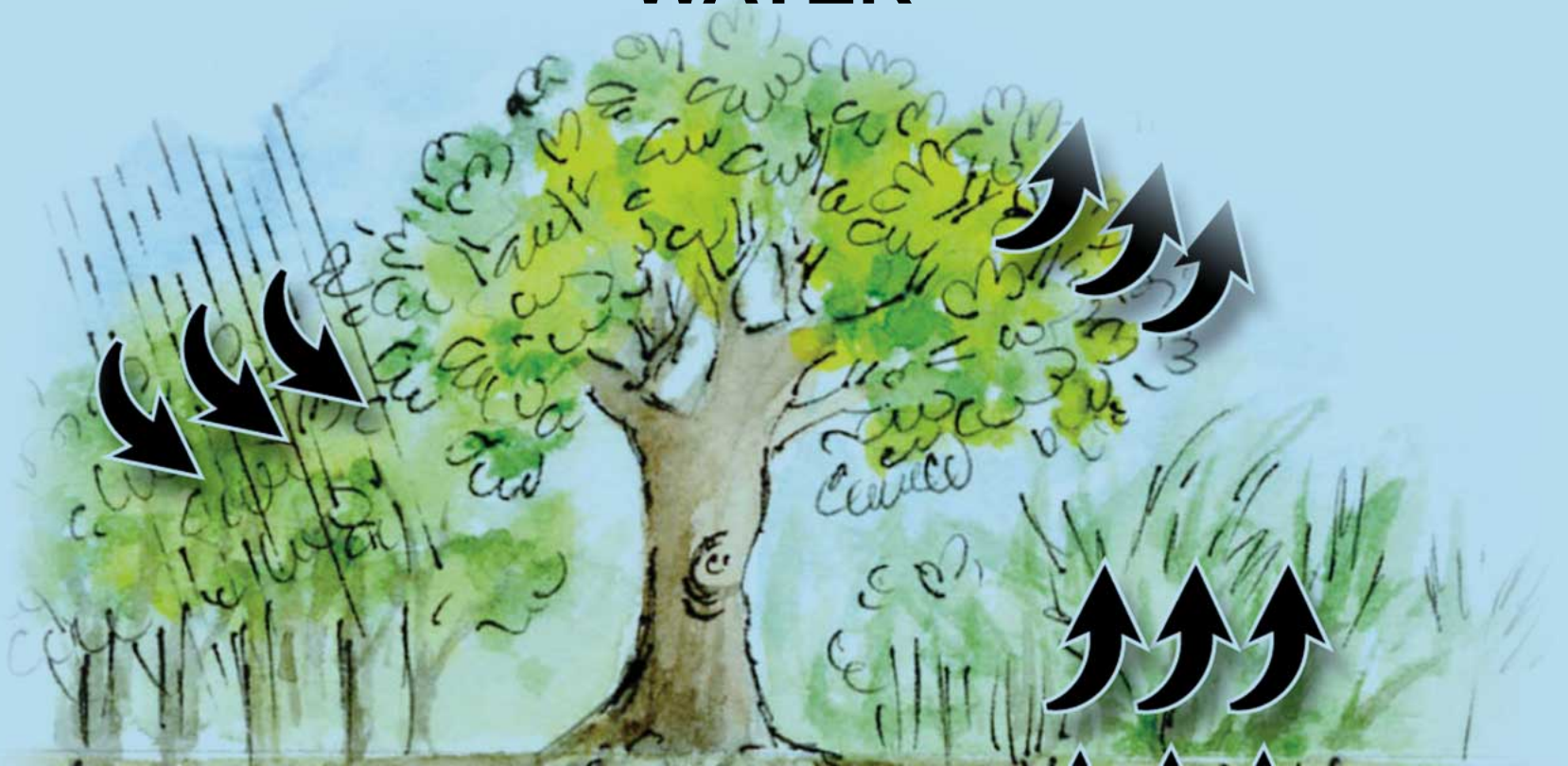


Section 4

LANDSCAPE WATER



LEARNING OBJECTIVES

1. Understand the concept of a landscape water budget
2. Have a basic understanding of evapotranspiration
3. Be familiar with sources of evapotranspiration and weather station information
4. Understand plant water use classifications
5. Understand hydrozones and the selection of plants based on various uses and other factors
6. Learn how to calculate a basic water budget
7. Learn how to calculate how much irrigation water to apply
8. Understand key issues for developing a water budget for a landscape site
9. Examples of water budgets

1. WATER BUDGET CONCEPT

- Understand the concept of a landscape water budget

1.1-1.2 DEFINITION AND PURPOSE

- A landscape water budget (water budget) is an estimate of **how much water is needed to maintain a healthy landscape** for a given time period
 - Year
 - Month
- Water budgets are an essential tool in planning and managing landscape water use

1.3 ELEMENTS OF A WATER BUDGET

- Three elements to a basic water budget:
 - Weather
 - Plant Type
 - Area

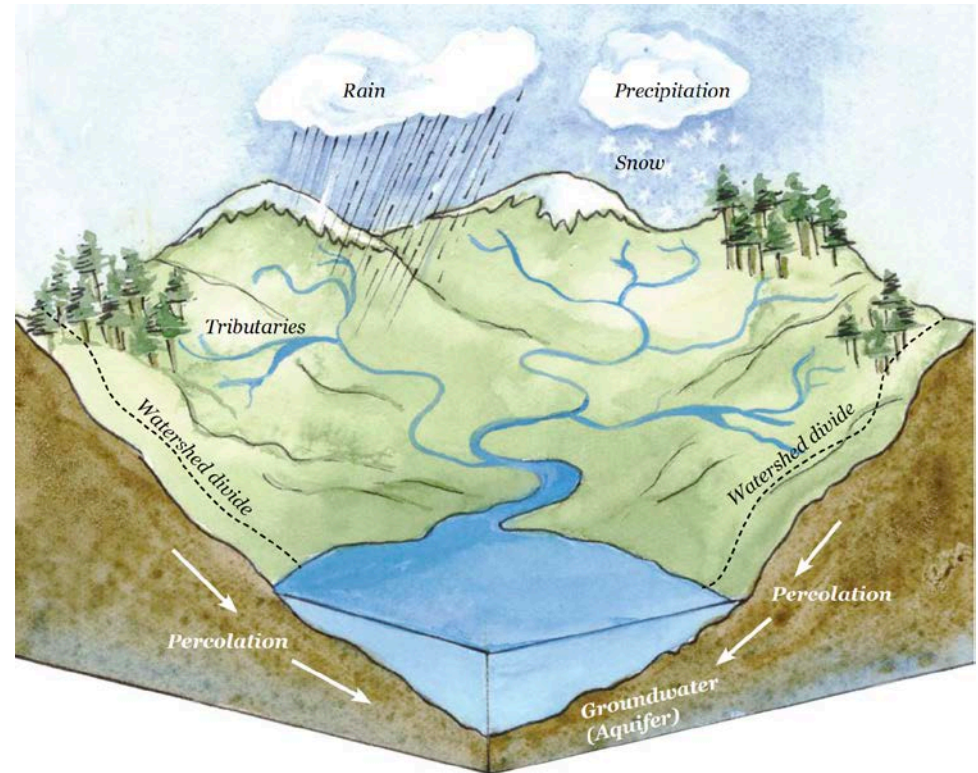
Water Budget = **Weather** x **Plant Type** x Area

2. EVAPOTRANSPIRATION

- Have a basic understanding of evapotranspiration

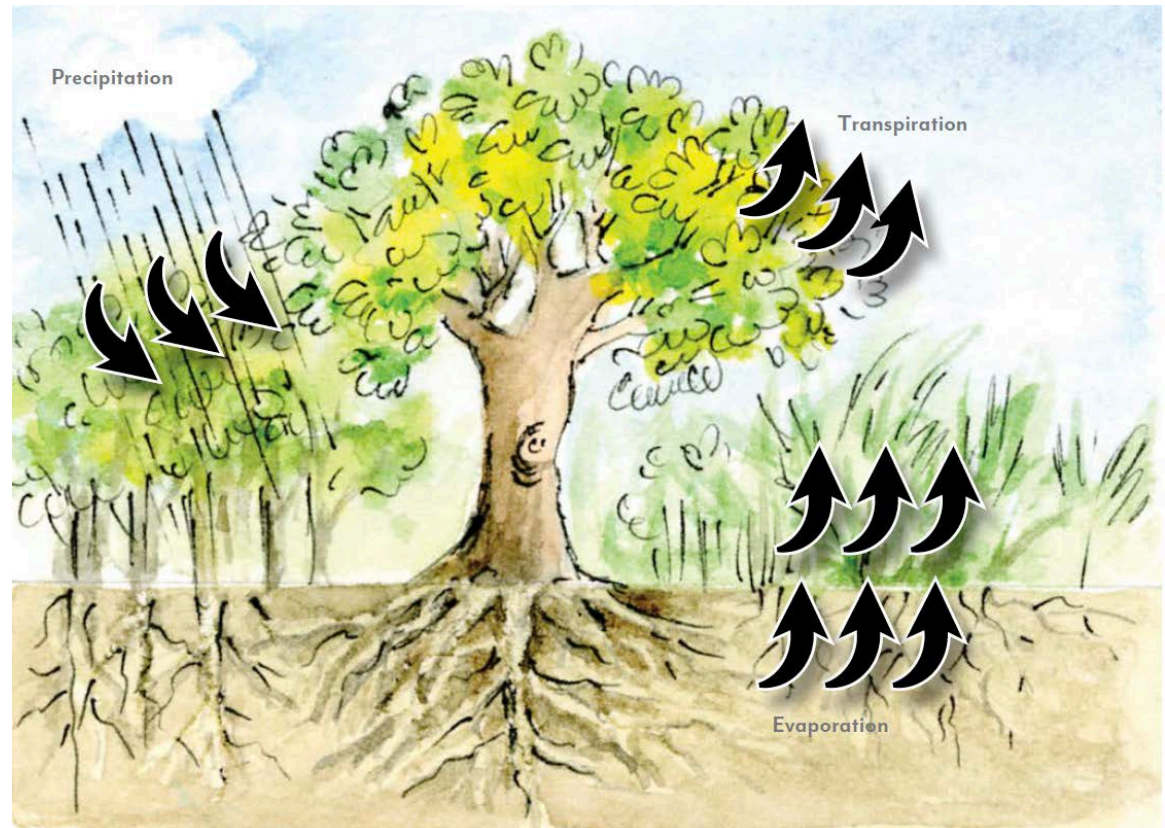
2.1-2.2 EVAPOTRANSPIRATION DEFINITION

- **Evapotranspiration** (ET) is the loss of water to the atmosphere by the combined processes of:
 - **Evaporation** from soil and plant surfaces
 - **Transpiration** through plant tissues
- Component of the water cycle
- ET is measured in **inches**



2.3 FACTORS AFFECTING ET

- Solar radiation
- Air temperature
- Relative humidity
- Wind speed
- Soil exposure
- Planting density



2.4-2.5 REFERENCE ET

- **Reference ET** (ET_o) is the reference point for landscape plant water use calculations
- ET_o is the ET from **well-watered cool season turf** grass maintained at 4 to 6 inches tall
- ET_o is the **weather** component of the water budget

Water Budget = **Weather** x **Plant Type** x Area

3. SOURCES OF ET_0

- Be familiar with sources of evapotranspiration and weather station information

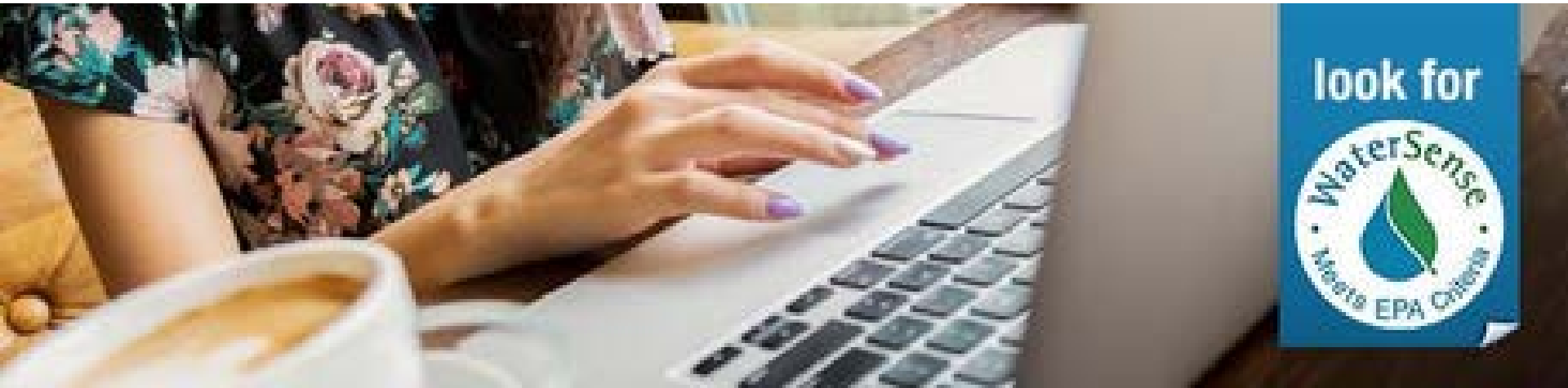
3.1-3.2 WEATHER STATIONS

- An accurate and reliable source of ETo is needed
- Weather stations measure:
 - Solar radiation
 - Soil temperature
 - Air temperature/relative humidity
 - Wind direction
 - Wind speed
 - Precipitation



3.3 EPA WATERSENSE DATA

- EPA WaterSense Water Budget Data Finder
 - Historical peak watering month
 - Evapotranspiration
 - Rainfall



3.4 CALIFORNIA: CIMIS

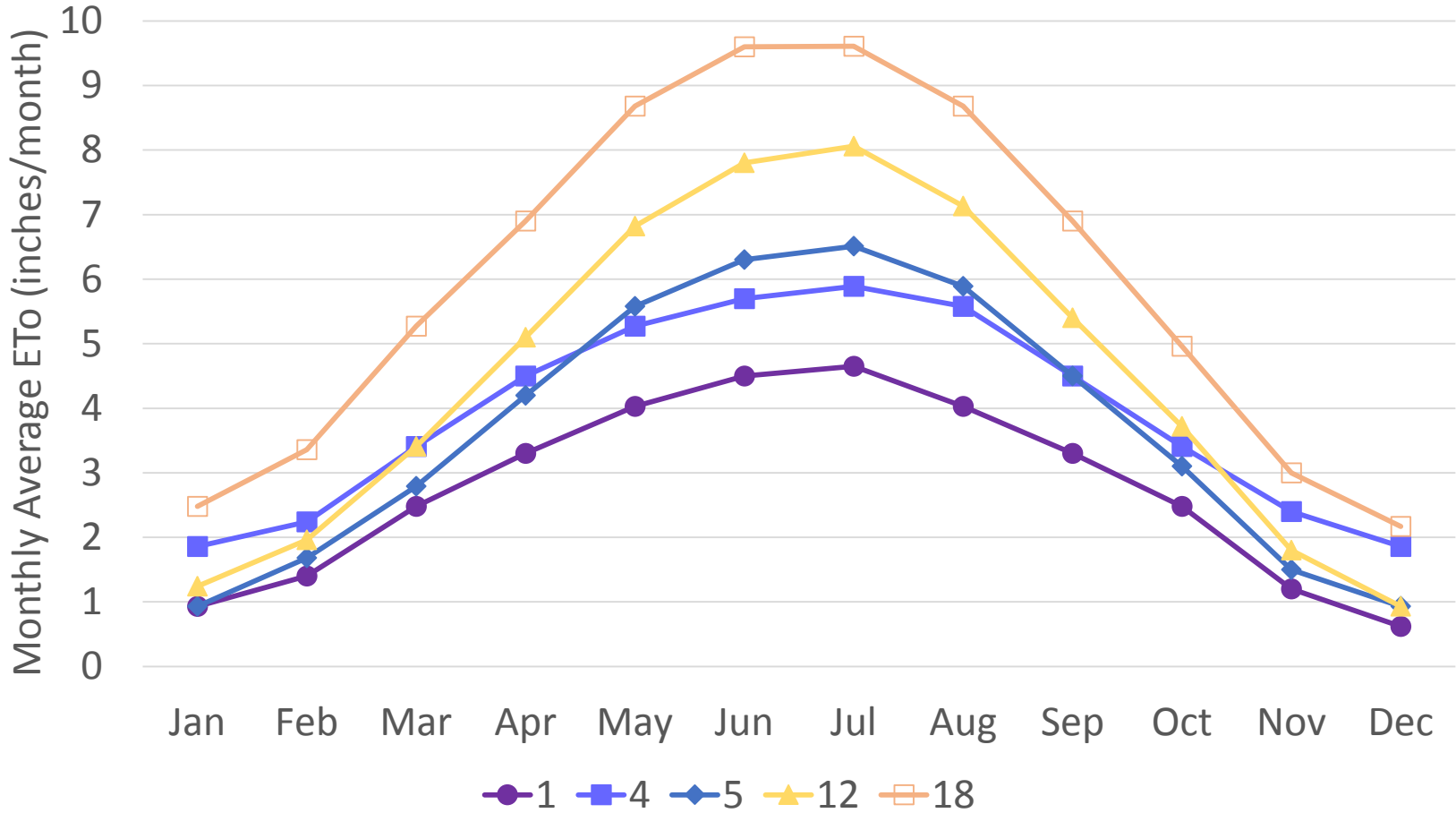
- California Irrigation Management Information System (CIMIS)
 - Operated by California Department of Water Resources
 - Network of over 145 weather stations
 - California divided into 18 climactic zones
 - Free access to data from 1989 to present



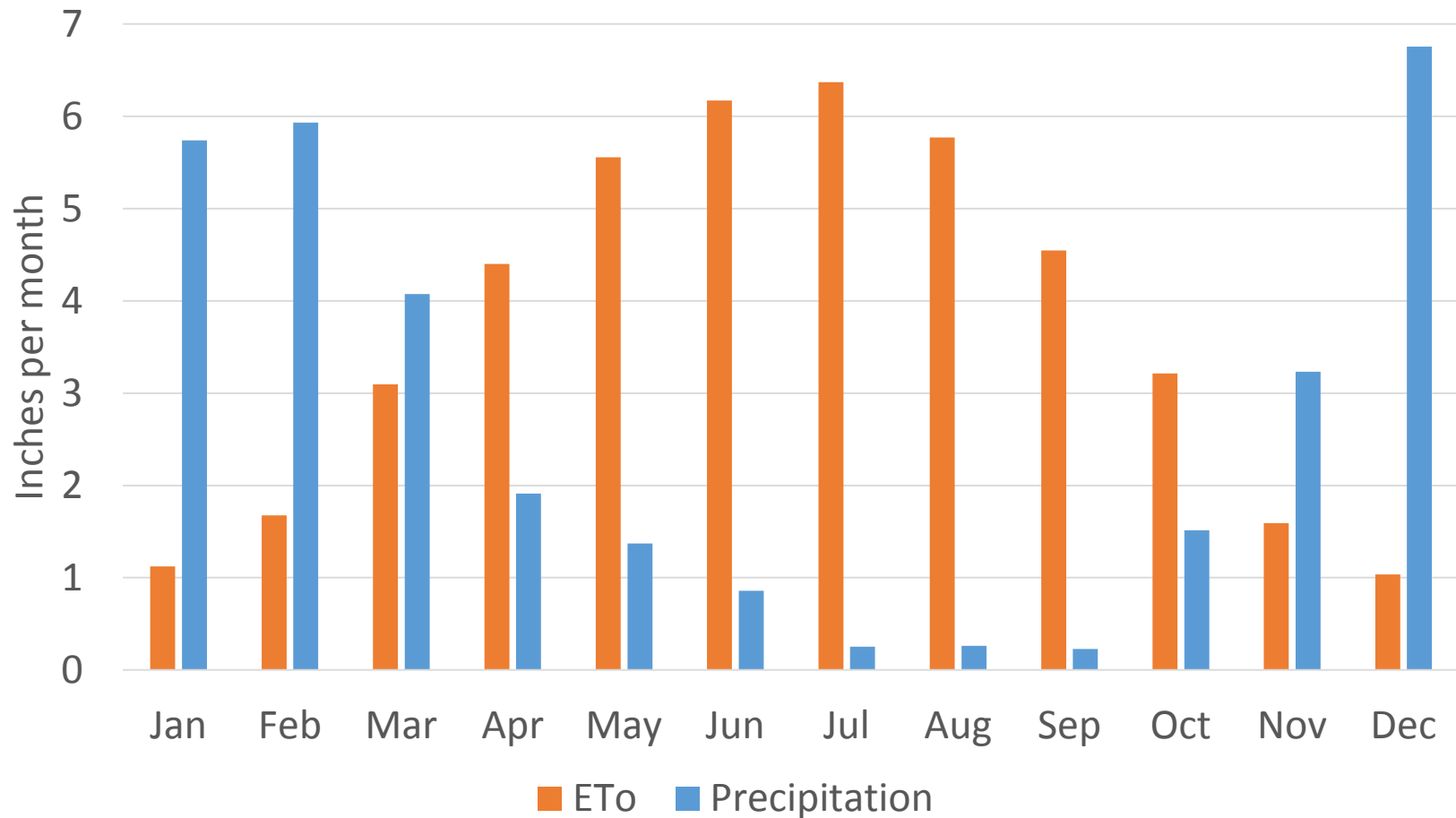
3.4 CALIFORNIA: CIMIS ZONES

1	COASTAL PLAINS HEAVY FOG BELT lowest ETo in California, characterized by dense fog	10	NORTH CENTRAL PLATEAU & CENTRAL COAST RANGE cool, high elevation areas with strong summer sunlight; zone has limited climate data & the zones selection is somewhat subjective
2	COASTAL MIXED FOG AREA less fog and higher ETo than zone 1	11	CENTRAL SIERRA NEVADA mountain valleys east of Sacramento with some influence from delta breeze in summer
3	COASTAL VALLEYS & PLAINS & NORTH COAST MOUNTAINS more sunlight than zone 2	12	EAST SIDE SACRAMENTO - SAN JOAQUIN VALLEY low winter & high summer ETo with slightly lower ETo than zone 14
4	SOUTH COAST INLAND PLAINS & MOUNTAINS NORTH OF SAN FRANCISCO more sunlight and higher summer ETo than zone 3	13	NORTHERN SIERRA NEVADA northern Sierra Nevada mountain valleys with less marine influence than zone 11
5	NORTHERN INLAND VALLEYS valleys north of San Francisco	14	MID-CENTRAL VALLEY, SOUTHERN SIERRA NEVADA, TEHACHAPI & HIGH DESERT MOUNTAINS high summer sunshine and wind in some locations
6	UPLAND CENTRAL COAST & LOS ANGELES BASIN higher elevation coastal areas	15	NORTHERN & SOUTHERN SAN JOAQUIN VALLEY slightly lower winter ETo due to fog and slightly higher summer ETo than zones 12 & 14
7	NORTHEASTERN PLAINS	16	WESTSIDE SAN JOAQUIN VALLEY & MOUNTAINS EAST & WEST OF IMPERIAL VALLEY
8	INLAND SAN FRANCISCO BAY AREA inland area near San Francisco with some marine influence	17	HIGH DESERT VALLEYS valleys in the high desert near Nevada and Arizona
9	SOUTH COAST MARINE TO DESERT TRANSITION inland area between marine & desert climates	18	IMPERIAL VALLEY, DEATH VALLEY & PALO VERDE low desert areas with high sunlight & considerable heat advection

3.4 CALIFORNIA: CIMIS ZONES



3.4 CALIFORNIA: SANTA ROSA ET₀ & PRECIPITATION



4. PLANT WATER USE CLASSIFICATIONS

- Understand plant water use classifications

4.1 PLANT FACTORS

- Different plant species require different amounts of water to remain healthy
- Expressed as a **percentage of ETo** and referred to as a **plant factor** (PF)
- PF is the **plant type** component of the water budget

Water Budget = **Weather** x **Plant Type** x Area

4.2 EPA WATERSENSE WATER BUDGET TOOL PLANT FACTORS

Plant Type	Low (%)	Medium (%)	High (%)
Trees	20	50	90
Shrubs	20	50	70
Groundcover	20	50	70
Turf grass	60	70	80

4.3 CALIFORNIA: WUCOLS

- Water Use Classification of Landscape Species
- 3,500 plants

Category	% of ETo	Examples
High (H)	70 - 90	Turf, annuals, willows and, redwoods
Moderate (M)	40 – 60	Many common ornamentals, fruit trees, roses, and perennials
Low (L)	10 – 30	Many California natives, Mediterranean, and low water use plants
Very low (VL)	< 10	Highly drought tolerant species

4.3 CALIFORNIA: WUCOLS

Region number	WUCOLS Region	Sunset climate zones	CIMIS zones	Representative Cities
1	North-Central Coastal	14, 15, 16, 17	1, 2, 3, 4, 6, 8	Healdsburg, Napa, San Jose, Salinas, San Francisco, San Luis Obispo
2	Central Valley	8, 9, 14	12, 14, 15, 16	Auburn, Bakersfield, Chico, Fresno, Modesto, Sacramento
3	South Coastal	22, 23, 24	1, 2, 4, 6	Irvine, Los Angeles, Santa Barbara, Ventura, Vista
4	South Inland	18, 19, 20, 21	9	Corona, Escondido, Pasadena, Riverside, San Bernardino, Santa Paula
5	High and Intermediate Desert	11	14, 17	Apple Valley, Barstow, Bishop, Lancaster, Lone Pine, Tehachapi
6	Low Desert	13	18	Borrego Springs, Blythe, Death Valley, El Centro, Needles, Palm Springs

4.4 OTHER SOURCES OF PLANT WATER NEEDS

- University research
- Local Master Gardeners
- Local plant nurseries
- City/Agency publications and websites
- Sunset Western Garden Book



4.5 IDENTIFYING CHARACTERISTICS

Ceanothus



Chalk Dudleya



Coast Live Oak



White Sage



- Water conserving features include:
 - Hard leathery leaves
 - Small leaves
 - Waxy or hairy leaves
 - Grey foliage
 - Fleshy stems and leaves

5. HYDROZONES & PLANT SELECTION

- Understand hydrozones and the selection of plants based on various uses and factors

5.1-5.2 HYDROZONES

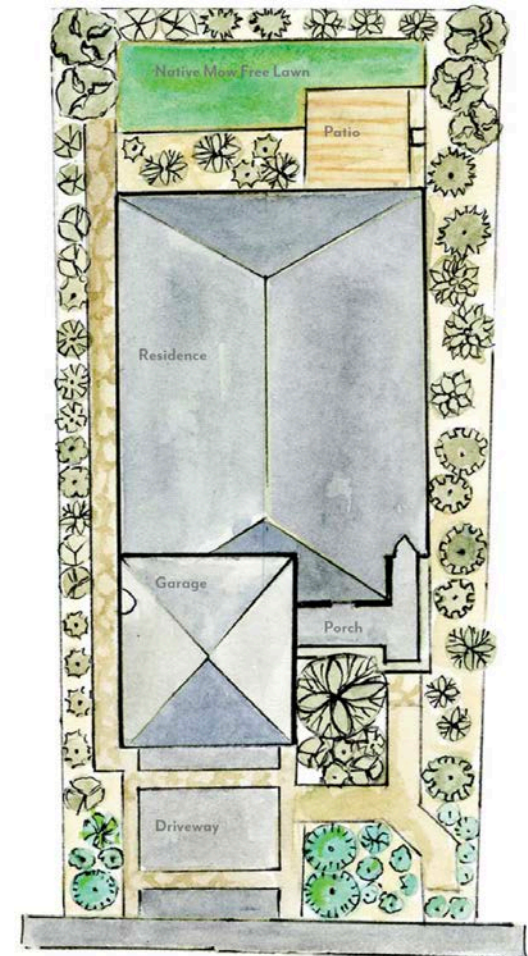
- A **hydrozone** is a group of plants with the same water use classification and microclimate assigned to a **single irrigation valve**
- The landscape area or hydrozone area is the area component used when calculating a water budget



Moderate Water Use



Low Water Use



Water Budget = **Weather** x **Plant Type** x Area

5.3 HYDROZONES

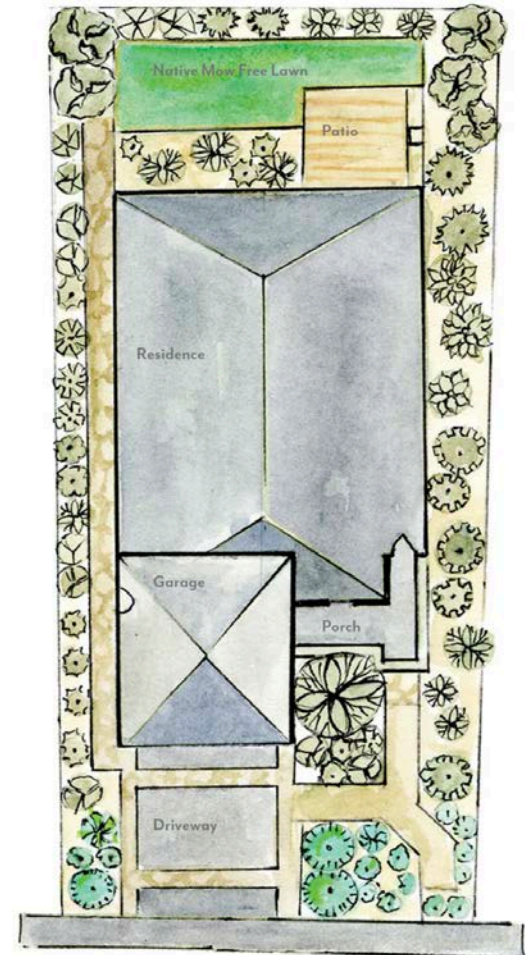
- Never mix **high** water use plants with **moderate** or **low** water use plants on the same hydrozone
- Where a landscape planting area must contain species with different water use classifications, the **highest plant water use** classification determines the plant factor for the entire hydrozone
- Results in water waste, and can lead to plant health issues



Moderate Water Use



Low Water Use



5.4-5.6 PLANT SELECTION



- Environmental site conditions
 - Sun, wind, temperature, precipitation, topography, soil, pH
- Mature plant size, growth rate, and management characteristics
- Plant function
 - Shade, wind block, screen, erosion control
- Regulations

6. WATER BUDGET CALCULATION

- Learn how to calculate a basic landscape water budget

6.1 WATER BUDGET FORMULA

Water Budget = **Weather** x **Plant Type** x Area

Water Budget = **ET_o** x **PF** x LA x 0.62

-
- ET_o = reference evapotranspiration (inches)
 - PF = plant factor
 - LA = landscape area (square feet)
 - 0.62 = conversion factor to convert from inches to gallons

6.2 WATER BUDGET EXAMPLES

1,000 sq. ft. landscape, plant factor of 0.8, peak monthly ETo of 6 inches

$$\begin{aligned}\text{Water Budget} &= \text{ETo} \times \text{PF} \times \text{LA} \times 0.62 \\ &= 6 \times 0.8 \times 1,000 \times 0.62 \\ &= 2,976 \text{ gallons}\end{aligned}$$

1,000 sq. ft. landscape, plant factor of 0.2, peak monthly ETo of 6 inches

$$\begin{aligned}\text{Water Budget} &= \text{ETo} \times \text{PF} \times \text{LA} \times 0.62 \\ &= 6 \times 0.7 \times 1,000 \times 0.62 \\ &= 744 \text{ gallons}\end{aligned}$$

6.3 CALIFORNIA: EXAMPLES

Water budget range for a 1,000 sq. ft. landscape in California

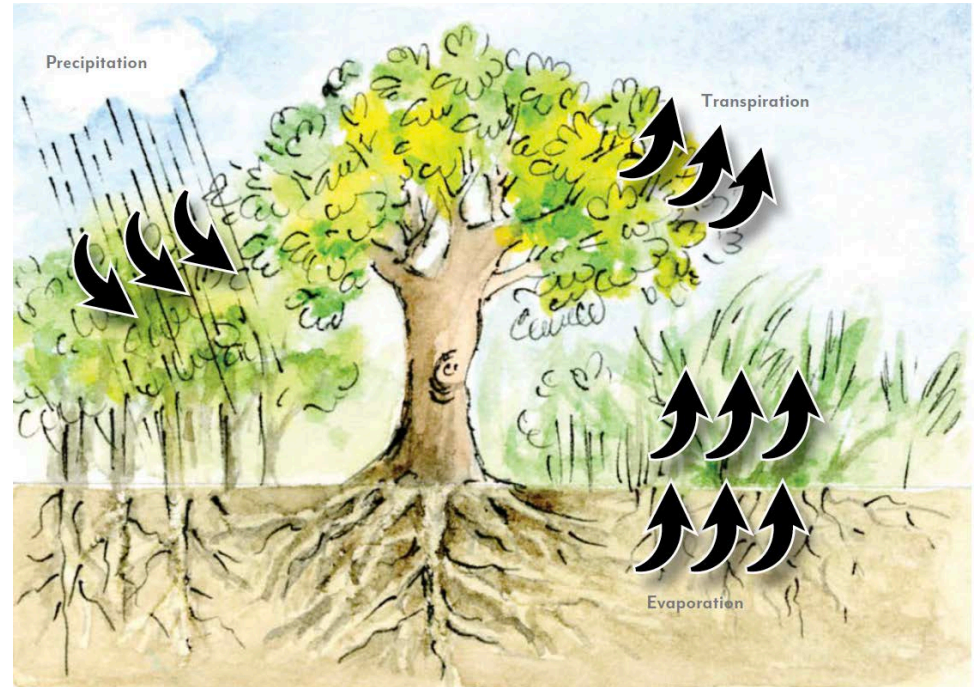
Category	PF	ETo (inches)	Water Budget (gallons)
High	0.8	32.9 – 71.6	16,318 – 35,514
Moderate	0.5		10,199 – 22,196
Low	0.2		4,080 – 8,878
Very low	0.05		1,020 – 2,220

7. IRRIGATION WATER

- Learn how to calculate how much irrigation water to apply

7.1 EFFECTIVE PRECIPITATION

- **Precipitation** reduces the need for supplemental irrigation
- **Effective precipitation (EP)** is the amount of precipitation that is actually added to, and stored in, the soil



7.2 IRRIGATION EFFICIENCY

- **Irrigation efficiency** reflects the amount of water that is beneficially used by plants compared to the amount of water that is applied by an irrigation system
- Typically less than 100% due to factors such as water management, runoff, evaporation, leakage, and wind spray
- It is necessary to apply more water than required by plants when using an irrigation system
- Irrigation efficiency is commonly estimated using **distribution uniformity** (DU)
- More detail in Section 7 Irrigation System Auditing

7.3 IRRIGATION WATER FORMULA

Irrigation Water = [(Weather x Plant Type) – Rain] x Area ÷ Efficiency

Irrigation Water = [(ETo x PF) – EP] x LA ÷ IE x 0.62

- ETo = reference evapotranspiration (inches)
- PF = plant factor
- EP = effective precipitation (inches)
- LA = landscape area (square feet)
- IE = irrigation efficiency
- 0.62 = conversion factor to convert from inches to gallons

7.4 IRRIGATION WATER REQUIREMENT EXAMPLES

1,000 sq. ft. landscape, plant factor of 0.8, peak monthly ETo of 6 inches, effective precipitation of 1 inches, irrigation efficiency of 0.7

$$\begin{aligned}\text{Irrigation Water} &= [(E_{To} \times PF) - EP] \times LA \div IE \times 0.62 \\ &= [(6 \times 0.8) - 1] \times 1,000 \div 0.7 \times 0.62 \\ &= 3,366 \text{ gallons}\end{aligned}$$

1,000 sq. ft. landscape, plant factor of 0.8, peak monthly ETo of 6 inches, effective precipitation of 1 inch, irrigation efficiency of 0.6

$$\begin{aligned}\text{Irrigation Water} &= [(E_{To} \times PF) - EP] \times LA \div IE \times 0.62 \\ &= [(6 \times 0.8) - 1] \times 1,000 \div 0.6 \times 0.62 \\ &= 3,927 \text{ gallons}\end{aligned}$$

8. WATER BUDGET ISSUES

- Understand key issues for developing a water budget for a landscape site

8.1-8.3 WATER BUDGET ISSUES

- Reference evapotranspiration must be known
- Determining the plant factor may not be straight forward in practice
- The irrigated landscape area must be known or measured
 - Visual estimation is not an effective method



9. WATER BUDGET EXAMPLES

- Examples of water budgets

9.1 EXAMPLES OF WATER BUDGETS

- Water budgets are used to provide a **water allowance** which is then compared to the **water requirement** for the landscape
- Irrigating a landscape to a water budget requires the water manager to take regular water meter readings to ensure that the amount of water applied does not exceed the budget

9.2-9.5 EXAMPLES OF WATER BUDGETS

- EPA WaterSense Water Budget Tool
- California: Model Water Efficient Landscape Ordinance (MWELO)
- Simplified Landscape Irrigation Demand Estimation (SLIDE)
- California: CLCA Water Management Certification Program

10. LANDSCAPE WATER REVIEW QUESTIONS

10. LANDSCAPE WATER REVIEW QUESTIONS

1. What is a landscape water budget and what are the three elements of a basic landscape water budget?
2. True or false: ET changes as the weather changes and is affected by factors including solar radiation, air temperature, relative humidity, and wind speed?
3. What does ETo stand for?
4. The plant factor is expressed as a percentage of ____.
5. Name a few identifying characteristics of low water use plants.
6. What is a hydrozone?

10. LANDSCAPE WATER REVIEW QUESTIONS

7. How do you calculate a basic landscape water budget using ETo, the plant factor (PF), and the landscape area (LA)?
8. What's the difference between the basic landscape water budget and the amount of irrigation water to apply?
9. California focus: What does CIMIS stand for?
10. California focus: What is the peak irrigation month for most climate zones in California?
11. California focus: What does WUCOLS stand for?