Drip Irrigation

Determining Distribution Uniformity and Irrigation Run time

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Getting it Right! Drip Irrigation,
Plant Selection and Lowering Water Use
Fair Oaks, CA
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University of California
Agriculture and Natural Resources

UCDAVIS
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Learning Objectives

- Measuring system performance
  - Determine application uniformity (Distribution uniformity)
- Determining how long to irrigate
  - Obtaining information needed
  - Calculating run time

Distribution Uniformity

- Math is necessary
  - because we have to measure
  - How “long” is “long enough”?

“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*

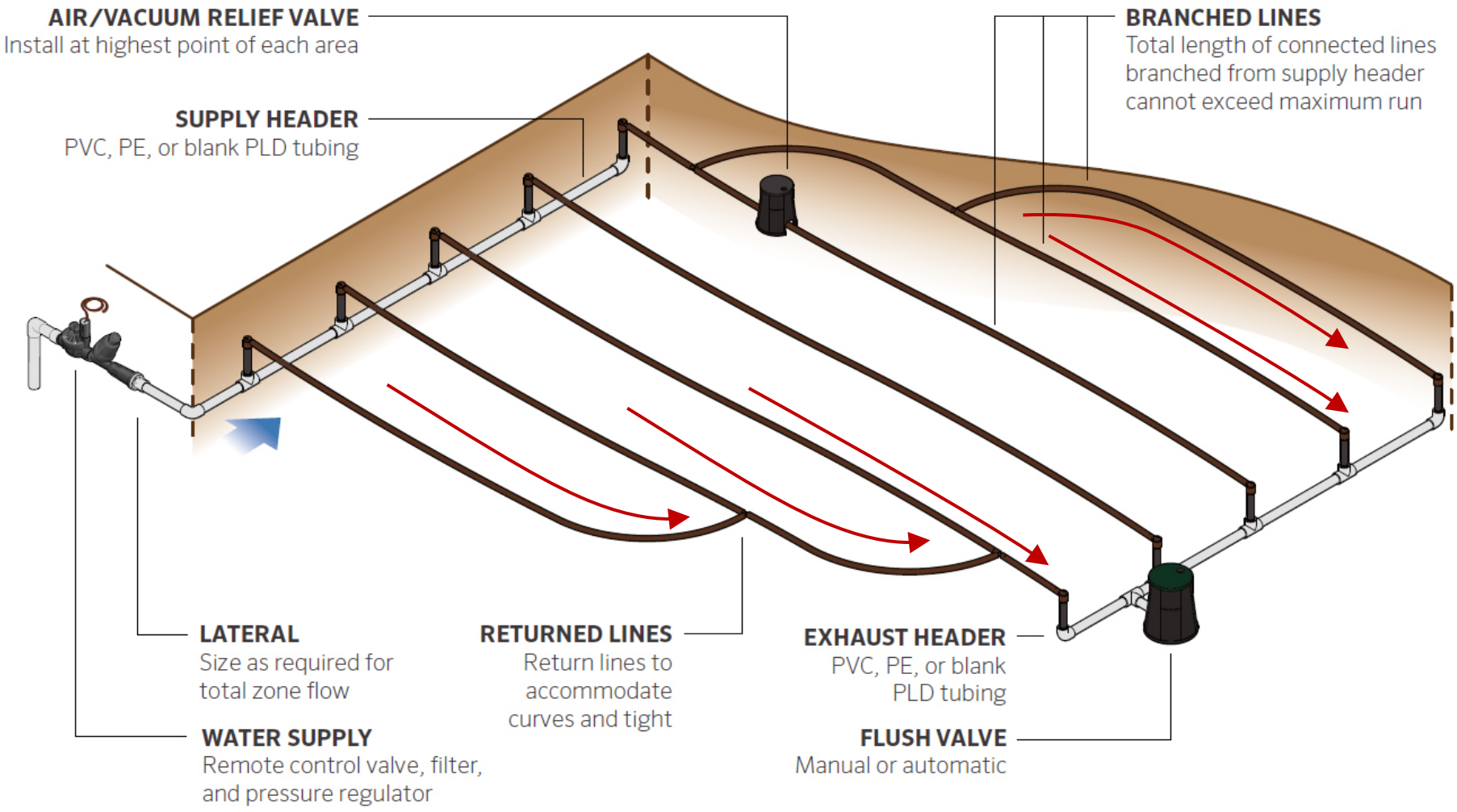
Distribution Uniformity

- Discussion focus:
  - Inline drip tube laid in a grid-like pattern
  - Under mulch

Distribution Uniformity

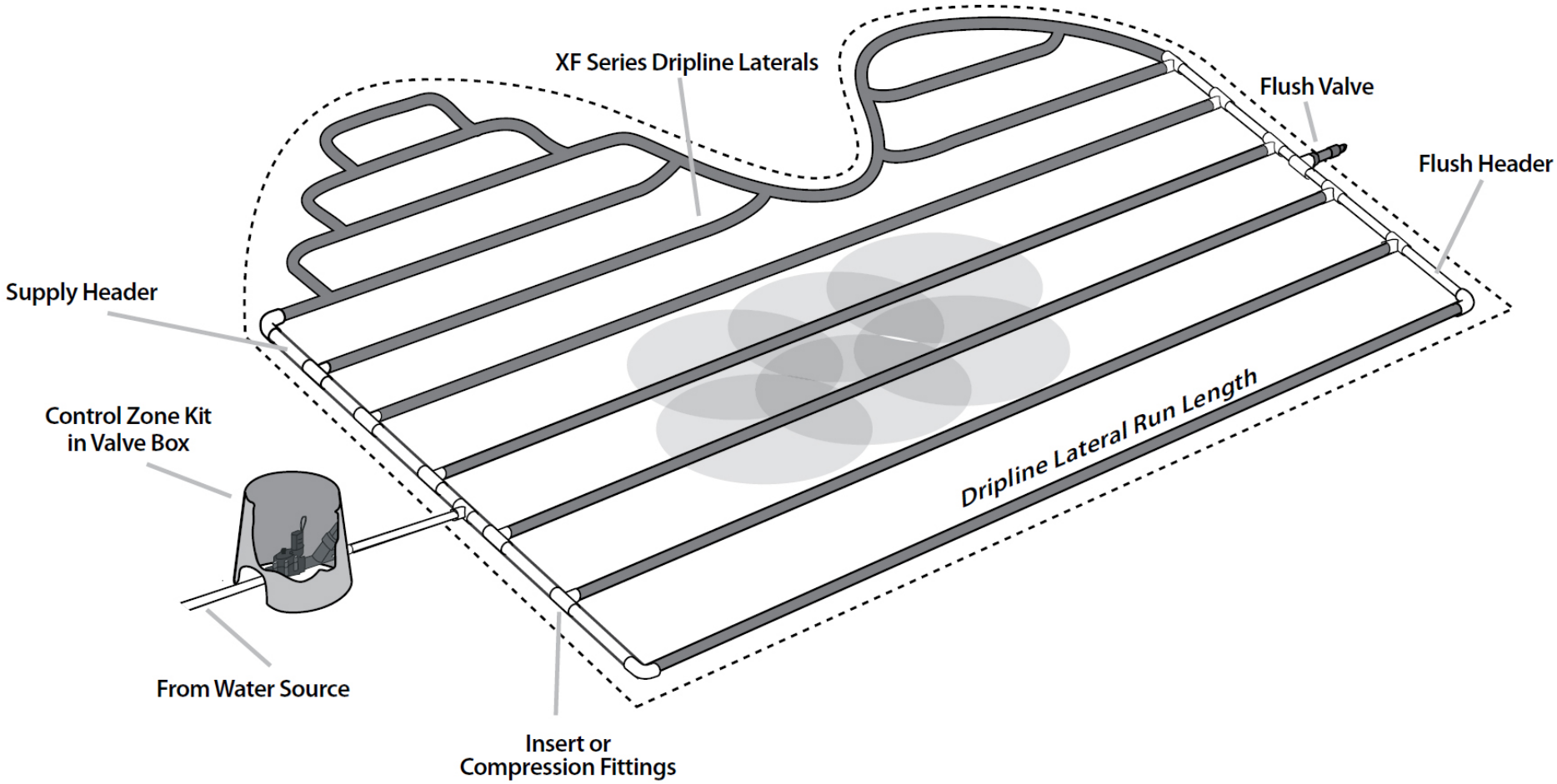
From: Netafim

Distribution Uniformity



From: Hunter Industries

Distribution Uniformity



From: Rain Bird

Distribution Uniformity

Site Assessment

- Inspect the site
- Tune up the irrigation system
- Test the system
- Measure and calculate performance
- Interpret the information

Credit: Irrigation Association
Landscape Irrigation Auditor
certification program

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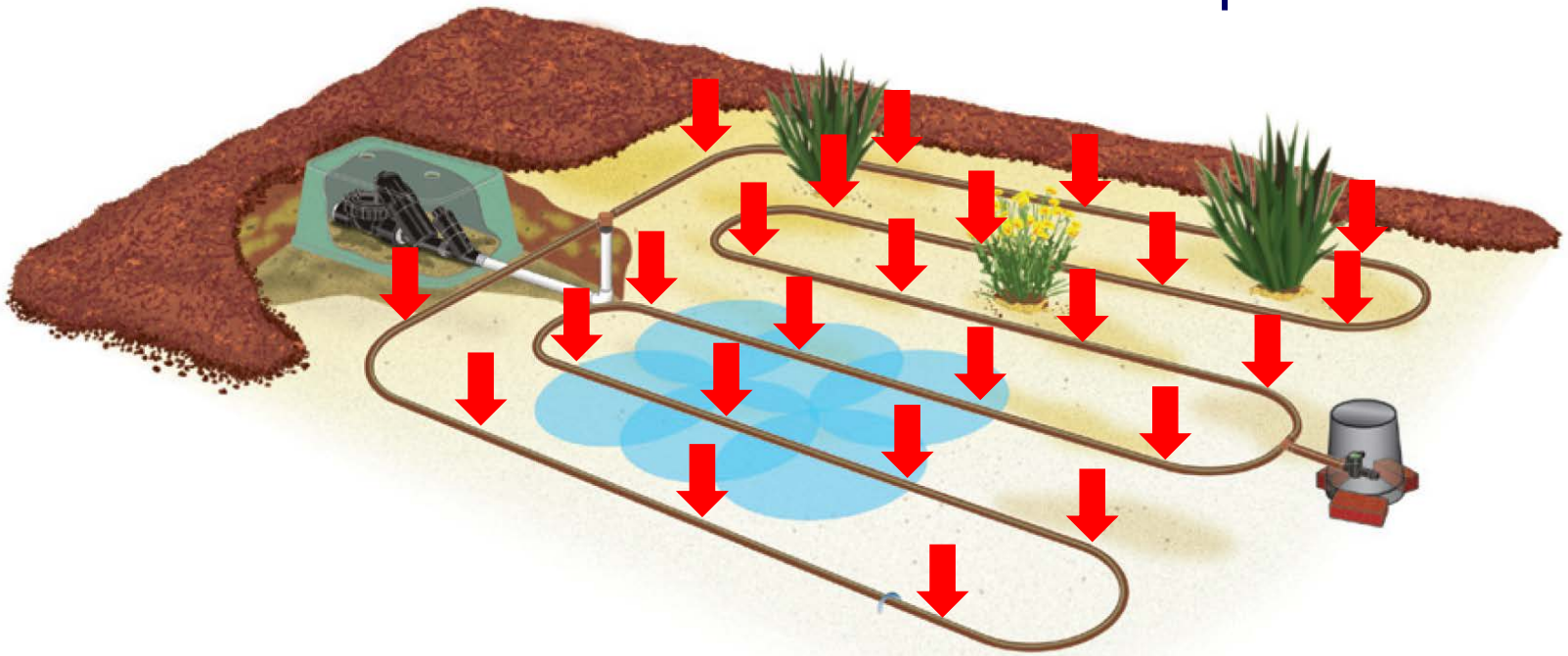
Distribution Uniformity

Select emitters to measure

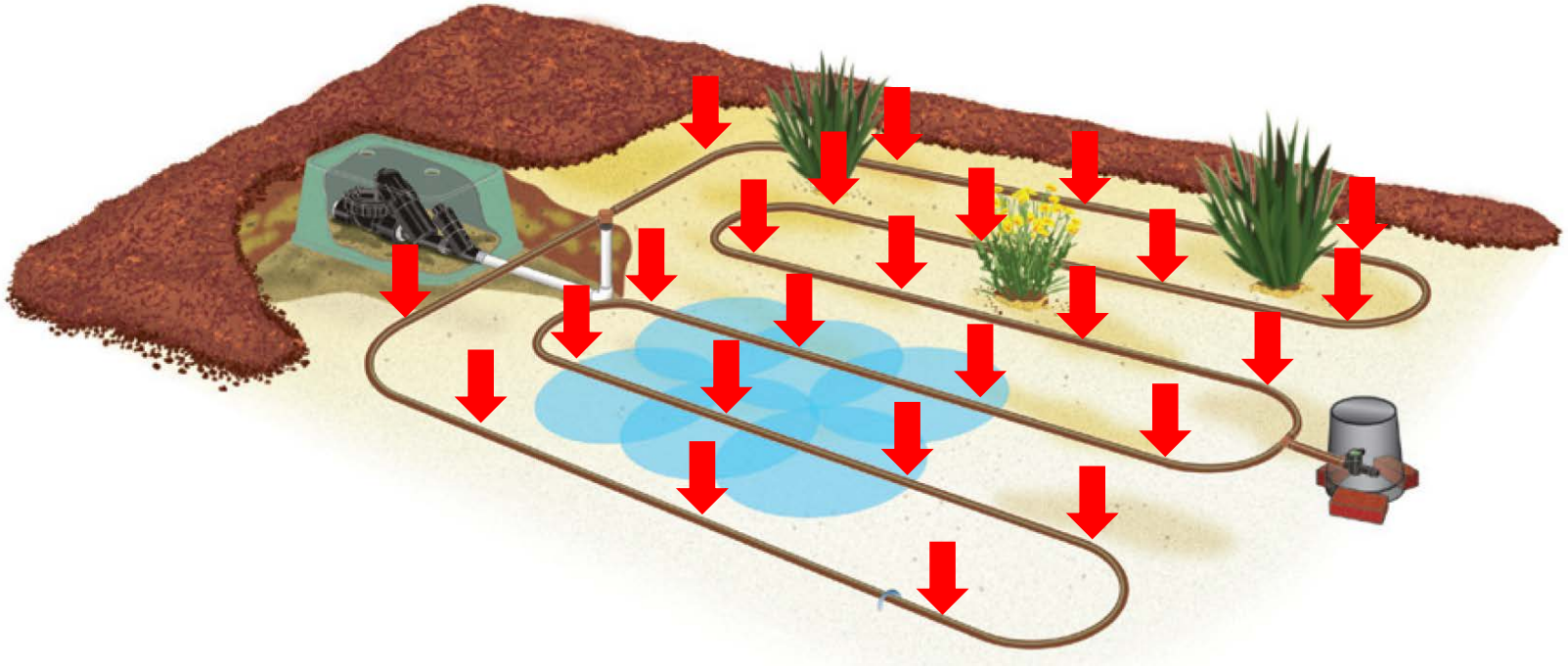
- Close to, far from valve
- Across the grid
- Even pattern
- At least 24
  - Multiples of 4



Distribution Uniformity

Select emitters to measure

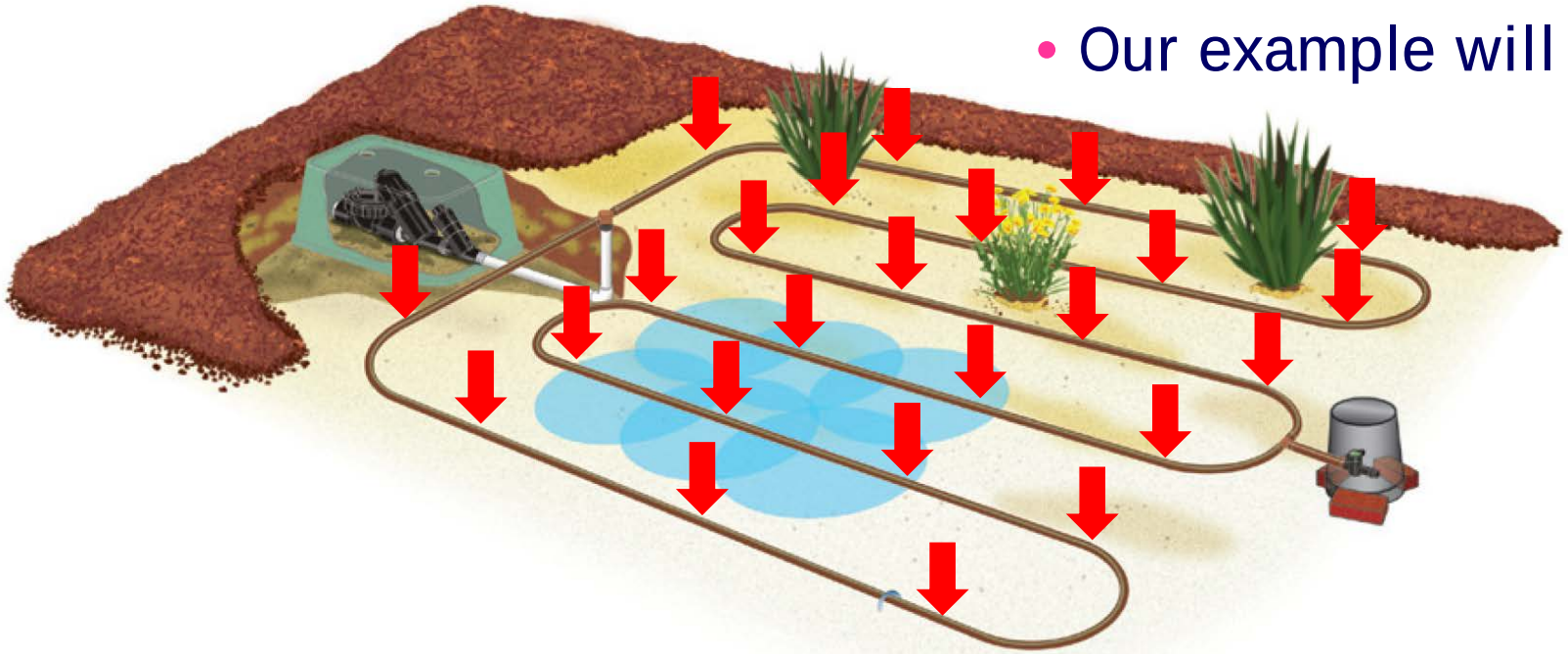
- Dig under emitter
- Container
  - 500 mL, 16 oz., pint
- Label containers
- Set container under emitter



Distribution Uniformity

Select emitters to measure

- Turn on valve
- Collect water
- DON'T OVERFILL!
- Turn off valve
- Note run time
  - Our example will be 6 min



Distribution Uniformity

Select emitters to measure

- Measure the volumes in each container
- Measure in mL (milliliters)
- Record the measurements

Distribution Uniformity

- Calculating DU
  - Average of all (Avg_T)

cont #	mL
1	230
2	255
3	208
4	235
5	225
6	237
7	223
8	258
9	202
10	241
11	232
12	202
Total=	2748
Avg_T=	229

Distribution Uniformity

- Calculating DU
  - Average of all (Avg_T)
  - Rank volumes

cont #	mL	rank
1	230	6
2	255	11
3	208	3
4	235	8
5	225	5
6	237	9
7	223	4
8	258	12
9	202	1
10	241	10
11	232	7
12	202	2
Total=	2748	
Avg_T=	229	

Distribution Uniformity

- Calculating DU
  - Average of all (Avg_T)
  - Rank volumes
  - Average of bottom ¼ (Avg_{LQ})

cont #	mL	rank
1	230	6
2	255	11
3	**208**	**3**
4	235	8
5	225	5
6	237	9
7	223	4
8	258	12
9	**202**	**1**
10	241	10
11	232	7
12	**202**	**2**
Total=	2748	
Avg_T=	229	

Distribution Uniformity

- Calculating DU
  - Average of all (Avg_T)
  - Rank volumes
  - Average of bottom ¼ (Avg_{LQ})

cont #	mL	rank	LowQ
1	230	6	
2	255	11	
3	**208**	**3**	208
4	235	8	
5	225	5	
6	237	9	
7	223	4	
8	258	12	
9	**202**	**1**	204
10	241	10	
11	232	7	
12	**202**	**2**	202
Total=	2748	Total=	614
Avg_T=	229	Avg_{LQ}=	205

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%

cont #	mL	rank	LowQ
1	230	6	
2	255	11	
3	**208**	**3**	208
4	235	8	
5	225	5	
6	237	9	
7	223	4	
8	258	12	
9	**202**	**1**	204
10	241	10	
11	232	7	
12	**202**	**2**	202
Total=	2748	Total=	614
Avg_T=	229	Avg_{LQ}=	205

$$DU = \frac{Avg_{LQ}}{Avg_T} = \frac{205}{229} = 0.89$$

Calculating Run Time

- Application rate
- Soil water holding capacity
- Depth to wet
- Scheduling multiplier
- Calculate run time

Application Rate

- We need to know
  - Area irrigated (sq ft)
  - Total number of emitters in the irrigated area
  - Emitter flow rate (gph)

Application Rate

- Example 1
  - Area irrigated (400 sq ft)
  - Total number of emitters in the irrigated area (178)
  - Emitter flow rate (0.6 gph)

$$Application\ rate = \frac{No.of\ emitters\ \times flow\ per\ emitter\ \times 1.604}{area}$$

$$0.43\ \text{inch/hr} = \frac{178\ \times 0.6\ \times 1.604}{400}$$

Application Rate

- Example 2
  - Emitter flow rate based on DU assessment

$$Flow\ per\ emitter = \frac{Avg_T}{run\ time \times 63.08}$$

$$0.61\ \text{gph} = \frac{229}{6 \times 63.08}$$

Application Rate

- Example 2
  - Emitter flow rate (0.61 gph from previous calculation)
  - 18” emitter spacing on tube
  - 18” spacing between tubes

$$Application\ rate = \frac{flow\ per\ emitter\ \times 231.1}{emitter\ spacing\ \times lateral\ spacing}$$

$$0.44\ \text{inch/hr} = \frac{0.61\ \times 231.1}{18\ \times 18}$$

Depth to Wet

- How deep to irrigate
  - Depends on plant types
    - Trees, shrubs, ground covers, turf
    - Drought tolerant or not
  - Typically 12”, 18”, 24” and 36”
  - For our example of drought tolerant shrubs, we’ll use **18”**

Plant Available Water

- How much water does the soil hold?
- Method 1: Use app
  - SoilWeb and SoilWeb online
- "Available Water Storage (0-100cm)"
- Values are in cm. (e.g., 18.71cm)
- This is equivalent to 0.1871 or ~0.19

Plant Available Water

- How much water does the soil hold?
- Method 2: Use cha
  - Need to know soil texture
- Back to Method 1
  - Use app
- For this example: **silty loam**
- PAW = 0.2

Soil Information			
Soil Texture		Infiltration* (in./hr)	Plant Avail Water (cm/cm)**
Coarse	sand / fine sand	1.5	0.05
	loamy sand	1	0.07
Moderately Coarse	sandy loam	0.8	0.11
Medium	loam	0.4	0.16
	silty loam	0.25	0.2
	silt	0.3	0.2
Moderately Fine	sandy clay loam	0.1	0.15
	clay loam	0.07	0.16
	silty clay loam	0.05	0.18
Fine	sandy clay	0.08	0.12
	silty clay	0.05	0.14
	clay	0.05	0.15

*Also known as intake rate

**IA Landscape Irrigation Auditor Manual page 177

Scheduling Multiplier

- To allow for nonuniformity (DU)

$$Scheduling\ Multiplier\ (SM) = \frac{1}{0.4 + (0.6 \times DU)}$$

$$1.07 = \frac{1}{0.4 + (0.6 \times 0.89)}$$

Calculate Run Time

- Need to know:
  - Depth to wet- 18”
  - Plant available water- 0.2
    - We will replace half of that amount
  - Application rate- 0.43 in/hr
  - Scheduling multiplier- 1.07

$$Run\ time = \frac{Depth\ to\ wet\ \times Plant\ available\ water}{Application\ rate \times SM \times 2}$$

$$3.91\ \text{hr} = \frac{18\ \times 0.2}{0.43 \times 1.07 \times 2}$$

Convert Run Time

- May need to convert run time to:
  - **hr:min**
  - 3.91hr=3hr + 0.91hr
    0.91 × 60 = 54.6 or ~55 minutes
  - 3:55
  - **Minutes**
  - 3.91 × 60 = 234.6 or ~235 minutes

Drip System Calculations

- Distribution uniformity
  - How evenly water is applied
- Run time
  - Application rate- two ways
  - Depth to wet
  - Soil water holding- Plant Available Water
  - Scheduling multiplier
  - Run time and time conversions


Thank you
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Photo: L.Oki