IRRIGATION TECH I

Introduction to basic irrigation systems including hands-on activities for:
• Controllers
• Valves
• Pipe & Sprinklers

Common types of AZ landscape irrigation:

• Sprinkler
  • High volume, high pressure
  • Measured in gallons per minute – GPM
  • Generally used to water large areas/lawns
  • Water lost to evaporation or drift
  • High output equals high potential for waste

Types of Landscape Irrigation

• Drip
  • Low volume, low pressure
  • Measured in gallons per hour – GPH
  • Generally used for individual shrubs & trees, bedding plants
  • Less evaporation so saves water - delivers water directly to the root zone

• Bubblers
  • High volume, high pressure
  • Measured in gallons per minute – GPM
  • Generally used for trees and shrubs
  • High output equals high potential for waste

Irrigation System Efficiency

• These different types of systems can be used on the same property but each has its specific requirements to be effective, so should never be mixed on the same valve/zone

• Efficient irrigation is a combination of proper plant selection and grouping (hydrozoning), the most efficient delivery system, and proper irrigation scheduling

• Soil type, grade/slope of the area, plant water requirements and weather must be taken into consideration for effective irrigation

• Plants generally need more water more often when first planted and getting established, then frequency can be reduced
How does an irrigation system work?

Common Irrigation Terms
- **GPM**: Gallons Per Minute
- **GPH**: Gallons Per Hour
- **PSI**: Pounds Per Square Inch
- **PR**: Precipitation Rate
- **MPR**: Matched Precipitation Rate
- **DU**: Distribution Uniformity
- **ET**: Evapotranspiration Rate

Irrigation System Components

Water Meter

Backflow Prevention
- What is backflow?
  - Backflow is the undesirable reverse flow of water (or mixtures of water and other undesirable substances) back into a potable water system
Backflow Prevention
It is important to understand the importance of a backflow preventer as it relates to:
• public safety
• different kinds of backflow preventers
• how and when each can be used
• how they are to be installed and maintained

Backflow Prevention
Reduced Pressure Assembly (RP)
• Reduced pressure devices protect against backpressure and back siphonage
• RPs are typically used on commercial projects
• You will experience approximately a 10 psi loss through the device, depending on flow
• RPs must be installed a minimum of 12” above ground
• RPs should be tested and certified at installation and then annually

Backflow Prevention
Pressure Vacuum Breaker (PVB)
• Per UPC code, a PVB must be used on irrigation systems with downstream valves, including irrigation or isolation valves
• PVBs are typically used on homes, pools, and small commercial projects
• A PVB must be installed 12” above all downstream piping/outlets
• PVBs should be tested and certified at installation and then annually

Backflow Prevention
Anti-Siphon Valve (ASV)
• Not intended for use under continuous pressure
• Can not be used as a ‘master valve’, with other valves after it
• Must be installed 6” above all downstream piping/outlets
• Can be used as a combination backflow prevention device and an irrigation valve

CONTROLLERS

Irrigation Controller Evolution
Hydraulic
Solid State Controller
Electro-mechanical Controllers
Irrigation Controller Evolution

- **Hydraulic** – the power of water
- **Electro-mechanical** – easy to program
- **Solid-state** – many more features
- **Hybrid** – best of both worlds

Shown with optional vandal resistant feature

Controller Programming Basics

Traditional controllers need to know three things:

- what time to start (start time)
- what days to water
- how long to water each station (run time)

Controller Programming Basics

- Each station should water based on the precipitation rate of the sprinklers or emitters and the evapotranspiration (ET) rate
- Run times should be seasonally adjusted
- Consider using the “water budgeting” feature
- Water in the evening or in the early morning to minimize evaporation and effects of wind
- Take advantage of multiple programs
- Use cycle/soak program to irrigate slopes

No Electricity?

Battery and Solar Powered Controller Options

Smart Controllers

Smart controllers utilize historical, regional, or site specific weather data, or a soil moisture sensor to automatically update irrigation.

Smart Controllers

- There is a progression of smart controllers from basic units to more sophisticated units which can be accessed and programmed from your smartphone or computer
- Some will send alerts and messages to you when there are issues/problems

Weather data is gathered from a network of ET weather stations and is delivered to the controller.
Smart Controllers

No matter which smart controller you choose, all have water saving features. Most include an optional sensor to adjust sprinkler run time based on the local weather conditions.

A solar sync makes this one ‘smart’

Typical Irrigation System
Adjustment Frequencies

IRRIGATION CONTROL VALVES
Irrigation Control Valves

Residential Valves
- Different inlet and outlet styles allow for local installation techniques and personal preference
- Most residential valves are 1”, rated to 150psi, with flows of about 20gpm
- Residential valves can be globe or angle style
- Valves can be manual or automatic

Commercial Valves
- Commercial valves can be made of plastic or brass
- Typically, pressure ratings are higher, up to 200psi
- Valves can be operated automatically or manually
- Optional equipment allows for pressure regulation or use with non-potable water
- Common valve sizes are 1”, 1-1/2”, and 2” with flows up to 150gpm

Control of Valves

Manual
- You are the power source for turning on and off
  - Bleed screw
  - Solenoid

Electric
- A solenoid receives current which opens a plunger and water comes on

Valves- What Brand? What Size?
- Look straight down at the valve and the information might be right on top if it is new and clean
- Size may be on side
- If you aren’t sure what you are looking at, snap a photo with your smart phone and send to your supplier
- Determine the direction of flow

Common Valves- Grab a Catalog
- These are helpful to carry with you to identify valves until you get good at recognizing them even when they are covered with dirt
- Preferable to replace a valve with the same model, if available
- Most common sizes 1” and 2”

Valves- Automatic Valves
- Most automatic valves have a diaphragm
- The diaphragm blocks the passage of water through the valve. It moves from a closed to an open position using the action of a spring and water pressure differences
Valves- Internal Parts

Valve Operation

Wiring

Multi-strand 18 Gauge (commonly used for residential)
Single-strand 14 Gauge (commonly used for commercial)

Wiring

Electric rules are similar to hydraulic rules

Voltage loss due to resistance traveling in wire is like pressure loss traveling in pipe.

https://www.youtube.com/watch?v=5rokXHhxRSw
Wiring

- Leave enough wire to work with and wrap it neatly in order to leave a valve box in better condition than you found it.

Traditional Controller Wiring

ESP-LXME Controller with FSM-LXME Flow Smart Module Wiring Diagram

Two Wire Controller Wiring

ESP-LXD Decoder Controller Wiring Diagram

Wire Connections

Proper Connectors

- Silicone filled
- Must be waterproof
- It’s worth a few pennies more

Types of Pipe

PIVC

- Polyvinyl chloride
- Extremely durable
- More expensive
- Needs more joints which takes time
- Used for sleeving, mainlines, and lateral lines

Poly

- Polyethylene
- More flexible
- Less expensive
- Connections easier to make
- Used for lower pressure
- Shorter life expectancy
Pipe – Friction Loss & Speed Limit

Water has a speed limit: Don’t exceed more than 5’ per second or there is excessive friction loss!

Non-potable Water Options

Use these sprinklers and related parts to identify any system using reclaimed or non-potable water.

Solvent Cement

How to Glue Pipe & Fittings

For a step-by-step guide to solvent cementing pipe, go to https://www.azlca.com/study-materials#irrigation

Solvent Cementing Pipe

- The time is dependent on:
  - Size of the pipe
  - Specific product used
  - Temperature
- Use chart from manufacturer
- Example using a popular product “WELD ON”

Set Times and Cure Times

- Chart showing average set and cure times for solvent cementing pipe.
Pipe Repair

PVC

- Replace or repair with the same kind of pipe that is already there

Pipe Repair

Set yourself up to do the job correctly

1. Have tarp/burlap to contain excavated soil so as not to contaminate granite or turf
2. Salvage rock before excavating surface

Pipe Repair

3. Carefully cut and remove turf into easily handled pieces so they can be replaced as seamlessly as possible
4. Expose as much pipe as possible
   a. Adequate excavation makes access to the repair much easier
   b. Helps keep dirt out of the pipe

Pipe Repair

Check Repair

- After recommended cure time, flush lines and check for leaks
- Don’t refill your hole before verifying that the repair is perfect

Backfill Procedure

- No rocks contacting pipe between joints
- Check for leaks before continuing
- Shade pipe with fine backfill dirt first
- Compact backfill every 6 inches using your feet, a shovel, a tamper—or water
- Fine grade finished surface before replacing granite or turf

Pipe Repair

Slip-fix Repair Coupling
Sch40 Slip Coupling
PVC Cement
Compression Coupling
Bolted Repair Coupling
Compression Coupling

- This coupling joins pipes together without solvent cementing due to a very precise fit and is a good alternative for repairs in tight places.
- This coupling cannot withstand pulling, pushing, or sideways pressure; they are great to use in the ground where they don’t have to support the weight of the PVC pipe full of water.

Slip Fix Coupling

- Provides an in-line repair capable of supporting high water pressure.
- Because the fitting is installed with PVC cement, the pipe must be dry and there is a curing time required for full strength.
- Best used in limited space applications.

Bolted Repair Coupling

- Heavy duty coupling for large flow commercial pipes
- Use with pipes under high pressure, for example, 3”, 4” and 6” lines
- Saves lots of digging

How to Install Teflon Tape

How to Install Teflon Tape

Sprinklers

- Use with pipes under high pressure, for example, 3”, 4” and 6” lines
- Saves lots of digging

Sprinkler Heads
Choosing the Right Sprinkler

Your choice will depend on:

- Size and shape of the area
- Contours, elevations and slope angles
- How much water and pressure is available
- Percolation rate of the soil
- Budget

Water Pressure

- Pressure is the force that moves water through a pipe
- Pressure is measured in psi (pounds per square inch)
- Pressure can be created by a pump
  - A pump creates pressure by pushing the water into a closed container (pipe) or a container with limited openings (pipe with sprinkler nozzles or drip emitters) so it is contained under a force
  - Pressure is created by gravity
  - Pressure changes in a system by friction losses or by elevation changes
    
    0.433 psi loss/gain per foot of elevation change

Sprinkler Choices

Spray heads

- Steady stream of water in pattern you set: 90°, 180° or 360°
- Different nozzles screw onto the stem to set the arc and distance
- Head mounts on a riser or swing joint which connects to the PVC pipe fitting

Rotors

- Stream or streams of water rotates for a full circle or part of a circle
- Can cover a long distance

How much water and pressure is needed?

Where does pressure come from?
Spray Heads

- Spray heads generally have a radius of up to 15’ with many, many different nozzle options
- It is important with all sprinkler systems in this area to design with head-to-head coverage
- Sprinklers come in a variety of pop-up heights including 2", 3", 4", 6", and 12"

Spray Head Advanced Features

- PRS ensures optimal nozzle performance at 30 PSI
- Eliminates fogging & misting
- Reduces costly accidents and property damage
- Restricts water loss by 70% if the nozzle is damaged

Water Management

Spray Head Advanced Features

- Recommended for use with spray heads and rotors
- Makes it easier to set heads at grade
- In situations where compaction or heavy traffic is likely to occur, swing joints help to prevent breaking a pipe or a fitting

Swing Joint

High-Efficiency Nozzles

- Easy installation on a spray head body
- Hunter MP rotator, for example, fits on other brands of spray heads
Rotors

- Reduced runoff on slopes and clay soils due to slower application of water, often reducing overall water use
- Increased radius range
- Better coverage based on distribution uniformity

Rotor Adjustment

- Match flow and flow rate
- Can replace with something else (different brand) but try to keep integrity of original system (precipitation rate)

Matched Precipitation Rate Nozzles

- PRS – Pressure Regulating Stem, similar to the 1800 PRS spray head, or a pressure regulating body
- Pressure regulation reduces inlet pressure to 45psi for optimal nozzle performance
- Eliminates head to head pressure variation
- Eliminates misting
- Improves distribution uniformity
Pressure Regulation with Rotors

Swing Joint

- Rotor with swing joint

Head-to-Head Spacing

Sprinklers – Precipitation Rates

- Precipitation rate (PR) is the speed at which water is being applied to a specific area
- In irrigation, it is important to ensure that the PR is even over the whole area or zone
- The PR for a sprinkler head is normally listed in the manufacturer’s catalog

How to Find the Precipitation Rate
Matched Precipitation Rate?

Matched Precipitation Rate?

- Rain Bird Maxi Paw 08 nozzle .45 in/hr at 45psi
- Rain Bird Mini Paw 07 nozzle .38 in/hr at 45psi
- Rain Bird 10H nozzle 1.52 in/hr at 30psi
- Toro 8H nozzle 1.80 in/hr at 30psi
- Toro 15H nozzle 1.77 in/hr at 30psi
- Toro 12H nozzle 1.72 in/hr
- Hunter PGP 06 nozzle .36 in/hr at 40psi
- Hunter 10A nozzle 1.88 in/hr at 40psi
- Hunter 17A nozzle 1.47 in/hr at 40psi

Matched Precipitation Rate

Allows sprinklers with various arcs and nozzles to be mixed on the same zone while maintaining even distribution rates

DRIP IRRIGATION

Drip = Low Volume Irrigation

- There are many different types of low-volume, or ‘drip’ irrigation and many different installation techniques
- Water is applied over a longer period of time directly to the roots of the plant
- Frequency of irrigation will be less than sprinklers or bubblers (use controller with multiple programs)

Pressure compensating emitters

- Deliver a more uniform amount of water regardless of changes in pressure
- Important because pressure can vary greatly from one end of a system to another
  - Due to length of pipe or tubing
  - Due to changes in terrain, slope or grade
Drip Irrigation

- Lateral lines can either be polyethylene (poly) tubing or PVC
- With poly tubing, fittings are either “compression” or ‘barbed’
- No solvent cement
- Do not run ½” poly over 300’
- Do not run ¼” spaghetti tubing over 5’
- Pressure regulation and filtration are normally required with drip irrigation systems

Drip Irrigation Control Zone Kit

Drip Irrigation

- Filters clog easily but that’s their job to catch all of the debris in the drip system
- Pressure regulator drops the pressure; drip systems are not designed to require high pressure because water is running through very small tubes

Drip Irrigation - Hydrozoning

- Hydrozoning - grouping plants with similar water requirements together
- Trees on one valve, shrubs on another
- Recommended whenever possible

Drip Irrigation - Hydrozoning

- What if we have a system that has plants with different water needs mixed on the same valve?
  - Use different gph emitters
  - Add or reduce the number of emitters as needed

Wasted Water Adds Up

- “Orphan” emitters where a plant used to be can be a huge waste of water
- One 1 GALLON PER HOUR EMITTER
  - 1 hour 4 times/week from April to Sept.
  - 1 hour 1 time/week from Oct. to March
  - 120 hours = 120 gallons
  - That is 25 trips with a 5 gallon bucket!

- Easy fix: Goof Plugs!
Turf Conversion

Locate and flag all spray heads within the zone.

Identify the center-most head to accept the Retro Drip Adapter.

Turf Conversion

Sparse planting

Dense planting

Turf Conversion

Turf Conversion

Backflow Troubleshooting

How to isolate a problem:

- If the assembly is leaking, use both shutoff valves—on upstream and downstream side of assembly—or shut off water meter
- Tell your supervisor

Who to notify if there is a problem?

- Anything up to the meter you would notify the purveyor (city or private water provider)
- Anything after the meter, notify the property owner (business, HOA, etc.)
Backflow Troubleshooting

Shut-off valves

Problems: Retesting

- If you have to open a backflow device because you are repairing a leak, you have to have it tested when you are done
- By a private certified tester
- Make sure you tell someone that a system needs to be tested

Troubleshooting Controllers

When a controller isn’t working, here are some simple steps to follow:

- Does it have power? Open the door and check if the display is on. If it has power, can you actuate the valve from the controller? If yes, problem is a hydraulic issue with the valve.
- Is it programmed correctly? Check for the 3 programming basics.
- If there is power and water running, and the controller is programmed correctly, the problem is not with your controller.
- Some controllers will tell you where a problem is in the system such as a wiring problem.

If the controller itself is the problem, they are not very easy to fix or really meant to be worked on. Likely it will need to be replaced.

Troubleshooting Valves

Videos helpful in diagnosing valve issues:

- Debris in the valve
  - [https://www.youtube.com/watch?v=yif_f7DRZps](https://www.youtube.com/watch?v=yif_f7DRZps)
- Valve not opening
  - [https://www.youtube.com/watch?v=Zijg05h-Lzw](https://www.youtube.com/watch?v=Zijg05h-Lzw)

Troubleshooting Valves

Valve is not coming on

- Is there water flowing?
  - First check valve to see if there is water flowing by manually operating the valve
  - If there is water flowing, check your solenoid for power test with a multi-meter

- If there is water flowing and your valve and solenoid are okay, then you should check for a clog

- You might also check the controller and see if the clocks are working and the solenoid is getting power

Troubleshooting Valves

Diaphragm

- Know how to look at a diaphragm and tell if it is cracked or has a hole in it
- It is cheaper and easier to fix this part than to replace the whole valve but age of valve should be taken into account
Troubleshooting Valves

Valve not shutting off

• If a valve is not shutting off, something is likely wrong with the diaphragm or the solenoid:
  • Diaphragm is torn
  • Something is stuck inside the diaphragm
  • Solenoid plunger is stuck due to debris

Flow Control

• The flow control shouldn’t give you any problems
• Whew! It allows you to “fine tune” the performance of your sprinklers

Leaks

• If water is weeping out of the sprinklers constantly then you may have a leak or rip in the diaphragm
• If you find water in the valve box then the valve itself or the fitting might have a crack

Solenoid is bad

• Use the volt meter that is in your toolbox to check if there is power flowing from the controller
  • Proper reading=24 volts (for most controllers)
  • Also you might want to use a multi-meter to check the resistance; proper range is 30-40 ohms
  • If resistance is too high (~60) or too low (0) then swap out

Troubleshooting Drip Irrigation

• Too much water pressure pops off emitters
• Recommend 200 mesh rated screen for Wye filter to catch debris
• Emitters wear out and get clogged

Sprinkler Maintenance
Sprinklers: Install Straight and at Grade

Troubleshooting Sprinklers

- Clogged nozzles
- Broken or missing nozzles
- Too much pressure
- Not enough pressure
- Too many heads in one zone
- Head-to-head spacing is not correct
- Vandalism

Common Problems with Spray Heads

- Replace the nozzle making sure to match the precipitation rate

What’s in your Toolbox?

- Volt meter
- Assorted Screwdrivers
- Camera/cell phone
- Pressure gauge
- Pipe cutter/saw
- Ratchet sets
- Nut driver
- Wrenches (adjustable, channel locks, pipe wrench)
- Side cutters
- Fitting Saver
- Irritool
- Sucker tube/siphon
- Strap wrench
- Sprinkler adjustment tools/keys (most common keys are CH751, HL238 & Rain Dial)
- Punch tool
- Assortment of shovels, rakes
- Hand trowel
- Wire strippers
- Soil probe and/or long handled screwdriver

Checklist for Irrigation

- Drip system checked (filters cleaned, lines flushed out at end caps)
- Turf irrigation checked and adjusted after mowing
- Broken or missing valve boxes and lids replaced
- Emitters without plants plugged
- Dead plants removed and emitters plugged
- Spaghetti tubing running above ground to be buried in soil (not granite) or cut and plugged just above granite
- Valve boxes and 6” boxes cleaned out for access to irrigation components

Checklist for Irrigation

- Leaking valves repaired
- Low valve boxes raised to 2” above soil grade
- All ball valves and gate valves to be exercised 4 times/year
- Make sure irrigation schedule is compatible with mowing schedule for dry turf on mow days
- Irrigation controllers checked weekly and programs adjusted monthly or as ET dictates
- Make sure controller menus are accurate and always in the controller
A huge “Thanks” to the folks who gave their time and expertise:

**Presentation**
- Doug Donahue
- Tim Foraker
- Jeff Fugere
- Shannon Scott
- Scott Simeon
- Drew Snyder
- Wade Taylor
- Paul Tripp
- Jim Trog
- Janet Waibel

**Photos**
- Roz Cook
- Kasey Billingsley
- Doug Donahue
- Ewing Irrigation
- Judy Gausman
- Scott Hayes
- Horizon
- Hunter
- Irritrol
- Rain Bird
- Shannon Scott
- Toro Company
- Weathermatic