Assessing Irrigation System Performance

Is yours wasting water?

Loren Oki
Dept. of Plant Sciences and
Dept. Human Ecology
UC Davis

Strategies for Water-Efficient Landscapes
San Diego
May 13 & 14, 2015

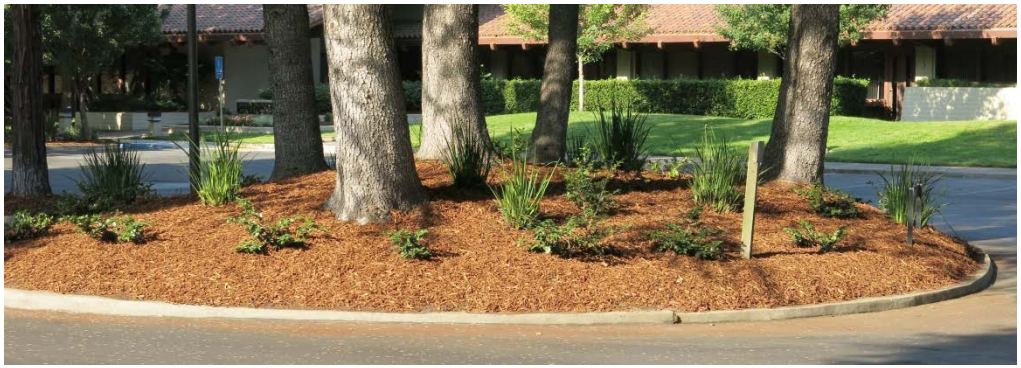
University of California
Agriculture and Natural Resources
UC Cooperative Extension
UCDAVIS
UNIVERSITY OF CALIFORNIA

Learning Objectives

- Measuring system performance
  - Conducting a system assessment
  - Checking for proper operation
  - Determine application uniformity
- Improving performance

Key elements for landscape water conservation

- Plant selection and design
- Mulching
- Composting
- Fertilization
- Irrigation
  - System Audit
  - Scheduling
  - Management



Conducting An Irrigation Audit

- Adapted from sprinkler systems
- Applicable to all types, including drip

Conducting An Irrigation Audit

- Math is necessary
  - because we have to measure

“To measure is to know.” *Lord Kelvin*

“If you can't measure it, you can't improve it.” *Lord Kelvin*

“If it can't be expressed in figures, it is not science; it is opinion.”
Robert Heinlein

Conducting An Irrigation Audit

- Inspect the site
- Tune up the irrigation system
- Test the system
- Calculate performance
- Interpret the information

Credit: Irrigation Association
Landscape Irrigation Auditor
certification program

Inspect the Site

- Locate the water meter
  - Learn and understand how to read it
- Locate and identify the controller type
  - Several manufacturers
  - MANY different models
  - Some are OLD
  - Learn to program it

Controller Types

- Time
  - Based on calendar/clock

Controller Types

- Time
- Weather (ET)
  - Uses weather information to estimate landscape water use
  - Adjusts irrigation program to replace water used by landscape

Controller Types

- Time
- Weather (ET)
- Soil moisture
  - Sensors measure water content of the soil
  - Initiates or allows irrigation when soil is dry
  - Stops irrigation when sufficient water is applied

Inspect the Site

- Locate the valves
- Measure system pressure
  - "Static" pressure
  - Close to source
  - Time of day matters

Inspect the Site

- Landscape features and design
  - Plant materials within each zone
  - Microclimates
  - Hardscape features

Inspect the Site

- Compacted soil
  - Reduces infiltration and percolation
- Soil Texture
  - Clay, Loam, and Sand
  - SoilWeb app*

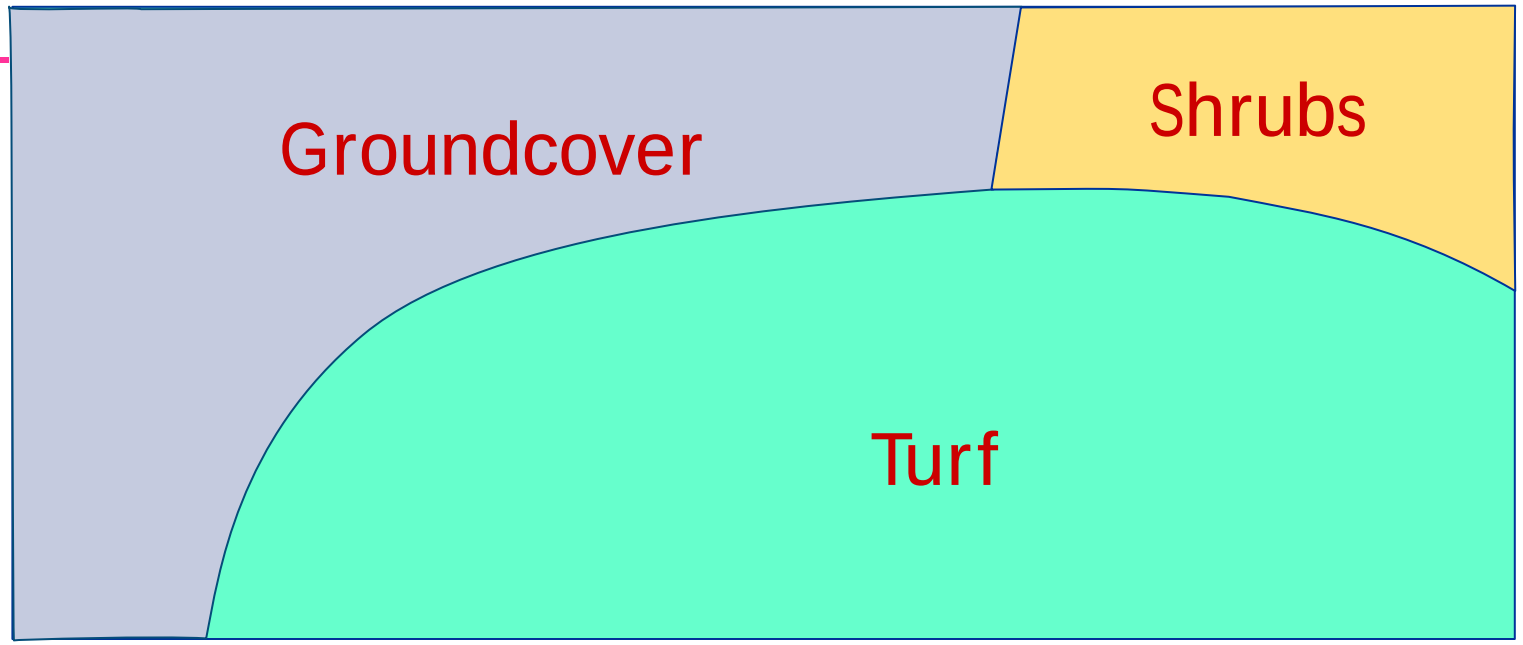
http://casoilresource.lawr.ucdavis.edu/gmap/

Inspect the Site

- Slopes
  - Runoff potential

Inspect the Site

- Irrigation Zones
  - How many?
  - Zone locations
  -



Sprinklers and Emitters

- Locations
  - Mark with flags
- Types
  - Sprays, rotors, rotary stream, impact
  - Drip tube, buttons (and flow rate), bubblers, micro sprays

Sprinkler Types

- Impact
- Sprays
- Rotary stream
- Gear drive rotor

Flow Rates

- Know the flow rates for each sprinkler
- Obtain this from the manufacturer
- You'll need to know dynamic pressure!

Flow Rates

- Calculate the total flow for each valve
- Multiply the flow per sprinkler times the number of sprinklers

Flow Rates

- Compare the calculated total to the actual flow
- This can reveal leaks, plugs, or other issues.

Maintenance

- Maintenance
  - Proper and timely

Maintenance

- Maintenance
  - Proper and timely

“Urban Drool”

Photos: D. Haver

Tune-up the System

- Sprinkler/emitter condition
  - Spacing
  - Measure the distance between sprinklers
  - Verify head-to-head coverage

Tune-up the System

- Sprinkler/emitter condition
  - Are sprinklers plumb?
  - Use bubble level
  - Check for tilt

Tune-up the System

- Sprinkler/emitter condition
  - Determine the dynamic pressure

Tune-up the System

- Sprinkler/emitter condition
  - Determine the dynamic pressure

Test the System

- Catch can test
  - Measures how fast water is applied
  - How evenly it is applied
- What is needed
  - Catch cans
  - Graduated cylinder

Test the System

- Set catch cans
  - At and in between sprinklers
  - At emitters
  - Regular and even spacing

Test the System

- Set catch cans
  - At and in between sprinklers
  - At emitters
  - Regular and even spacing
- Minimum number of catch cans=24
  - Multiples of 4
- Wind less than 5 mph

Test the System

- Turn on the valve
  - Duration 10-20 minutes
  - Optimal volume (in mL) is 1½ times the area of the opening (in sq.in.)
  - If there are several valves for an area, use the same duration for each
  - Observe runoff and when it occurs

Test the System

- Check for proper operation
- Deflections

Test the System

- Check for proper arc (pattern)
- and radius (distance)

Test the System

- Measure the water in each container

Using the Catch Can Data

- Distribution Uniformity (DU)
  - How evenly a sprinkler system applies water
  - Typical response to a dry spot:

    INCREASE RUN TIME

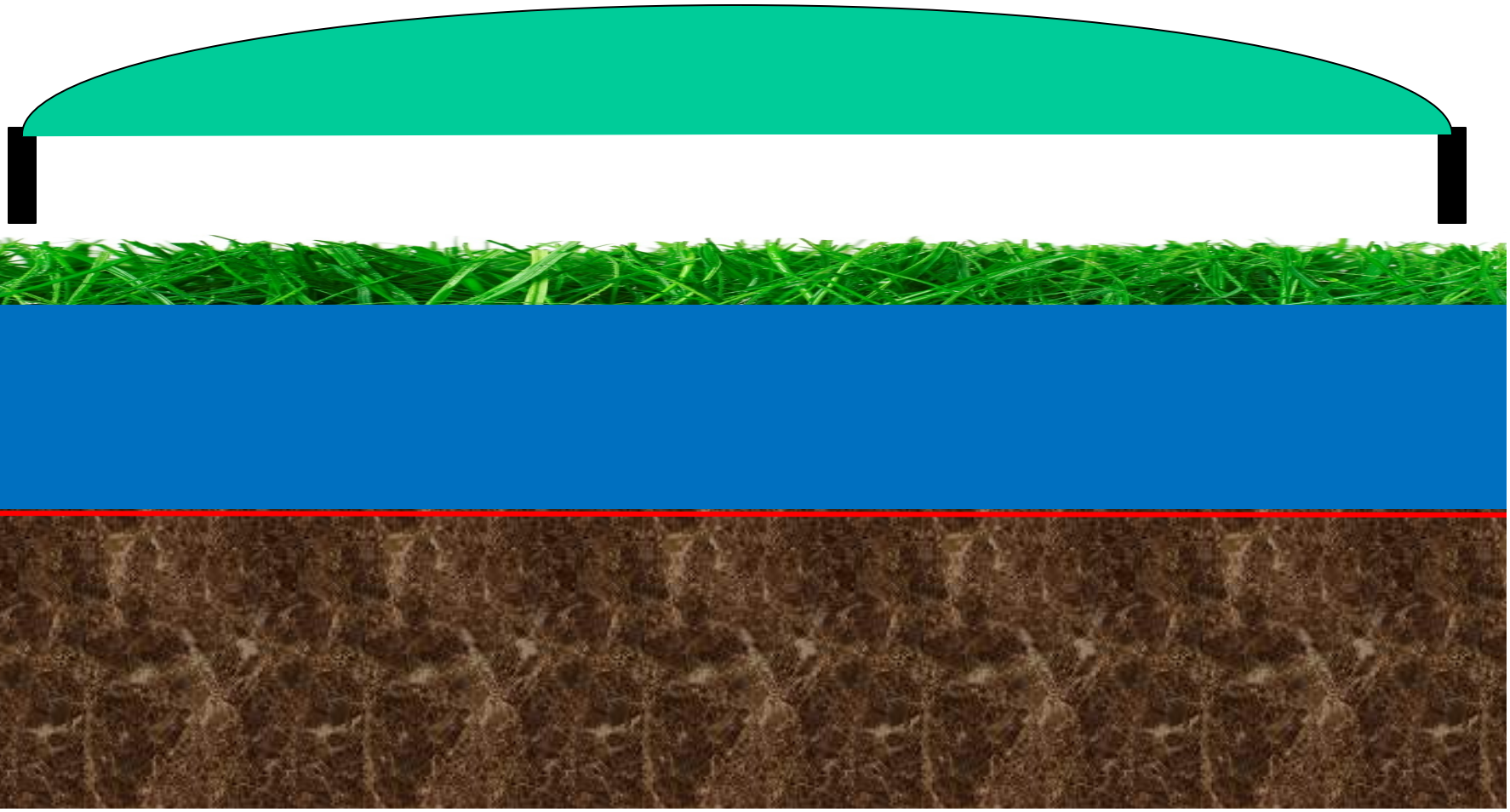
Using the Catch Can Data

- Distribution Uniformity (DU)
  - How evenly a sprinkler system applies water
  - Effect on run time

DU%	min/wk	
58	131	
80	95	=22% reduction

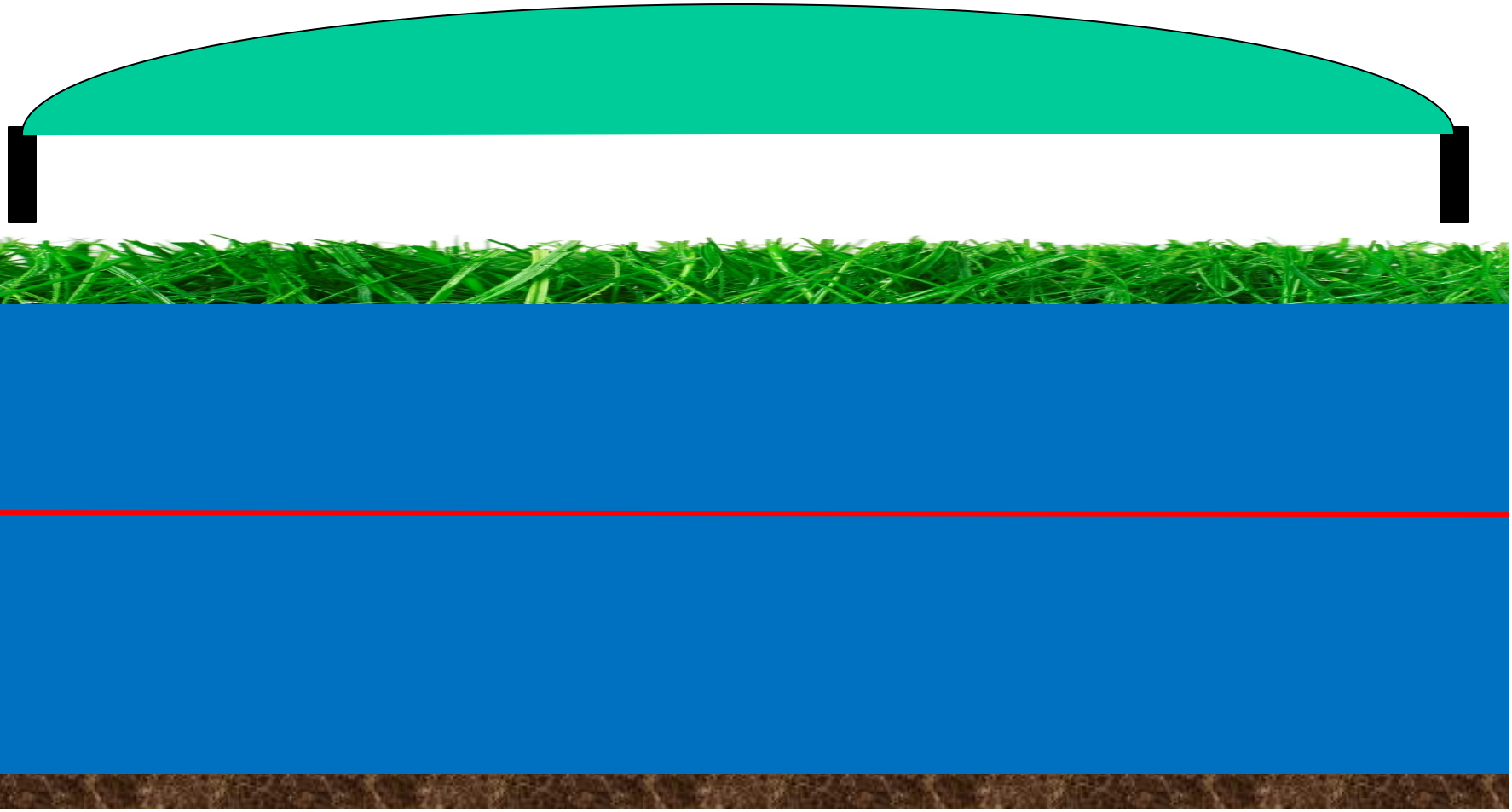
Distribution Uniformity

- DU=Excellent
- Duration: Replace ET



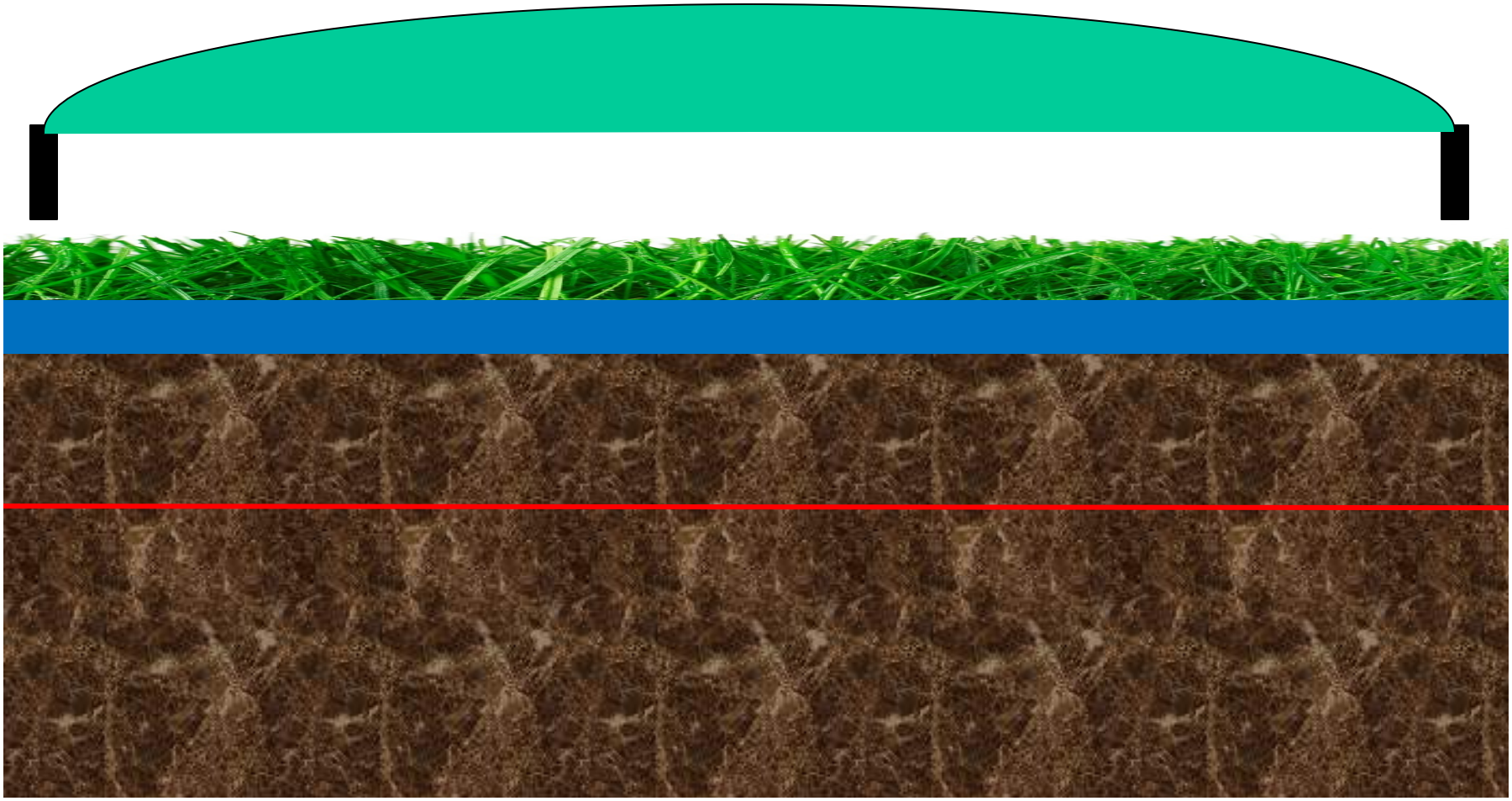
Distribution Uniformity

- DU=Excellent
- Duration: Too long



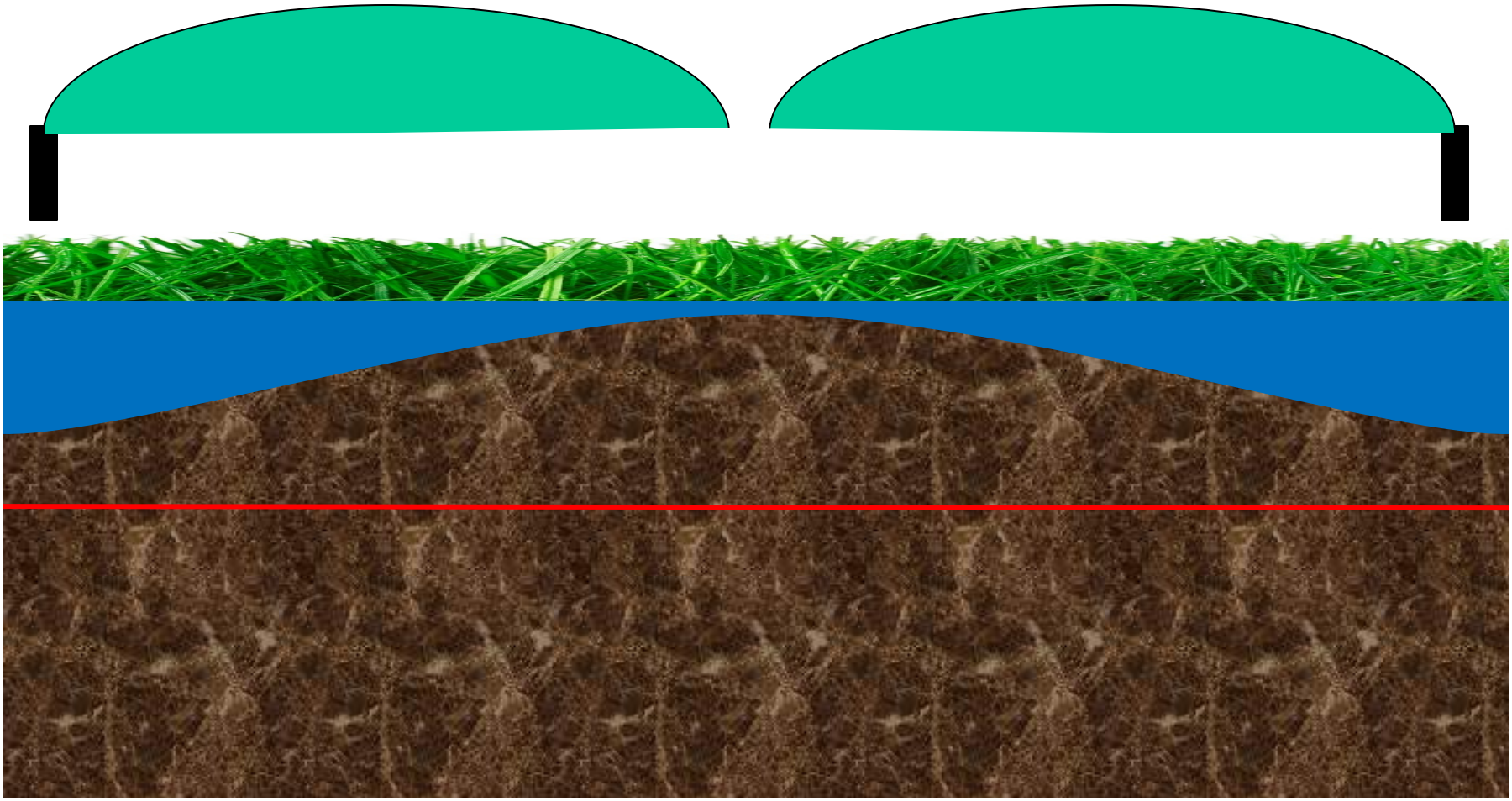
Distribution Uniformity

- DU=Excellent
- Duration: Too short



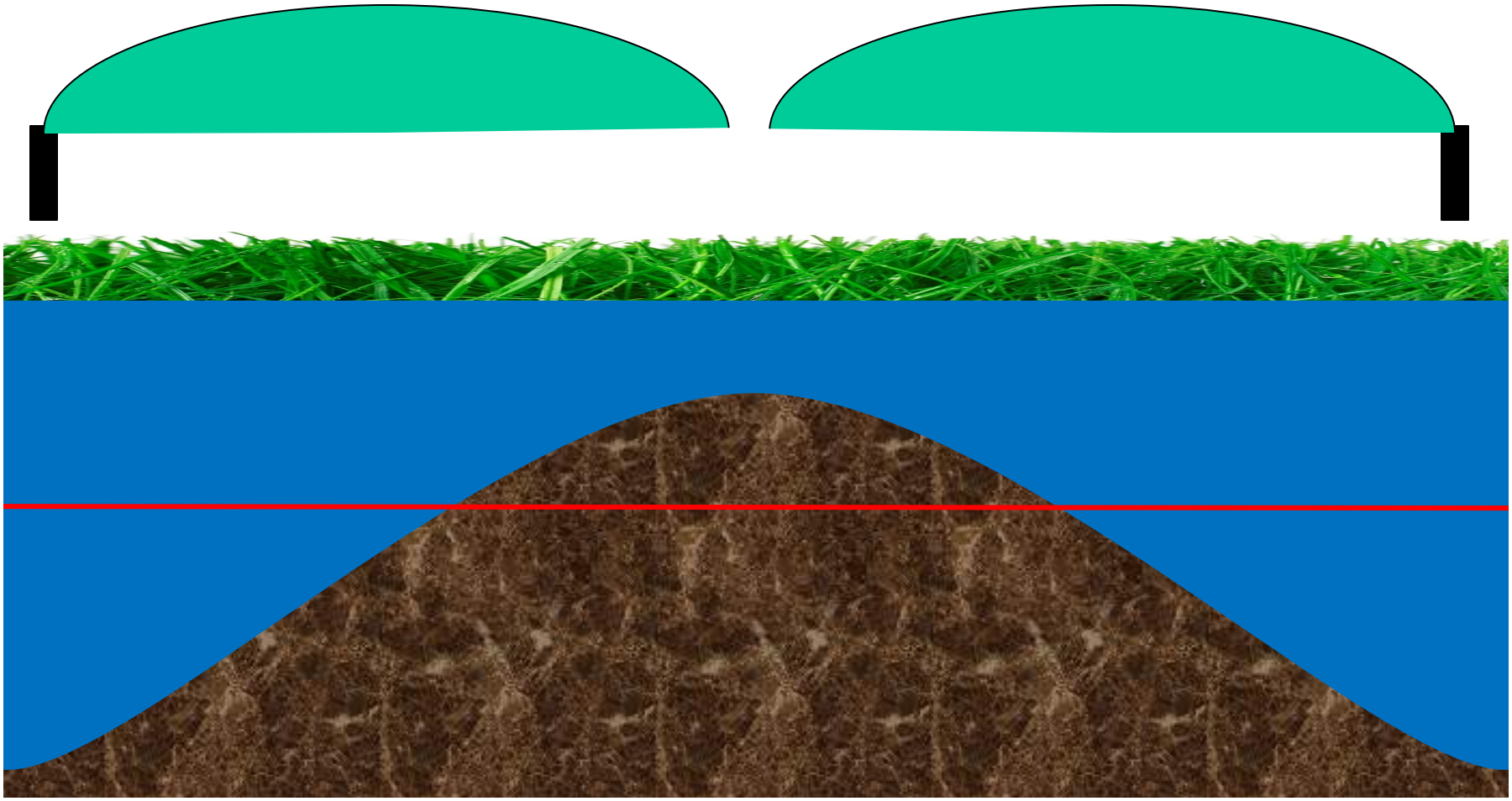
Distribution Uniformity

- DU=Poor
- Duration: Too short



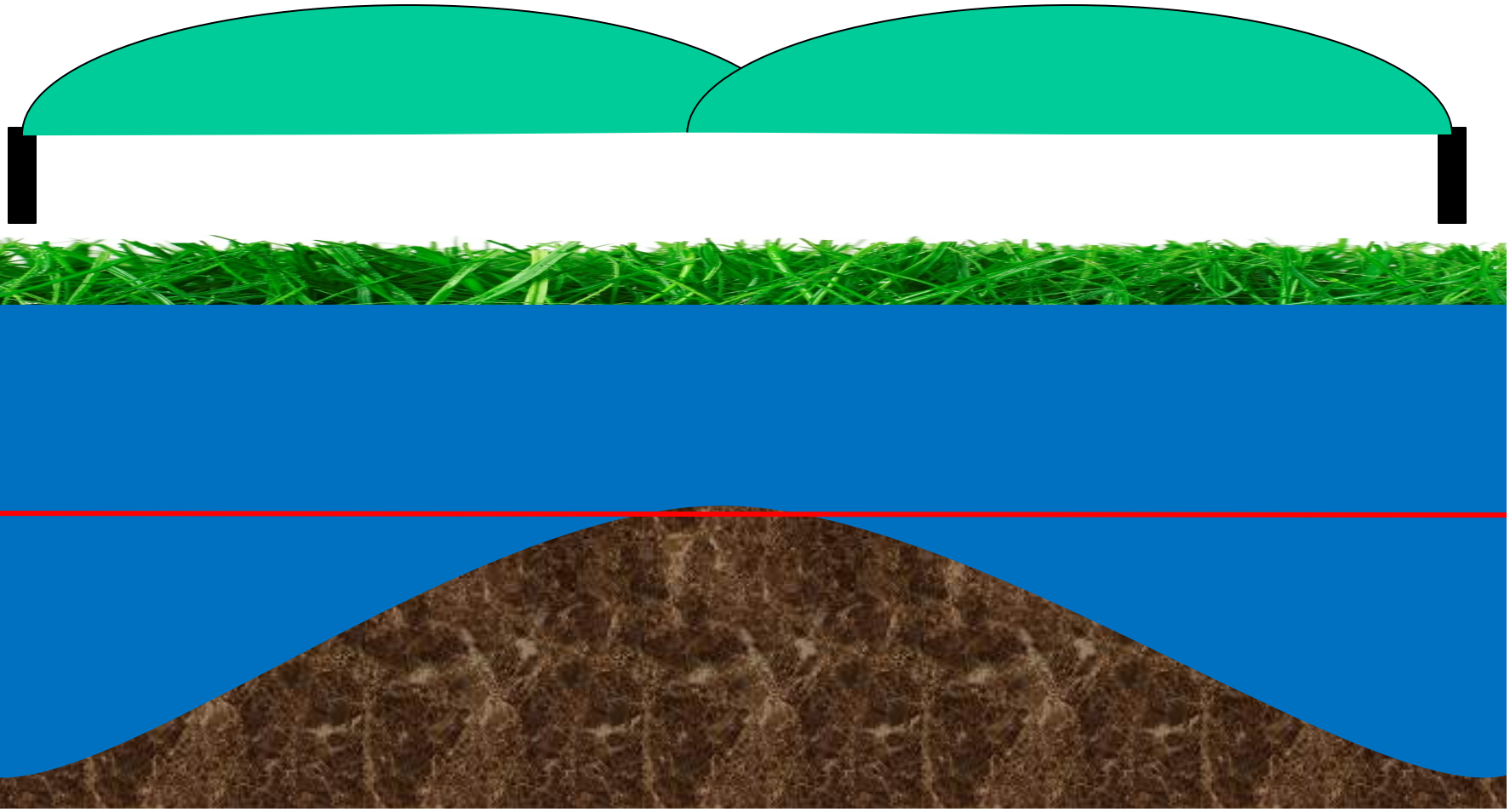
Distribution Uniformity

- DU=Poor
- Duration: Longer



Distribution Uniformity

- DU=Marginal
- Duration: Replace ET



Distribution Uniformity

- Calculating DU
  - Average of all (Avg_T)
  - Rank volumes
  - Average of bottom ¼ (Avg_{LQ})
  - DU= $Avg_{LQ} \div Avg_T$
- Target
  - Minimum 70%

	mL	rank	LowQ
	36	11	
	29	9	
	18	3	18
	19	4	
	26	8	
	33	10	
	16	2	16
	22	5	
	38	12	
	22	6	
	14	1	14
	21	7	
Avg_T =	24.5	Avg_{LQ} =	16

$$DU = \frac{Avg_{LQ}}{Avg_T} = \frac{16}{24.5} = 65\%$$

Improving DU

- Managing water pressure
- Effect on spray pattern

12’ fixed 30 psi

12’ fixed 45 psi

Improving DU

- Know the pressure recommended for your sprinklers
- This one is rated for 50 to 90 psi

7005 Nozzle Performance ■ ▲

Pressure psi	Nozzle	Radius ft.	Flow GPM	Precip In/h	Precip In/h
50	04	39	3.8	0.48	0.56
	06	45	5.6	0.53	0.62
	08	49	6.6	0.53	0.61
	10	53	9.3	0.64	0.74
	12	57	11.1	0.66	0.76
	14	59	12.6	0.70	0.81
	16	61	14.3	0.74	0.85
	18	63	16.1	0.78	0.90
60	04	39	3.8	0.48	0.56
	06	45	6.1	0.58	0.67
	08	49	8.4	0.67	0.78
	10	53	10.1	0.69	0.80
	12	59	12.0	0.66	0.77
	14	61	14.3	0.74	0.85
	16	65	15.9	0.72	0.84
	18	65	17.8	0.81	0.94

Improving DU

7005 Nozzle Performance ■ ▲

Pressure psi	Nozzle	Radius ft.	Flow GPM	Precip In/h	Precip In/h
50	04	39	3.8	0.48	0.56
	06	45	5.6	0.53	0.62
	08	49	6.6	0.53	0.61
	10	53	9.3	0.64	0.74
	12	57	11.1	0.66	0.76
	14	59	12.6	0.70	0.81
	16	61	14.3	0.74	0.85
	18	63	16.1	0.78	0.90
60	04	39	3.8	0.48	0.56
	06	45	6.1	0.58	0.67
	08	49	8.4	0.67	0.78
	10	53	10.1	0.69	0.80
	12	59	12.0	0.66	0.77
	14	61	14.3	0.74	0.85
	16	65	15.9	0.72	0.84
	18	65	17.8	0.81	0.94

Improving DU

- Know the pressure recommended for your sprinklers
- This one is rated for 25 to 55 psi and does best at 40 psi

MP ROTATOR PERFORMANCE DATA

MP1000

MP1000
Radius: 8' to 15'
Adjustable Arc & Full Circle
Maroon: 90° to 210°
Lt. Blue: 210° to 270°
Olive: 360°

Arc	Pressure PSI	Radius ft	Flow GPM	Flow GPH	Precip in/hr ■	Precip in/hr ▲
90°	25	...	...	...	...	...
	30	12	0.16	9.6	0.43	0.50
	35	13	0.18	10.8	0.40	0.46
	40	**14**	**0.19**	**11.4**	**0.39**	**0.45**
	45	14	0.20	12.0	0.39	0.45
	50	14	0.21	12.6	0.38	0.43
	55	15	0.22	13.2	0.37	0.43
180°	25	...	...	...	...	...
	30	12	0.32	19.2	0.43	0.50
	35	13	0.35	21.0	0.40	0.46
	40	**14**	**0.37**	**22.2**	**0.39**	**0.45**
	45	14	0.40	24.0	0.39	0.45
	50	14	0.41	24.6	0.38	0.43
	55	15	0.43	25.8	0.37	0.43

Improving DU

- Upgrade sprinklers if possible
- At three study sites upgrades resulted in DU increases of 21%, 24%, and 18%

Irrigation Management

- Know your system
- Precipitation and infiltration rates
- Distribution uniformity
- Water pressure

Assessing Distribution Uniformity

- If irrigating large turf areas, may be:
  - Largest impact for least effort
  - Low cost
- Obtain Water/ Irrigation Audit Kit


Thank you
lroki@ucdavis.edu
Photo: L.Oki