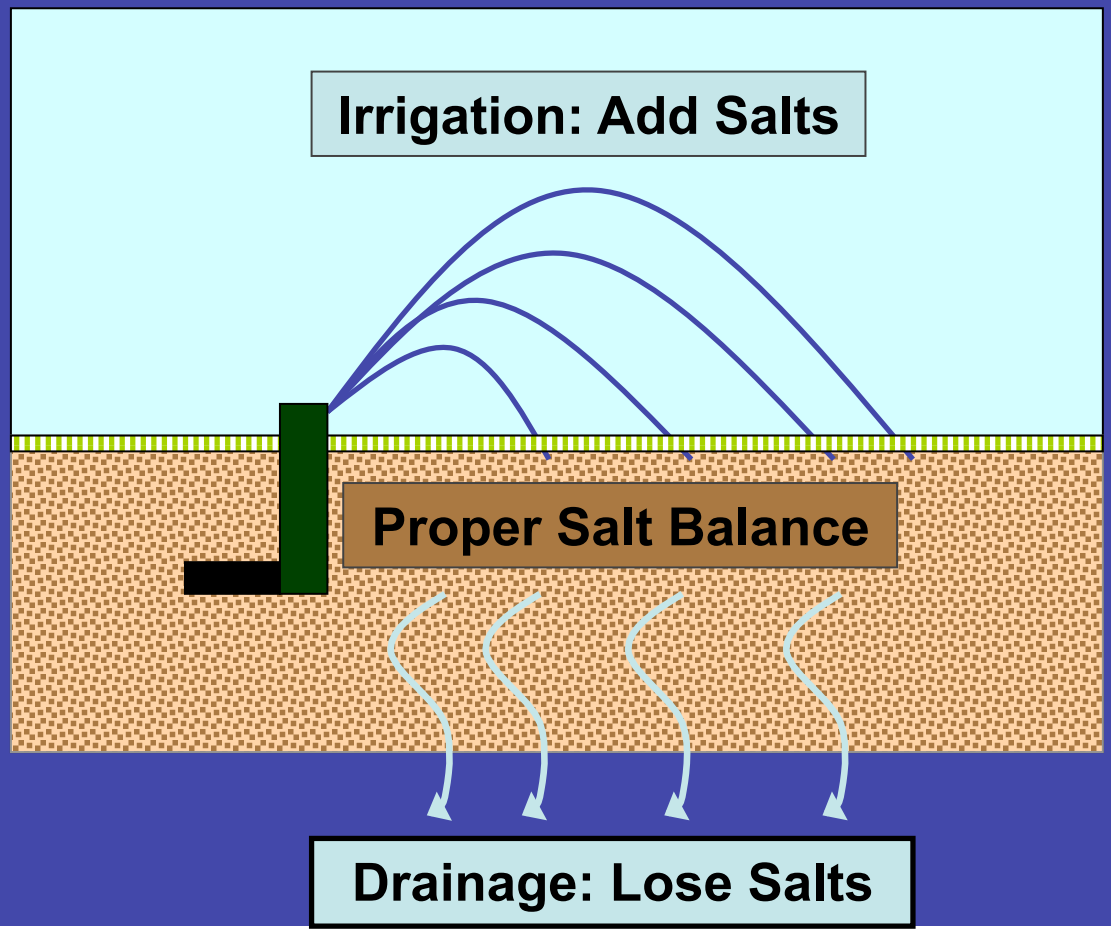
IRRIGATION MANAGEMENT
&
CAPPING SOILS

Paul Brown
Extension Specialist
Dept. of Soil, Water & Environmental Science
University of Arizona

LEACHING:

Key To Salinity Management



Input of Salts From Irrigation Must Be Offset By Loss of Salts In Drainage.

HOW MUCH WATER SHOULD WE APPLY?

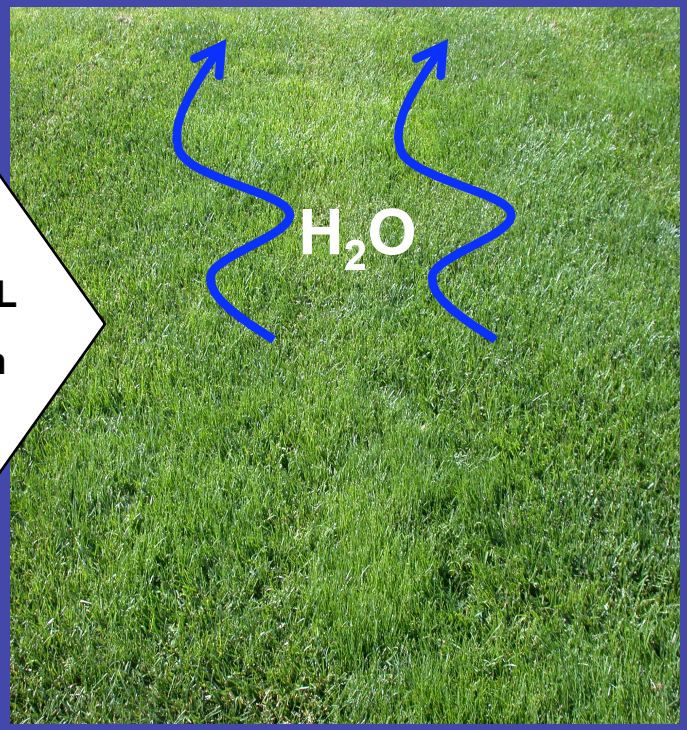
ET + LEACHING FRACTION

ET (EVAPOTRANSPIRATION)

Weather Stations Can Provide Accurate Estimates of ET

EVAPORATION MODEL

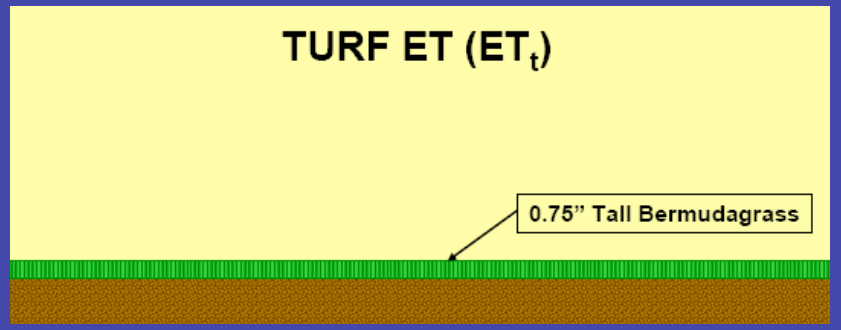
Penman Monteith Eqn



ET: Evaporation from Vegetation

WEATHER STATIONS

Don't Directly Estimate ET



Convert Station ET (ETo) To Turf ET

-Year Round Green Turf Uses ~80% of Weather Station ET

- Irrigation + Rainfall Should Exceed 80% To Avoid Deficit Irrigation

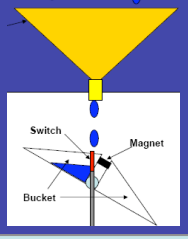
MAINTAIN WEATHER STATIONS!

Wind Speed

Rotates Smoothly & Quietly in Light Wind

Solar Radiation

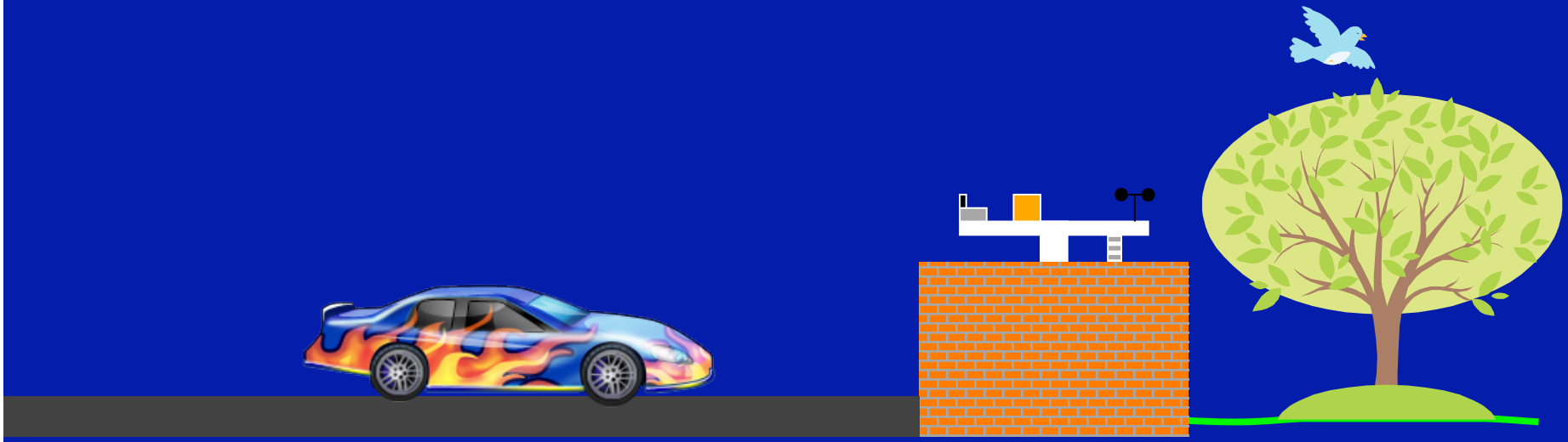
Keep Level & Remove Dirt, Bird Droppings, etc. from White Circle



Rain Gauge

Remove Debris From Screen and/or Buckets

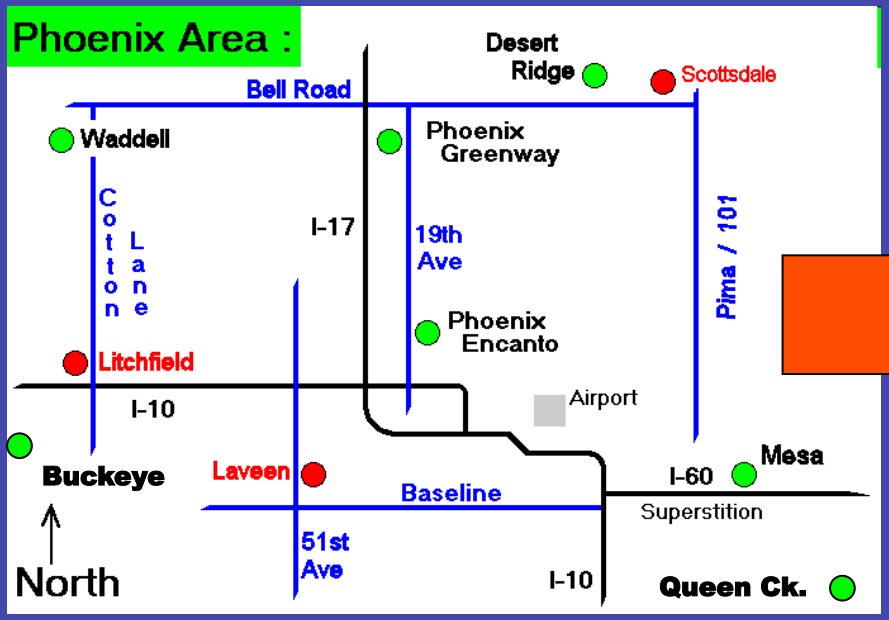
SITING WEATHER STATIONS



Stations should located in open, relatively level areas away from shade. The station should be surrounded by green, well-watered turf.

NO WEATHER STATION???

Phoenix Area Turf Water Use Report



Phoenix Area Turf Water Use Report

NOV, 1 2008

Turf: Winter Rye

LOCATION	Water Use In Inches For Previous Day AC	Day HQ	3 Days AC	3 Days HQ	7 Days AC	7 Days HQ
Phoenix Greenway	.07	.08	.21	.24	.56	.65
Phoenix Encanto	.06	.07	.19	.21	.51	.59
Desert Ridge	.09	.10	.27	.31	.68	.77
Waddell	.06	.07	.18	.21	.48	.54
Mesa	.07	.09	.23	.27	.60	.68
Buckeye	.09	.10	.29	.33	.86	.99
Queen Creek	.11	.13	.32	.37	.86	.99
AREA AVERAGE	.08	.09	.24	.28	.65	.74

AC: Acceptable Quality Turf
HQ: High Quality Turf

AZMET Stations

http://ag.arizona.edu/azmet

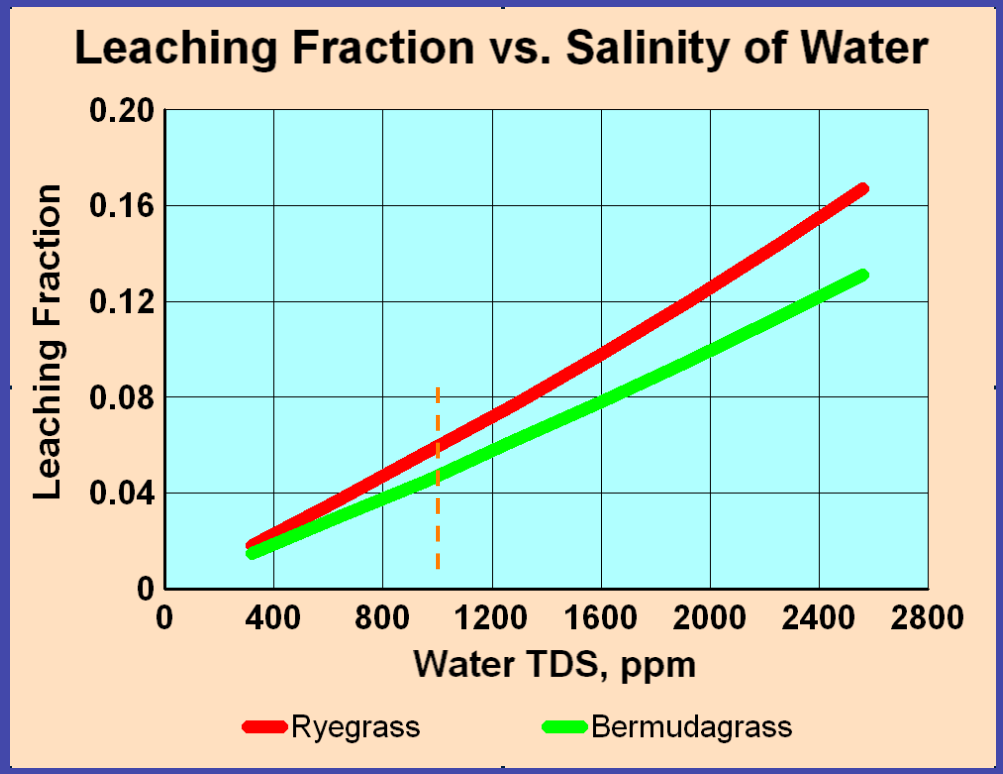
Available From AZMET Website or By Email (Simply Provide Email Address)

LEACHING REQUIREMENTS

Football Practice Field: Mesa Community College

LEACHING REQUIREMENT (LR)

Water Applied In Excess of ET To Leach Salts



$$LR = \frac{ECw}{5 * ECe + ECw}$$

ECw: Salinity of Water

ECe: Turf Salinity Tolerance

ET: 5.0'/Year

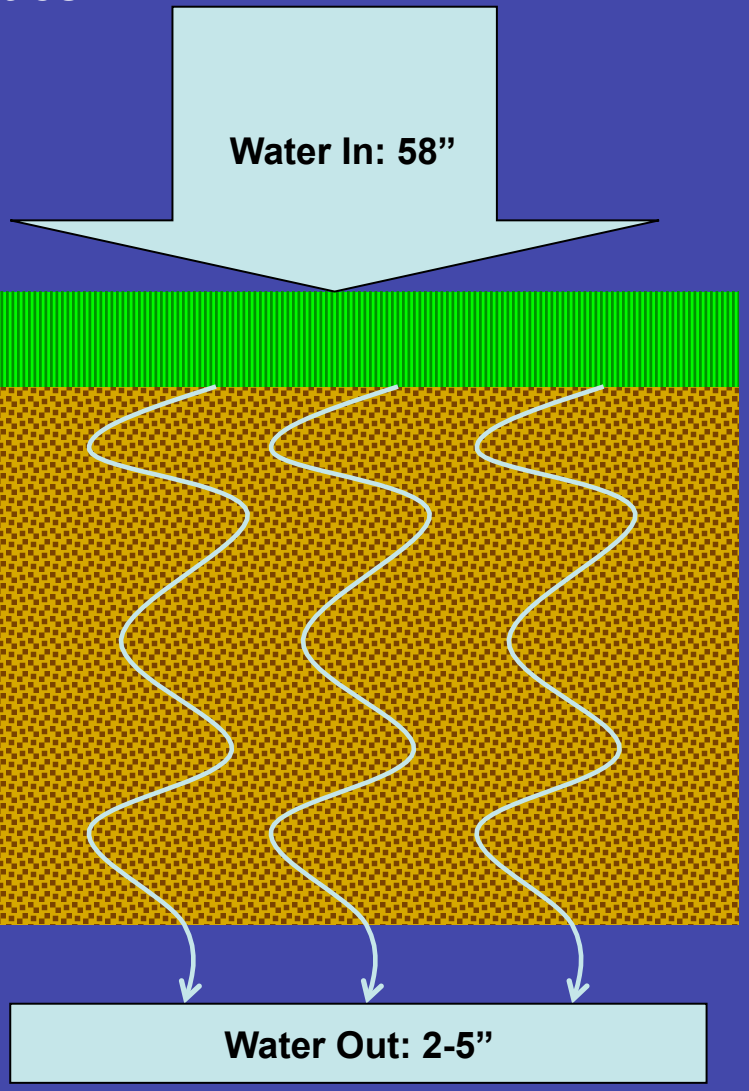
LR: 0.05

$$WR = \frac{ET}{1 - LR} = \frac{5.0'}{1 - 0.05} = 5.26'$$

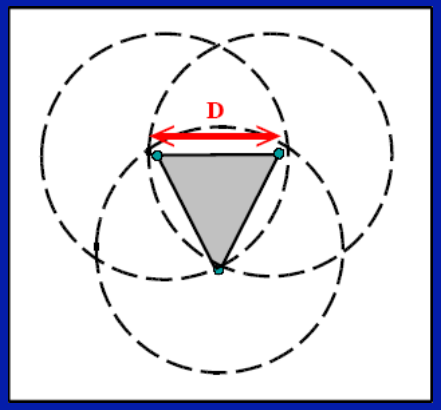
LEACHING FRACTION

2-5” For Most Facilities

Water TDS	Leaching, % of CU		Leaching, Inches	
ppm	Bermuda	Ryegrass	Bermuda	Ryegrass
100	0.4	0.6	0.27	0.33
250	1.1	1.4	0.68	0.85
400	1.8	2.3	1.11	1.38
550	2.6	3.2	1.55	1.93
700	3.3	4.2	2.00	2.50
850	4.1	5.2	2.46	3.09
1000	4.9	6.2	2.94	3.70
1150	5.7	7.2	3.43	4.34
1300	6.6	8.3	3.93	5.00
1450	7.4	9.5	4.46	5.69
1600	8.3	10.7	4.99	6.40
1750	9.2	11.9	5.55	7.14
1900	10.2	13.2	6.12	7.92
2050	11.2	14.5	6.71	8.72
2200	12.2	15.9	7.32	9.57
2350	13.3	17.4	7.95	10.44
2500	14.3	18.9	8.61	11.36



KNOW PRECIPITATION RATES



$$PR = (GPM * 96.3)/[D^2 * 0.866]$$

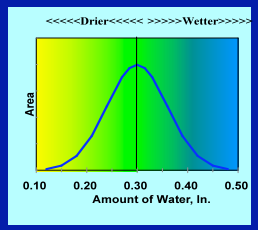
Where: PR is the precipitation rate in inches/hour
GPM is Discharge of full circle head in gallons per minute.
D is the spacing distance between adjacent heads in feet.

Precipitation Rates Are Often Estimated From Formulas or Meters

Measured Rates Are Often 10-20% Less Than Computed Rates.

EVEN IF YOU GET ET CORRECT…

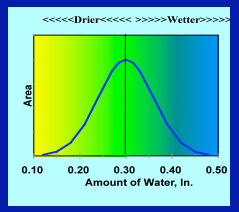
You Have To Deal With Non-Uniform Irrigation To Avoid Deficit Irrigation

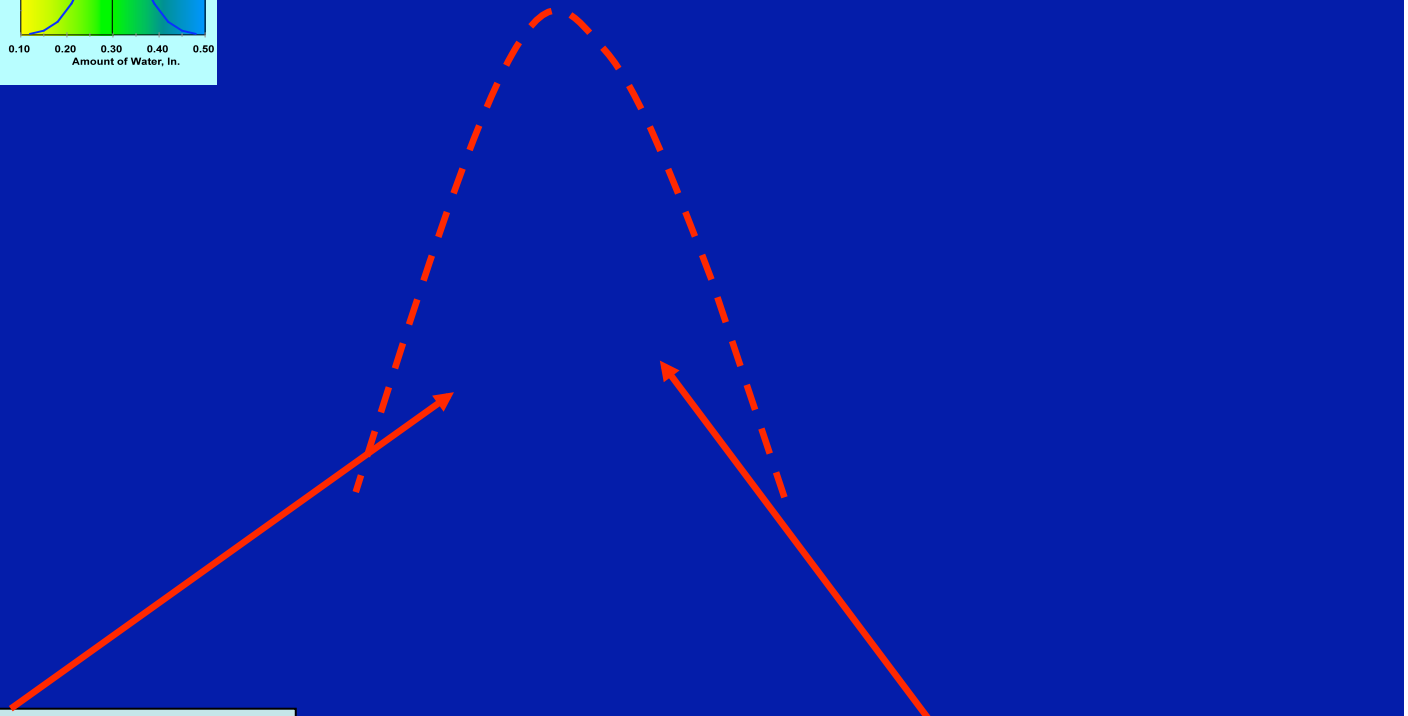


Too Dry

Too Wet

MANUAL WATERING & ADJUSTING HEADS ALTERS DISTRIBUTION

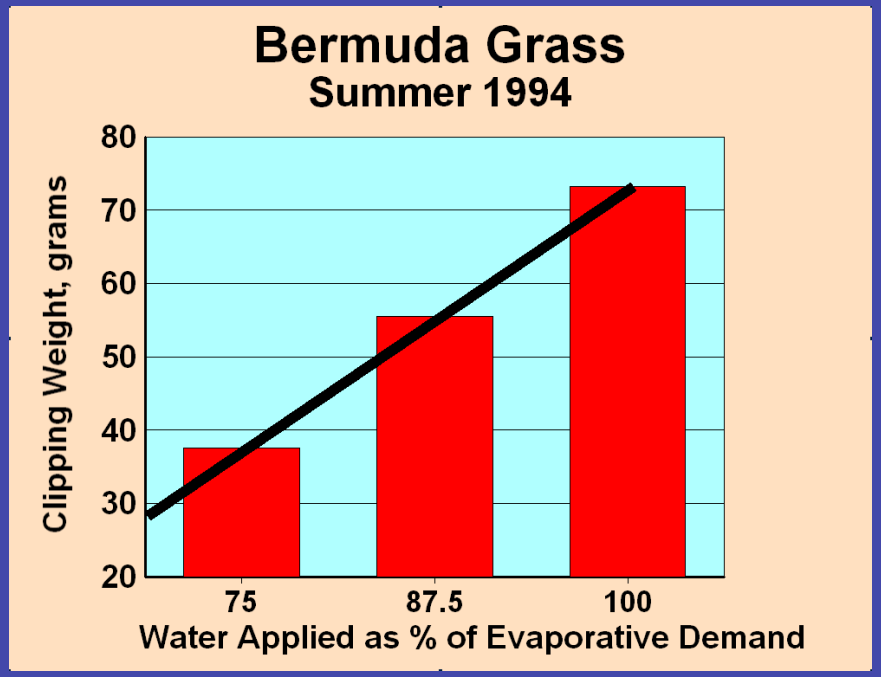


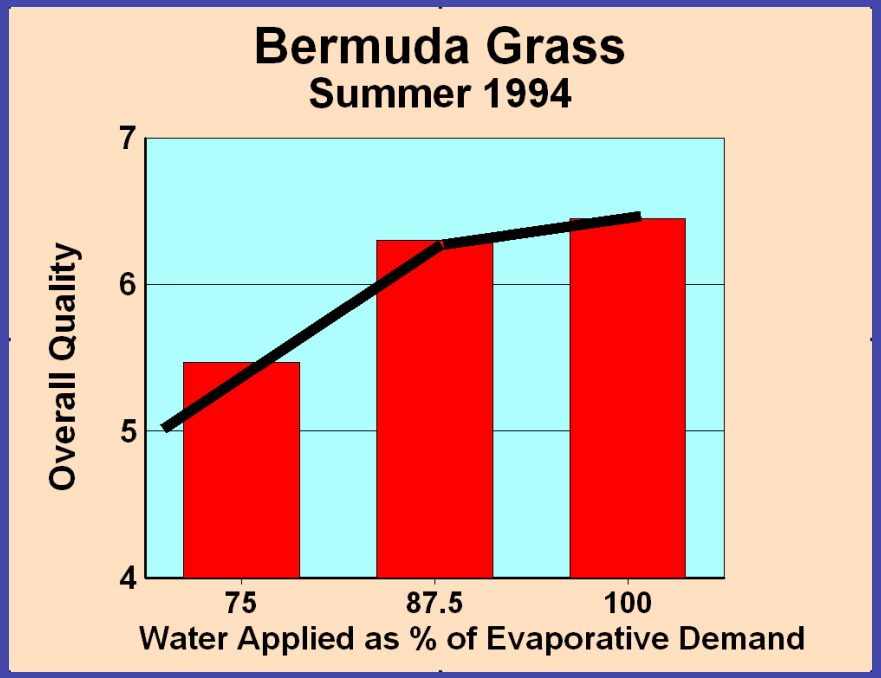


Potential for Acceptable Quality Turf With Deficit Irrigation

Optimal Slow Leaching

DEFICIT IRRIGATION

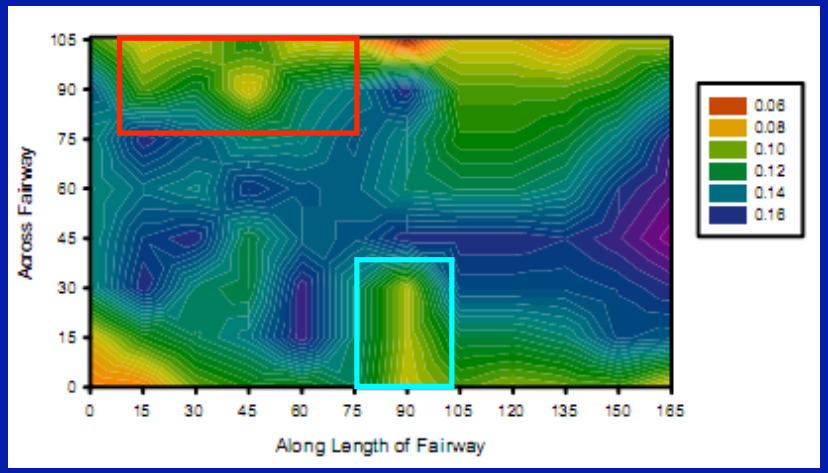




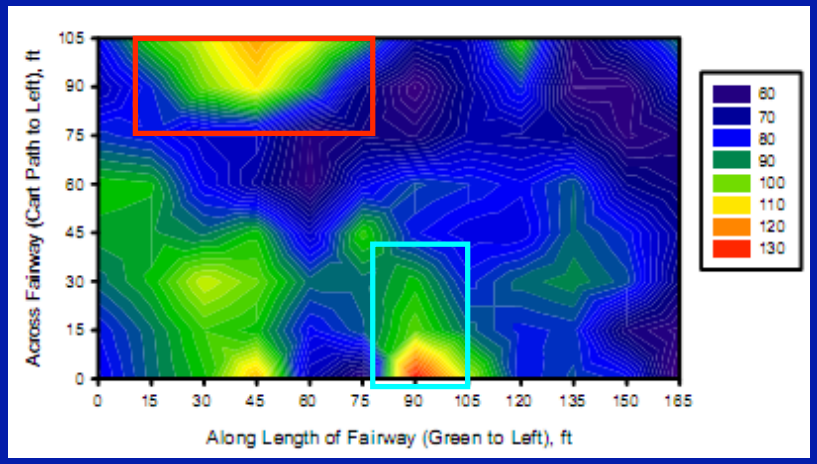
1. Growth Declines Rapidly With Deficits
2. Quality Declines More Slowly
3. Substandard Performance Below 85% of ET

RECENT RESEARCH

Irrigation:



Salinity:



LOCATING DEFICIT IRRIGATION

Severely Deficit Areas Often Exhibit Poor Turf Quality

SCREW DRIVER TEST

- Push Into Soil
- Reading
  - No Deficit: Easily Penetrates
  - Deficit: Pentrates Short Distance
- Rocks Lessen Effectiveness

SCREWDRIVER IN ACTION

GCSSA Sponsored Line Source Study in Tucson

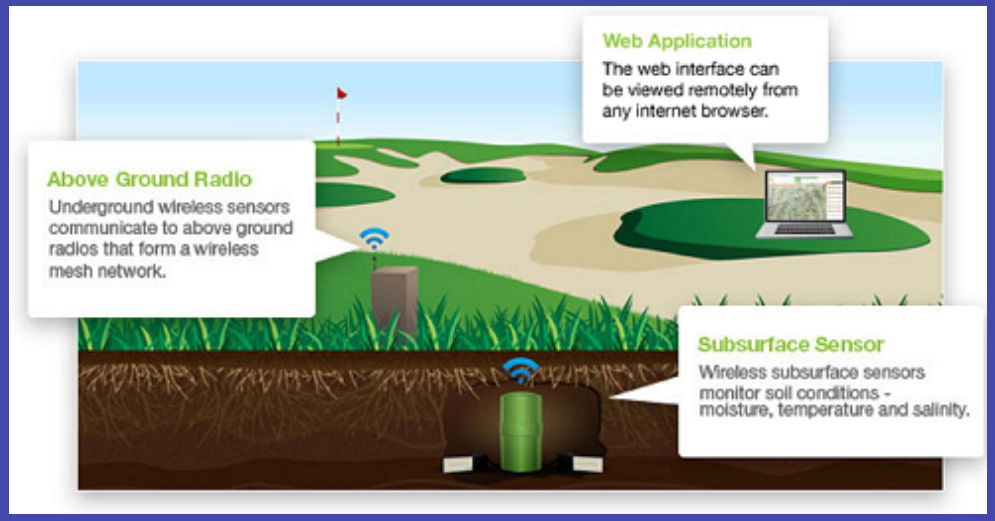
125% of ET

100% of ET

75% of ET

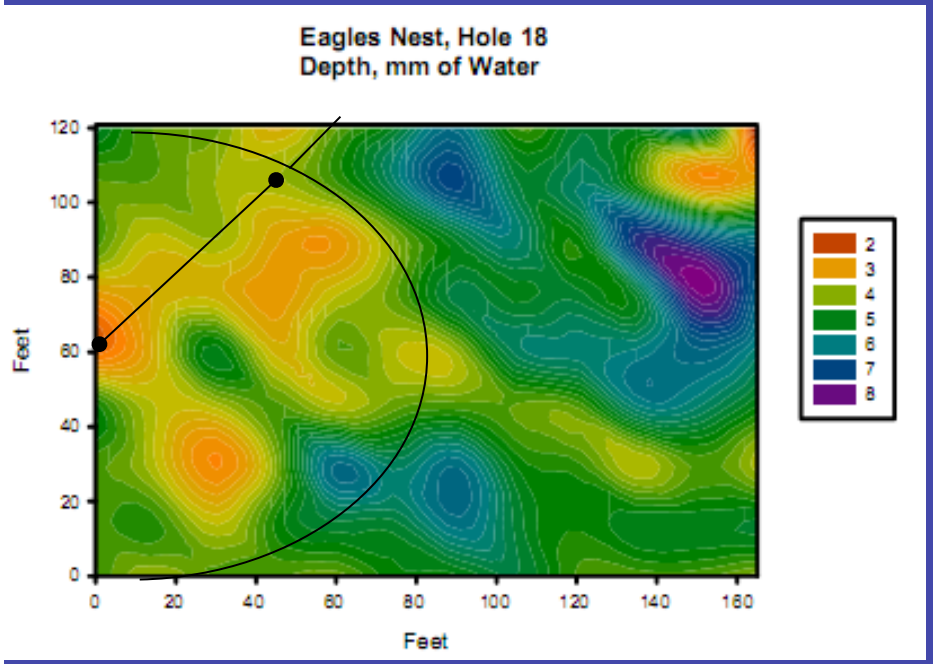
50% of ET

ELECTRONIC SENSORS



A Number of Soil Moisture/Salinity Sensors Are Available or Are Coming to Market. Many of These Sensors Work Well, But Installation & Interpretation of Readings Requires Some Experience. Cost & Spatial Variation Are Issues of Importance.

DEALING WITH DEFICIT AREAS



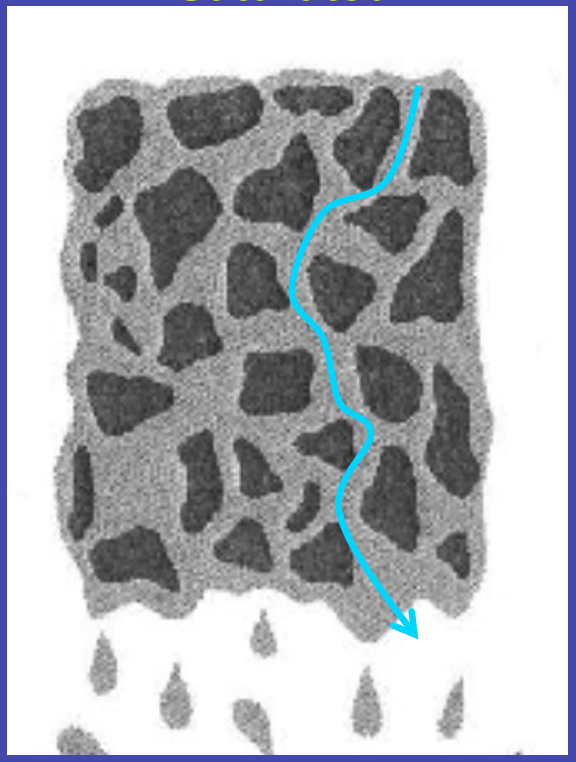
Running Regular Heads in Dry Areas

Use Screw Drive To Evaluate Effectiveness

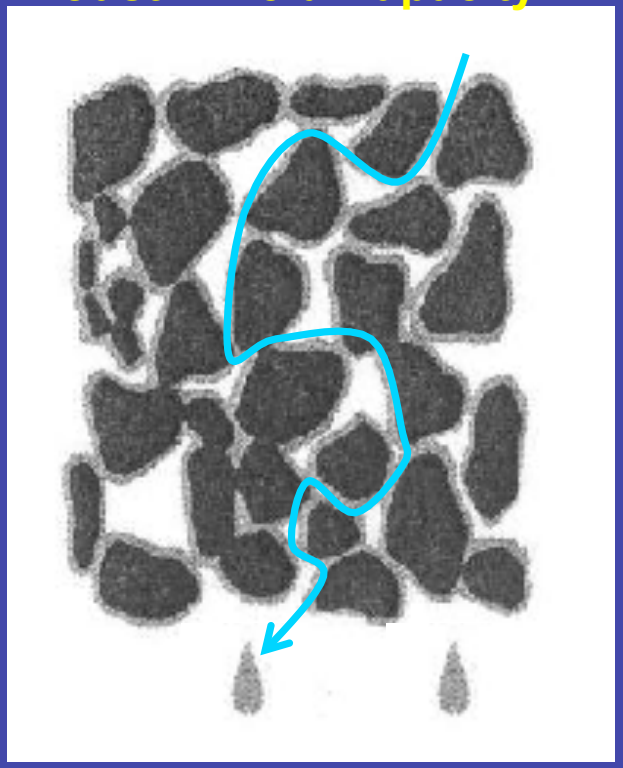
Temporary/Portable Sprinklers

MOST EFFICIENT WAY TO LEACH

Saturated



Just > Field Capacity



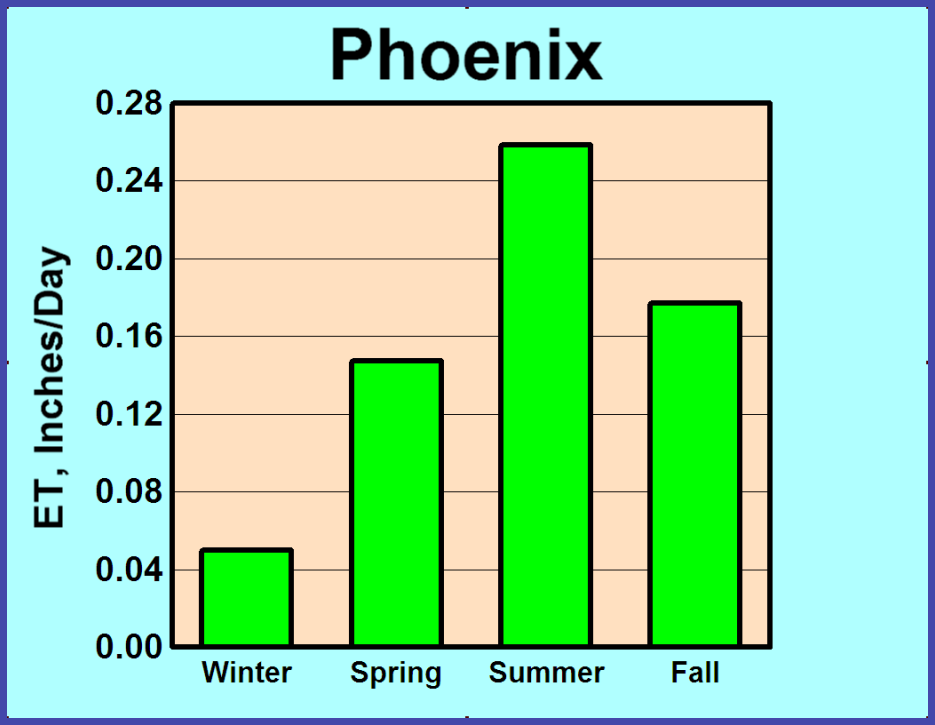
Slow Leaching (Adding Leaching Fraction Each Day) Is Generally Considered More Efficient (Than Flooding) as Water Moves Slowly Through Smaller Pores and More Efficiently Removes Salts.

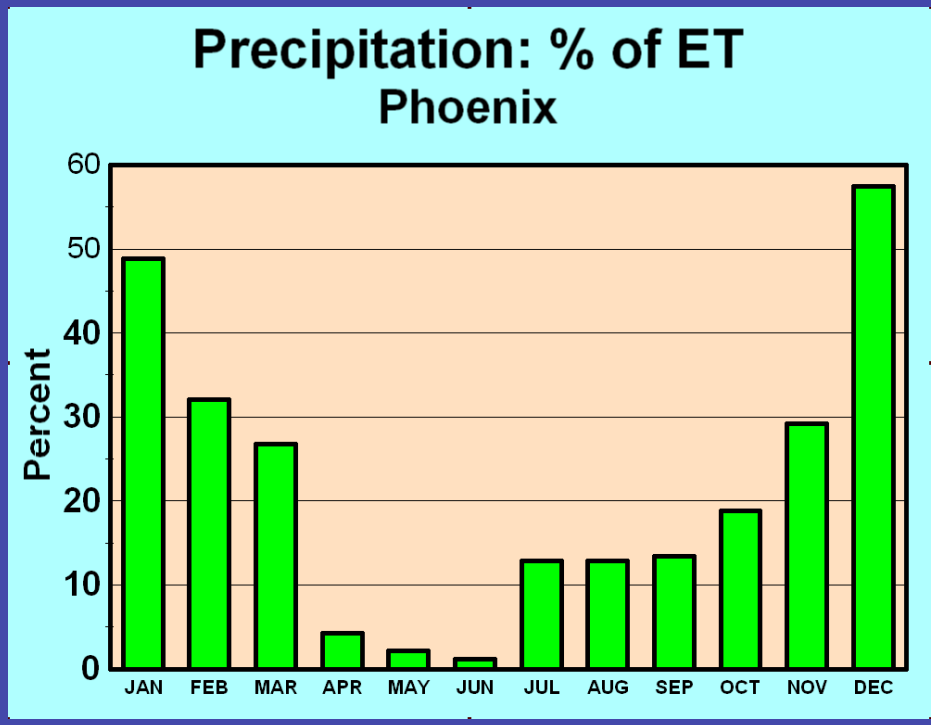
LEACHING OPTIONS

- Add Leaching Fraction Each Day
  - Difficult Due To Accomplish
  - Irrigation Non-Uniformity
  - Excessive Wetness
- Facility Closed One Day/Week
  - Night Before Closed Day
  - Irrigate 0.1” More Than ET
    - Generates 5.0” Leaching Over Year
- Short Term Leaching Options
  - High Rainfall
  - Overseeding

LEACHING OVER SHORT INTERVALS

Winter is Best Time: ET is Low & Precipitation is Higher Fraction of ET

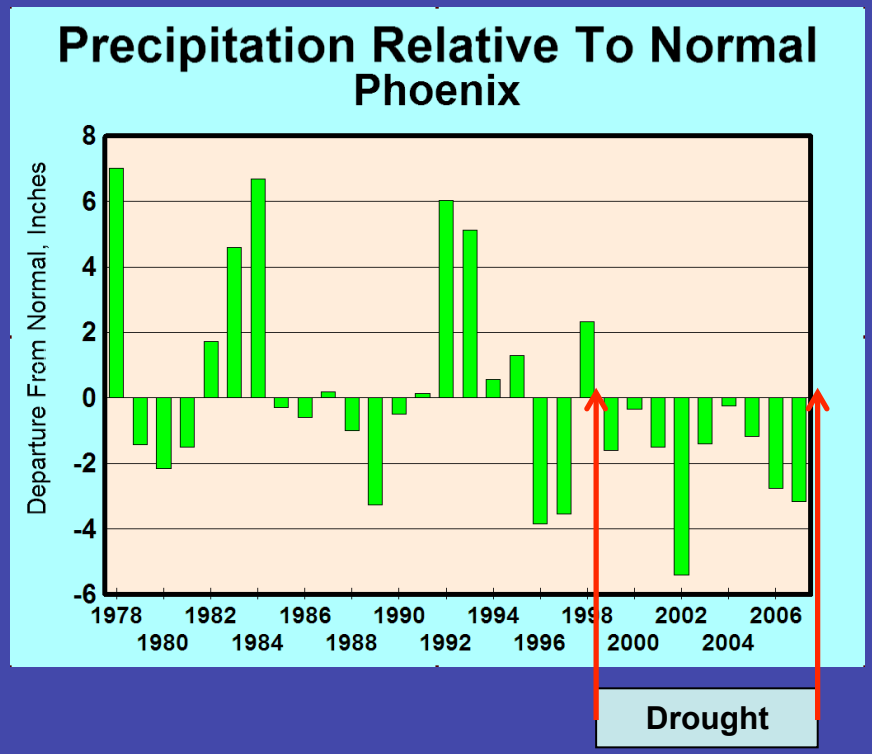


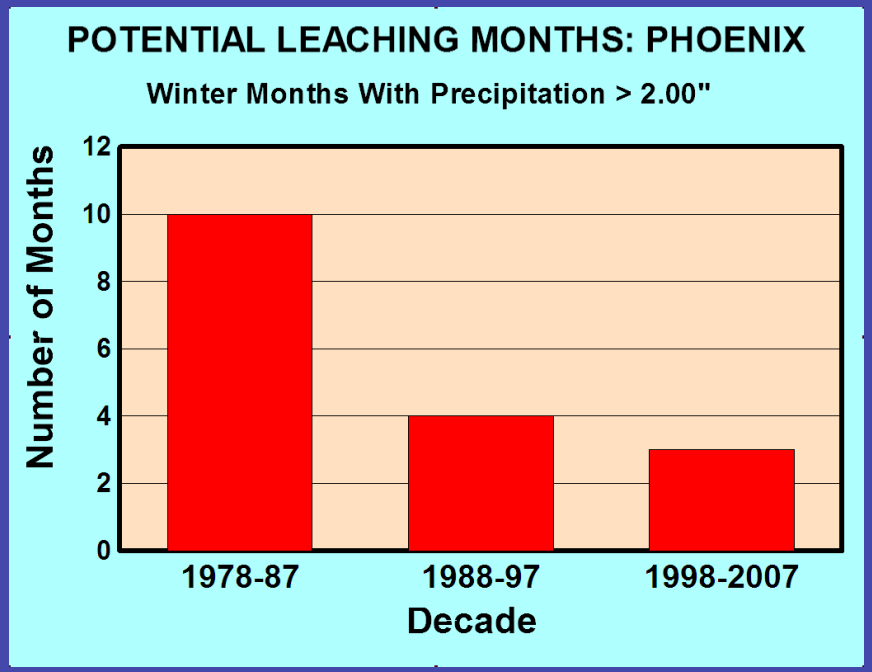


0.25” in Winter Nets 0.20” of Leaching

0.25” in Summer Produces Little or No Leaching

RAINFALL IS GOOD OPTION





But Nature is Not Cooperating!!!

LEACHING DURING OVERSEEDING

- Courses Closed
- Excess Wetness Required/Allowed
- Moderate ET Rates
- Courses Often Complete Tillage in Summer
- Right Before “Wet” Season

LEACHING DURING OVERSEEDING

Water TDS	Leaching, Inches	
ppm	Bermuda	Ryegrass
100	0.27	0.33
250	0.68	0.85
400	1.11	1.38
550	1.55	1.93
700	2.00	2.50
850	2.46	3.09
1000	2.94	3.70
1150	3.43	4.34
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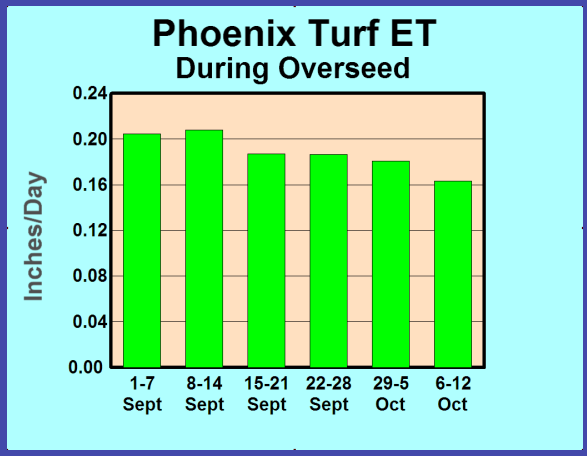
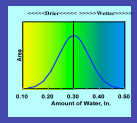




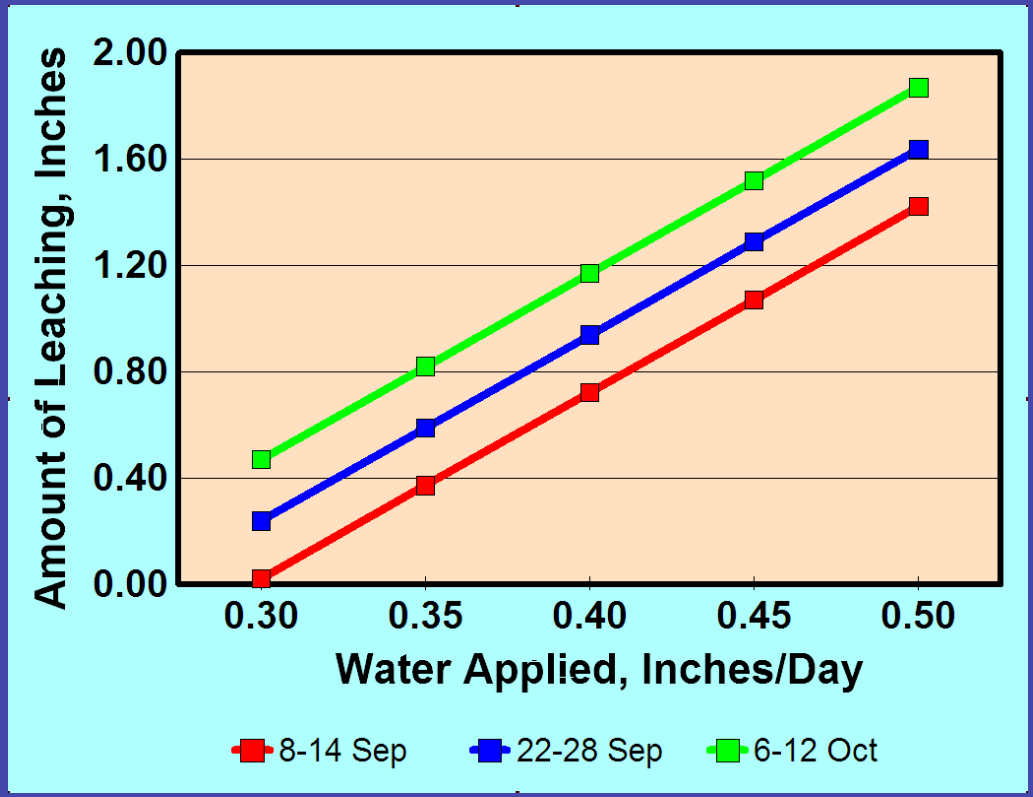
Leaching Requirement | **Turf Requirement** | **Irrigation Uniformity**

Leaching Rate = Water Applied – ET

Must Deal With Dry Side of Irrigation Distribution

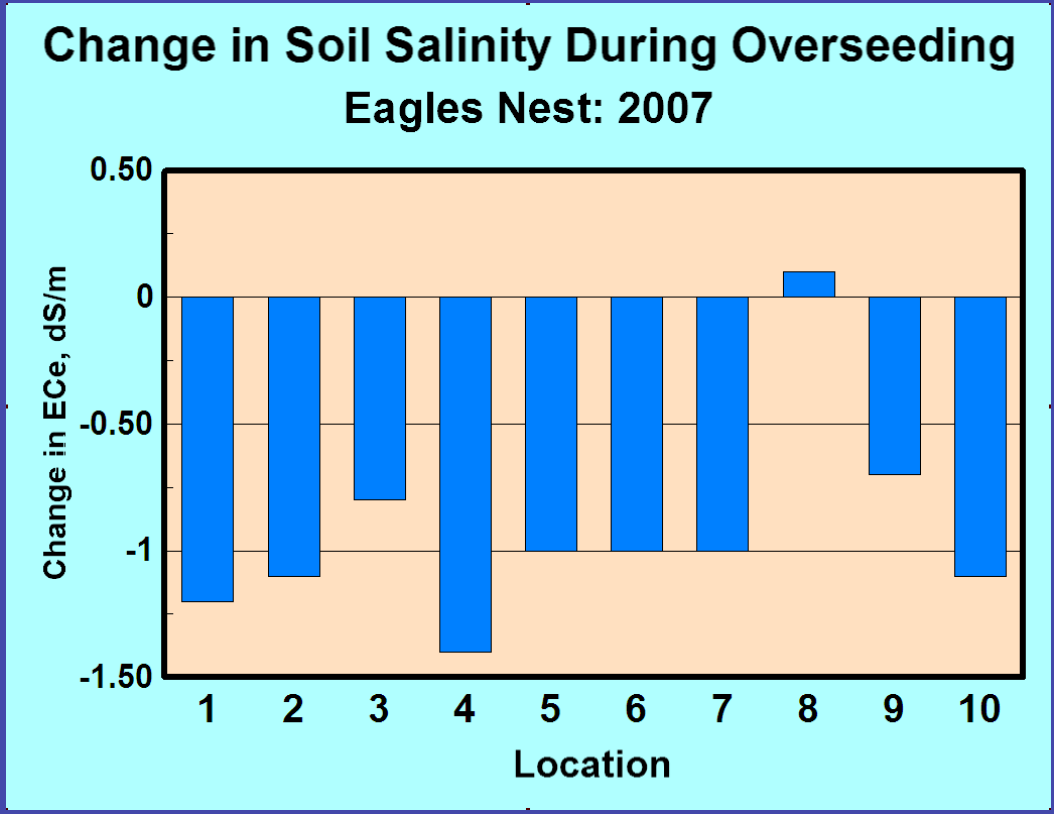
LEACHING DURING OVERSEED

- ET
  - 80% of ETo
- Irrigation Uniformity
  - DU = 0.70
- Irrigation Rates
  - 0.30-0.50”/Day
- Leaching Amount
  - Weekly Total
  - 90% of Course



High Rates of Irrigation During Overseed Establishment Can Generate 1-2”/Week of Leaching.

CAN WE ACCOMPLISH LEACHING DURING OVERSEEDING?



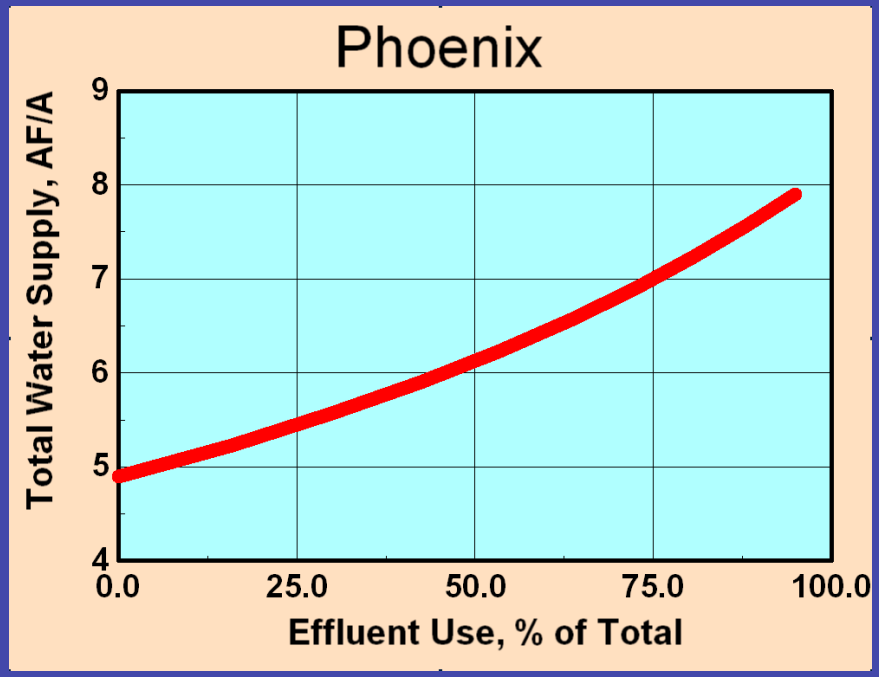
Pre-Overseed Samples Obtained 9 October 2007

Post Overseed Samples Obtained 21 November 2007.

INFILTRATION IS KEY TO LEACHING

EXTRA WATER FOR LEACHING?

Effluent as Part of Supply



Groundwater In Excess of 1000ppm

D. Leaching Allotment Addition

The owner or operator of a turf-related facility may apply to the director for an allotment addition for leaching purposes. The director shall approve the application if the water supply used for landscape watering at the facility contains at least 1,000 milligrams per liter of total dissolved solids. If the director approves an allotment addition for leaching purposes, the director shall calculate the additional allotment as follows:

$$\text{Leaching Allotment Addition} = \left(\frac{1}{1 - \left(\frac{EC_w}{5EC_e - EC_w} \right)} - 1 \right) \times \frac{CU}{0.85}$$

Where:

EC_w = *Electrical conductivity of water used*
EC_e = *Tolerance of the grass species grown to the soil salinity in electrical conductivity of the soil saturation extract*
CU = *Consumptive use requirement for the grass species*

Any allotment addition granted under this subsection shall remain in effect until the water supply used for landscape watering at the facility contains less than 1,000 milligrams per liter of total dissolved solids or until the first compliance date for the facility's conservation requirements in the Fourth Management Plan, whichever occurs first.

Effluents Generally Require Higher Leaching Fractions. Regulations Allow Turf Facilities To Use More Water When Using Effluent.

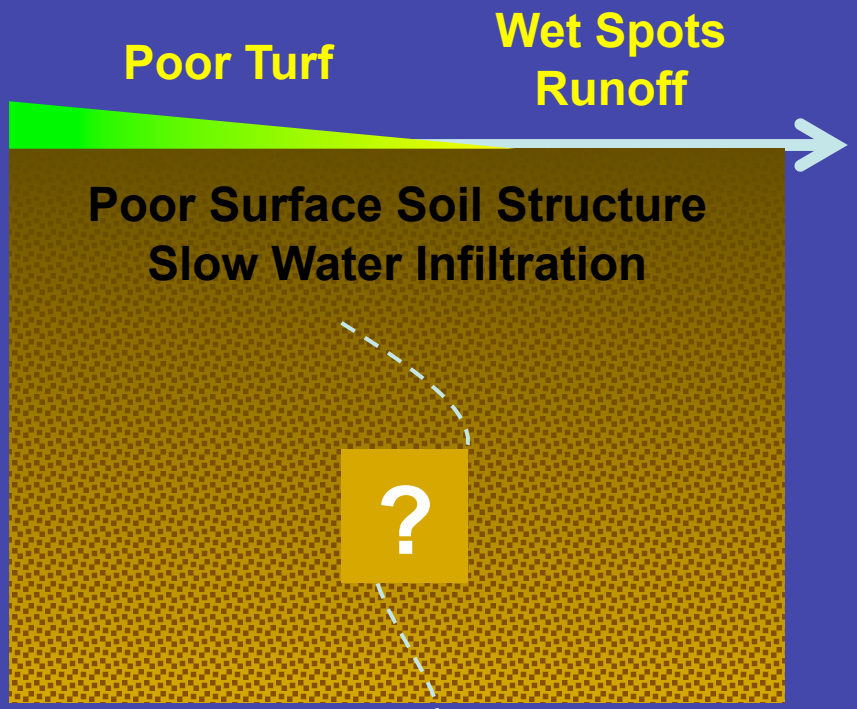
DWR Provides Additional Water For Leaching If Salinity Exceeds 1000ppm. Few Facilities Have Applied for This Adjustment.

EXTRA WATER FOR LEACHING

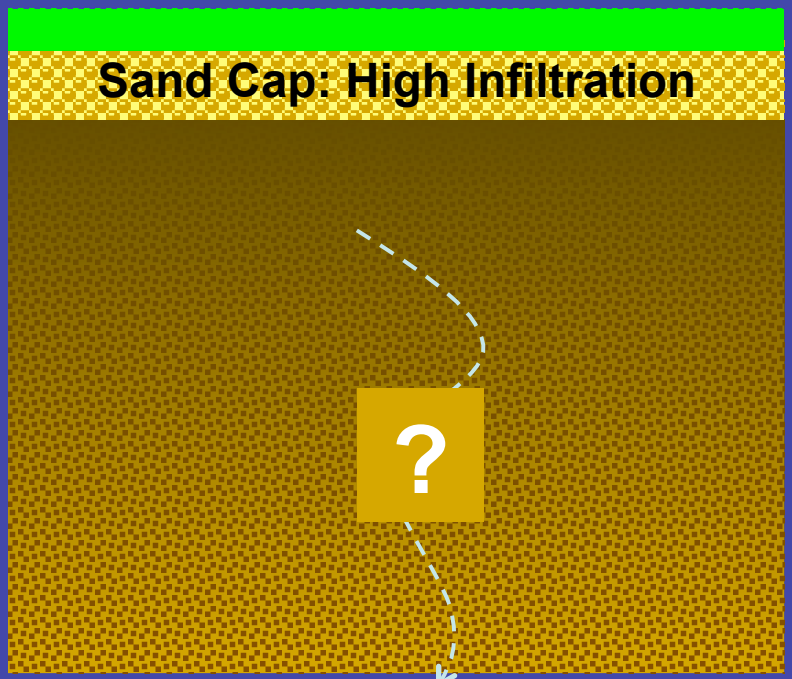
Reduce Overseeding

- **Water Savings: <18”/Acre**
  - **Winter Is Low ET Season**
  - **Precipitation Runs 30-50% of Overseeded ET**
  - **Still Have To Irrigation In Oct, Mar & Apr**
- **Assume Savings Is 16”/Acre**
  - **You Need 4” Additional Water For Leaching**
  - **Leach 4 Acres For Each Acre Not Overseeded**
    - 18 Acres Not Overseeded
    - Can Leach Remaining 72 Acres

SAND CAPS



Little or No Leaching



Minimize Surface Infiltration Issues

What About Leaching?

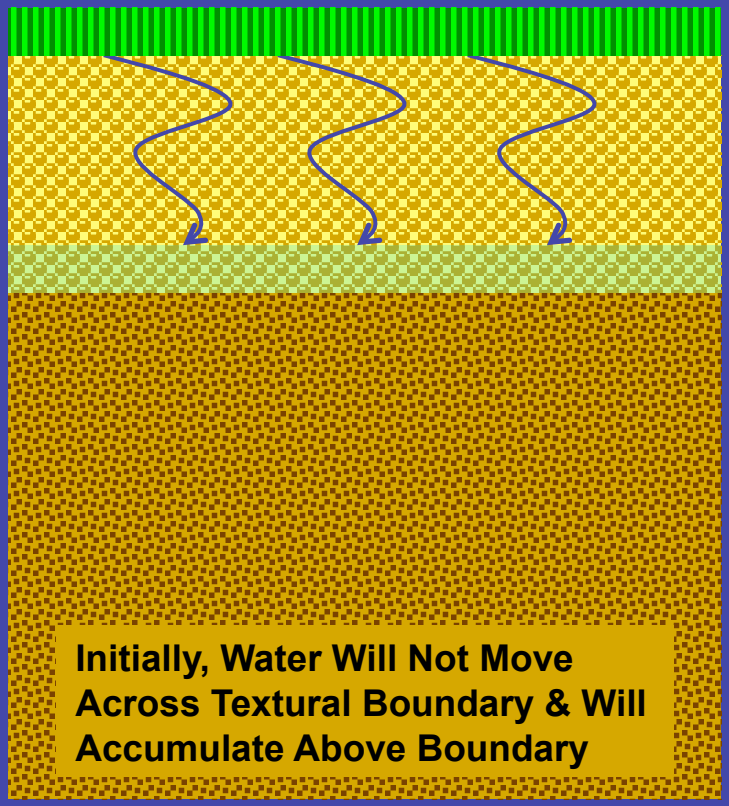
SAND CAPPING FAIRWAYS

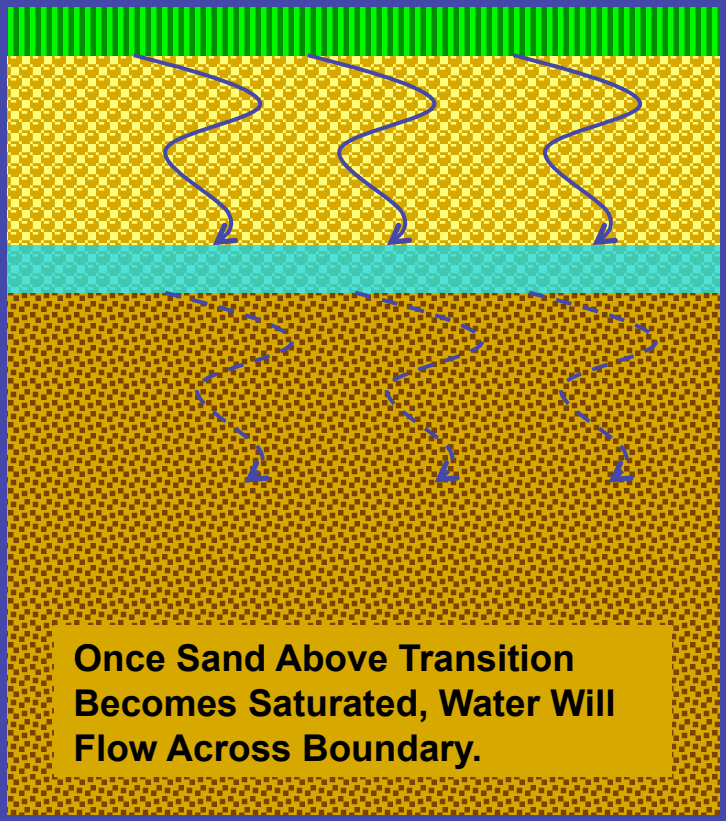
Some Things To Consider

- Water Movement
  - Deep Percolation & Leaching
  - Drainage
- Water Holding Capacity
- Nutrient Management

LAYERED SOILS

Water Movement Inhibited At Boundary

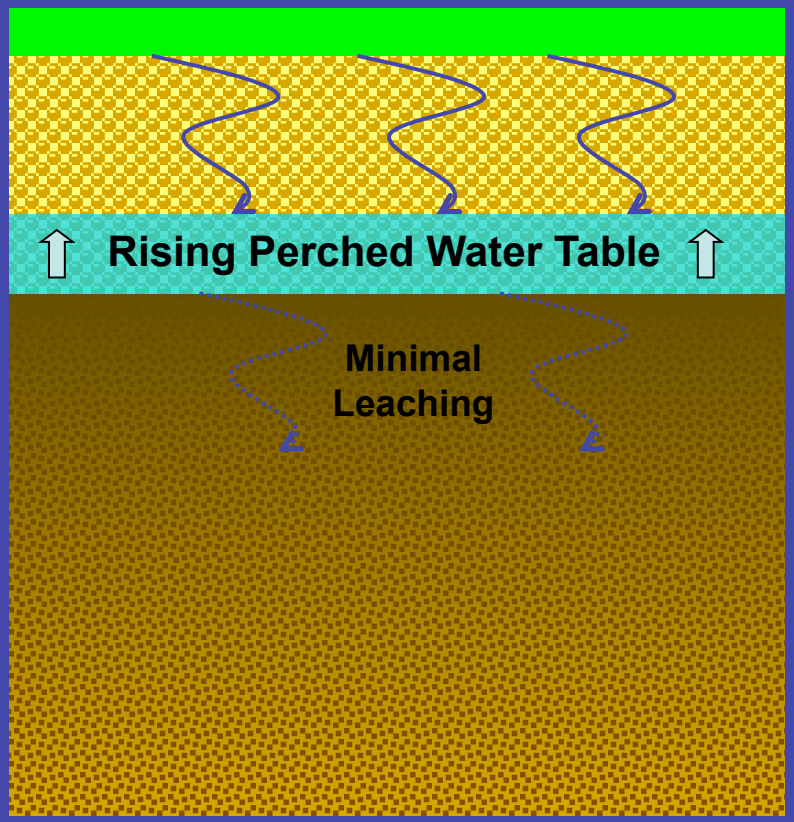




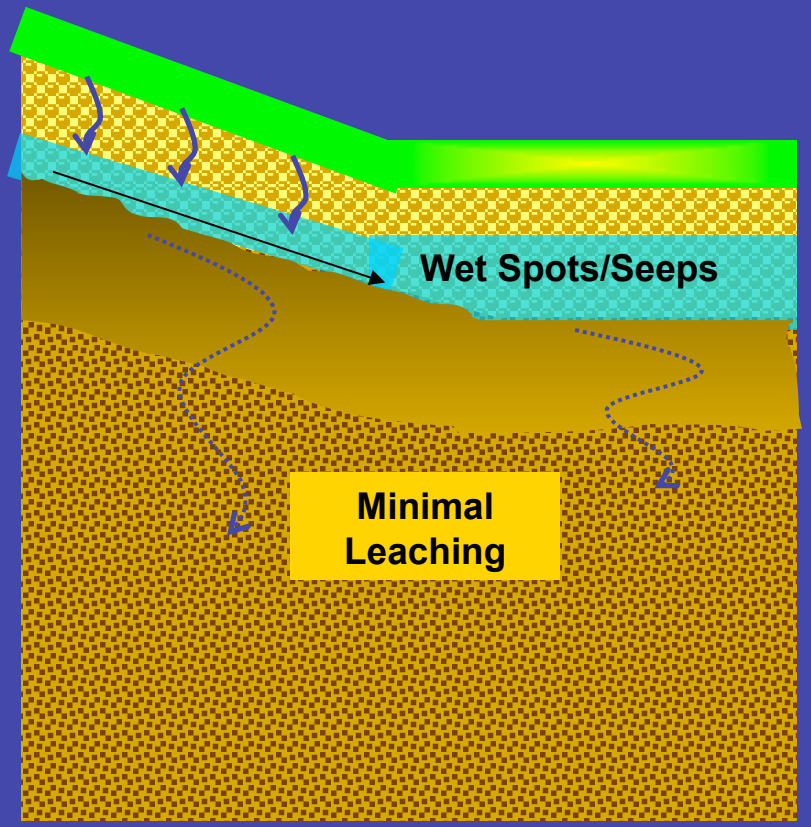
Difficult Leaching Situation & Potential For Anaerobic Root Zone

CAPPING POOR INFILTRATION SOILS

Burying A Problem??

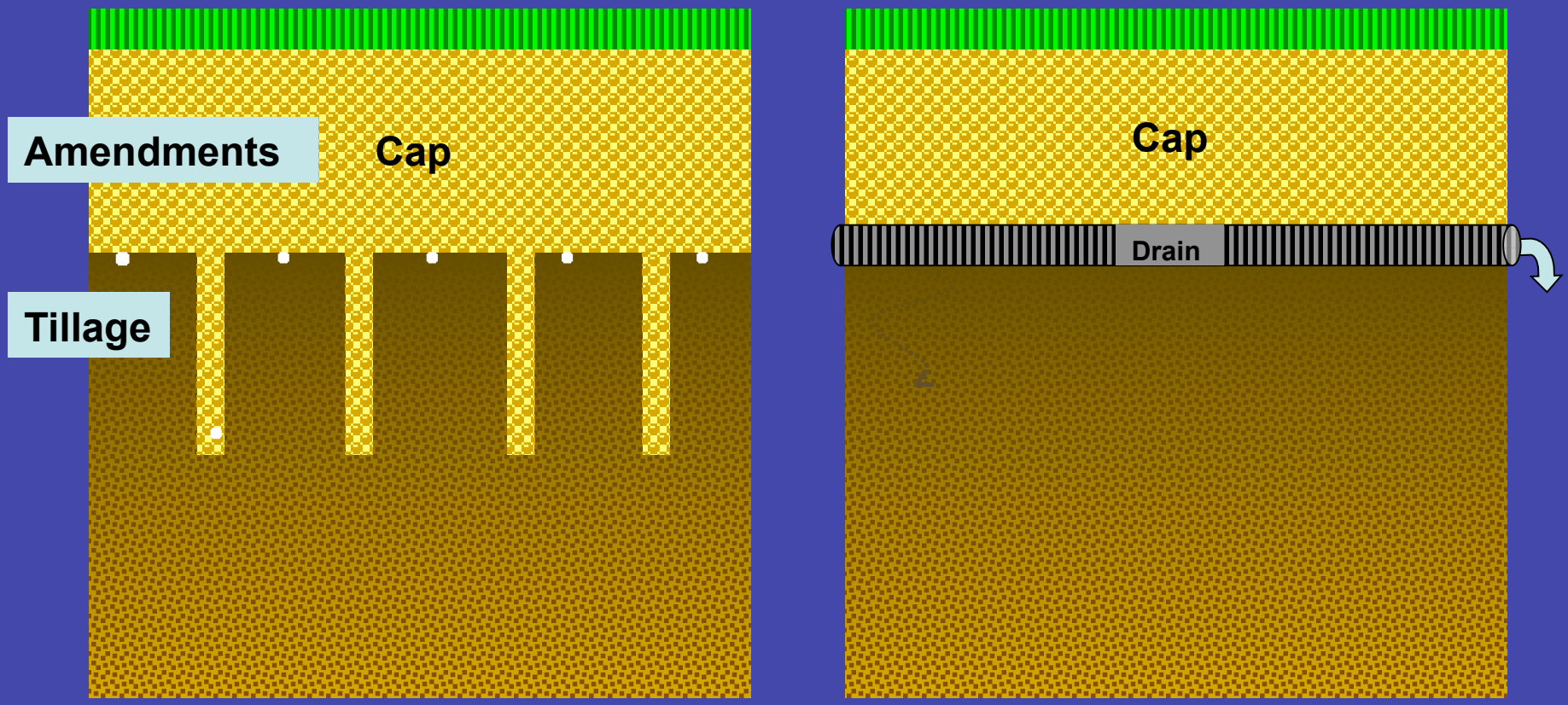


Potential: Shallow, Salty Root Zone



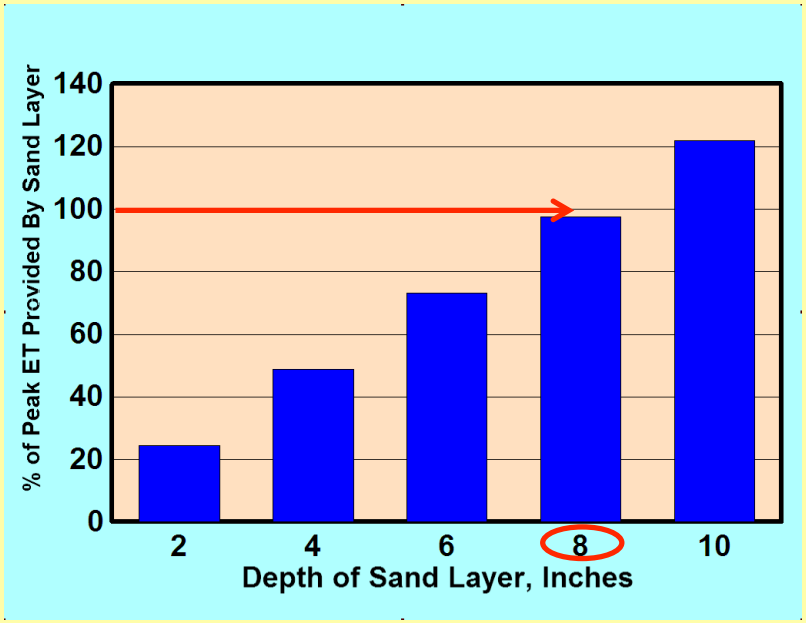
Potential: Wet Spots/ Salty Seeps

CAP INSTALLATION



WATER HOLDING CAPACITY

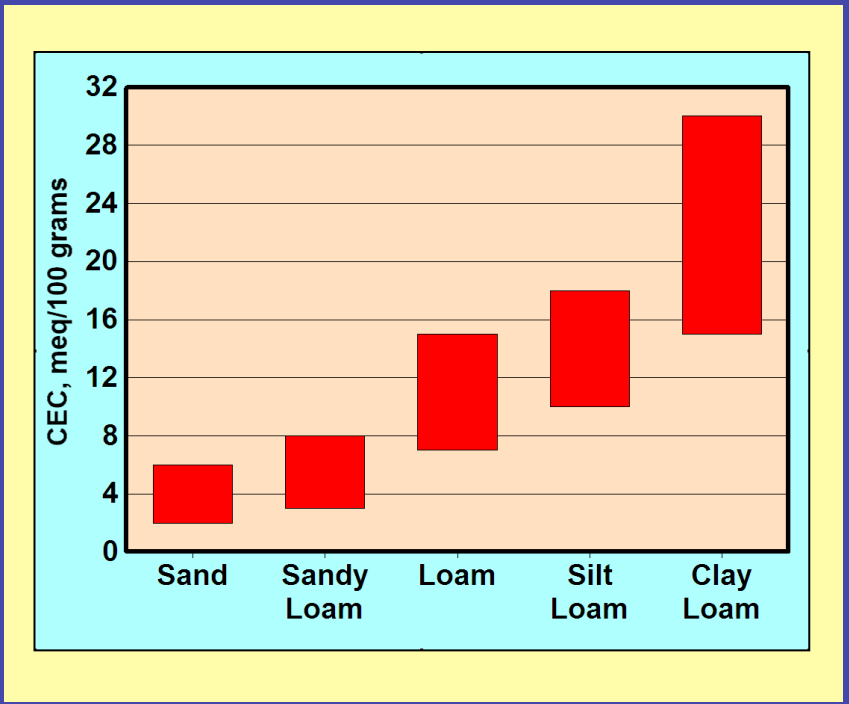
- Field Capacity
  - 1.2”/Ft
- Plant Available Water
  - 0.75”/Ft
- Allowed Depletion
  - Before Stress
  - ~0.38”/Ft
- Peak ET (Early July)
  - 0.26”/Day



~8” Required To Avoid Using Old Soil As Source of Water

NUTRIENT MANAGEMENT

- Without Clay Content
  - Low Cation Exchange Capacity (CEC)
  - Little Nutrient Storage
  - Nearly Hydroponic System
- Different Nutrients Mgmt.
  - More Frequent Applications
  - Lower Rate/Application
  - Slow Release Materials



QUESTIONS?

pbrown@ag.arizona.edu