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Sprinkler Irrigation in the Landscape

Irrigation is one of three powerful landscape management tools. (The others are fertilization and cutting, e.g., pruning or mowing.)

Landscape irrigation provides year round plant growth in warm climates, assists establishment, and effects a shift in the climax vegetation on a site to more long-lived and woody species. Xeric sites that would be naturally dominated by annuals and herbaceous plants, e.g., grasses can be made through irrigation to support a denser, more luxuriant canopy, which many clients favor.

Plants have inherited cycles of leafing, flowering, and seed dispersal, compatible with annual cycles of rainfall in their natural habitat. Irrigation, the artificial watering of the soil, drastically changes where and how plants grow.

The most widespread landscape plant in North America, Kentucky bluegrass (*Poa pratensis*), is a Eurasian plant which naturalized in urban lawns due to irrigation. For all practical purposes it wouldn't be here without irrigation. When people talk about having a "lawn as green as the Joneses" they are quoting an expression that originated in the Kentucky bluegrass belt, and this arose from sprinkler irrigation.

Ecologically, irrigation interacts with other major landscape management tools. Close cutting of turfgrass, which weakens the plant and prevents adequate root development, leads to minimal available soil moisture reserve. Therefore, close-cut turf wilts and dries out more readily, and more frequent irrigation is required. In using irrigation to maintain close-mown, luxuriant stands of turfgrass throughout the growing season, turfgrass areas demand more frequent irrigation than wooded areas. This is the opposite of the natural occurrence of grasslands in drier areas, and woodlands in wetter areas.

In a negative sense, the practices of mowing, watering, and fertilization act in a vicious cycle to weaken and change natural ecosystems. Plants such as the slash pine (*Pinus elliottii*) that are adapted to a wet-dry cycle often show decline and death under irrigation. In a positive sense, irrigation coordinates with other tools, so people can accomplish the kind of landscape that they like. Performed with precision and good judgement, irrigation can be quite efficient in providing a healthy landscape, with reduced impacts on natural resources and ecosystems.

Unfortunately, there is too much bad irrigation. For this reason, the landscape and turfgrass manager can play a pivotal role in serving the client by installing, retrofitting, and maintaining irrigation systems according to sound design principles.

The most essential essentials of sprinkler irrigation.

I. Objectives

II. Physics of water

A. Pressure (psi, pascals, head-foot), force, energy, and velocity

- 1) atm=14.7 psi = 33.9 feet
- 2) Pressure is independent of area
- 3) Comparison with traffic flow
- 4) Comparison with electronics

B. Friction loss, turbulent flow

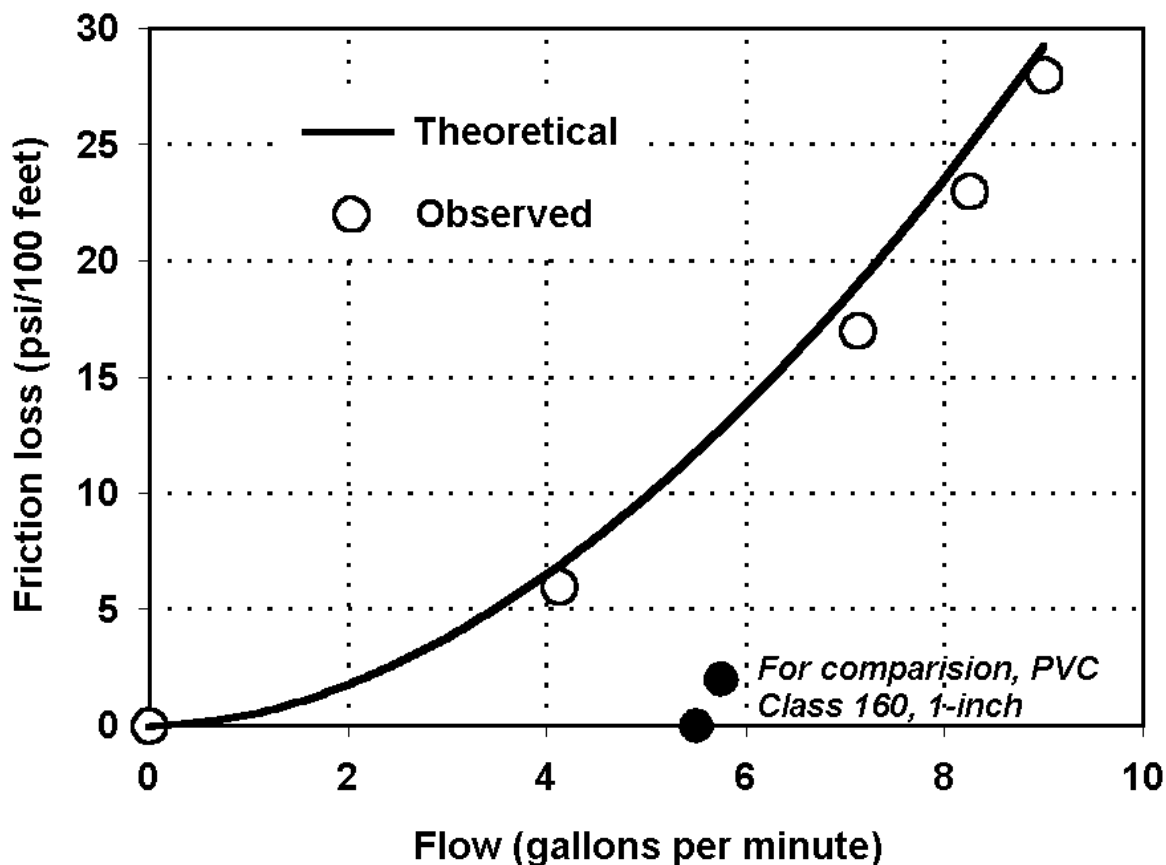
III. Mathematical conversions involving irrigation

A. Weight, volume, flow, pounds, gallons, gpm

cubic foot = 7.48 gallons (U.S.); gallon water = 8.35 pounds

cubic foot water = 62.4 pounds

Friction loss and flow in PVC Sch 40 1/2-inch pipe



- B. Precipitation rate, coefficient of uniformity (the average relative difference of individual point precipitation rates compared with the overall)
- C. Measurement of areas, acre, square foot, square meter
- D. Chain formula
- E. Other factors: percolation, infiltration

IV. System components

- A. Source of water
- B. Pumps and pump curves, e.g. head-capacity
- C. Pipes
 - 1) Pipe materials: galvanized steel, iron, copper, plastics (PVC, ABS, PE, etc.) e.g., PVC 1220 = polyvinyl chloride Type I, Grade 2, 2000 psi design strength.
 - 2) Pipe size: nominal pipe size, O.D., I.D., wall, I.P.S., length, Schedule (obsolete for irrigation pipe), Class (preferred), SDR
 - 3) Pipe connections: slip, threaded, etc.
 - 4) Friction loss tables
- D. Main lines
 - 1) Loop vs. straight
 - 2) Pressurized vs. master control
 - 3) Surge, hammer, cavitation
- E. Fittings
 - 1) Types of connections: ell, tee, adapters, bushings (or reducers), caps, plugs
 - 2) Outlets and adapters (S, C, M, Fe, reducing, etc.)
 - 3) Special terminology: threaded nipple, street ell, 90° vs. 45° etc., various repair and special couplings, e.g., saddle, clamp, clamp saddle, insert fittings, compression couplings
 - 4) Symbols: e.g., 1/2" S x 3/4" Fe
- F. Valves
 - 1) Gate valves: rising stem vs. non-rising stem. Globe valves vs. angle valves.
 - 2) Remote control valves
 - (a) Electric diaphragm, normally closed
 - (b) Hydraulic diaphragm, normally open
 - (c) Other: hydraulic piston, electric thermal motor, pressure reducing

- 3) Swing check valves, anti-siphon valves, garden hose valves, drain valve, quick-coupling
- 4) Importance of sectioning the system: fixed supply, problems of friction loss (see system design, below)

G. Controllers

- 1) Electromechanical, electrical
 - (a) Wiring: master switch
 - (b) Valve wiring
 - (c) Problem solving: lightning, failure of zones to open
- 2) Electromechanical, hydraulic control
 - (a) Pressure
 - (b) Problem solving: zones that always stay on
 - (c) Filters
- 3) Solid state
- 4) Satellite
- 5) Scheduling: watering cycle start time, calendar programming, station timing

H. Sprinkler heads

- 1) Fixed, sideways pattern, e.g., spray heads wrongly called "mistifiers." Parts: nozzle, adapter or guide, stem, body, flange, riser. Options: pop-up, matched-precipitation, partial-circle, low-angle heads, etc. Problems: obstructions, lateral support, runoff.
- 2) Rotary, stream patterns. Parts: nozzle, body, housing, driver arm and impact arm, reversing mechanism for impact drive heads or "knockers", and for the gear driven rotaries, gear case, gear train, water wheel, swirl plate, and drive shaft. Other power sources include cam drive and ball drive.
- 3) General comparison of fixed vs. rotary based on cost, precipitation rate, and susceptibility to corrosion.
- 4) Other: quick couplers, bed spray heads, shrub sprays, bubbler, flood, micro emitters, subsurface, and adjustable risers.
- 5) Reading sprinkler tables and understanding performance characteristics, distribution patterns

V. System design

(Remember, the main purpose is uniformity and secondly it is control)

- A. Measuring a plot plan: property details, water supply
- B. Sprinkler placement: placing round circles in square holes
 - 1) Equilateral or triangular vs. rectilinear spacing
 - 2) Street fronts, corners, fences, trees
- C. Zoning
- D. Routing the main, sizing pipes and valves
- E. Wiring, controller selection

VI. Irrigation installation

- A. Staking and stringing
- B. Ditches: depth, width, uniformity, backfilling, clean up
- C. Pipe connections: solvent welds, etc.
- D. Valve boxes, controller housings
- E. Setting heads
- F. Specialty tools: valve key, nipple extractor
- G. Practical considerations

VII. Maintenance

- A. Time clock considerations
- B. Visual check
- C. Capture

1001 ways to have a really bad irrigation system

1. Undersize your source of water.

Select a pump that can just barely supply your smallest zone when the system is first installed.

2. Doom the suction line.

Install the suction line near a fast growing tree. Within a few years, roots will push the line up out of the ground, so you'll always know where it is. That also helps aerify the irrigation water. The pump is guaranteed to suck air, if you can ever get it primed.

3. Mix, don't match.

Use a combination of high precipitation spray heads and low precipitation rotary heads within the same zone. This ensures that dry spots dry out while wet areas drown.

4. Bury your valves.

The easiest way of covering a valve is to just bury it. This way it will never be an esthetic nuisance, and if anyone ever does find it again, the handle will be so corroded it will just break off and not be a problem.

5. Provide vertical irrigation.

South Floridians are accustomed to rust-stained walls. It's almost a badge of honor to have an expensive plate-glass window that you can't see out of, or a fancy corporate sign that is tarnished in rust. You can contribute to this phenomenon by placing undependable impact drive heads close to walls. The painters will enjoy steady employment, year after year.

6. Use the smallest pipe size you can find.

The tighter you squeeze water, the higher the pressure. You can prove this rule of physics by putting your thumb on the end of a hose and seeing how much farther the water squirts.

7. Use even smaller pipes on long, narrow runs.

This creates an attractive geometric series of green oases surrounded by brown.

8. If you have to use valve boxes, bury them, too.

While placing the top of the valve box two or three inches deep is enough to hide it, deeper is better. In fact, you should place the valve box directly on top of the pipe, so that the pipe will support the valve box when you drive over it.

9. Mister heads need 80-100 pounds pressure.

Why else are they called misters?

10. Water at about 4 p.m.

This way you can see if the sprinklers are working when you drive home. Besides cooling the grass, motorists and bicyclists appreciate a refreshing shower.

11. When digging a trench, only wimps and nerds need a string line.

The stronger irrigation technicians should be able to wrestle 4-inch PVC pipes into the most crooked ditch, gluing so-called straight fittings at incredible angles.

12. Use extra glue to cover gaps in pipes.

Whether you think you got some sand in the fitting or you see a crack that just won't close, keep putting as much glue as possible on the outside as a form of insurance.

13. Space sprinklers twice their diameter.

If the droplets from one sprinkler just touch the droplets from next sprinkler, you've got perfect coverage.

14. Extend the pipe to prevent breakage.

If you have pipes breaking due to water hammer, you need to use a tee to extend the ends of the pipes beyond the sprinklers to take the stress.

15. Always use schedule 40 pipe.

No matter the size of the pipe, schedule 40 is right.

16. Use both a foot valve and a check valve

This prevents leaks in the suction line.

17. When it's hot, water in the middle of the day.

It cools the grass.

How to have a really good irrigation system

1. Know your source of water.

Well, surface, or municipal treated?

2. Know your pump.

Output pressure varies as a function of flow. For larger systems, a variable frequency pump may be appropriate.

3. Select the right sprinkler heads.

Select sprinkler heads appropriate for the size and shape of the area, the size of the zone, and the characteristics of the water source.

4. Know the characteristics of heads.

Rotary vs. fixed, spray vs. stream, impact drive vs. gear drive vs. etc. Full circle, partial circle, or adjustable.

5. Space the heads appropriately.

Distance between heads should be about the same as the distance of throw, depending on the head.

6. Fit the round pegs in square holes.

Most landscapes are more-or-less rectilinear, e.g., square or rectangular. Sprinkler heads tend to put out circular distributions. It's a real challenge to prevent water from getting on the streets, walls, and bike paths.

7. Know hydraulics.

There are good tables that will tell you the relationship of pipe size and type and flow and friction loss. Be able to look up the values and use them in design. What is friction loss? What is the maximum tolerable speed of water flow in standard irrigation pipes?

8. Place irrigation components safely and in a way that can be maintained.

Valve boxes are one of the most obvious placement issues, but proper routing for irrigation control wire, drawings, reinforcement for heads, and other issues exist.

9. Know pressure appropriate for particular heads.

What are the standard operating pressures?

Solve problems to have a really good irrigation system

Source of water

1. What are the three common sources of water for South Florida landscapes? Well, surface (pond or canal), municipal treated, and _____.
2. What are the potential problems associated with each source?
[Water quality, price, pressurized or not.]
3. A pump provides what two things to an irrigation distribution system?

_____ and _____
4. What are the three commonest ways of activating a pump?
Manual, pressure sensor, and timer.
5. What are two ways of using a timer to activate a pump?
 - (a) Pump start switch is activated with the initiation of the irrigation cycle.
 - (b) Pump is started and stopped at intervals for each zone; allows for a means to open and close off zones that originate at a distributor.
6. What are the parts of a suction line and what do they do?
Filter, check valve, culvert, grating, unions, pipe.
7. What are the accessory parts of a pump station besides the pump?
Pressure and heat sensors, flow monitor, clay valve, shut off devices.

Main line

8. How does the shape and size of the landscape affect the possible arrangements for a main irrigation line? What are the possible arrangements of a main line?
9. What are the special problems in maintaining a main line?
 - (a) If system is pressurized, there is no tolerance for leaks
 - (b) Pipe is large diameter, fittings are large, inflexible, and expensive, making in-line repairs difficult and expensive with little tolerance for error.
 - (c) Pipe is deep and often hard to get at, sometimes in contact with rock, underneath roads, close to other utilities, and vulnerable to damage by other construction work.
 - (d) Special provisions must be made that valve boxes and covers are safe and can be maintained.
10. What are special solutions to problems of a main line?
Valves, maps, inspections, proper installation (use a string line).

Zones (valves, pipes, and heads)

11. Define an "irrigation zone."
12. What are the two purposes of an irrigation zone?
13. What is a sample formula for the maximum size of an irrigation zone?

area = pump capacity / precipitation rate

Unfortunately, there will be a problem converting units, but if the pump capacity is in gpm (gallons per minute), the precipitation rate is inches per hour, the area in thousand square feet will be:

$$\begin{aligned} \text{area (K)} &= 60 * 12 / 7.48 \text{ gpm} / \text{ppt (inches/hr)} \\ &= 96 \text{ gpm/ppt} \approx 100 \text{ gpm} / \text{ppt} \end{aligned}$$

14. A Rainbird 15 series nozzle is similar to other spray head nozzles that are widely used. At 30 psi (pounds per square inch) the full circle form 15F will cover 15 feet radius and deliver 3.70 gpm. If we vary the spacing between heads, how will this affect:
 - (a) gallons per head
 - (b) the ppt (precipitation) rate
 - (c) the number of heads per area
 - (d) the uniformity
15. What are the important table values for an irrigation head?
16. An irrigation zone has nine sprinkler heads, one 15F and eight other heads, half-and quarter-circle, with matched precipitation. Draw the irrigation plan and answer the questions which follow.

What is the total gpm at 30 psi?

Assume the area is supplied by a 1" Class 160 PVC pipe, and the main line is 100 feet between the source and the valve, what is the pressure loss?

What is the main reason that this is an estimate, not a final value?

What are other reasons that this is an estimate?

Trouble shooting, retrofitting

17. The first thing to check following an irrigation leak is:

18. What are the first steps to "tune" an irrigation system?

19. Assume that an irrigation system provides poor uniformity of distribution, what are the possible causes?

20. Why does the irrigation designer need to know something about the site?

21. An irrigation technician discovered a new problem. All three sprinkler heads on an irrigation zone were not throwing sufficient distance to provide uniform distribution. Realizing that the reduction in pressure was consistent for all three heads, he was sure that there was a problem in the common valve. He dug up the globe valve and replaced it with a brand-new, straight-through valve. Did this correct the problem and what was the problem?

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