look at the amount of run time on the controller.	Manually run the zone for the amount of minutes scheduled on the controller. Watch to see the wetted patterns around the plants. If the plants are not getting enough water, increase the overall time by five or ten minutes and observe. Your goal should be to wet enough area so roots will have room to grow.
Leaks at fittings	Pressure may be too high. Fittings may not be the correct type (barbed vs. compression).	Install a pressure regulator if necessary. Replace fittings with correct ones.
Leaks at holes or cuts	Animals or gardening tools have punctured the tubing.	Cut out damaged portion and replace with correct connectors.
Emitter blown off	Pressure is too high.	Be sure a pressure regulator is installed.
No water coming out of emitter	Plugged	Replace emitter. If using dripline tubing, a new emitter can be punched in near the plugged one.



## CONTROLLER (Clock or Timer)

PROBLEM	CAUSE	SOLUTION
<b>Controller not operating at the desired time</b>	The date and time are incorrect.	Follow the manufacturer's directions to set the correct time and day.
<b>Zones do not turn on</b>	The controller programs are set incorrectly.	Verify the controller programming.
	The controller and/or valve wire and connections may be damaged.	Inspect the connections and use waterproof wire connectors.
	Either the valve or the system is shut off.	Inspect and correct.
<b>Zones do not shut off after watering</b>	Controller is not programmed correctly.	Verify the controller programming.
<b>The system is watering when it is raining and/or waters a few days after it rains.</b>	System needs a rain shut-off device which interrupts watering when it is raining and for several days after the rain.	Purchase or replace a rain shut-off device.
<b>The system is watering when it doesn't need to be watering</b>	The controller is not weather-based so it is watering according to how it is programmed into the controller.	Purchase a smart, weather-based controller or soil moisture sensors.

# IRRIGATION





# Sustainable Landscaping

What exactly is a “sustainable landscape” and how can you create your own? Simply put, sustainable landscaping involves selecting plants that are adapted to your climate and microclimate, and implementing environmentally sound maintenance practices.

## **BENEFITS OF SUSTAINABLE LANDSCAPING INCLUDE:**

- Beautiful water-efficient landscapes
- Healthy soils with a greater diversity of beneficial microbes
- Cleaner oceans and waterways
- Greater diversity of pollinators and beneficial wildlife
- Cleaner air
- Energy conservation
- Lower water, electric, and gas bills

# EVOLUTION OF SOUTHERN CALIFORNIA LANDSCAPES

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The semi-arid climate of inland Southern California with its historically cool, wet winters and hot, dry summers has been described as a gardener's paradise. In the last two centuries, the mild climate paired with plentiful resources allowed us to design gardens to match every style, from the lush lawns and water-loving trees often found in formal Colonial and English gardens to the informal Cottage and Romantic style gardens where grasses, flowering perennials and shrubs predominate. Southern California yards were often high water-using, lush, wet, and dark green year around.

During the postwar building boom in California, water was inexpensive and seen as a relatively unlimited resource. Thirsty lawns, framed by exotic trees and shrubs were installed by home builders who knew how a carpet of turf, foundation shrubs, and maybe a tree as a focal point could create curb appeal and make small lots look larger. Homeowners were assured that all their landscapes would thrive using a few sprinklers and maybe the occasional pest control potion from the hardware store.

By the mid-1980s, a major mindset shift began to occur, drawing attention to dwindling water supplies, drought, and a need to conserve water indoors and outdoors. Our groundwater aquifers were being depleted faster than they were being replenished and our reliance on imported water was taking a toll on the ecosystems of the Sacramento-San Joaquin Delta and Colorado River watersheds.

In the 1990s, researchers became aware of pesticide pollution resulting from urban landscape runoff. It is now recognized as one of several key sources of waterway pollution that leads to unhealthy ecosystems for pollinators, birds, pets, and humans.

Over the past decade, a greater emphasis has been placed on water-efficient landscapes due to drought, dwindling water supplies, higher water costs, stormwater pollution, and climate change.



# CLIMATE CHANGE

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Numerous studies published in peer-reviewed journals have linked human activities as well as natural causes to climate change. The result of these combined activities is the release of billions of tons of carbon dioxide (CO<sub>2</sub>) and other heat-trapping greenhouse gases into the atmosphere annually. Over time, climate change can lead to higher temperatures causing more extreme wildfires and rising sea levels. Greenhouse gases come from a variety of human activities, including burning fossil fuels for heat and energy, clearing forests, fertilizing crops, storing waste in landfills, raising livestock, and producing certain industrial products.

Energy and resources we use to install and maintain our landscapes also contribute to CO<sub>2</sub> pollution from the production, transportation, and use of products such as plastic irrigation pipe, pumping systems, and gasoline used in our lawnmowers. We can reduce this trend by minimizing the use of high carbon products in our yard, and by planting trees and shrubs. Carbon is sequestered by plants and is stored in the soil, roots, trunks, and limbs via the process of photosynthesis. If all of us make even small changes to the way we plant and maintain our landscapes, collectively we can reduce our carbon footprint leading to secure and sustainable natural resources into the future.

WE CAN REDUCE THIS TREND BY MINIMIZING THE USE OF HIGH CARBON PRODUCTS IN OUR YARD, AND BY PLANTING TREES AND SHRUBS THAT SEQUESTER CARBON.



# STEPS TO CREATING A BEAUTIFUL SUSTAINABLE LANDSCAPE

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INCREASE THE SUSTAINABILITY OF YOUR LANDSCAPE BY IMPLEMENTING THE FOLLOWING STEPS. IN MOST CASES, MAKING JUST A FEW CHANGES CAN MAKE A BIG DIFFERENCE!

## Conserve Water

### SELECT PLANTS RECOMMENDED FOR YOUR CLIMATE ZONE

“Right plant, right place” is one of the most important concepts you can follow to ensure that your plants thrive for years to come. Choose plants based on their intended hydrozone from the plant lists provided in the appendix of this book and from other reputable sources. For the most sustainable landscape, consider using plants that are native to your local area. Avoid choosing invasive plants that can get out of hand and crowd out other plants. Excellent references listing both invasive plants and alternatives include Plant Right at [plantright.org](http://plantright.org) and the California Invasive Plant Council at [cal-ipc.org](http://cal-ipc.org).

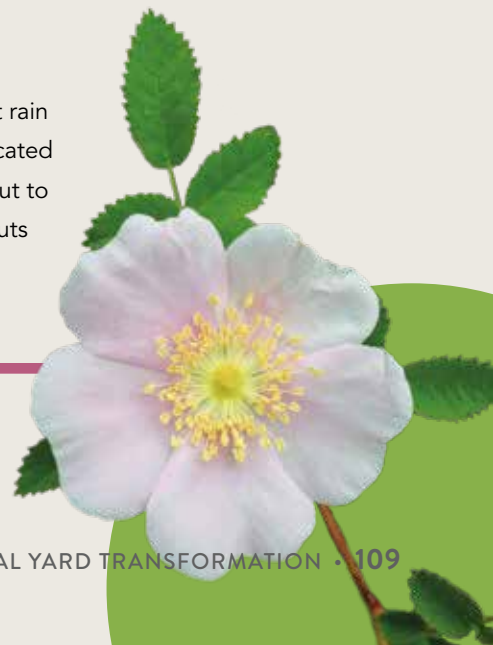
### IRRIGATE BASED ON THE SEASON, PLANT SPECIES, SOIL TEXTURE, PLANTING DENSITY AND MICROCLIMATE.

By following the tips in the Irrigation chapter, you can reduce water waste by 80% or more and keep your plants healthier, too! Water deeply and infrequently.

### MAKE YOUR LANDSCAPE A MINI WATERSHED.

Retain as much rainwater as possible on your site. Direct rain gutter downspouts so they empty into the landscape located a sufficient distance away from the foundation but not out to the gutter. Or, install rain barrels to rain gutter downspouts to collect the rain that falls on your roof. Mulch your soil so it becomes more permeable to water.

FOR THE MOST SUSTAINABLE LANDSCAPE,  
CONSIDER USING PLANTS THAT ARE  
NATIVE TO YOUR LOCAL AREA.



**WHEN IT RAINS,  
IT POURS!**

ONE INCH OF RAIN  
COLLECTED FROM A  
1,000 SQUARE FOOT  
ROOFTOP YIELDS  
623 GALLONS.





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## Recycle Organic Matter and Build a Healthy Soil

Did you know that Californians generate over 43 million tons of municipal solid waste each year (six pounds per person per day), and that natural soil formation takes thousands of years to complete? Composting your own tree and shrub trimmings, lawn clippings, and expired annuals keeps plants out of our crowded landfills and adds valuable microbes to your garden when used as a soil amendment or mulch. And, it can be made in one season! When used as a mulch or soil amendment, compost increases the water-holding capacity of sandy soils and improves the drainage of soils high in clay, and provides a favorable environment for beneficial soil organisms. Consider leaving your fallen leaves on the ground and let Mother Nature create your mulch.



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## Protect Water Quality

Runoff water carrying pesticides, fertilizers, and pet wastes pollute waterways and can harm aquatic life. Make sure your irrigation system applies water slowly enough, or with multiple cycles, to let water seep into the soil before it starts to run off. Since nitrogen and phosphorus are particularly problematic, fertilize only when necessary at the low end of the recommended rate. Choose pest-resistant or native plants whenever possible and incorporate the use of non-chemical pest management strategies.

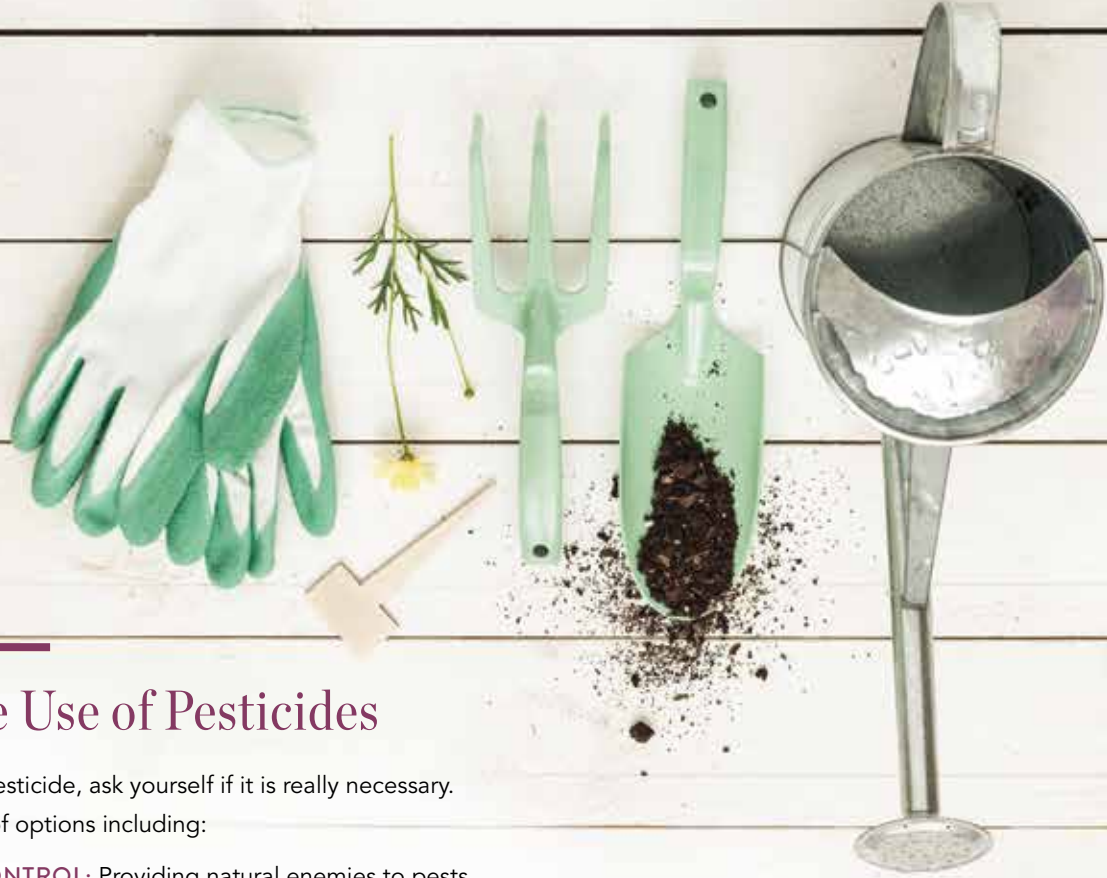
**Apply pesticides only as a last resort.**



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## Conserve Energy

Did you know that about 40% of the unwanted heat that builds up in your house enters through windows? Block sunlight before it enters by planting deciduous trees along the northeast-to-southeast and northwest-to-southwest sides of your house to cool it in the summer and warm it during the winter. Reduce the impact of "heat islands" by placing shrubs and groundcovers adjacent to asphalt or concrete driveways and walkways. Consider swapping out your inefficient outdoor lighting for LED lighting. Dust off those old hand tools and retire your power tools! Other ways to conserve energy are to grow your own fruits and vegetables, propagate your own plants and swap them with your neighbors, and use locally sourced or recycled building materials.



## Reduce the Use of Pesticides

Before you apply a pesticide, ask yourself if it is really necessary. There are a number of options including:

**BIOLOGICAL CONTROL:** Providing natural enemies to pests

**CULTURAL CONTROLS:** Creating a favorable environment for your desired plants and an unfavorable environment for the pests

**MECHANICAL AND PHYSICAL CONTROLS:** Trapping or excluding critters, hand-weeding, etc.

The University of California Cooperative Extension has a wonderful website loaded with pest control information at: [ipm.ucanr.edu](http://ipm.ucanr.edu).



## Protect and Encourage Pollinators and Desirable Wildlife

An estimated 6,000 acres of open space are lost each day in the U.S. resulting in a significant reduction of wildlife habitat. While some losses are due to urban sprawl and development, misuse of pesticides, invasive plant species, climate change, and other stresses have also been responsible for diminished wildlife habitats. Helping create and sustain a balanced ecosystem that supports a wide array of plant and animal species is a primary goal of sustainable landscaping. Butterflies, birds, pollinators, beneficial insects, and other wildlife will find a home in your landscape if you provide their basic requirements: food, water, cover, and space. Using native plants will provide the most support for a sustainable landscape.







For a more detailed, expanded version of the above principles related to developing your own sustainable landscape, download the free University of California, “Sustainable Landscaping in California” publication found at [anrcatalog.ucanr.edu/pdf/8504.pdf](http://anrcatalog.ucanr.edu/pdf/8504.pdf)

It is our hope that this book will provide the inspiration needed for you to create your very own sustainable landscape, even if it's taking a few small steps, a little at a time. Over time you'll be greeted by new species of birds, butterflies, and pollinators. You will have the perfect excuse to get your hands dirty by enriching your native soil with freshly-made compost. You might decide to start out simply by rerouting your rain gutters or repairing your irrigation system. Later, you might want to consider adding more drought-resistant and native plants, and planting a shade tree or two that will cool your home during the summer and warm it during the winter.

If your landscape is low maintenance and small in size, and you enjoy gardening and being outdoors, you may do just fine maintaining it yourself. However, if your landscape is large and high maintenance (with lots of irrigation and large trees), it is best to hire an expert. Trained water auditors can perform regular “catch can tests” and keep your irrigation system fine-tuned. International Society of Arboriculture (ISA) certified arborists or ISA certified tree workers can keep your cherished trees safe and beautiful by pruning them according to professional standards.

In addition, the Environmental Protection Agency's Water Sense® has certified several programs for landscape professionals. See [epa.gov/watersense/professional-certification-0](http://epa.gov/watersense/professional-certification-0). Many local water districts hold classes on sustainable landscaping for homeowners.



A valuable resource is your local University of California Cooperative Extension Master Gardener program in your county. Get your gardening questions answered by trained volunteers!

**Orange County Master Gardeners**

hotline@uccemg.com or  
mgorange.ucanr.edu/Gardening\_Hotline/  
(949) 809-9760

**Riverside County Master Gardeners**

anrmgriverside@ucanr.edu  
(951) 683-6491 x 231

**San Bernardino County Master Gardeners**

mgsanbern@ucanr.edu  
(909) 387-2182

In this book you have found tips and techniques for creating your own sustainable landscape by some of California's foremost authorities on their respective topics. Implementing the suggestions and advice will not only help you create your own beautiful sustainable landscape, but also help conserve and preserve precious natural resources for our children's children.

*So, if you are ready to get your hands dirty, let's dig in!*

# APPENDIX

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## USE AN IRRIGATION SCHEDULE FOR THE CITY THAT IS THE CLOSEST MATCH TO YOUR LOCAL CLIMATE.

No irrigation schedule is perfect. These are suggested schedules for watering high and low water-use plants with spray and rotor sprinkler heads. Results will vary depending upon the condition and layout of your irrigation system, and the physical characteristics of the land and soil. These schedules are meant only as a guide. Individual sites vary and will need to be adjusted accordingly. In other words, don't be afraid to take a trowel to your soil and see how deep your irrigation is going. Your goal is to irrigate enough in one day to soak just past the root zone, then let the soil dry down a few days.

The best time to water is in the early morning hours. Allow 30 to 60 minutes between watering cycles so water has a chance to soak in the soil. The heavier the soil, the longer the soak time needed. As water needs increase, don't add time to the cycles, or you will get runoff. Instead, add cycles if a small increase in watering is needed. Otherwise, add watering days.

For those of you who like details, the schedules are based on the following information.

- Monthly historical average  $ET_o$  data from [cimis.water.ca.gov](http://cimis.water.ca.gov) was used for four cities in the Santa Ana Watershed:
  - Irvine, Pomona, Riverside, and Hemet.
- The schedules assume no rain. Obviously, if you get rain, you can turn off your controller for several days to several weeks or more.
- Mountain communities like Big Bear have a historical annual average  $ET_o$  of 51.4 inches. They average 20 inches of rain and 67 inches of snow annually. Big Bear's rain and snow totals exceed the  $ET_o$  for the year, but most of the precipitation occurs in winter. Therefore, some irrigation may be needed during the summer—especially for non-native plants.
- High water-use plants = cool-season turf grasses such as tall fescue. Lawns don't need water every day except in extremely hot weather. Cool-season turfgrass can function normally down to 80% of  $ET_o$  (unless it gets extremely hot).
- Low water-use plants = most established trees and shrubs
- The high water-use category was calculated at 100% of historical average monthly  $ET_o$ .
- The low water-use category was calculated at 50% of historical average monthly  $ET_o$ .
- In reality you will be effectively irrigating at less than the calculated ET percentage because no irrigation system is 100% efficient.
- Soil texture = heavy, slow draining soil. If you have faster draining soil, then less cycles of longer duration can be used.
- Precipitation rate of fixed spray heads = 1.58 inches/hour
- Precipitation rate of rotor heads = 0.4 inches/hour.

# APPENDIX

For the purposes of calculating the irrigation schedules, a rotor head can be single stream or multi-stream, multi-trajectory. The precipitation rate of these types of sprinklers can vary quite a bit depending on nozzle size and adjustments. The precipitation rate of 0.4 inches/hour was used for calculating the irrigation schedules.

## DRIP IRRIGATION SCHEDULING

### GRID DRIP IRRIGATION

Drip in a grid pattern = 1.44 inches/hour if in a grid pattern of tubing with 1 gph emitters spaced 12 inches apart.

This looks like you can irrigate with drip for just a little more time than spray heads. However, if drip is going to be used to irrigate shrubs or trees, the run time will need to be about 30 minutes to reach a depth of 12 inches and one hour to reach a depth of 24 inches, depending on your soil texture. If your soil is heavy or clay-like, you will need to break up the watering time into two or three cycles to avoid runoff. Additionally, because you will be watering deeper than a few inches, you do not have to water as often. This is where a soil moisture meter can help you (see page 98).

### POINT-SOURCE DRIP IRRIGATION

Point-source drip irrigation is calculated using emitters per plant size.

**NUMBER OF EMITTERS PER PLANT.** Table courtesy of the Rain Bird Corporation.

	SOIL TYPE		
	Coarse	Medium	Fine
Estimated wetted diameter per emitter, feet	2.0	3.0	4.5
Estimated wetted area per emitter, square feet	3	7	16

PLANT CANOPY DIAMETER, feet	PLANT CANOPY AREA, square feet	NUMBER OF EMITTERS PER PLANT, 100% of area		
2	3	2	2	2
3	7	2	2	2
4	13	4	2	2
5	20	6	3	2
6	28	9	4	2
7	38	12	5	2
8	50	16	7	3
9	64	20	9	4
10	79	25	11	5
12	113	36	16	7
14	154	49	22	10
16	201	64	28	13
18	254	81	36	16
20	314	100	44	20

# APPENDIX

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## IRVINE

### SPRAY HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	3	3
April	3	3	5
July*	5	2	5
October	3	2	5

\*Extreme temperatures will require more water.

### SPRAY HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	3	3
April	2	3	4
July	3	3	3
October	2	2	4

### ROTOR HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	20
April	3	3	19
July*	4	3	18
October	3	2	20

\*Extreme temperatures will require more water.

### ROTOR HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	2	20
April	2	3	14
July	2	3	18
October	1	3	20

# APPENDIX

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## POMONA

### SPRAY HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	4
April	4	2	5
July*	5	3	4
October	3	2	5

\*Extreme temperatures will require more water.

### SPRAY HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	3	3
April	2	3	4
July	3	3	3
October	2	2	4

### ROTOR HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	16
April	3	3	18
July*	4	3	19
October	3	2	19

\*Extreme temperatures will require more water.

### ROTOR HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	2	15
April	2	2	20
July	2	3	18
October	1	3	19

# APPENDIX

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## RIVERSIDE

### SPRAY HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	5
April	4	3	4
July*	4	4	4
October	3	3	4

\*Extreme temperatures will require more water.

### SPRAY HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	3	4
April	2	3	4
July	4	2	4
October	2	3	3

### ROTOR HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	21
April	3	3	21
July*	4	3	21
October	3	3	15

\*Extreme temperatures will require more water.

### ROTOR HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	2	21
April	2	2	24
July	2	3	21
October	1	3	23

# APPENDIX

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## HEMET

### SPRAY HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	5
April	4	3	4
July*	6	3	4
October	3	3	4

\*Extreme temperatures will require more water.

### SPRAY HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	2	5
April	2	3	4
July	4	2	4
October	2	3	4

### ROTOR HEADS – HIGH WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	2	2	19
April	3	3	20
July*	4	3	22
October	3	2	23

\*Extreme temperatures will require more water.

### ROTOR HEADS – LOW WATER USE PLANTS

Month	Watering days per week	Cycles per day	Minutes per cycle
January	1	2	19
April	2	2	23
July	2	3	23
October	1	3	23



# GLOSSARY

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**Acidic** – A pH of less than seven. Acidic soils tend to be in areas of higher rainfall such as the eastern United States, and the coastal Pacific Northwest.

**Alkaline** – A pH of more than seven. Alkaline soils tend to be in arid climates of the western half of the United States

**Alluvial** – Soil made up of materials left by the water from rivers and floods. It is typically loose and fast-draining.

**Amendment (in soil)** – Anything added to a soil, generally for biological and/or physical enhancement.

**Anaerobic** – Without oxygen.

**Anti-siphon valve** – Allows water to flow in only one direction. Prevents water from being sucked back into the water supply line.

**Aqueduct** – A manmade channel for moving water.

**Atmospheric backflow preventer** – Prevents backflow into water supply.

**Bay Delta** – A nickname for the Sacramento – San Joaquin Delta. A 1,100 square mile area in Northern California from which our watershed gets most of its imported water.

**Berm** – an elevated ridge of land. Typically several inches to several feet in height.

**Capillary action** – Attraction of water to surfaces. Allows for water to move opposite of gravity.

**Catch can test** – A method used to determine irrigation efficiency. Catch cans are water-holding containers, about one cup in size. When placed on the ground in a pattern, they catch water from an operating sprinkler zone for a specified time. Once the sprinklers are turned off, the water in each catch can is measured. The greater the difference in the volume of water in each catch can, the greater the irrigation inefficiency.

**Circuit** – See “Zone.”

**Clock** – Another name for an irrigation timer or controller.

**Compost** – Made of organic matter that has decomposed. It can be incorporated in soil as an amendment or applied to the top of soil as a mulch. It looks nothing like the original materials that were used to make it. Compost is typically dark brown and has an earthy aroma.

**Controller** – Another name for an irrigation timer or clock.

**Deadheading** – The removal of dead flower or seed heads from a plant.

**Deciduous** – Seasonal shedding. An example is the loss of leaves from trees in the winter months.

**Decomposition** – The natural biological and chemical process by which organic matter (such as dead plants) is broken down into compost.

**Desalting** – A water treatment process of removing salt from water. Fresh water is produced from brackish or seawater.

# GLOSSARY

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**Exudate (from plant roots)** – Chemically diverse compounds from the circulatory system of the plant. It is excreted from the roots into the soil as a defense mechanism against pathogens.

**Feel method** – An unscientific way to determine the state of soil by feeling it. A desirable soil feels somewhat squishy, but not gooeey; somewhat crumbly, but it will hold together when squeezed.

**Garden Room** – An outdoor area that is defined with elements similar to an indoor room to create a sense of space. Elements can include flooring such as stone or tile; an overhead cover such as a pergola; walls from hedges, pottery, or curtains; a fireplace; kitchen equipment or bar-b-q; seating, etc.

**Genera** – A class or group marked by common characteristics. Plants are named botanically with a genus and species name. The genera would be all plants with the same genus name.

**Groundwater** – Water that is found underground in the spaces of soil, sand, and fractured rock. It is considered a type of water storage.

**Habitat** – A natural environment for an organism such as a plant or animal.

**Head** – A shortened name for sprinkler head.

**Heat island** – An area that is significantly warmer compared to its surrounding area.

**Humus** – An organic component of soil consisting of well-decayed plant and animal matter. Microorganisms can't decompose it any further, so it is a very stable product that last for years. It greatly increases the water-holding capacity of soil by aggregating soil particles.

**Hydrozone** – An area of plants with the same or similar water needs.

**Inorganic** – Consisting of matter other than living or formally living substances. An example would be minerals or most types of rock.

**Loam** – A desired soil consisting of sand, silt, and clay.

**Microbes** – Microscopic critters that live in the soil such as bacteria, fungi, protozoa, and nematodes. They can be beneficial or pathogenic.

**Microclimate** – A local climate formed in a small site or habitat. Many things can form a microclimate such as shade, reflected heat, structures, topography, soil, etc.

**Mulch** – A material spread on top of the soil to protect and possibly enrich the soil. It can be either organic, such as wood chips, or inorganic, such as rocks.

**Mycorrhizae** – a beneficial soil fungus that greatly enhances water and nutrient uptake by performing as an extension of plant roots. It actually helps plants communicate with each other. Approximately 90% of land plants have formed some type of mycorrhizal relationships with other plants.

**Native plant** – A plant that has evolved and adapted naturally in a local ecosystem or location without direct or indirect human intervention.

# GLOSSARY

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**Non-potable water** – Water that is not safe to drink.

**Nozzle** – a device used to control the output of water from a sprinkler head.

**Organic** – Derived from living organisms. Contains the element, carbon.

**Ornamentals** – Plants that are used for ornament rather than plants used for crops and food sources.

**Pathogen** – An organism that causes disease.

**Precipitation rate** – A measure of the rate at which water is applied to a specific area in a specified time. Usually measured in inches per hour.

**Point-source drip irrigation** – A method of drip irrigation where drip emitters are placed only in the plants root zone.

**pH** – a measure of how acidic or alkaline water is. A scale of 1 to 14 is used with 7 being neutral, below 7 being acidic, and above 7 being alkaline.

**Photosynthesis** – A process in green plants that uses sunlight to create and transfer energy.

**Potable water** – Water that is safe to drink.

**Prune** – Selective removal of parts of a plant such as branches, twigs, or roots.

**PSI** – Pounds per square inch. It is a measure of force.

**Rain garden** – From the National Resource Conservation Service: Rain gardens are low or depressed areas landscaped with perennial flowers and native vegetation that soak up rainwater. They are strategically located to capture runoff from impervious surfaces, such as roofs and streets. Rain gardens fill with a few inches of water after a storm and then water filters into the ground, rather than running off to a storm drain. As urban areas grow, increased storm water runoff from impervious surfaces becomes a problem. As more impervious surfaces are added to our communities, it is more important than ever to help rainwater infiltrate. This protects water quality and reduces storm water runoff.

**Recycled Water** – Wastewater that has been adequately treated for use as irrigation water or recharge of groundwater basins.

**Reservoir** – A body of water used as a source of water supply such as a lake or pool.

**Runoff** – Water that drains off of a land surface. When speaking in terms of irrigation, runoff is water that flows off of the irrigated target area and is wasted.

**Sacramento Bay Delta** – See Bay Delta

**Smart controller** – An irrigation controller that uses weather data to automatically determine appropriate watering schedules.

**Soil food web** – A community in the soil consisting of a diversity of organisms from one-celled bacteria to small vertebrate animals and plants. The organisms interact and depend on each other to produce energy and provide nutrients to plants.

# GLOSSARY

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**Soil texture** – The ratio of sand, silt, and clay particles in a soil. For example, clay loam, or silty clay are soil texture names.

**Solenoid** – An electromagnetic device on an irrigation valve that allows a valve to open and close via an electrical current. The solenoid is connected to an irrigation controller with electrical wiring.

**Species** – A group of living organisms, such as plants or animals, with similar characteristics in which two individuals can produce offspring.

**Spray Sprinkler** – A sprinkler type that has a nozzle with a fixed spray pattern, typically fan-shaped, with a radius of approximately four to 15 feet.

**Sprinkler** – A device that emits water with a controlled rate, pattern, and distance.

**Stormwater** – Surface water resulting from heavy rain or snow melt.

**Sunset® climate zones** – Refined climate zones for the western United States developed by Sunset, Time, Inc.

**Swale** – A low place in the landscape where water collects.

**Timer** – Another name for an irrigation clock or controller.

**Transpiration** – A process where water enters plant roots, transports through the plant, and exits the leaves as water vapor.

**Treated wastewater** – Sewage and wastewater that has been treated chemically, physically, and biologically to remove contaminants so it can be safely returned to the environment or put to beneficial use such as groundwater replenishment or irrigation.

**Turf or Turfgrass** – Grass that is used as a lawn as opposed to wild grasses, prairie, or agronomic grasses.

**Valve** – An irrigation device that controls the flow of water through pipes and sprinklers.

**Watershed** – An area of land where all streams and rainfall drain to a common outlet. If you are standing on land, you are standing in a watershed.

**Weather-based controller** – See “smart controller.”

**Zone** – An irrigated area controlled by one valve.

# RESOURCES

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## PLANT LISTS – BOOKS AND WEBSITE

*Landscape Plants for California Gardens* by Bob Perry (2010)

*Sunset New Western Garden Book* by Kathleen Norris, ed. (2012)

*Water Use Classification of Landscape Species IV* by University of California Cooperative Extension (2014) – An exhaustive anecdotal list of over 3,500 plant species throughout California. [ucanr.edu/sites/WUCOLS](http://ucanr.edu/sites/WUCOLS)

## INVASIVE PLANT SPECIES

Plant Right: [plantright.org](http://plantright.org)

California Invasive Plant Council: [cal-ipc.org](http://cal-ipc.org)

## CALIFORNIA NATIVE PLANT LISTS AND INFORMATION

Rancho Santa Ana Botanic Garden – [rsabg.org](http://rsabg.org)

Theodore Payne Foundation – [theodorepayne.org](http://theodorepayne.org)

California Native Plant Society's plant database – [calscape.org](http://calscape.org)

## CLIMATE ZONES

*Sunset New Western Garden Book* (see Plant Lists)

USDA: [planthardiness.ars.usda.gov/PHZMWeb](http://planthardiness.ars.usda.gov/PHZMWeb)

ET Data: [cimis.water.ca.gov](http://cimis.water.ca.gov)

## SOIL HEALTH

[nrcs.usda.gov/wps/portal/nrcs/main/soils/health](http://nrcs.usda.gov/wps/portal/nrcs/main/soils/health)

## UNIVERSITY OF CALIFORNIA

University of California Center for Landscape & Urban Horticulture: [ucanr.edu/sites/urbanhort](http://ucanr.edu/sites/urbanhort)

University of California Integrated Pest Management: [ipm.ucanr.edu](http://ipm.ucanr.edu). This website is a treasure of credible information on more than just pests. Take a look at Quick Tips: [ipm.ucanr.edu/QT/index.html](http://ipm.ucanr.edu/QT/index.html), and a list of plants with their common pests: [ipm.ucanr.edu/PMG/GARDEN/plantmenu.html](http://ipm.ucanr.edu/PMG/GARDEN/plantmenu.html).

The University of California Agriculture & Natural Resources has an extensive list of informative publications at [anrcatalog.ucanr.edu](http://anrcatalog.ucanr.edu). The following is a sampling that can be retrieved by entering the publication number in the search box on their website. Most publications are free.

9027: California Master Gardener Handbook

8553: Keeping Plants Alive under Drought or Water Restrictions

8536: Use of Graywater in Urban Landscapes in California

8531: Coastal California Rain Gardens

8504: Sustainable Landscaping in California

8322: Landscaping Tips to Help Defend Your Home from Wildfire

# RESOURCES

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8255: Lawns 'n' Dogs

8228: Home Landscaping for Fire

8046: Planting Landscape Trees

8044: Lawn Watering Guide for California

8036: Water Conservation Tips for the Home Lawn and Garden

8035: Turfgrass Selection for the Home Landscape

## **HORTICULTURAL MYTHS AND THE INFORMED GARDENER**

Even though this is from outside of California (Washington State University Extension), the information is applicable, informative, and well-presented for listening or reading – [puyallup.wsu.edu/lcs](http://puyallup.wsu.edu/lcs)

## **CALIFORNIA STATE MODEL WATER EFFICIENT LANDSCAPE ORDINANCE**

If your landscape changes exceed 2,500 square feet and triggers a permit, you are required to comply with the State landscape ordinance. (This is based on the most recent ordinance of 2015.) Check with your local jurisdiction, as their requirements may exceed the State ordinance – [water.ca.gov/wateruseefficiency/landscapeordinance](http://water.ca.gov/wateruseefficiency/landscapeordinance)

## **IRRIGATION**

Irrigation Consumer Handbook by the Irrigation Association – [irrigation.org/uploadedFiles/SWAT/SWAT\\_2/Irrigation\\_Consumer\\_Handbook.pdf](http://irrigation.org/uploadedFiles/SWAT/SWAT_2/Irrigation_Consumer_Handbook.pdf)

Landscape Irrigation Best Management Practices by the Irrigation Association – [irrigation.org/uploadedFiles/Standards/BMPDesign-Install-Manage.3-18-14\(2\).pdf](http://irrigation.org/uploadedFiles/Standards/BMPDesign-Install-Manage.3-18-14(2).pdf)

California Irrigation Management Information System – [cimis.water.ca.gov](http://cimis.water.ca.gov)

## **IRRIGATION DESIGN GUIDES**

Hunter Irrigation – [hunterindustries.com/sites/default/files/design\\_guide\\_Residential\\_System\\_LIT-226-US.pdf](http://hunterindustries.com/sites/default/files/design_guide_Residential_System_LIT-226-US.pdf)

Netafim (dripline) – [netafimusa.com/landscape/support-materials/literature-download](http://netafimusa.com/landscape/support-materials/literature-download)

Rain Bird – [rainbird.com/landscape/resources/DesignGuides.htm](http://rainbird.com/landscape/resources/DesignGuides.htm). Rain Bird has a complete library of design guides.

Irritrol (The Toro Company) – [irritrol.com/en/product-literature](http://irritrol.com/en/product-literature)

## **HIRING PROFESSIONALS**

Any work totaling over \$500 requires a contractor's license in California! Know your rights by visiting the California State Licensing Board – [cslb.ca.gov/Consumers/Consumers.aspx](http://cslb.ca.gov/Consumers/Consumers.aspx)

EPA WaterSense® Professionals – [epa.gov/watersense/professional-certification-0](http://epa.gov/watersense/professional-certification-0)

Irrigation professionals – [irrigation.org/HireCertified](http://irrigation.org/HireCertified)

Landscape contracting professionals – [clca.org/consumers/consumers\\_home.php](http://clca.org/consumers/consumers_home.php)

Tree care professionals – [treesaregood.com](http://treesaregood.com)

# RESOURCES

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## ENVIRONMENTAL ADVOCACY

California Native Plant Society – [cnps.org](http://cnps.org)  
Inland Empire Waterkeeper – [iewaterkeeper.org](http://iewaterkeeper.org)  
Orange County Coastkeeper – [coastkeeper.org](http://coastkeeper.org)  
Rivers and Lands Conservancy – [riversandlands.org](http://riversandlands.org)  
Riverside County Watershed Protection – [rcwatershed.org](http://rcwatershed.org)  
Santa Ana Watershed Association – [sawatershed.org](http://sawatershed.org)

## RESOURCE CONSERVATION DISTRICTS

Inland Empire RCD – [iercd.org](http://iercd.org)  
Riverside-Corona RCD – [rcrcd.com](http://rcrcd.com)  
San Jacinto Basin RCD – Phone: (909) 654-7733  
Elsinore-Murrieta-Anza RCD – [teamrcd.org](http://teamrcd.org)

## WATER CONSERVATION DISTRICTS

Chino Basin Water Conservation District – [cbwcd.org](http://cbwcd.org)  
San Bernardino Valley Water Conservation District – [sbvwcd.org](http://sbvwcd.org)

## STORMWATER POLLUTION PREVENTION

Orange County Watersheds – [ocwatersheds.com](http://ocwatersheds.com)  
Riverside County Flood Control and Conservation District – [floodcontrol.co.riverside.ca.us](http://floodcontrol.co.riverside.ca.us)  
San Bernardino County Stormwater Pollution Prevention – [sbcountystormwater.org](http://sbcountystormwater.org)

## WASTE MANAGEMENT DISTRICTS (RECYCLING, COMPOSTING, WASTE)

Cal Recycle – [calrecycle.ca.gov/PublicEd/default.htm](http://calrecycle.ca.gov/PublicEd/default.htm)  
Orange County Waste & Recycling – [oclandfills.com/recycling](http://oclandfills.com/recycling)  
Riverside County Department of Waste Resources – [rcwaste.org](http://rcwaste.org)  
San Bernardino County Department of Public Works –  
[cms.sbcounty.gov/dpw/SolidWasteManagement/ReductionRecycling.aspx](http://cms.sbcounty.gov/dpw/SolidWasteManagement/ReductionRecycling.aspx)

## WATER AGENCIES WITHIN THE SANTA ANA WATERSHED – WHOLE OR PART

Santa Ana Watershed Protection Authority (SAWPA) – [sawpa.org](http://sawpa.org)

### Los Angeles County

Golden State Water Company serving Claremont – [www.gswater.com](http://www.gswater.com)  
Pomona, City of – [www.ci.pomona.ca.us](http://www.ci.pomona.ca.us)

# RESOURCES

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## Orange County

Anaheim, City of – [anaheim.net](http://anaheim.net)

Brea, City of – [ci.brea.ca.us](http://ci.brea.ca.us)

Buena Park, City of – [buenapark.com](http://buenapark.com)

Claremont, City of - [ci.claremont.ca.us/](http://ci.claremont.ca.us/)

East Orange County Water District – [eocwd.com](http://eocwd.com)

El Toro Water District – [etwd.com](http://etwd.com)

Fountain Valley, City of – [fountainvalley.org](http://fountainvalley.org)

Fullerton, City of – [cityoffullerton.com](http://cityoffullerton.com)

Garden Grove, City of – [ci.garden-grove.ca.us](http://ci.garden-grove.ca.us)

Golden State Water Company serving Cowan Heights, Placentia, and West Orange – [gswater.com](http://gswater.com)

Huntington Beach, City of – [huntingtonbeachca.gov](http://huntingtonbeachca.gov)

Irvine Ranch Water District – [irwd.com](http://irwd.com)

La Habra, City of – [lahabracity.com](http://lahabracity.com)

La Palma, City of – [cityoflapalma.org](http://cityoflapalma.org)

Mesa Water District – [mesawater.org](http://mesawater.org)

Municipal Water District of Orange County – [mwdoc.com](http://mwdoc.com)

Newport Beach, City of – [newportbeachca.gov](http://newportbeachca.gov)

Orange, City of – [cityoforange.org](http://cityoforange.org)

Orange County Water District, member agency of SAWPA – [ocwd.com](http://ocwd.com)

Santa Ana, City of – [ci.santa-ana.ca.us](http://ci.santa-ana.ca.us)

Seal Beach, City of – [sealbeachca.gov](http://sealbeachca.gov)

Serrano Water District – [serranowater.org](http://serranowater.org)

Tustin, City of – [tustinca.org](http://tustinca.org)

Westminster, City of – [westminster-ca.gov](http://westminster-ca.gov)

Yorba Linda Water District – [ylwd.com](http://ylwd.com)

## Riverside County

Banning, City of – [ci.banning.ca.us](http://ci.banning.ca.us)

Beaumont Cherry Valley Water District – [bcvwd.org](http://bcvwd.org)

Box Springs Mutual Water Company – [boxspringswater.com](http://boxspringswater.com)

Corona, City of – [discovercorona.com](http://discovercorona.com)

Eagle Valley Mutual Water Company –

Eastern Municipal Water District, member agency of SAWPA – [emwd.org](http://emwd.org)

Elsinore Valley Municipal Water District – [evmwd.com](http://evmwd.com)

Fern Valley Water District – [fernvalleywater.com](http://fernvalleywater.com)



# RESOURCES

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## **Riverside County continued...**

Hemet, City of – [cityofhemet.org](http://cityofhemet.org)

Home Gardens County Water District – Phone: (951) 737-4741

Idyllwild Municipal Water District – [idyllwildwater.net](http://idyllwildwater.net)

Jurupa Community Services District – [jcsd.us](http://jcsd.us)

Lake Hemet Water District – [lhmwd.org](http://lhmwd.org)

Norco, City of – [norco.ca.us](http://norco.ca.us)

Nuevo Water Company – Phone: (951) 928-1922

Perris, City of – [cityofperris.org](http://cityofperris.org)

Pine Cove Water District – [pcwd.org](http://pcwd.org)

Riverside Highland Water Company – [rhwco.com](http://rhwco.com)

Riverside Public Utilities – [riversideca.gov/utilities/default.asp](http://riversideca.gov/utilities/default.asp)

Rubidoux Community Services District – [rcsd.org](http://rcsd.org)

San Geronio Pass Water Agency – [sgpwa.com](http://sgpwa.com)

San Jacinto, City of – [ci.san-jacinto.ca.us](http://ci.san-jacinto.ca.us)

Santa Ana River Water Company – [sarwa.epayub.com/Pages/default.aspx](http://sarwa.epayub.com/Pages/default.aspx)

Temescal Valley Water District – [temescalvwd.com](http://temescalvwd.com)

Western Municipal Water District, member agency of SAWPA – [wmwd.com](http://wmwd.com)

## **San Bernardino County**

Big Bear Community Services District – [bbccsd.org](http://bbccsd.org)

Big Bear Lake Municipal Water District – [bbmwd.com](http://bbmwd.com)

Chino, City of – [cityofchino.org](http://cityofchino.org)

Chino Basin Desalter Authority – [chinodesalter.org](http://chinodesalter.org)

Chino Hills, City of – [chinohills.org](http://chinohills.org)

Colton, City of – [ci.colton.ca.us](http://ci.colton.ca.us)

Cucamonga Valley Water District – [cvwdwater.com](http://cvwdwater.com)

East Valley Water District – [eastvalley.org](http://eastvalley.org)

Fontana Water Company – [fontanawater.com](http://fontanawater.com)

Inland Empire Utilities Agency, member of SAWPA – [ieua.org](http://ieua.org)

Loma Linda, City of – [lomalinda-ca.gov](http://lomalinda-ca.gov)

Marygold Mutual Water Company – Phone: (909) 877-0516

Monte Vista Water District – [mvwd.org](http://mvwd.org)

Muscoy Mutual Water Company – Phone: (909) 877-2964

Ontario, City of – [ontarioca.gov](http://ontarioca.gov)

Redlands, City of – [cityofredlands.org](http://cityofredlands.org)

Rialto, City of – [yourrialto.com](http://yourrialto.com)

# RESOURCES

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## San Bernardino County continued...

Running Springs Water District – [runningspringswaterdistrict.com](http://runningspringswaterdistrict.com)

San Antonio Water Company – [sawaterco.com](http://sawaterco.com)

San Bernardino, City of – [ci.san-bernardino.ca.us](http://ci.san-bernardino.ca.us)

San Bernardino Valley Municipal Water District, member agency of SAWPA – [sbvmwd.com](http://sbvmwd.com)

South Mesa Water Company – [southmesawater.com](http://southmesawater.com)

Terrace Water Company – Phone: (909) 825-5224

Upland, City of – [uplandpl.lib.ca.us](http://uplandpl.lib.ca.us)

West Valley Water District – [wvwd.org](http://wvwd.org)

Western Heights Water Company – [westernheightswater.com](http://westernheightswater.com)

Yucaipa Valley Water District – [yvwd.dst.ca.us](http://yvwd.dst.ca.us)



# FOOTNOTES

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## SOIL, PLANT, AND IRRIGATION CHAPTERS

Excerpts from *California Master Gardener Handbook, 2nd Edition*; D. Pittinger et al. UC ANR Publication #3382; ISBN #978-1-60107-857-5. The Regents of the University of California. Copyright 2015. Used by permission.

## NATIVES CHAPTER

1. McLellan, Richard. Ed. *Living Planet Report 2014*. worldwildlife.org. World Wildlife Fund. 2014. Web. 11 April 2017.
2. Tallamy, Doug. *Bringing Nature Home*. Timber Press. 2009.
3. Heath, Fred. *An Introduction to Southern California Butterflies*. Mountain Press Publishing Company. 2004.
4. Ackerman, Russell. 2013. *Sustainable Landscape – The Numbers Speak for Themselves*. smgov.net. City of Santa Monica, Landscape garden-garden. 2013. Web. 11 April 2017.
5. North American Bird Conservation Initiative. *The State of North America's Birds 2016*. stateofthebirds.org. Environment and Climate Change Canada. 2016. Web. 11 April 2017.
6. Pavlik, Bruce M., et al. *Oaks of California*. Cachuma Press. 1993.

## IRRIGATION CHAPTER

1. Values do not apply to any plant production operations, such as nurseries, greenhouses, sod farms, or commercial farms.
2. Plant Factor shown is the annual average value; monthly or seasonal factors may be available if more precision is desired.
3. Plant Factor does not apply to sports fields, golf greens or tees.
4. ANSI/ASABE Standard S623, *Determining Landscape Plant Water Requirements*. asabe.org. American Society of Agricultural and Biological Engineers. Oct 2015. Web. 11 April 2017.  
  
Meyer, J.L., V.A. Gibeault, and V.B. Youngner. International Turfgrass Research Conference. *Irrigation of Turfgrass below Replacement of Evapotranspiration as a Means of Water Conservation: Determining Crop Coefficient of Turfgrasses*. 1985. France. Sports Turf Research Institute. 1985.  
  
Snyder, R.L. *Irrigation Scheduling: Water Balance Method [Basic Irrigation Scheduling]*. biomet.ucdavis.edu. UC Davis Biomaterology Group. 2014. Web. 11 April 2017.
5. *CIMIS Station Reports*. cimis.water.ca.gov. California Irrigation Management Information System. Web. April 2017.
6. Hartin, Janet. *Re: Quote about 80%*. Message to Pam Pavela. April 14, 2017. Email.
7. Rain Bird Corporation. *Project PRS: Study of Pressure Regulated Versus Non-Pressure Regulated Sprays and Rotors*. Metropolitan Water District of Southern California Innovative Conservation Program. 2014.

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62	Pam Pavela - landscape
63	Lisa Novick – female valley carpenter bee on <i>Abutilon palmeri</i>
63	Antonia Warner – cedar waxwing birds on <i>Heteromeles arbutifolia</i>
64	Pam Pavela – <i>Heteromeles arbutifolia</i>
65	Lisa Novick – bee on <i>Eriogonum fasciculatum</i>
65	Pam Pavela – <i>Lavatera maritima</i> and <i>Eriogonum giganteum</i> 'St. Catherine's Lace'
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79	Pam Pavela – irrigation valve
80	The Toro Company, Hunter Industries, and Rain Bird Corp.
81	The Toro Company – bubbler nozzle in action
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83	Mallory Gandara – drip grid installation
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