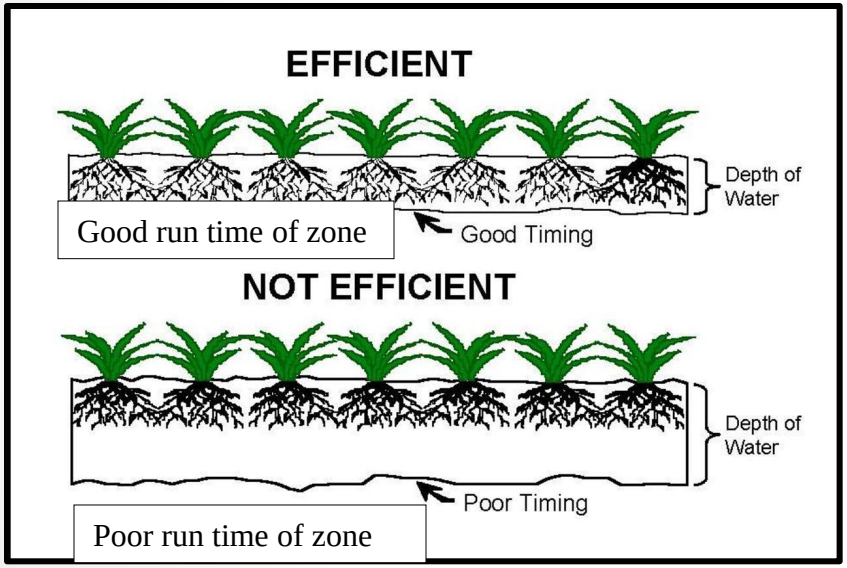
STMA Mid American Regional Conference 2012

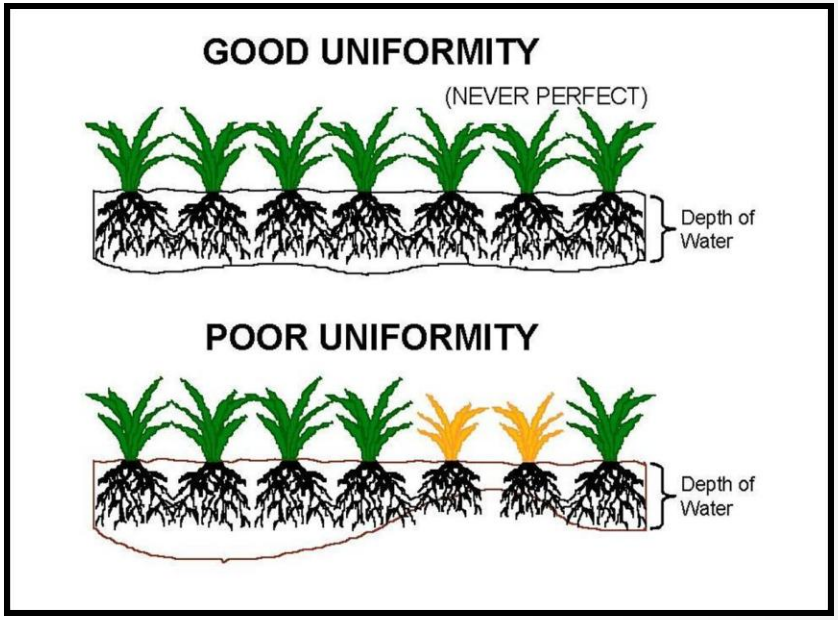
Efficiency versus Uniformity

- ***Efficiency***: is the ratio between how much water the plant beneficially uses compared to how much water the irrigation system applies.
- ***Uniformity***: relates to how evenly the water is applied over an area. Equipment selection affects uniformity.

Efficiency versus Uniformity

Efficiency & Uniformity





Why is Maximizing Water Use & Maintaining Optimum Uniformity Important?

- **Environmental**
  - Water Conservation
  - Energy Conservation
  - Eliminate Nutrient Leaching $$$
  - Reduce Weed and Disease Control Needs

Why is Maximizing Water Use & Maintaining Optimum Uniformity Important?

- **Turf Management**
  - **Safety**
  - **Manage Salinity / Poor Water Quality**
  - **Improve Playing Conditions**
  - **Improve Aesthetics**
  - **Healthier Turf**

The Facts….

- **Outdoor water use is under increased, if not constant observation**
- **Water is our #1 most valuable resource, worldwide!**
- **Large percentage of water is wasted due to inefficient systems**

What Is The Answer?

- **More efficient irrigation systems?**
  - **The irrigation system is only as good as the designer/ installer/ operator/ manager**
  - **The irrigation system is only as good as the written specifications the designer & contractor must follow**

Irrigation System Performance Audit

Class Objectives:

- be able to perform field audits on irrigation systems
- be able to identify problems that cause poor uniformity

Key Irrigation Auditor Actions

- Identify equipment problems
- Determine actual system performance based on uniformity tests
- Adjust run times for DU or SC

Irrigation Audits

- Site inspection - system tune up
- System audit
- Calculate distribution uniformity; precipitation rate; runtime

Water savings achieved by:

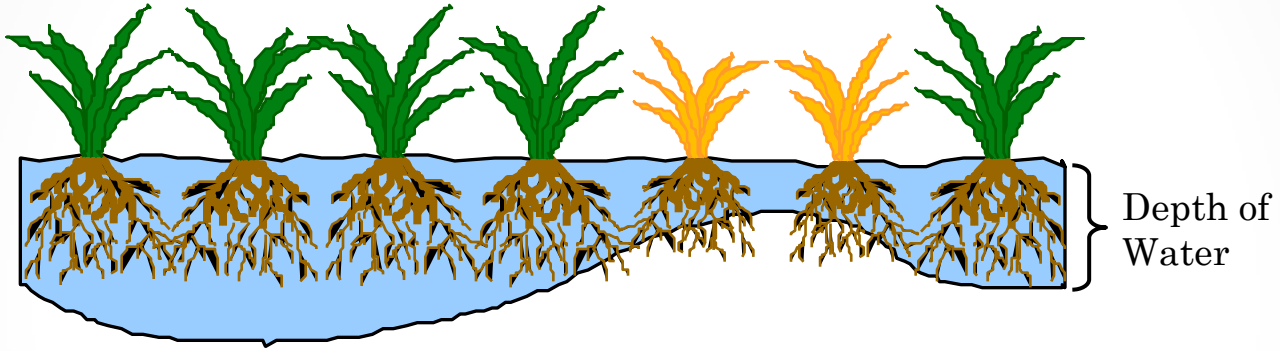
- Checking and fixing equipment
- Using state-of-the-art water saving equipment and programs
- Following the weather throughout the season
- Maintaining the system at peak efficiency

Concepts and Problems

Problem areas….non-uniformity

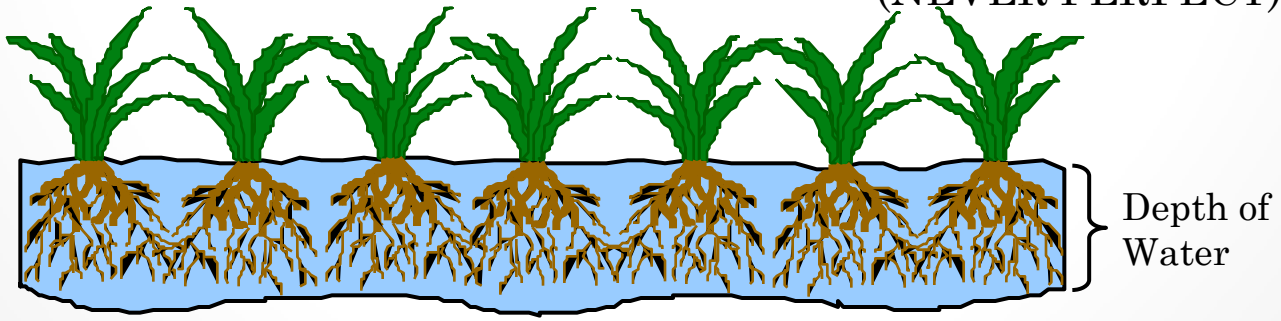
Water Application and Uniformity

POOR UNIFORMITY



GOOD UNIFORMITY

(NEVER PERFECT)



Broken Sprinklers

Bad Seals


High Pressure


Low Pressure


Wrong nozzle selection
and incorrect runtimes

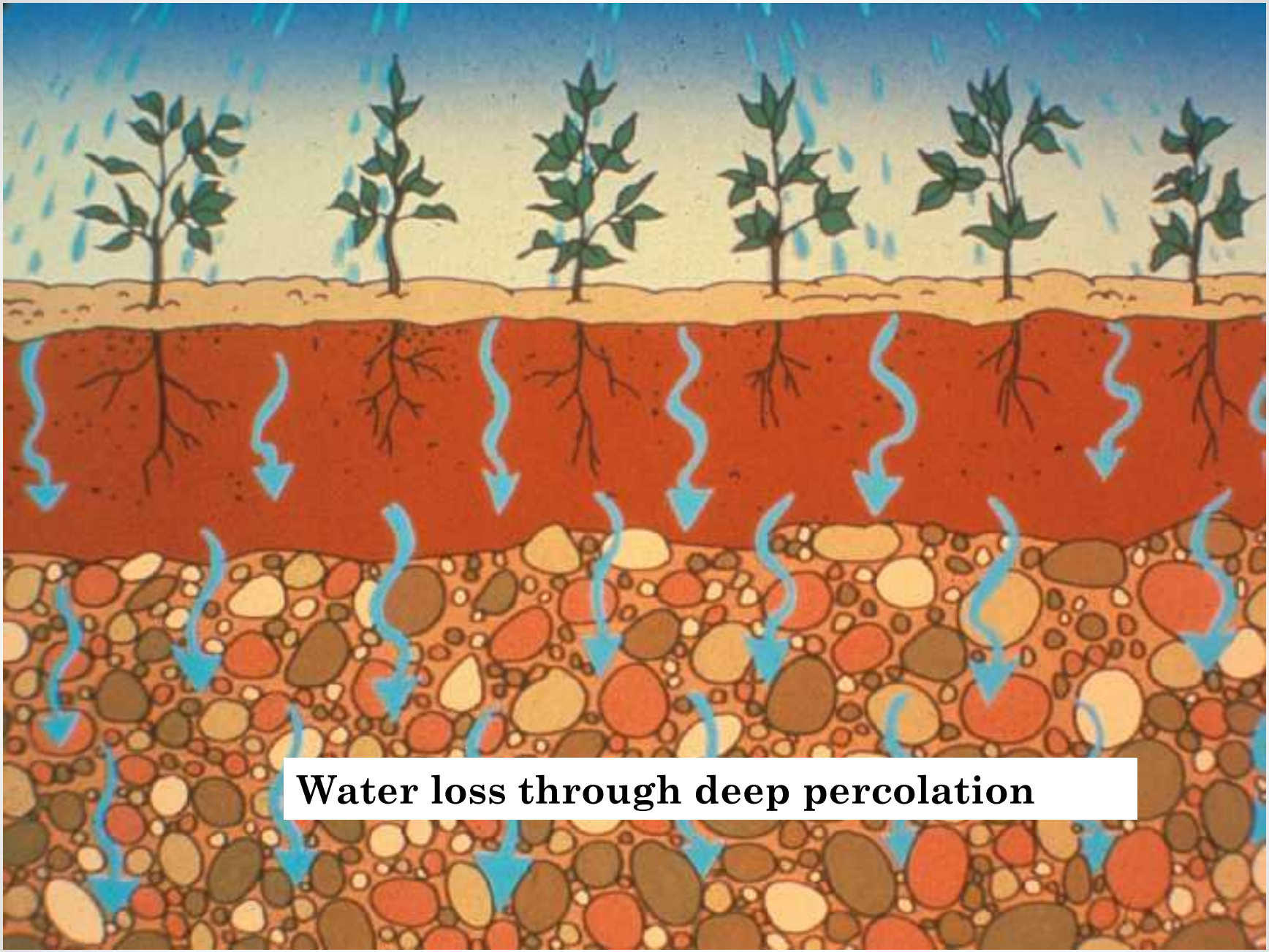

Sunken Sprinklers

Mismatched Sprinklers

Blocked Sprinklers

Infiltration Rate in./hr

- Rate at which water moves into soil
- Sandy soils accept water rapidly
- Heavy soils accept water slowly
- Decreases during irrigation


Water loss through deep percolation

Precipitation Rate (in./hr)

- How fast does system apply water?
- Varies from station to station
- Even varies within a station
- Many systems' precipitation rates exceed the infiltration rate

Theoretical Precipitation Rate (in./hr)

$$PR = \frac{96.3\,Q}{A}$$

Q = flow rate into area (gpm)

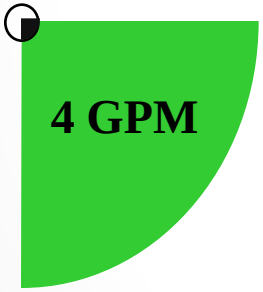
A = area (sq. feet)

Matched Precipitation Rates

- all the heads have similar precipitation rates
- matched precipitation rates can help to avoid wet and dry spots AND help save water!
- you must verify during the site inspection
- can drastically alter the uniformity

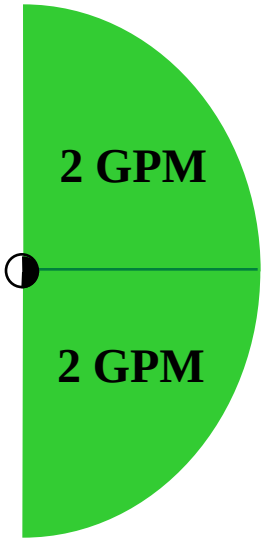
Heads WITHOUT Matched Precipitation Rates

Quarter Circle Head



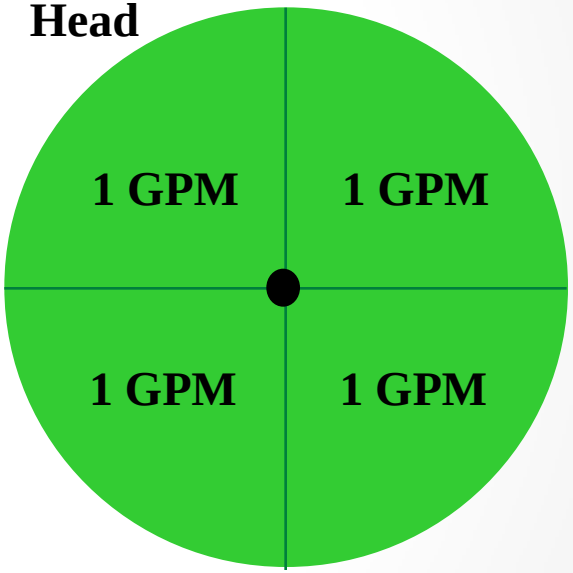
Area Covered
78.5 sq. ft. - 4 GPM

Half Circle Head



Area Covered
157 sq. ft. - 4 GPM

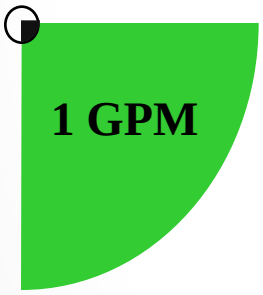
Full Circle Head



Area Covered
314 sq. ft. - 4 GPM

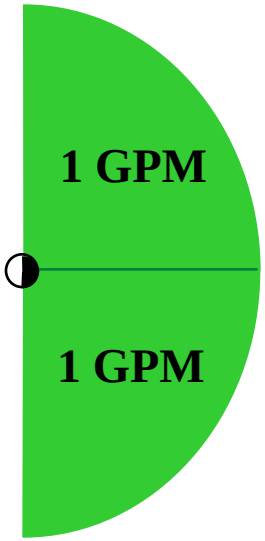
Matched Precipitation Rates

Quarter Circle Head



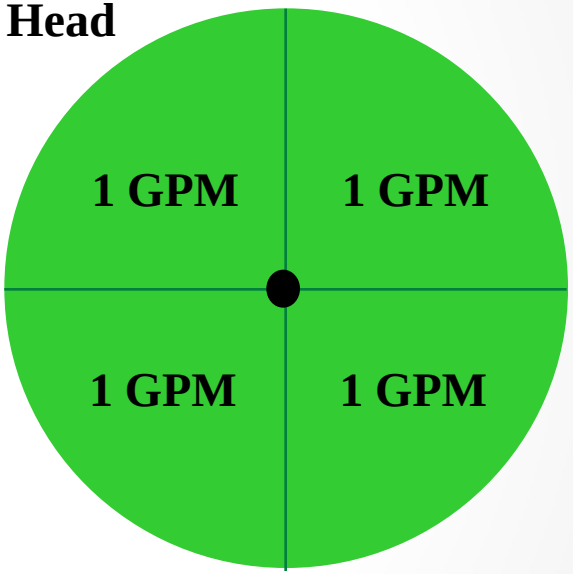
Area Covered
78.5 sq. ft. - 1 GPM

Half Circle Head



Area Covered
157 sq. ft. - 2 GPM

Full Circle Head



Area Covered
314 sq. ft. - 4 GPM

To the field!

Site Inspection

Step one: get the system working right

Site Inspection Priorities (what to repair)

- What is the "**goal**" of the audit?
- Minor, not major repairs
- Low heads
- Plugged heads
- Tilted heads
- No matched precipitation rate
- Mixed unmatched heads

SYSTEM TUNE UP

- Spray Deflection
- Plugged Equipment
- Broken Heads
- Tilted and Sunken Sprinklers
- Arc Misalignment
- Non-Rotating Heads

Information to Collect in the Site Inspection

- Site conditions
- Point of connection data
- Controller data
- Brand of products used
- Pressure at nozzles

REQUIRED EQUIPMENT for an Audit…

- Flags
- Tape Measure – 100 feet minimum
- Pressure Gauge – 0 to 160 psi minimum
- Wind gauge
- Measuring Device (Cup)
- Watch or time measuring device
- 2 People
- Clip board and pencil

REQUIRED EQUIPMENT

AUDITING PROCEDURE

- Flag/ mark Sprinklers
- Set out cups
- Pressure – Measure Static
- Operate sprinklers
- Pressure – Measure Dynamic
- Measure wind speed

Determining Pressures….

Liquid filled Pitot Tube

Dynamic pressure w/ hose and pitot tube

Static pressure w/ gauge

Dynamic pressure w/ pitot tube

Dynamic pressure w/ gauge for spray bodies

Measuring Wind Speed

- Handheld anemometer
- Upwind-Downwind Ratio

Catch Devices

- Calculate falling water from sprinklers
- Used to determine precipitation rate & uniformity
- All catch devices must be identical
- May measure in millimeters or inches
- Volume measurement with a wide throat area allows for shorter test times

Catch Device Types

Placement of Catch Cans

- Use a grid system
  - Rotors typically between 10’ to 20’ centers
  - Sprays use smaller grid between 4-8’ centers
- Size of test area determines grid spacing
- An minimum number of **24 cans** per test area is preferred
- More data is better than less data
- Number of catch cans should be a **multiple of 4** if possible

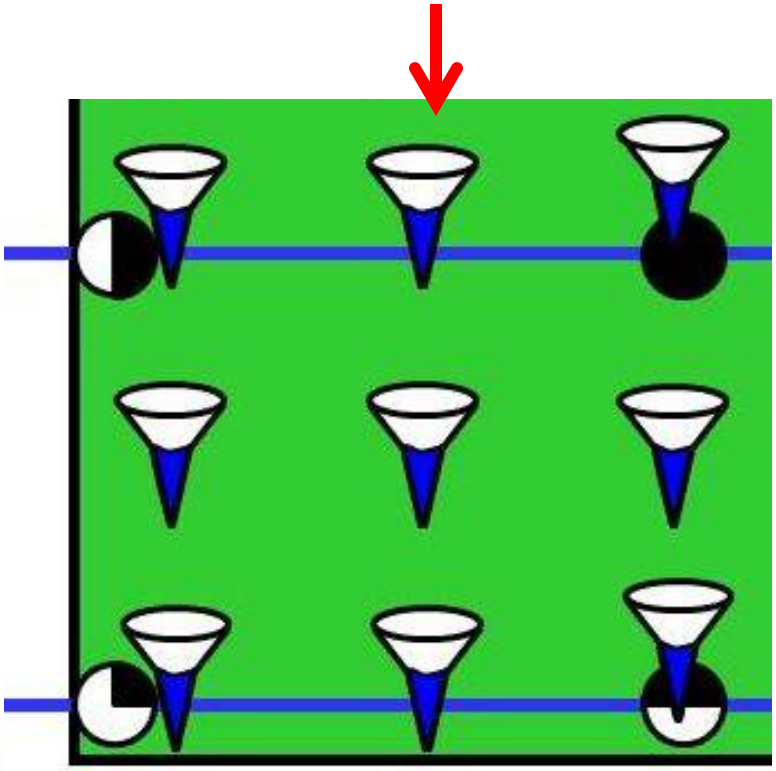
Placement of Catch Cans

- **Spacing: how many catch cans and where?**
  - **< 59’ Sprinkler Spacing = 3’ X 3’ apart**
  - **> 59’ Sprinkler Spacing = 10’ X 10’ apart**
  - **Place in a grid; do not place in front of sprinkler!**

Laying out catch cans

Placement of Catch Cans….

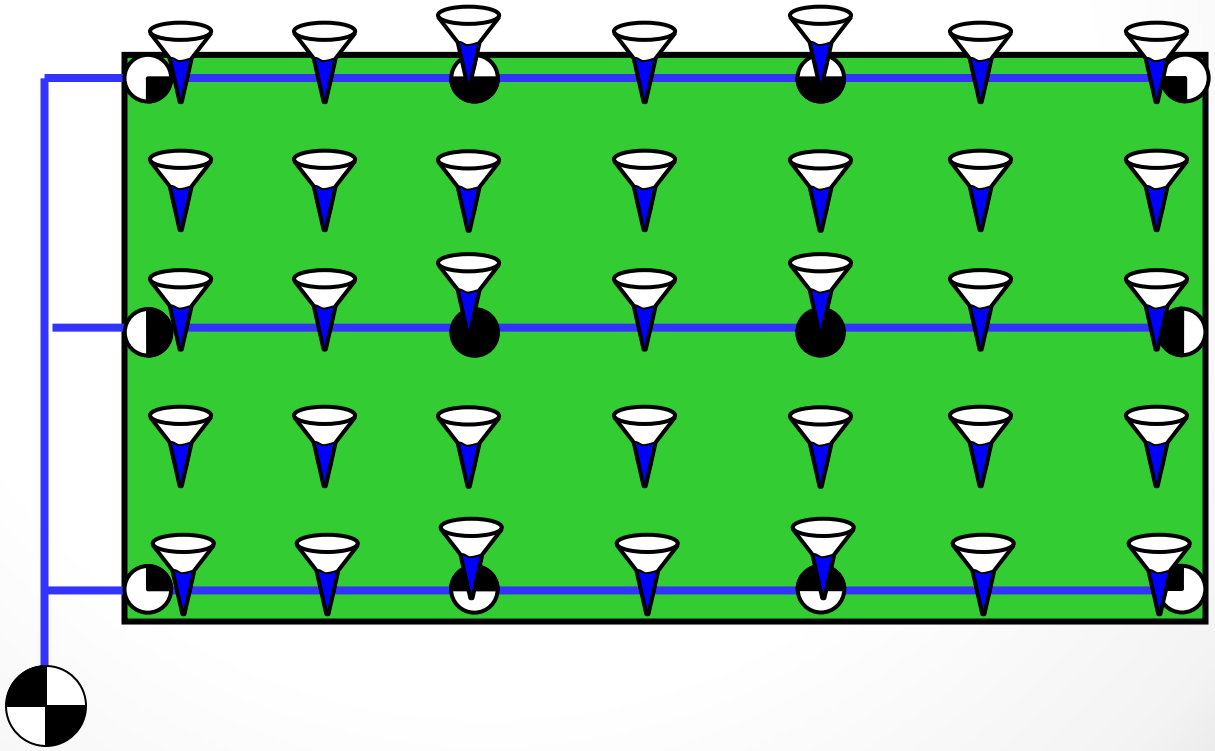
“At a sprinkler; halfway to the next”



Catch Device Placement

Single Station Test Area

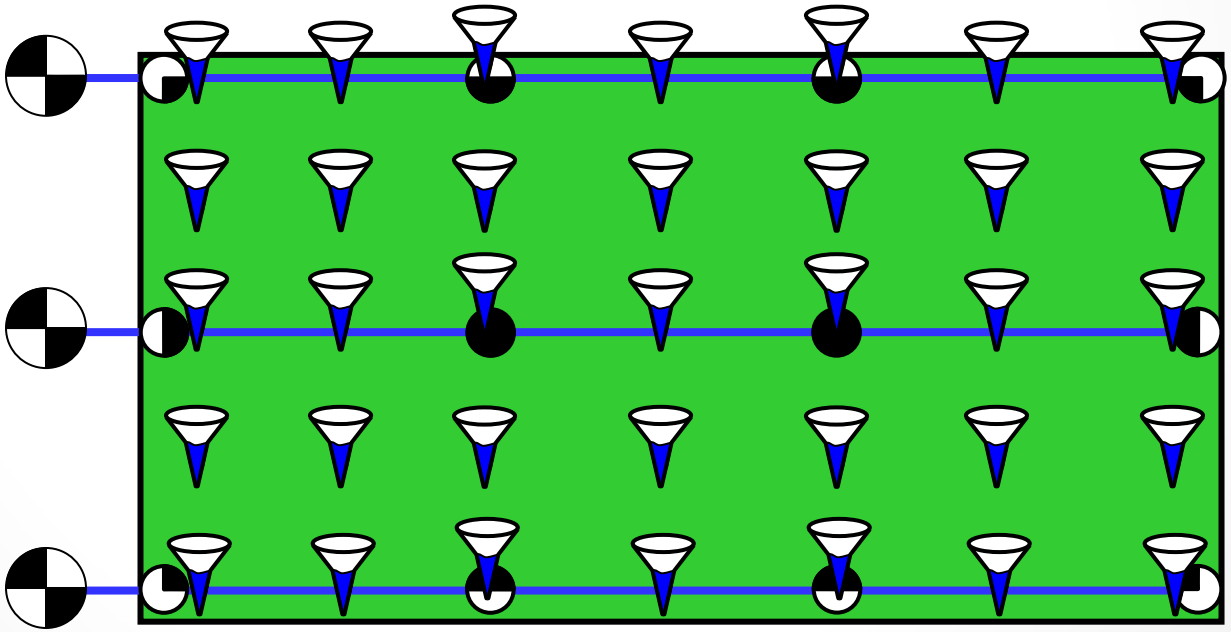
- Rectangular sprinkler spacing



Catch Device Placement

Multi-Station Test Area

- Rectangular sprinkler spacing



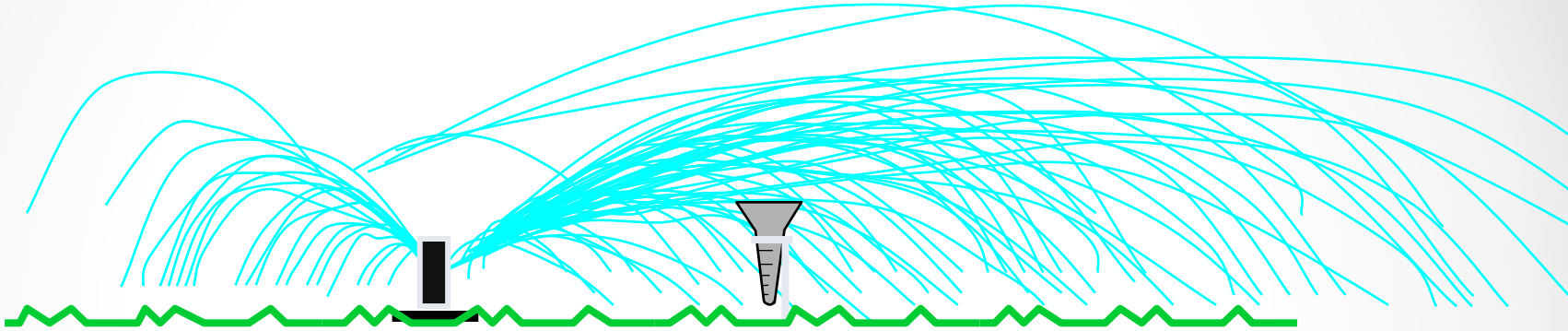

Testing
area
with
irregular
boundaries


Testing grass strip

Catch Device Placement

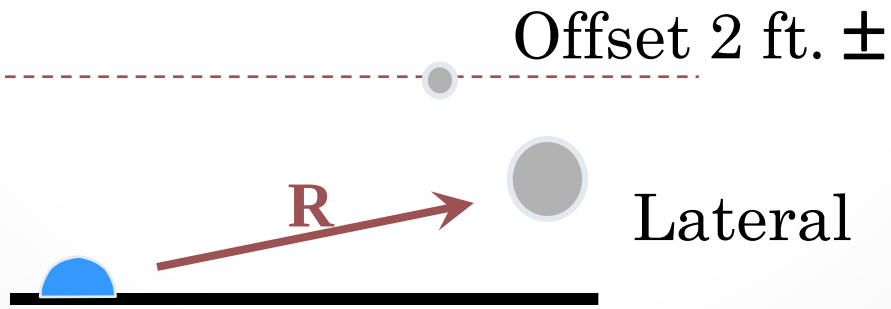
Catch Device Placement

Catch Device Placement



Full Circle

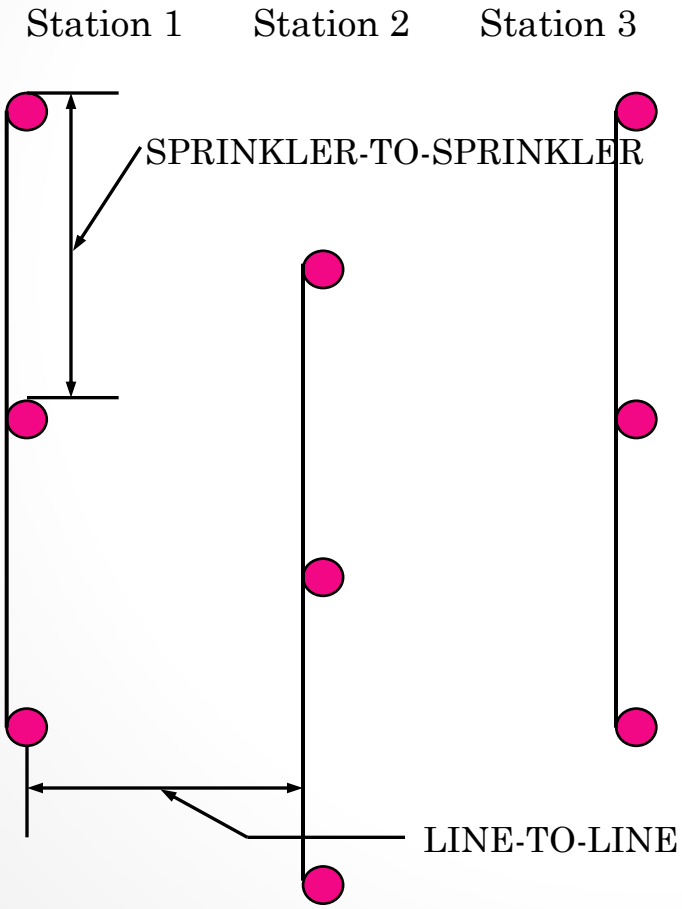
Part Circle



Collect other data during station runs.

- Spacing of sprinklers:
  - head to head
  - line-to-line
- Test soil type and root zone depth

Spacing Measurement



SAMPLE

Spacing Measurement: Triangular Spacing

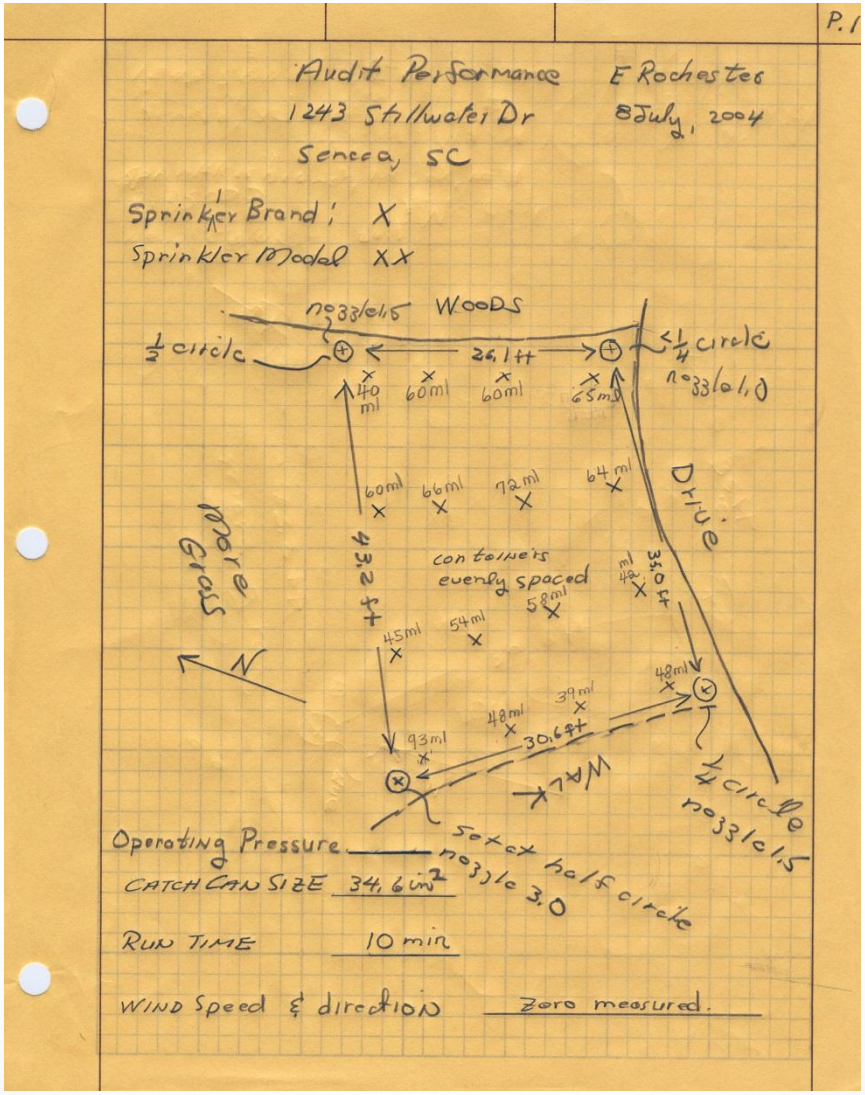
Running the Test

Run test during typical wind conditions!

Testing Run Times (min.)

- How long the station runs for test
- Affects quantity of water in catchments
- Spray heads = 3-6 minutes
- Rotary heads = 10- 20 minutes

Recording Data



Read and Record the Volume

- Estimate to the nearest milliliter
- Better if the same person reads the catch volumes
- Record the volumes in relation to the sprinklers on the drawing

Performance Calculations

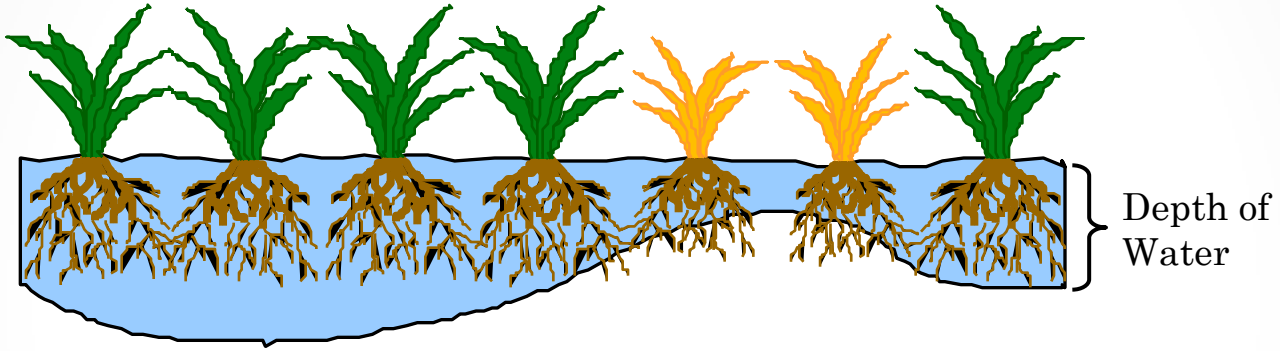
- The results of the catch test
  - Net Precipitation Rate
  - Distribution Uniformity
- A snap shot of how the equipment is performing at a specific moment in time
  - Only maintenance and management can sustain a well performing irrigation system
  - Only maintenance and management can improve a poorly performing system

Distribution Uniformity

- The measure of how evenly the water is being distributed by sprinklers in overlapping coverage
- Expressed as a decimal
  - 1.00 is perfect (unattainable)
- Uniformity is affected by
  - Pressure
  - Spacing
  - Flow
  - Maintenance
  - Wind
  - Interference

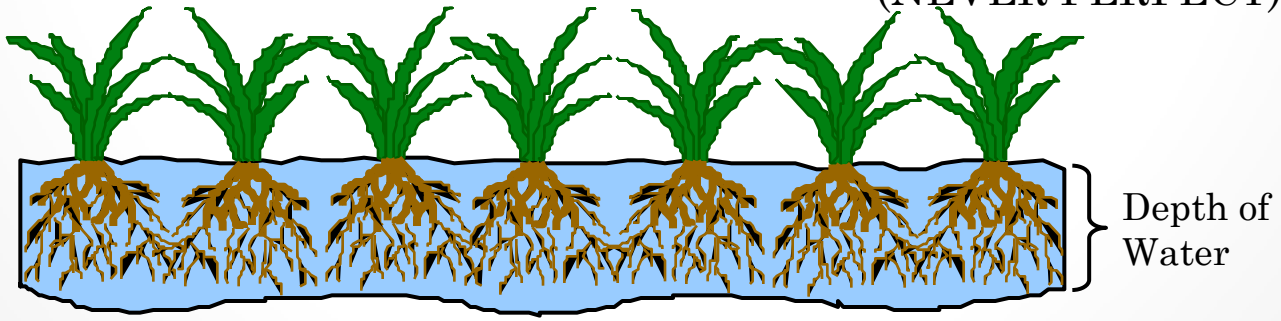
Distribution Uniformity

POOR UNIFORMITY

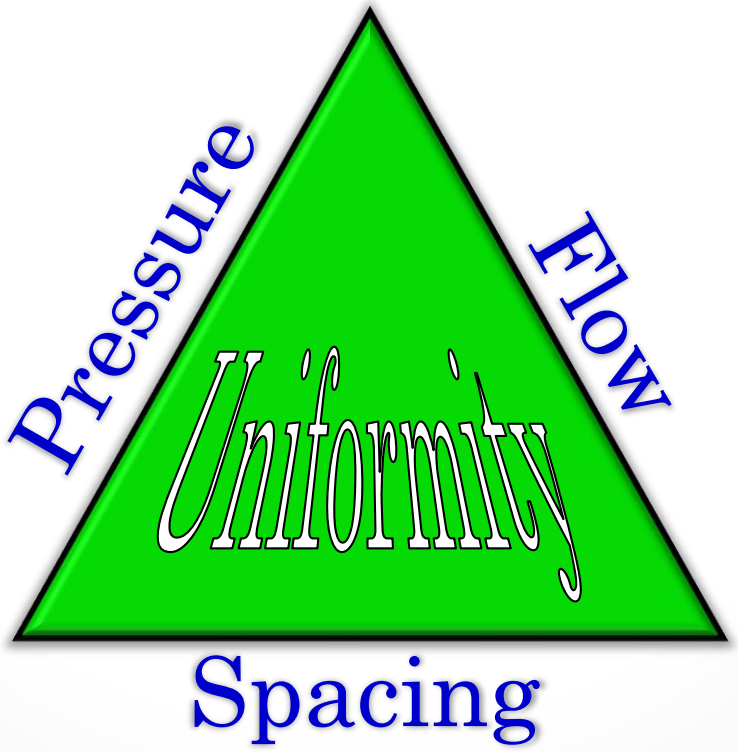


GOOD UNIFORMITY

(NEVER PERFECT)



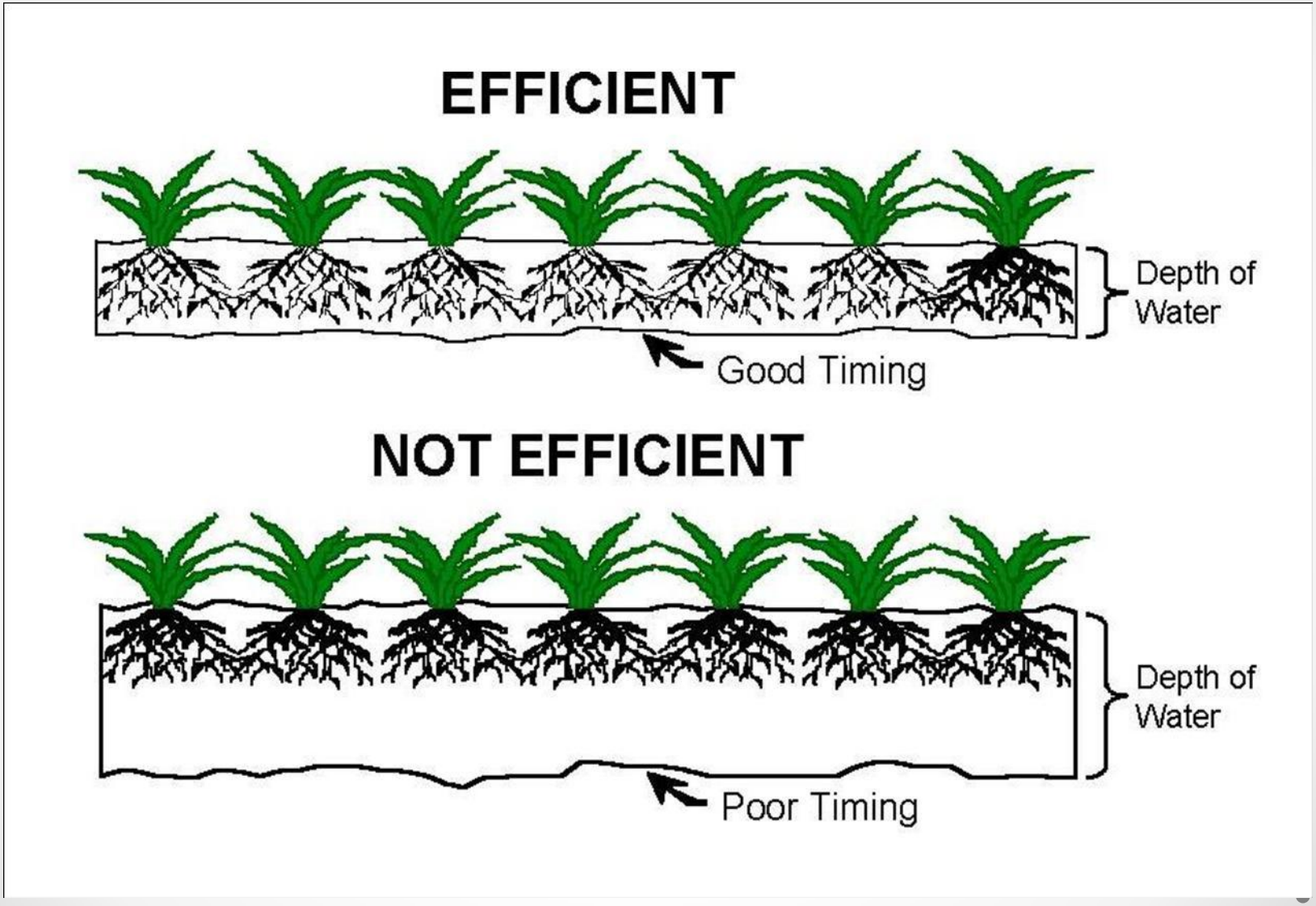
Elements of Uniformity



Application Efficiency

- The ratio of total water applied to the total water infiltrated and stored in the soil
- Often mistakenly used interchangeably with uniformity
- Efficiency is affected by
  - Uniformity
  - Scheduling
  - Maintenance

Application Efficiency



DU_{LQ}

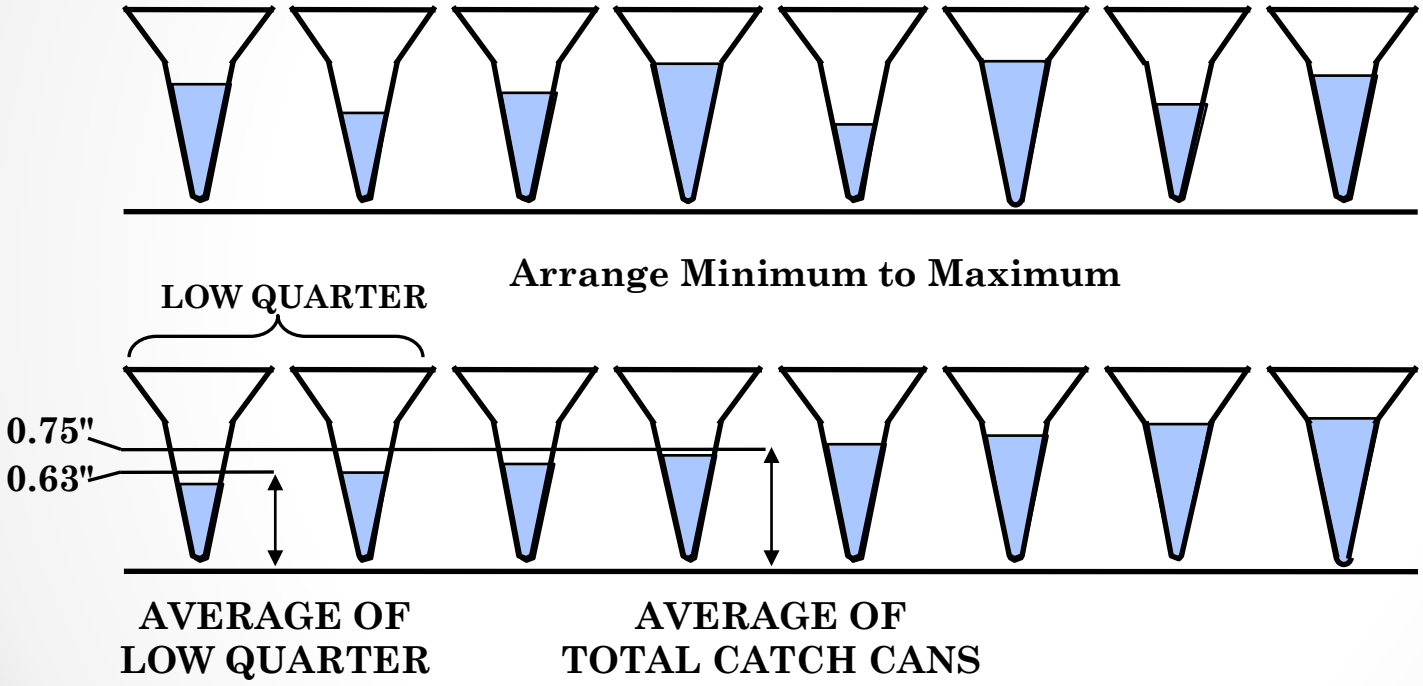
- One way of measuring system uniformity
- Average of the lowest 25% of catchments divided by the average total catchments

Distribution Uniformity (D.U.)(%)

$$DU_{LQ} = \frac{Avg.\ depth\ of\ \ lower\ \ quarter}{Avg.\ depth} 100\%$$

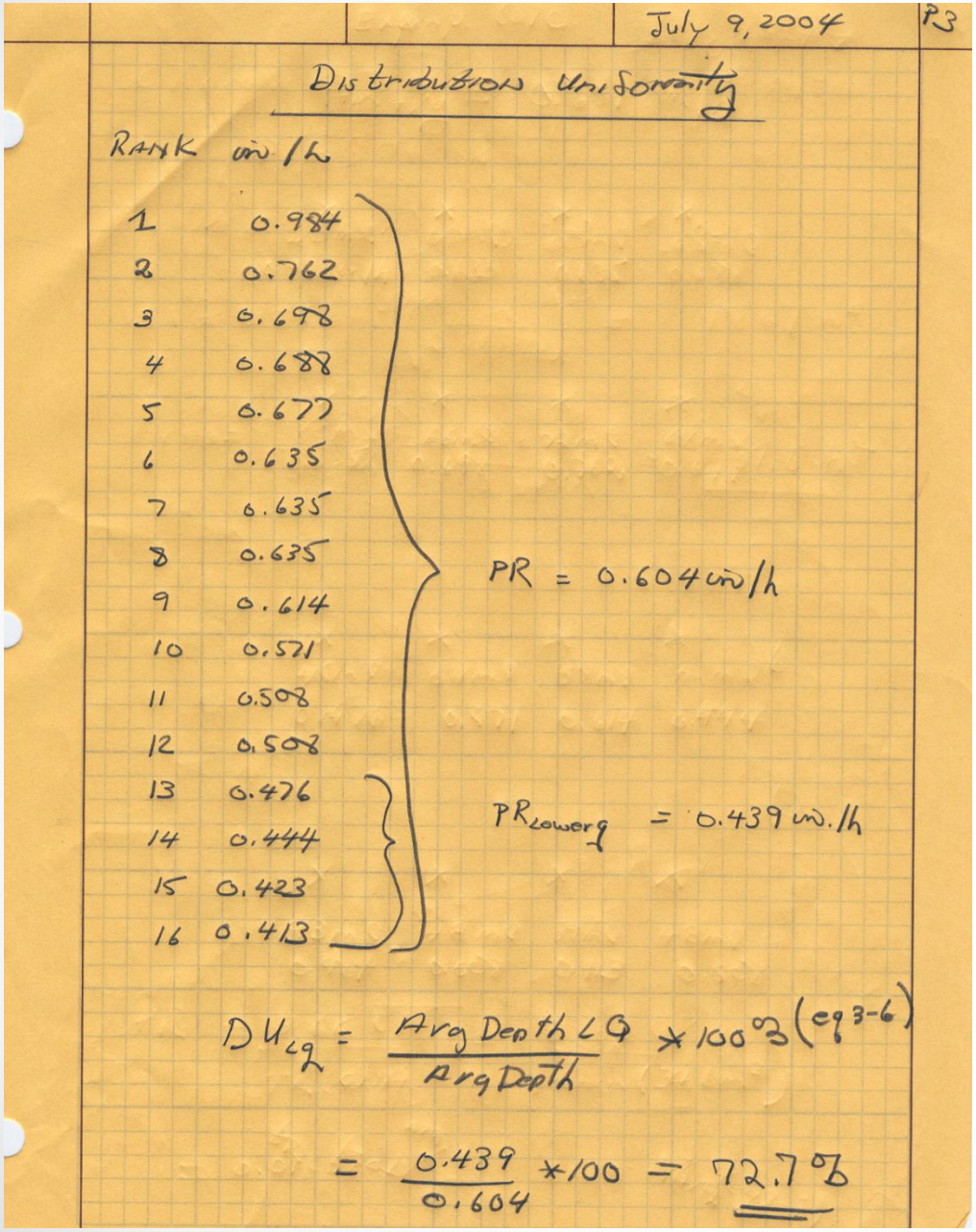
Distribution Uniformity (DU_{LQ})

Field Test



CALCULATE $DU_{LQ} = \frac{0.63}{0.75} \times 100 = .84$ **or 84%**

Distribution Uniformity



July 9, 2004 P3

Distribution Uniformity

RANK	in/h
1	0.984
2	0.762
3	0.698
4	0.688
5	0.677
6	0.635
7	0.635
8	0.635
9	0.614
10	0.571
11	0.508
12	0.508
13	0.476
14	0.444
15	0.423
16	0.413

$PR = 0.604$ in/h

$PR_{lowerq} = 0.439$ in/h

$$DU_{lq} = \frac{\text{Avg Depth } LQ}{\text{Avg Depth}} * 100\% \quad (\text{eq } 3\text{-}6)$$

$$= \frac{0.439}{0.604} * 100 = 72.7\%$$

Expected DU_{LQ}

Sprinkler Type	Achievable (DU_{LQ})	Target (DU_{LQ})	Historical (DU_{LQ})
Rotary Sprinklers	**0.75 – 0.85**	**0.65 - 0.75**	**0.55 – 0.65**
Spray Sprinklers	**0.65 – 0.75**	**0.55 – 0.65**	**0.45 – 0.55**

If lower than historical, consider system improvements

Scheduling:

- **EXAMPLE:**
- **Kc = cool season turf = .80**
- **ETo = .25”/ day**
- **DU = 45%**
- **Soil = sandy loam**
- **PR = .50”/ hr.**

- $T = \frac{60 \times ETo \times Kc}{PR \times EA}$ $T = \frac{60 \times .25 \times .80}{50 \times .45}$

- $T = \frac{12.0}{.23}$ **T = 53 minutes run time**

Scheduling:

- **EXAMPLE:**
- **Kc = cool season turf = .80**
- **ETo = .25”/ day**
- **DU = 70%**
- **Soil = sandy loam**
- **PR = .50”/ hr.**

- $T = \frac{60 \times ETo \times Kc}{PR \times EA}$ $T = \frac{60 \times .25 \times .80}{.50 \times .70}$

- $T = \frac{12.0}{.35}$ **T = 34 minutes run time**

How Uniformity affects runtimes:

DU %	Plant Water Req.	\	DU	Runtime
30%	1"	\	.30	3.33
50%	1"	\	.50	2.00
70%	1"	\	.70	1.42

Think in terms of $$$'s for cost of water & pumps…..

Poor Uniformity Leads to Longer Run Times

Key Irrigation Auditor Actions

- Identify equipment problems
- Determine actual system performance based on uniformity tests
- Adjust run times according to DU and Precipitation rates

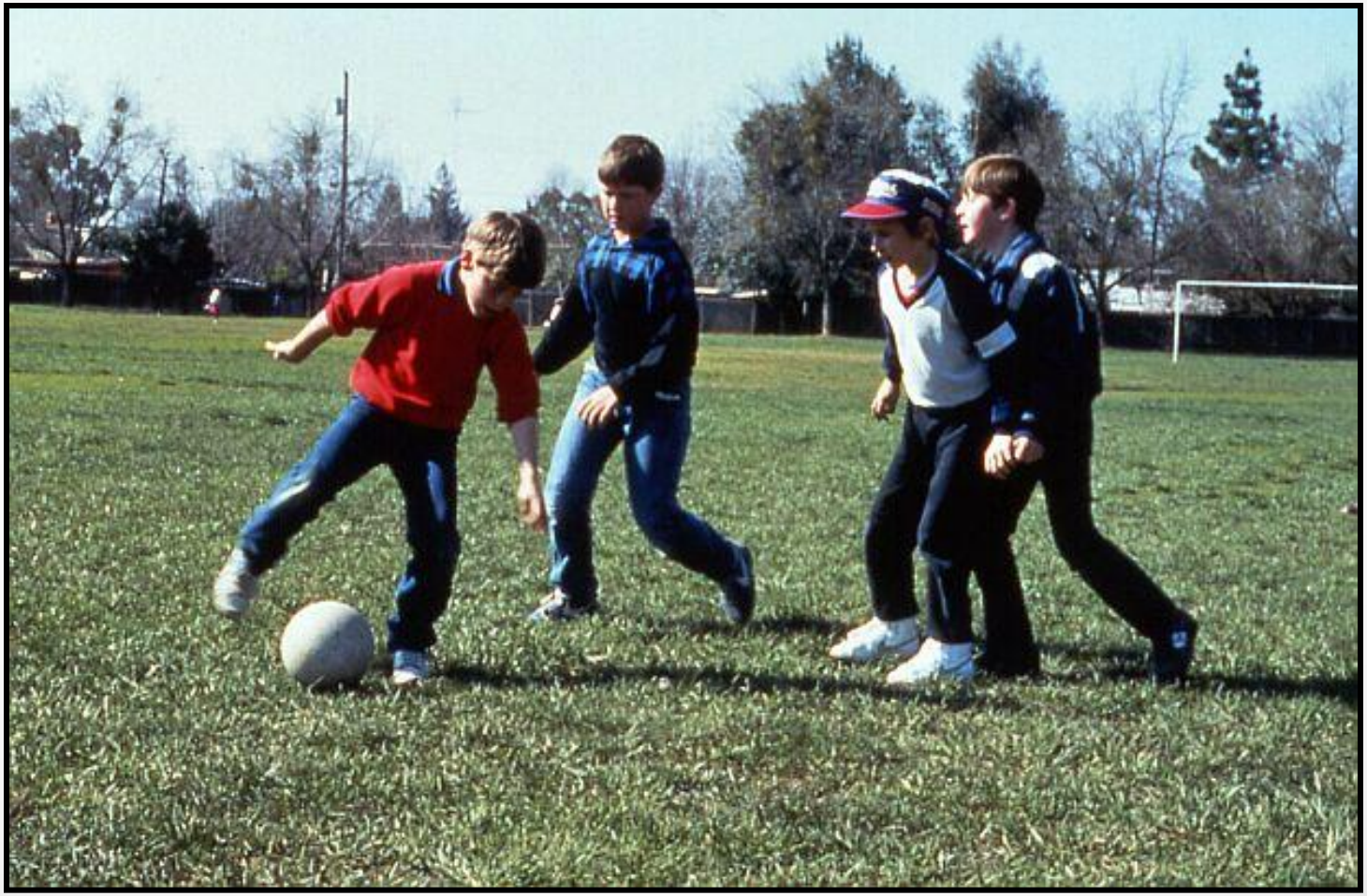
Site Report

- Letter format for management review
- Formal document/ report
- Document hardware changes to consider
- Statistical data to justify renovations!!

Recap Key Actions

- Identify equipment problems
- Repair problems
- Determine actual system performance based on uniformity tests
- Make recommendations for improvement

Considerations…



Considerations…

Considerations…

- Conservation of Water
- Healthy Plant Material
- Aesthetically Pleasing Landscapes
- Prevent Liabilities
- Overall Lower Costs

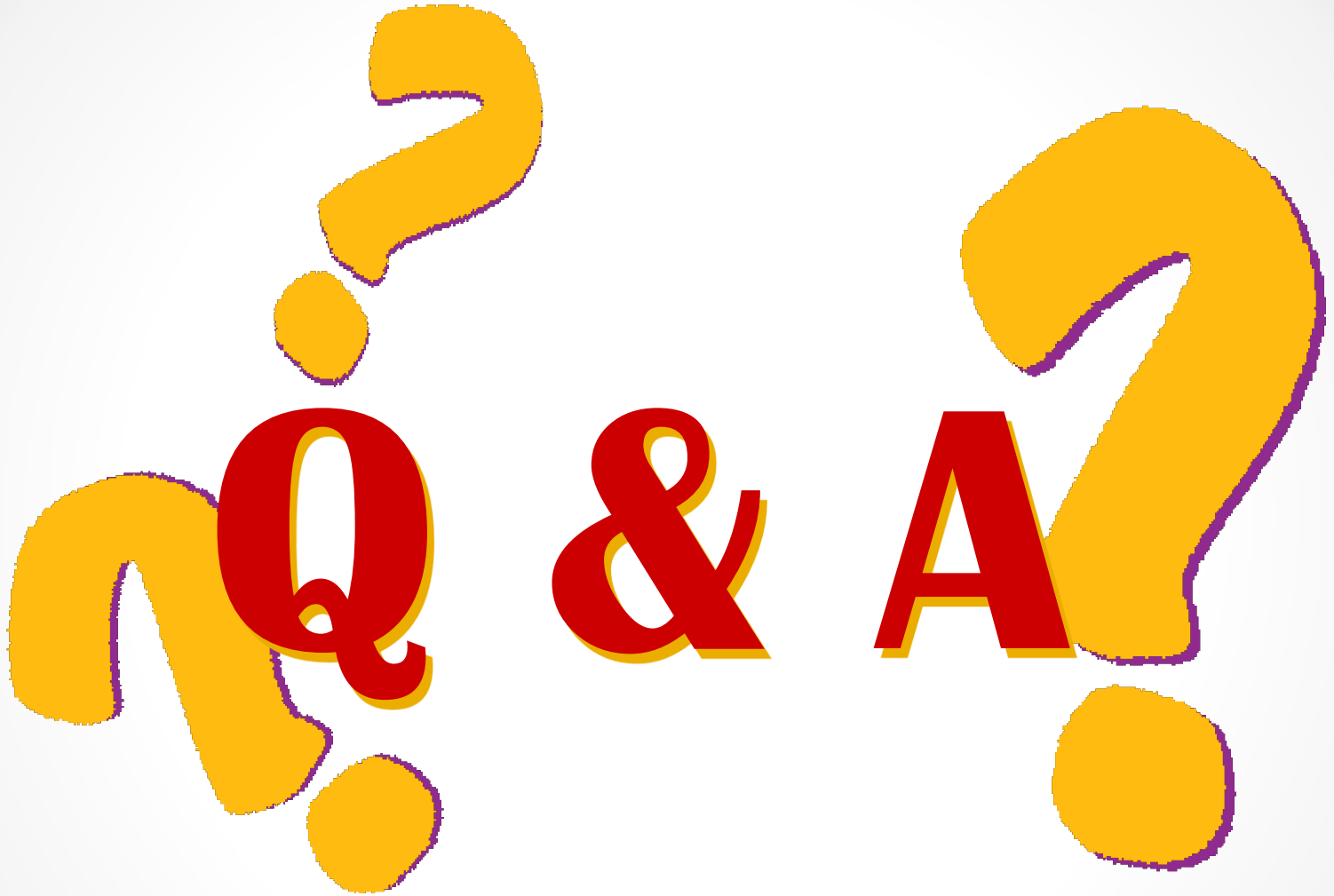
STMA = SUCCESS!

SportsTurf
MANAGERS ASSOCIATION

Experts on the Field, Partners in the Game.

Your #1 Resource

www.stma.org


Q & A

Thank You!

Lynda Wightman; Hunter Industries

406.544.1911 (m)

lynda.wightman@hunterindustries.com