ORIGINS OF SALINITY & SODIUM PROBLEMS IN TURF

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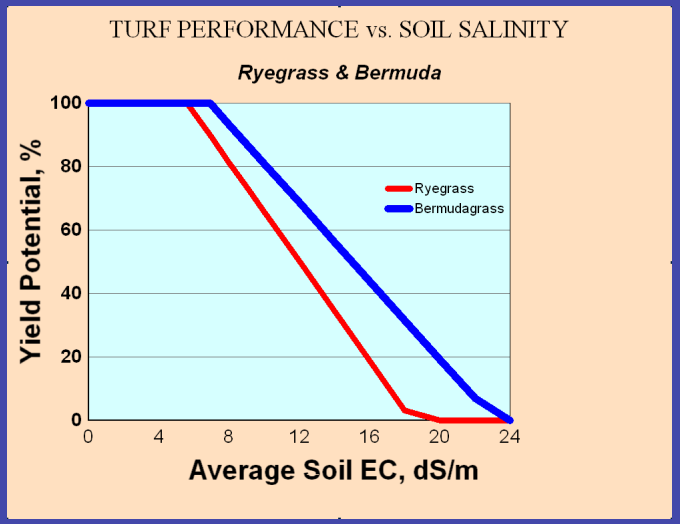
"SALINITY" PROBLEMS

- **Excess Soil Salinity**
  - **Impacts:**
    - Turf Performance
    - Germination of Overseed
- **Excess Soil Sodium**
  - **Impacts:**
    - Soil Structure
    - Water Infiltration
    - Turf Performance
- **Specific Ion Toxicities**
  - **Impacts:**
    - Trees & Ornamentals
    - Foliar Damage and/or Plant Death

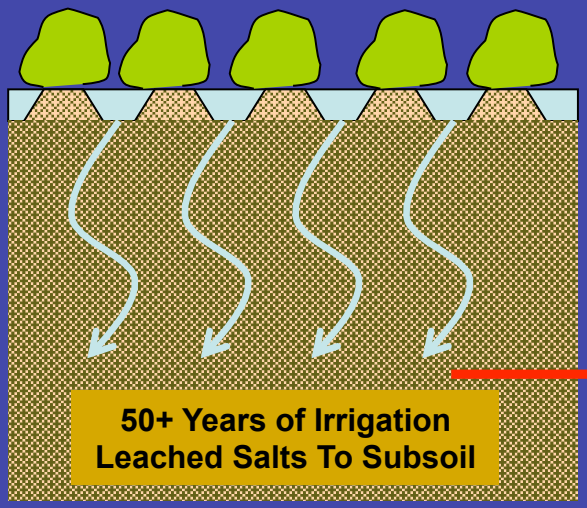


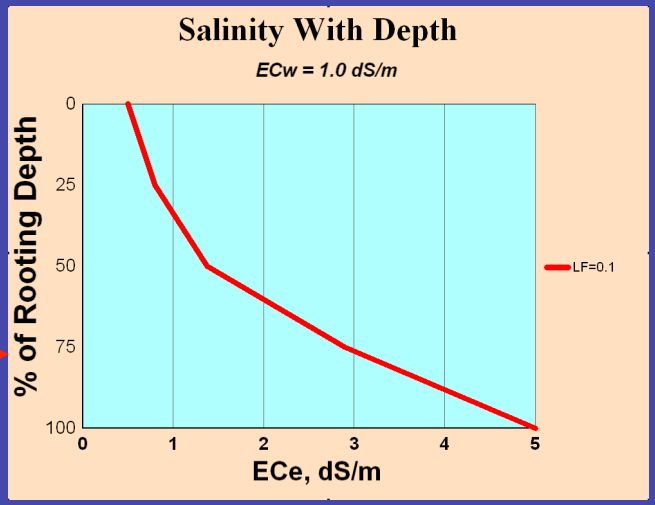
SALINITY RELATED PROBLEMS IN ARIZONA TURF

Two General Causes

- Inherited Salinity
- Insufficient Leaching

INHERITED SALINITY PROBLEMS

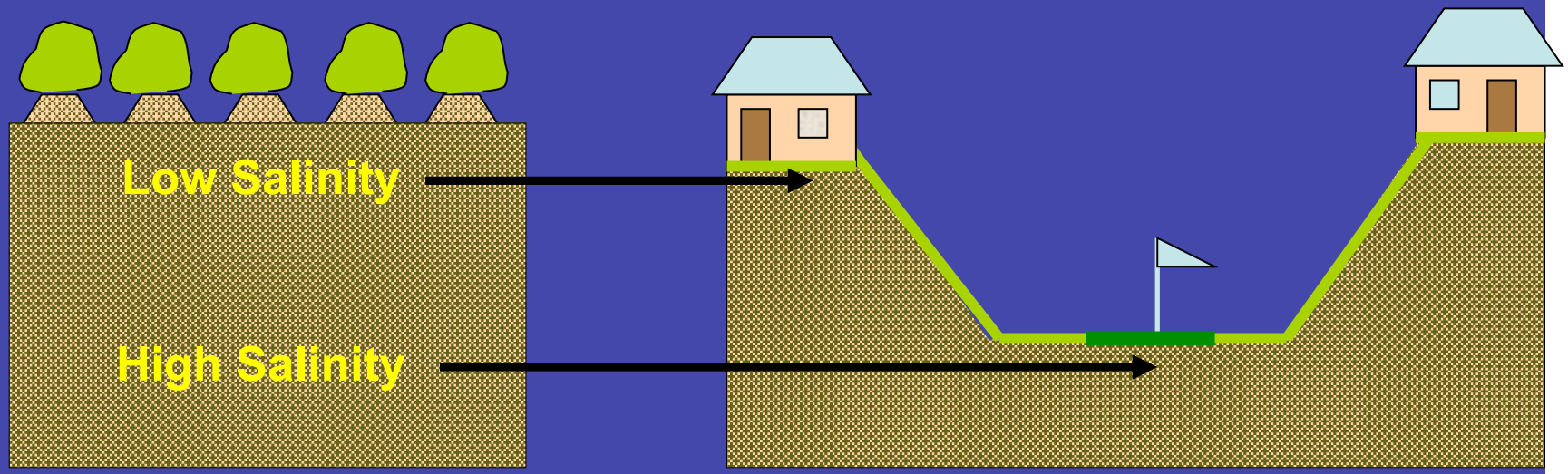




Soils That Previously Supported Agricultural Production Have Been Leached For Decades. This Leaching Process Produces High Levels of Salinity (Often 5-10x Higher Than Surface Values) Deep In The Soil Profile.

INHERITED SALINITY PROBLEMS

Irrigation Design, Orientation & Construction

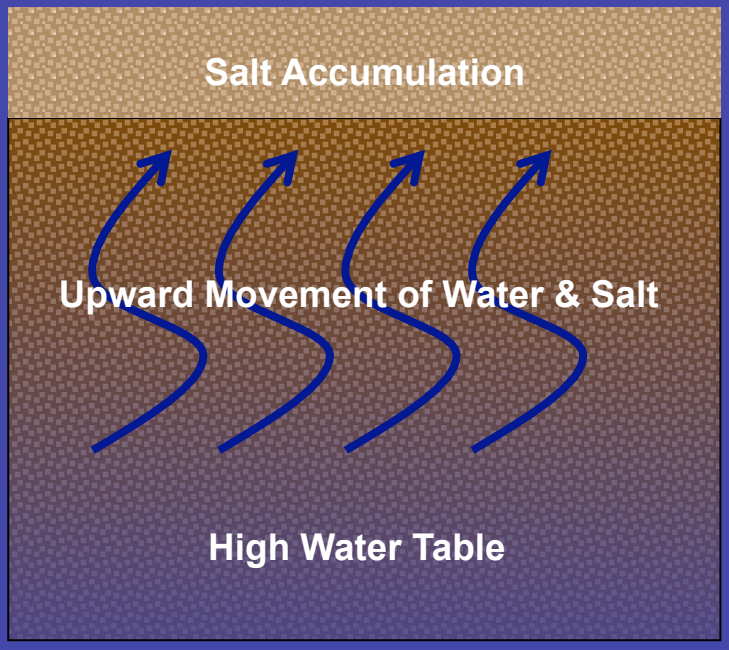


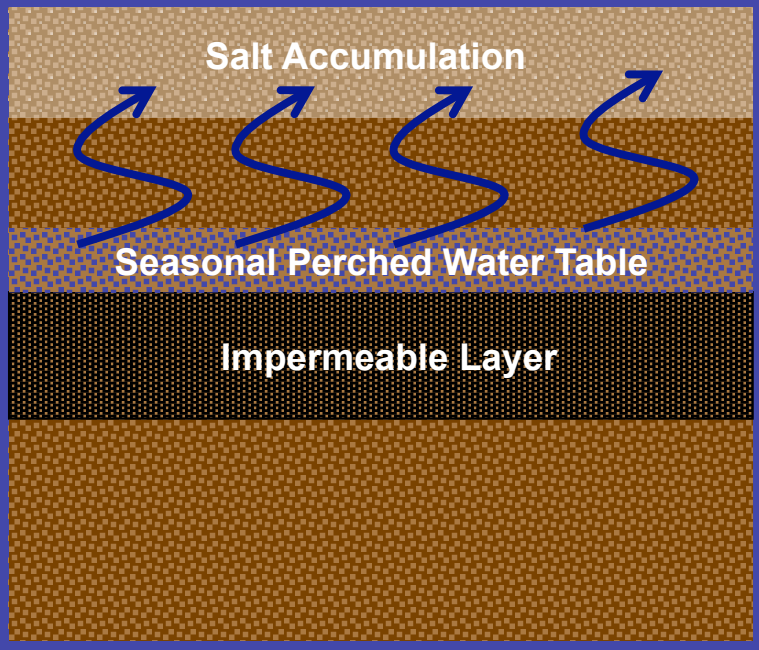
Agricultural Land

Excavated For Course

INHERITED SALINITY

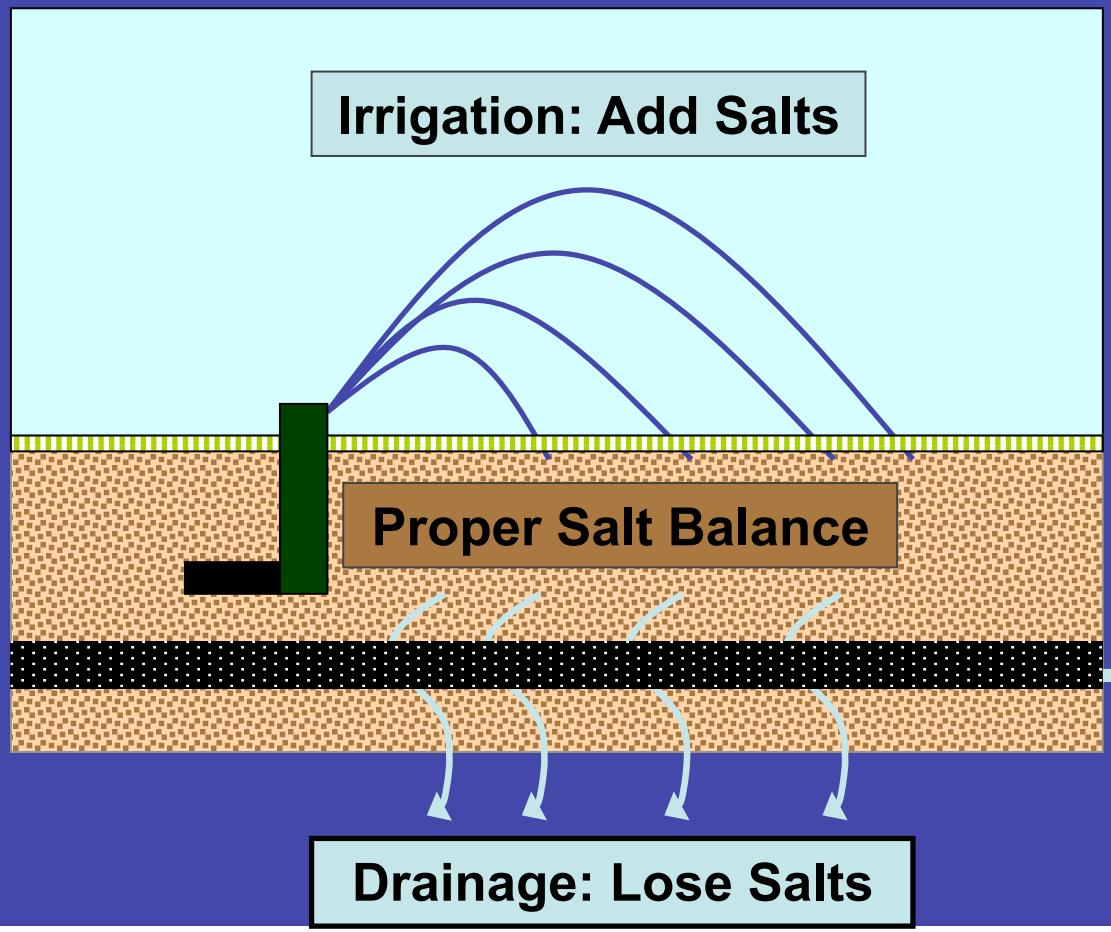
High Water Tables Caused By Adjacent Rivers, Lakes or Impermeable Layers Can Limit Leaching & Result In Salt Accumulation Over Time





LEACHING:

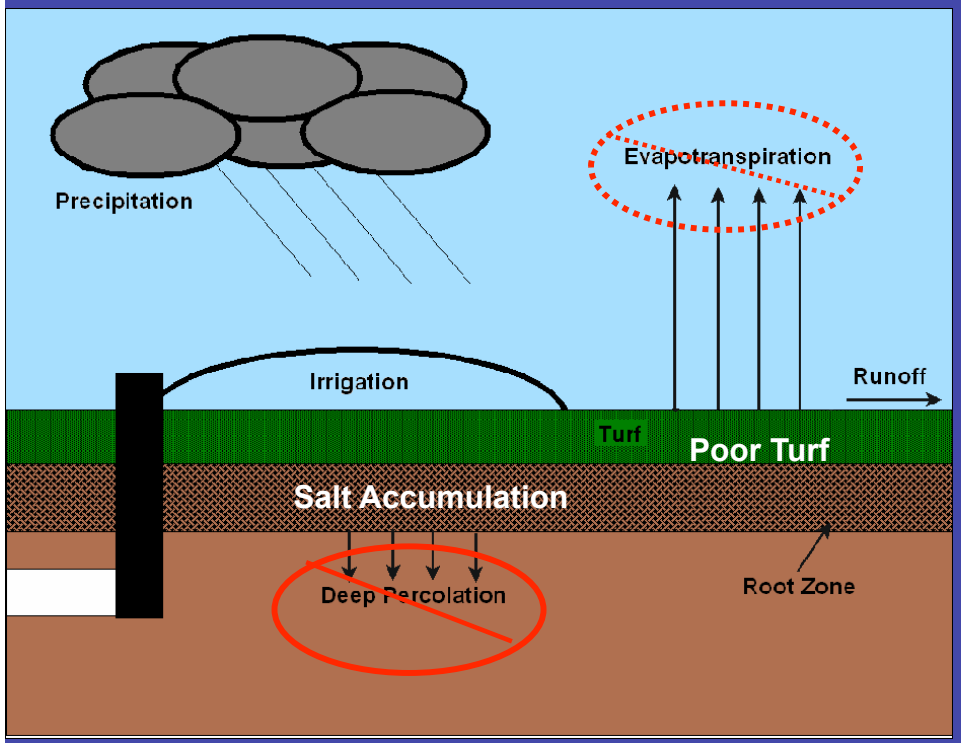
Key To Salinity Management



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

DEFICIT IRRIGATION

Reduces or Eliminates Drainage Required To Remove Salts



1. Mild Deficit Irrigation: Reduces Drainages Allowing Salts to Accumulate
2. Deficits Over Time Reduce Turf Growth Due To Water and/or Salinity Stress

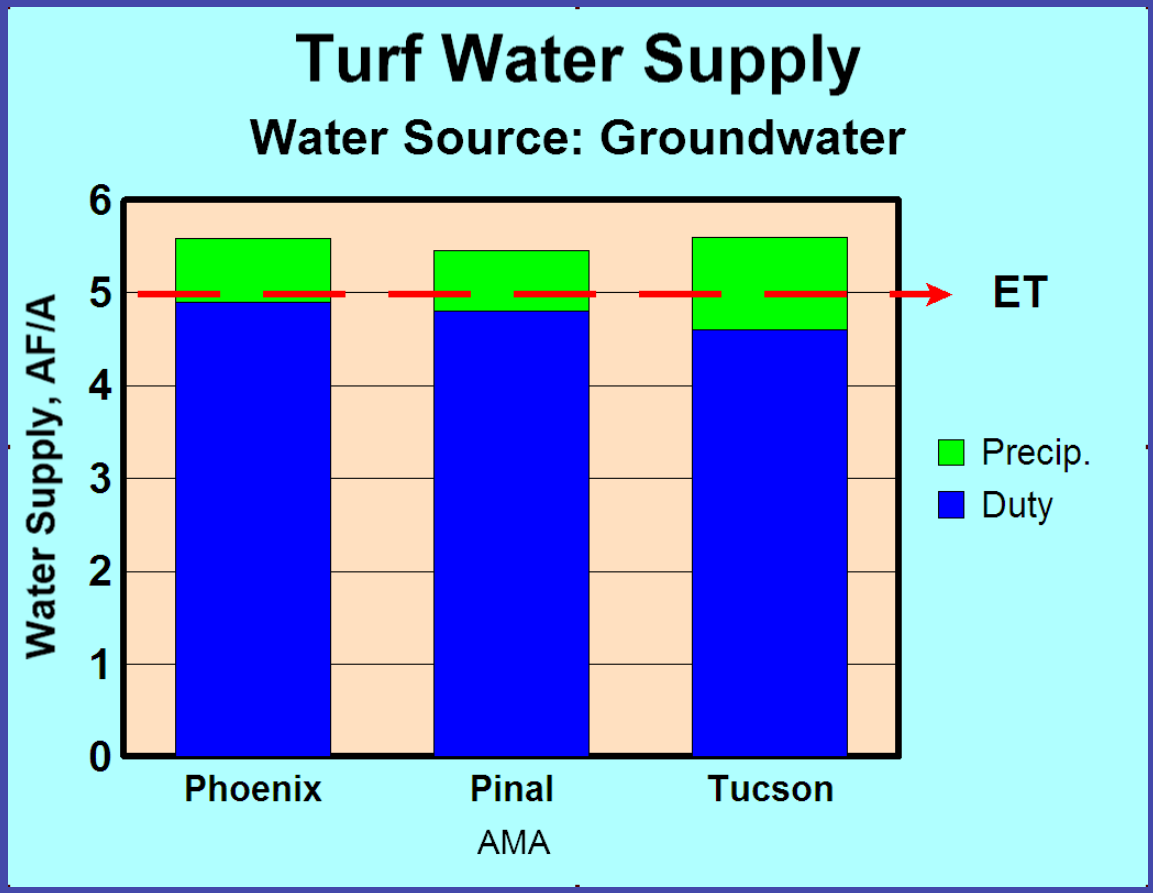
DEFICIT IRRIGATION

Contributing Factors

- Water Supply Limitations
  - Quantity
  - Quality
- Irrigation Management
  - Efficiency Issues
  - Playability
  - Leaching Fraction
- Drought
- Infiltration Problems

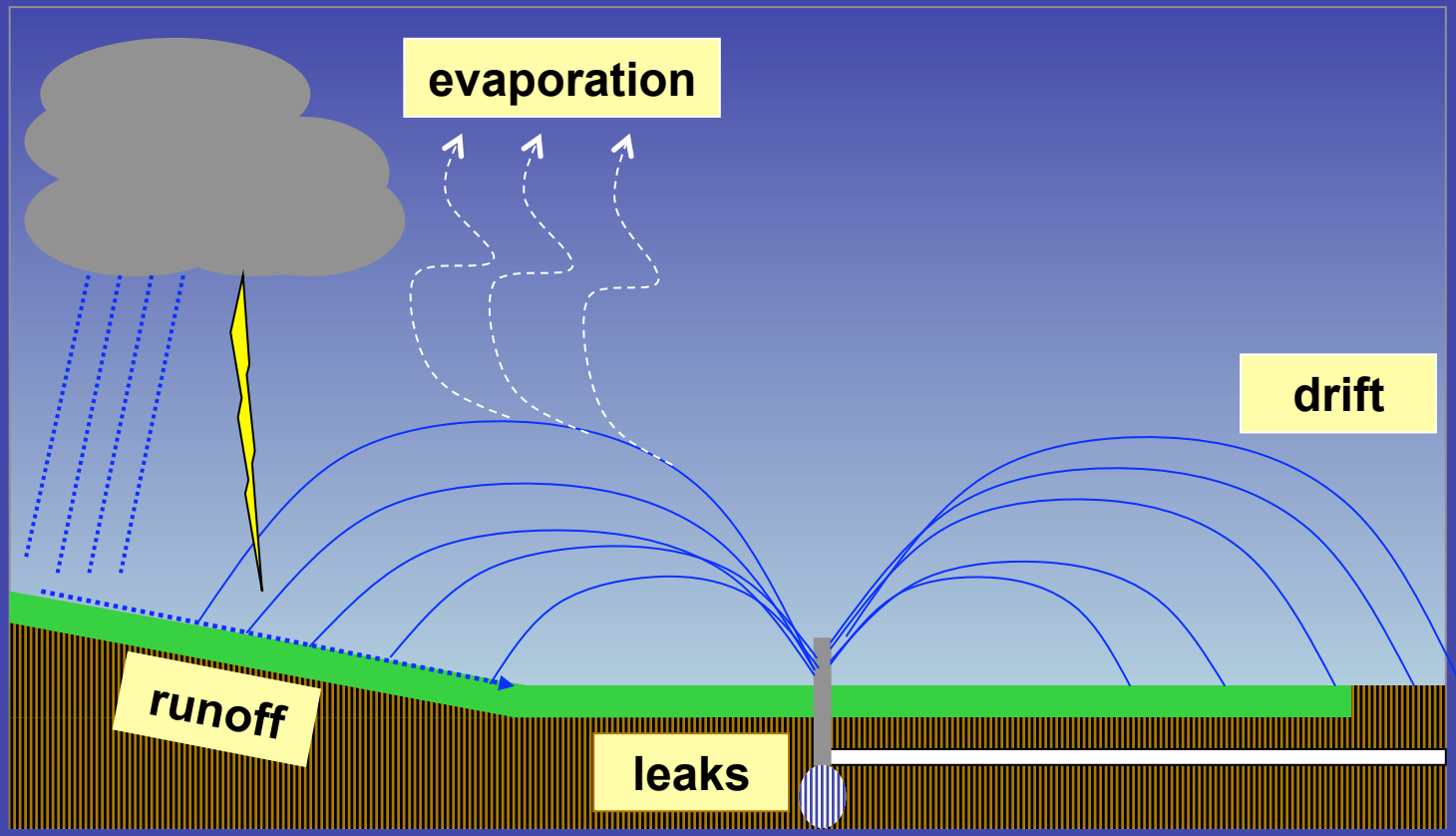
WATER SUPPLY FOR TURF

Turf ET Exceeds Water Duty in Low Deserts



Potential Water Supply: Consists of Water Duty Plus Precipitation.

USABLE WATER SUPPLY IS ALWAYS LESS THAN POTENTIAL



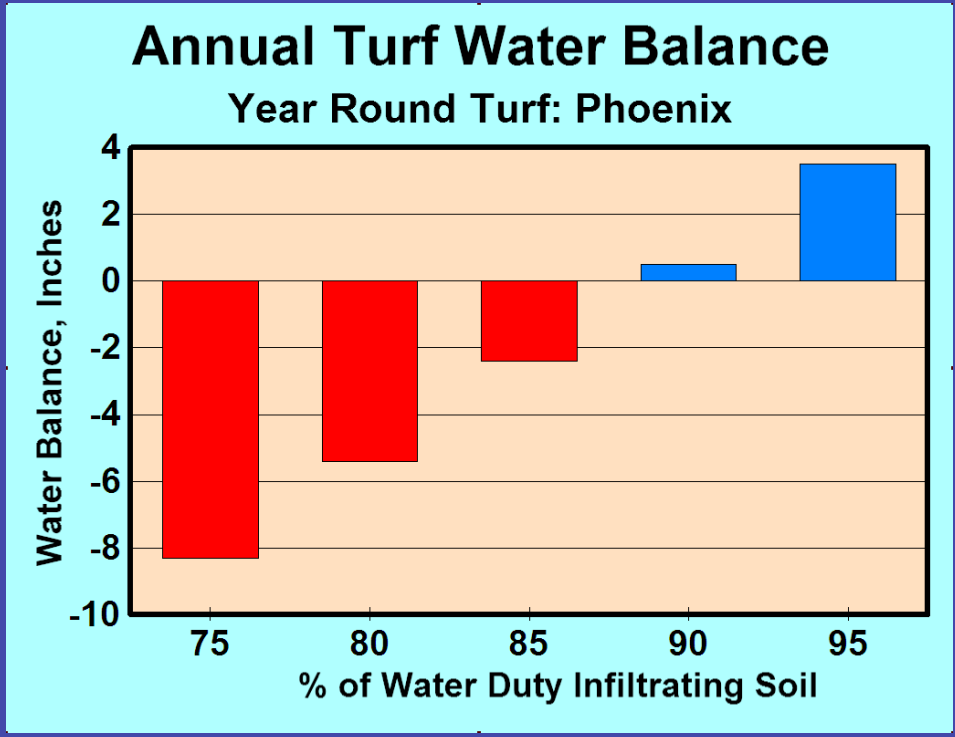
ARIZONA COOPERATIVE EXTENSION

THE UNIVERSITY OF ARIZONA

College of Agriculture and Life Sciences

AZ1381 06/06

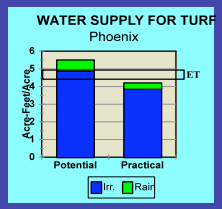
EVALUATION OF ADWR WATER DUTIES FOR LARGE TURF FACILITIES



Blue Bars: Surplus Water for Leaching/Conservation

Red Bars: Deficit Water Situation & Potential Salinity Problems

WATER SUPPLY LIMITATIONS



Assumes

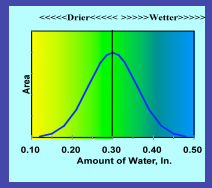
80% Irrigation Efficiency

50% Infiltration of Rainfall

The Potential Water Supply Consisting of the Water Duty & Precipitation Exceeds the ET of Turf. However, When Irrigation Efficiency & Runoff of Rainfall Are Considered, The Water Supply Can Lead To A Deficit Irrigation Regime.

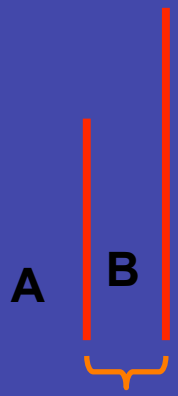
PLAYABILITY & DEFICIT IRRIGATION

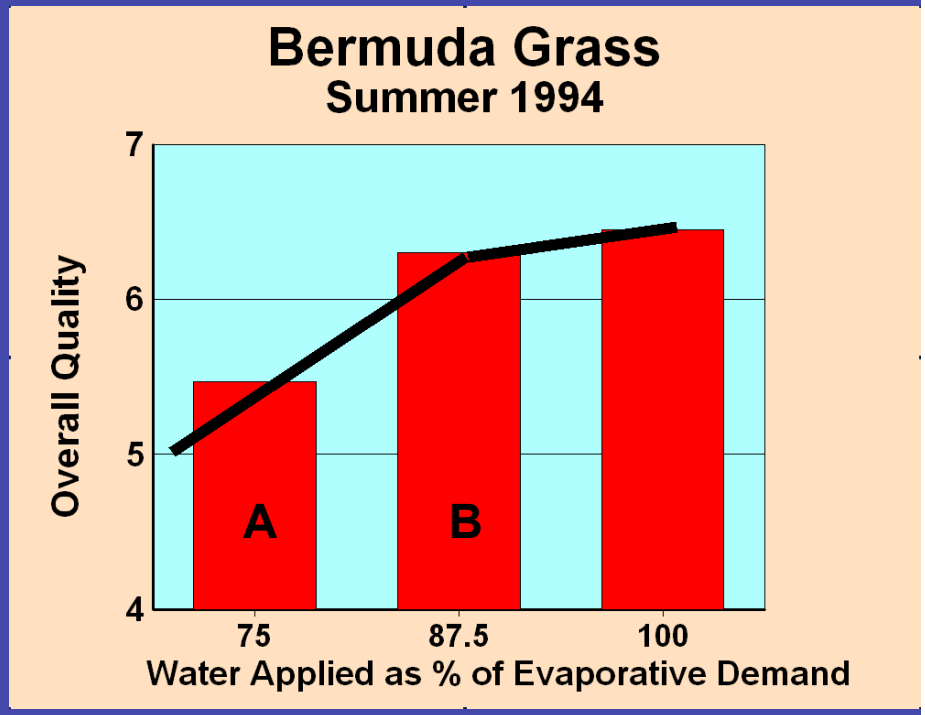
Superintendents Fight Both Ends of the Precipitation Distribution. Most Keep Turf On The Dry Side For Improved Playability.



Too Dry

Too Wet



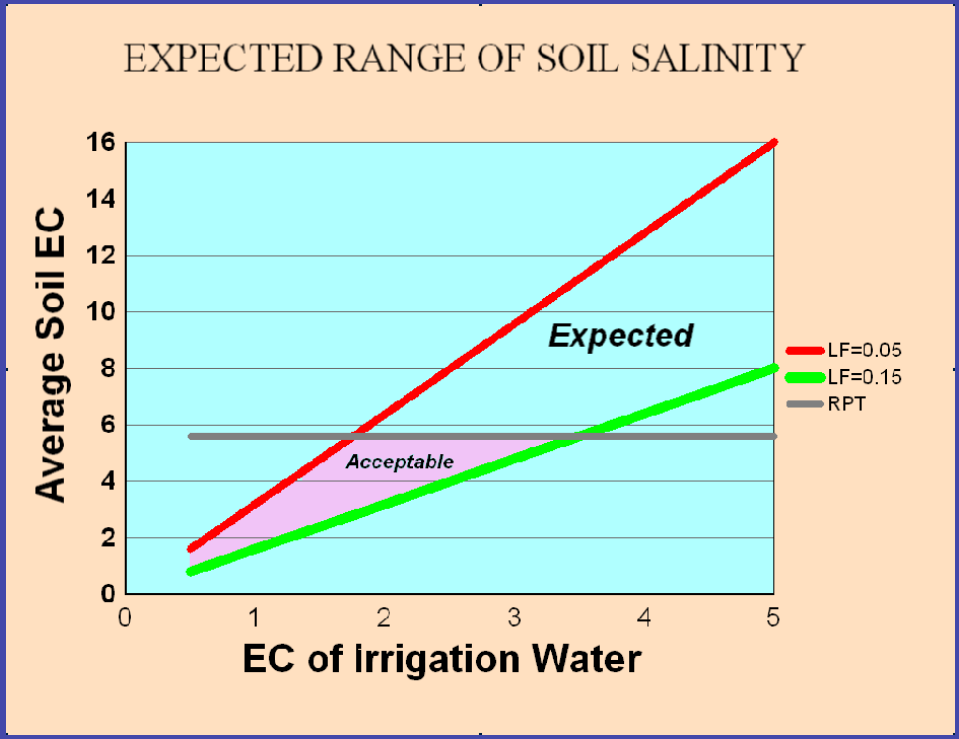


A: Poor Turf Quality Due To Deficit Irrigation

B: Acceptable Turf Quality But Irrigation Still At Deficit Levels

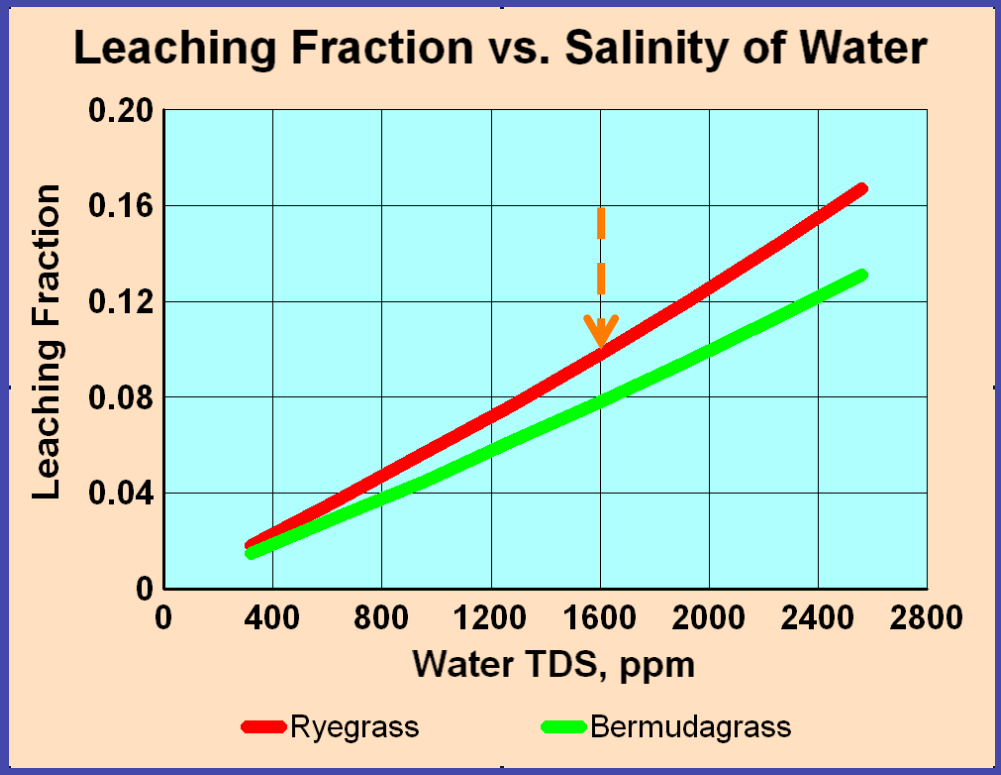
WATER QUALITY

The Quality of Water Varies Considerably, But Is Generally Declining As More Facilities Use Reclaimed Water



The Salinity of the Irrigation Water Impacts Salinity Levels in the Soil. Poor Quality Water or Poor Irrigation Management Can Lead To Excessive Soil Salinity & Poor Turf Performance.

LEACHING FRACTION & WATER REQUIREMENT (WR)



$$WR = \frac{ET}{1 - LF}$$

ET: Turf Water Requirement

LF: Leaching Requirement

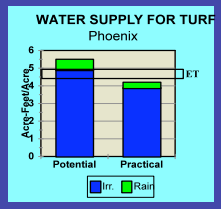
ET: 5.0'/Year

LF: 0.10

$$WR = \frac{ET}{1 - LF} = \frac{5.0'}{1 - 0.10} = 5.55'$$

Leaching Fraction: Water In Excess of ET Required To Maintain Soil Salinity At Acceptable Levels

LEACHING REQUIREMENTS ADD TO POTENTIAL FOR DEFICIT IRRIGATION

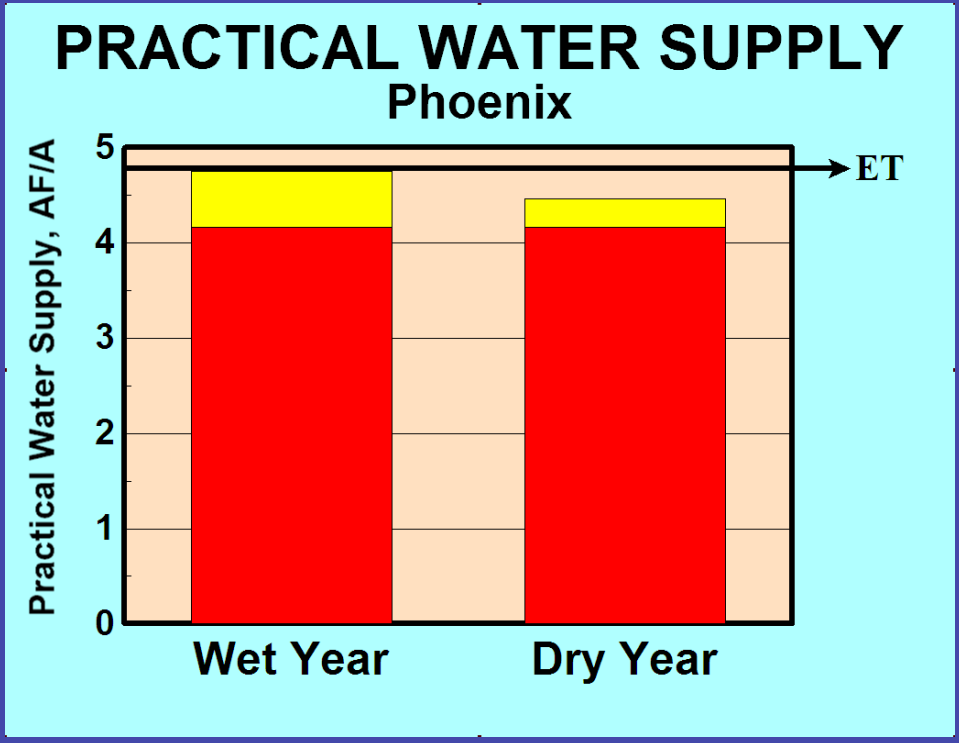


Water Requirement Is Higher Than ET Due To Leaching Requirement

Leaching Requirements Range From 2-5”/Year For Most Facilities

DROUGHT

Impact Overall Water Balance



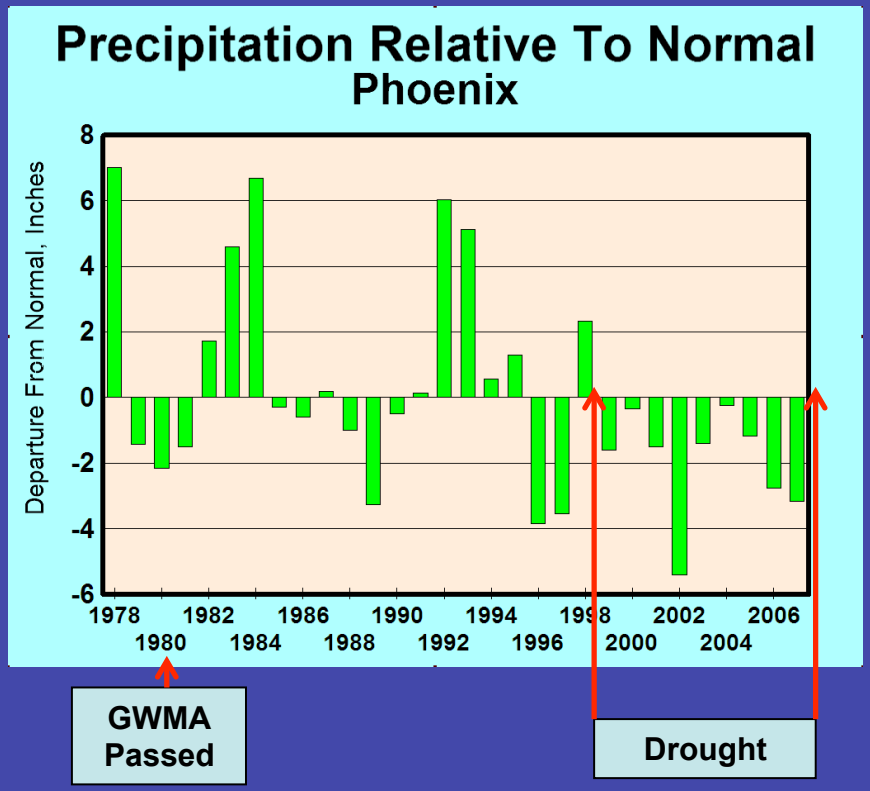
Water TDS	Leaching, % of CU		Leaching, Inches	
ppm	Bermuda	Ryegrass	Bermuda	Ryegrass
100	0.4	0.6	0.27	0.33
250	1.1	1.4	0.68	0.85
400	1.8	2.3	1.11	1.38
550	2.6	3.2	1.55	1.93
700	3.3	4.2	2.00	2.50
850	4.1	5.2	2.46	3.09
1000	4.9	6.2	2.94	3.70
1150	5.7	7.2	3.43	4.34
1300	6.6	8.3	3.93	5.00
1450	7.4	9.5	4.46	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

Assumes 85% Of Water Duty & 70% of Rainfall Infiltrates Into Soil. Dry Years Generate Deficit of ~4” of Water.

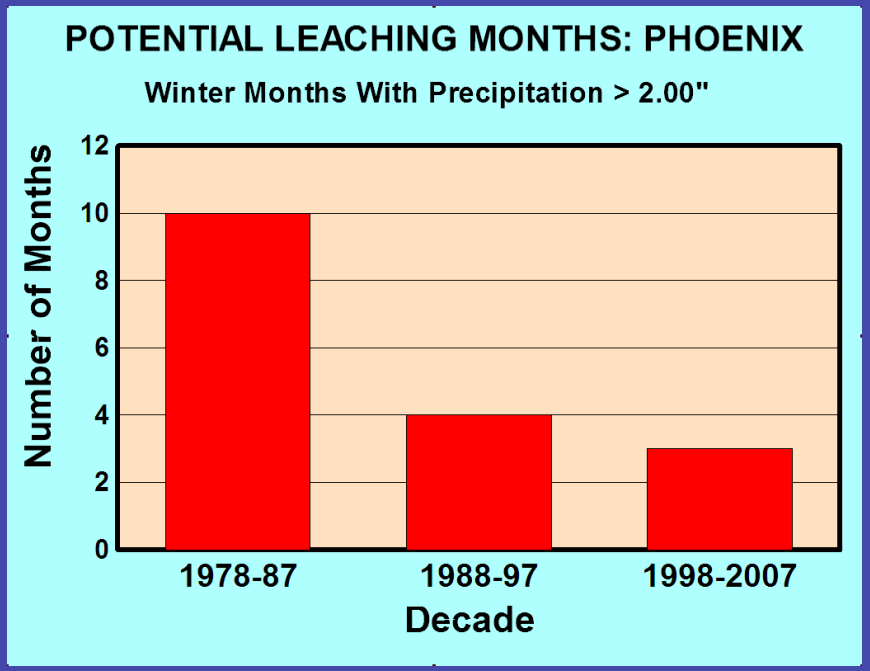
A Deficit of 4” Is Equivalent To the Amount of Leaching Required in Most Circumstances.

DROUGHT

Natural Rainfall May Be Best Means of Leaching



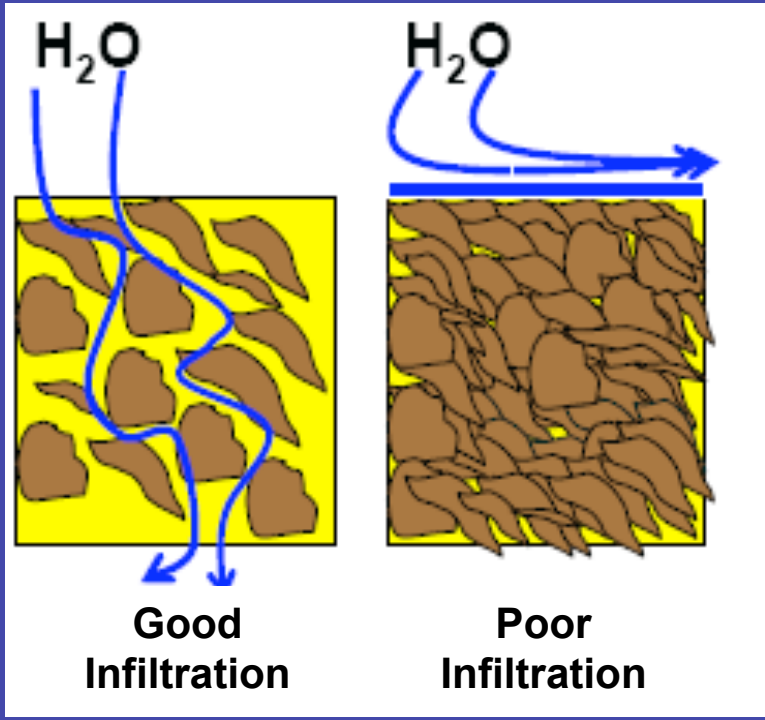
Precipitation in Phoenix Has Been Below Normal for Nine Straight Years.



The Number of Leaching Months Has Declined During The Past Two Decades.

Leaching Month Is Defined As A Winter Month Where Precipitation Exceeds ET.

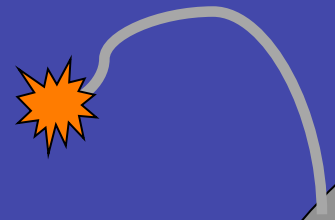
INFILTRATION PROBLEMS



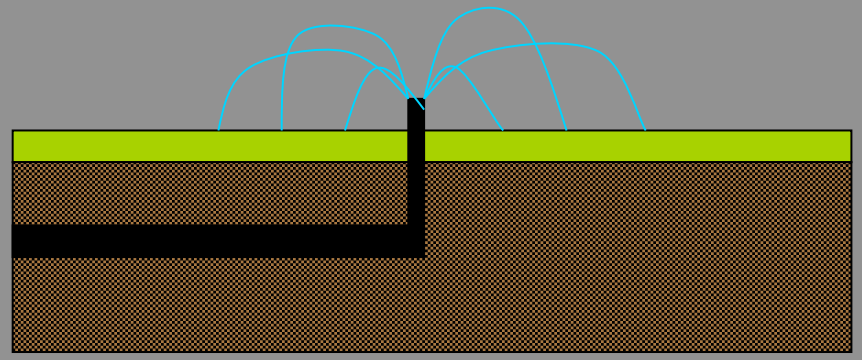
- Soil Type
- Compaction
- Soil/Water Chemistry

Even If The Proper Amount of Water Is Applied, Poor Infiltration Rates Can Lead To Runoff or Reduced Irrigation Rates To Avoid Excessive Surface Wetness. Both of These Results Can Lead To A Deficit Irrigation Regime.

THE SALINITY TIMEBOMB



Lower Quality & Less Water Applied To Turf



Salt Accumulation: Increased Salt Load & Less Leaching

Playability

Water Quantity

Drought

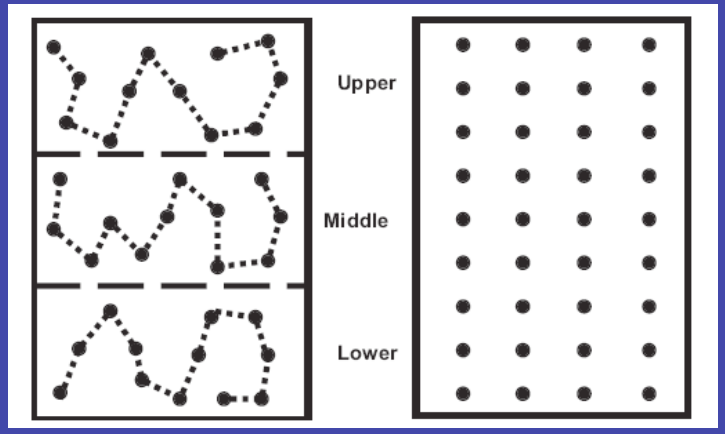
Infiltration

Water Quality

Irrigation System/Mgmt.

DO WE HAVE A PROBLEM?

Is There A Non-Destructive Means of Assessing Soil Salinity?



Traditional Soil Sampling Options

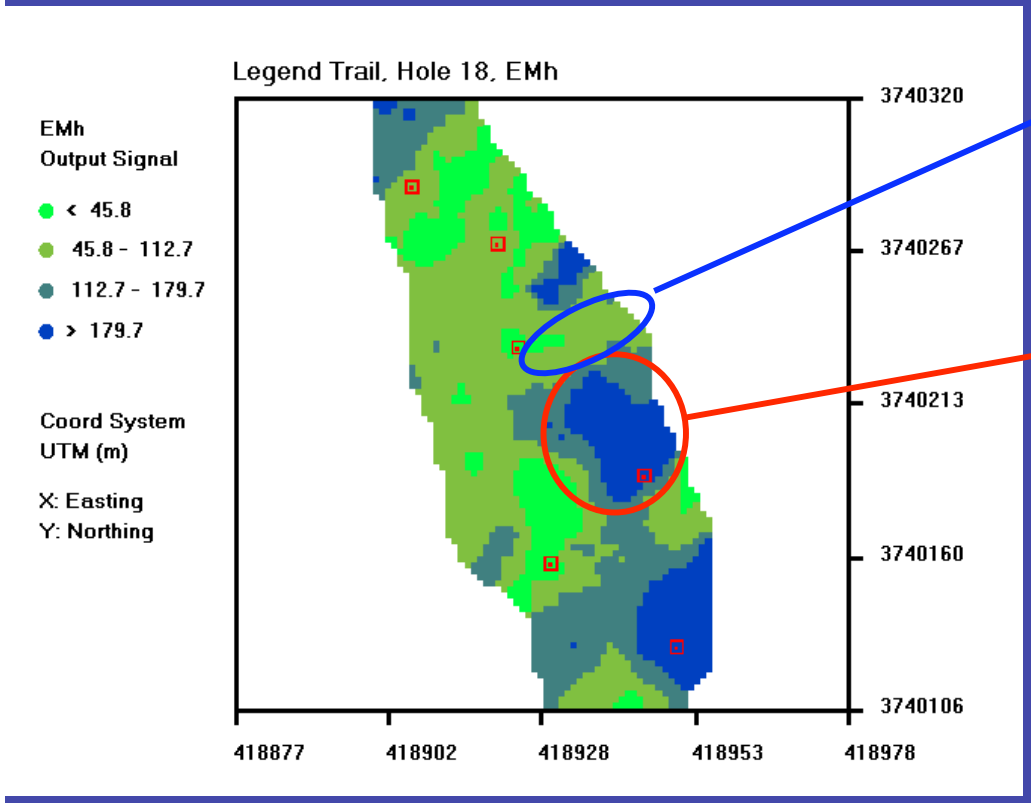
Source: Soil Sampling & Analysis, J. Walworth. 2006. CALS Pub.: AZ1421. Univ. of Arizona.

Non-Destructive Electromagnetic Induction Conductivity Meter

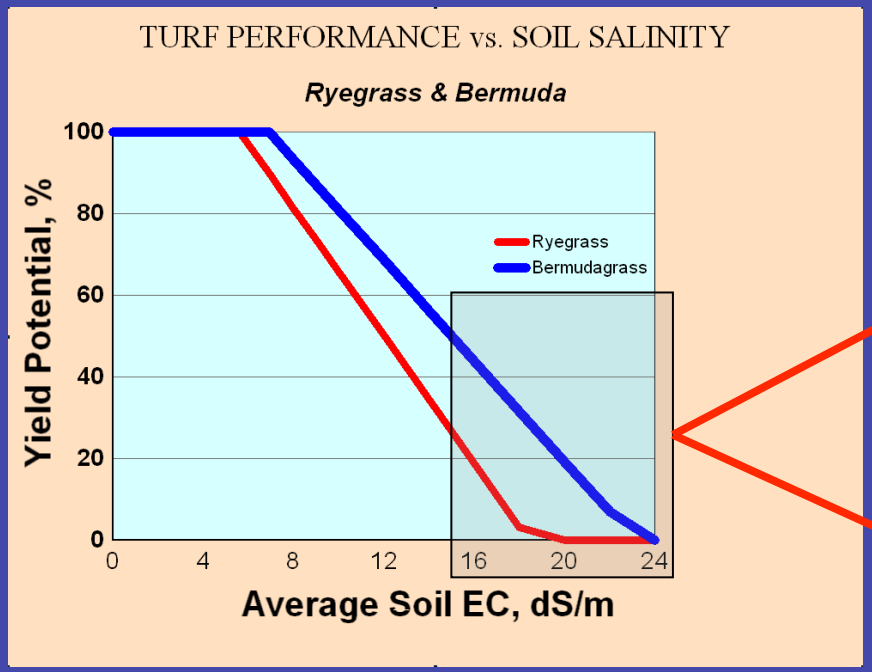
Soil Sampling, The Traditional Approach To Salinity Assessment, Is Difficult To Implement When Salinity Varies Significantly on a Spatial Basis.

SOME ISSUES WERE OBVIOUS

Conductivity Maps Confirmed Problems Areas In Many Cases

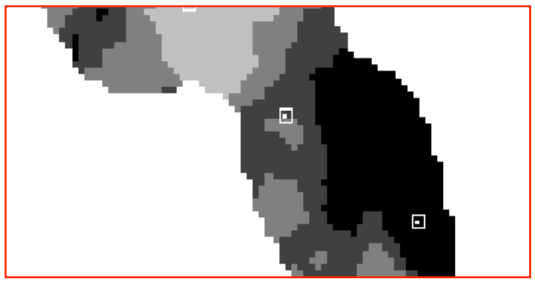


HIGH SALINITY & SODIUM LEVELS CAUSE POOR TURF PERFORMANCE

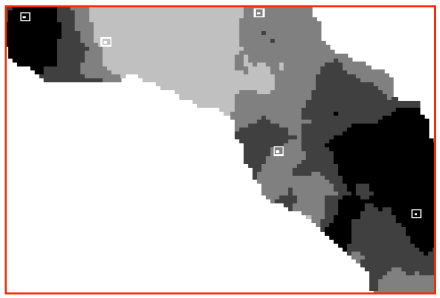


BULK CONDUCTIVITY PATTERNS ARE VERY STABLE

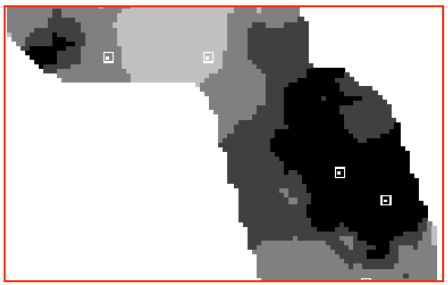
Eagles Nest: Hole 18



31 March 2006



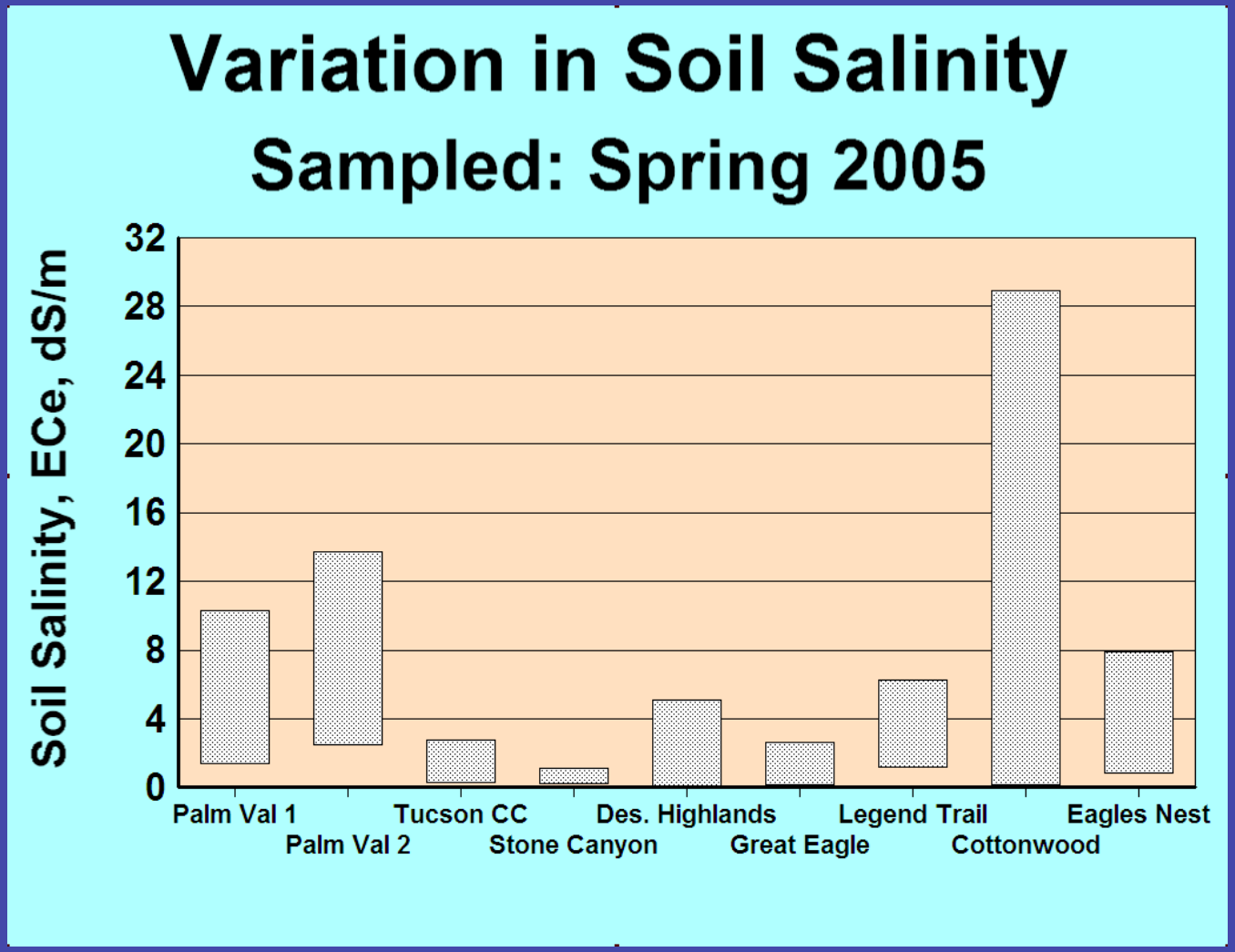
28 June 2006



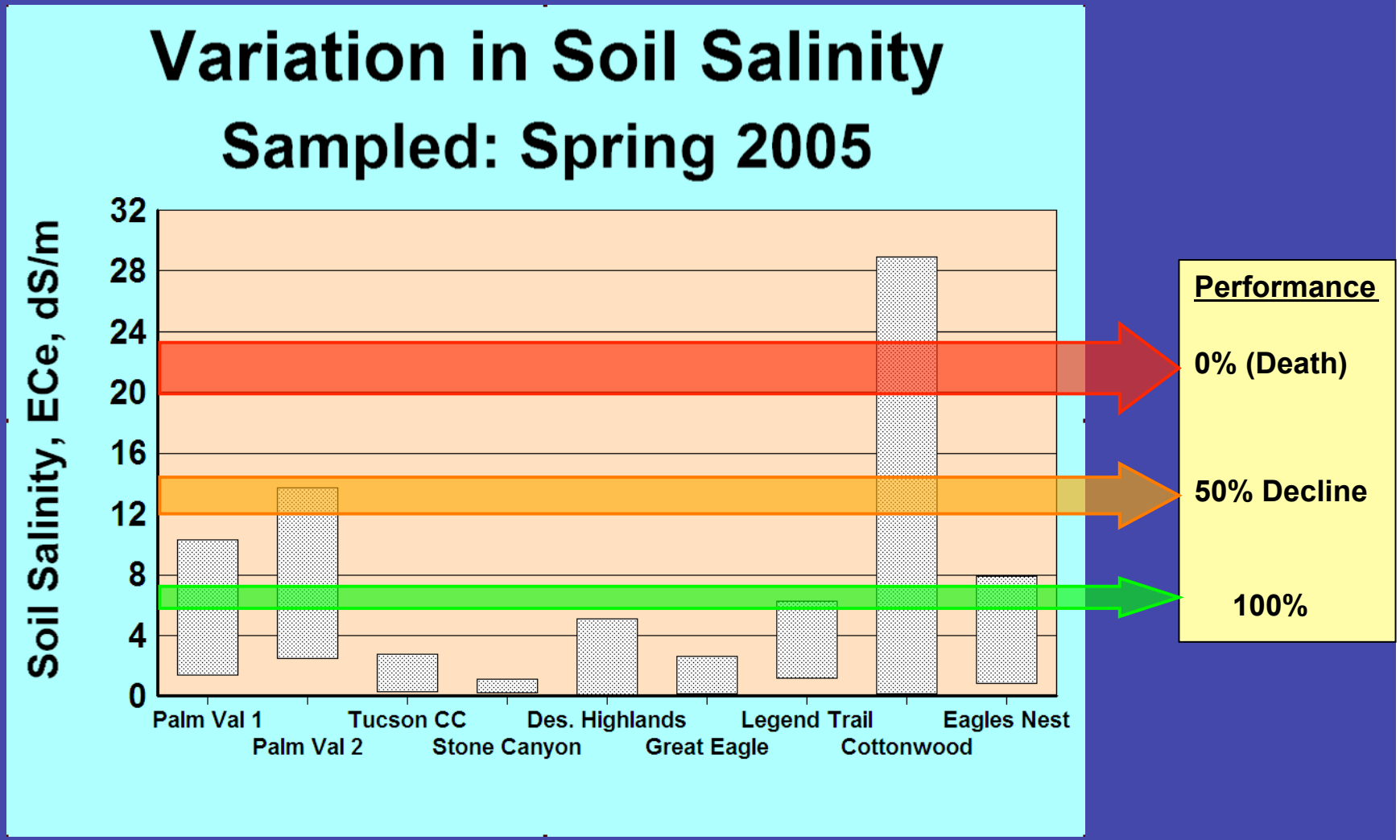
21 September 2006

EM 38 Conductivity Meter Generates Similar Relative Trends Over Time Indicating ECb Doesn't Change Rapidly With Time. This Also Indicates The Meter Has Utility In Evaluating Salinity Trends Over Time.

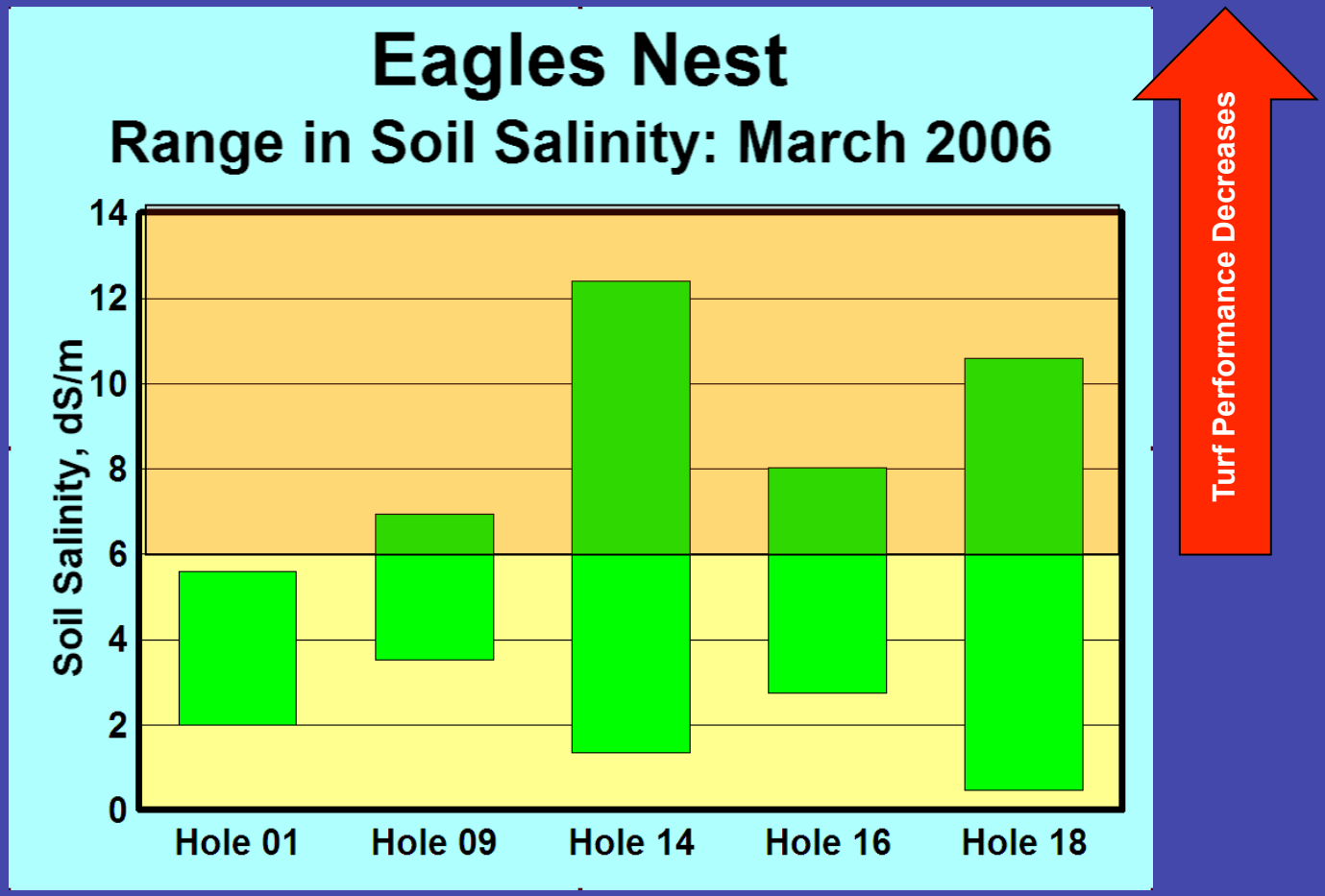
VARIABILITY!!!



POTENTIAL PROBLEMS?

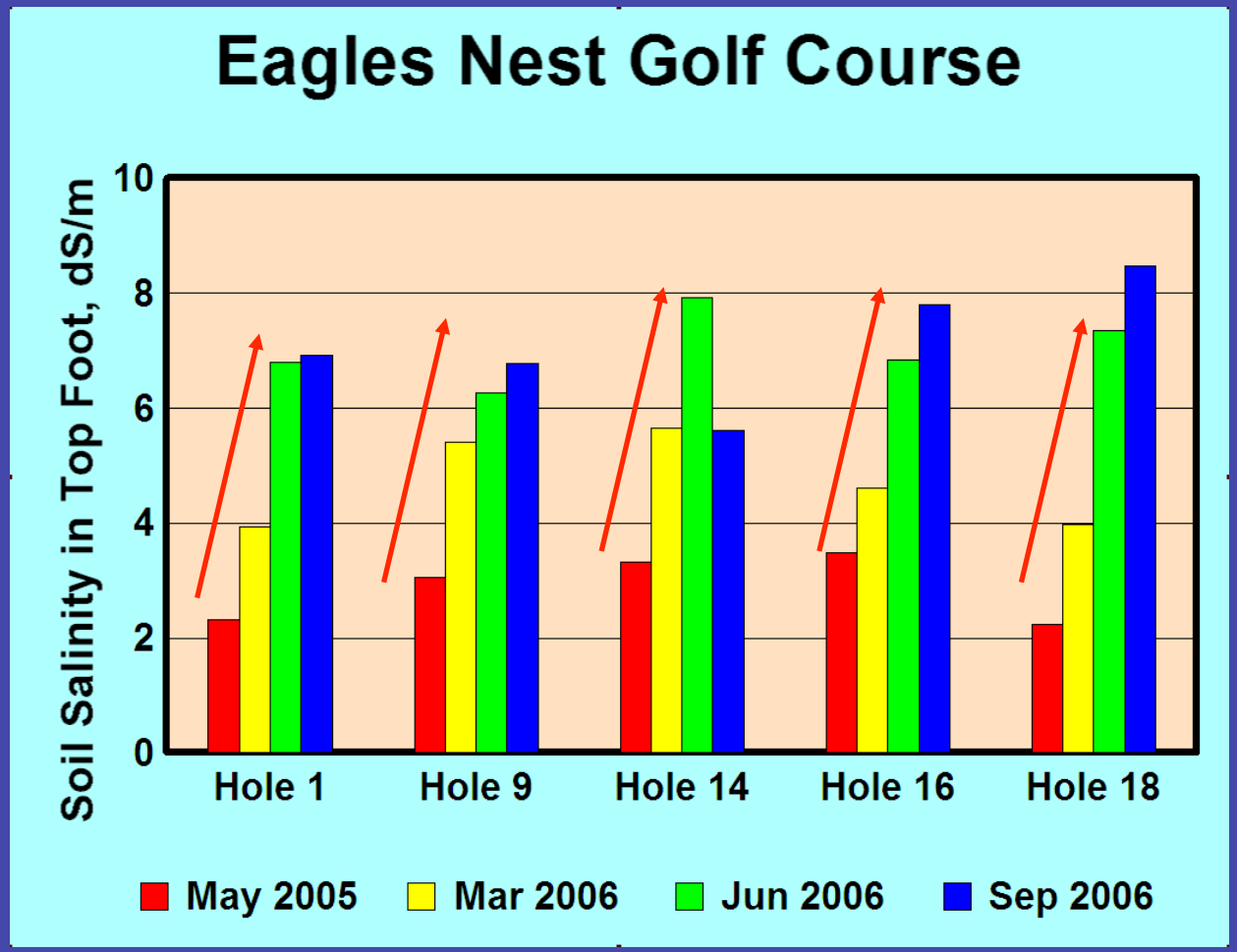


SOIL SALINITY VARIES CONSIDERABLY AMONG FAIRWAYS

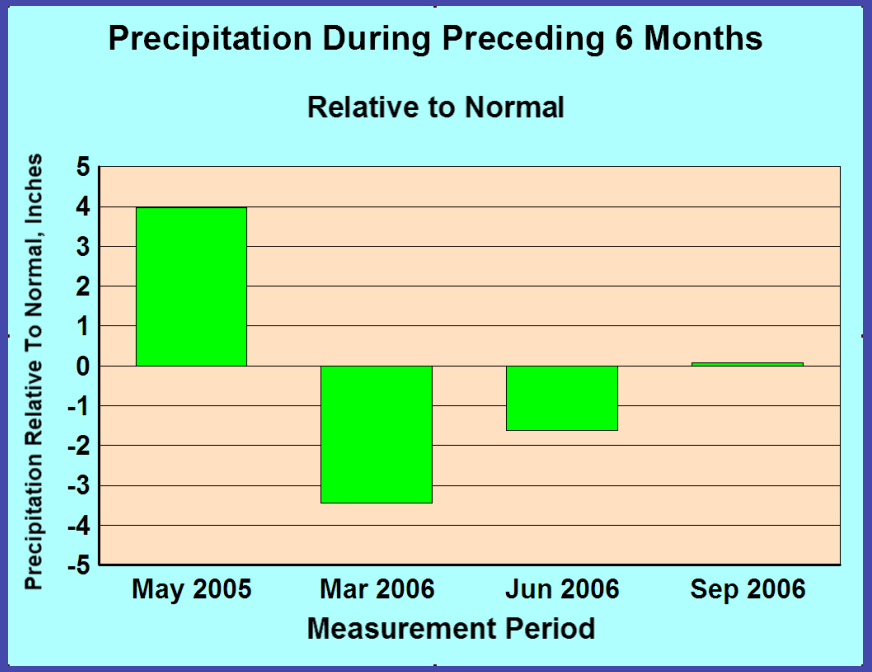


Some Fairways Are Good & Some Vary From Good To Poor

WORRISOME TRENDS…



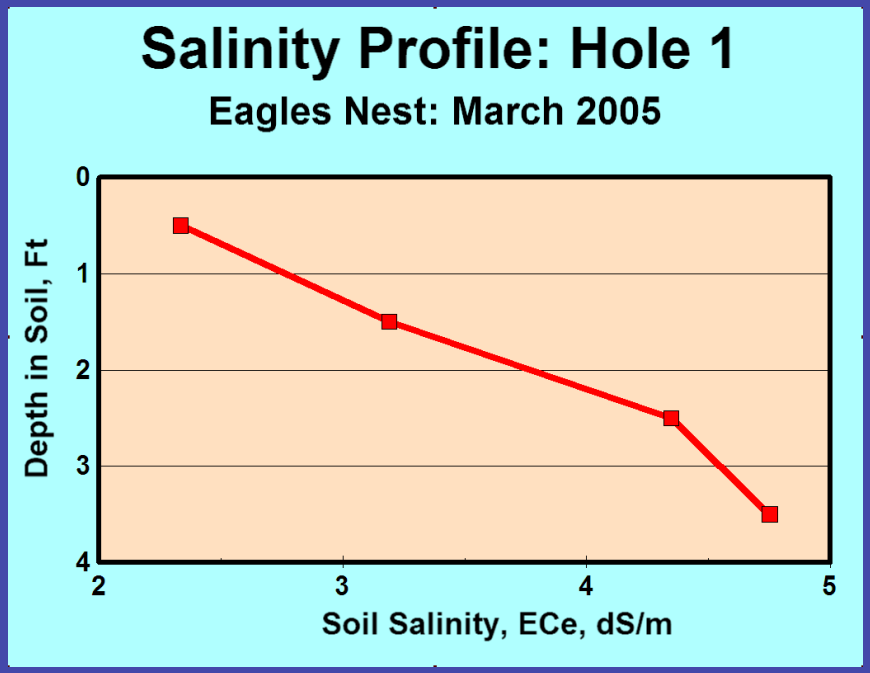
THAT MAY BE RELATED TO RAINFALL

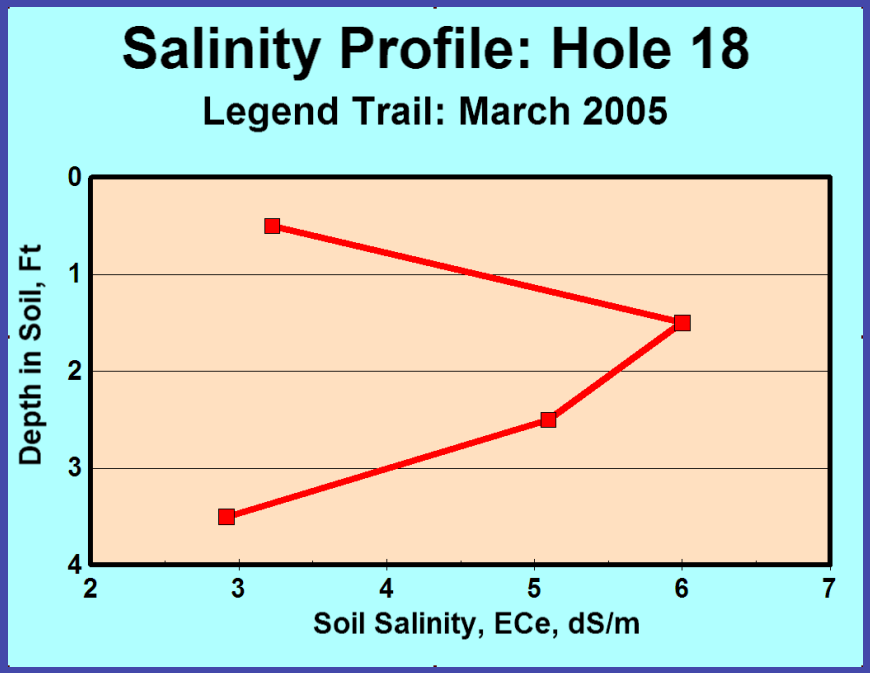


Our Limited Rainfall Appears To Be Very Important!!!

SALINITY PROFILES

How Salinity Changes With Depth





Good: Salinity Increasing With Depth

Problem: Inverted Profile Developing

WHY THIS WORKSHOP?

- Science of Salinity & Sodium Management
  - Well Understood From Agricultural Research
- Implementation of Science To Turf
  - Lacking (Very Few Published Studies)
- This Workshop Will…
  - Review The Science of Salinity & Sodium Management
  - Summarize Initial Findings/Recommendations/Ideas
    - How To Quantify/Remediate Problems
  - Summarize Selected On-Course Management Programs
- Serve As Basis For Improved Research/Management
  - Improved Communication
  - New Ideas
  - Priority Needs

TODAY'S WORKSHOP

755-825 am: Understanding Salinity & Sodium Problems in Soils
Dr. Jim Walworth, Extension Specialist, University of Arizona

825-855 am: Water Quality: Impact on Salinity & Sodium Problems in Soils
Dr. Jim Walworth, Extension Specialist, University of Arizona

855-915 am: Break

915-1045 am: Management & Remediation of Salinity/Sodium Problems

915-940 am: Soil & Water Amendments
Dr. Jim Walworth, Extension Specialist, University of Arizona

940-1005 am: Tillage
Brian Whitlark, Agronomist, Southwest Green Section, USGA

1005-1025 am: Irrigation Management
Dr. Paul Brown, Extension Specialist, University of Arizona

1025-1050 am: Turf Options
Dr. Dave Kopec, Extension Specialist, University of Arizona

1045-1130 am: Salinity Management: The Superintendent's Perspective

1045-1100 am: Mark Clark, *Troon Country Club*

1100-1115 am: Shawn Emerson, *Desert Mountains Golf Club*

1115-1130 am: Bill Todd, *Cottonwood/Palo Verde Country Club*