Best Management Practices for Landscape Irrigation System Water Conservation

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- **The irrigation system design should be based on the site landscape design, water use zones and water use of the matured landscape.**

- **Irrigation zones should be divided according to water supply amount available.**

- **Use appropriate applicators for the plant materials and to fit the irrigated area for each zone.**

- **System design should fit the site's soil type, topography and climate.**

- **System design should consider the time available for applying irrigation.**

- **Installation should follow the irrigation design specifications and component manufacturer's specifications.**

- **Upon completion of the irrigation system installation a field performance audit should be conducted to determine distribution uniformity and precipitation rates for each zone.**

- **Use a separate or secondary meter for the irrigation system.**

- **Size meters, pipe, and pumping systems for optimal performance.**

- **Use lower trajectory sprinklers to minimize wind and evaporative losses.**

- **Include rain shutoff and other sensor devices as appropriate for site conditions.**

- **Provide a system controller that has flexibility and capacity.**

- **Use soil moisture sensing based or real-time weather based control for irrigation management.**

- **Use the short cycle feature for low permeability soils or steep slopes to prevent runoff.**

- **Perform a thorough irrigation system inspection annually.**

- **Repair or replace damaged or worn components in a timely manner preferably before the next irrigation application.**

- **Conduct a field performance audit on an irrigation system every 5 years.**
- **As plants grow and mature, trim or remove vegetation that blocks applicator pattern to preserve the intended distribution of irrigation water.**
- **Carry out a regular winterization of the irrigation system if it will not be used for an extended period of time in the winter.**

Introduction

Irrigation systems should provide efficient water use and uniform distribution of water in the landscape, must be economical to install and operate, and be simple to operate and adjust. There are many local codes and state laws that the irrigation installer and designer must know to create an efficient design and to install an irrigation system correctly. Many of the codes, laws, rules and regulations do not pertain directly to water use efficiency, but some do, and those will be discussed.

The water conservation practices presented are considered the primary responsibility of landscape irrigation designers, installers, and commercial landscape maintenance personnel. The landscape contractor also has a responsibility to teach the customer how to operate the system efficiently.

Irrigation system design, installation and maintenance should be performed by licensed, certified and when appropriate, bonded professionals. While Georgia does not have certification requirements for irrigation professionals, the Irrigation Association (IA) (http://www.irrigation.org) has a national certification program. To become certified, irrigation professionals can contact the IA or the Georgia Irrigation Association (http://www.gairr.org). Certification indicates that a contractor is a competent professional.

Irrigation System Design

- **The irrigation system design should be based on the actual site landscape design, water use zones and water use of the matured landscape.**

Efficient irrigation design begins with a good landscape design. The landscape design should be the basis for the irrigation system. Unfortunately, it is much too common for a new development with similar lot sizes to install irrigation systems with a “one size fits all” approach. While this approach usually costs less to design and install, it generally leads to inefficiency and non-uniformity of the irrigation system. This is generally because of the site variability in soil types, topography, landscape design and microclimate influences.

Irrigation system design should include specifications of the manufacturer, model numbers, and nozzle size for each applicator. An “As-built”, a drawing of the system layout with all valves, irrigation zones, control equipment, and points of connection labeled should also be included. The layout should include key landscape features such as trees, fences, and buildings so that it is easy to locate components of the system.

In the design documents provided to the customer, the designer should diagram the area of each irrigation zone, the location of all points of connection, control sensors, valves and sprinkler applicators and areas where drip irrigation are used. The design documents for each irrigation zone should also include the water use zone and plant materials, soil types, rootzone depths used for design, estimated precipitation rates, expected distribution uniformity, area square footages, and gallons per minute flow rate for each valve and applicator. Figure 4-1 is an example of a simple “As-built” to provide a customer.

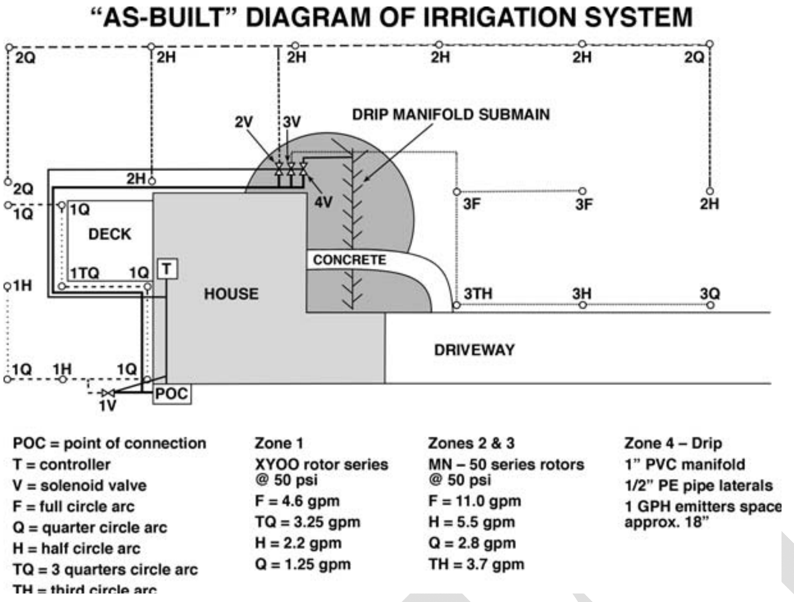

Figure 4-1. This "as-built" diagram would be adequate for owner/operator maintenance and management of the irrigation system. The specification of gallons per minute information will be needed for sizing replacement nozzles correctly. No zones are identified

Plant materials should be grouped into water use zones in the landscape design. A water use zone is an area of the landscape with all the plants having similar water requirements. If the landscape is laid out in water use zones, then the irrigation system can be designed to allow independent control of irrigation for the different zones. Figure 4-2 shows a landscape design layout.

The water use zones are designated as high, moderate and low use zones. Once plants are established, the low water use zones should not need irrigation. However, these plants will need irrigation during the establishment phase. The moderate and high water use zones will need similar irrigation coverage and uniformity of application, but will be run on different schedules that suit the needs of the plant material for each zone. For more information on water use zones, refer to Chapter 2 of this publication or to Georgia Cooperative Extension Service Bulletin B-1073 at http://pubs.caes.uga.edu/caespubs/pubcd/B1073.htm.

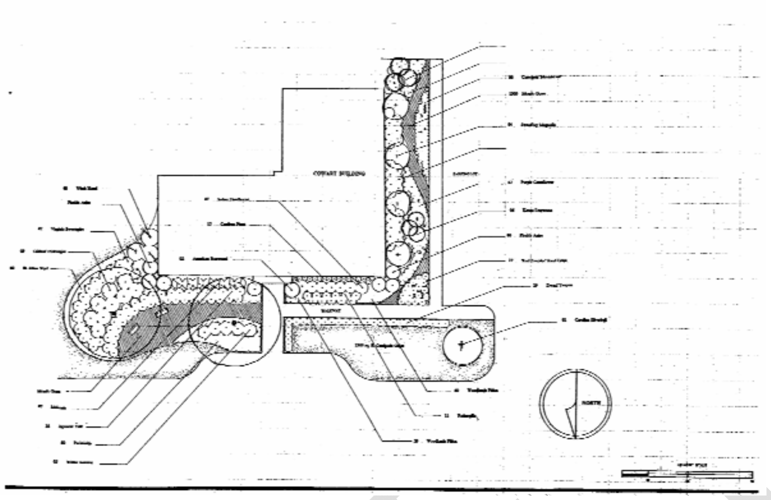

Figure 4-2. Landscape design layout. Must be enlarged

Irrigation systems in landscapes are presumed to have a lifetime of 15-20 years. The water supply and irrigation zone layout should be based on the water needs of the mature landscape, so that the system will be able to apply sufficient water for the lifetime of the system. It is much easier and less stressful to plants to run an irrigation system less frequently and for shorter duration while the landscape is young rather than trying to add additional water capacity or re-zone the system as the landscape matures and ages.

During the design process consider the mature landscape, shrubs and trees, such that irrigation equipment is not blocked or hindered. Take this into account as the applicators are put in place in the design. Figure 4-3 shows an example of an irrigation system design that did not plan for the landscape design correctly. The irrigation head is completely blocked for part of its application arc by a tree.

Figure 4-3. Poor design and/or installation of the applicator location wastes water because the sprinkler pattern is blocked by a tree 35 inches from the applicator.

- **Irrigation zones should be divided according to water supply amount available.**

Water for irrigation can be pumped from an onsite well or storage or it may come from a municipal supply line. Whatever the source, the water supply delivers a limited volume and pressure where the irrigation system is connected. An irrigation zone is a set or grouping of irrigation applicators isolated from the rest of the irrigation system by a control valve. The valve is used to start or stop irrigation. The area covered by an irrigation zone is limited by the amount of water that can be delivered to the zone from the water supply. A large contiguous area may be divided into two or more irrigation zones because the water supply does not have a sufficient flow rate to irrigate the whole area at the required operating pressure.

- **Use appropriate applicators for the plant materials and to fit the irrigated area for each zone.**

There are many kinds of irrigation application devices that can be used in landscapes. Irrigation zones may be differentiated in the design process because different application devices or different management is needed from one area to the next. Keeping different kinds of application devices separated into different irrigation zones allows each zone to be operated in a way that is consistent with the application rate for similar application devices.

The two main categories of irrigation application devices are sprinkling type applicators or micro-irrigation applicators. Sprinkling application devices spread water in a broadcast manner over the whole area to be irrigated mimicking rainfall while micro-irrigation devices do not broadcast water over an entire area. To spread water evenly over an area sprinkle application devices must have overlap of their water streams. Micro-irrigation application devices, also called drip irrigation, apply water directly to the root zone areas of plants minimizing the wetted area of the soil surface. They do not have overlapping wetting patterns.

Sprinkle applicators can be sprays or sprinklers. Spray applicators do not have any movement of the water streams that form the pattern, or wetted area of the spray, and have no moving parts in the spray head. Figure 4-4 is a picture of spray applicators operating in a landscape. Sprinklers have moving water streams broadcasting water over an area that forms the pattern of the sprinkler. Sprinkler types include rotor, impact, and rotator style movements of the water streams. Figure 4-5 and 4-6 picture a rotor and rotator applicator respectively. Most sprinkler or spray applicators can be housed in pop-up canisters that recede below the soil level when not applying water. They may also be placed on top of a riser, a vertical length of pipe, to provide broadcast application above taller plants. Table 4-1 has a summary of some key characteristics of sprinkle type applicators. Note that the water application rates and pattern sizes of the different sprinkling applicators varies considerably. The differences in the various applicator types require that they be managed differently and that they be laid out in a design differently. Their differences make them suitable for different kinds of landscape areas.

Figure 4-4. Spray applicators are pop-up style heads that will let the applicators recede below the turfgrass when irrigation stops.

Figure 4-5. These two rotor applicators have overlapping radius of throw to get a more even broadcast application of the irrigation water.

Figure 4-6. The pop-up rotator applicator has several individual small moving streams rather than the one large stream of a rotor applicator.

Table 4-1. Characteristics of different sprinkling application devices.

Application Characteristics	**Sprays**	**Rotors and Impacts**	**Rotators**
Radius of Throw	3-15 ft	15-80 ft	16-30 ft
Operating Pressures	15-45 psi	25-90 psi	25-55 psi
Precipitation Rates	1-2.5 in/hr	0.3-0.75 in/hr	0.37-0.47 in/hr
Flow Rates	0.1-5 gpm	3-22 gpm	0.3-4.3 gpm
Uses	Smaller and odd shaped areas	Larger and simple shaped areas	Areas with widths and lengths greater than 8 ft

Micro-irrigation devices include drip emitters, inline emitters in rigid lateral pipe, drip tape, micro-sprinklers, and micro-sprays. The most common micro-irrigation device in landscapes is the drip emitter which is installed along a lateral pipeline laid on the surface of the ground. Drip emitters are positioned along lateral pipelines where needed to apply water by dripping water over the rootzone of individual plants. Figure 4-7 shows a drip emitter that has been installed into a lateral pipe. Semi-rigid polyethylene pipe laterals have inline emitters embedded at regular intervals such as 12 inches within or along one side of the pipe. Drip tape is a flatter more flexible polyethylene hollow “tape” with emitting devices evenly spaced along the tape. Drip tape and inline emitter piping can be buried or be placed at the soil surface. Micro-sprays and micro-sprinklers have low volume application rates similar to drip emitters, but the low volume of water is spread out over a larger area than with drip emitters. Micro-sprinklers are similar to micro-sprays except they have moving parts and water streams. Figure 4-8 is a picture of a micro-spray that is not applying water. Neither micro-sprays nor micro-sprinklers are designed to have overlapping water patterns like other sprinkling application devices. These micro-sprays or micro-sprinklers are needed where soils have a low water holding capacity and high permeability, so that the water applied does not move below the rootzone without adequately refilling a large area of the rootzone.

Figure 4-7. A drip emitter connected to a pipe lateral at each plant will provide water directly to the soil surface. This emitter and lateral are on the ground surface and would usually be covered by a layer of mulch.

Figure 4-8. This is a micro-spray applicator positioned above a mulch layer by a plastic stake driven into the soil. Micro-sprays and micro-sprinklers must be above the mulch layer so that the mulch will not inhibit their water spray or sprinkling pattern.

Some plant materials such as herbaceous perennials and woody plants are more amenable to drip irrigation while turfgrass areas will be better suited to the broadcast application of sprinkler irrigation. The appropriate system for herbaceous annuals depends on their spacing and growth habit. Where there are steep slopes and plant materials other than turfgrass, drip irrigation is a better system since it will apply water slowly and prevent runoff. For turfgrass on steep slopes, low application rate sprinklers are preferred.

The designer should choose applicators such that impervious surfaces are not irrigated. Spray applicators come in many shapes to accommodate difficult spaces. Both sprays and sprinklers can have arcs that are less than 360° to prevent watering impervious areas. Most sprinklers and sprays come in standard quarter, third, half, three-quarter and full circle arcs. There are also sprinklers and sprays with adjustable arcs for spaces that need more or less than the standard arc sizes. When these partial or adjustable arc applicators are used, the flow rate of the nozzle should be proportionately less than a comparable full circle nozzle flow rate based on the ratio of the reduced arc area to the full circle area.

For more information on different kinds of applicators, please refer to Georgia Cooperative Extension Service Bulletin 894 at http://pubs.caes.uga.edu/caespubs/pubcd/B894.htm .

Any irrigation device requires a certain operating pressure and flow rate. The operating pressure results from the static pressure at the upstream start of the irrigation system minus the pressure losses in the delivery lines and equipment of the irrigation system. Static pressure is the pressure measured when there is no flow, i.e. reading a pressure gauge just behind or at a closed valve is the static water pressure.

Where a municipal water supply is the irrigation source, new land development downstream along the municipal supply can mean reduced static pressure in the upstream pipes. For this reason, the system design should factor in a 10 % reduction in static pressure of the water supply to accommodate future expansion of the supply system.

To ensure adequate pressure for all applicators, pressure losses due to distribution and topography for each irrigation zone throughout the system should be analyzed to ensure applicators at locations with the least pressure are adequately pressurized. Careful choices in the layout of distribution lines can reduce the amount of pressure difference among the applicators within an irrigation zone which will provide a more uniform distribution of water to the applicators.

If the actual operating pressure is higher than appropriate for the applicators, the system uniformity will be compromised. Pressure regulators are needed where excess pressures would occur. High pressures are common at the base of steep slopes.

- **System design should fit the site's soil type, topography and climate.**

A good design includes obtaining direct knowledge of site conditions and not relying only on plot plans to generate a design. Taking measurements on site to verify actual pressure and flow rate is necessary for proper sizing of equipment. Design should also be based on the soils at the site with adaptations made for soil variability around the site. While at the site the designer should record possible microclimate variations. Important things affecting microclimate includes the topography, shade from buildings and other structures, impervious areas, and soil conditions. The plant materials, the soil type, and microclimate influences will dictate different water needs for different areas. The soil type and site topography influence how the irrigation water will infiltrate into the soil and the potential for runoff problems around the site.

Precipitation rate is defined as the depth of water applied per hour. This rate of water applied is comparable to rainfall rate. Ideally, an irrigation zone's precipitation rate would not exceed the ability of the soil to absorb and retain the water applied during one application. For sprinkler zones in high clay content soils, heavily compacted soils or on steep slopes, it may not be feasible to have a precipitation rate less than the basic infiltration rate. At such sites, low application rate is important, but flexibility of the control equipment is also needed to prevent runoff. The irrigation system controls should allow for intermittent water application for a series of cycles during one application event. Irrigation can be applied for repeated short intervals switching the water between several irrigation zones. This allows the water to infiltrate between irrigation cycles preventing the runoff that would occur with one long application period.

Typical weather conditions affect the changes in water needs with changing seasons. Hotter, drier and windy climate conditions will mean higher water use for the plants in a landscape. Climates where maximum temperatures are not as high or do not persist will have lower water needs for plants. Because humid air is already close to saturation with water vapor, humid conditions limit the transpiration rate of plants. As a result plants use less water in humid conditions than they would at the same temperature and sunlight levels in a drier climate.

Topography can also affect the pressure within the system. The site topography must be considered in laying out irrigation zones. Steep areas can be isolated for better management in irrigation zones separate from zones for flatter areas. This allows for better pressure control and better irrigation management for topography differences. Flat areas at the base of a steep area may receive some runoff from the steep area and will need less irrigation water.

As part of a complete design, it is recommended that the designer include an average water use budget for the months that irrigation is typically required based on the local climate conditions. The expected monthly irrigation water usage is based on the historical evaporation or evapotranspiration for a given location. Table 4-2 has an example average water use budget worked out for Atlanta weather and a typical sandy clay loam soil of that area. This budget does not take into account average precipitation. To deal with rainfall variability, a rain shutoff sensor and a controller set up with the water use budget will prevent over watering. For more information on how to calculate the average water use budget see Sidebar 4-1. Because an irrigation control system is often initially set to establish a new landscape, the average water use budget based on evapotranspiration provides a reasonable estimate for irrigation frequency and run-time once the landscape is established.

For more information on planning an irrigation system for the landscape, please refer to Georgia Cooperative Extension Service Bulletin 894 at http://pubs.caes.uga.edu/caespubs/pubcd/B894.htm .

- **System design should consider the time available for applying irrigation.**

Landscapes may have times that they are being used and irrigation is impractical. Irrigation systems should not be operating when the landscape areas are needed for use. For many soil types, traffic produces more damage and/or compaction when soils are near or at saturation. The destruction of the soil structure affects the health of the turfgrass, so there needs to be a period of little or no traffic immediately after irrigation water is applied. The required water supply flow rate should be adequate to provide no less than 70 % of the peak water demand during the time available for application.

Another time constraint in Georgia is the mandatory watering schedule for the state (see http://www.conservewatergeorgia.org) for details of the mandated watering schedule for the state of Georgia. The state requires all commercial and residential landscape irrigation to follow a weekly alternate day schedule (Chapter 1). Therefore, an irrigation system must be able to apply all irrigation water that might be needed under peak water demands in three days or less per week.

Installation of the Irrigation System

- **Installation should follow the irrigation design specifications and component manufacturer's specifications.**

When the contractor or installer and the designer for an irrigation system are not the same person, there should be interaction between the two as the system is being installed. If issues arise during installation that the contractor sees as problematic with the design, the contractor should consult with and get approval from the designer to make the appropriate changes.

Landscape designs and irrigation systems get modified at the time of installation for many reasons. It is important for the irrigation designer to be consulted prior to any changes to the design on paper to ensure that the change is within design performance specifications.

For example, when installing an irrigation system into an established landscape the trenching close to large trees needs to be minimized to prevent damage to the trees. The undue stress of disturbing the root system of an established tree will reverse any benefits that an irrigation system might provide. This is the kind of decision that may not be addressed on the drawing board. But the installer will be able to recognize obstructions to the irrigation system created by the landscape that may not have been apparent during planning.

The designer should visit the site during installation to check for adherence to the design. Particular issues that the designer should check are

- Service meter and backflow prevention assembly
- Main line and other pipe sizes and layout
- Valves and control wires
- Irrigation system controller
- Application devices and other water conserving devices specified in the design.

Table 4-2. This is an irrigation schedule developed for a sandy clay loam with Atlanta historical weather data. This schedule does not factor rainfall into application amounts or timing. The table includes a schedule for centipede turfgrass and for a bed of woody ornamentals. The centipede turfgrass is assumed to have an 8 inch active root zone requiring 0.67 inches net application to refill the root zone at 50% depletion, and to refill the 18 inches of root zone for the woody ornamentals bed would take 1.5 inches net application. For more details on how the schedule, run-time and net application is calculated, see Sidebar 4-1.

Month	ET_R	**Centipede Turfgrass**				**Woody Ornamentals**				
	Inches	K_C	ET_A Inches	Interval Between Applications Days	Run-time - sprinkler Minutes	K_C	ET_A Inches	Interval Between Applications Days	Run-time- Sprinkler Minutes	Volume to Apply - Drip Irrigation Gallons/ week
January*	0.9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
February*	1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
March	3.0	0.85	2.6	8	91	0.70	2.1	30	300	1.2
April	4.4	0.85	3.7	5	91	0.70	3.1	15	300	1.8
May	6.0	0.85	5.1	4	91	0.70	4.2	10	300	2.4
June	6.5	0.85	5.5	4	91	0.70	4.6	10	300	2.7
July	6.4	0.85	5.4	4	91	0.70	4.5	10	300	2.6
August	5.5	0.85	4.7	4	91	0.70	3.9	10	300	2.2
September	3.8	0.85	3.2	6	91	0.70	2.7	15	300	1.6
October	2.7	0.85	2.2	9	91	0.70	1.9	30	300	1.1
November*	1.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
December*	0.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Annual Total	**42.4**		**32.4**		**728**		**27**		**2400**	**67.8 gallons**

*For Atlanta in these months, the evapotranspiration is minimal and usually there is excess rainfall so no irrigation is needed.

ET_R = Reference Evapotranspiration Estimate, inches

K_C = crop coefficient

ET_A = Actual Plant Evapotranspiration Estimate, inches

Before installation operations begin, the contractor or installer needs to verify that the point of connection (POC) flow rate, static and dynamic pressures meet the design criteria. Neglect of this check at the outset can waste money and time for the installer when the system does not work as expected. The installer is also responsible for making sure that the installation is in accord with the design specifications and the equipment manufacturer's published performance standards.

- **Upon completion of the irrigation system installation a field performance audit should be conducted to determine distribution uniformity and precipitation rates for each zone.**

A field performance audit provides a measure of distribution uniformity and the actual precipitation rate of the system as installed. Precipitation rate and uniformity are needed to estimate accurate application time for each of the irrigation zones. This audit may be carried out by the installer or by a third party auditor.

An "as-built" set of drawings as shown in Figure 4-1 should be provided to the owner of the system that includes all system layout and component changes from the original design. At a minimum, the "as-built" set of drawings needs to include a site map showing the location of each POC, water meter, backflow prevention device, controller(s), irrigation zone valves, and irrigation zones served by each valve.

Either the designer, contractor or installer should spend some time with the owner or operator of the irrigation system to make sure they are aware of;

- Irrigation scheduling recommendations for the landscape
- Location of the controller, valves, sensors, pressure regulators, backflow device, metering device and application devices
- Operational requirements of the controller including advanced programming capabilities
- Maintenance requirements for the system components
- Product warranties and documentation of operating instructions for all

equipment.

In the end, the most efficient irrigation system design with the most flexible controller does not conserve water unless the end user understands the basics of the irrigation system, the water requirements of plants, and the effect of weather conditions on need for irrigation. In Georgia, irrigation water is only a supplement to rainfall which is the main source of water for landscapes. Conserving water with an irrigation system takes more time and more effort than conserving water without an irrigation system, and the owner should recognize this reality.

The irrigation schedule should include the expected monthly run time of each irrigation zone in minutes. The run-time is based on the expected plant water requirement, effective rainfall, system precipitation rate, distribution uniformity, estimated application efficiency and the area of the sprinkler zones. The monthly minutes of run time then needs to be translated into a program that is entered into the controller for each month. To do this, divide the monthly station zone run time into irrigation events. Next, divide the irrigation events into repeat cycles where needed to avoid runoff. See Sidebar 4-1 for an example of these calculations.

Equipment Considerations

- **Use a separate or secondary meter for the irrigation system.**

Having a separate meter dedicated to the irrigation system allows for more accurate management of the irrigation system and makes it easier to find leaks thus preventing waste of water. Initially, the separate irrigation meter will cost more than a combined meter. Depending on the local cost of water and wastewater treatment, the separate meter may have a quick payback period due to cost savings of water and sewer charges. Some local laws and codes do not allow separate supply metering for irrigation, so check with the local building codes office. If separate supply meters are not allowed, then it may be permissible to add an in-line meter dedicated to the irrigation system. This in-line meter will be no more expensive and will provide guidance for irrigation management.

If the water supply is a pumped source such as a well, then an in-line meter is also recommended. It is difficult to evaluate whether water is being used efficiently if there is no way to know how much water is being used for irrigation. Over time the amount of water that a pump supplies and the system pressure will change with wear and age. Having a flow meter allows for adjustment for the symptoms of age.

- **Size meters, pipe, and pumping systems for optimal performance.**

For municipal water supplies the maximum safe flow rate should be determined based on these three rules.

1. The maximum allowable pressure loss through the meter should be less than 10% of the static pressure at the meter.
2. The maximum flow rate through the meter should not exceed 75% of the maximum safe flow rate through the meter.
3. The velocity of water through the service line supplying the meter should not exceed 7.5 feet per second (fps).

The design should allow for a reduction of 10 % in the static pressure of the water supply to accommodate possible expansion in the supply network.

Use of an alternative water source rather than potable water conserves drinking water. With any alternative water source for pressurized irrigation, a pumping system will be needed to adequately pressurize the water. The alternative source and the pumping system must be able to provide sufficient pressure and flow rate to provide all of the irrigation zones with uniform application.

The distribution system is made up of the pipes, valves and fittings that carry water from the supply to the applicators. The sizing and lengths of pipes will be dictated by the supply pressure and volume, pressure requirements of application devices, elevation changes and the distance that water must travel to reach each irrigation zone. To create a uniform application within a zone, pipes should be sized such that the variation in operating pressure among application devices within the same zone is 10 % or less. Water velocities should not exceed 5 fps throughout the distribution pipes. Pressure regulators can keep low pressure applicators or applicators in low areas from having operating pressures that are too high. Thrust blocks and air release valves should be specified in the appropriate parts of the distribution system to eliminate system damage due to pressure surges.

For more information on landscape irrigation system components, planning an irrigation system and pipe sizing, see Georgia Cooperative Extension Service Bulletin 894 at http://pubs.caes.uga.edu/caespubs/pubcd/B894.htm .

- **Use lower trajectory sprinklers to minimize wind and evaporative losses.**

Sprinklers with lower trajectories usually will have smaller diameters for a particular nozzle size and flow rate, also they reduce the evaporative losses because water drops do not travel in the air as high or as far. The benefits of low trajectory sprinklers must be weighed against the increased number of applicators needed when the diameter of throw is less to find the right balance between cost and efficiency.

- **Include rain shutoff and other sensor devices as appropriate for site conditions.**

Any automated irrigation control system should have a rain shut-off sensor to stop irrigation if there is significant rainfall at the site. There are also other sensors that can stop irrigation due to freezing temperatures and/or wind conditions, but these are not needed at all locations while the rain shutoff sensor is applicable in almost any climate. Figure 4-9 is an example of a rain shut-off sensor.

Figure 4-9. A wireless rain shut-off device. The wireless style is more expensive, but much less costly to install.

Rain shutoff sensors are relatively inexpensive and can be easily installed in current automated irrigation systems and new irrigation system designs. There are several mechanisms used by the sensors for determining how long the irrigation system should be turned off. Most can be adjusted for a certain amount of rainfall before the irrigation system is shutdown. Rain shutoff sensors can be wired into the electrical controls or they can be wireless. The wireless sensors do not require the installer to have training in low voltage electrical installation to install them.

- **Provide a system controller that has flexibility and capacity.**

The irrigation control system should be only as complex and flexible as the system requires. The controller needed depends on the number of irrigation zones, variability of application devices in different zones, variability of water use zone water needs, soil variability and local outdoor watering restrictions or guidelines. Minimum recommendations for an automated control system are:

- Three independent programs
- Station run times from 1 to 200 minutes
- Four start times per program
- Odd/even and weekly interval programming capability up to 30 days
- Water budgeting from 0-100 % by 10 % increments by program
- 365 day calendar
- Non-volatile memory or battery back-up
- “Off,” “Auto” and “Manual” operation modes without disturbing programs
- Rain shut-off device capability
- Circuitry to signal when a station is shorted or a power failure has occurred

- **Use soil moisture sensing based or real-time weather based control for irrigation management.**

Soil moisture sensors can be used to monitor soil moisture and suspend irrigation if the moisture reserve in the rootzone is adequate. To do this, a separate common wire from the controller to each water use zone station valve is required to allow for soil moisture sensor-based control of each water use zone.

Weather data measured on site and used to calculate water requirement can also be used to control irrigation application timing. Both real-time weather data and real-time soil moisture data are also available from satellites. This satellite data can be used to control irrigation systems and apply water only when the weather or soil moisture dictates a need. See Chapter 6 for additional information.

Irrigation System Maintenance and Management

- **Use the short cycle feature for low permeability soils or steep slopes to prevent runoff.**

The more flexible irrigation control systems allow water to be applied in several cycles for one application. Cycling the water “on” and “off” within a water use zone prevents runoff by allowing extra time for water to infiltrate between cycles. This is necessary when the infiltration rate of the soil is lower than the applicator’s precipitation rate or the irrigation zone is on a steep slope.

- **Perform a thorough irrigation system inspection annually.**

An irrigation system must be maintained so that its performance remains consistent with the design specifications. The maintenance of the system should result in sustaining an efficient and uniform distribution of the water. The maintenance contractor, owner, manager, or irrigation contractor needs to establish a periodic maintenance schedule for inspection and reporting performance conditions to the end-user (or owner) of the irrigation system. A map of irrigation zones is useful for writing down needed repairs and maintenance. A minimum frequency of this thorough inspection should be each spring. Inspection and reporting should include

- Reviewing the system components to verify that the components meet the original design criteria
- Verifying that the backflow prevention device is working correctly.
- Verifying that the water supply pressure is within 10 % of the design specifications.
- Verifying that pressure regulators are adjusted for desired operating pressure.
- Examining filters and cleaning filtration elements.
- Verifying proper operation of the controller including confirmation of the correct date/time input and functional back-up battery.
- Verifying that sensors used in the irrigation system are working properly and are within their calibration specifications.
- Adjusting valves for proper flow and operation.
- Adjusting valve flow regulators for desired closing speed.
- Verifying that sprinkler and spray heads are properly adjusted. This includes checking the nozzle size, arc, radius, and height with respect to slope.
- Verifying that the applicators and risers are perpendicular to the actual slope.
- Verifying that other kinds of application devices such as drip emitters or drip tape are not clogged and have the expected flow rates.
- Repairing or replacing broken hardware and pipe; restoring the system to its design specifications.

- **Repair or replace damaged or worn components in a timely manner preferably before the next irrigation application.**

Repairs need to be completed in a timely manner to support the integrity of the irrigation design and to minimize the waste of water. There should be a visual inspection of irrigation systems weekly or bi-weekly depending on the size of the system.

Ensure that the replacement hardware used for system repairs matches the existing hardware and is in accordance with the design and installation plan. This is difficult if the owner or manager of the system has not been provided a complete set of design and installed specifications for the system. The repairs to a system should be tested and the end-user (or owner) notified of any deviations from the original design. Any substantial changes made to the original design should be recorded in the design plan records and drawings.

- **Conduct a field performance audit on an irrigation system every 5 years.**

A field performance audit is recommended every five years if proper maintenance is carried out on the system during that time. For a system that has not been maintained, the system should have an initial inspection and repairs made and then a field performance audit performed to test the system. Figure 4-10 pictures a catch can layout for a performance audit to be performed on a turfgrass area.

Figure 4-10. Catch cans are laid out in a uniform grid for this version of an irrigation system performance audit.

Irrigation systems change with age, and any changes have the possibility of reducing the system uniformity. The original uniformity of the system is likely to change slowly over time for many reasons that cannot be controlled through regular maintenance such as water supply pressure changes. A field performance audit will indicate if uniformity has declined and whether changes need to be made to the system. To adjust for changes in the system, irrigation management decisions need to be updated once the audit is complete. The calibration of any sensor equipment that signals the control of the system should also be checked.

- **As plants grow and mature, trim or remove vegetation that blocks applicator pattern to preserve the intended distribution of irrigation water.**

As the landscape matures, there may be more interference from the plants with applicator patterns. It is easiest to trim back vegetation that is interfering with the distribution of sprinklers, but sometimes that could cause disproportion in the landscape. Another possibility is to add additional sprinklers or other hardware as required to compensate for blocked spray patterns or changes in the irrigation needs of the landscape. When making such changes, ensure that system modifications do not cause landscape water demand to exceed the hydraulic capacity of the system.

- **Carry out a regular winterization of the irrigation system if it will not be used for an extended period of time in the winter.**

Freezing water and soil cab damage irrigation system components. The best way to minimize damage due to freezing is to drain water from the system before freezing occurs. The irrigation controller should be turned off or set to a “rain” setting if appropriate to keep the main valve from opening. The main control valve, usually between the point of connection and the first irrigation zone, should be closed to stop water from entering the irrigation system in the winter. The valves for each zone should be opened to release all of the upstream water after the main control valve has been shut. Then, pipes within the irrigation zones should be drained.

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References

Florida Green Industries. 2002. *Best Management Practices for Protection of Water Resources in Florida.* Department of Environmental Protection. 60pp.

Irrigation Association. 2004. *Turf and Landscape Irrigation Best Management Practices.* http://www.irrigation.org/PDF/IA_BMP_FEB_2004.pdf 50 pp.

Landry, Gil and Tim Murphy. 2002. *Centipede Lawns*. University of Georgia College of Agricultural & Environmental Sciences Cooperative Extension Bulletin No. L-313. http://pubs.caes.uga.edu/caespubs/pubcd/L313-w.html 4 pp.

Tyson, A. and K. Harrison. 1995. *Irrigation for Lawns and Gardens*. University of Georgia College of Agricultural & Environmental Sciences Cooperative Extension Bulletin No. B-894. http://pubs.caes.uga.edu/caespubs/pubcd/B894.htm   12 pp.

Smith, S. W. 1997. *Landscape Irrigation Design and Management.* John Wiley & Sons, Inc.

Wade, Gary L, James T. Midcap, Kim D. Coder, Gil Landry, Anthony W. Tyson and Neal Weatherly, Jr. 2003. *Xeriscape a guide to developing a water-wise landscape.* University of Georgia College of Agricultural & Environmental Sciences Cooperative Extension Bulletin No. B-1073. http://pubs.caes.uga.edu/caespubs/pubcd/B1073.htm . 44 pp.

Side Bar 4-1 Example calculation for scheduling irrigation.

Example of Calculating An Irrigation Schedule for One Month

Given: Centipedegrass in the city of Atlanta on a sandy clay loam soil with a sprinkler irrigation system that applies 0.45 inches per hour net precipitation rate. (Net application means that the efficiency of the system is factored into the precipitation rate) Calculate the water schedule and time of application for the month of July.

Assume that centipedegrass requires about 5.4 inches of water from rain or irrigation in the month of July. (The value of 5.4 inches was determined by looking at the historical evapotranspiration (ET) average for the City of Atlanta at http://www.griffin.uga.edu/aemn/, the Georgia Automated Environmental Network. The average monthly ET was calculated to be 6.4 inches for July. Centipedegrass growing in Georgia has a crop coefficient of 0.85 for July, so 6.4 x 0.85 = 5.4).

The rootzone for centipedegrass can be 2 to 8 inches deep; assume 8 inches. A sandy clay loam soil will hold about 2 inches of water available for plants per 1 foot of soil, so the 8 inch rootzone for centipedegrass can store a total of about 1.33 inches of water for plant use. The rootzone should be refilled when about 50 % of the available water has been evaporated or transpired, so 1.33 x 0.5 = 0.67 inches of water to refill the rootzone.

Ideally, an irrigation application would apply 0.67 inches of water to refill the rootzone when evaporation and transpiration have used that amount. To apply the 5.4 inches needed in July will require 8 irrigation events (5.4inches/0.67 inch = 8.1, rounded to 8). Since there are 31 days in July, a schedule for irrigation that applies water evenly through the month would require irrigations 4 days apart (31/8 = 3.9 rounded to the nearest number of days). To apply 0.68 inch will take 1.5 hours or 91 minutes (0.68 inches/0.45 inches per hour = 1.5 hours).

In Georgia, there is a watering schedule requirement that allows irrigation only 3 days out of each week. For most places, this means that even numbered addresses can water only on Monday, Wednesday and Saturday, and odd numbered addresses can water only on Tuesday, Thursday and Sunday. This adds an additional constraint to the generic schedule already developed. With the state required watering schedule, irrigations cannot be spread evenly with 4 days between applications. The closest schedule to our calculated schedule would water twice a week, every other watering day available, i.e. Monday….Saturday… Wednesday… Monday…, resulting in a 4 or 5 day interval between irrigations.

A similar schedule should be determined for each month of the year, and a controller adjusted monthly.

Reference for Crop Coefficient for centipedegrass:
Carrow, R.N. 1995. Drought resistance aspects of turfgrasses in the southeast: evapotranspiration and crop coefficients. *Crop Sci.* 35:1685-1690.

Side Bar 4-2 Protecting the water supply from contamination.

Water Supply Protection

Whether the water source is municipal or private, proper water supply protection equipment is mandatory. For municipal supplies typically there are local code requirements for backflow prevention devices. An excellent source of information on backflow prevention device specifications is the *Ninth Edition of Manual of Cross-Connection Control* published by the University of Southern California Foundation for Cross-Connection Control and Hydraulic Research (http://www.usc.edu/dept/fccchr) . For groundwater supply, the Georgia Anti-siphon Act (http://agr.georgia.gov/vgn/images/portal/cit_1210/50/23/41395562PI_Georgia_Anti-syphon_Device_Act.pdf) prescribes the appropriate well protection equipment for any system that will be injecting chemicals. This well protection equipment is recommended for any landscape irrigation system supplied by a well or a surface water source even if no chemigation is planned for the system. This prevents other accidental contamination of the water supply. The cost of this minimal protection equipment is minor compared to the total cost of the system and the risk of water supply contamination.

Follow Local Codes

The distribution system and all equipment attached to it must meet all applicable plumbing and electrical codes. The Irrigation Association has several resources on the national electrical codes, but often local codes will have some differences, so consult your local codes enforcer for information.