DRIP AND OTHER LOW VOLUME IRRIGATION

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BASED ON PRESENTATION BY Mel Hengen, Master Gardener

IRRIGATION AND SOIL

- AS LITTLE AS 2% ORGANIC MATTER IN THE SOIL CAN REDUCE IRRIGATION NEEDS BY 75% OVER POOR SOILS WITH LESS THAN 1% ORGANIC MATTER
- SHADING WITH MULCH AND PLANT LEAVES CAN REDUCE IT BY 60%
- (RAINWATER HARVESTING FOR DRYLANDS AND BEYOND VOLUME 23 PAGE 20)

CUTTING COST$

IT IS NOT WISE TO TRY AND SAVE A FEW DOLLARS ON IRRIGATION SYSTEM DESIGN, INSTALLATION OR MAINTENANCE. YOU MAY END UP WITH

AN IRRITATION SYSTEM!

IRRIGATION OBJECTIVE

- **THE PURPOSE OF AN IRRIGATION SYSTEM IS TO SUPPLEMENT NATURAL PRECIPITATION BY DELIVERING THE RIGHT AMOUNT OF WATER, AT THE RIGHT TIME, WITH LITTLE WASTE, SO PLANTS MAINTAIN GOOD HEALTH AND APPEARANCE.**


WE NEED BETTER IRRIGATION

DRIP IRRIGATION WATERING ONE DROP AT A TIME

HISTORY OF DRIP *IRRIGATION*

- **THE STATE OF ISRAEL BEGAN DEVELOPING LOW VOLUME IRRIGATION FOR AGRICULTURE OVER 50 YEARS AGO**

  ISRAEL

- **HAD POOR WATER QUALITY**
- **WAS IN A DESERT AREA WITH FEW WATER RESOURCES**
- **HAD A GROWING POPULATION TO FEED**

DRIP IRRIGATION WAS DEVELOPED FOR AGRICULTURE

WHAT IS DRIP OR LOW VOLUME *IRRIGATION?*

- **A SYSTEM OF DELIVERING WATER ON A SLOW, EVEN, AND ACCURATE RATE TO THE ROOT ZONE**

ADVANTAGES OF DRIP

- $AVE UP TO 50% OF WATER USED OVER A POORLY DESIGNED OVERHEAD SYSTEM
- HEALTHIER PLANTS (ONLY IF DESIGNED AND OPERATED CORRECTLY)
- FEWER WEEDS
- INJECTION OF LIQUID FERTILIZER/PESTICIDES IF NEEDED

DISADVANTAGES OF DRIP

- CAN'T "SEE" IT WORKING
- CAN'T "HEAR" IT WORKING
- CLOGGING (DUE TO MINERALS
- IN THE WATER, ALGAE AND DIRT)
- EASILY DAMAGED
- SALT BUILD UP IN THE SOIL
- FREQUENT CHECKING
- HIGH MAINTENANCE
- SMALLER ROOT SYSTEMS IF NOT EXPANDED

DRIP COMPONENTS

- FILTER
- LOW FLOW VALVES
- PRESSURE REGULATOR
- AIR RELIEF VALVE
- FLUSH END AND CAP
- POLYETHYLENE TUBING

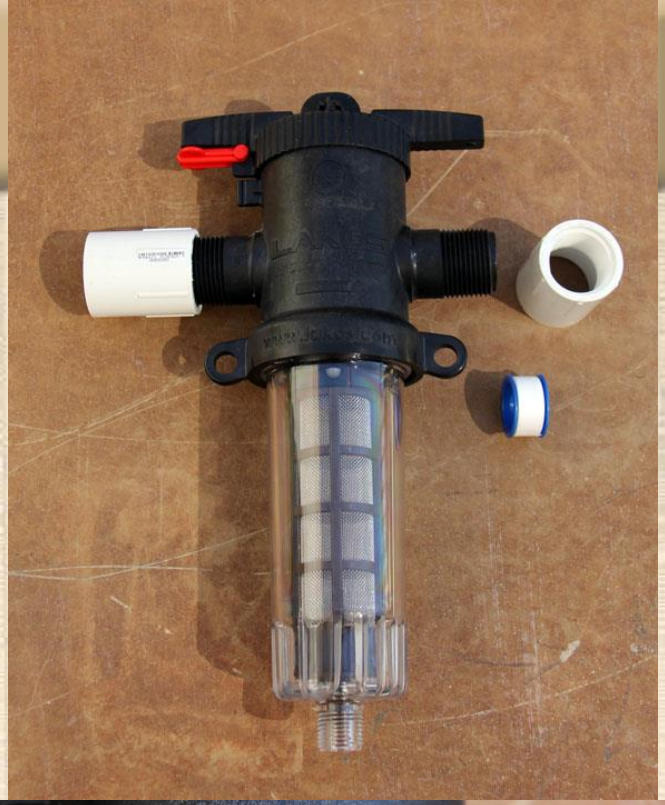
(1/4 SPAGHETTI TUBING, MAIN LINES ½ OR ¾ INCH)

FILTER

- USE A 150 MESH FILTER FOR DRIP IRRIGATION
- USE A 200 MESH FILTER FOR 1/2 GPH DRIPPERS

FILTER

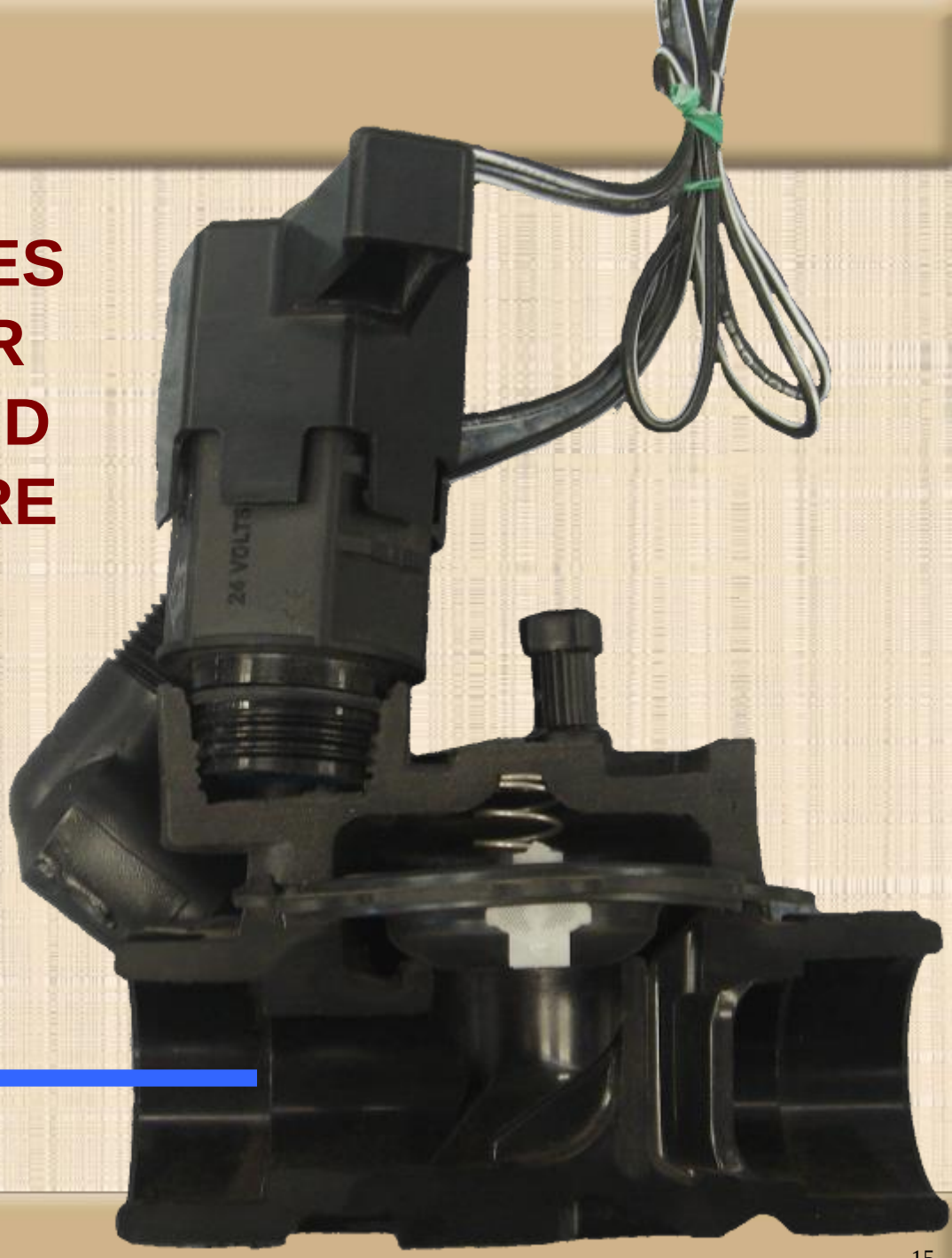
- **ORGANIC FILTER**



- **INORGANIC FILTER**

VALVES

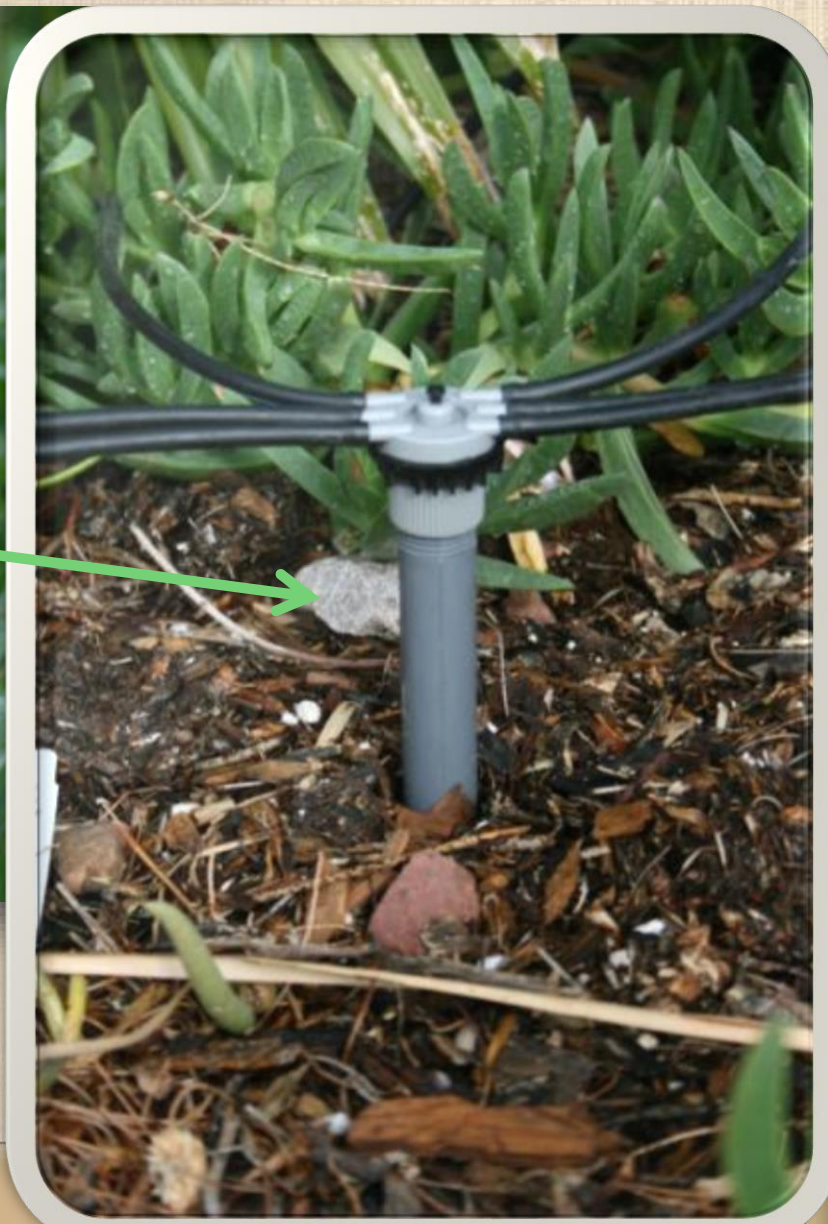
- SELECT VALVES DESIGNED FOR LOW FLOW AND LOW PRESSURE OPERATION
- FLOW ARROW



PRESSURE REGULATOR

- USE A 20 OR 25 PSI PRESSURE REGULATOR FOR DRIP IRRIGATION
- SELECT A PRESSURE REGULATOR WITH A LOW FLOW RATE
- E.G. 1/10 - 8 GPM
- FLOW ARROW

DRIP MANIFOLD



DRIP MANIFOLD

DRIP EMITTERS

- ALWAYS USE PRESSURE COMPENSATING DRIP EMITTERS
- CONSISTENT FLOW RATES AT ANY PRESSURE
- ADJUSTABLE EMITTERS
- FLAG DRIPPERS
- BUTTON DRIPPERS
- INLINE EMITTERS

ADJUSTABLE EMITTERS

- SOMETIMES CALLED "SHRUBLERS" OR MINI-BUBBLERS
- ADJUSTABLE FROM 0 TO 30 GPH
- NOT PRESSURE COMPENSATING
- EASY TO TAKE APART AND CLEAN
- MISTAKENLY THOUGHT TO BE MIRACLE WORKERS THAT SOLVE ALL IRRIGATION PROBLEMS!

WATERS A LARGER *AREA?*

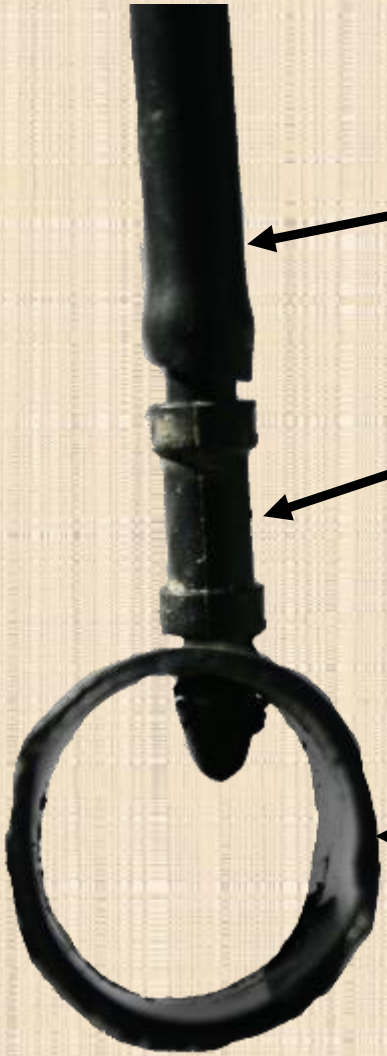
BEST FOR

SANDY SOILS

BUTTON DRIPPERS

- 1, 2, 4 GPH
- NOT ALL ARE PRESSURE COMPENSATING
- SOME HIGHER FLOW ARE AVAILABLE
- 5 UP TO 24 GPH
- THIS ONE IS PC AND SELF-CLEANING, CAN BE TAKEN APART, CLEANED AND REUSED

INSIDE THE TUBING



SPAGHETTI TUBING

BARBED CONNECTOR

¾ BLACK POLY TUBING


EMITTER
MULTI TOOL
Poly Tubing
Punch and
Cutter
POLY PUNCH
EMITTER INSERT
TUBING CUTTER
Replaceable
Blade, Punch
& Barb Holder
RESIDENTIAL AND COMMERCIAL IRRIGATION


POLY PUNCH
EMITTER INSERT
TUBING CUTTER

INLINE EMITTERS

- INLINE DRIP EMITTERS ARE ENCLOSED INSIDE 1/4 OR 1/2 INCH POLYETHYLENE TUBING
- EMITTERS ARE SPACED 6, 12 OR 18 INCHES APART, DEPENDING ON SOIL TYPE
- TWO THAT CAN BE BURIED ARE GEOFLOW (TORO) AND NETAFIM

(THE USE OF THESE TWO BRANDS IS NOT AN ENDORSEMENT OF THESE PRODUCTS)

INLINE EMITTERS

(THE USE OF THESE TWO BRANDS IS NOT AN ENDORSEMENT OF THESE PRODUCTS)

INLINE EMITTERS

VEGETABLE/HERB BEDS

INLINE EMITTERS USED IN VEGITABLE GARDENS

IN A NEW ANNUAL BEDS

IN THE LANDSCAPE KEEP COVERED WITH MULCH

WHEN YOU SEE THIS COLOR

MINNIE SPRY HEADS

A GOOD PLACE FOR DRIP IRRIGATION

A GOOD PLACE FOR DRIP IRRIGATION OR REMOVE THE PLANTS IN AREAS THAT ARE NARROW AND WITH A SLOPE

TREES AND PLANTS DON'T HAVE MOUTHS

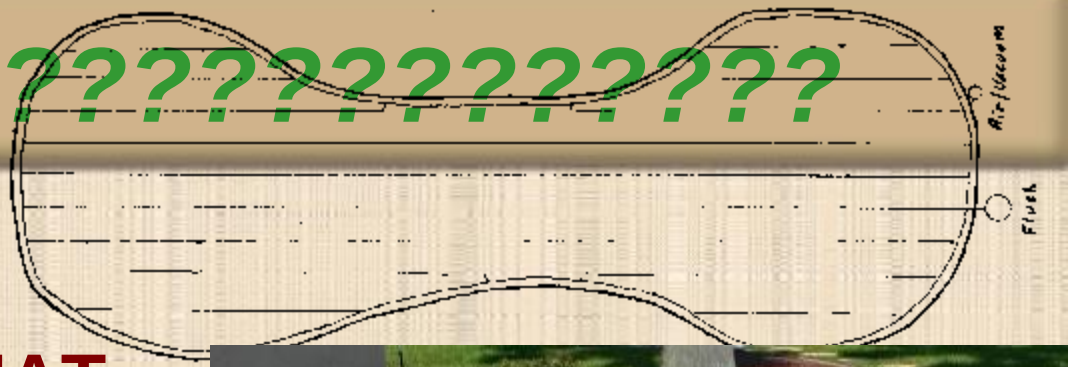
NETAFIM USED AS TEMPORARY IRRIGATION FOR TREES

TREE CIRCLES

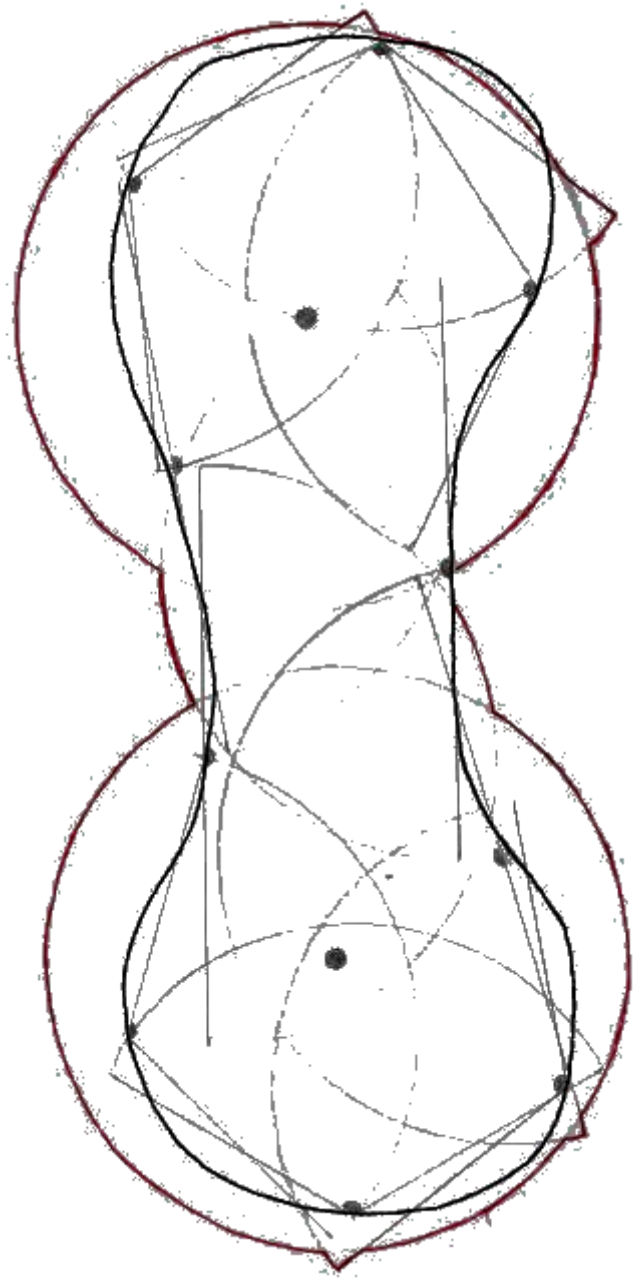

THIS TREE IS ALL READY SHOWING DIE BACK

TREES NEED TO BE IRRIGATED IN THE DESERT AND WILL DIE WHEN TURF AND TURF IRRIGATION IS TAKEN OUT WITHOUT REPLACING IT WITH A NEW LOW VOLUME IRRIGATION SYSTEM THAT WATERS THE TREE ROOTS

FOR TURF??????????????????



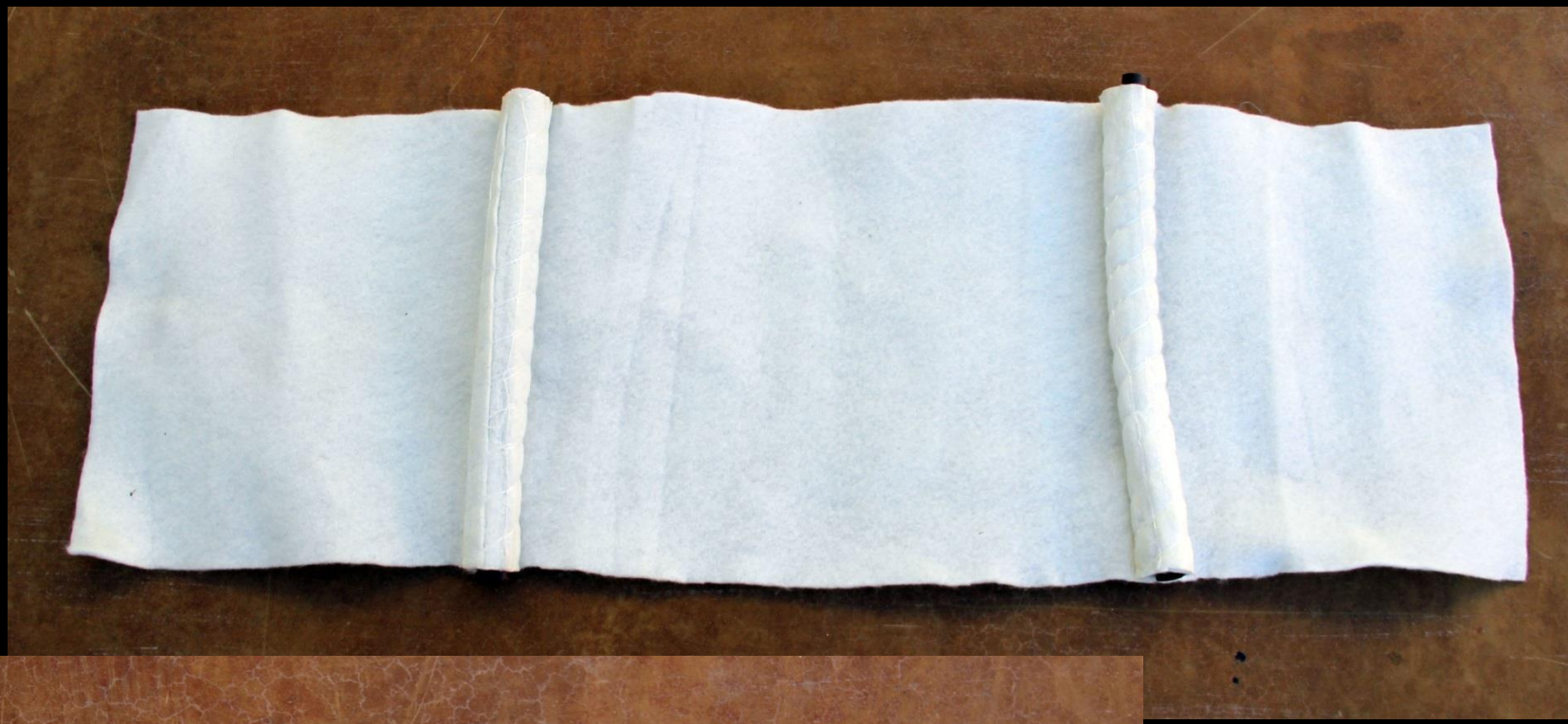
IT IS NOT RECOMMENDED THAT TURF BE USED IN THIS MANNER



COST COMPARISON

- SPRINKLER
  - MATERIALS
  - $0.392/SQ. FT.
  - LABOR = $$
  - WATER WASTED = $$$
- NETAFIM
  - MATERIALS
  - $0.642/SQ. FT.
  - LABOR = $$$
  - WATER WASTED = NONE

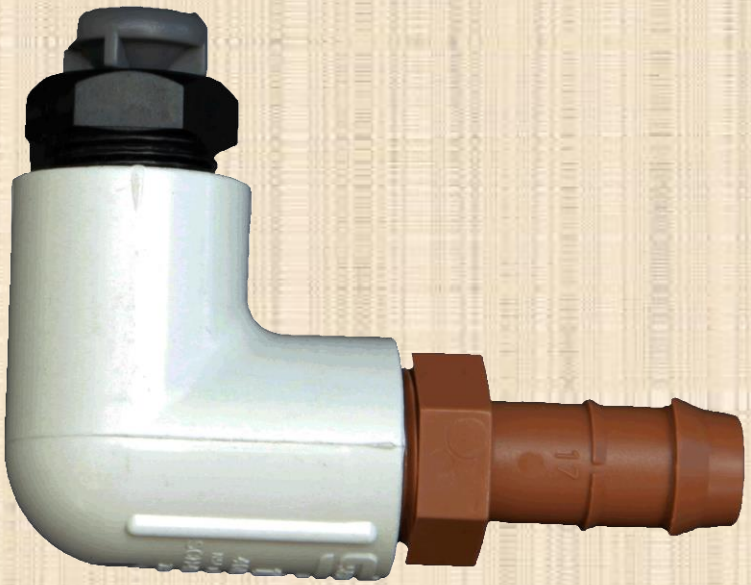
NETAFIM FOR SUBSURFACE



END OF EACH TUBING LINE

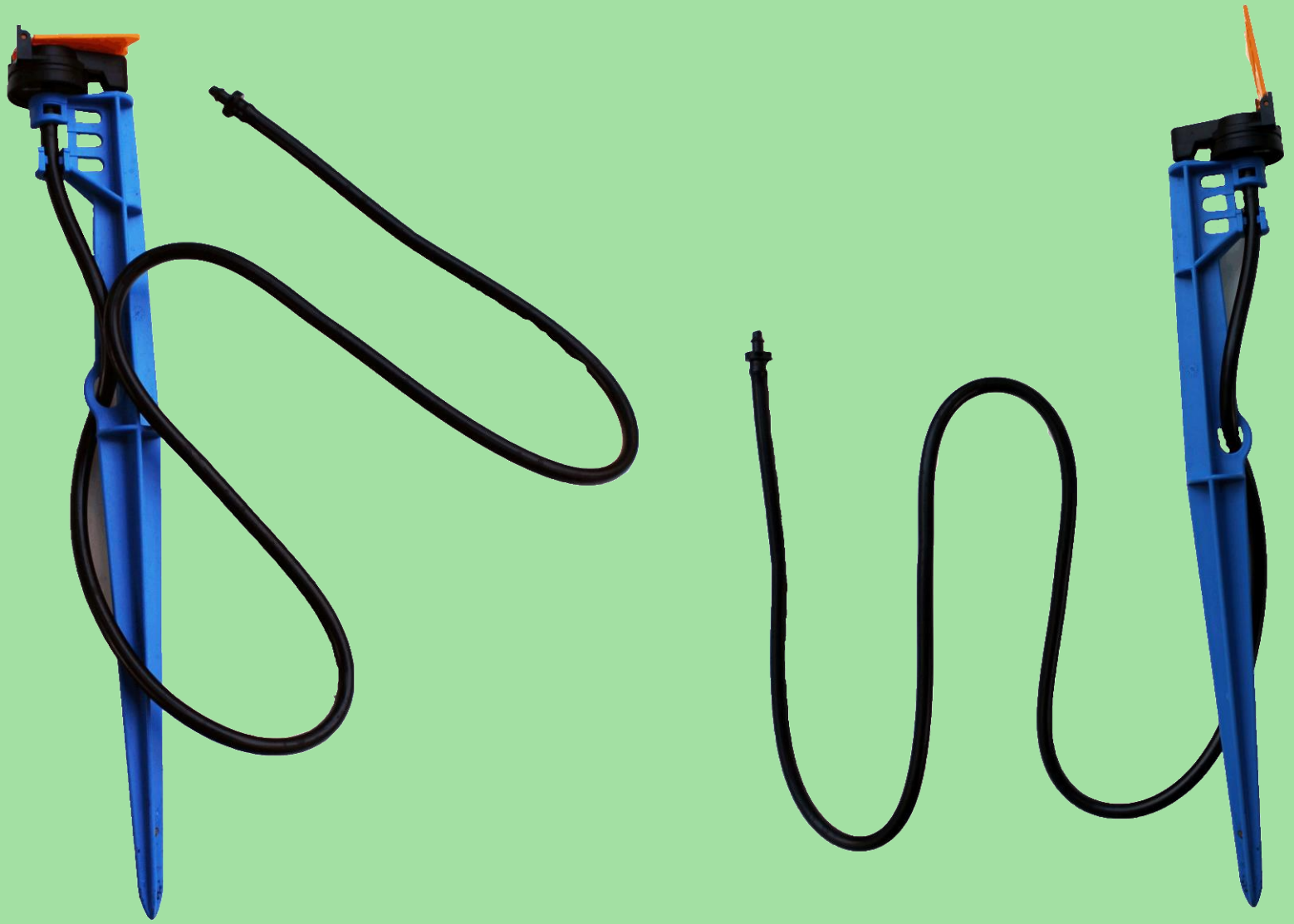
- FIGURE 8 END
  - THE MOST COMMON FITTING TO END A LINE
  - CAN'T EASILY FLUSH THE LINE
- MALE HOSE END W/CAP
  - EASY TO FLUSH LINES

DRIPLINE FLUSH VALVES

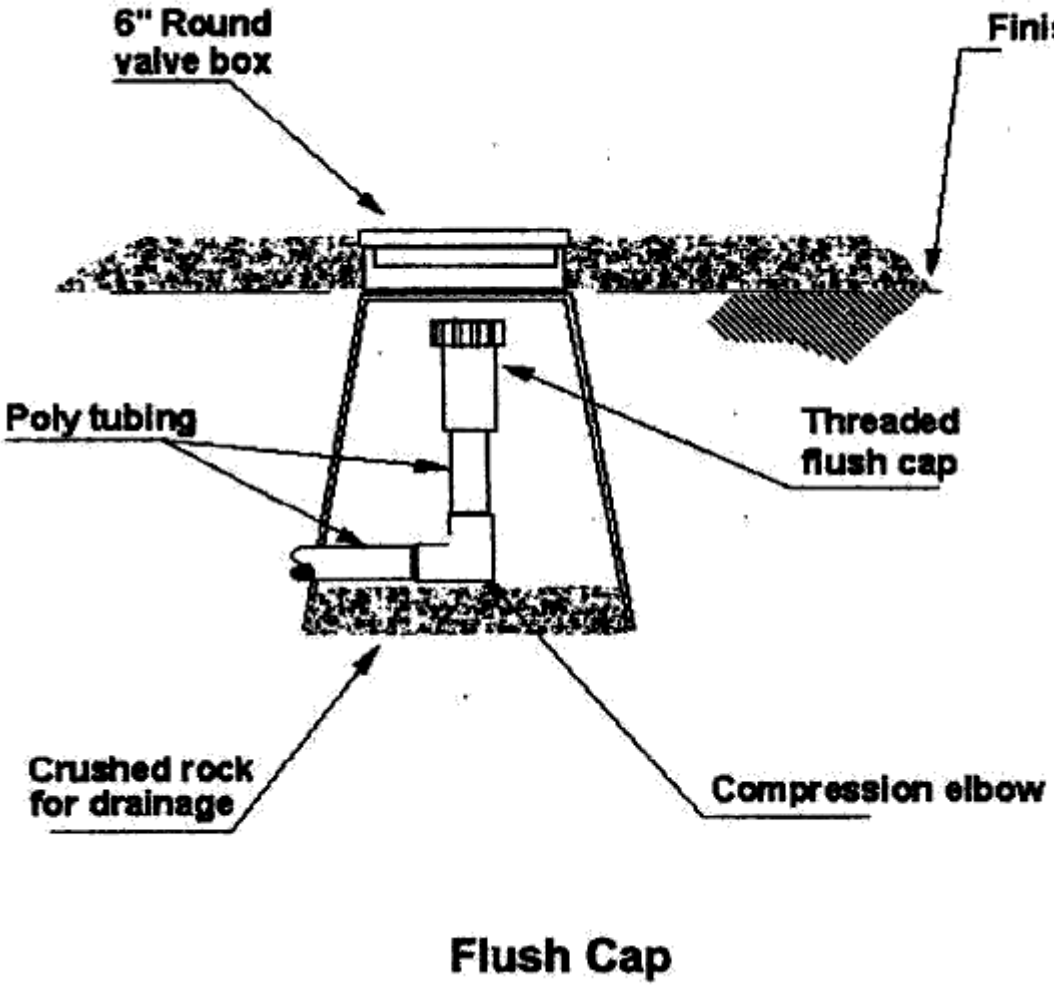


DRIPLINE FLUSH VALVES

NETAFIM PRESSURE INDICATOR



FLUSH CAP INSTALLATION



Flush Cap

POLY TUBING

POLY TUBING

- 1 INCH TUBING USED FOR SOME COMMERCIAL LANDSCAPE
- ¾ INCH TUBING USED MOSTLY FOR COMMERCIAL LANDSCAPE
- ½ INCH TUBING USED MOSTLY FOR HOME LANDSCAPES
- SPAGHETTI TUBING TO ATTACH EMITTER TO ¾ OR ½ FEEDER LINES

BLACK POLY TUBING

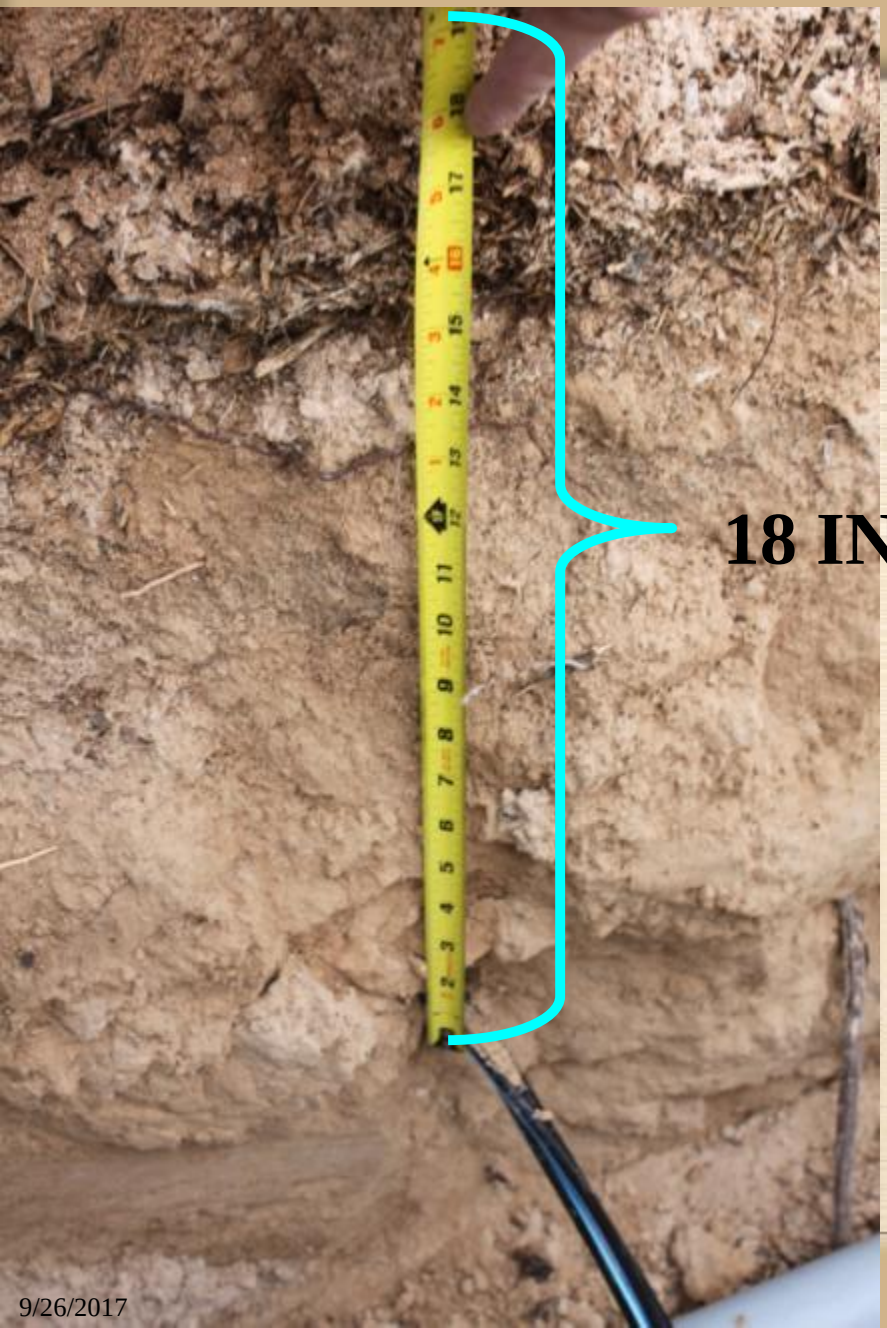
1 INCH, ¾ AND ½ INCH

DON’T BURY TUBING TOO DEEP !

DON'T BURY EMITTERS !

KEEP SPAGHETTI TUBING SHORT

DON'T BURY TUBING TOO DEEP !



KEEP SPAGHETTI AND BLACK POLY TUBING NEAR THE SURFACE

DON'T BURY BLACK POLY TOO DEEP! BETTER TO JUST COVER WITH ORGANIC OR ROCK MULCH

CHANGE AND MOVE EMITTERS AS LANDSCAPE PLANTS/TREES GROW AND MATURE!

MAINTAIN AND UPDATE IRRIGATION

- **ADD MORE EMITTERS TO LOW-VOLUME SYSTEMS AS PLANTS GROW**

CHECK YOUR IRRIGATION SYSTEM OFTEN

CHECK YOUR IRRIGATION SYSTEM OFTEN

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CHECK YOUR IRRIGATION SYSTEM OFTEN

RUN NEW SPAGHETTI TUBING

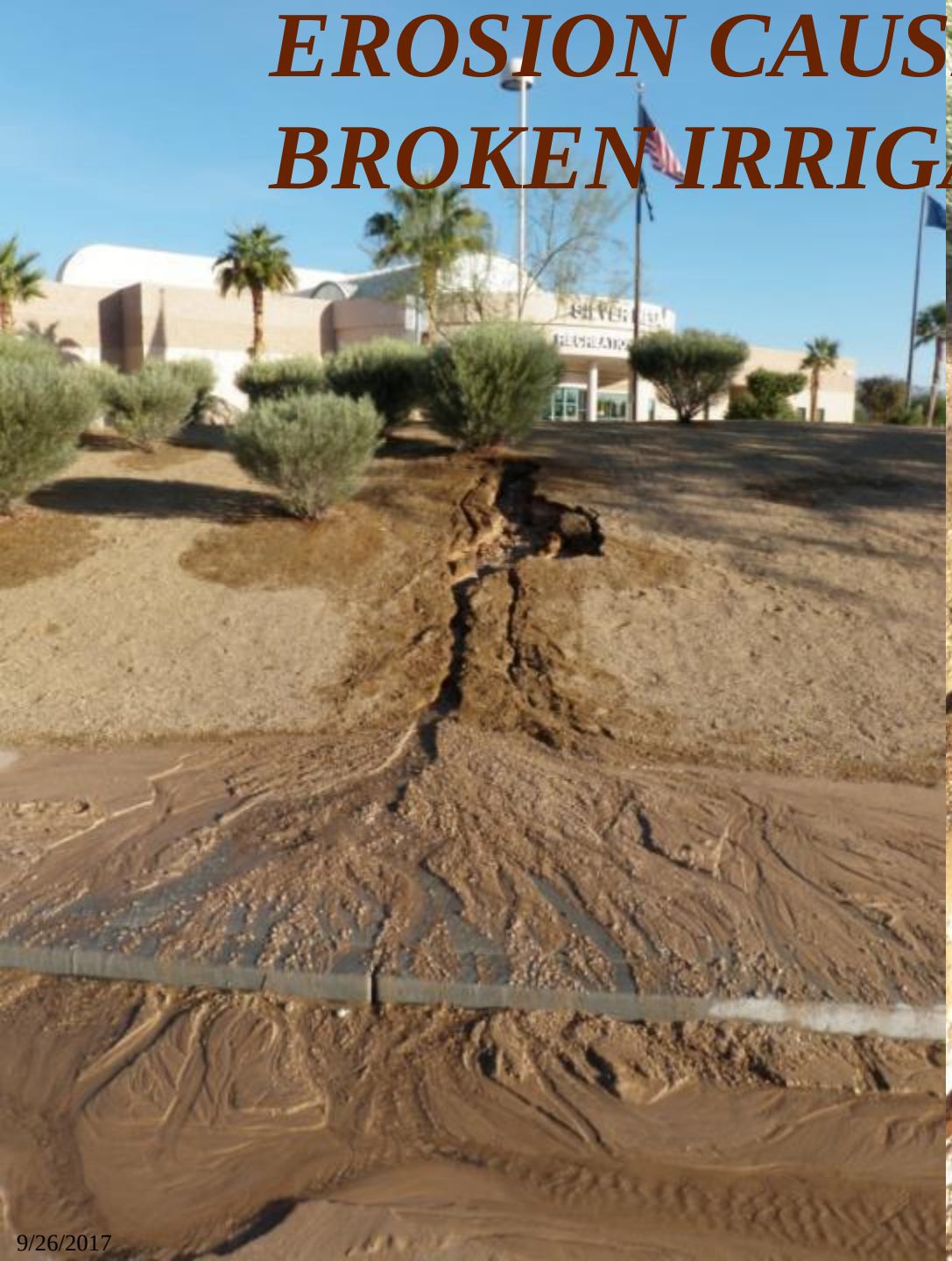
FROM THE MAIN BLACK POLY LINES

DO NOT PUT SPAGHETTI TUBING AROUND OR UNDER PLANT ROOTS

CHECK YOUR IRRIGATION SYSTEM OFTEN

CHECK YOUR IRRIGATION SYSTEM OFTEN

EROSION CAUSED BY A BROKEN IRRIGATION LINE

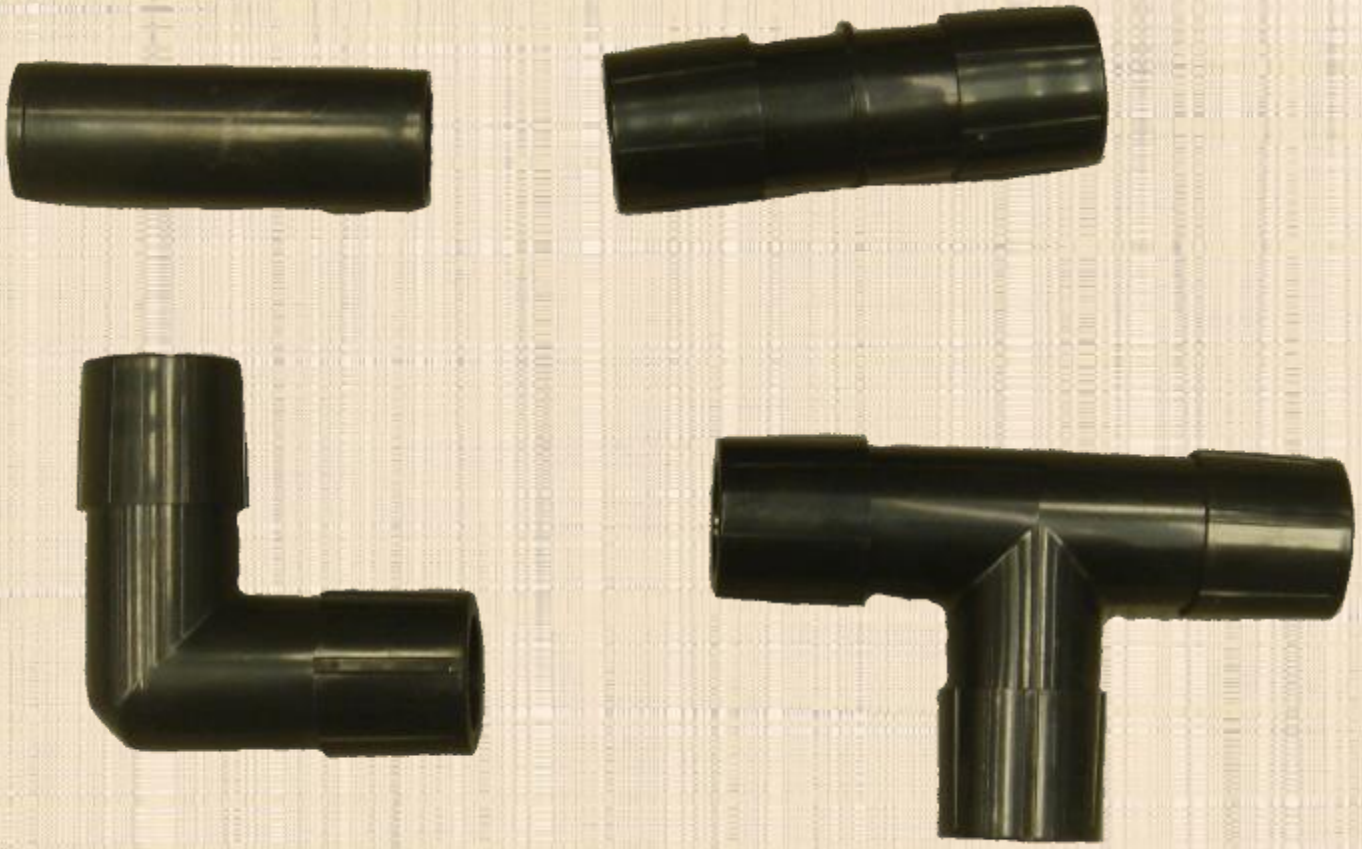



CHECK YOUR IRRIGATION SYSTEM OFTEN

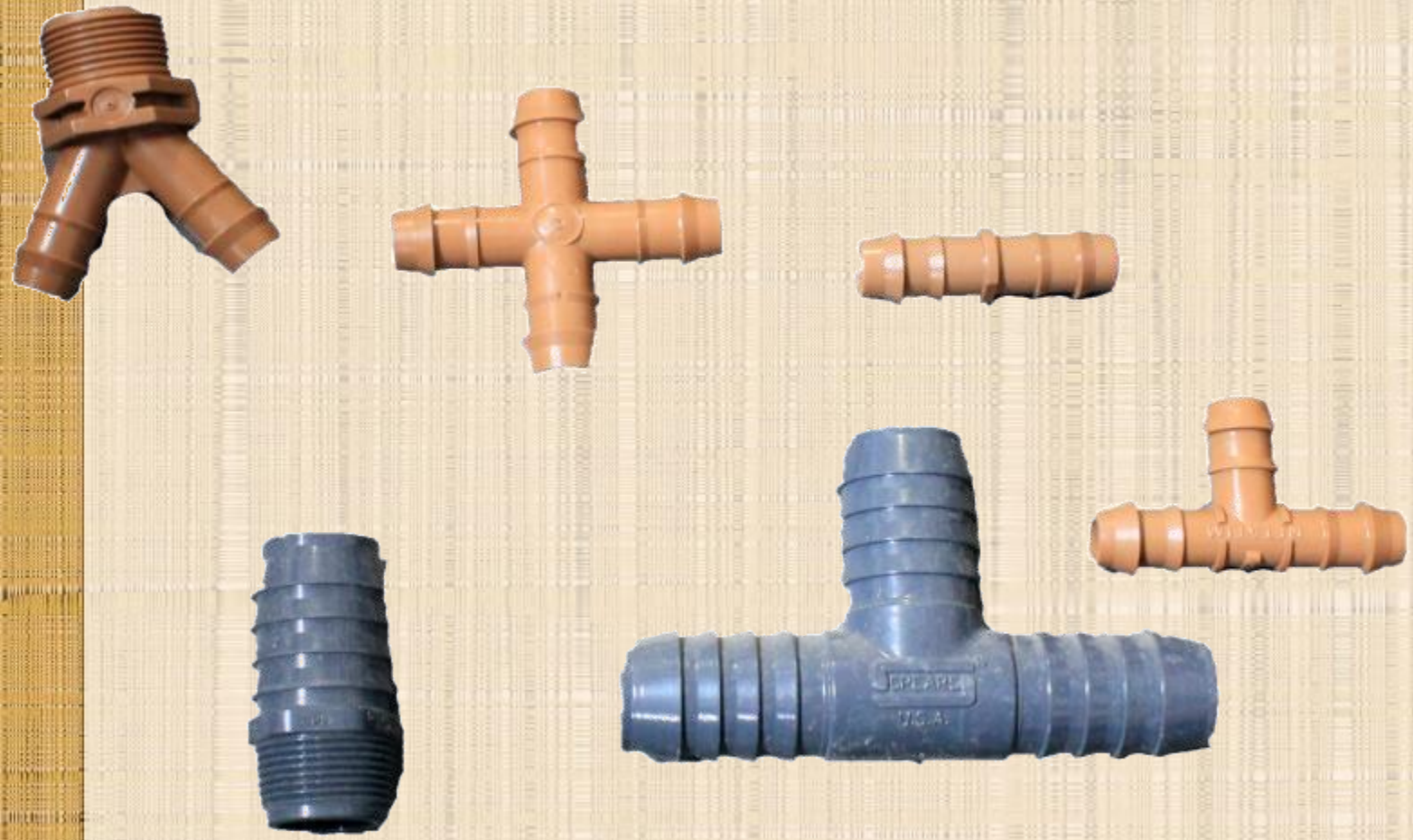

CHECK YOUR IRRIGATION SYSTEM OFTEN


REMEMBER
SOUTHERN
NEVADA
HAS POOR
QUALITY
WATER
AFTER 14 YEARS

COMPRESSION FITTINGS



BARBED FITTINGS

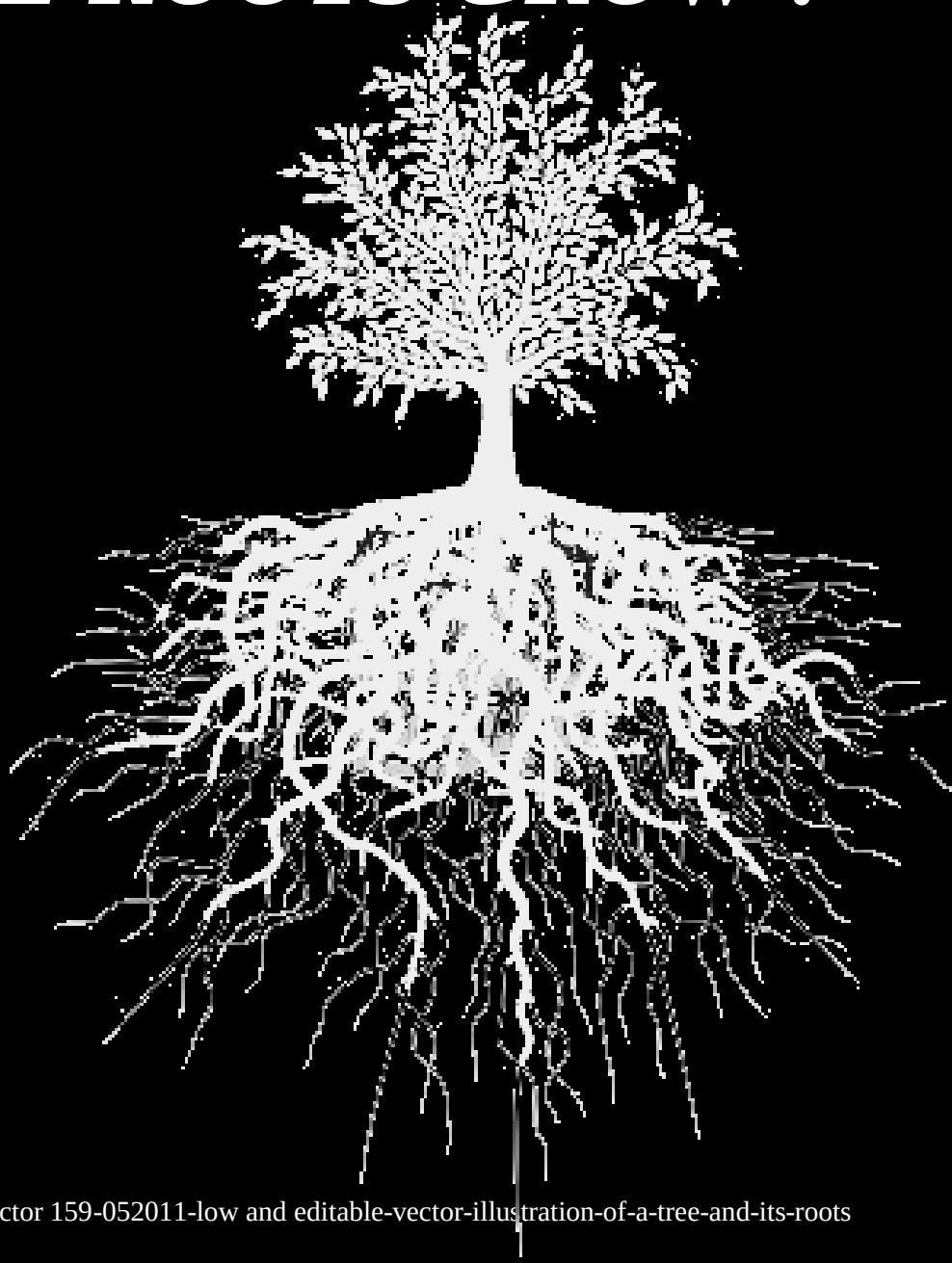


BARBED FITTINGS

DRIP IRRIGATION FOR YOUR LANDSCAPE SHOULD NOT BE INTENSIVE CARE

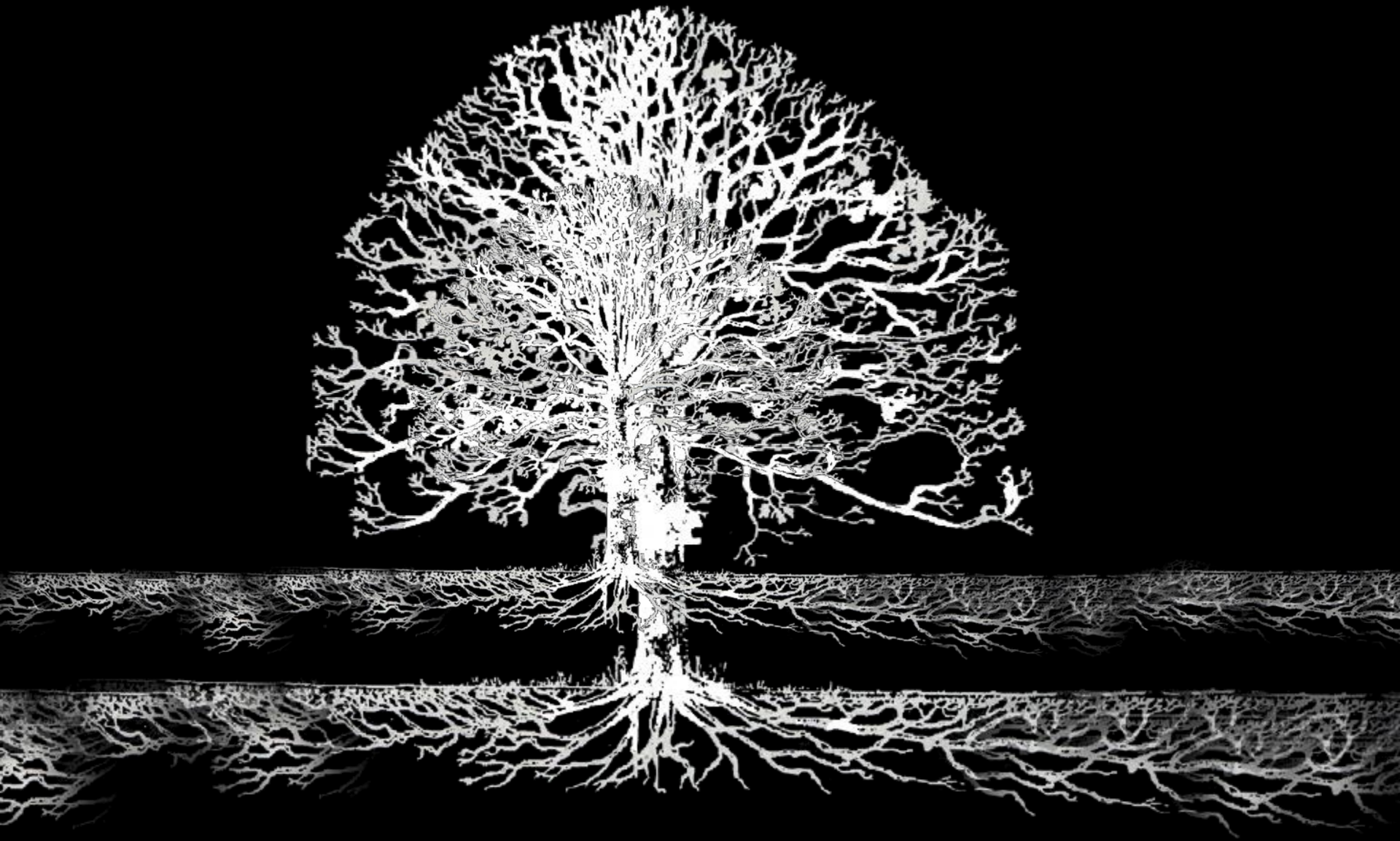
WHERE DO TREE ROOTS GROW ?

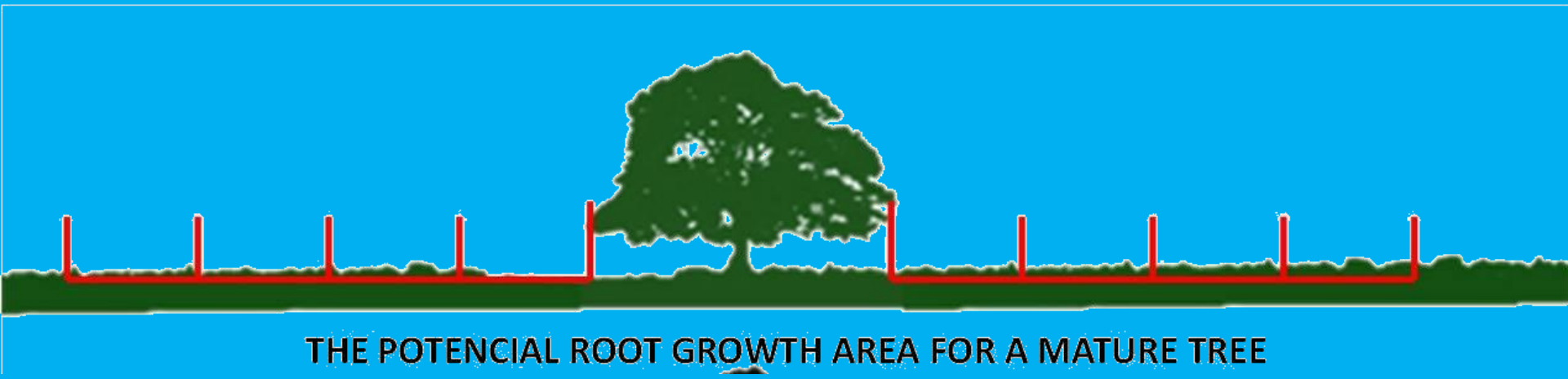
NOT HERE



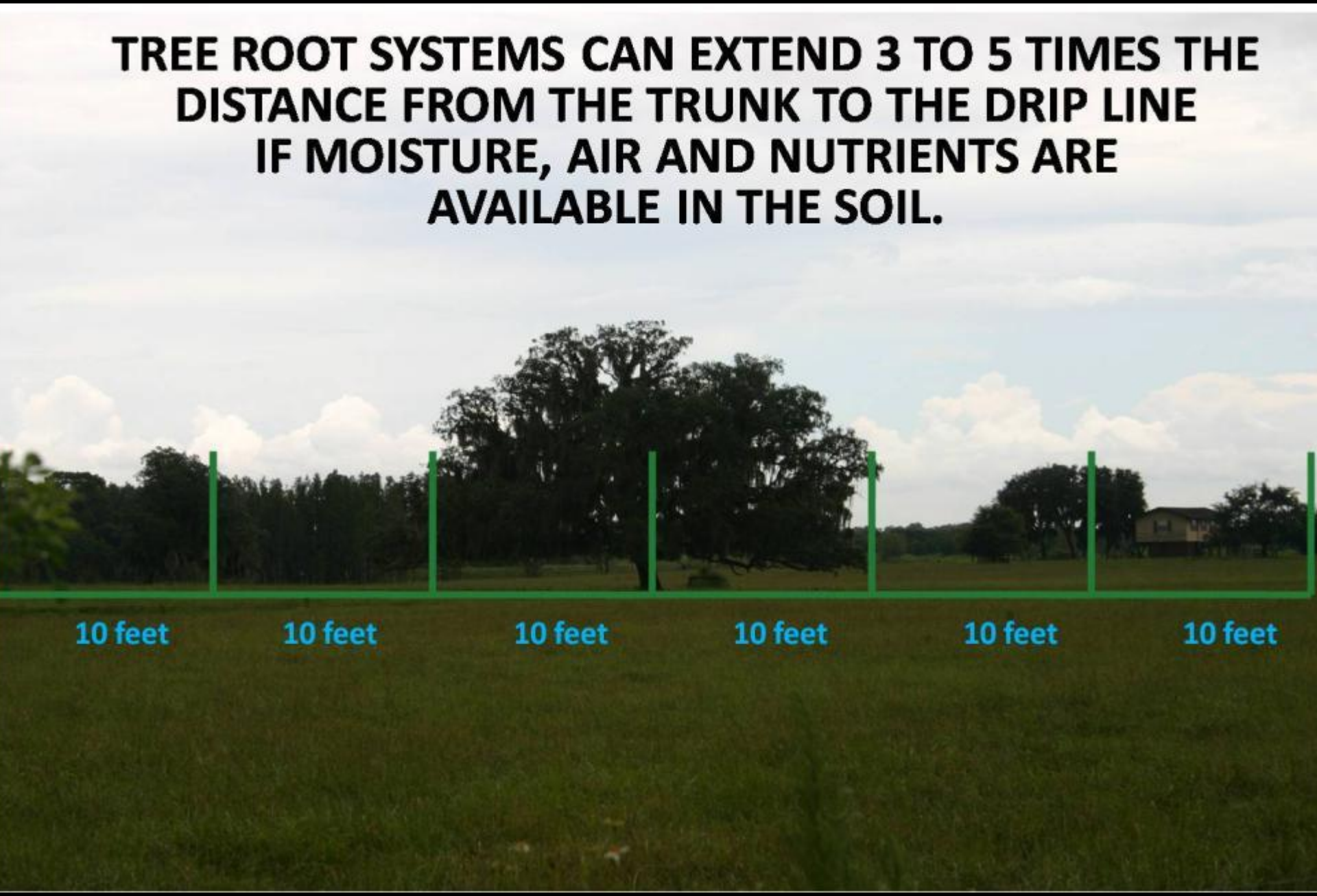
PIX FROM tree roots vertical royalty free stock vector 159-052011-low and editable-vector-illustration-of-a-tree-and-its-roots

WHERE DO TREE ROOTS GROW ?





THE POTENCIAL ROOT GROWTH AREA FOR A MATURE TREE


TREE ROOT SYSTEMS CAN EXTEND 3 TO 5 TIMES THE DISTANCE FROM THE TRUNK TO THE DRIP LINE IF MOISTURE, AIR AND NUTRIENTS ARE AVAILABLE IN THE SOIL.
10 feet
10 feet
10 feet
10 feet
10 feet
10 feet

IRRIGATION OF PINE TREES
THE AMOUNT OF AVAILABLE WATER MAKES THE DIFFERENCE

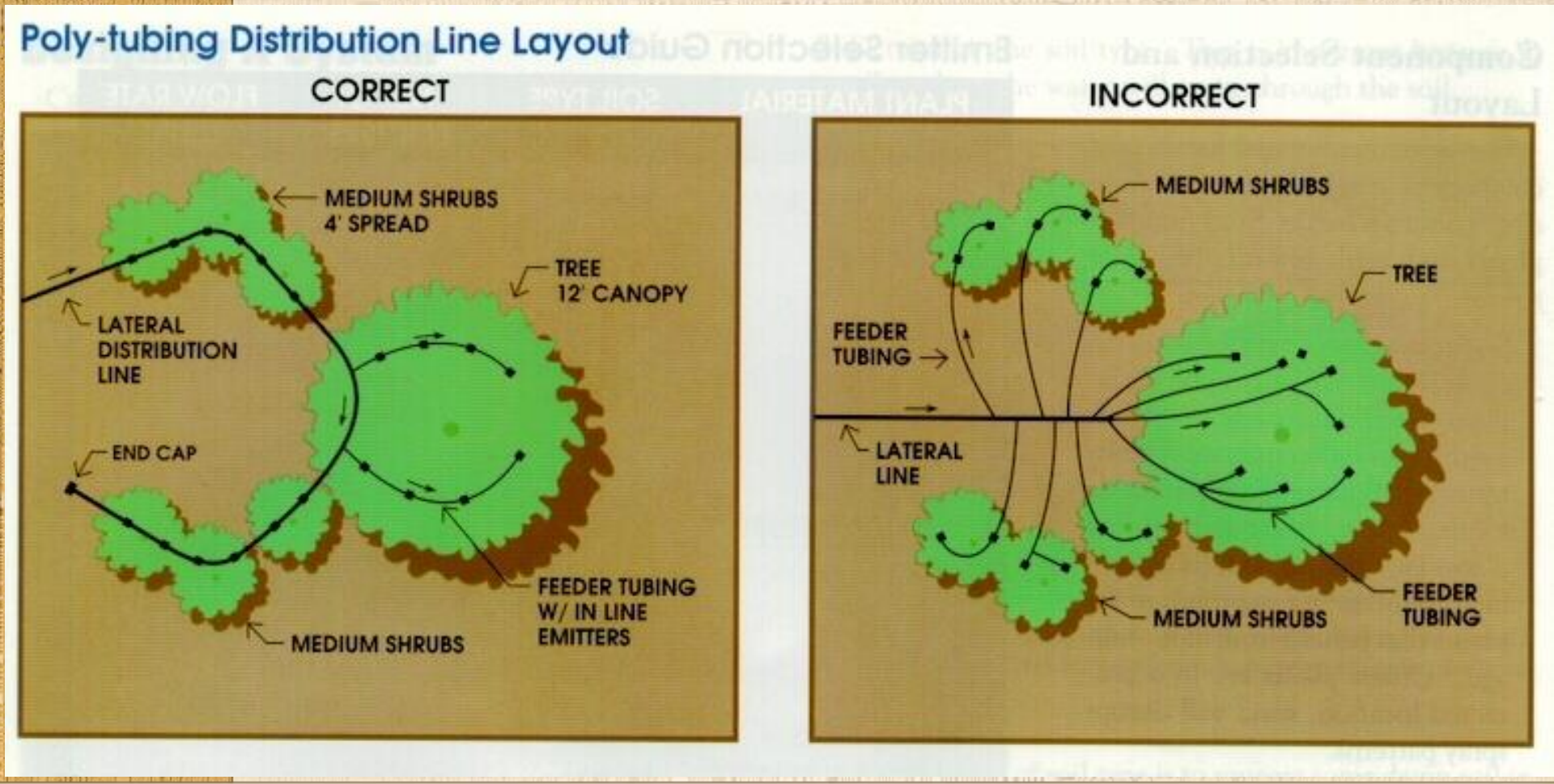
THE CLOSER TO THE TURF IRRIGATED AREA THE LARGE THE PINE TREE

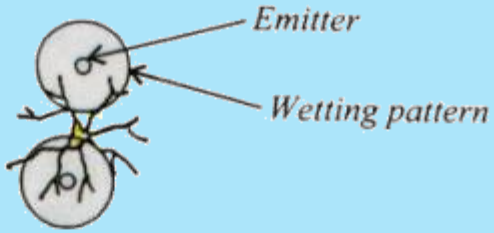
SPRAY IRRIGATION OF TURF

DRIP IRRIGATION AND SOME SPRAY

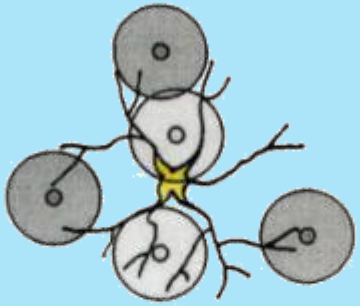
DRIP IRRIGATION NOT ALL WORKING

DRIP LINE LAYOUT

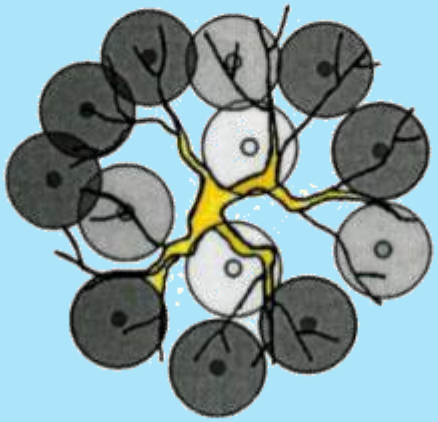




New Tree

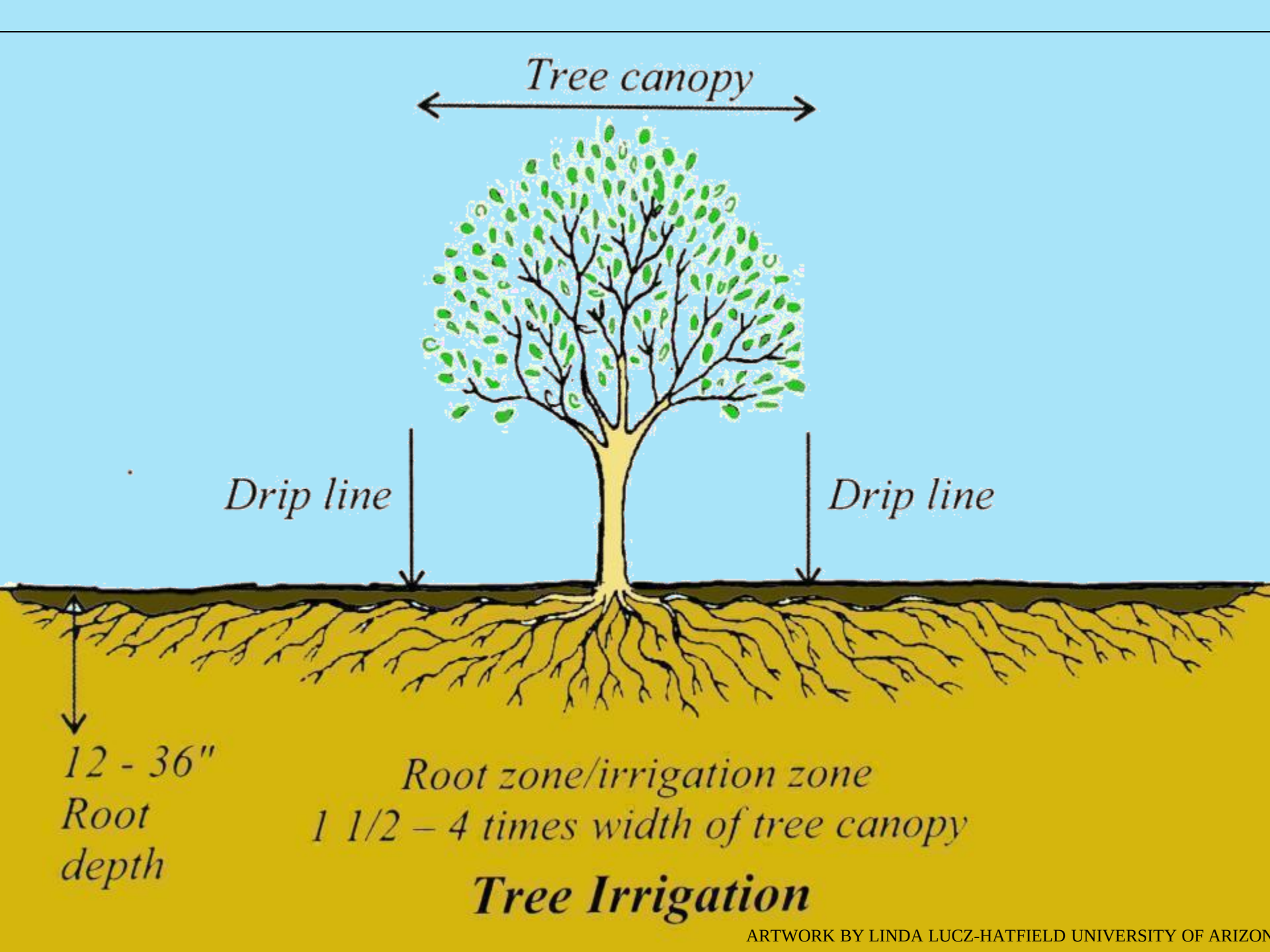


Two to Three Year-old Tree



Mature Tree

Drip Emitter Placement for Trees (overview)


Tree canopy
Drip line
Drip line
12 - 36"
Root
depth
Root zone/irrigation zone
1 1/2 – 4 times width of tree canopy
Tree Irrigation
ARTWORK BY LINDA LUCZ-HATFIELD UNIVERSITY OF ARIZON

TREE EMITTERS

DON'T CAP EMITTERS NEAR TREE

DON'T PUT EMITTERS NEXT TO THE TRUNK


ROOTS ONLY GROW WHERE THE WATER IS

PLAN FOR THE FUTURE

WATER PATTERNS

WHAT IS THE PROBLEM HERE ????

WATER PATTERNS

THE PROBLEM HERE ????

WATER PATTERNS

PLACEMENT OF EMITTERS

DON'T PLACE EMITTERS NEXT TO TRUNKS AND STEMS

**THIS IS ESPECI
TRUE OF CACTU
SUCCULENT**

KEEP EMITTERS AWAY FROM PLANT STEMS AND TRUNKS

CHOOSE THE RIGHT PLANTS AND WATER THEM SO THEY CAN SURVIVE

- **THESE PLANT HAD THE WATER TURNED OFF FOR JUST 3 DAYS IN THE SUMMER**

CHECK YOUR IRRIGATION


NEVADA

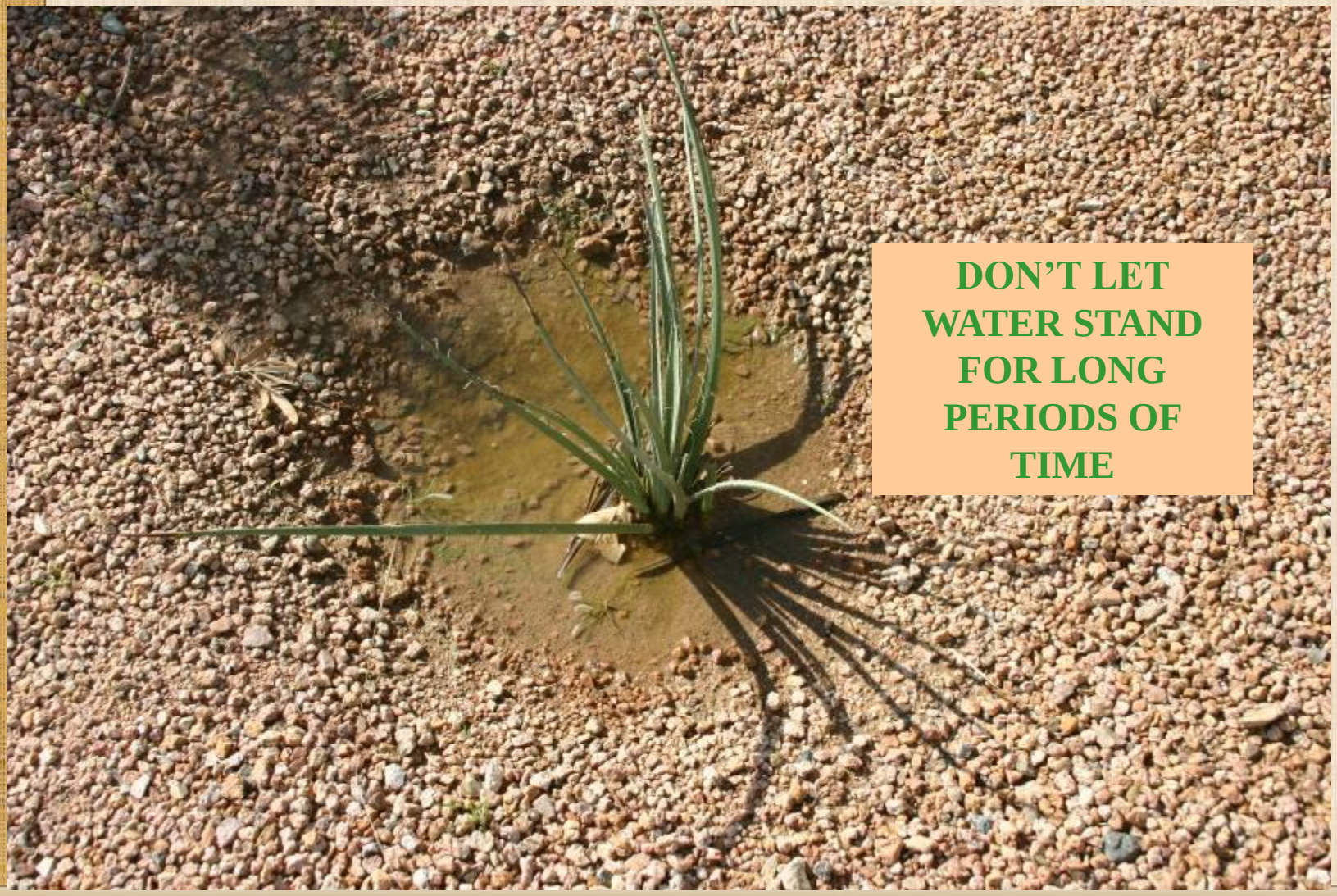
WATER ROOT ZONE

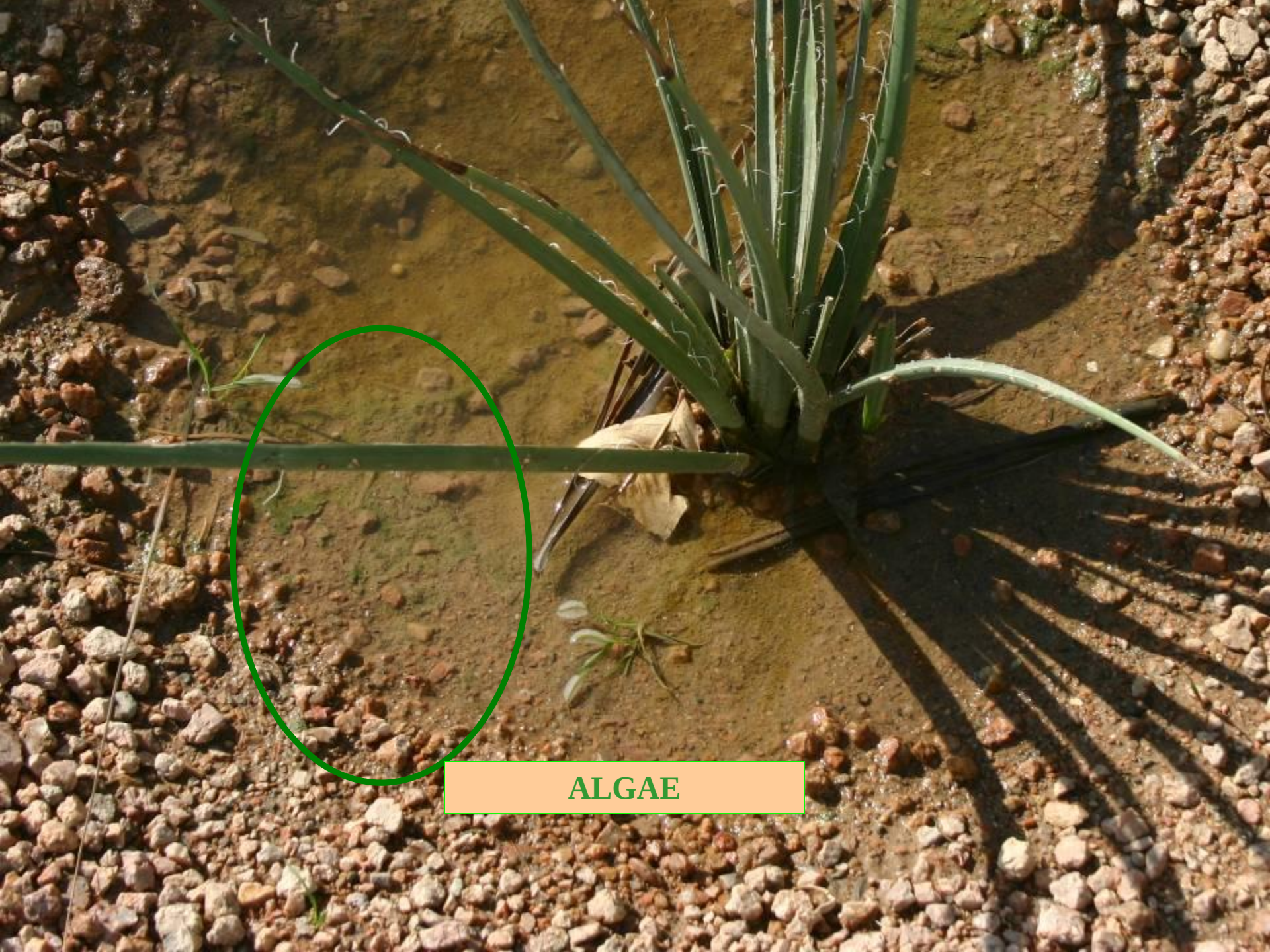
MULCH

- COVER THE POLY TUBING WITH ROCK, BARK OR OTHER ORGANIC MULCH DEEP ENOUGH TO PROTECT FROM THE SUN BUT NOT TO DEEP TO EASILY WORK ON AND FIND PROBLEMS
- 2 OR 3 INCHES DEEP
- NEVER USE PLASTIC
- NEVER PUT MULCH SO IT'S AGAINST THE STEM OR TRUNK OF THE PLANT

MULCH: ORGANIC OR ROCK?

CHECK THE DRAINAGE BEFORE AND OFTEN TO PREVENT




ALGAE

CALIBRATING A DRIP SYSTEM

USE A CONTAINER

TIME HOW LONG IT TAKES TO FILL

HOW MUCH TO IRRIGATE

LOOK AGROUND

HAND WATERING

BUY A GOOD CONTROLLER
GET RID OF OLD ONES

OLD

BUY A GOOD CONTROLLER

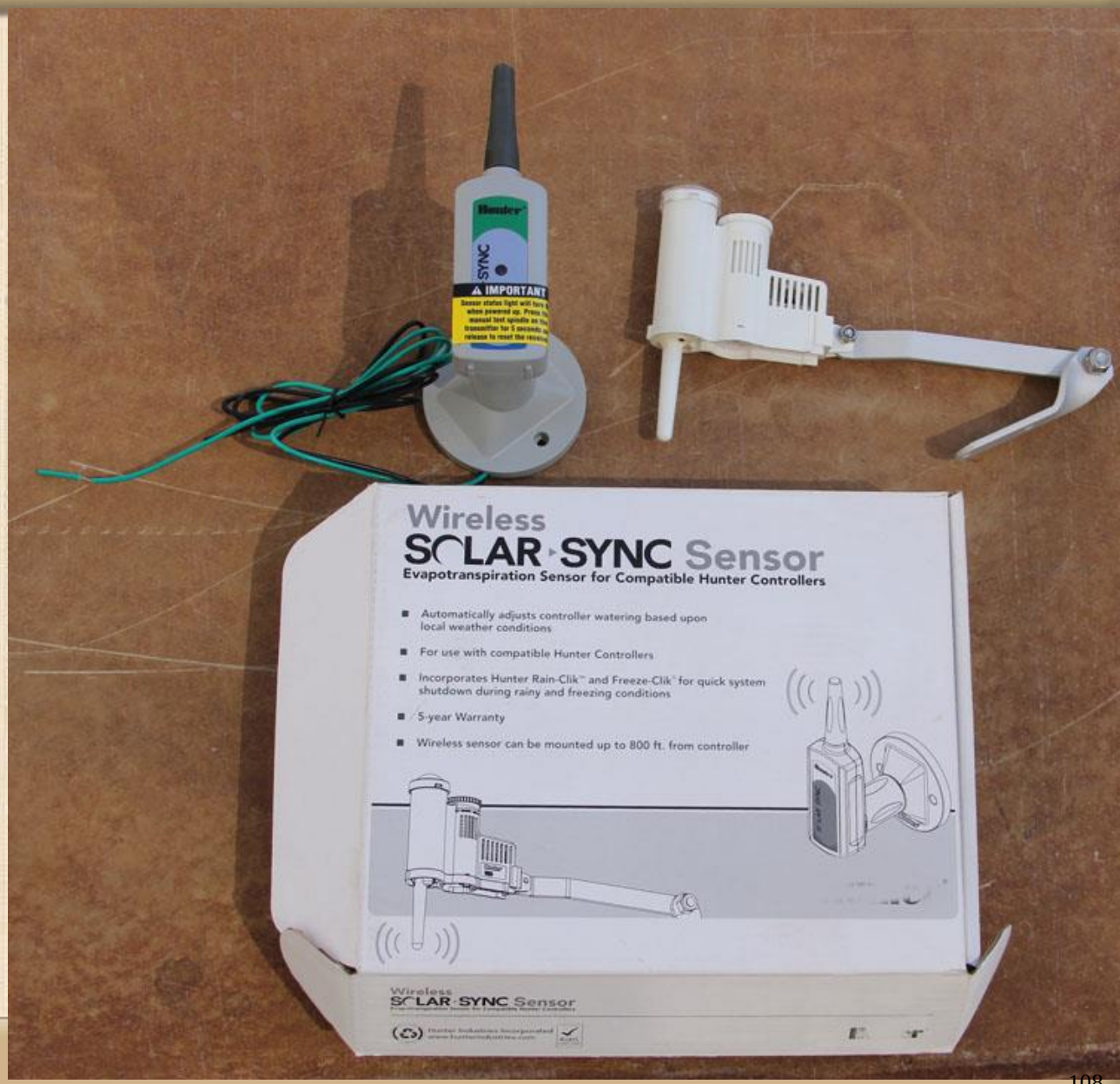
- USER FRIENDLY
- EXCEEDS THE NEEDS OF YOUR IRRIGATION SYSTEM
- SEASONAL ADJUSTMENT
- INTERVAL & EVEN/ODD DAY WATERING
- BATTERY BACKUP

I-CORE Controller (Metal Wall Mount)

SOLAR SYNC SENSOR TO REGULATE CONTROLER

NEW

- ADJUSTS IRRIGATION
- TO LOCAL WEATHER CONDITIONS
- ET SENSOR
- INCLUDES RAIN AND FREEZE TURN OFF
- WIRLESS COMMUNICATION WITH CONTROLER

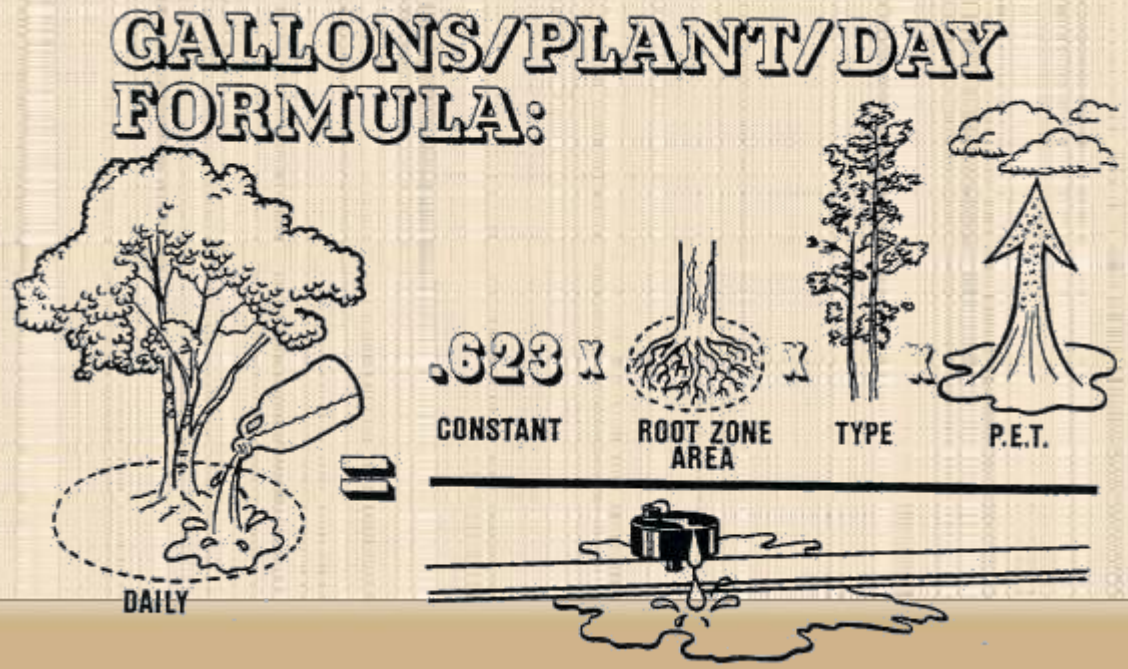


THERE IS ALWAYS NEW PRODUCTS

WHEN AND HOW MUCH TO WATER

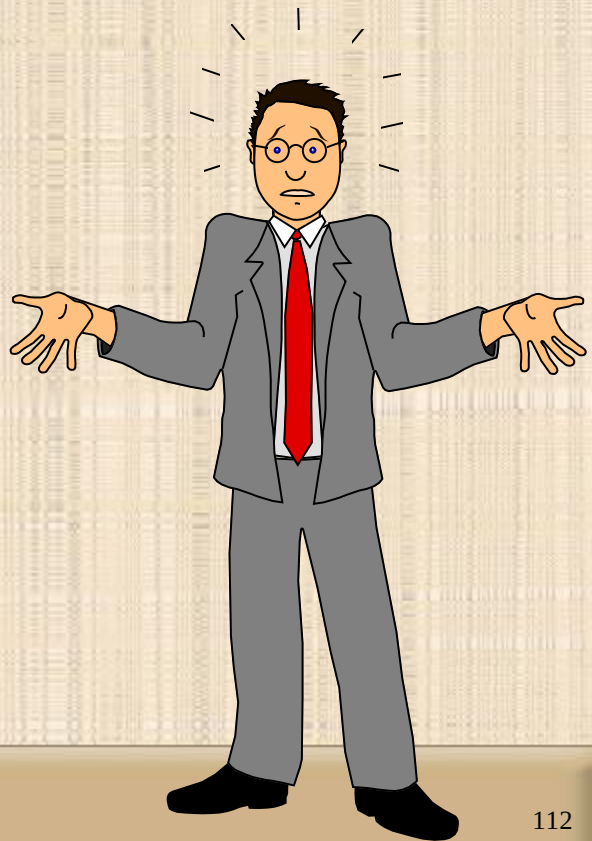
PLANTS.

- WATER USE OF SHRUBS AND TREES IS CALCULATED IN *GALLONS* PER DAY OR WEEK
- OR ENOUGH TIME TO MOISTEN THE ROOT ZONE DURING EACH WATERING



CONTROLLERS

- **HOW MANY OF YOU HAVE CONTROLLERS WITH INCH AND/OR GALLON SETTINGS?**



UNCE RECOMMENDS TO ALWAYS WATERING DEEPLY AND INFREQUENTLY

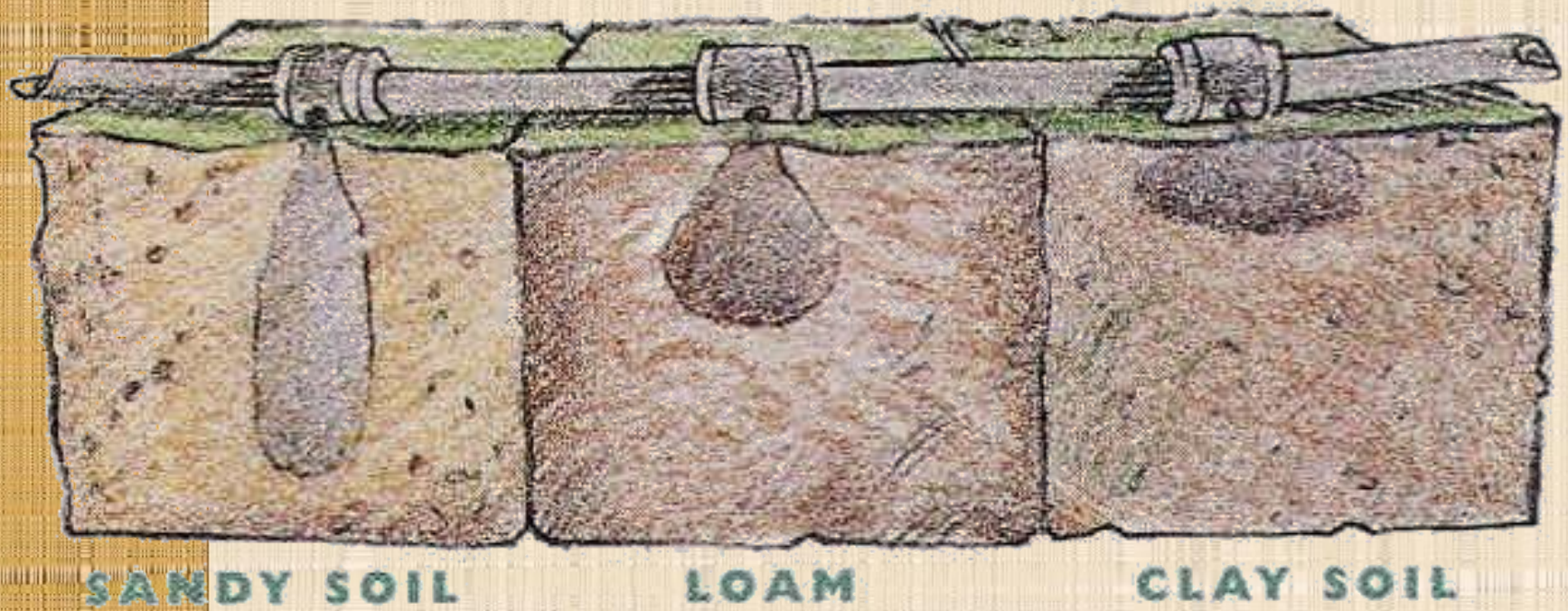
- HOW DEEP ?
- DEPENDS ON 5 FACTORS:
  - ROOT ZONE DEPTH
  - TYPE OF SOIL
  - PLANT WATER NEEDS
  - EVAPOTRANSPIRATION
  - (INCLUDING TEMPERATURE AND TIME OF YEAR)
  - IRRIGATION SYSTEM

ROOT ZONE DEPTH

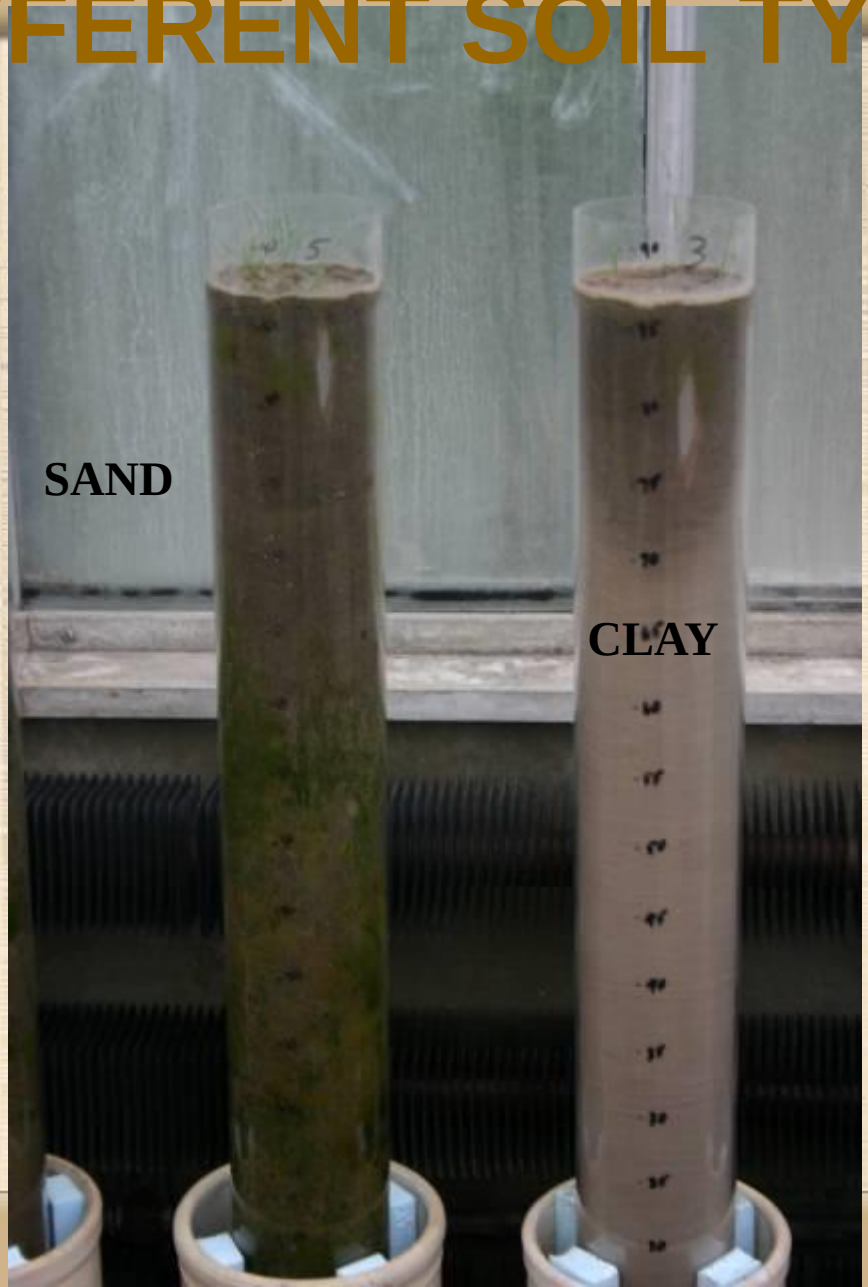
- HOW DEEP?
  - DEEP ENOUGH TO WET THE ENTIRE ROOT ZONE EVERY TIME YOU WATER
    - LAWNS: 6-12 (OR MORE) INCHES
    - FLOWERS, HERBS & VEGGIES: 6-10 INCHES
    - SMALL SHRUBS: 10-14 INCHES
    - LARGE SHRUBS, SMALL TREES: 12-24 INCHES
    - LARGE TREES: 16-24 INCHES (OR DEEPER IN SANDY SOILS)

    (REMEMBER ROOTS ONLY GROW WHERE THERE IS OXYGEN, WATER AND NUTRIENTS)

SOIL TYPE



WATER DISPERSES DIFFERENTLY IN DIFFERENT SOIL TYPES



GOOD WATER PATTERNS

GOOD WATER PATTERNS

CYCLE IRRIGATION TIMES TO WATER DEEP AND NOT FLOOD

FINDING THE SOIL TYPE

(ALL YOU NEED IS A JAR, 1 CUP OF YOUR SOIL, WATER AND 12 TO 24 HOURS)

PLANT WATER USE

- LARGE PLANTS USE MORE WATER THAN SMALL PLANTS
- PLANTS WITH LARGE LEAVES USE MORE WATER THAN PLANTS WITH SMALL LEAVES
- PLANTS WITH DARK GREEN LEAVES USE MORE WATER THAN PLANTS WITH GREY OR SILVER LEAVES

(DESERT PLANTS VS. NON-DESERT PLANTS)

EVAPOTRANSPIRATION (ET)

- EVAPO: EVAPORATION FROM THE PLANT IN THE FORM OF WATER VAPOR FROM THE LEAF SURFACE, COMPLEX BUT CAUSED BY HIGH WIND AND TEMPERATURES.
- TRANSPIRATION IS THE RESPIRATION OF PLANTS AS THEY GIVE OFF WATER TO COOL THEMSELVES

  (IT ALSO HELPS COOL THE SURROUNDING AREA)
- MEASURED IN INCHES PER DAY

IRRIGATION SYSTEM

- SPRAY, BUBBLER OR DRIP
  - KNOW YOUR SOIL TYPE
  - KNOW THE PLANT'S WATER NEEDS:
    - HOW MUCH? HOW OFTEN?
- SELECT THE SYSTEM THAT BEST MEETS THE NEEDS OF THE PLANTS AND DELIVERS WATER AT A RATE THE SOIL CAN ACCEPT

  (INFREQUENT DEEP WATERING IS BEST)

DO THE TEST

- RUN THE CONTROLLER FOR 15 MINUTES
- WAIT 1 1/2 HOURS FOR THE WATER TO PERCOLATE DOWN
- PUSH THE SCREWDRIVER INTO THE SOIL IN SEVERAL PLACES IN THE LAWN (IN SANDY AND LOAM SOILS USE A SOIL PROBE)
- THE WATER HAS STOPPED WHERE THE SCREWDRIVER MEETS RESISTANCE

- 1 INCH OF WATER (RAIN OR IRRIGATION) = 6 TO 12 INCHES OF MOISTEN SOIL
- DEPENDS ON SOIL TYPE
- IT IS BEST TO CYCLE IRRIGATION
- EXAMPLE: IRRIGATE FOR 15 MINUTES, THEN TURN THE SPRINKLERS OFF FOR AN HOUR AND LET THE WATER SOAK DOWN. REPEAT THE PROCESS UNTIL THE DESIRED MOISTURE DEPTH IS REACHED.

HOW OFTEN?

(SUBJECT TO DROUGHT RESTRICTIONS)

- COOL SEASON GRASS
  - DAYS/WEEK
- NOV - FEB 1
- MAR - APR 3
- SEP - OCT 3
- MAY - AUG 7

- WARM SEASON GRASS
  - DAYS/WEEK
- DEC & JAN 1/2
- FEB & NOV 1
- MAR - APR 3
- SEP - OCT 3
- MAY - AUG 7

THIS IS ONLY A PLACE TO START - ADJUST AS NECESSARY

(I WATER 1 OR 2 TIMES A WEEK IN THE SUMMER AND ONCE A MONTH OR LESS IN THE WINTER)

WHAT TIME DO I WATER?

- **WATER JUST ONCE/DAY**
- **APRIL THROUGH OCTOBER**

  3 TO 5 AM
- **NOVEMBER THROUGH MARCH**

  9 TO 11 AM
- **NOTE: 1ST AVERAGE FROST IS NOVEMBER 15**
- **LAST AVERAGE FROST IS MARCH 15**

SOIL PROBES

- ANYTHING THAT PENETRATES THE SOIL CAN BE USED AS A SOIL PROBE
  - A PIECE OF REBAR
  - AN OLD ALUMINUM SHAFT ARROW
  - A SHOVEL OR DIGGING FORK
  - A SOIL PROBE
- THE WATER STOPS WHERE THE PROBE MEETS RESISTANCE
  (REMEMBER THAT SOUTHERN NEVADA SOILS ARE HARD AND ROCKY. SAMPLE MANY AREAS TO MAKE SURE THE RESISTANCE IS FROM DRY SOIL AND NOT ROCK, THIS DOES NOT WORK IN HIGH ORGANIC OR SANDY SOILS)

HOW MUCH ARE YOU GIVING PLANTS?

WATERING TIME	AMOUNT OF 8 OZ. CUPS OF WATER	GALLONS
60 MINUTES OR 1 HOUR	16	1
30 MINUTES	8	1/2
15 MINUTES	4	1/4
10 MINUTES	2.7	1/6
5 MINUTES	1.3	1/12
1 MINUTE	.27	1/60

WATERING FOR 3 MINUTES 3 TIMES WITH TWO EMITTERS GIVES THE PLANT ONLY ALMOST 5 CUPS

SCREWDRIVER TEST FOR LAWNS

- TALL FESCUE
  - 8 INCHES
- BERMUDAGRASS
  - 6 INCHES

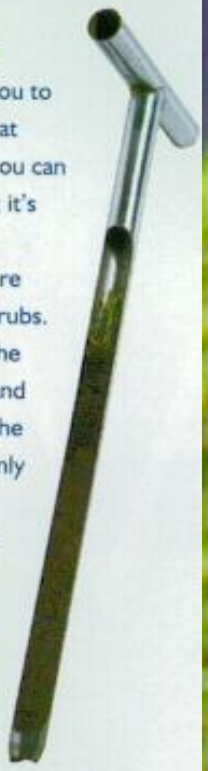
THE LENGTH BELOW GROUND = WATERING DEPTH

(REMEMBER THAT SOUTHERN NEVADA SOILS ARE HARD AND ROCKY. SAMPLE MANY AREAS TO MAKE SURE THE RESISTANCE IS FROM DRY SOIL AND NOT ROCKS, THIS DOES NOT WORK IN HIGH ORGANIC OR SANDY SOILS)

TYPES OF SOIL PROBES

Using a soil sampling tube

This device allows you to check soil moisture at deeper levels than you can reach with a trowel; it's especially useful for checking soil moisture around trees and shrubs. Push the tube into the ground, pull it out, and examine the soil in the tube. If it is dry or only slightly moist, it's time to water. If the top layer is damp and the rest is dry, you need to water longer to ensure deeper penetration.



SOIL PROBES

CALIBRATING A DRIP SYSTEM

USE A CONTAINER

TIME HOW LONG IT TAKES TO FILL

HOW OFTEN?

- AS OFTEN AS NECESSARY SO THE ROOT ZONE DOES NOT DRY OUT
  - MEDIUM & HIGH WATER USE PLANTS NEED WATER WHEN 50% OF THE ROOT ZONE IS DRY
  - NATIVE AND NON-NATIVE LOW WATER USING PLANTS NEED TO BE WATERED WHEN 80% OR MORE OF THE ROOT ZONE IS DRY
- HOW DO YOU TELL?
  - USE A SOIL PROBE

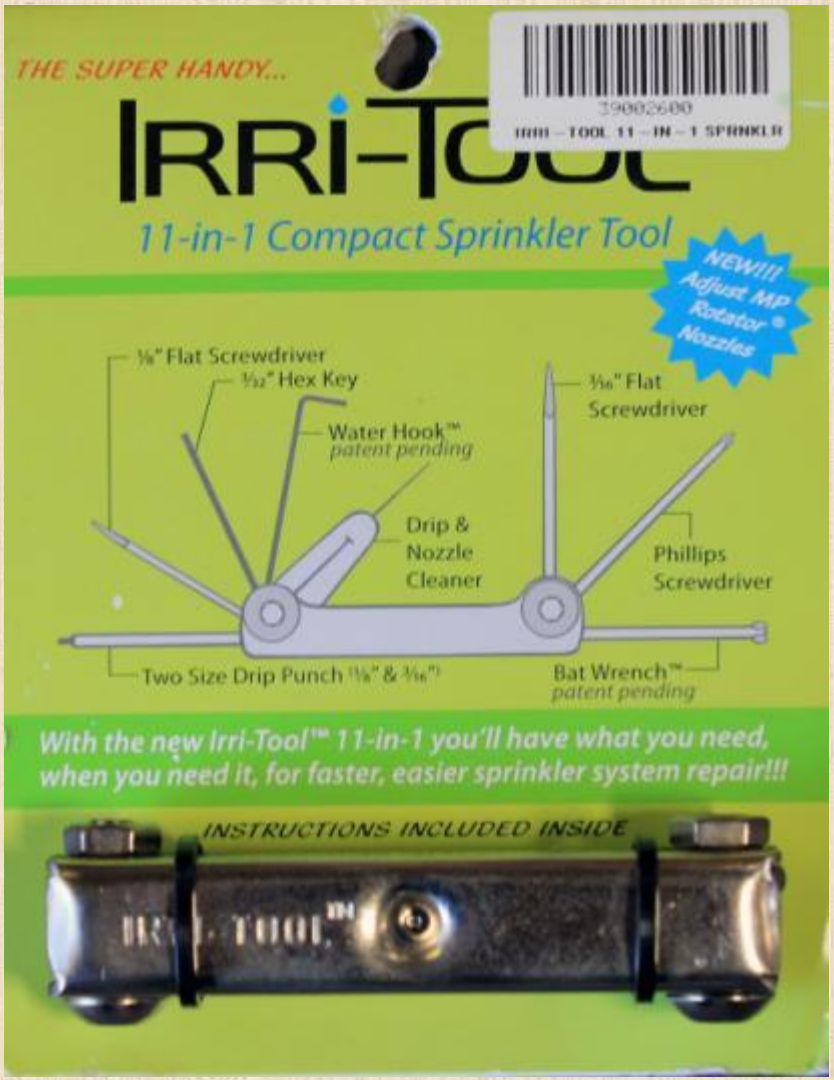
THE “CRUMBLE” TEST

- PLACE A SAMPLE OF THE SOIL FROM THE MIDDLE OF THE ROOT ZONE IN YOUR PALM AND SQUEEZE IT
  - SQUISHY = DOESN’T NEED WATER
  - FORMS A BALL THAT YOU CAN TOSS FROM HAND TO HAND = JUST RIGHT
  - CRUMBLES = NEEDS WATER

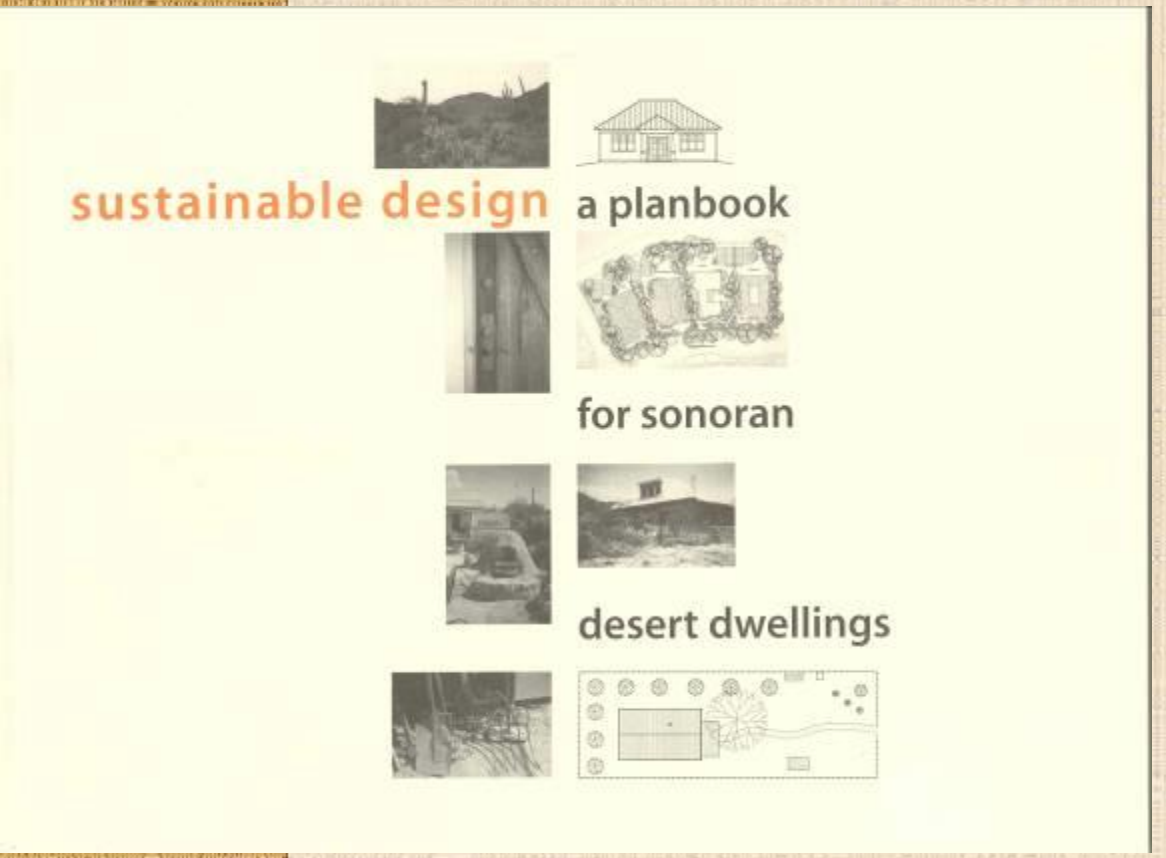
IRRIGATION AND SOIL

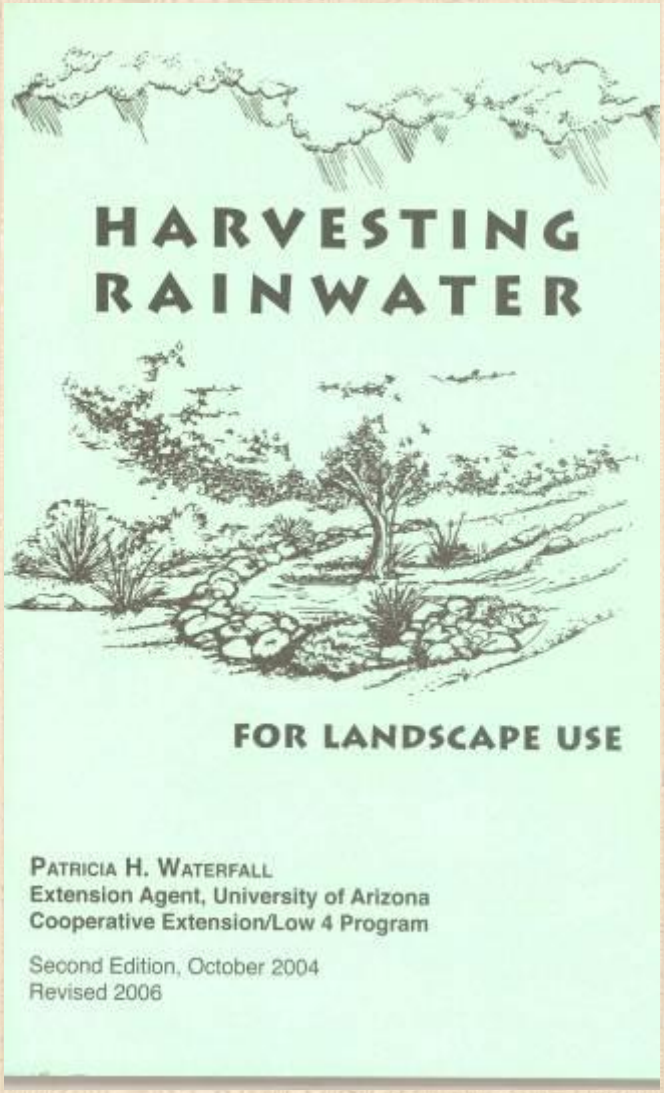
- AS LITTLE AS 2% ORGANIC MATTER IN THE SOIL CAN REDUCE IRRIGATION NEEDS BY 75% OVER POOR SOILS WITH LESS THAN 1% ORGANIC MATTER
- SHADING WITH MULCH AND PLANT LEAVES CAN REDUCE IT BY 60%
- (RAINWATER HARVESTING FOR DRYLANDS AND BEYOND VOLUME 23 PAGE 20)

NEW PRODUCTS



FOR MORE INFORMATION





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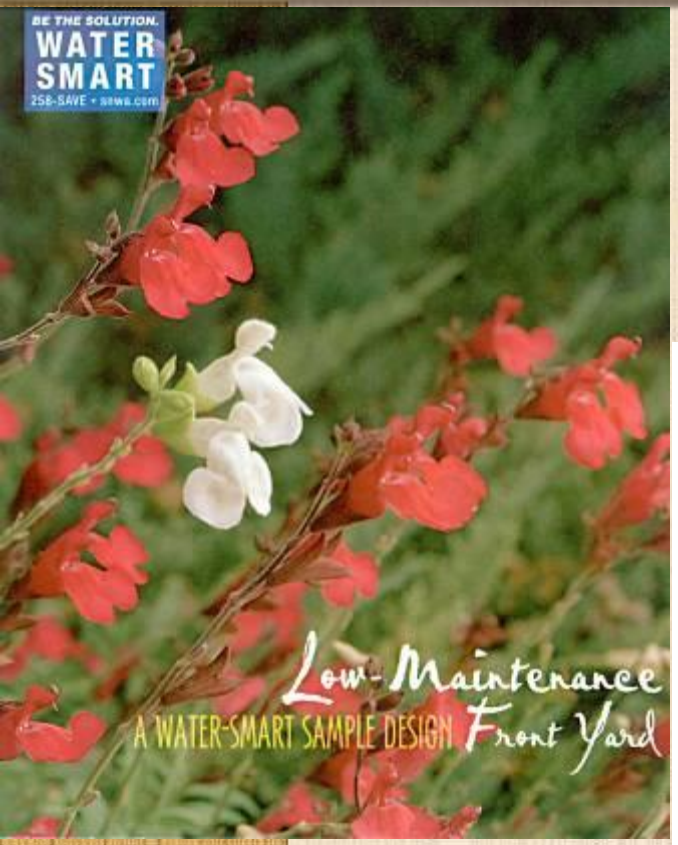
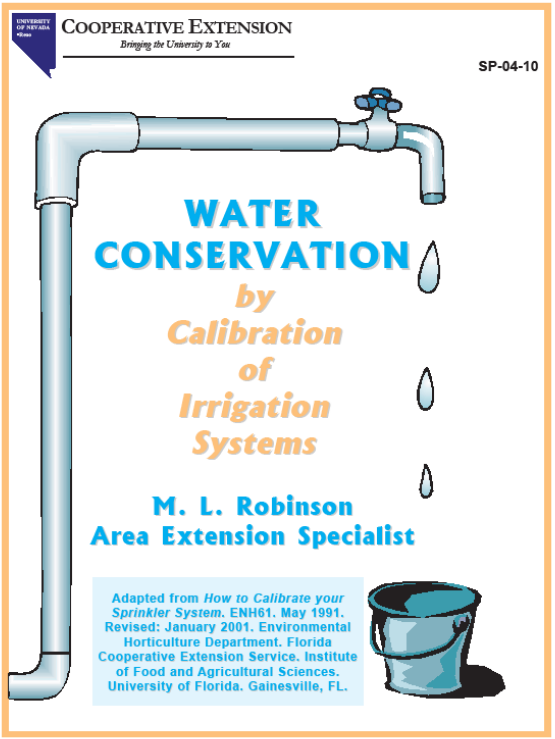
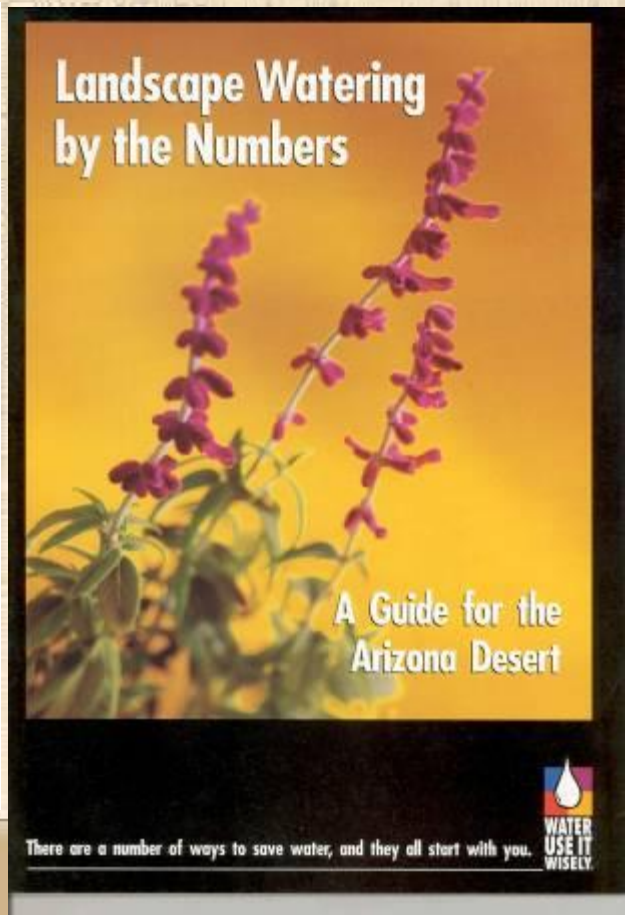
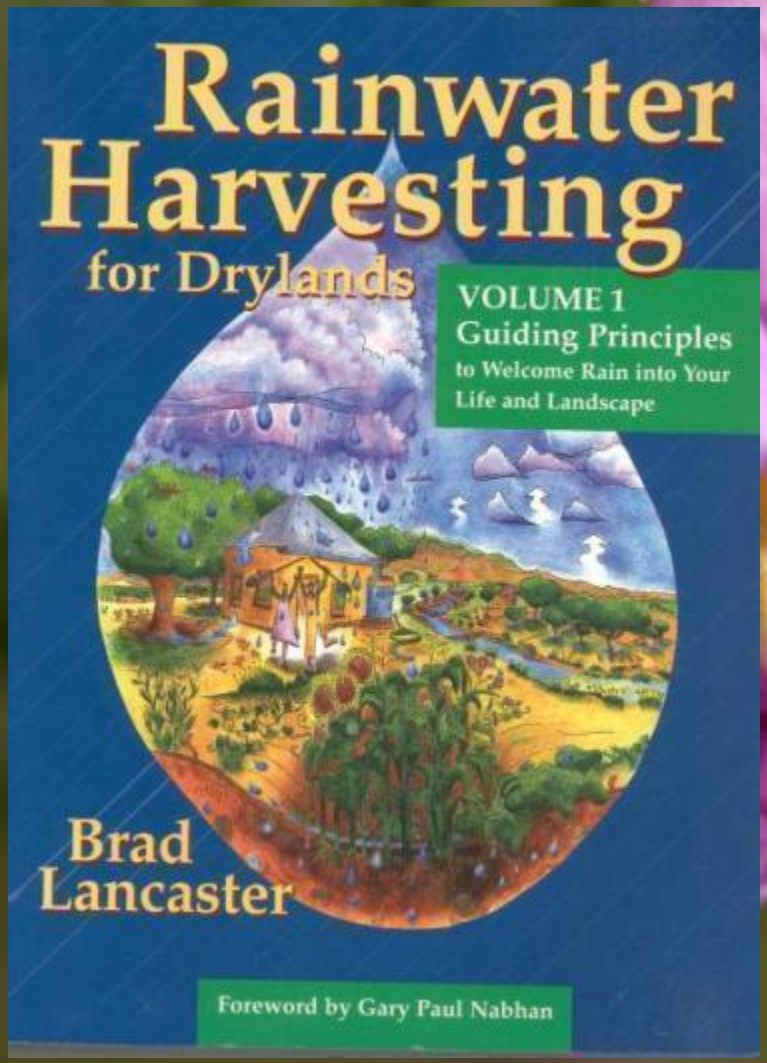
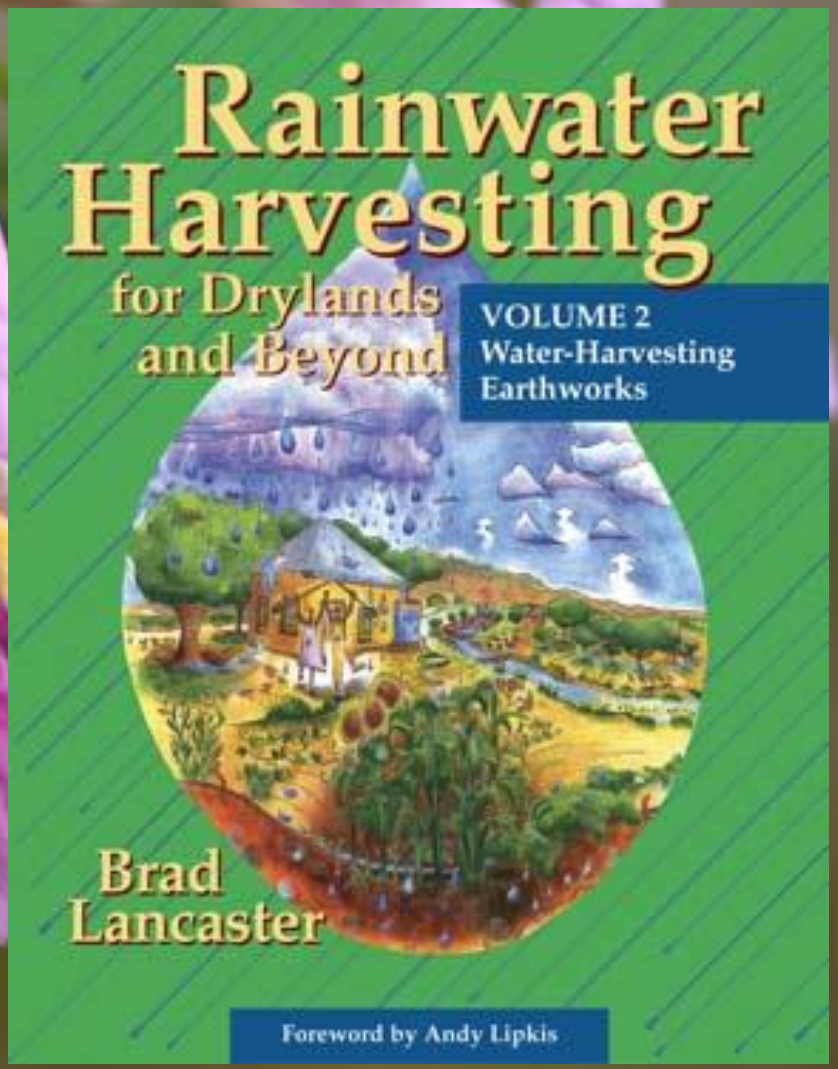




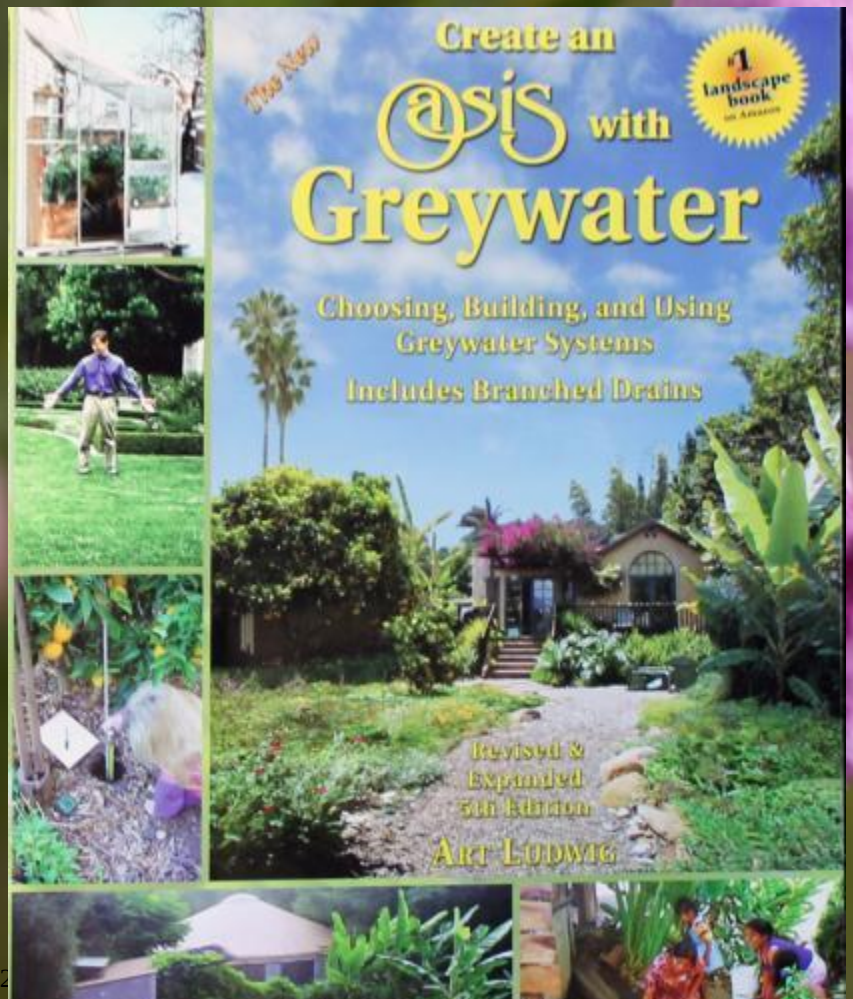


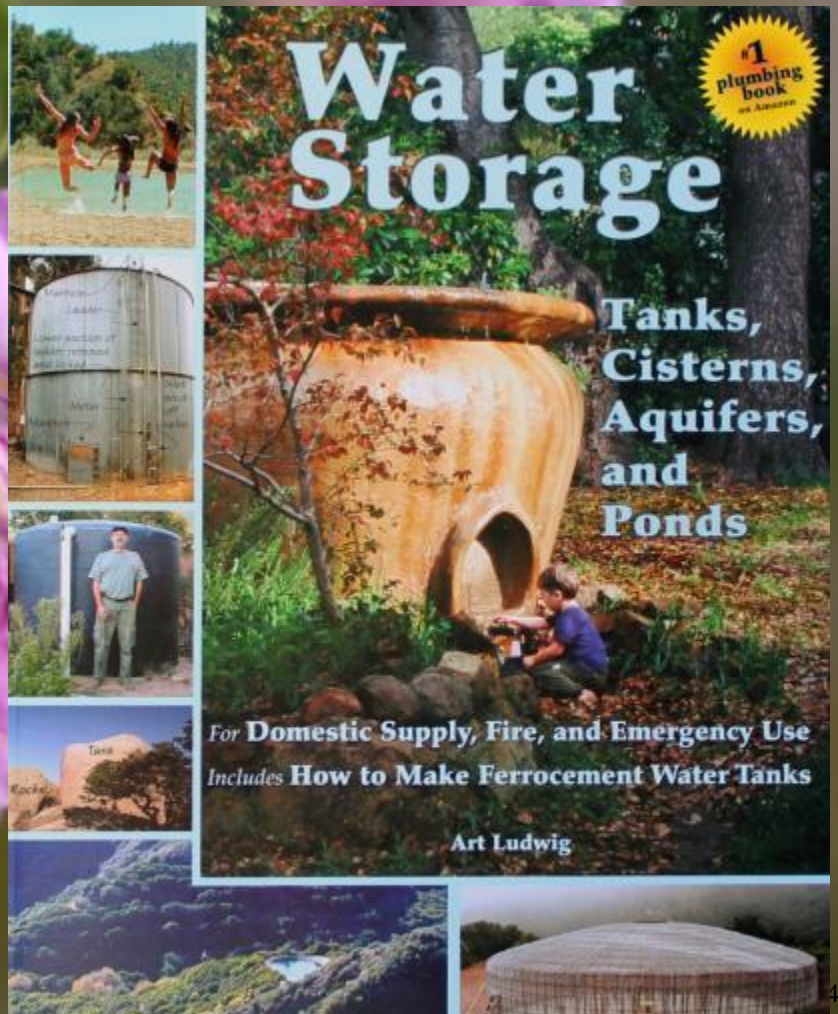
WATER HARVEST MORE INFORMATION

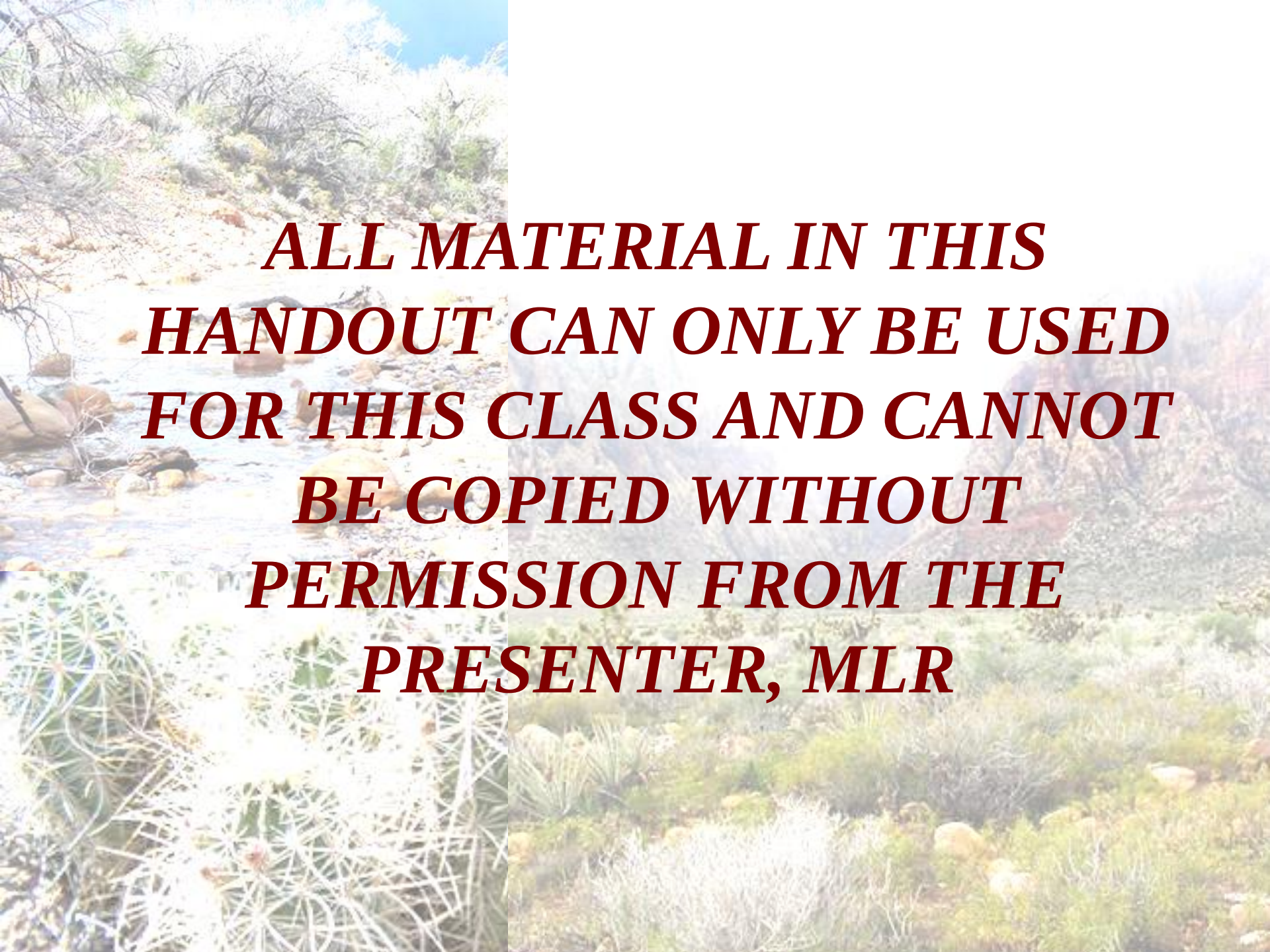




WATER HARVEST
MORE INFORMATION







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REFERENCES

HUNTER INTERNATIONAL

HARVESTING RAINWATER FOR LANDSCAPE USE UNIVERSITY OF ARIZONA

EWING IRRIGATION LAS VEGAS

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