Irrigation Basics

Under watering

- Yield reduction
- Crop quality loss
- Death of crop

Over watering

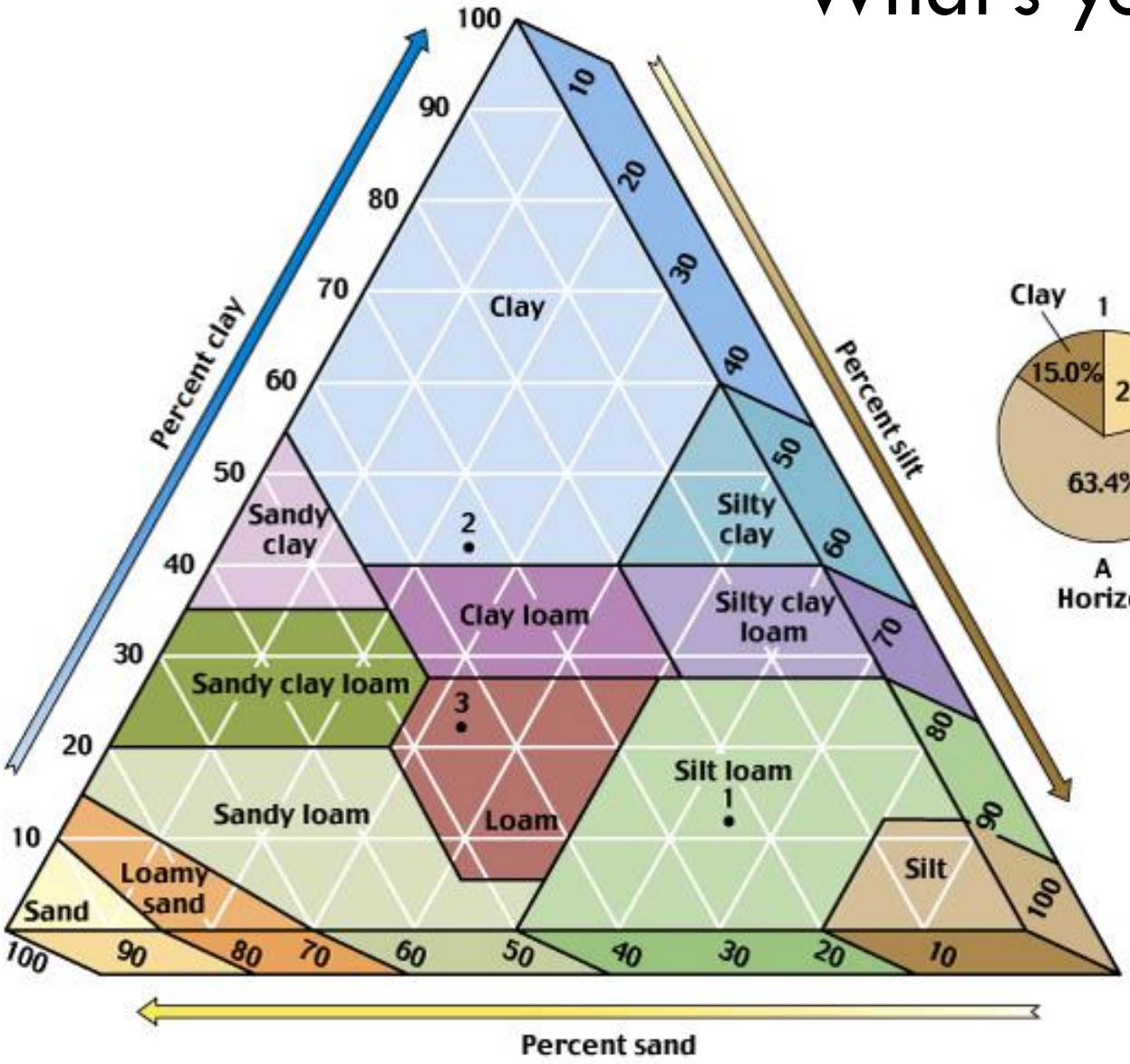
- Disease promotion
- Crop quality loss
- Promotes shallow root systems (less drought tolerant)
- Loss of nutrients through leaching
- Groundwater contamination
  - 20% of drinking water wells exceed 10 mg/l NO3-N
- Increased water bills
- Increased power bills

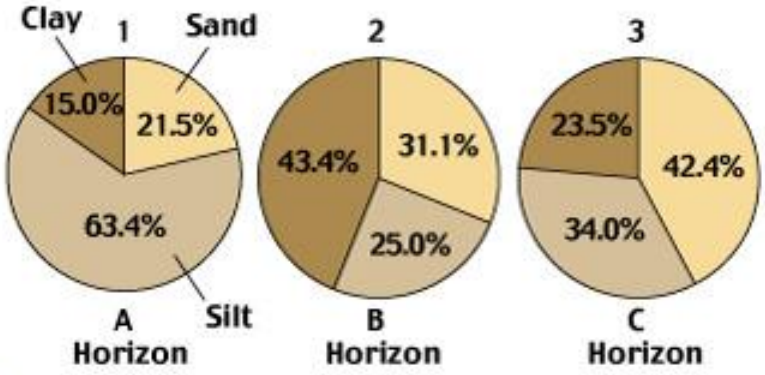
SOIL TEXTURE-

WHAT ARE THE SOIL MINERAL PARTICLES?

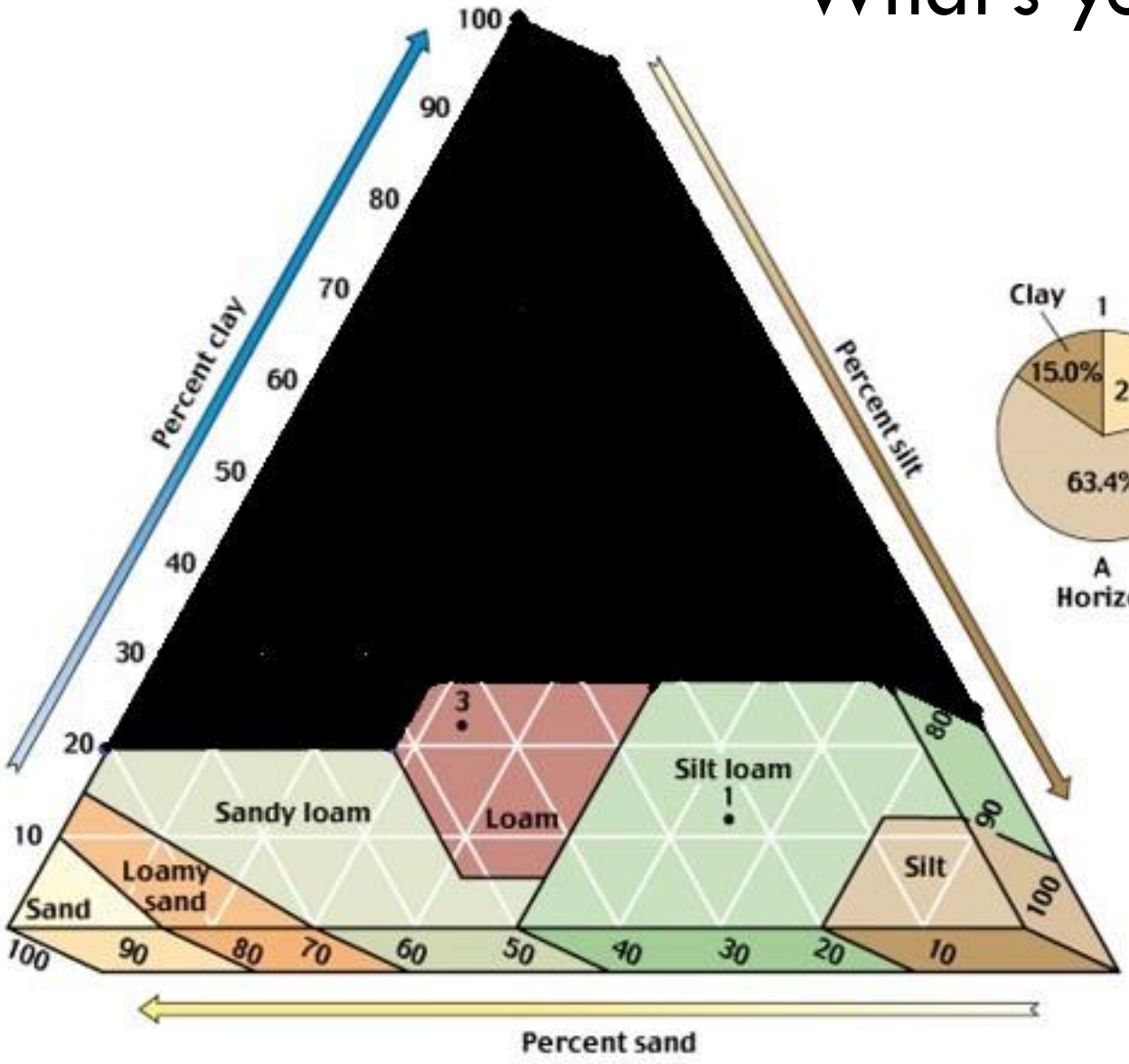
- SAND – WHICH IS LARGE, OR COARSE
- SILT – WHICH IS A MEDIUM TEXTURE
- CLAY – THE SMALLEST PARTICLES, FINE TEXTURED

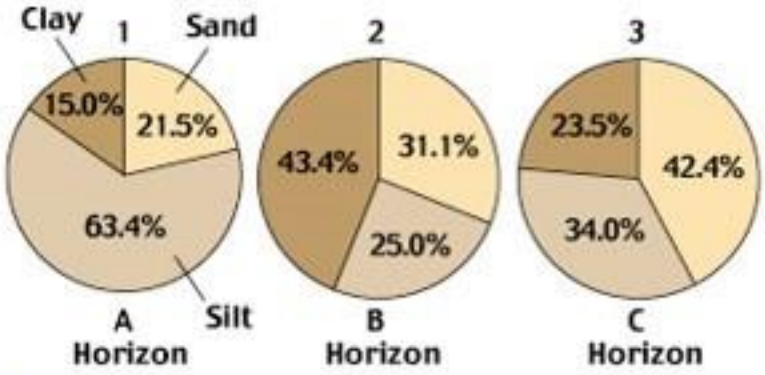
What's your type?

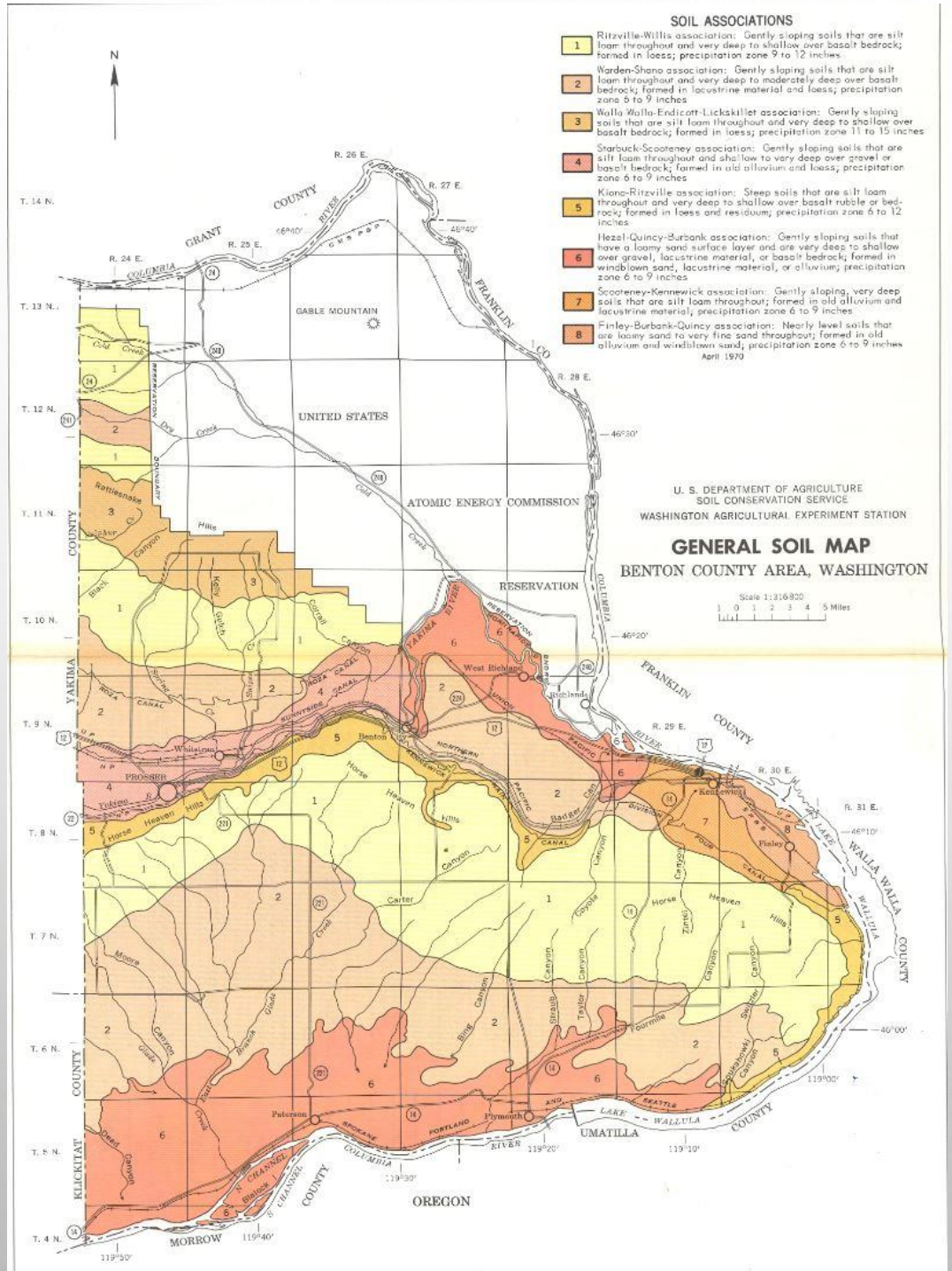




What's your type?






SOIL ASSOCIATIONS
1 Ritzville-Willis association: Gently sloping soils that are silt loam throughout and very deep to shallow over basalt bedrock; formed in loess; precipitation zone 9 to 12 inches
2 Warden-Shano association: Gently sloping soils that are silt loam throughout and very deep to moderately deep over basalt bedrock; formed in lacustrine material and loess; precipitation zone 6 to 9 inches
3 Walla Walla-Endicott-Lickskillet association: Gently sloping soils that are silt loam throughout and very deep to shallow over basalt bedrock; formed in loess; precipitation zone 11 to 15 inches
4 Starbuck-Scooteney association: Gently sloping soils that are silt loam throughout and shallow to very deep over gravel or basalt bedrock; formed in old alluvium and loess; precipitation zone 6 to 9 inches
5 Kiona-Ritzville association: Steep soils that are silt loam throughout and very deep to shallow over basalt rubble or bedrock; formed in loess and residuum; precipitation zone 6 to 12 inches
6 Hezel-Quincy-Burbank association: Gently sloping soils that have a loamy sand surface layer and are very deep to shallow over gravel, lacustrine material, or basalt bedrock; formed in windblown sand, lacustrine material, or alluvium; precipitation zone 6 to 9 inches
7 Scooteney-Kennewick association: Gently sloping, very deep soils that are silt loam throughout; formed in old alluvium and lacustrine material; precipitation zone 6 to 9 inches
8 Finley-Burbank-Quincy association: Nearly level soils that are loamy sand to very fine sand throughout; formed in old alluvium and windblown sand; precipitation zone 6 to 9 inches
April 1970
N
R. 24 E.
R. 25 E.
R. 26 E.
R. 27 E.
R. 28 E.
R. 29 E.
R. 30 E.
R. 31 E.
T. 14 N.
T. 13 N.
T. 12 N.
T. 11 N.
T. 10 N.
T. 9 N.
T. 8 N.
T. 7 N.
T. 6 N.
T. 5 N.
T. 4 N.
GRANT COUNTY
FRANKLIN CO.
GABLE MOUNTAIN
UNITED STATES
ATOMIC ENERGY COMMISSION
RESERVATION
YAKIMA COUNTY
KLICKITAT COUNTY
BENTON COUNTY
FRANKLIN COUNTY
WALLA WALLA COUNTY
UMATILLA COUNTY
MORROW COUNTY
OREGON
COLUMBIA RIVER
YAKIMA RIVER
SNAKE RIVER
46°40'
46°30'
46°20'
46°10'
46°00'
119°50'
119°40'
119°30'
119°20'
119°10'
119°00'
Rattlesnake Hills
Horse Heaven Hills
Badger Canyon
Benton
Prosser
Whitstran
West Richland
Richland
Kennewick
Finley
Paterson
Plymouth
Boardman
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WASHINGTON AGRICULTURAL EXPERIMENT STATION
GENERAL SOIL MAP
BENTON COUNTY AREA, WASHINGTON
Scale 1:316800
1 0 1 2 3 4 5 Miles

SOIL LEGEND

The first capital letter is the initial one of the soil name. The second capital letter, or pair of capital letters, shows the class of slope. Symbols without a slope letter are those of land types that have a considerable range of slope. A final number, 2 or 3, in the symbol shows that the soil is eroded or severely eroded.

SYMBOL	NAME
BbA	Burbank loamy fine sand, 0 to 2 percent slopes
BbC	Burbank loamy fine sand, 0 to 15 percent slopes *
BbD	Burbank loamy fine sand, 2 to 15 percent slopes
BdE	Burbank loamy fine sand, basalt substratum, 0 to 30 percent slopes *
BfE	Burbank rocky loamy fine sand, basalt substratum, 0 to 30 percent slopes *
BkF	Burbank rocky loamy fine sand, 30 to 65 percent slopes *
BlA	Burbank loamy fine sand, gravelly substratum, 0 to 2 percent slopes
BlD	Burbank loamy fine sand, gravelly substratum, 2 to 15 percent slopes
BmA	Burke silt loam, 0 to 2 percent slopes
BmB	Burke silt loam, 2 to 5 percent slopes
BmAB	Burke silt loam, 0 to 5 percent slopes *
BmC	Burke silt loam, 5 to 8 percent slopes
BmE3	Burke silt loam, 15 to 30 percent slopes, severely eroded *
BmF	Burke silt loam, 30 to 65 percent slopes *
BnB	Burke silt loam, shallow, 0 to 5 percent slopes *
BnC	Burke silt loam, shallow, 5 to 8 percent slopes
BoA2	Burke very fine sandy loam, 0 to 2 percent slopes, eroded
BoB2	Burke very fine sandy loam, 2 to 5 percent slopes, eroded
BoC2	Burke very fine sandy loam, 5 to 8 percent slopes, eroded
BoD2	Burke very fine sandy loam, 0 to 15 percent slopes, eroded *
BrC2	Burke very fine sandy loam, shallow, 0 to 8 percent slopes, eroded
Du	Dune land *
EfB	Ellisforde silt loam, 0 to 5 percent slopes *
EfE3	Ellisforde silt loam, 15 to 30 percent slopes, severely eroded *
EnB	Endicott silt loam, 0 to 5 percent slopes *
EnD	Endicott silt loam, 5 to 15 percent slopes *
EoE	Endicott silt loam, shallow, 0 to 40 percent slopes *
EsA	Esquatzel fine sandy loam, 0 to 2 percent slopes
EsB	Esquatzel fine sandy loam, 0 to 5 percent slopes *
EuA	Esquatzel silt loam, 0 to 2 percent slopes
EuB	Esquatzel silt loam, 2 to 5 percent slopes
EuAB	Esquatzel silt loam, 0 to 5 percent slopes *
FeA	Finley fine sandy loam, 0 to 2 percent slopes
FeB	Finley fine sandy loam, 2 to 5 percent slopes
FeC	Finley fine sandy loam, 0 to 15 percent slopes *
FeD	Finley fine sandy loam, 5 to 15 percent slopes
FfE	Finley stony fine sandy loam, 0 to 30 percent slopes *
FgB	Finley gravelly fine sandy loam, 2 to 5 percent slopes
FnA	Finley fine sandy loam, moderately deep, 0 to 2 percent slopes
FnB	Finley fine sandy loam, moderately deep, 2 to 5 percent slopes
HeA	Hezel loamy fine sand, 0 to 2 percent slopes
HeD	Hezel loamy fine sand, 2 to 15 percent slopes
HeE	Hezel loamy fine sand, 0 to 30 percent slopes *
KeA	Kennewick silt loam, 0 to 2 percent slopes
KeB	Kennewick silt loam, 2 to 5 percent slopes
KeC	Kennewick silt loam, 5 to 8 percent slopes
KeD	Kennewick silt loam, 8 to 15 percent slopes
KeE3	Kennewick silt loam, 15 to 30 percent slopes, severely eroded *
KnE	Kiona very stony silt loam, 0 to 30 percent slopes *
KnF	Kiona very stony silt loam, 30 to 65 percent slopes *
KoC	Koehler loamy fine sand, 0 to 8 percent slopes *
LcE	Lickskillet very stony silt loam, 0 to 30 percent slopes *
LcF	Lickskillet very stony silt loam, 30 to 65 percent slopes *
PaA	Pasco fine sandy loam, 0 to 2 percent slopes
PcA	Pasco silt loam, 0 to 2 percent slopes
PoA	Prosser silt loam, 0 to 2 percent slopes
PoB	Prosser silt loam, 2 to 5 percent slopes
PoD	Prosser silt loam, 5 to 15 percent slopes
PoE	Prosser silt loam, 0 to 30 percent slopes *
PrD2	Prosser very fine sandy loam, 0 to 15 percent slopes, eroded *

SYMBOL	NAME
QuA	Quincy loamy sand, 0 to 2 percent slopes
QuD	Quincy loamy sand, 2 to 15 percent slopes
QuE	Quincy loamy sand, 0 to 30 percent slopes *
QyE	Quincy loamy sand, moderately shallow, 0 to 30 percent slopes *
ReB	Ritzville silt loam, 0 to 5 percent slopes *
ReE3	Ritzville silt loam, 15 to 30 percent slopes, severely eroded *
ReF	Ritzville silt loam, 30 to 65 percent slopes *
RfD2	Ritzville very fine sandy loam, 0 to 15 percent slopes, eroded *
Rh	Riverwash *
Ro	Rock outcrop *
ScA	Scooteney silt loam, 0 to 2 percent slopes
ScB	Scooteney silt loam, 2 to 5 percent slopes
ScAB	Scooteney silt loam, 0 to 5 percent slopes *
ScC	Scooteney silt loam, 5 to 8 percent slopes
SdA	Scooteney silt loam, gravelly subsoil, 0 to 2 percent slopes
SdB	Scooteney silt loam, gravelly subsoil, 2 to 5 percent slopes
SdD	Scooteney silt loam, gravelly subsoil, 5 to 15 percent slopes
SeE	Scooteney stony silt loam, 0 to 30 percent slopes *
SgB	Scooteney gravelly silt loam, 2 to 5 percent slopes
ShA	Shano silt loam, 0 to 2 percent slopes
ShB	Shano silt loam, 2 to 5 percent slopes
ShAB	Shano silt loam, 0 to 5 percent slopes *
ShC	Shano silt loam, 5 to 8 percent slopes
ShD	Shano silt loam, 8 to 15 percent slopes
ShE3	Shano silt loam, 15 to 30 percent slopes, severely eroded *
ShF	Shano silt loam, 30 to 65 percent slopes *
SmB	Shano silt loam, deep, 2 to 5 percent slopes
SmC	Shano silt loam, deep, 5 to 8 percent slopes
SnD2	Shano very fine sandy loam, 0 to 15 percent slopes, eroded *
SnE2	Shano very fine sandy loam, 15 to 30 percent slopes, eroded *
SoC2	Shano very fine sandy loam, deep, 2 to 8 percent slopes, eroded
SrB	Starbuck silt loam, 0 to 5 percent slopes
SrC	Starbuck silt loam, 5 to 8 percent slopes
SrBC	Starbuck silt loam, 0 to 8 percent slopes *
SsE	Starbuck rocky silt loam, 5 to 45 percent slopes *
StD	Starbuck stony silt loam, 0 to 15 percent slopes *
UmB	Umapine silt loam, 0 to 5 percent slopes *
UpA	Umapine silt loam, drained, 0 to 2 percent slopes
WaB	Walla Walla silt loam, 0 to 5 percent slopes *
WaD	Walla Walla silt loam, 5 to 15 percent slopes *
WaE3	Walla Walla silt loam, 15 to 30 percent slopes, severely eroded *
WaF	Walla Walla silt loam, 30 to 65 percent slopes *
WbA	Wamba silt loam, 0 to 2 percent slopes
WdA	Warden silt loam, 0 to 2 percent slopes
WdB	Warden silt loam, 2 to 5 percent slopes
WdAB	Warden silt loam, 0 to 5 percent slopes *
WdC	Warden silt loam, 5 to 8 percent slopes
WdD	Warden silt loam, 8 to 15 percent slopes
WdE3	Warden silt loam, 15 to 30 percent slopes, severely eroded *
WdF	Warden silt loam, 30 to 65 percent slopes *
WfA2	Warden very fine sandy loam, 0 to 2 percent slopes, eroded
WfB2	Warden very fine sandy loam, 2 to 8 percent slopes, eroded
WfC2	Warden very fine sandy loam, 0 to 15 percent slopes, eroded *
WfE2	Warden very fine sandy loam, 15 to 30 percent slopes, eroded *
WfD2	Warden very fine sandy loam, 8 to 15 percent slopes, eroded
WsB	Willis silt loam, 0 to 5 percent slopes *
WsE3	Willis silt loam, 15 to 30 percent slopes, severely eroded *
WsF	Willis silt loam, 30 to 65 percent slopes *
WtD	Willis silt loam, shallow, 0 to 15 percent slopes *

WOR

Highways and road

Dual .....

Good motor ...

Poor motor ....

Trail .....

Highway markers

National Intersta

U. S. .....

State or county

Railroads

Single track ...

Multiple track

Abandoned ....

Bridges and crossi

Road .....

Trail .....

Railroad .....

Ferry .....

Ford .....

Grade .....

R. R. over .....

R. R. under ...

Tunnel .....

Buildings .....

School .....

Church .....

Mine and quarry

Gravel pit .....

Power line .....

Pipeline .....

Cemetery .....

Dams .....

Levee .....

Tanks .....

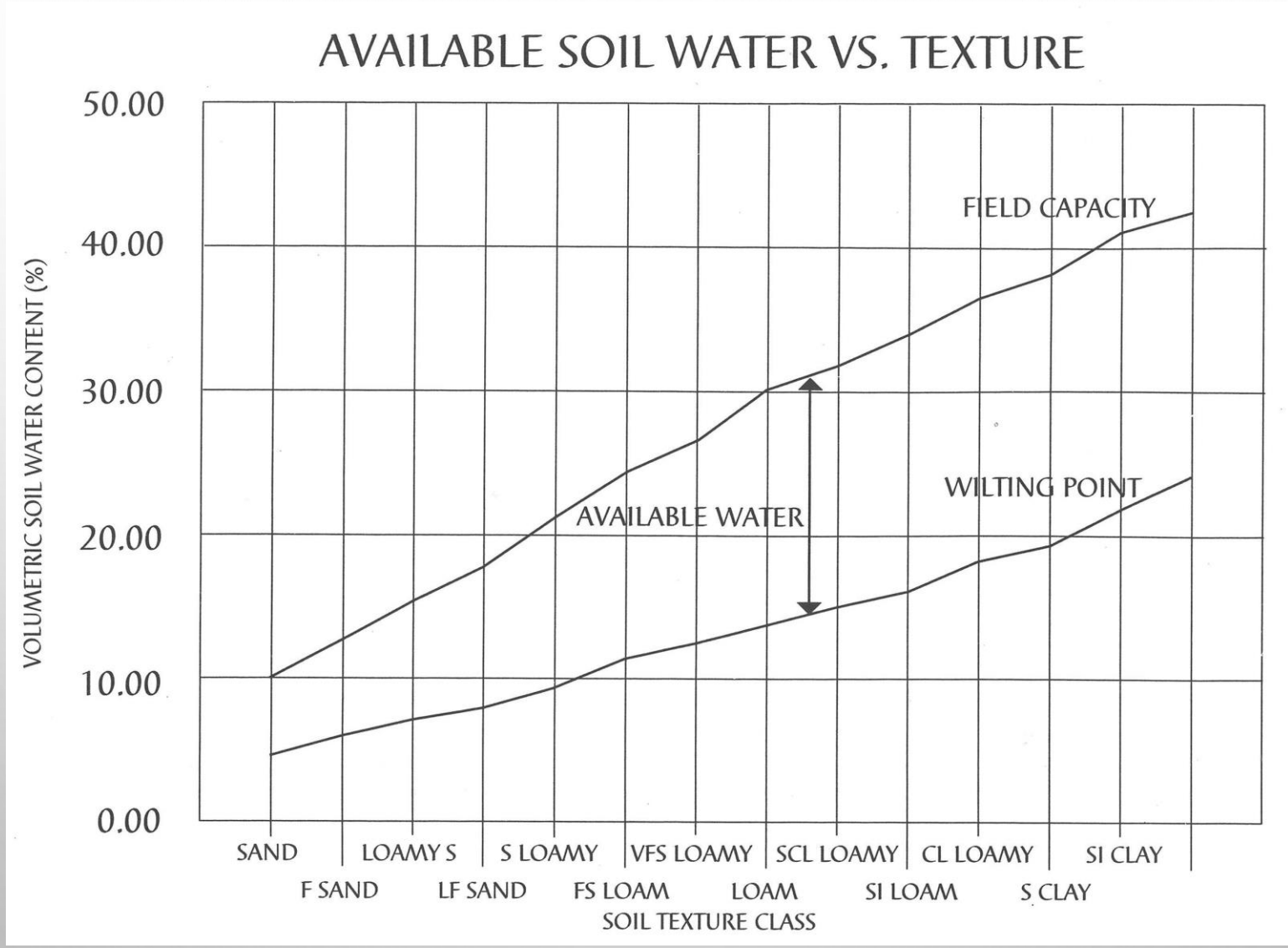
Well, oil or gas ..

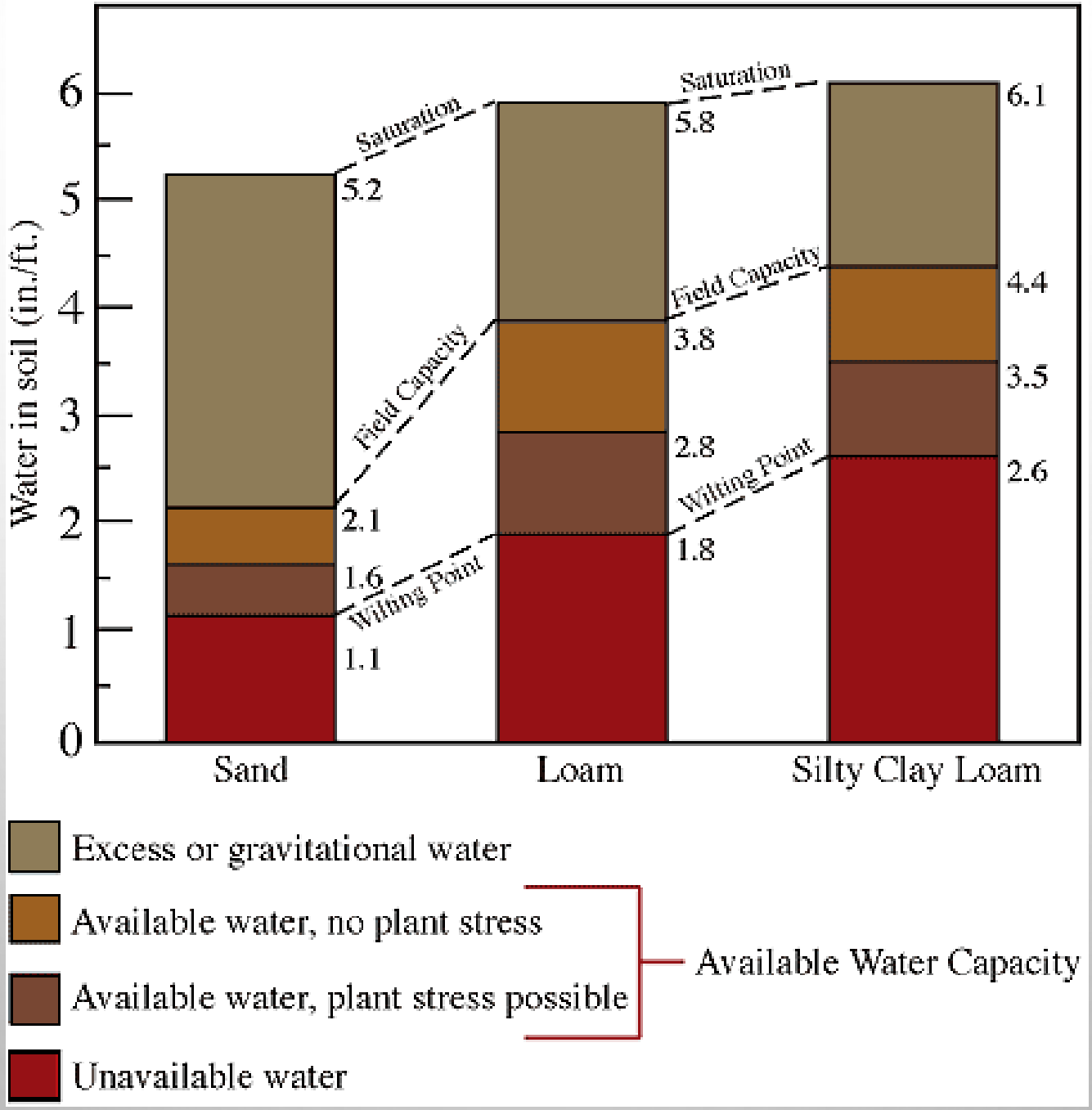
Forest fire or look

Windmill .....

Representative values of soil bulk density, total porosity, and available soil water for various generalized soil textures.

Soil Texture	Bulk Density (g/cm^3)	Porosity (%)	Available Soil Water (inches/foot of soil depth)	
			Range	Average
Coarse				
Sand	1.65	38	0.5 - 0.8	0.7
Fine Sand	1.60	40	0.6 - 1.0	0.8
Loamy Sand	1.60	40	0.7 - 1.1	0.9
Gravel/Cobble in Coarse Texture	—	—	0.6 - 0.8	0.7
Moderately Coarse				
Loamy Fine Sand	1.55	42	1.0 - 1.3	1.2
Sandy Loam	1.50	43	1.2 - 1.6	1.4
Fine Sandy Loam	1.50	43	1.2 - 1.7	1.5
Medium				
Gravel/Cobble in Medium Texture	—	—	1.1 - 1.3	1.2
Very Fine Sandy Loam	1.45	45	1.6 - 2.2	1.9
Loam	1.40	47	1.6 - 2.3	2.0
Moderately Fine				
Sandy Clay Loam	1.35	49	1.7 - 2.4	2.1
Silt Loam	1.35	49	1.8 - 2.5	2.2
Clay Loam	1.35	49	1.8 - 2.5	2.2
Fine				
Sandy Clay	1.30	51	1.9 - 2.5	2.3
Silty Clay	1.25	53	1.9 - 2.5	2.3
Clay	1.20	55	2.0 - 2.5	2.3
Peats and Mucks	—	—	2.0 - 3.0	2.5


AVAILABLE SOIL WATER VS. TEXTURE
50.00
40.00
30.00
20.00
10.00
0.00
VOLUMETRIC SOIL WATER CONTENT (%)
FIELD CAPACITY
WILTING POINT
AVAILABLE WATER
SAND
LOAMY S
S LOAMY
VFS LOAMY
SCL LOAMY
CL LOAMY
SI CLAY
F SAND
LF SAND
FS LOAM
LOAM
SI LOAM
S CLAY
SOIL TEXTURE CLASS


Water in soil (in./ft.)
0
1
2
3
4
5
6
Saturation
5.2
Field Capacity
2.1
Wilting Point
1.6
1.1
Saturation
5.8
Field Capacity
3.8
2.8
Wilting Point
1.8
Saturation
6.1
Field Capacity
4.4
3.5
Wilting Point
2.6
Sand
Loam
Silty Clay Loam
Excess or gravitational water
Available water, no plant stress
Available water, plant stress possible
Unavailable water
Available Water Capacity

USDA Web Soil Survey

https://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Expected maximum crop rooting depths, effective rooting depths for water management purposes and management allowable depletion (MAD) values for several PNW crops.

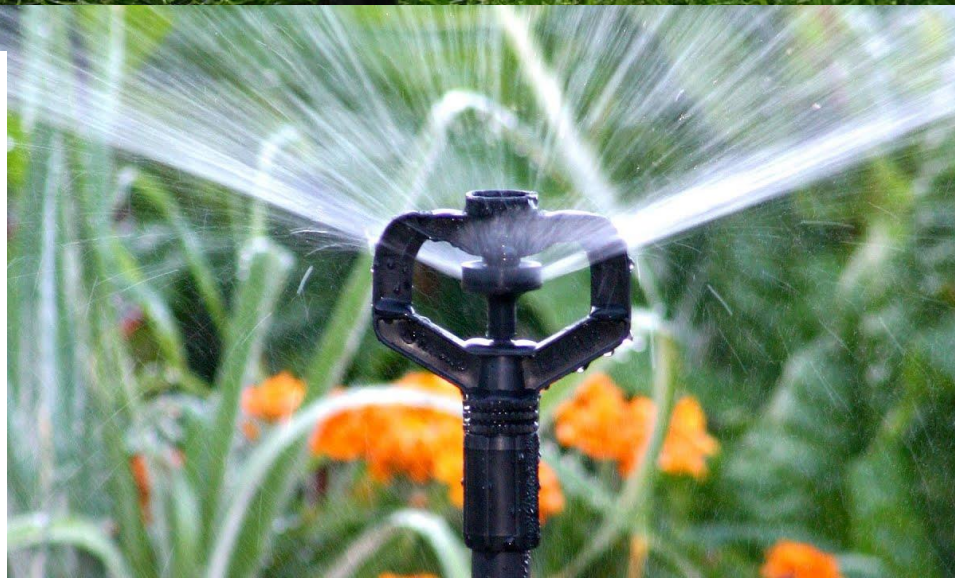
Crop	Maximum Root Depth (ft) in Deep, Well-Drained Soil	Effective Root Depth (ft) for Water Management in Deep, Well-Drained Soil	Management Allowable Soil Water Depletion (%)
Alfalfa	6	4	65
Apples (with/without cover crop)	6	3.5-4	50-65
Apricots	6	3.5-4	50-65
Asparagus	6	4	50
Beans, dry	3	2	50
Beans, green	3	2	40-50
Carrots	3	2	40-50
Cherries (with/without cover crop)	6	3.5-4	50-65
Clover/grass hay	2	2	50-65
Corn, grain	4	3	65
Corn, sweet	4	3	40-65
Crucifers	2	2	40-50
Cucumber	4	2	40-50
Grapes (with/without cover crop)	6	3	65
Hop	6	4	65
Mint	3	1.5-2	35
Onions, dry	2	1	40-50
Onions, green	2	1	40-50
Pasture grass	2	1.5-2	50-65
Peaches (with/without cover crop)	6	3.5-4	50-65
Peas	2	1.5	50-65
Pears/plums (with/without cover crop)	6	3.5-4	50-65
Potato	2	1.5-2	20-35
Radish	2	1	40-50
Raspberries	4	3	50
Safflower	6	4	50-65
Sorghum	3	2	65
Soybeans	3	2	65
Spinach	2	1.5	40-50
Spring grain	3	3	50-65
Strawberries	1	1	50-65
Sugar Beets	4	3	50-65
Sunflower	6	4	65
Tomato	4	3	40-50
Turfgrass	2	1.5-2	50
Winter wheat	3	3	50-65

HOW MUCH SHOULD I WATER?

- AWC X RD X MAD = TAWC
- Ex. Pasture Grass on Sandy Loam
  - 2 Ft. Rooting Depth
  - 1.40 Inches/Foot
  - 50 – 65% MAD (use 55%)
- 1.4” X 2’ X .55 = 1.54”

HOW LONG SHOULD I WATER?

- Need to Know Irrigation System Application Rate and Efficiency.
  - Design (Dealer, Nozzle rating @ varying psi)
  - Flow Measurement (Easiest with Impact Sprinklers)
  - Catch Measurement (Use Straight Edge Container i.e. Tuna can, vegetable can, etc.)



HOW LONG SHOULD I WATER?

- Design (Dealer, Mfg. Nozzle rating @ varying psi)

F33S — Single Nozzle — 3/4" Brass Arm

	1/8"		9/64"		5/32"		11/64"		3/16"		13/64"		7/32"	
NOZ. PSI	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.	GPM	DIA. FT.
25	2.25	78	2.88	80	3.52	82	4.24	83	5.00	85	5.90	86	6.85	88
30	2.47	79	3.15	81	3.85	85	4.64	88	5.50	91	6.50	94	7.55	96
35	2.68	80	3.40	82	4.16	87	5.02	90	5.96	94	7.05	97	8.20	100
40	2.87	81	3.64	83	4.45	88	5.37	92	6.38	96	7.55	99	8.80	102
45	3.05	82	3.86	84	4.72	89	5.70	94	6.78	98	8.00	101	9.35	104
50	3.22	83	4.07	85	4.98	90	6.01	95	7.16	100	8.45	103	9.9	106
55	3.38	84	4.27	86	5.22	91	6.30	96	7.52	101	8.85	104	10.40	107
60	3.53	85	4.46	87	5.45	92	6.57	97	7.85	102	9.25	105		
65	3.68	86	4.65	88	5.68	93	6.83	98	8.18	103	9.60	106	Do not operate over 60 PSI	
70	3.82	86	4.83	89	5.90	94	7.09	99	8.50	104	9.95	107		
75	3.96	87	5.00	90	6.11	95	7.34	100	8.80	105	10.25	108		
80	4.09	87	5.17	91	6.30	96	7.58	101	9.09	106	10.50	109		

- IPH = Avg. Nozzle gpm X 96.3/Sp. Spacing X Lateral Spacing X Eff.
- ((5.22 gpm X 96.3)/(40' X 60')) X 75% = 0.16 IPH
- 9.8 hours to fill 1.54" soil depletion
- 1.92" / 12 hrs. Or 3.84" / 24 hrs.

HOW LONG SHOULD I WATER?

- Design Info (Dealer, Mfg. Nozzle rating @ varying psi)

Plate/Nozzle Options and Flow Performance in Gallons Per Minute

25° Plate Options	Recommended Nozzles	Model & Radius	PSI 25	30	35	40	45	50	55	60	65
 12113 BLUE WF10	Dk. Blue #10 #9306-078	R2000LP Rad. 30-32'	0.88	0.97	1.05	1.12	1.19	1.25	–	–	–
	Nozzle/Body Assy. (5/64") #9920-010	R2000WF Rad. 33-35'	–	–	–	1.12	1.19	1.25	1.31	1.37	1.44
 PURPLE WF12 #10452	Orange #11 #9306-086	R2000LP Rad. 32-34'	1.07	1.17	1.27	1.36	1.45	1.53	–	–	–
	Nozzle/Body Assy. (11/128") #9920-011	R2000WF Rad. 35-37'	–	–	–	1.36	1.45	1.53	1.61	1.68	1.76
	Purple #12 #9306-094	R2000LP Rad. 33-35'	1.27	1.39	1.50	1.61	1.70	1.80	–	–	–
	Nozzle/Body Assy. (3/32") #9920-012	R2000WF Rad. 37-38'	–	–	–	1.61	1.70	1.80	1.89	1.98	2.06

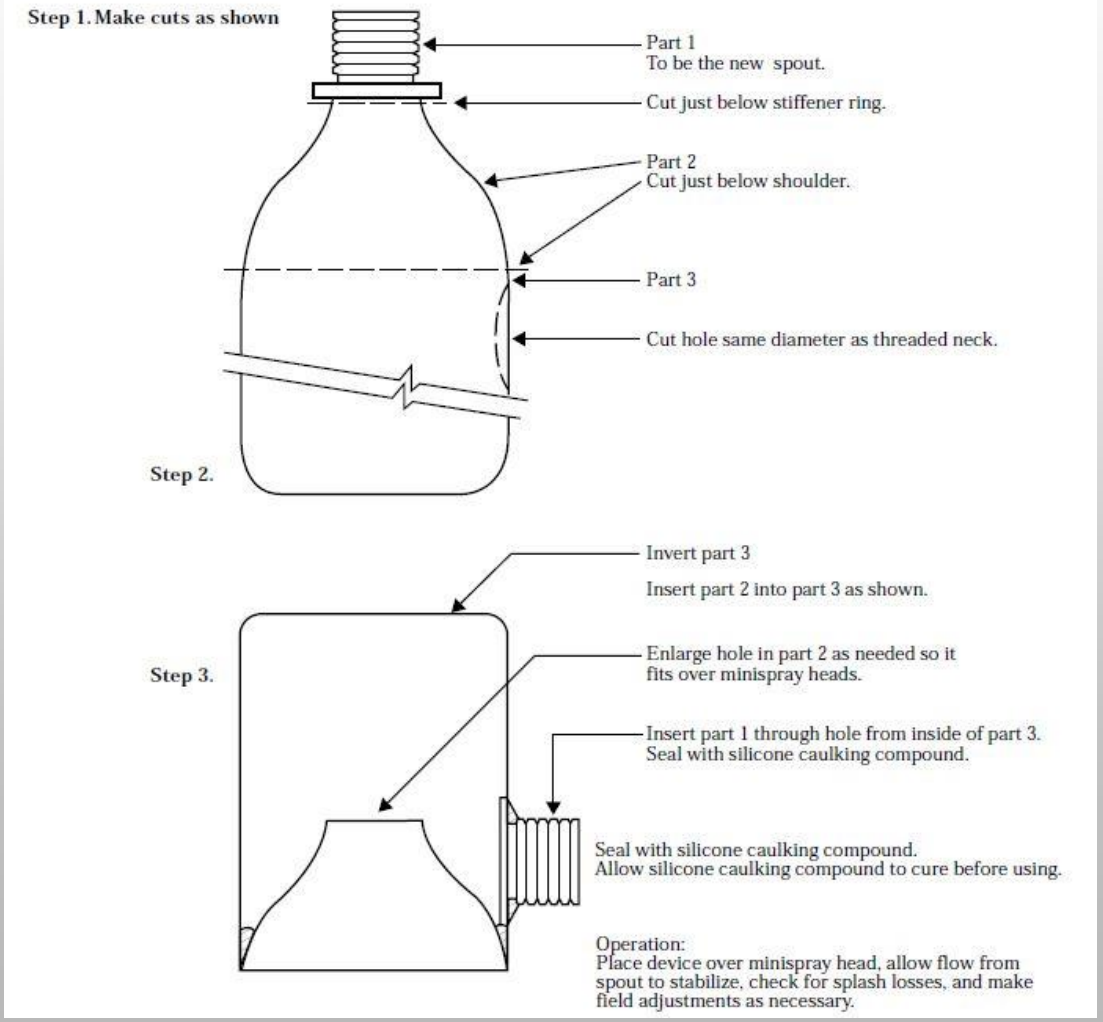
- IPH = Avg. Nozzle gpm X 96.3/Sp. Spacing X Lateral Spacing X Eff.
- ((1.80 gpm X 96.3)/(40' X 40')) X 85% = 0.09 IPH
- 16.7 hours to fill 1.54" soil depletion
- 1.08" / 12 hrs. Or 2.16" / 24 hrs.

HOW LONG SHOULD I WATER?

- Nozzle Flow Measurement
  - Impact Sprinker
  - Micro-spray Sprinkler
  - Drip

HOW LONG SHOULD I WATER?

Figure 9–13 Minispray head catch device (made from a 2-liter plastic soft drink bottle)



HOW LONG SHOULD I WATER?

- Nozzle Flow Measurement
  - Impact Sprinker
  - Micro-spray Sprinkler
  - Drip

Ex. 5 Gal./1.5 minutes = 3.33 gpm

Ex. 5 Gal./47 seconds = 6.38 gpm

Ex. ¼ cup/1 minute = .94 gph

HOW OFTEN SHOULD I WATER?

- EVAPOTRANSPIRATION = EVAPORATION + PLANT TRANSPIRATION
  - USBR – AGRIMET HTTPS://WWW.USBR.GOV/PN/AGRIMET/
    - Crop Water Use Charts
  - WSU – AGWEATHERNET HTTP://WEATHER.WSU.EDU/
    - Daily Crop Water Use
    - Irrigation Scheduler – Check book method.

SOIL MOISTURE MONITORING METHODS

Soil Sampling (Oven Dry/Gravimetric)

Tensiometers

Electrical Resistance Blocks (Watermarks)

Time Domain Reflectometry

RF Capacitance

Neutron Probe (Consultants)

SOIL MOISTURE MONITORING METHODS

Soil Sampling (Gravimetric)

SOIL MOISTURE MONITORING METHODS

Tensiometers

SOIL MOISTURE MONITORING METHODS

Electrical Resistance (Watermark)

SOIL MOISTURE MONITORING METHODS

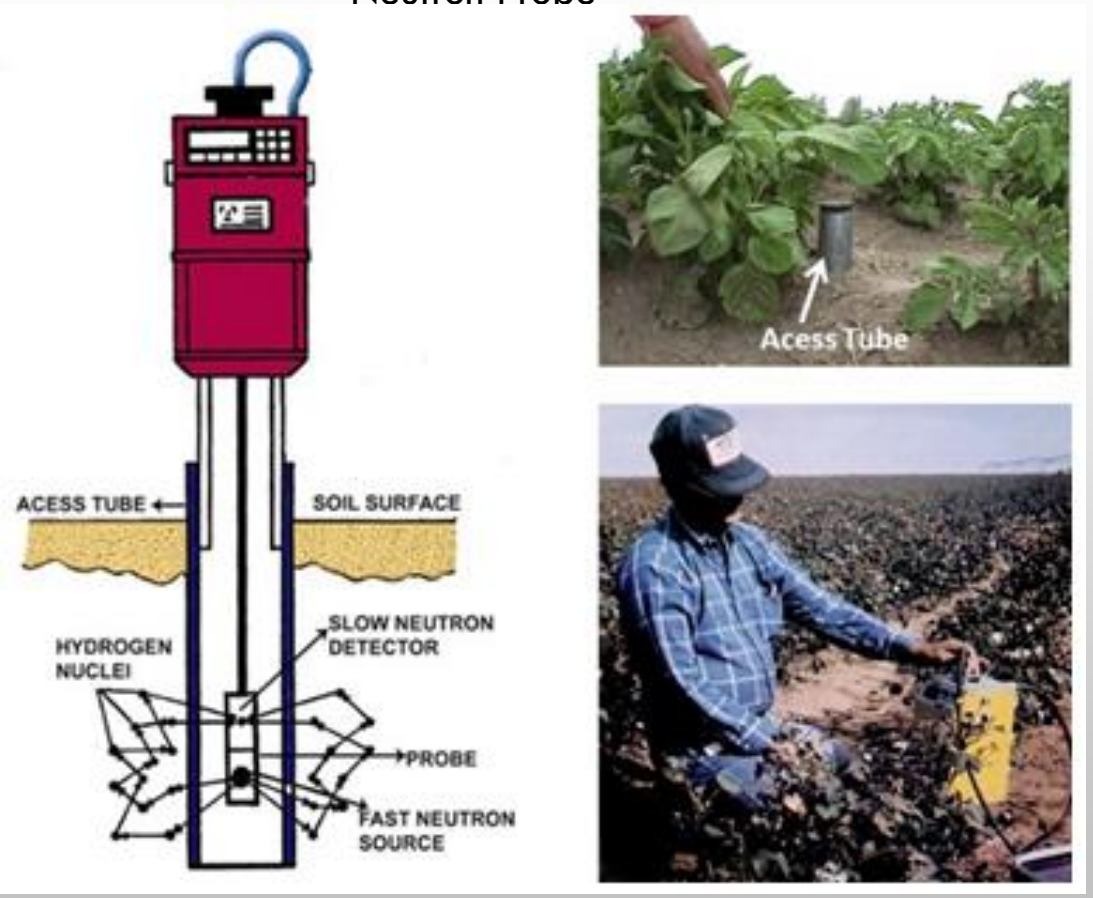
Time Domain Reflectometry / Tranmissometry

SOIL MOISTURE MONITORING METHODS

RF Capacitance/FDR

SOIL MOISTURE MONITORING METHODS

Neutron Probe



SOIL MOISTURE MONITORING METHODS

Real Time Readings

HTTPS://CROPLOGIC.COM/CROPLOGIC-REALTIME/

HTTPS://WWW.CROPX.COM/

IRRIGATION SCHEDULING

1. Know your application rate
2. Know how much water the soil holds
3. Know the rooting depth of your crop
4. Know how much water you can deplete before plant stress
5. Know how fast the plant is using the water