The One Thing

Drip Irrigation systems are popular for their low pressure requirements and slow precise application of water. Many drip systems do not have this capability due to poor scheduling. This is largely the case because their rates of application are not known

The Situation

Irrigation runoff with drip irrigation systems into the waterways of the state and within the drip zones shifting water away from the intended target. A significant loss of plant material due to poor scheduling. Much of this occurs because drip application rates are not known!

This area is under drip (point source) irrigation. How many minutes per week should it be watered in Sacramento in July

This area is under line source (brown tubing) irrigation. How long should this station water?

The Answer!

Who could know with such limited information?

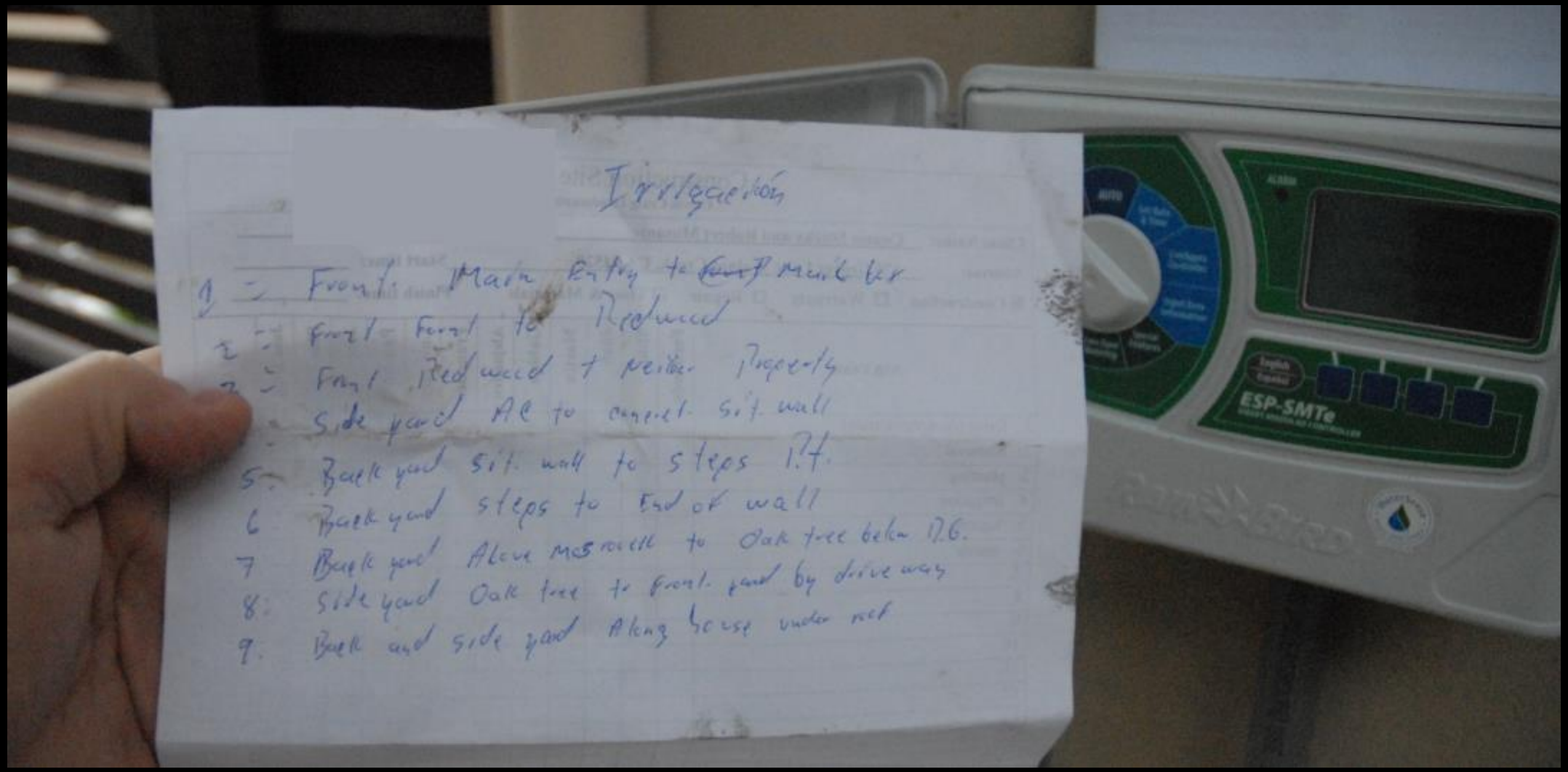
Irrigation runoff in a common area in north Chico, CA

This water in the gutter pan the morning after an irrigation event

The soil appears dry, but water is seeping out under the curb

Valve boxes are all flooded!

Look to the Irrigation Controller for site information – area irrigated, plant material, and application rate!



REMOVE TO EXPOSE ADHESIVE REMOVE TO EXPOSE ADHESIVE REMOVE TO EXPOSE ADHESIVE

REMOVE TO EXPOSE ADHESIVE REMOVE TO EXPOSE ADHESIVE REMOVE TO EXPOSE ADHESIVE

RAIN BIRD.

PROGRAMMING CHART
for ESP LX+ Controllers

Technical Assistance: 800-247-3782

Watering Days

Program Start Times

Water Budget

Station Delay

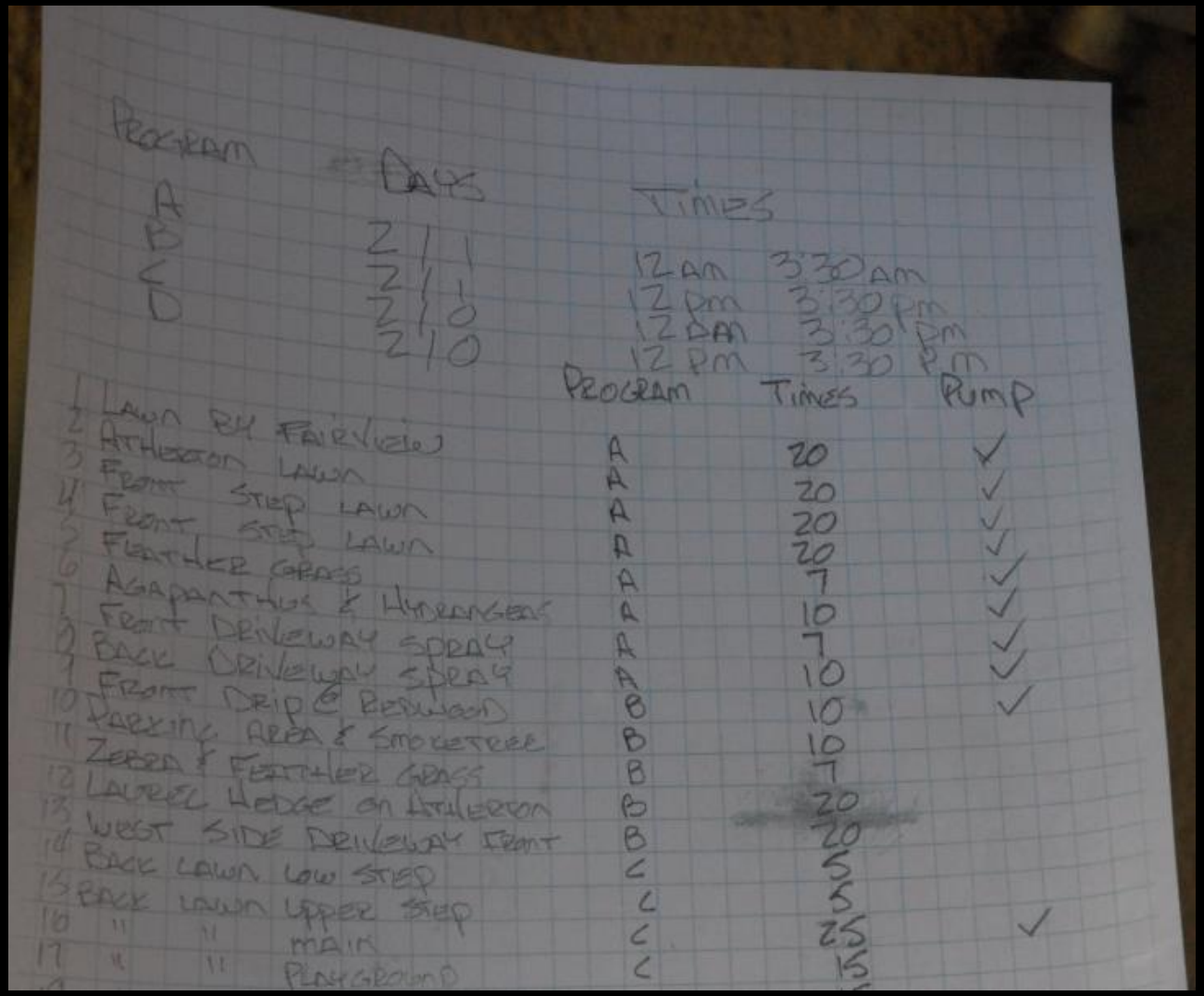
Program A	Program B	Program C	Program D
M T W T F S S ○ ___-Day cycle ○ even ○ odd	M T W T F S S ○ ___-Day cycle ○ even ○ odd	M T W T F S S ○ ___-Day cycle ○ even ○ odd	M T W T F S S ○ ___-Day cycle ○ even ○ odd
1 am/pm	1 am/pm	1 am/pm	1 am/pm
2 am/pm	2 am/pm	2 am/pm	2 am/pm
3 am/pm	3 am/pm	3 am/pm	3 am/pm
4 am/pm	4 am/pm	4 am/pm	4 am/pm
5 am/pm	5 am/pm	5 am/pm	5 am/pm
6 am/pm	6 am/pm	6 am/pm	6 am/pm

Station	Description	MV/Pump Relay	Run Time	Run Time	Run Time	Run Time
1	South East Rotors.	☐on	12			
2	South East - Rocks	☐on	15			
3	SE Rotor Nursery.	☐on	10			
X 4	? ?	☐on				
5	Front R.	☐on			4	
6	" R Street	☐on	side			
7	Front ~~Area~~ Side	☐on	Pavement			
8	Pop up Entrada	☐on	Lado izquierdo			
X 9	*	☐on				
X 10	*Rotors By Clock	☐on	1 Hr 0			
11	~~By Electric Rotors~~	☐on	15			
12	12 Rotors By clock	☐on	1 30			
13		☐on				
14		☐on	Rocks South side Builder			
15		☐on	Mail box and North side			
16	Rotors	☐on	45			
17		☐on				
18	North Side Builder	☐on	Rotors			
19		☐on				
20						

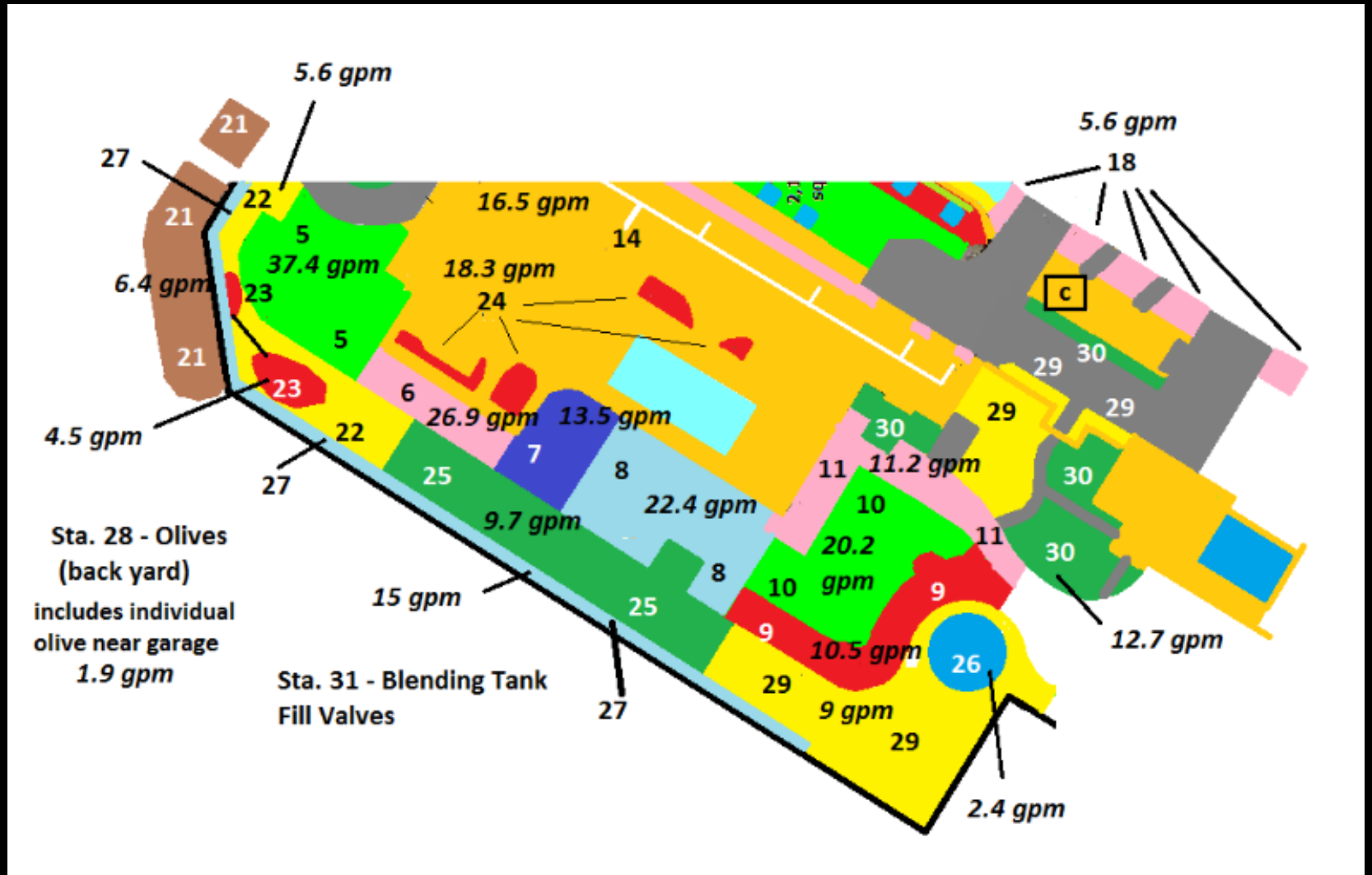
PROGRAMS		A							B							C						
WATER DAYS		M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
Interval or Odd/Even Days																						
Event Day(s) Off																						
START TIME(S)	1																					
Set the time(s) to start the program's watering cycle(s).	2																					
⚠ *Only one program start time is needed to run the cycle.*	3																					
	4																					

STATION	Location	Station Run Time	Station Run Time	Station Run Time
1	Lawn Strip at mesa and	street		
2	Plants R side	Front		
3	Plants L-R Lower area	Front		
4	Lawn back yard	Lower		
5	[illegible]	[illegible]		
6	[illegible]	Plants drip	Lawn back yard by shed	
7		Plants drip	L. and Lower area	
8	[illegible]	Plants drip	R. and circle	
9			Plants drip upper area	
10			by shed	
11				
12				
13				
14				
15				

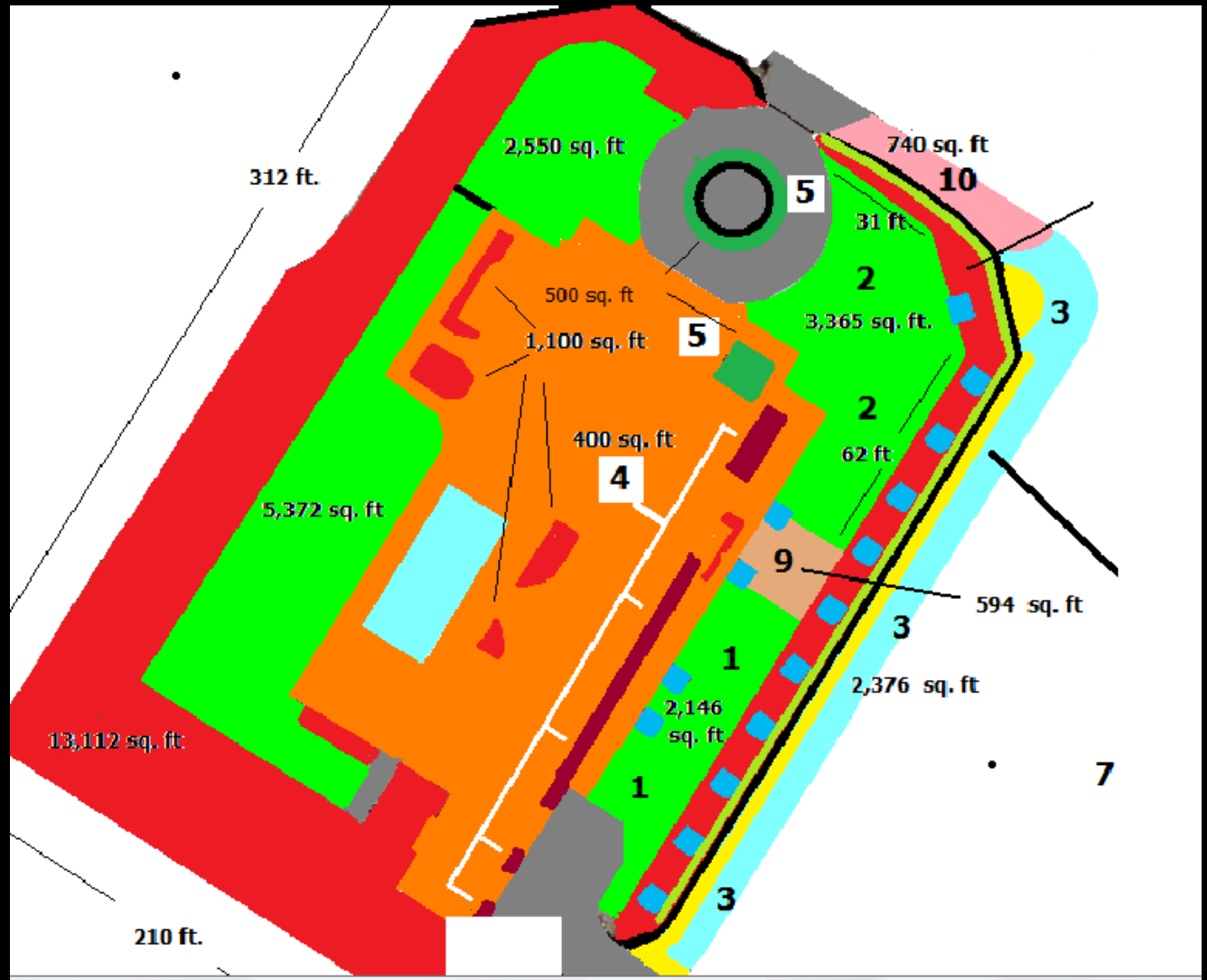
No information on sprinkler type or application rates, limited info on plant material



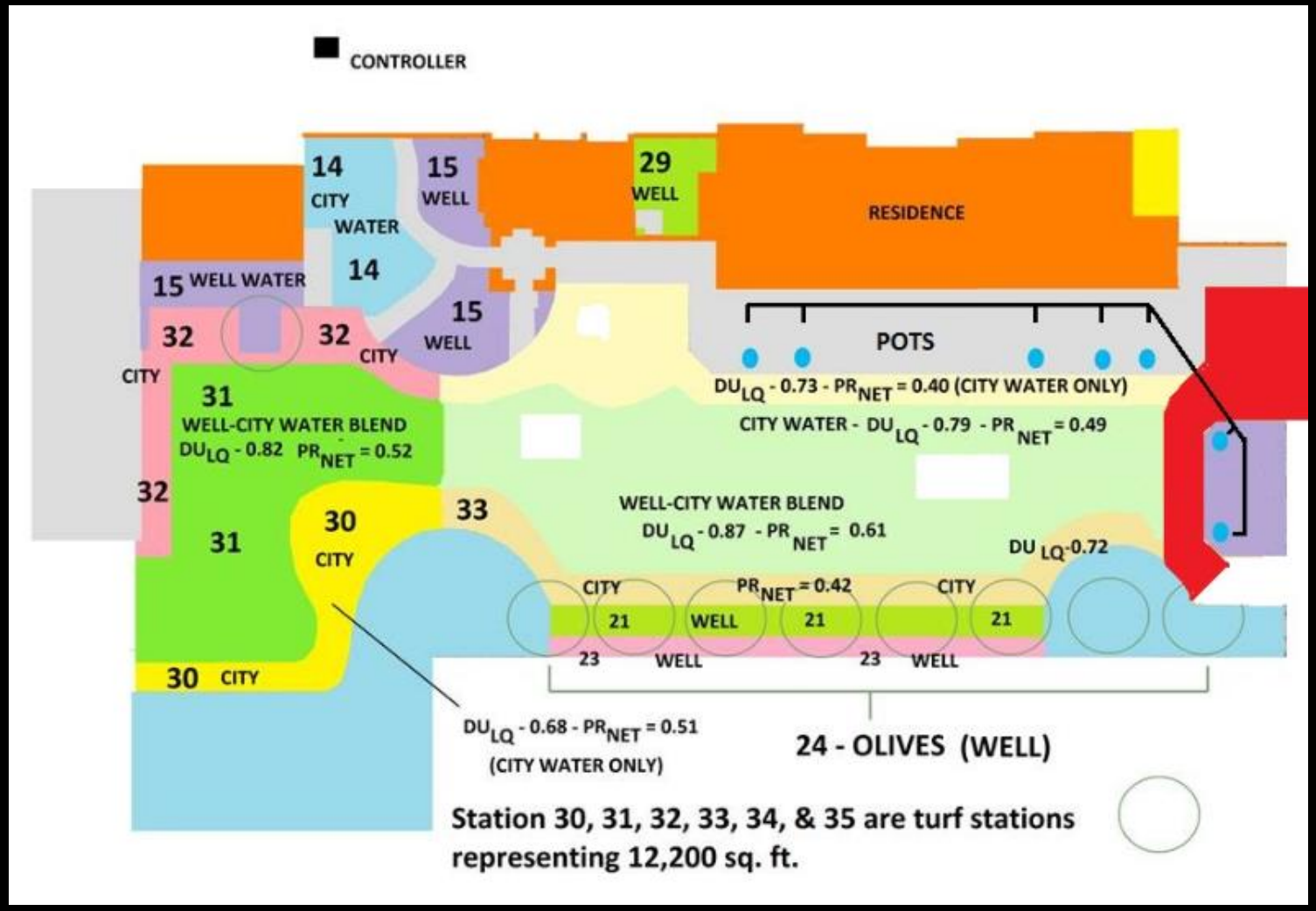
This residential landscape has flow information for all stations



The area in square feet of each valve circuit (hydrozone) is known so application rates can be calculated



The map makes scheduling easier. A separate sheet shows plant material by circuit. Note precipitation/application rates



Learning Objectives

- Demonstrate an understanding of the resources available to determine plant water requirement – CIMIS and WUCOLS
- Demonstrate an understanding of site data that must be collected to determine a drip system application rate. Process this information manually with the formula or the “APP” to develop an application rate.
- Develop an irrigation run time for a 3 day interval in July for low water use shrubs irrigated with a drip system

Learning Objectives

- Demonstrate an understanding of key design and installation criteria necessary to insure a viable drip system

Where we’re trying to go today!

Match the Plant Water Requirement to the Irrigation Application Rate and develop a run time in minutes (without runoff)

Run Time Formula – Point Source Irrigation

(a constant)

divided by!

$$RT = \frac{\text{Plant Water Requirement (in inches)}}{\text{Application rate of emitters (inches/hr.)}} \times 60$$

$$RT = \frac{0.50"}{0.25" / hr} \times 60 = 120 \text{ min (2 hrs)}$$

Run Time Formula – Line Source Drip Irrigation

(a constant)

divided by!

$$RT = \frac{\text{Plant Water Requirement (in inches)}}{\text{Application rate of emitters (inches/hr.)}} \times 60$$

$$RT = \frac{0.50"}{1.44" / hr} \times 60 = 21 \text{ min}$$

Determining Plant Water Requirements

CIMIS – (California Irrigation Management Information System)- Plant Water Requirement in Inches / Month
ET_O – evapotranspiration – transpiration and evaporation are indicators of plant water use and this is expressed in inches

California Irrigation Management Information System (CIMIS)

CIMIS Monthly Average ETo Report

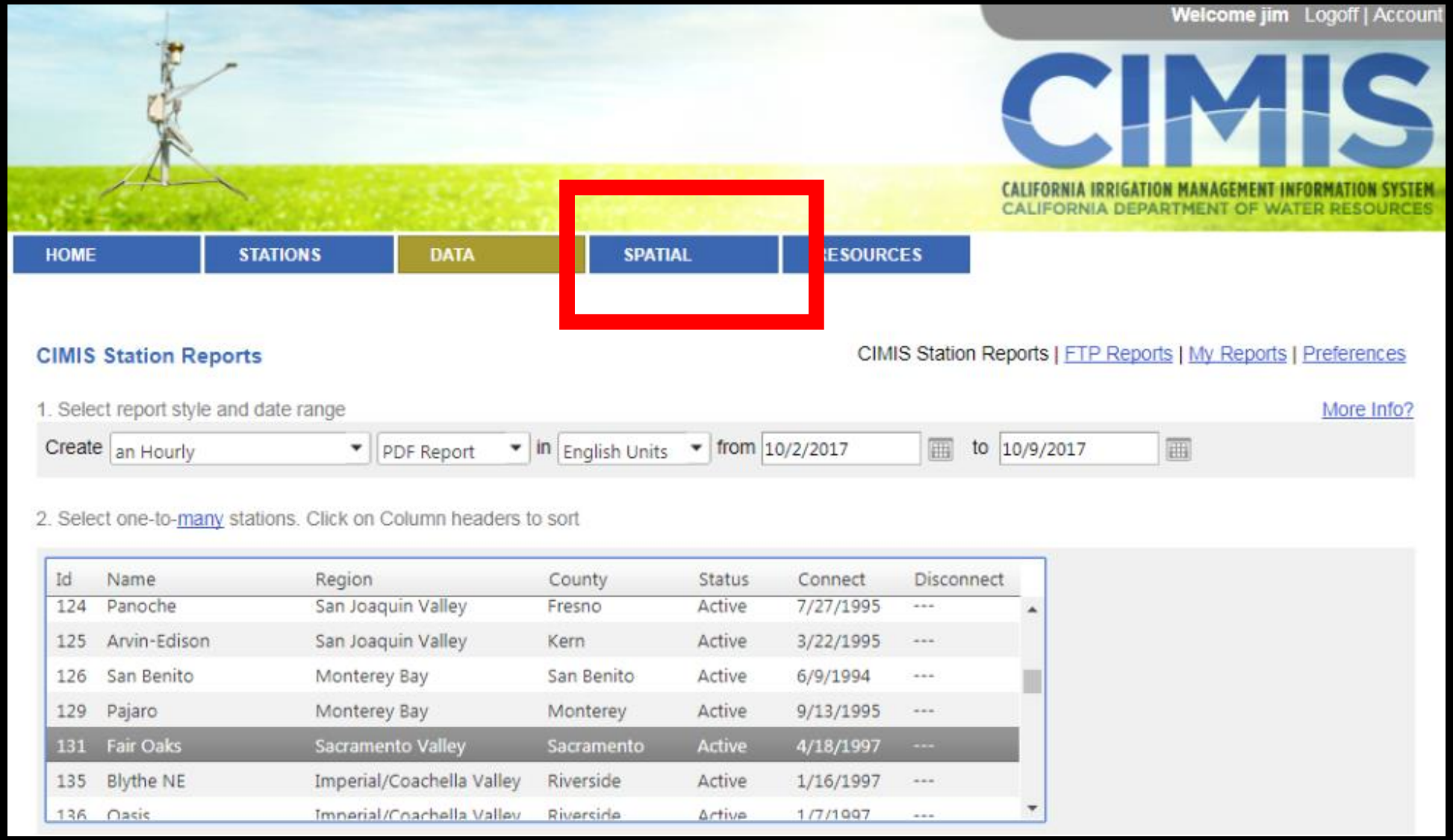
Rendered in ENGLISH Units.
Printed on Monday, October 09, 2017

Average ETo Values by Station

Stn Id	Stn Name	CIMIS Region	Jan (in)	Feb (in)	Mar (in)	Apr (in)	May (in)	Jun (in)	Jul (in)	Aug (in)	Sep (in)	Oct (in)	Nov (in)	Dec (in)	Total (in)
131	Fair Oaks	SAV	1.13	1.78	3.28	4.54	6.40	7.44	7.90	7.02	5.13	3.31	1.59	1.01	50.53

CIMIS Region Abbreviations

What if your landscape is outside the area served by a CIMIS weather station – SPATIAL CIMIS



So we know to a certainty how much water plants generally need in inches of water per month or per day from CIMIS - ET_O

How much water do specific ornamental shrubs trees and groundcovers need relative to the ET_O?

The Answer is WUCOLS! (water use classification of landscape species) a key resource for WELO

SHARE EMAIL PRINT SITE MAP Enter Searc

WUCOLS IV

Water Use Classification of Landscape Species

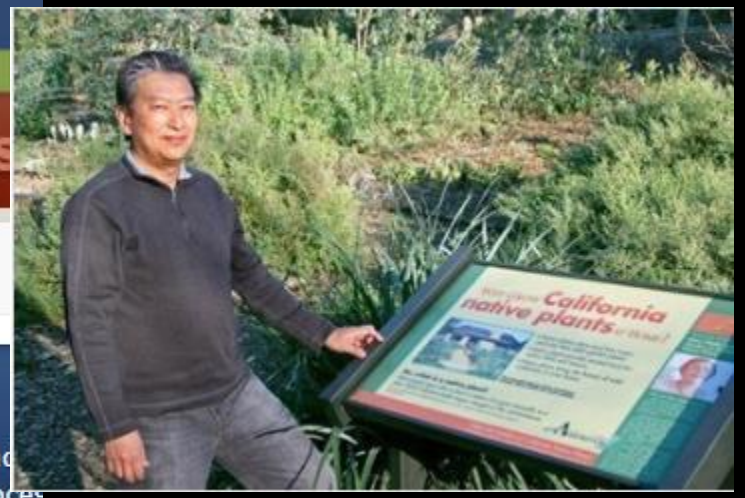
- **Home Page**
- User Manual
- Plant Search Instructions
- Plant Search Database
- Download WUCOLS IV Plant List
- Download WUCOLS IV User Manual
- Water Requirements for Turfgrasses
- Partners
- Acknowledgements

Home Page

GETTING STARTED

If you are using the WUCOLS list for the first time, it is essential that you read
The manual contains very important information regarding the evaluation proces
water needs, plant types, and climatic regions. It is necessary to know this infor
WUCOLS evaluations and the plant search tool appropriately. To access the *User*
the tab (on left) and view specific topics.

Water conservation is an essential consideration in the design and management of California landscapes. Effective strategies that increase water use efficiency must be identified and implemented. One key strategy to increase efficiency is matching water supply to plant needs. By supplying only the amount of water needed to maintain landscape health and appearance, unnecessary applications that exceed plant needs



WUCOLS categorizes over 3,700 landscape plants as to their plant water use.

Categories of Water Needs

Category	Abbreviation	Percentage of ET_o
High	H	70–90
Moderate/Medium	M	40–60
Low	L	10–30
Very Low	VL	< 10

Species were evaluated as needing high (H), moderate/medium (M), low (L), and very low (VL) amounts of irrigation water. Expressed as a percentage of reference evapotranspiration (ET_o)[1], these categories were quantitatively defined as follows.

A High water use plant in an 8.0 inch (ETO) month at 80% would require 6.4” of water. (8.0” x 0.80 = 6.4”)

A daily requirement is 0.21” (8.0/31)

WUCOLS categorizes over 3,700 landscape plants as to their plant water use.

Categories of Water Needs

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High	H	70–90
Moderate/Medium	M	40–60
Low	L	10–30
Very Low	VL	< 10

Species were evaluated as needing high (H), moderate/medium (M), low (L), and very low (VL) amounts of irrigation water. Expressed as a percentage of reference evapotranspiration (ET_o)[1], these categories were quantitatively defined as follows.

A Low water use plant in an 8.0 inch (ETO) month at 10% would require 0.80” of water.
(8.0” x 0.10 = 0.80”)

A daily requirement is 0.025” (0.80/31)

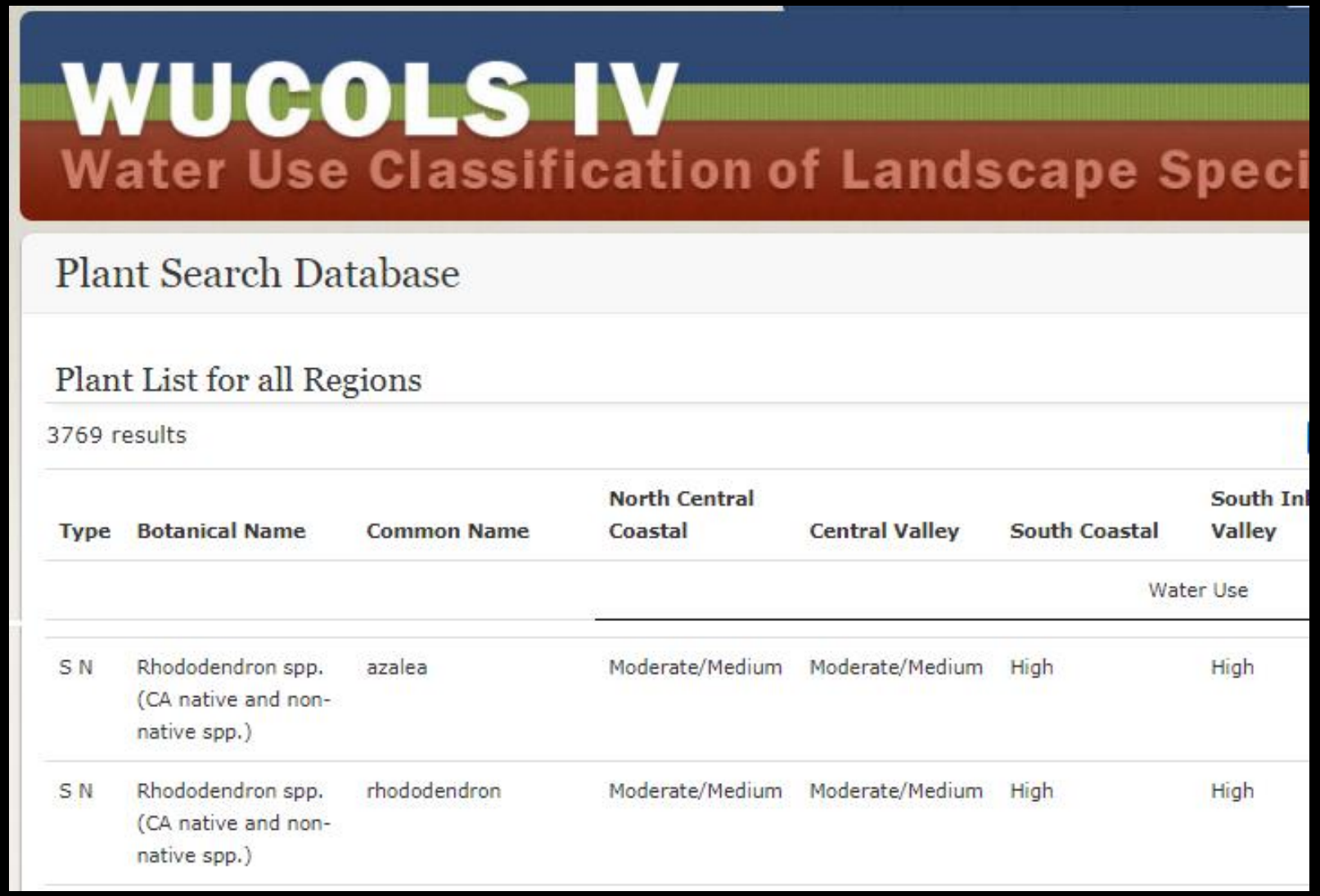
The state is broken down into six geographical regions that define use

Regions

Since substantially different climate zones exist in California, species were evaluated for regions that represent six different climatic conditions. These are not the only climate zones that exist in California, but they include much of the state where irrigated landscapes occur. For locations outside of the six regions, it is best to use species evaluations from a region that is most similar climatically to the location of interest.

Number	WUCOLS Region	Sunset climate zones*	CIMIS ET_0 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, Ventu 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

We can research plant material on-line or export a database



WUCOLS IV

Water Use Classification of Landscape Speci

Plant Search Database

Plant List for all Regions

3769 results

Type	Botanical Name	Common Name	North Central Coastal	Central Valley	South Coastal	South In Valley
						Water Use
S N	Rhododendron spp. (CA native and non-native spp.)	azalea	Moderate/Medium	Moderate/Medium	High	High
S N	Rhododendron spp. (CA native and non-native spp.)	rhododendron	Moderate/Medium	Moderate/Medium	High	High

Two Resources on-line – Links are in your handout

- CIMIS – local weather station or spatial CIMIS provides information based on ET_O as to how many inches of water plants generally need
- WUCOLS – indicates % of ET_O that should be replaced on a regional basis

How much water do sprinklers apply?

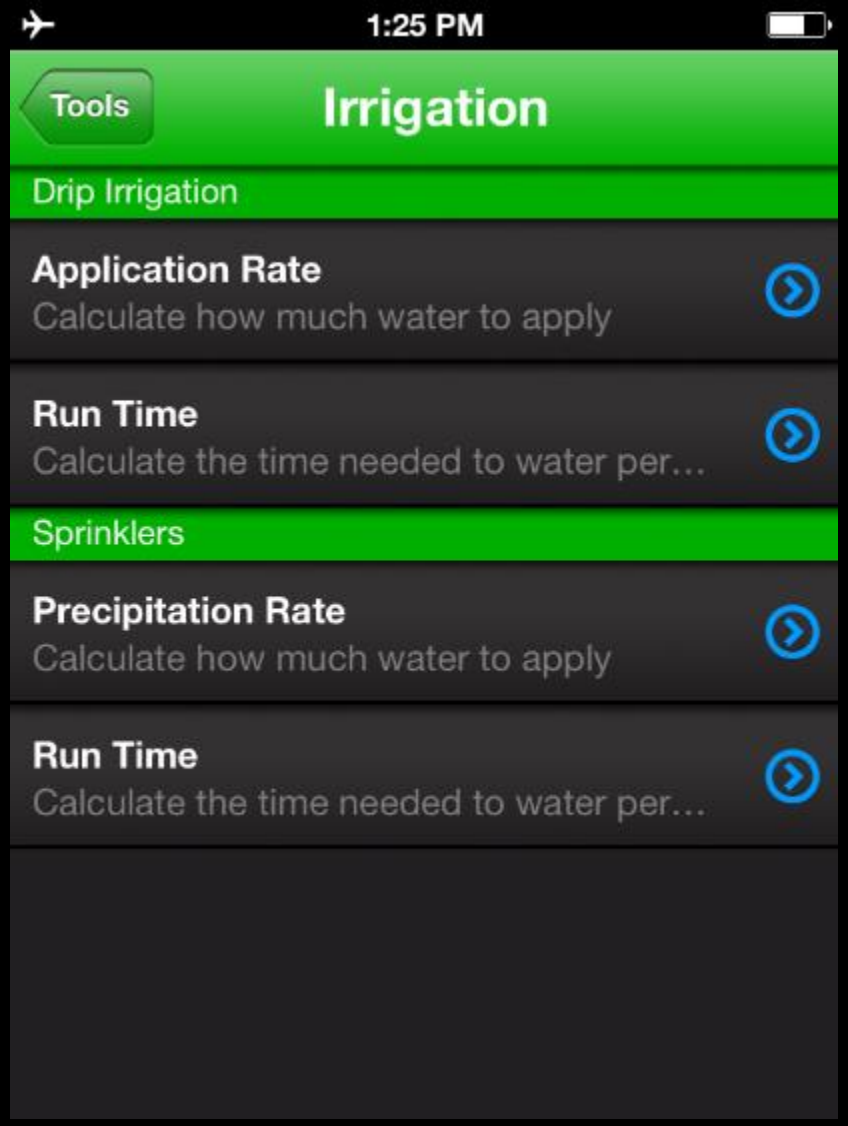
Why is this important?

An Award Wining Landscape in Northern CA (They did not wand drip so they used PC bubblers)

2 foot diameter shrub 3.14 sq ft of canopy

There were two of these on a 2 foot shrub – ½ gpm which is 30 gallons per hour

Use the Ewing “APP” to calculate application rate



Runoff because the clay soils with an intake rate of 0.10” per hour are overwhelmed with an application rate of 15 inches /hr.

Determining application rate of any drip irrigation zone (data to collect)

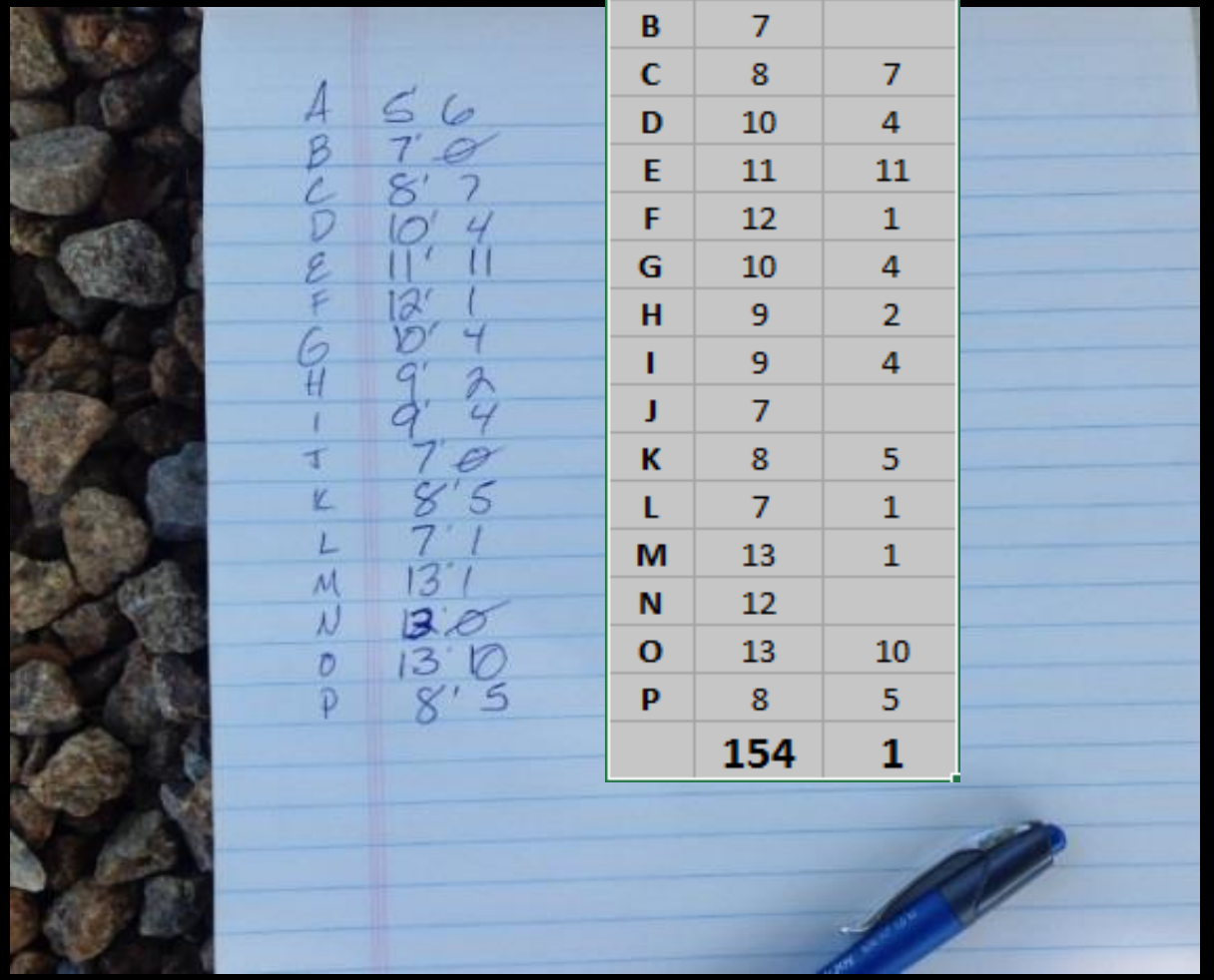
- Area that is served by the drip zone in square feet
- Circuit flow in cubic feet, or gallons per hour

Steps in calculating canopy area

- Activate the zone and operate until wet margins of the zone appear
- Measure the canopy area using the 16 point Ewing method

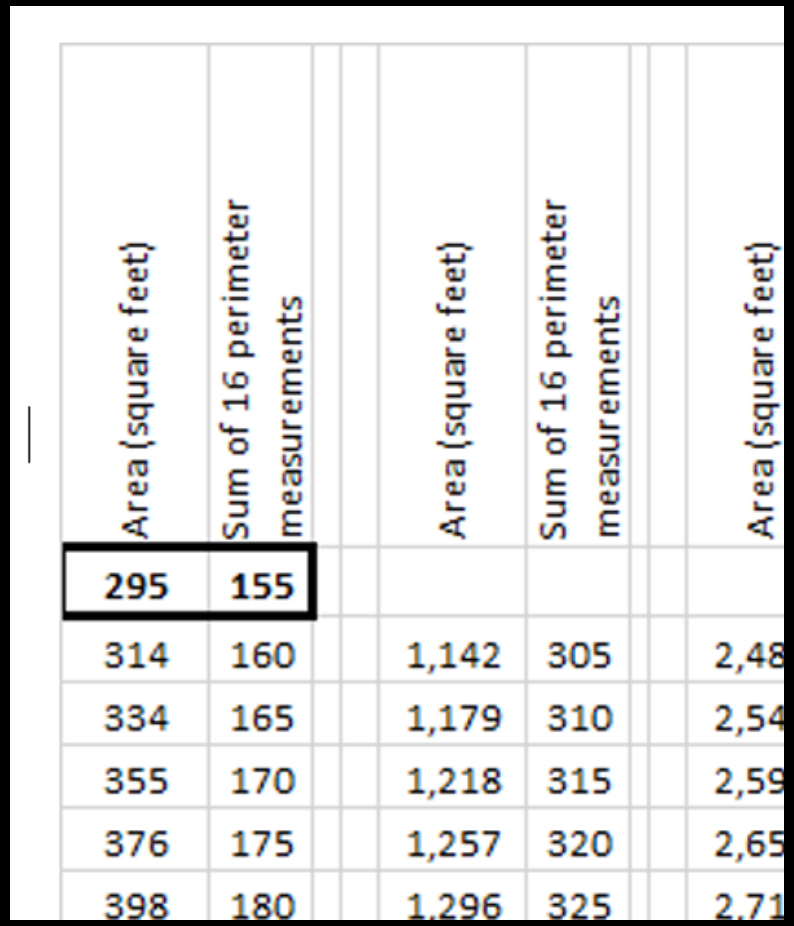
Sixteen Point Method – Determining the Average Perimeter (Radius) measure from the center to the canopy edge 16 times at 22.5 degree increments

Add the measurements together



	FEET	INCHES
A	5	6
B	7	
C	8	7
D	10	4
E	11	11
F	12	1
G	10	4
H	9	2
I	9	4
J	7	
K	8	5
L	7	1
M	13	1
N	12	
O	13	10
P	8	5
	154	**1**

Access the tables to determine area in square feet!



Area (square feet)	Sum of 16 perimeter measurements		Area (square feet)	Sum of 16 perimeter measurements		Area (square feet)
295	**155**					
314	160		1,142	305		2,48
334	165		1,179	310		2,54
355	170		1,218	315		2,59
376	175		1,257	320		2,65
398	180		1,296	325		2,71

Measure the flow to the zone in cubic feet in 1 minute

Commercial meters – 1 ½” and larger – each revolution 10 cubic feet or 74.8 gallons – each 1/10th Is 7.48 gal

Residential meters – 1” and smaller – each revolution 1 cubic foot or 7.48 gallons – each 1/10th Is 0.748 gal

Let’s calculate a drip zone application rate given the following area and flow

- Flow on the residential meter – 2/10ths of a revolution in 1 minute
- Area is 612 square feet

Just remember - 721

Application Rate Formula and Calculation

$$\text{Application Rate (inches/hr)} = \frac{\text{cubic feet / min} \times 721}{\text{area in square feet}}$$

$$\frac{0.2 \times 721}{612 \text{ sq. ft}}$$

$$\frac{144}{612} = 0.235 \text{ " / hr}$$

Check it out with the “APP”

- 0.2 cubic feet per minute must be converted to GPH (gallons per hour) (0.2 x 7.48 = 1.496 gpm) x 60 = 90 gph
- Area is 612 sq. ft


●●●●○ AT&T 3G
12:53 PM
Irrigation
Irrigation
Drip Irrigation -
Application Rate
Send
Gallons per Hour
90
Area in Square Feet:
612
Solution:
0.236 in. per hour
Calculate
Use solution to calculate run time

What about application rates for linear drip

- Since it is a grid, you'll need to know the flow and the spacing!

Dripline Selection Guidelines

	Clay	Loam	Sand
Nominal Emitter Flow Rate	0.4 gph	0.6 gph	1.0 gph
EZ-ID Color Code	Orange	Blue	White
Emitter Spacing	18"	12"	12"
Dripline Row Spacing	18"	18"	12"
Application Rate (Inches/Hour)	0.29	0.64	1.60
Time to Apply 1/4" of Water	53 mins.	23 mins.	10 mins.

TECHLINE CV	TURF												SHRUB & GROUNDCOVER											
	CLAY SOIL			LOAM SOIL			SANDY SOIL			COARSE SOIL			CLAY SOIL			LOAM SOIL			SANDY SOIL			COARSE SOIL		
EMITTER FLOW	0.26 GPH			0.4 GPH			0.6 GPH			0.9 GPH			0.26 GPH			0.4 GPH			0.6 GPH			0.9 GPH		
EMITTER SPACING	18"			12"			12"			12"			18"			18"			12"			12"		
LATERAL (ROW) SPACING	18"	20"	22"	12"	14"	18"	12"	14"	18"	12"	14"	16"	18"	21"	24"	18"	21"	24"	16"	18"	20"	16"	18"	20"
BURIAL DEPTH	Bury evenly throughout the zone from 4"to 6"												On-surface or bury evenly throughout the zone to a maximum of 6"											
APPLICATION RATE (INCHES/HOUR)	0.19	0.17	0.15	0.64	0.55	0.43	0.98	0.84	0.65	1.48	1.27	1.11	0.19	0.16	0.14	0.30	0.26	0.23	0.73	0.65	0.59	1.11	0.99	0.89
TIME TO APPLY ¼" OF WATER (MINUTES)	80	89	97	23	27	35	15	18	23	10	12	13	80	93	106	50	58	66	20	23	26	13	15	17
Following these maximum spacing guidelines, emitter flow selection can be increased if desired by the designer. 0.9 GPH flow rate available for areas requiring higher infiltration rates, such as coarse sandy soils.																								

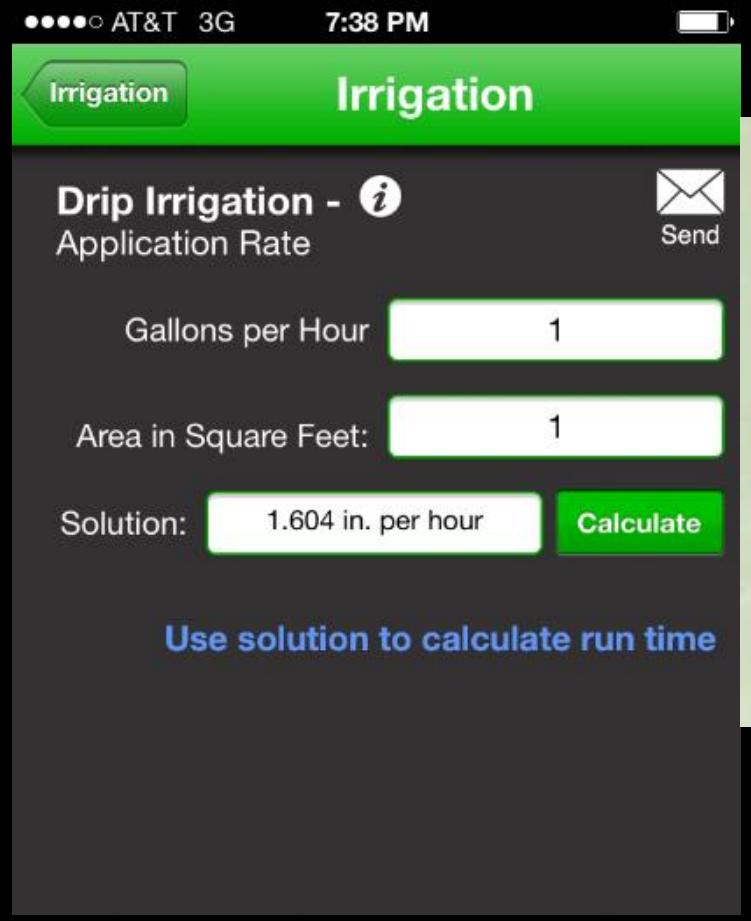
Note: 0.4, 0.6 and 0.9 GPH are nominal flow rates. Actual flow rates used in the calculations are 0.42, 0.61 and 0.92 GPH.

You can measure the emitter spacing at 12 or 24” in the tube and measure the parallel row spacing

But what is the emitter flow in GPH?

EMITTER FLOW (TIME TO FILL 2" CAP)		
EMITTER TYPE	GPH	FILL TIME
POINT SOURCE	2.00	56 SECONDS
POINT SOURCE	1.00	1 MIN 52 SECONDS
LINE SOURCE	0.92	2 MIN 2 SECONDS
LINE SOURCE	0.61	3 MIN 4 SECONDS
POINT SOURCE	0.50	3 MIN 45 SECONDS
LINE SOURCE	0.42	4 MIN 26 SECONDS

So let's calculate with the "APP" a 12" x 12" spacing with a 1.0 gph emitter!



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Emitter Spacing	18"	12"	12"
Dripline Row Spacing	18"	18"	12"
Application Rate (Inches/Hour)	0.29	0.64	1.60
Time to Apply 1/4" of Water	53 mins.	23 mins.	10 mins.

So calculating “APP” rates for linear drip can be easier as tables are available

Let’ complete our final objective

The criteria for scheduling

- Given – a calculated application rate of 0.25” per hour
- A low water use hydrozone in Sacramento in July
- Watering every 4 days

Ornamental Shrubs with a species factor

DU_{LQ}	0.9	
PR Rate	0.25	inches / hr.
RTM	1.06	

		Fair Oaks ET_O Avg Monthly	Fair Oaks ET_O Avg. daily	Fair Oaks Orn. Shrub Req't daily
31	Mar	3.28	0.1058	0.0529
30	Apr	4.51	0.1503	0.0752
31	May	6.46	0.2084	0.1042
30	Jun	7.44	[illegible]	0.1240
31	Jul	7.91	0.2552	0.1276
31	Aug	7.02	[illegible]	0.1132
30	Sep	5.13	0.1710	0.0855
31	Oct	3.33	0.1074	0.0537

Categories of Water Needs

Category	Abbreviation	Percentage of ET_o
High	H	70–90
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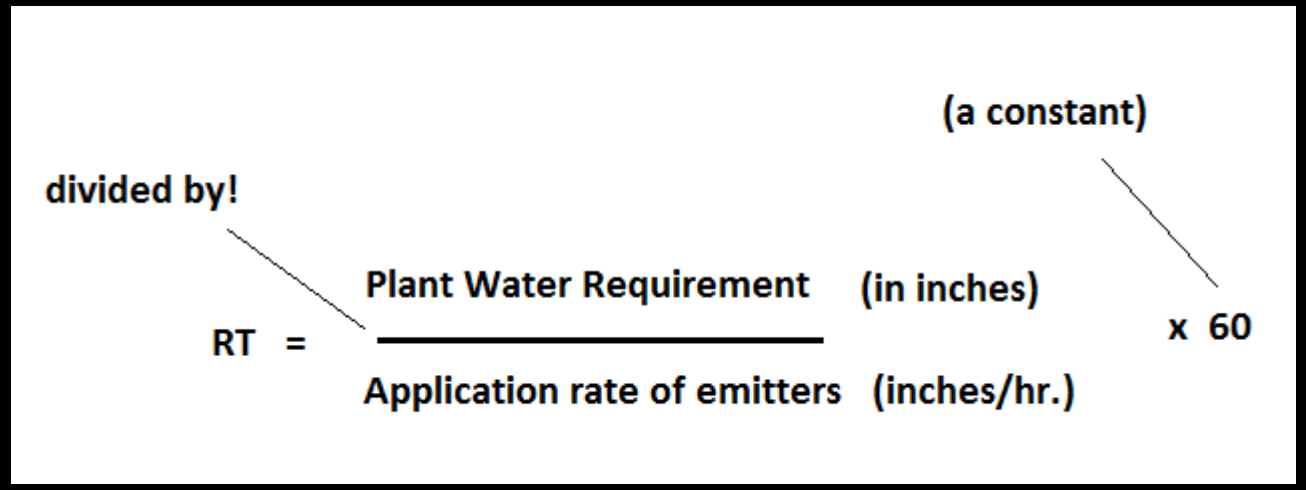
Very Low	VL	< 10

Species were evaluated as needing high (H), moderate/medium (M), low (L), and very low (VL) amounts of irrigation water. Expressed as a percentage of reference evapotranspiration (ET_o)[1], these categories were quantitatively defined as follows.

4 days x 0.2552 = 1.028 ET_O

1.028 ET_O x 0.25 = 0.255” plant water requirement after 4 days

Run Time Calculation – Point Source



$$RT = \frac{0.255"}{0.25" / hr} \times 60 = 61 \text{ min.}$$

What about runoff????

Application Rate - in/hr	Time to runoff in minutes (flat clay)	Application Rate - in/hr	Time to runoff in minutes (flat clay)	Application Rate - in/hr	Time to runoff in minutes (flat clay)	Application Rate - in/hr	Time to runoff in minutes (flat clay)
0.10	60	0.60	10	1.05	6	1.50	4
0.15	40	0.65	9	1.10	5	1.55	4
0.20	30	0.70	9	1.15	5	1.60	4
0.25	24	0.75	8	1.20	5	1.65	4
0.30	20	0.80	8	1.25	5	1.70	4
0.35	17	0.85	7	1.30	5	1.75	3
0.40	15	0.90	7	1.35	4	1.80	3
0.45	13	0.95	6	1.40	4	1.85	3
0.50	12	1.00	6	1.45	4	1.90	3

Minutes of run time before run off occurs at varying application rates on flat clay

All bets are off if installation is poor or pressure is low

- 10 psi minimum for point source systems
- 15 psi for line source or emitters will not open
- Arrange point source emitters so all plant material on the hydrozone has the same application rate (see attached sheet)
- Do not use 0.9 gph or 1 gph linear tubing
- Keep line source tubing parallel

The Pressure Test

Learning Objectives

- Demonstrate an understanding of the resources available to determine plant water requirement – CIMIS and WUCOLS
- Demonstrate an understanding of site data that must be collected to determine a drip system application rate. Process this information manually with the formula or the “APP” to develop an application rate.
- Develop an irrigation run time for a 3 day interval in July for low water use shrubs irrigated with a drip system

Learning Objectives

- Demonstrate an understanding of key design and installation criteria necessary to insure a viable drip system

Certificate of Attendance

Andrew Alday

For attending the workshop

Get a Grip on Drip:

Drip Irrigation Workshop for Landscape Managers
4 hours – October 10th, 2017

Jim Borneman, Vice President Emeritus
Ewing Irrigation Products

William Granger
Water Conservation Administrator
City of Sacramento

UC DAVIS
University of California
Agriculture and Natural Resources

RCJA

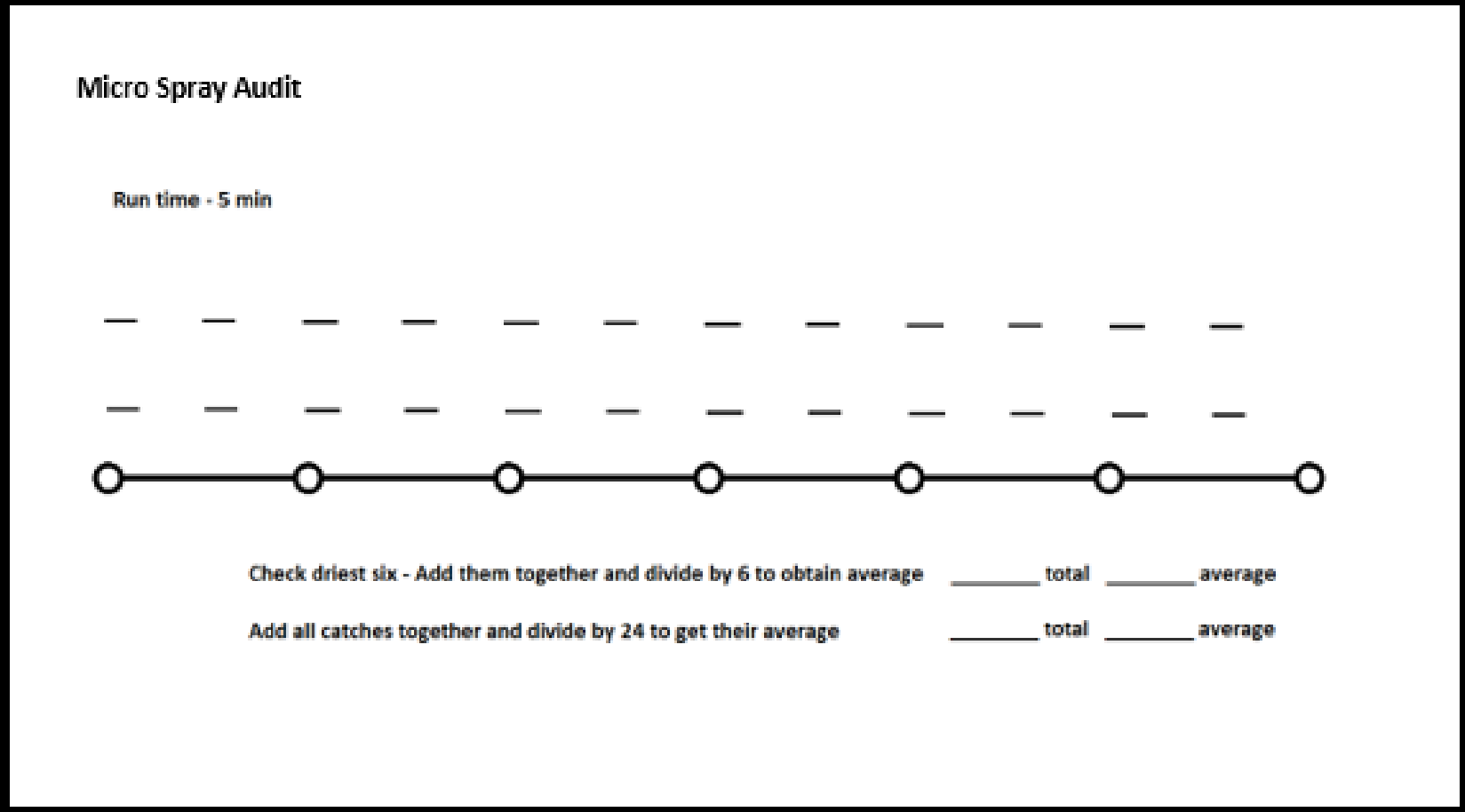
City of SACRAMENTO
Department of Utilities

EWING

CCUH
CALIFORNIA CENTER FOR URBAN HORTICULTURE

This certificate may be used for obtaining Continuing Education Units (CEUs) for National Association of Landscape Professionals (NALP) or Irrigation Association (IA) certifications

Exercises – “A” Group – Micro Spray Audit



Exercises – B Group – Area Measurement and Application Calculation

Determining Application Rates with cap

	A	B	C	D	E
Time to fill	___	___	___	___	___
Flow	___	___	___	___	___
Canopy Diameter	2 ft	5 ft	12" x 12" sp	12" x 24" sp	10 ft
Area					
Application Rate					

Estimating Irregularly shaped Areas

Measurement

A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
K	
L	
M	
N	
O	
P	
TOTAL	
AVG/16	
SQ. FT	
METER	
FLOW	
CFM	
PR Rate	

EMITTER FLOW (TIME TO FILL 2" CAP)		
EMITTER TYPE	GPH	FILL TIME
POINT SOURCE	2.00	56 SECONDS
POINT SOURCE	1.00	1 MIN 52 SECONDS
LINE SOURCE	0.92	2 MIN 2 SECONDS
LINE SOURCE	0.61	3 MIN 4 SECONDS
POINT SOURCE	0.50	3 MIN 45 SECONDS
LINE SOURCE	0.42	4 MIN 26 SECONDS