IRRIGATION MANAGEMENT & CAPPING SOILS

Paul Brown
Extension Specialist
Dept. of Soil, Water & Environmental Science
University of Arizona
LEACHING: Key To Salinity Management

Irrigation: Add Salts

Proper Salt Balance

Drainage: Lose Salts

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

ET: Evaporation from Vegetation

EVAPORATION MODEL
Penman Monteith Eqn
WEATHER STATIONS

- 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
Stations should be 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

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

Water Applied In Excess of ET To Leach Salts

\[
LR = \frac{ECw}{5 \times ECe + ECw}
\]

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

<table>
<thead>
<tr>
<th>Water TDS ppm</th>
<th>Leaching, % of CU</th>
<th>Leaching, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bermuda</td>
<td>Ryegrass</td>
</tr>
<tr>
<td>100</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>250</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>400</td>
<td>1.8</td>
<td>2.3</td>
</tr>
<tr>
<td>550</td>
<td>2.6</td>
<td>3.2</td>
</tr>
<tr>
<td>700</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>850</td>
<td>4.1</td>
<td>5.2</td>
</tr>
<tr>
<td>1000</td>
<td>4.9</td>
<td>6.2</td>
</tr>
<tr>
<td>1150</td>
<td>5.7</td>
<td>7.2</td>
</tr>
<tr>
<td>1300</td>
<td>6.6</td>
<td>8.3</td>
</tr>
<tr>
<td>1450</td>
<td>7.4</td>
<td>9.5</td>
</tr>
<tr>
<td>1600</td>
<td>8.3</td>
<td>10.7</td>
</tr>
<tr>
<td>1750</td>
<td>9.2</td>
<td>11.9</td>
</tr>
<tr>
<td>1900</td>
<td>10.2</td>
<td>13.2</td>
</tr>
<tr>
<td>2050</td>
<td>11.2</td>
<td>14.5</td>
</tr>
<tr>
<td>2200</td>
<td>12.2</td>
<td>15.9</td>
</tr>
<tr>
<td>2350</td>
<td>13.3</td>
<td>17.4</td>
</tr>
<tr>
<td>2500</td>
<td>14.3</td>
<td>18.9</td>
</tr>
</tbody>
</table>

Water In: 58”

Water Out: 2-5”
KNOW PRECIPITATION RATES

Precipitation Rates Are Often Estimated From Formulas or Meters

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.

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

![Graph showing Too Wet and Too Dry conditions]
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
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
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

Leaching Requirement

<table>
<thead>
<tr>
<th>Water TDS (ppm)</th>
<th>Leaching, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bermuda</td>
</tr>
<tr>
<td>100</td>
<td>0.27</td>
</tr>
<tr>
<td>250</td>
<td>0.68</td>
</tr>
<tr>
<td>400</td>
<td>1.11</td>
</tr>
<tr>
<td>550</td>
<td>1.55</td>
</tr>
<tr>
<td>700</td>
<td>2.00</td>
</tr>
<tr>
<td>850</td>
<td>2.46</td>
</tr>
<tr>
<td>1000</td>
<td>2.94</td>
</tr>
<tr>
<td>1150</td>
<td>3.43</td>
</tr>
<tr>
<td>1300</td>
<td>3.93</td>
</tr>
</tbody>
</table>

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.

Change in Soil Salinity During Overseeding
Eagles Nest: 2007
INFILTRATION IS KEY TO LEACHING
EXTRA WATER FOR LEACHING?

**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

Poor Surface Soil Structure
Slow Water Infiltration

Poor Turf
Wet Spots
Runoff

Little or No Leaching

Sand Cap: High Infiltration

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

Initially, Water Will Not Move Across Textural Boundary & Will Accumulate Above Boundary

Once Sand Above Transition Becomes Saturated, Water Will Flow Across 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
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