Plant Water Soil Relationships

Landscape Water Management

Weather Reach®
Smart Irrigation Control

Steven Moore

Founder and President of Irrisoft, Inc.
A Campbell Scientific Company

My Passions

Beautiful Landscapes

Efficient Water Use

The Problem

Stop the Waste

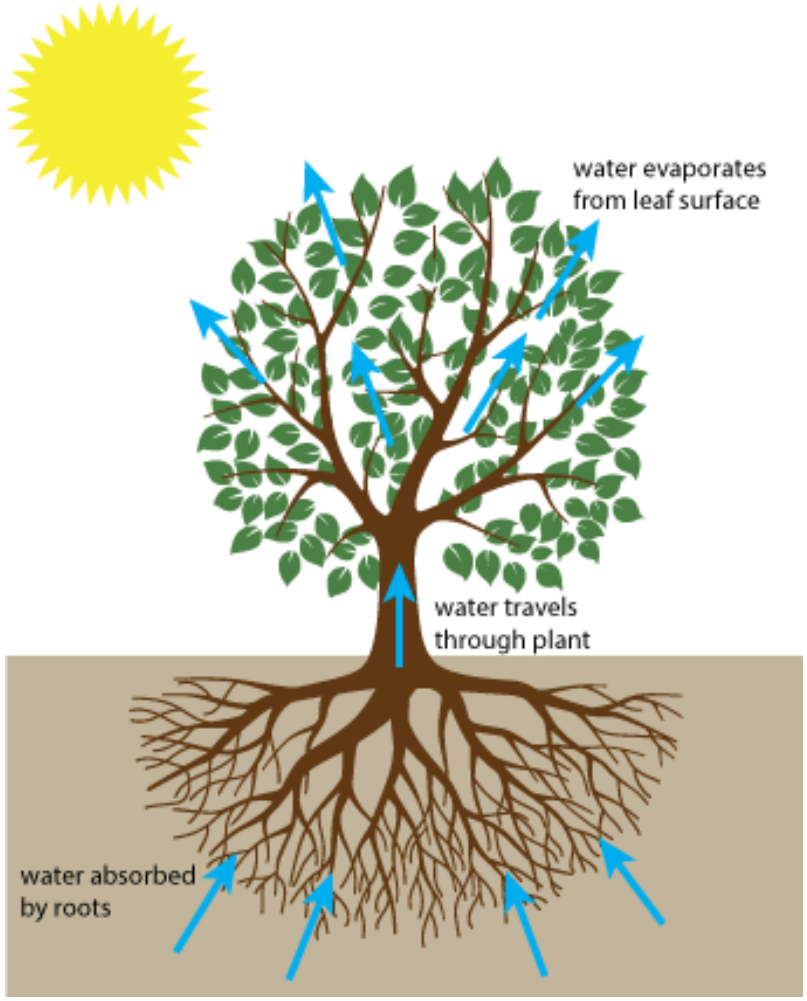
Landscapes are Over Watered

- 2x as much or more
- Cause?
  - Inefficient Systems
  - Schedule Guessing
  - Weather Changes
- Impact?
  - Wasting Money
  - Wasting Water

Need vs. Use

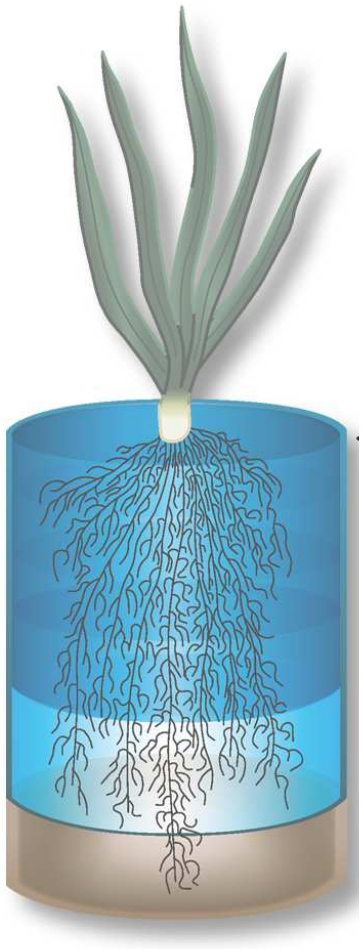
Plant Water Soil Relationships

- Soil
  - Components
  - Texture
  - Profiles
- Water
  - Properties
  - Movement
  - Soil Moisture Content
- Plant
  - Tissue
  - Photosynthesis
  - Roots
- ET
  - Evaporation
  - Transpiration



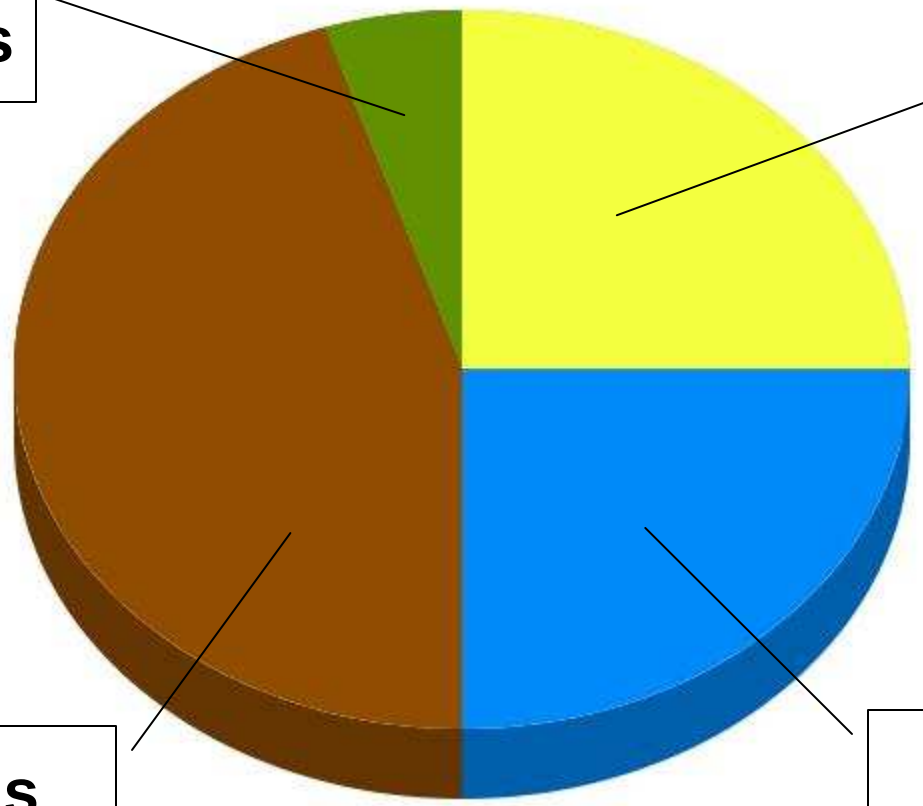
Irrigation
Three Dimensional Problem

- Irrigation
  - **Fill a Soil Reservoir**
- Reservoir Capacity
  - Soil Type
    - Pore Space
  - Root Depth



Soil Composition

Optimum

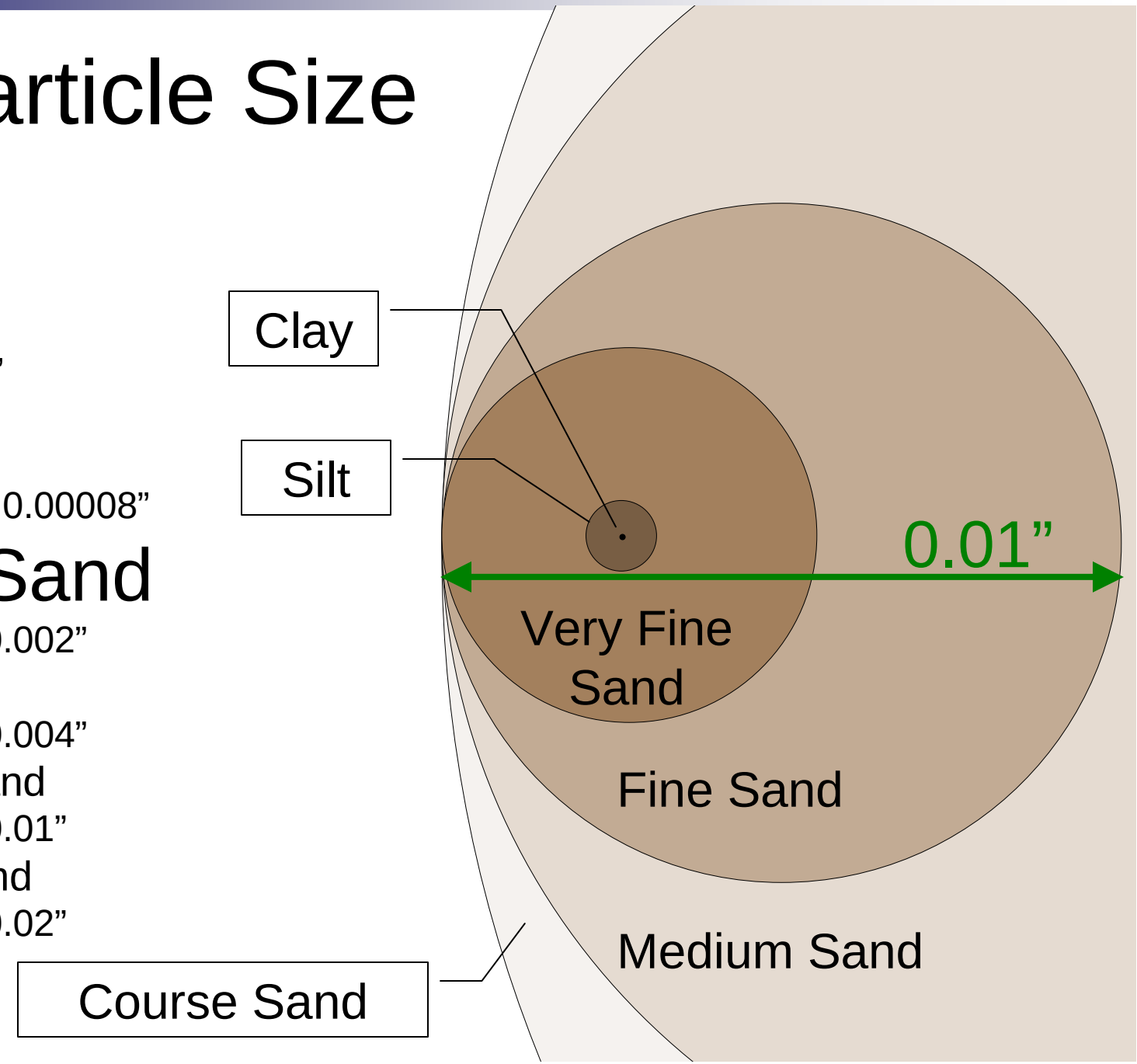


Source: Irrigation 6th Edition

Soil Particle Size

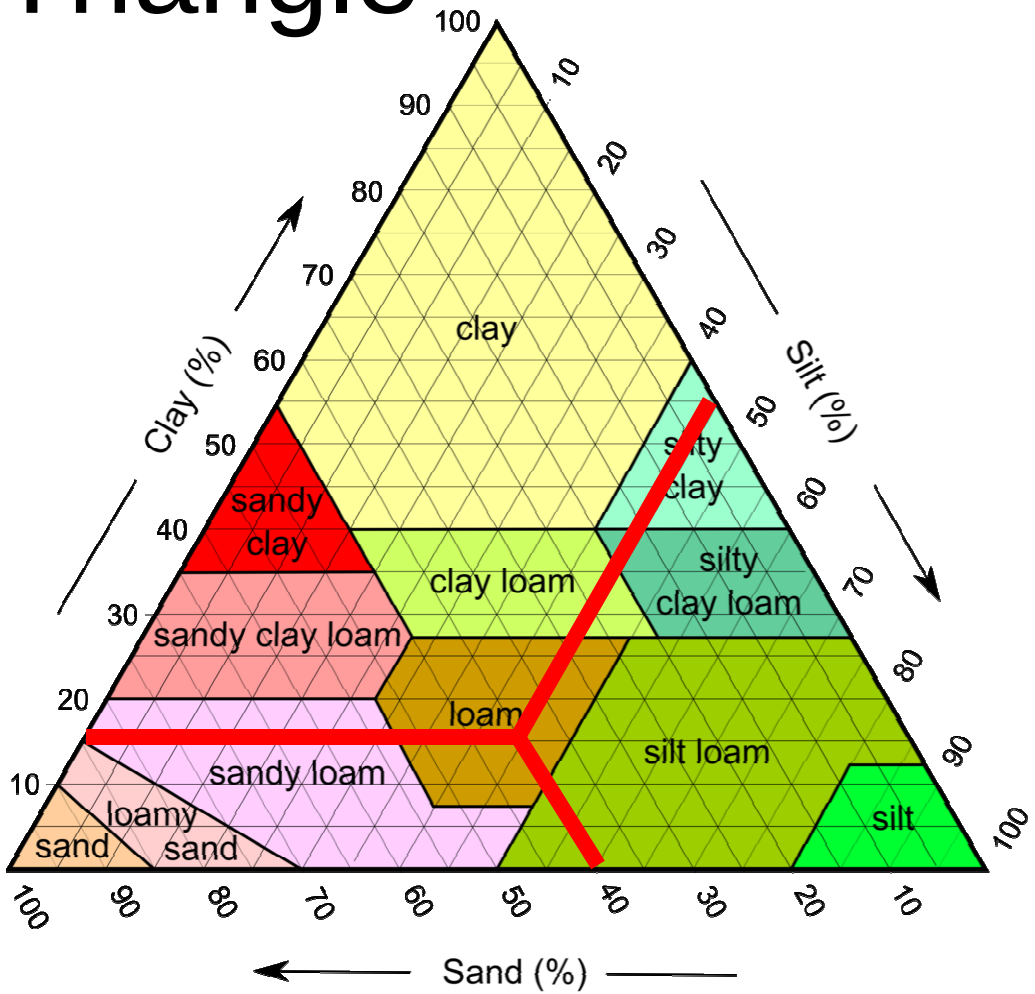
Inches

- Clay
  - <.00008”
- Silt
  - 0.002” – 0.00008”
- Very Fine Sand
  - 0.00” – 0.002”
- Fine Sand
  - 0.01” – 0.004”
- Medium Sand
  - 0.02” – 0.01”
- Course Sand
  - 0.04” – 0.02”



Soil Texture Triangle

- Sand
- Loamy Sand
- Sandy Loam
- Loam
- Sandy Clay Loam
- Sandy Clay
- Silty Loam
- Clay Loam
- Silt
- Silty Clay Loam
- Silty Clay
- Clay

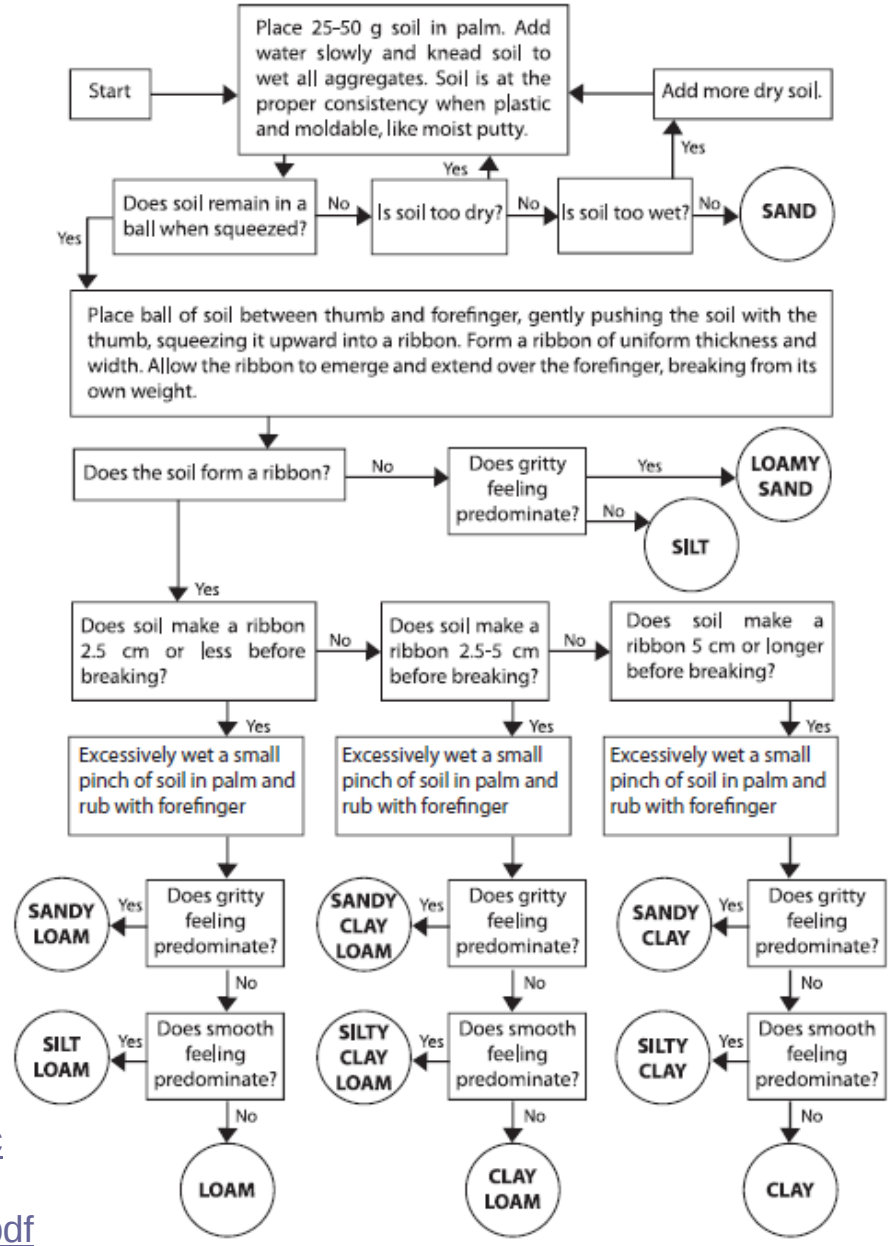


Sorce: SoilTexture USDA

Loam = 15% Clay + 45% Silt + 40% Sand

Soil Texture

- By feel method

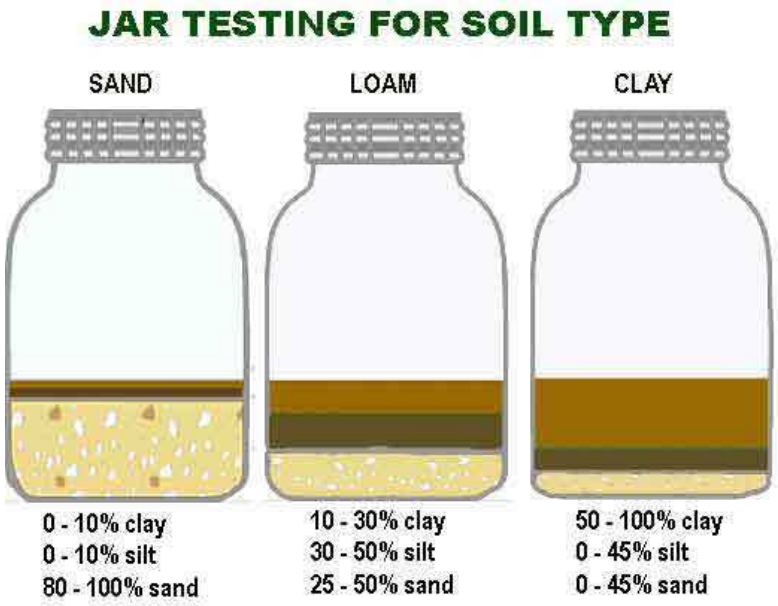


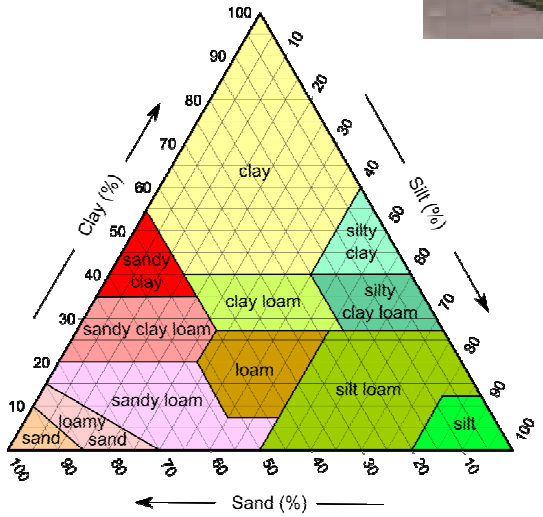
http://www.youtube.com/watch?v=GWZwbVJCNec

http://www.ksre.ksu.edu/bookstore/pubs/MF2852.pdf

Jar Test

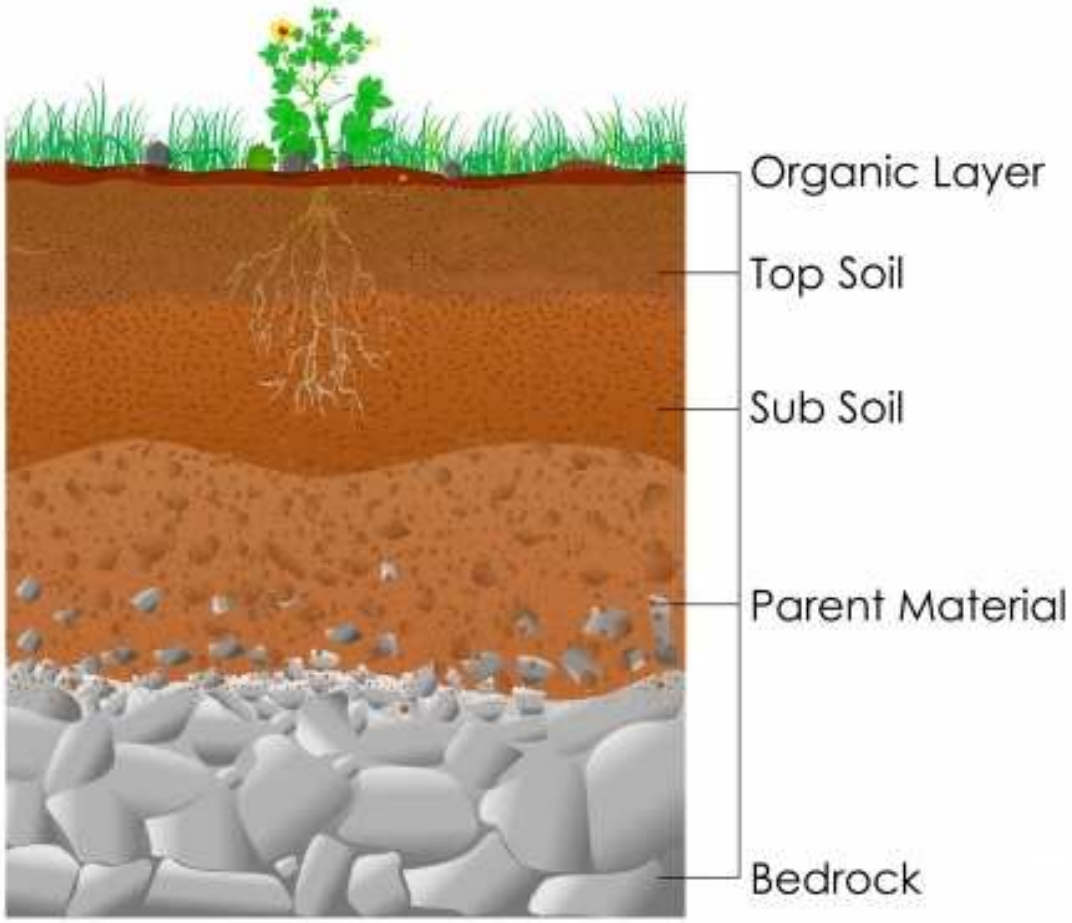
- Put soil and water in a jar
- Add dishwashing detergent
- Shake and let it settle
- Measure the proportions of the layers
- Compare to the Soil Texture Triangle





Soil Profile

- Layers of Soil



Beacon Athletics - $85.00

Properties of Water

Water is Sticky

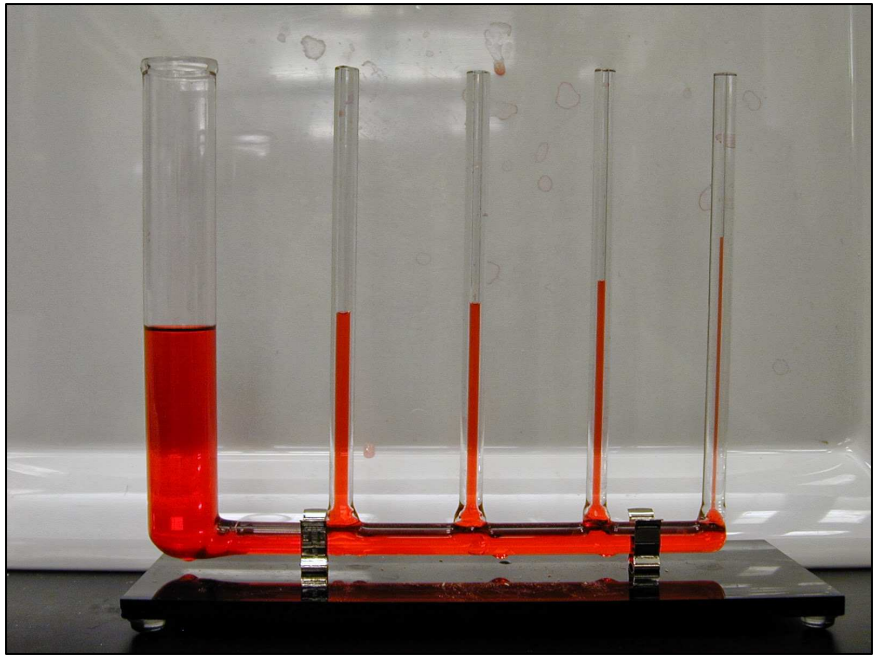
- Cohesion
  - Water is attracted to water
- Adhesion
  - Water is attracted to other substances

Surfactants or Wetting Agents reduce surface tension, making water wetter.

Capillary Action

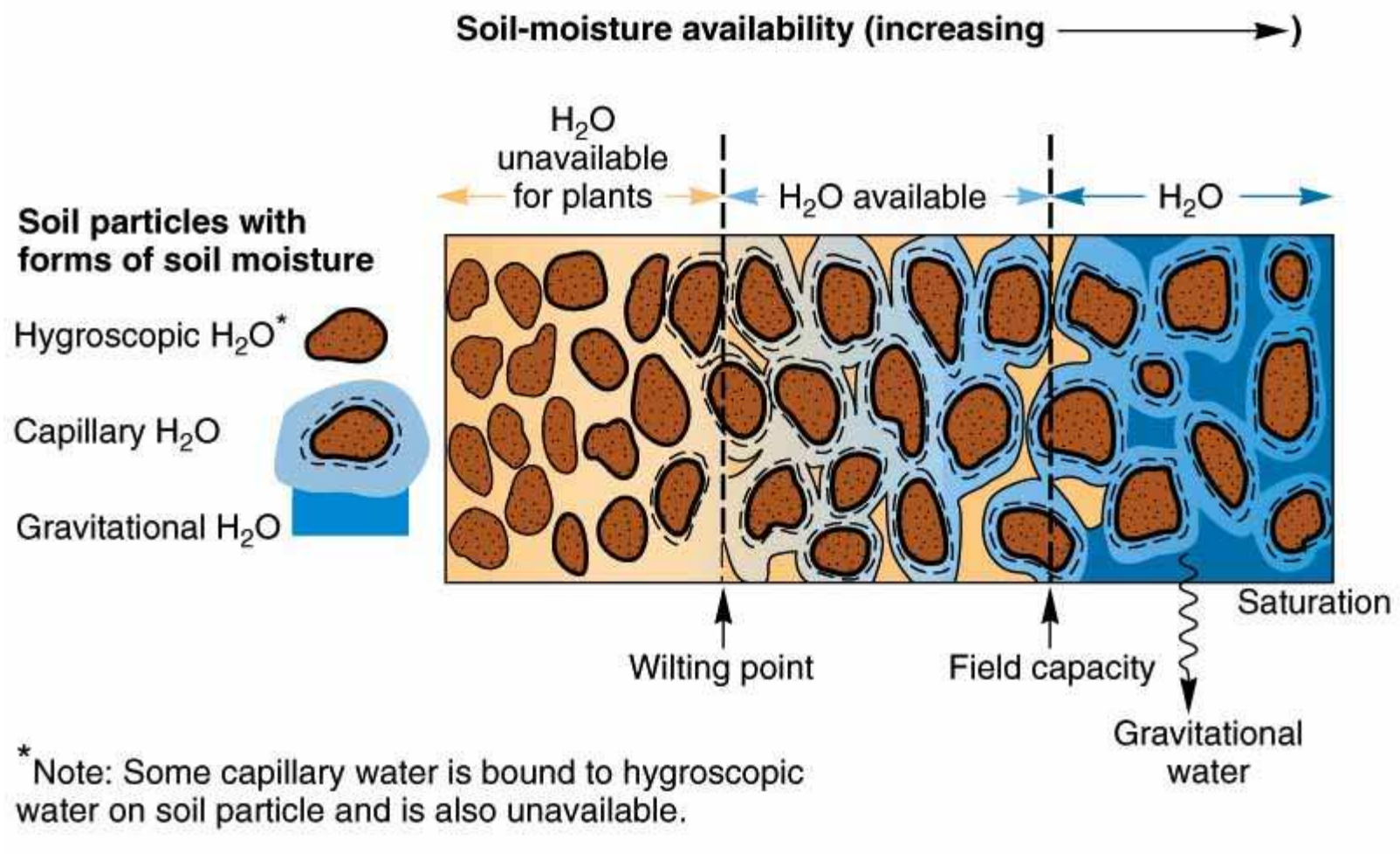
Soil Water

- Water Moves
- Retention
- > Gravity
- ↑ Smaller Pore

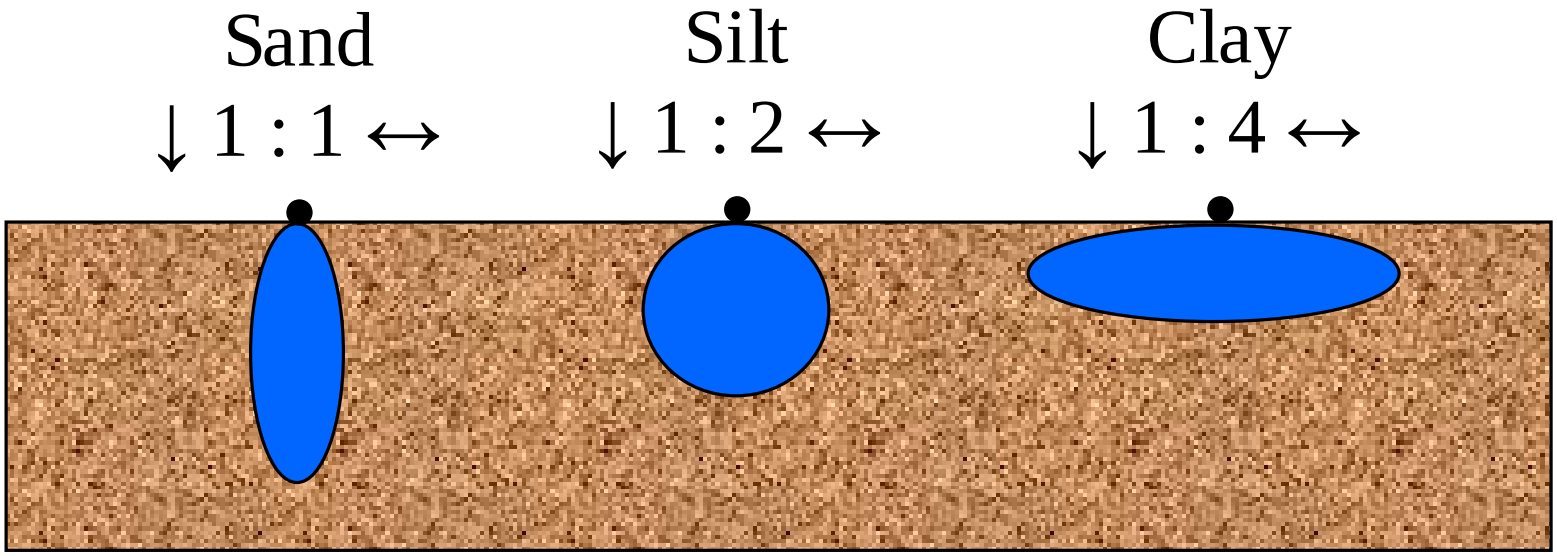


Soil Moisture

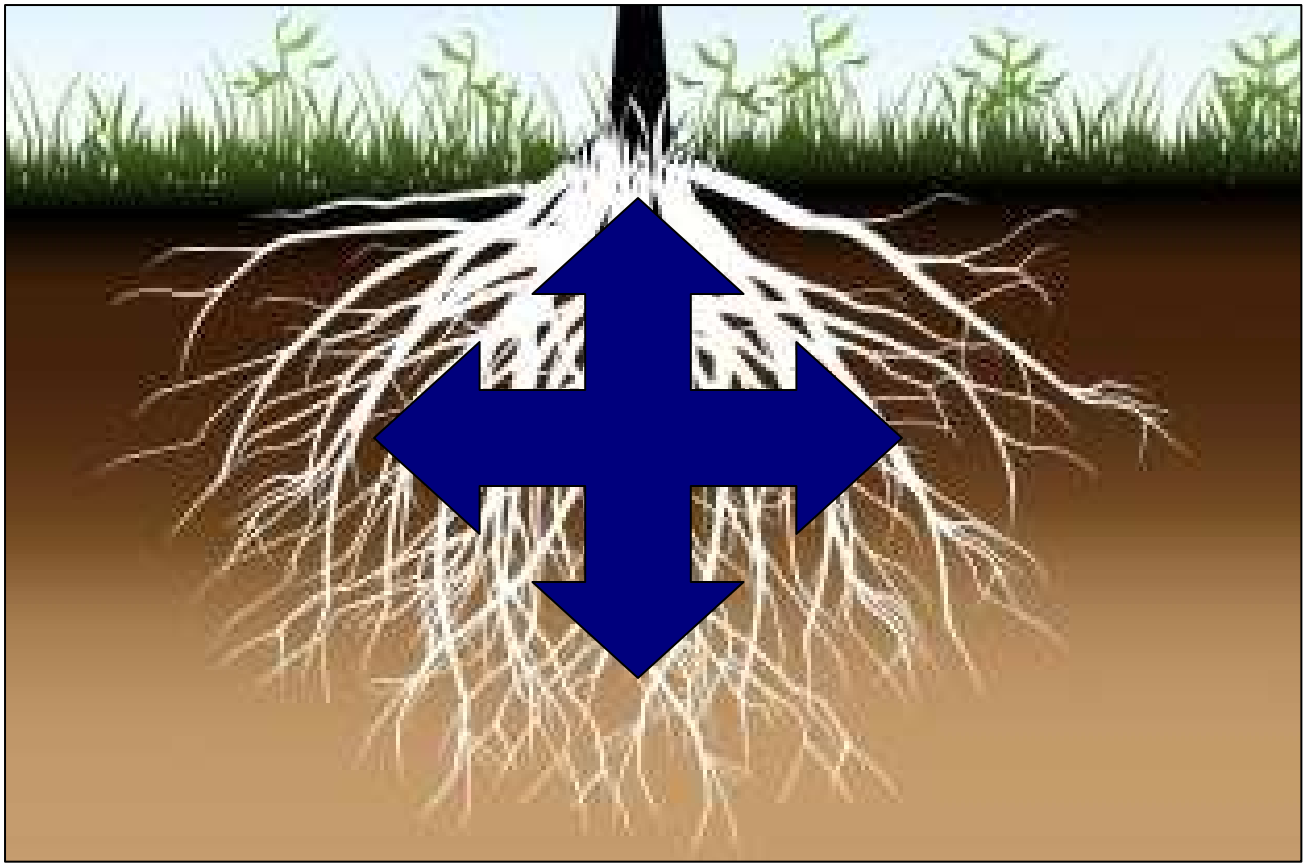
Hygroscopic > Capillary > Gravitational > Surface



Wetting Patterns



Capillary Movement



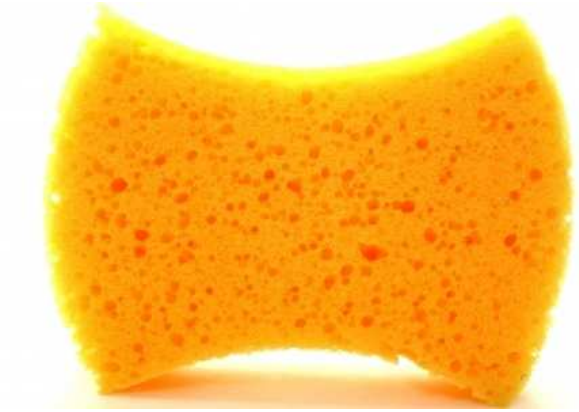
Soil Moisture Uniformity vs. Irrigation System Uniformity

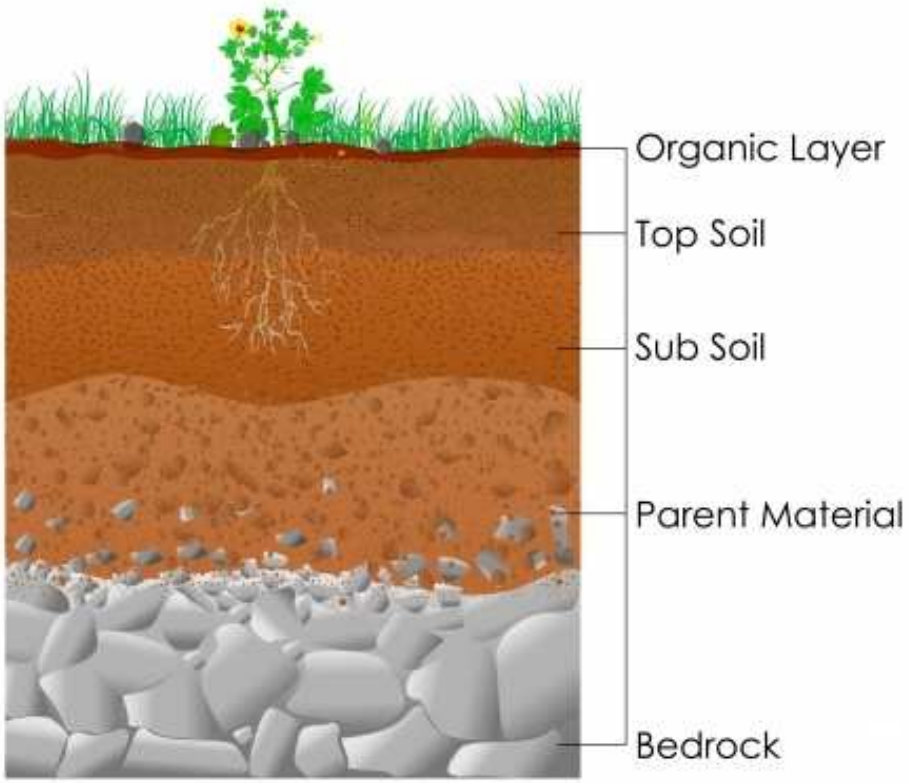
- Clay Loam 4.8”
  - 0.72 DU
  - 0.84 TDR
  - 17%
- Sandy Clay Loam 3”
  - 0.71 DU
  - 0.84 TDR
  - 18%
- Sandy Loam 4.8”
  - 0.64 DU
  - 0.91 TDR
  - 42%

Factors Limiting Root Depth

Water & Soil Conditions

- Air
- Compaction
- Soil Profile
  - Fine soil over course
  - Course soil over fine





Moisture Intake Rate

Infiltration Rate

- Soil Type
- Compaction
- Moisture Content

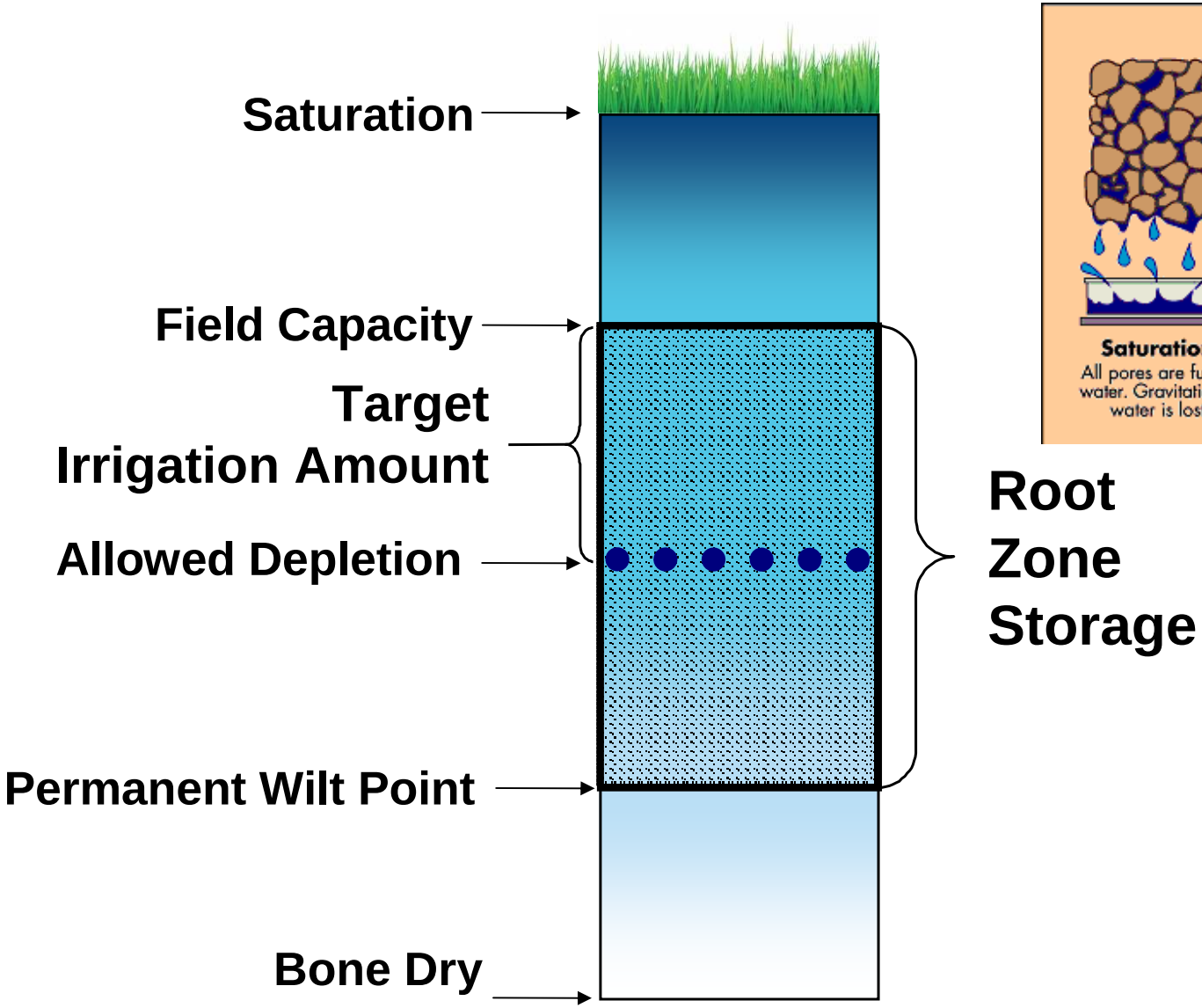
Soil Type	Steady Infiltration Rate (Inches per Hour)
Course Sand	0.75 - 1.00
Fine Sand	0.50 - 0.75
Fine Sandy Loam	0.35 - 0.50
Silt Loam	0.25 - 0.40
Clay Loam	0.10 - 0.30
Clays	<0.10

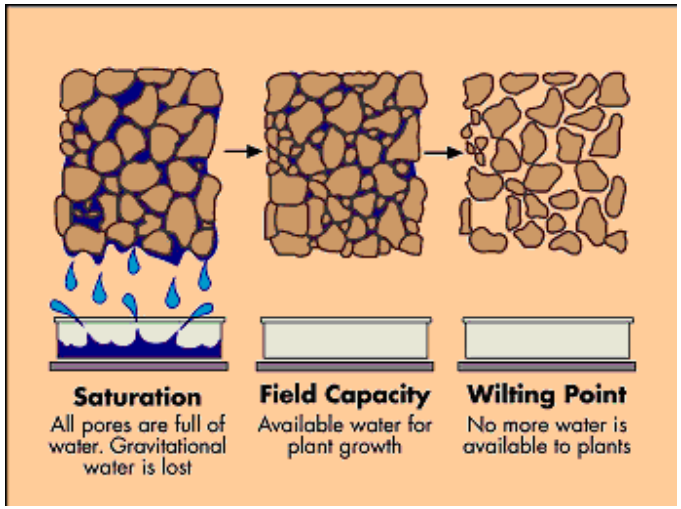
Irrigation 6th Edition Table 3.7

Irrigation application rates that exceed infiltration rates = Ponding

Potential Run-Off

Soil Moisture Content





Soil Moisture Holding Capacity

Inches of Water per Inch of Soil

Target Irrigation Amount

Soil Type	Available Water* Inch / Inch	MAD %**	Calculated Allowable Depletion					
			Root Depth in Inches					
			2	4	6	8	12	18
Sand	0.02	60%	0.02	0.05	0.07	0.10	0.14	0.22
Fine Sand	0.06	60%	0.07	0.14	0.22	0.29	0.43	0.65
Loamy Sand	0.07	60%	0.08	0.17	0.25	0.34	0.50	0.76
Sandy Loam	0.12	50%	0.12	0.24	0.36	0.48	0.72	1.08
Sandy Clay	0.16	50%	0.16	0.32	0.48	0.64	0.96	1.44
Loam	0.17	50%	0.17	0.34	0.51	0.68	1.02	1.53
Sandy Clay Loam	0.15	50%	0.15	0.30	0.45	0.60	0.90	1.35
Silty Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Clay Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Silt	0.17	50%	0.17	0.34	0.51	0.68	1.02	1.53
Silty Clay Loam	0.20	50%	0.20	0.40	0.60	0.80	1.20	1.80
Silty Clay	0.16	40%	0.13	0.26	0.38	0.51	0.77	1.15
Clay	0.15	30%	0.09	0.18	0.27	0.36	0.54	0.81

***** Soil Conservation Service Nation Engineering Handbook, September 1997

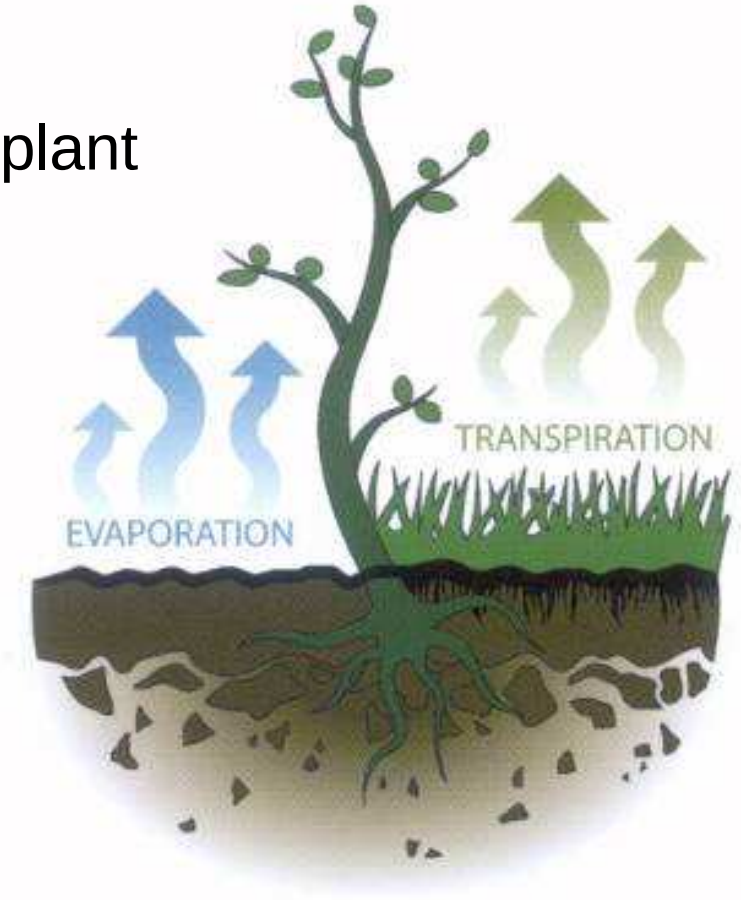
****** Irrigation Association Best Management Practices – Landscape Irrigation Scheduling and Water Management, September 2003

Measure Soil Moisture Content

- Direct
  - Total Weight vs. Soil Weight = Weight of Water
- Indirect – Soil Moisture Sensors
  - Neutron Probe
  - TDR Probe
  - FD Probes
  - ADR Probes
  - Tensiometers
  - Gypsum Block
  - Soil Psychrometer
- Moisture Balance
  - ET
  - Rain

Evapotranspiration (ET)

- Evaporation of water from the soil or plant surfaces and transpired from leaves.



- Weather conditions affect ET:
  - Solar radiation
  - Temperature
  - Wind
  - Humidity

- Typically measured in inches

Moisture Balance

Checkbook Method

ET Depletes Soil Moisture

Rain & Irrigation Replenish Soil Moisture

Seattle Center

Crop Coefficient (Kc)=0.80

	Jun 9	Jun 10	Jun 11	Jun 12	Jun 13	Jun 14	Jun 15	Jun 16	Jun 17	Jun 18	Jun 19	Jun 20	Jun 21	Jun 22
Evaporation	0.09	0.13	0.09	0.13	0.10	0.09	0.13	0.11	0.13	0.15	0.07	0.04	0.09	0.15
Rain			0.02									0.33	0.06	
Irrigation			0.50					0.50						
Moisture Level	0.16	0.03	0.46	0.33	0.23	0.14	0.01	0.40	0.27	0.12	0.05	0.34	0.30	0.15

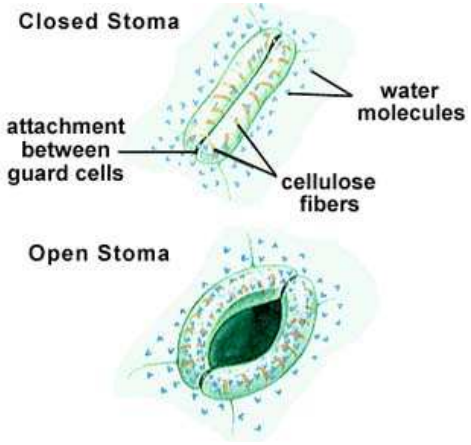
Plant Water Use

- Tissue
  - Herbaceous 80% - 90% Water
  - Woody Plants ~50%
- Transport
  - Water
  - Nutrients
- Photosynthesis

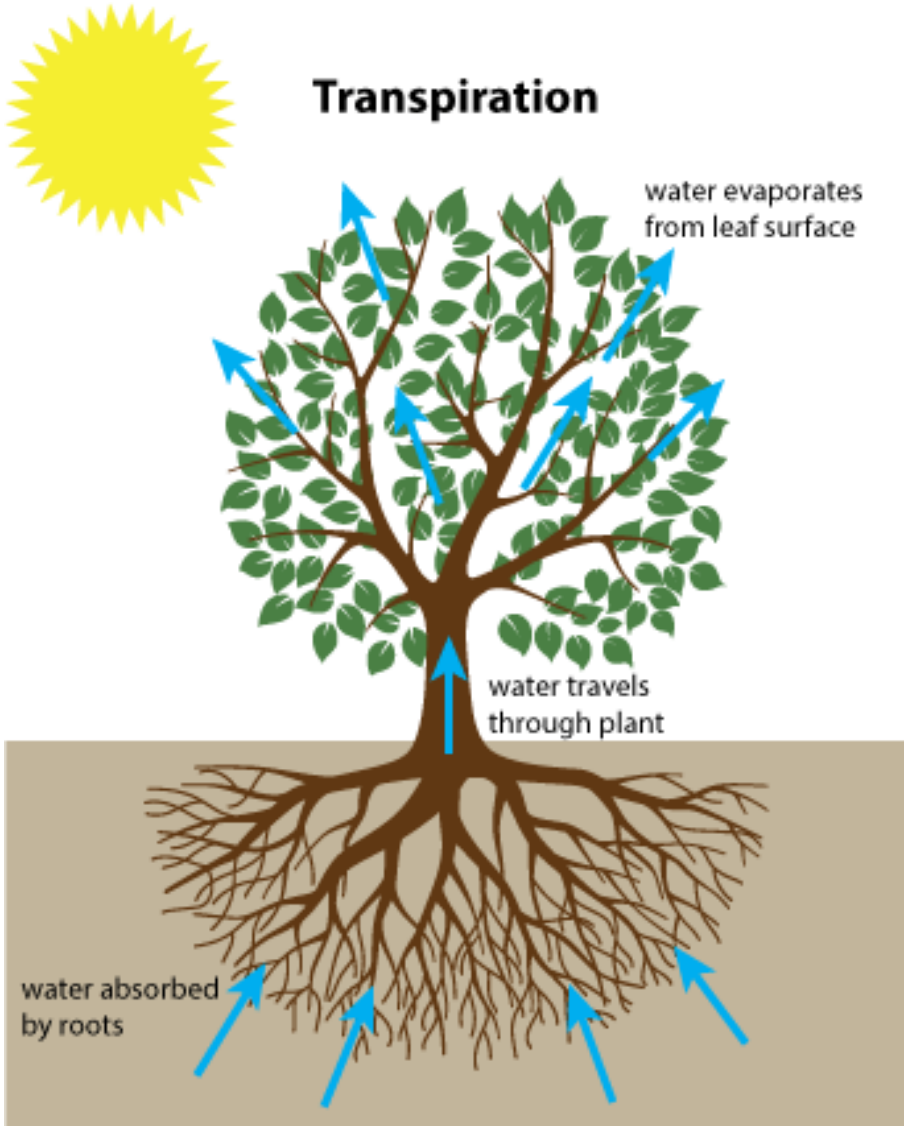
Transpiration

Circulation

- Light opens stomata

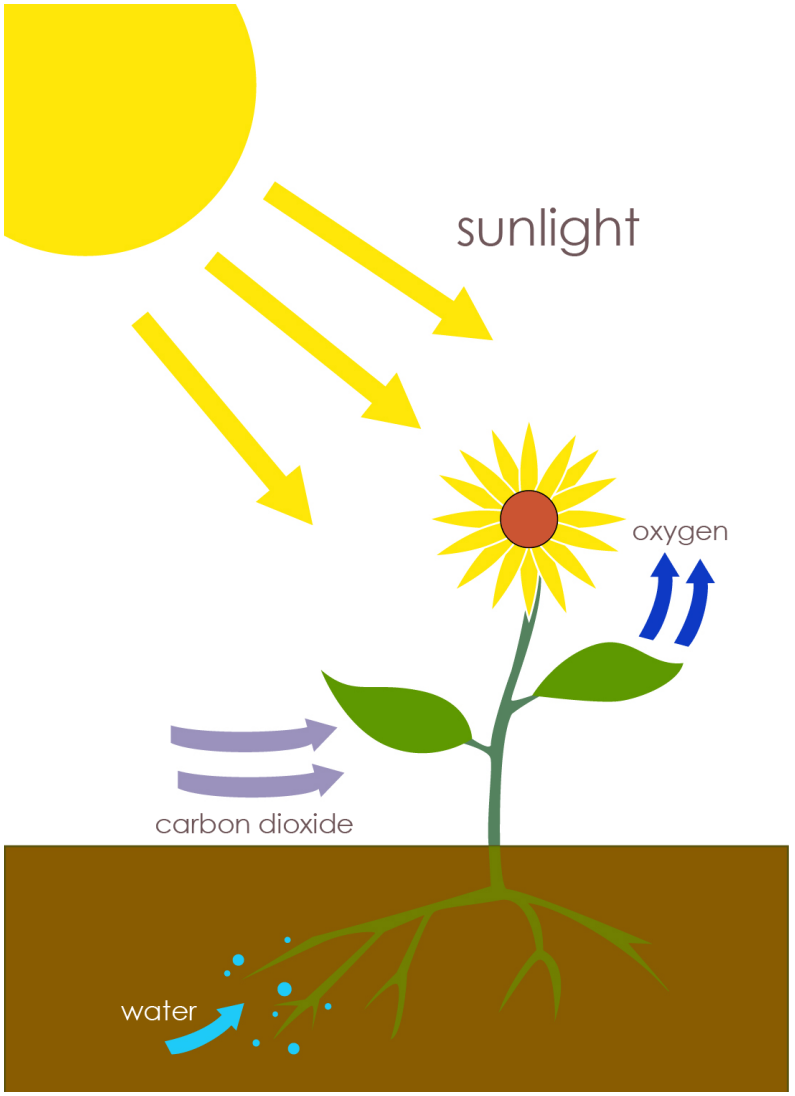


- Evaporation
- Capillary force draws water from the soil
- Nutrients and H_2O



Photosynthesis

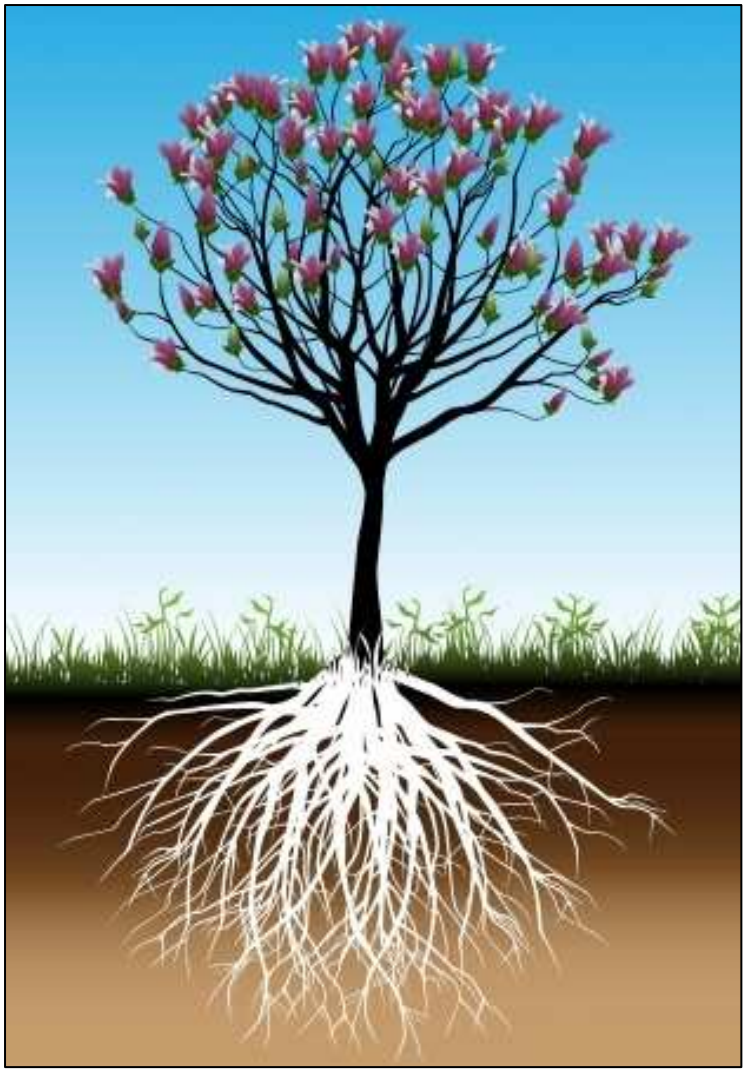
- Photo = Sunlight
- Synthesis = Combine
  - Plant
  - Water
  - CO_2
- Result
  - Oxygen
  - Carbohydrates



Plant + H_2O + CO_2 + Sunshine = Oxygen & Carbohydrates

Roots

- Anchor – Stability
- Absorb
  - Water
  - Nutrients
  - Oxygen



Potential Root Depth

Turf Grass

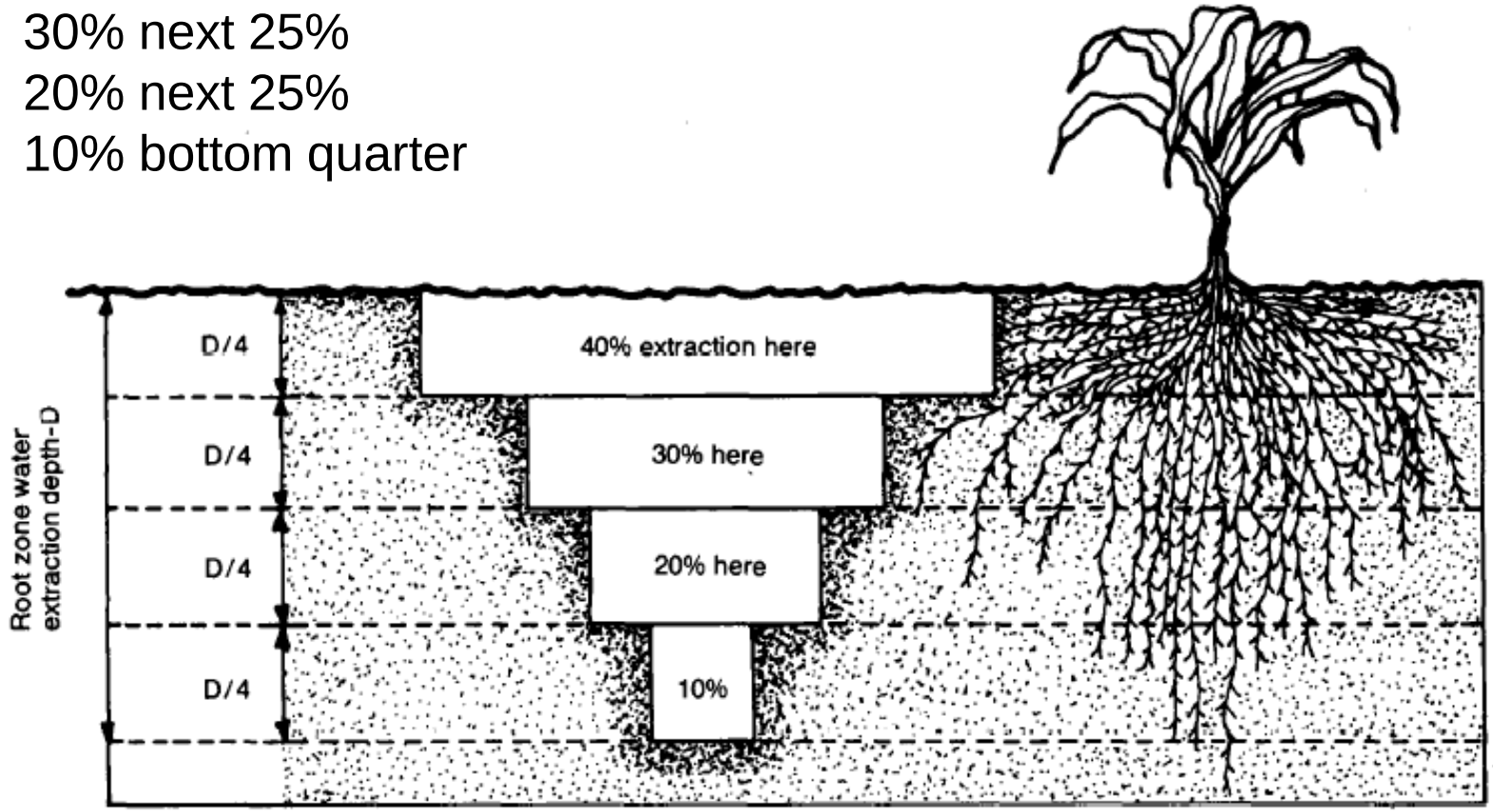
- Shallow: 1 - 8 inches
  - Poa Annua
  - Bentgrass *(18”-24”)
- Medium: 8 - 18 inches
  - Kentucky bluegrass *(18”-24”)
  - Red fescue
  - Ryegrass *(18”-24”)
  - St. Augustine
- Deep:18 - 60 inches
  - Zoysia
  - Bermuda *(4’-6’)
  - Tall fescue *(3’-4’)

Source: https://agops.ucr.edu/turf/publications/ctc/ctc35_1234.pdf

* Dr. Paul Johnson – Turf Grass Specialist - Utah State University

Water Extraction

- 40% of Water drawn from Top 25% Root
- 30% next 25%
- 20% next 25%
- 10% bottom quarter

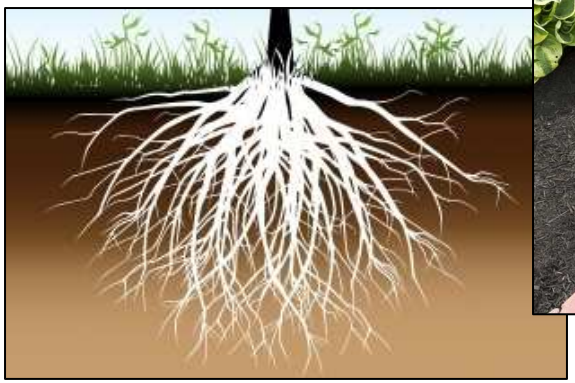


Source: National Engineering Handbook 15-1

Minimize Evaporation

Saves Water

- Stomatal Resistance
  - Metabolism
  - Plant types
- Deep Roots
  - Evaporation vs. Transpiration
  - Keep water away from evaporative energy
    - Solar Radiation, Wind, Temperature
- Mulch



Deep, Less Frequent Watering

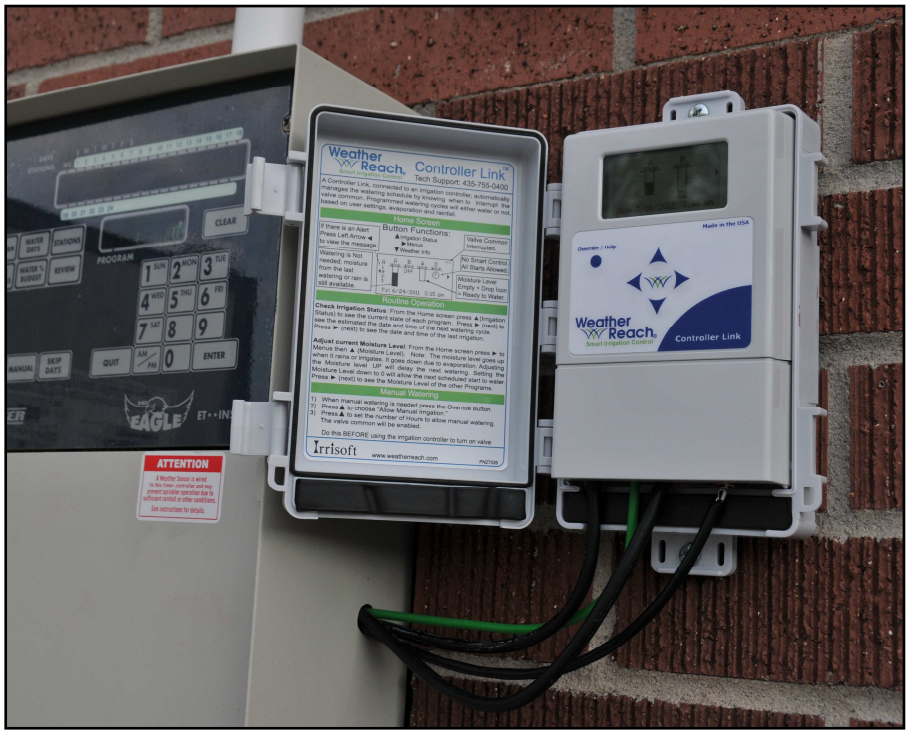
Improved plant health

- Deeper roots
- Healthy balance of air and water
- Improved soil moisture uniformity
- Conserves water – Evaporation is reduced

Water Managers Stand on a Three Legged Stool

- Irrigation System
  - Deliver water evenly and to the right place.
- Base Irrigation Schedule
  - Landscape Conditions + Sprinkler Capabilities.
- Automate the Schedule
  - Weather-Based Irrigation Control.

Connect Controller Link to an Existing Sprinkler Controller



Wi-Fi enabled to retrieve weather data via the Internet.

Free!

Controls Watering

Simple & Effective

Controller Link Key Settings

- Landscape Adjustment %
  - Turf
  - Shrubs
  - Etc.
- Irrigation Amount
  - Soil Type
  - Root Depth

Conclusions

- Soil is a reservoir
  - Capacity based on soil type & root depth
- Soil Components:
  - 25% Air, 25% Water, 45% Minerals & 5% Organics
- Soil type is a combination of:
  - Clay, Silt & Sand
- Capillary action & gravity affect water movement and soil moisture holding capacities
- Run-off directly related to soil intake rates
- Water is essential to plant life:
  - Cells, Photosynthesis & Circulation.
- Deep, less frequent watering improves plant health:
  - Root depth, air & soil moisture uniformity

Water Management with Smart Control is a Business Opportunity

- Landscapes are overwatered.
  - Let ET Control Watering Schedules
- Improve system & scheduling efficiency.
- Climate controlled irrigation
  - Reduce wasteful overwatering.

Save Money - Save Time - Save Water - Make Money

Plant Water Soil Relationships

Resources:

- Irrigation Association
  - Book: Irrigation 6th Edition - Chapter 3: Soil-Water-Plant Relationships
- USGS – Water Properties
  - http://ga.water.usgs.gov/edu/waterproperties.html
- Comparison of Distribution Uniformities of Soil Moisture and Sprinkler Irrigation in Turfgrass
  - http://irrigationtoolbox.com/ReferenceDocuments/TechnicalPapers/IA/2007/P1695.pdf
- Soil Texture by Feel
  - http://www.youtube.com/watch?v=GWZwbVJCNec
  - http://www.cdpr.ca.gov/docs/county/training/inspprcd/handouts/soil_moist_feel_test.pdf
  - http://www.ksre.ksu.edu/bookstore/pubs/MF2852.pdf
- National Engineering Handbook – Soil-Plant-Water Relationships
  - http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=18350.wba
- MAD Simulation
  - http://www.weatherreach.com/mad/
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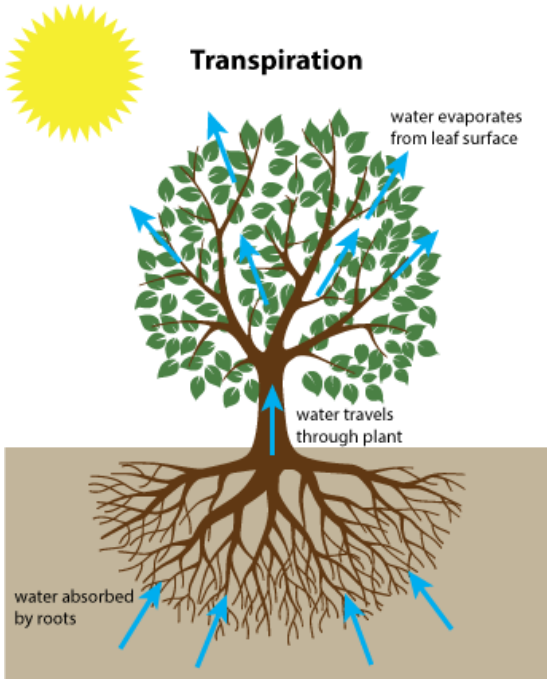

Future Webinars

- Managed Allowed Depletion
- Base Irrigation Schedule
- Smart Irrigation Control Products
- Flow Sensors
- System Fine Tuning
- Return on Investment
- Selling Water Management

Next Webinar:

Jan. 28th at 2:00

"Managed Allowed Depletion"

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Landscape Water Management

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