

FUNDAMENTAL IRRIGATION STEWARDSHIP

Irrigation System Maintenance



Keeping up with routine irrigation system maintenance isn't easy, but it's a great way to save water and improve playing conditions. Basic tasks like leveling heads and checking arcs can have a big impact. (USGA/Steve Boyle)

SNAPSHOT

This strategy deals with properly adjusting and maintaining irrigation systems. It is a low-impact, low-cost strategy applicable to all golf courses.

Expected cost	< \$25K per acre
Ease of implementation	Daily maintenance
Potential water savings for affected area	< 10%
Highest potential impact areas	Nationwide

OVERVIEW

A properly functioning and well-maintained irrigation system will use less water and last longer than a poorly maintained, inefficient system. In most parts of the U.S., it's virtually impossible to maintain golf course turfgrass in a playable condition throughout the year without an irrigation system. In fact, there are very few locations in the world where acceptable golf course turfgrass, particularly putting greens, can be maintained year round without supplemental irrigation. That makes irrigation system maintenance critical. Just like there are equipment technicians on staff to work on specialized golf course mowers, there must be staff time dedicated to caring for the vast and complex irrigation system and its components.

In most cases, the irrigation system is one of the biggest capital investments at a golf facility. A new system can cost \$3 million to sometimes more than \$5 million, depending on geographic location and system complexity. All irrigation systems – even the best – require constant maintenance and will become more prone to problems with age. Eventually they need to be replaced, but the cost of a new system often means that older systems are used far longer than superintendents would prefer.

Developing a preventive maintenance program is the best way to minimize the severity and frequency of problems and extend the life of a system, regardless of its age. It's also an important strategy to conserve water, reduce energy use and produce better playing conditions.

SCENARIOS FOR USE

The primary goal of irrigation system maintenance is to ensure water is applied to the playing surfaces as uniformly and efficiently as possible. The level and frequency of maintenance required depends on each component of the irrigation system, as well as the age and type of system. The golf course superintendent will typically determine a maintenance schedule for various system components such as pumps, controllers, sprinklers and nozzles, and they are ultimately responsible for the system's upkeep. Most 18-hole golf courses have at least one staff member who spends all or part of their time as an irrigation technician to diagnose and repair leaks, check sprinkler performance and perform myriad other irrigation-related duties.

In addition to routine maintenance and minor repairs, the superintendent, irrigation technician and others will scout for leaks around the course, watch the system run to check for proper operation and ensure sprinklers have correct nozzles, spray arcs and pressure. Occasionally, outside vendors may be needed for audits, major repairs, pump service, complex electrical issues, or emergency repairs during hot and dry weather.

Basic tasks include regular inspection and adjustment of sprinkler heads, cleaning and replacing nozzles, and repairing minor leaks. Tasks that are more complex and require more time include irrigation audits, performing major repairs, and making system upgrades. Making significant changes to the design or configuration of the system goes beyond the subject matter covered in this chapter and typically requires the services of a professional design consultant and an irrigation contractor.



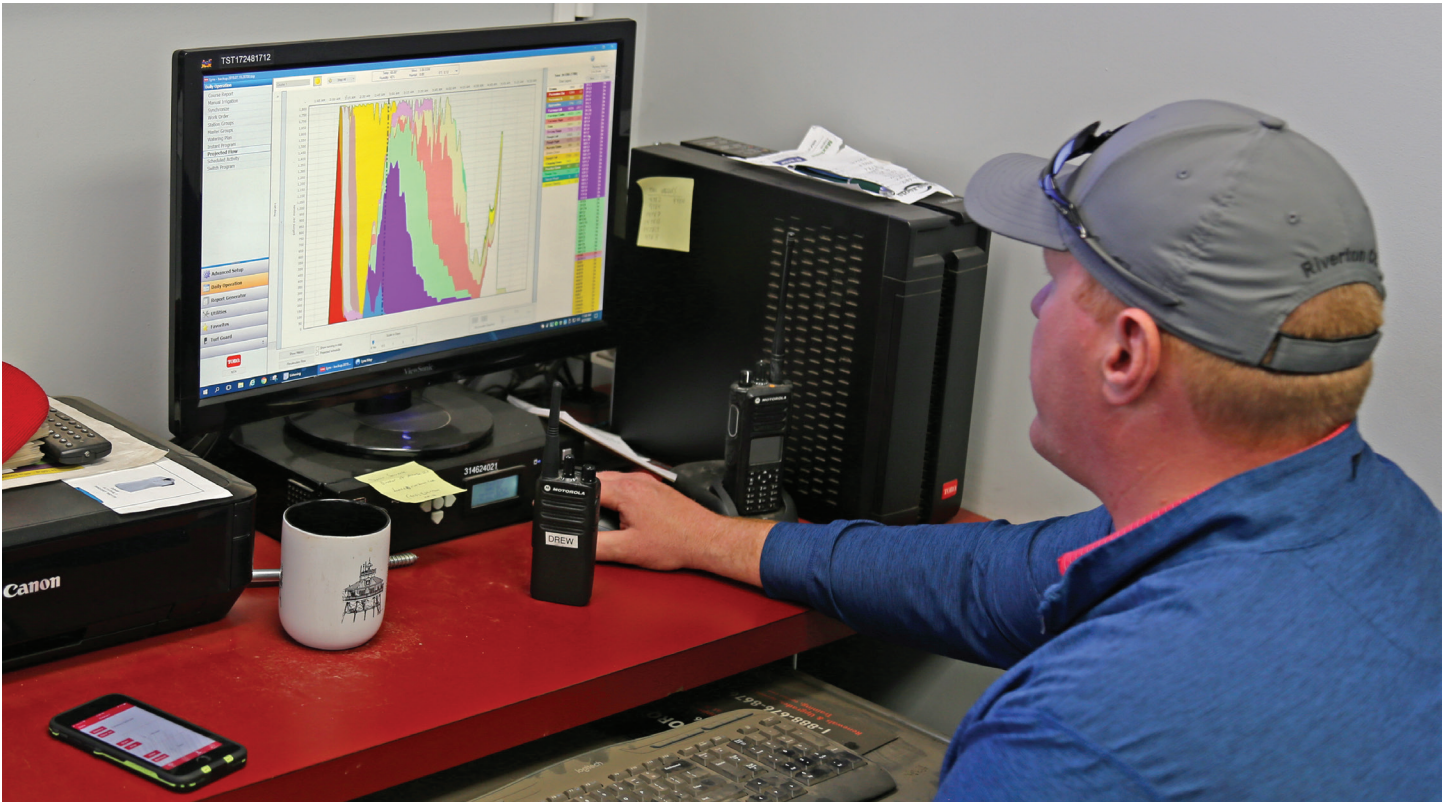
Ideally, a course will have a dedicated irrigation technician that spends most or all of their time making repairs and monitoring system operation. (USGA/JD Cuban)

Focus Areas

Every golf course with an irrigation system must perform regular maintenance. The irrigation system typically “begins” at the water source – e.g., at a well, potable or effluent water connections, an irrigation pond or other water sources. Maintenance of these components is important but usually less frequent than other parts of the system and typically requires the expertise of an outside company. Mainlines and lateral lines move a large volume of water around the course and maintenance is typically focused on repairing pipe breaks and malfunctioning or leaking valves. Wiring is a critical component of the system but typically doesn’t require routine maintenance. If pumps and connections to water sources are where the system begins then sprinklers, couplers for hand watering and subsurface drip irrigation emitters are where the system ends. These all-important components are ultimately responsible for distributing water to the turfgrass and typically need the most maintenance – especially sprinkler heads.

Irrigation field controllers may be located around the course, while central control computers, if present, are usually in the golf course maintenance office to simplify irrigation scheduling. They can require occasional electronic troubleshooting and physical or structural maintenance. For example, field controllers can be damaged by lightning

or falling branches. Central computer systems may require regular software updates and will also require proper programming of the distribution pipeline system. This is to avoid hydraulic issues that can lead to “pipe fatigue” from water hammer and dynamic (operating) pressure losses due to excessive flow rates (velocity of flow) as well as significant elevation changes on a property.



Along with maintaining irrigation system components on the course, it's important to keep the information and software in the central irrigation controller up to date.

Site Specifics

Irrigation system maintenance is important for all golf courses, but there is some regionality and site specificity in the emphasis and focus areas. In arid areas like the southwestern U.S., water resources are limited and/or expensive. Incremental savings through maximizing the efficiency of the irrigation system can lead to especially meaningful water and cost savings in areas like this. Another example of regional variation is in colder climates where irrigation systems are winterized – a process where compressed air is forced through the system to remove all water and protect critical components from freeze damage. The process of shutting down and then restarting the system in these areas often requires considerable time and attention. In warmer climates, irrigation systems are used all year, which imposes greater wear and tear. Additionally, areas with recycled water or other water sources with significant suspended particulates may require more frequent maintenance to manage worn or clogged components such as nozzles and sprinklers, and internal components such as drive motors.

Opportunities To Expand Preventive Maintenance

Unfortunately, irrigation system maintenance is often lacking, which leads to inefficient water use. All too often, irrigation maintenance is limited to repairing obvious malfunctions like major leaks and broken components. This is understandable, considering current labor challenges and material costs, but deferred maintenance leads to water waste, worse playing conditions and bigger future problems. Opportunities for most courses to improve their preventive maintenance program include:

Perform audits: Golf courses should audit their irrigation system every couple of years. Audits help to identify inefficient water use, weaknesses in the system, a wide range of functional issues, and they help superintendents maintain a detailed record of maintenance and system performance over time. An audit does not have to cover the entire golf course to provide valuable information. At minimum we recommend auditing the putting green sprinklers and a representative sample of fairways. Covering more will provide more information, but also requires more investment.

Monitor moisture uniformity: Monitoring soil-moisture uniformity in key areas and tracking changes over time will identify opportunities to improve system function and use water more efficiently, especially where unusual topography and/or poor sprinkler performance might influence watering.

Proper training: Staff training and education will improve the team's overall knowledge and awareness of irrigation issues, which means that problems get identified and solved faster. At minimum, all staff should be able to identify unusually wet or dry areas and know to report these issues to someone who can take the next steps toward solving the problem. If certain staff members can be trained to perform basic repairs and maintenance, that reduces the burden on whomever is typically responsible for maintaining the system, freeing them to focus on larger problems.

System upgrades: Using new technologies and making system upgrades increases irrigation precision, reduces water use and improves playability. Even if a new irrigation system is not in the budget, there are many upgrades that can be made to improve the performance of an existing system. Incorporating soil moisture sensors, portable moisture meters and on-site weather stations can improve the quality of irrigation scheduling and save water. Improving coverage by adding/upgrading heads to increase control or address coverage issues is another type of upgrade that can be performed in-house when time allows and deliver meaningful improvement. Adding subsurface drip irrigation for bunker surrounds or tees can improve chronically dry areas.



Conducting irrigation audits on a regular basis is a good way to evaluate the system, identify issues and track changes in performance over time.

BENEFITS

Water Conservation

The amount of water that can be saved through regular irrigation system maintenance is variable and difficult to estimate. What is clear is that leaks, breaks or applying water where it is not intended to go wastes water. Some specific examples of the potential savings include:

Replacing nozzles and sprinkler heads: There is limited information on the benefits of replacing nozzles and sprinkler heads. In a study conducted several years ago, new nozzles reduced water use by 6.5% compared to old nozzles when averaged across six different golf courses in California (Zoldoske, 2003). Similar savings may exist when upgrading to new sprinkler heads depending on the current heads being used.

Adjusting sprinkler arcs: Observing sprinkler arcs to make sure each head is watering only the intended area can save a significant amount of water and will improve playing conditions. Part-circle heads often come out of adjustment. When they do, a significant percentage of their runtime may be spent watering the wrong area. Converting full-circle arcs to part circles to avoid overwatering an area is another example of how routine sprinkler adjustments can save water and improve playing conditions.

Leveling heads and removing obstructions: Raising and leveling heads, trimming turf around them and removing any obstructions that interfere with water thrown from the sprinkler are simple tasks that can save water and improve playing conditions. For example, heads around greens or near bunkers often become low as sand from top-dressing or bunker shots accumulates in the turf around them. If they become low enough, water from the sprinkler will be blocked by the surrounding turf and won't reach its intended target area. When a sprinkler head is obstructed consider several options: if the obstruction is permanent (like a wall or tree) then relocating the head is advisable, if the obstruction can be easily removed or relocated (like a sign or low-hanging branch) leave the head in place and address the obstruction. Routine observation and maintenance can prevent or minimize these issues.

Scheduling: Water savings can also be achieved by using ET estimates or moisture sensor data to guide irrigation scheduling, rather than irrigating purely by “feel” or experience. In one study on bermudagrass, water savings of 29% was reported for ET-based scheduling and 39% for soil moisture sensor guided scheduling compared to scheduling purely in increments of time (Serena et al., 2020). Turning off or reducing the runtime of sprinklers in wet areas is another example of how scheduling adjustments can save water.



Turf growth, topdressing and sand splash from bunkers can elevate the surface around sprinkler heads. Low heads eventually need to be raised to ensure proper water distribution.

Improved Playing Conditions

Delivering the right amount of water to the right locations is essential for maintaining quality turf and the desired playability. Wet and dry areas around a golf course are frequently caused by a lack of irrigation system maintenance and they can lead to poor conditions and unhappy golfers. Beyond the playability and turf health impact of obvious issues like leaks, minor adjustments like trimming the turf around sprinklers and checking sprinkler arcs can make the difference between good and excellent conditions, especially on high-profile surfaces like putting greens and approaches. Achieving uniform moisture content and water distribution will lead to better and more-consistent playing conditions, improving the golfer experience.

Maintenance Efficiency

Irrigation system maintenance improves the efficiency and quality of the entire maintenance operation. For example, if sprinklers are not functioning properly, dry areas may require time-consuming hand watering. Wet spots may limit mowing with larger equipment and force the maintenance team to use smaller machinery that is slower and less efficient. Wet areas can also lead to fungal disease and turfgrass death. If dry and wet areas lead to turf decline, valuable staff time may be spent on regrassing projects that could have been avoided. Sprinklers that are out of adjustment can throw water into naturalized areas, causing excessive growth that must then be managed. Leaks cause pumps to cycle on and off more frequently and are wasteful of both water and electricity. Unexpected repairs due to poor maintenance can upend a superintendent's course maintenance plans for the day and negatively impact golfers. A well-maintained irrigation system minimizes these and other similar issues – allowing the staff to operate more efficiently and effectively.



If sprinklers throw water where they shouldn't, that usually means more work for the maintenance team.

CONSIDERATIONS

Lack of Awareness

Unfortunately, the simplicity of regular irrigation system maintenance can lead to a perceived lack of importance. There is a general lack of awareness and understanding about the potential risks of deferred irrigation system maintenance. There also is a general resistance to change in favor of sticking with traditional methods and old components that at least appear to be still functioning. Often the mindset is: “If it is not broken, don’t fix it.”

Technical Unknowns

There is uncertainty around how the aging of an irrigation system affects the performance of components. It is also difficult to estimate the amount of water that could be saved with improved maintenance. A typical golf course maintenance operation is continually addressing problems with the irrigation system. However, when routine upkeep is abandoned for several years, the decline in system performance can be significant. The useful life of individual components is affected by environmental conditions, amount of use, water quality, level of preventive maintenance, and quality of the original construction and materials. A system’s useful life has traditionally been considered approximately 25 years. However, there are examples of courses with functioning systems that are more than 40 years old.

There is also no clear-cut line for when simple components like nozzles need to be replaced. Historical data from irrigation audits can help superintendents identify declining performance. Performing catchment tests on parts of the system where new components have been installed compared to old ones can help quantify the difference in performance and potential water savings.

Practical Challenges

There are some practical issues that make it challenging for golf courses to perform regular maintenance on the irrigation system.

Out of sight, out of mind: Most irrigation system components are located underground. It can be difficult to identify signs of a problem until a major failure occurs.

Available staff: It is challenging to find, train and retain qualified staff that are proficient in repairing and maintaining large irrigation systems.

Nuance: It takes time to learn the nuances of a system in order to successfully maintain it. This also means that the relative value of adjustments will vary from system to system.

Opportunity cost: With so many tasks to complete on a golf course, it’s difficult to allocate enough time for irrigation system maintenance. The staff who are skilled in irrigation repair are often in demand for other tasks and if the irrigation system is not broken their time may be prioritized elsewhere.

Budget: If all seems to be going well with the irrigation system, it can be hard to budget for new materials and preventive maintenance when there are other pressing maintenance needs as well.

IMPLEMENTATION

Expected Cost and Time Requirements

Routine irrigation maintenance is traditionally built into general labor costs. The cost for replacement parts varies from a few dollars per nozzle, to a few hundred dollars to replace a sprinkler, to thousands of dollars to service or replace pumps or add in-ground soil moisture sensors to help schedule irrigation. Additional costs also can include specialty tools, electrical components, lubricants, gaskets and seals. Costs vary for professional service repairs or audits (based on the type of service, time required and potential travel) but are typically in the thousands of dollars.

The expected time for common repairs depends on conditions and resources, but the following are some general estimates.

Adjustments: Generally, just a few minutes per sprinkler are needed for routine adjustments. However, considering that a golf course may have thousands of sprinklers, significant staff time can be needed.

Minor repairs: Repairing or lifting low sprinklers to a proper level, or replacing a sprinkler, can take hours depending on soil conditions. Even a minor leak to a lateral line can take most of a day to repair, or potentially longer depending on the circumstances.

Major repairs: A major repair to components like pumps or a mainline can take days and there may be a long wait time for parts or the availability of repair specialists.



Routine maintenance and adjustments may not take much time for an individual sprinkler, but golf courses can have thousands of heads to keep track of. (USGA/JD Cuban)

Assessment and Prioritization

Irrigation system maintenance begins by assessing the quality of the playing surfaces and current system performance. Simply noting wet and dry areas or standing water from seeping sprinkler heads and small leaks is foundational to thoughtfully maintaining the irrigation system. The system components also should be evaluated for wear and tear due to age. Once a list of maintenance items is established, a plan can be developed for the frequency, timing and types of repairs or major upgrades. Comprehensive assessments should be done at least once annually, ideally in advance of the primary irrigation season. A more-detailed assessment can be done by contracting a professional irrigation auditor.

Following assessment, create a regular schedule of irrigation maintenance and determine the budget and labor needs that will provide an adequate level of irrigation system maintenance. Ideally, at least one person on staff will be responsible for, and have the majority of their time allotted to, maintaining the irrigation system under the direction of the golf course superintendent.

Make sure to distinguish between in-season maintenance operations such as edging sprinkler heads, and offseason maintenance such as replacing major components. As part of the offseason maintenance, manual operation of isolation valves should take place (close and open at least once) to exercise the valve.

Prioritize repairs or upgrades based on complexity, cost and potential benefit, and then determine the timeline for implementation. Some tasks can be easily performed by staff, whereas others may require a long-term plan and capital investment or help from an irrigation contractor.

Budget time and resources to educate your staff on how to best operate and maintain the irrigation system and familiarize everyone with how to identify and report issues.



Abnormally wet or dry areas often point to an irrigation issue.

Considerations for Specific Irrigation System Components

Sprinklers

Sprinklers are the end point of the irrigation system and are ultimately responsible for delivering water to turfgrass. Regular inspections and audits, whether in-house or with a certified auditor, ensure that sprinklers are at a proper level and angle adjustment in relation to the turf surface and are not clogged, stuck or rotating improperly. Inspect the area for leaks or other signs of a poor connection between the sprinkler and the swing joint. Depending on the type of turfgrass and growing environment, periodic cleaning and edging is necessary to prevent sprinklers from being obstructed or buried by grass.

Periodic checks will ensure that sprinkler seals and gaskets are not the cause of leaks resulting in water loss and improper operating pressure. If the water pressure at the nozzle is below what is required for the sprinkler to function properly, cleaning the filter screen or inspecting the sprinkler body is necessary. Also, make sure that the body of the sprinkler is not cracked or otherwise damaged and replace if necessary. Many older sprinklers are no longer manufactured and it's sometimes more economical and practical to simply replace a damaged sprinkler with a new one.

Make sure any replacement sprinklers fit your golf course needs in terms of radius, flow, precipitation rate and operating pressure. Match the original sprinkler's specifications as closely as possible. If there is not a good option for doing so, a strategic plan to replace entire areas of complementing sprinklers may become necessary. Harvested sprinklers from an upgrade area can be saved and used for parts and repairs in other parts of the course that have not yet been converted to the new sprinkler model.

It's important to check the connection of the sprinkler with the pipe and also pilot valves, tubes and solenoids, since these connections are prone to leaks and can lead to pressure losses or wasting water. Any casings or assemblies that are beyond repair need to be replaced – including any sprinklers that mowers or aerifiers have permanently damaged. Older sprinklers, such as impact rotors, are no longer manufactured and replacement parts are usually not available. They should be upgraded with modern technology when the time comes. If a sprinkler requires frequent maintenance intervention, it's often more economical to replace it instead of troubleshooting the problem again and again. This also allows you to select sprinklers that perform better and use water more efficiently. Typically, sprinklers are tested and set by the manufacturer to a predetermined operating pressure. Ensure the pressure settings of new sprinklers match the requirements for the one being replaced.



Trimming turf around sprinkler heads is a routine maintenance task that may have to be performed several times each year.

Nozzles

The configuration and type of nozzles have a major impact on the distribution of irrigation water from a sprinkler and can have a big impact on water conservation. Therefore, it's critical to install the correct nozzles and inspect them periodically to ensure proper operation. They are most often made of plastic, but some are made of brass for durability. The friction caused by the high operating pressure and particulates in irrigation water subject nozzles to wear and tear. The recommended replacement rate for sprinkler nozzles is every five to eight years, depending on the frequency of use, amount of flow, water pressure and water quality. Data from occasional catch-can audits can help verify how much distribution uniformity has been affected by use over time. Regularly inspect nozzles for signs of wear or damage. It can be helpful to compare with new nozzles for reference.

Always ensure the actual precipitation rate of nozzles matches the designated precipitation rate in the central control computer. Precipitation rate is indicated by the color of the nozzle. Whenever a nozzle is changed, record the adjustment in the central control computer.

Finally, consider upgrading nozzles with new models or products that have demonstrated water conservation compared to your existing nozzles.



Replacing worn nozzles and adjusting them to achieve the desired coverage can save water and improve turf quality.

Sprinkler valves

There are many types of valves that control the flow of water through an irrigation system. Isolation valves that restrict water flow to parts of the system are discussed later. The focus of this section is on valves that activate sprinklers.

Modern sprinkler technology employs valve-in-head control, which means the valve that activates the sprinkler is part of the sprinkler body itself. In a traditional or “block” system, an independent valve controls multiple sprinklers. These valves are much larger and require more-frequent maintenance. Any type of sprinkler valve will eventually require replacement – just like sprinkler bodies, nozzles and every other part of an irrigation system. Pressure losses or water leaks can be caused by a stuck or malfunctioning valve. Periodically check that all sprinkler valves activate, both electronically and manually. Make any necessary repairs if valves are not operating properly.

The reason for malfunctioning sprinkler valves often is the valve diaphragm or solenoid. Debris commonly prevents the diaphragm from seating, which manifests as seeping sprinklers. Occasionally a clogged tube or orifice in the pilot valve assembly can cause the valve to operate slowly or not open at all. If a solenoid is to blame, the head will typically be stuck on or will not activate electronically. Another common point of failure is the wiring connection with the valve. A multimeter is very useful for checking for an electric signal between the solenoid and controller. This tool can also check for faulty solenoids and diagnose many other issues.

Mainline and lateral lines

Mainlines and lateral lines transport water from the pump to the sprinklers. They are almost always buried underground, making maintenance more challenging. Typically, these pipes are made of polyvinyl chloride (PVC), but older systems can have pipes made of metal or other materials.

Underground leaks can usually be identified by pressure loss or inspecting the property for unusually wet areas. A certified expert can also conduct pressure checks at several points to evaluate the integrity of the irrigation pipes, but this would fall outside of routine annual maintenance. Leaks need to be repaired promptly to ensure the irrigation system can operate at the correct pressure and to avoid wasting water.

Manual isolation valves (both mainline and lateral isolation valves) should be exercised at least once annually. Exercising valves means completely closing and then reopening them to clean the threads of the



Underground leaks in lateral lines and mainlines are usually identified by wet areas at the surface. Repairs must be performed as soon as possible to ensure proper system function and minimize water waste.

operating stem and break away any minor corrosion that has developed over time. This task can be reserved for the offseason or times when watering is not a priority. Mainline and lateral isolation valves that do not fully close should be identified for replacement before they are needed in an emergency situation.

Pumps

Pumps provide the pressure and flow to distribute water through the irrigation system. There are simple ways pumps can be maintained by a golf course superintendent or irrigation technician, but more complex issues will require a professional contractor. Regular inspection of the pump house allows you to check for any abnormal noises, leaks or motor overheating.

Many types of pumps require frequent lubrication, or the refilling of an automatic lubrication system. It's important to check the status of seals and gaskets, as they can wear out easily. Any excessive vibration during operation indicates issues with bearings, alignment or impeller damage. It is essential to perform a pressure test at least once per year and record the results and condition of the pumps. This will identify issues and allow for the planning of replacement parts or equipment before failure.

A dynamic pump efficiency test can be done by a contractor. This test can identify worn impellers and bowls and project energy savings if repairs are performed. Occasionally, energy providers will subsidize these tests and/or the needed pump repairs identified.

If a replacement pump becomes necessary, consider upgrading to a modern variable frequency drive (VFD) pump and configuring pumps to minimize stress on pipes. VFDs help pumps operate more efficiently and produce less water hammer, therefore reducing the frequency of catastrophic failures in older pipes.



Visit the pump station regularly to check for any abnormal noises, operation when sprinklers aren't running, leaks and other issues.

Central control system and satellites

Together with satellites, the central computer allows for control of each valve (or zone in a block system) and sets the runtime and schedule for irrigating the golf course. They can be integrated with weather stations and sensors to better decide when and how much to irrigate. These components are less subject to wear and tear, but they can be vulnerable to power surges, corrosion and other failures. Certain preventive measures will increase performance and longevity.

Central controllers can also manage the distribution of water through the system. The software can match flow and operating pressure of pump systems to meet demand, when correctly programmed. This programming is typically operating in the background without any adjustments needed by golf course staff making daily irrigation schedules. The hydraulics portion of the software should be programmed by a qualified individual such as the irrigation designer to avoid water hammer and pressure drops resulting from incorrect flow through the system.

Keep up with software updates and the functionality of the central controller. Modern central control systems and two-wire decoders require frequent software and firmware updates. Typically, there are built-in methods for installing these updates but a monthly check will ensure everything is updated as soon as possible.

Satellite controllers out on the course should be inspected routinely for any physical damage or issues with wires that interfere with communication with valves or the central computer. Make sure outdoor components are waterproof and keep pests away. Communication between the central controller and the field satellites should be checked periodically and after any thunderstorms.



Satellites on the course should be inspected routinely for physical damage, wiring issues and the presence of pests or unwanted animals. (USGA/JD Cuban)

For systems with batteries, make sure they hold a charge and are still performing well. If there are any sensors attached to the central controller, such as a weather station or in-ground soil moisture sensors, routinely check their connectivity and functionality.

Wiring

Wiring connects satellites and the central controller to sprinkler valves. While the wires used in golf course irrigation are designed for longevity and typically don't require maintenance, damage can occur. Burrowing animals may chew on wires, or they can be damaged by cultural practices or renovation projects. It is not unusual for a golf course to have multiple stations that need to be run manually for a period of time because of damaged wires. Manual operation is not efficient from a time or water use perspective and should be kept to a minimum. Therefore, it is important to periodically look for symptoms of damaged or broken wires and to make repairs as soon as possible.

Specialized wire locators and other tools are often needed to diagnose and repair breaks in irrigation wires. When repairing or connecting wire underground, direct burial or other similarly rated splice kits must be used. Carefully map any additions, rerouting or "jumping" of irrigation wires to simplify future work on the system. Use the appropriately colored wire when making modifications to avoid confusion.

Proper grounding won't necessarily stop a lightning strike from damaging irrigation system components, but it can certainly minimize any issues. Two-wire systems and associated decoders are particularly susceptible to lightning damage and it's critical they are grounded properly, usually at a minimum of every 500 feet. Satellite field controllers and traditional 14-gauge wire are usually protected through mandatory grounding, but surge protectors can add an extra level of protection.

Isolation and drainage valves

There are various situations when it is necessary to isolate or clear water out of irrigation lines, which requires closing one or more valves. All irrigation and drainage valves need to be easy to find and readily accessible. The turf around valve boxes should be trimmed to keep them from becoming hidden or difficult to open. All valves should be exercised – i.e., fully opened and fully closed – at least once each year to reduce the risk of them getting stuck or not closing properly. Exercising the valves is also an opportunity to identify problems before a crisis hits and a valve will not close.

Filters

Filters and screens protect irrigation system components from contaminants and particles in the water. They are used in pump intakes, sprinkler bodies and other irrigation system components. Clogging will reduce operating pressure and system functionality so inspection and/or cleaning on an annual or regularly scheduled interval should be part of the normal irrigation system maintenance schedule.

IRRIGATION AUDITS

An irrigation audit is used to gather information about the water distribution uniformity, rate of precipitation and overall functionality of an irrigation system. Methods also exist for testing performance of drip irrigation systems. Formal audits are usually conducted by an [independent certified professional](#), but superintendents can use the same methods to perform system checks. An irrigation audit should be performed at minimum every five years.

Key Elements of an Audit

Visual inspection: Observe each sprinkler (or zone in a block system) to identify issues causing inefficient water use such as damaged or leaking sprinklers, incorrectly positioned sprinklers, improperly adjusted arcs, low or crooked sprinklers, improper sprinkler spacing, unusual patterns that may indicate low or high water pressure, malfunctioning rain sensors and poor system design features.

Evaluate uniformity: Many of the issues discovered during the inspection will impact the distribution uniformity of irrigation water. Catch-can tests are a common way to measure the uniformity of application and are performed by positioning collection containers in a grid pattern, running the sprinklers, and recording the amount of water in each container. The data from this analysis will identify areas that were overwatered or underwatered relative to the targeted application rate. Often, results of a catch-can test reflect observations of turf quality and playing conditions.

Determine precipitation rate: With simple math, catch-can test results also give the rate of water being applied by the irrigation system. Water pressure, nozzles, sprinkler spacing and many other variables can impact how much water is actually being applied to a given area. Confirming precipitation rates is vital for scheduling irrigation appropriately.

Assess turfgrass water needs: Even two nearby putting greens on the same golf course can have much different water needs. Turfgrass species, soil types, drainage, shade, wind, angle to the sun, time of year and countless other things are all factors to consider in reviewing an irrigation schedule during an audit.

Review irrigation scheduling and methodology: During the audit, the current irrigation schedule will be assessed, and recommendations made based on the above information and other factors. Recommendations may include adopting new methods for scheduling irrigation like using ET measurements or soil moisture sensors as a guide.

Irrigation Audit Considerations

An irrigation audit can be a daunting task – especially with limited resources. It may be more sensible to contract a professional service to conduct a formal audit. You do not necessarily need to audit the entire golf course to gain a good picture of irrigation functionality. Auditing all greens and a representative sample of fairways is a reasonable option. Occasionally, municipalities offer rebates or other programs to assist with irrigation audits, especially when documenting improvement in performance.



Irrigation audits should be performed on key areas of the course at least every five years. Auditing all greens and a representative sample of fairways is a good place to start.

TIPS FOR SUCCESS

Keep up with repairs, don't let the list grow.

There is a lot that goes into golf course maintenance and it can be easy to put off a small irrigation repair or adjustment in favor of completing another task that seems more important. Unfortunately, irrigation issues will just keep coming and the punch list can grow quickly. While you're waiting for a good time to make repairs and adjustments, irrigation issues are having a negative impact on course conditions and likely wasting water. Train staff to perform routine maintenance, assign responsibilities, and budget time for staff to perform maintenance tasks on a consistent basis. This keeps the list of issues from growing too long, optimizes playing conditions, saves water, and reduces the risk of minor problems escalating into emergency repairs.

Watch the system run and listen to the pumps.

Golf course superintendents are busy, and it can be difficult finding time to watch sprinklers run. Yet this is one of

the best ways to discover issues with the irrigation system. Whether it's watering-in a wetting agent application or running heads on a hot afternoon, watching sprinklers operate during the day offers a great chance to identify problems. All staff should be trained to identify malfunctioning sprinklers and report them for repair. Listening to your pump station operating is another good way to catch problems before a decline in performance or total failure occurs. Hearing an unusual sound emanating from the pump station, or hearing it cycle on and off when you are not irrigating, is almost always indicative of a problem.



Watching sprinklers run during the daytime is a great way to catch issues.

An irrigation audit is only worthwhile if action follows.

An irrigation audit is a valuable tool that is often cited as a way for golf courses to conserve water. However, it is only information. It is ultimately up to the golf course maintenance staff to ensure the recommendations from an audit are put into practice for water conservation and improved playing conditions to be realized.

Look for “WaterSense” labeling.

The U.S. Environmental Protection Agency (EPA) has released their WaterSense specifications for sprinkler nozzles. Recent studies have found that several models of nozzles reduce water use for irrigation (Li et al., 2019). Installing WaterSense-labeled nozzles or replacing existing ones throughout an irrigation system can save more than 2,400 gallons of water annually on the average-sized residential landscape and can result in significant savings if deployed on golf course acreage. Visit the EPA [WaterSense website](#) to learn more.

It takes a team.

The maintenance staff, golfers, golf shop staff and even residents that live around a course can all act as an alert network for irrigation issues. Scouting for leaks and abnormalities is a regular part of irrigation maintenance, but golf courses typically occupy more than 100 acres so it can be challenging to inspect the entire property. Taking some time to educate people who may be out on the course on how to identify issues and get in touch with the superintendent can be a great strategy for catching problems early and engaging staff and stakeholders.

Keep supplies for routine maintenance and major repairs on hand.

It’s hard for golf courses to keep up with routine irrigation maintenance, so you want to make it as convenient and efficient as possible. A key element of that is keeping the supplies and parts necessary on hand and organized for quick access. Every hour can count when it comes to making repairs that shut down large sections of the irrigation system. Larger repair couplers and other parts can also be difficult to find on short notice, particularly on weekends or holidays, so it is important to keep an up-to-date inventory of all irrigation parts. Certain parts that require routine replacement like solenoids and nozzles should be kept in abundance.



Keep irrigation supplies well stocked and organized so that the staff has what they need to make repairs quickly. (USGA/JD Cuban)

Eventually, every golf course needs a new irrigation system.

Keeping up with routine maintenance optimizes the system you have, but declining performance and/or an increasing number of repairs will eventually indicate that it's time for a new irrigation system. New systems can cost up to \$6 million and they are seldom a popular investment, but they greatly improve the efficiency and effectiveness of irrigation and the overall maintenance program. New systems feature improved components that break less often and perform better than what is commonly found in systems that are decades old.

BMP CASE STUDIES

“Leveling Sprinkler Heads Conserves Water and Improves Playing Conditions”

USGA Green Section Record, 2017

The Country Club of Detroit had numerous sprinkler heads that were low or tilted and the superintendent recognized that irrigation system performance was being negatively affected. He developed a plan to assess and correct underperforming sprinkler heads that were wasting water and compromising playing conditions. On average, about 30 to 40 sprinkler heads at the Country Club of Detroit required adjustment each year.

The golf course benefitted tremendously from the sprinkler head maintenance program. Playing surfaces were much more evenly watered and golfers were extremely pleased with the improved consistency. The superintendent reported a significant drop in the need for hand watering on fairways, which allows those resources to be reallocated to other maintenance tasks. The unsightly “donuts” of lush, overwatered turf that once surrounded underperforming heads have been eliminated, improving both playing conditions and aesthetics.

“Leveling Irrigation Heads Improves Playing Conditions”

USGA Green Section Record, 2017

Pelham Country Club hired a contractor to raise and level 165 sprinkler heads in just two days, significantly more than the maintenance staff could have completed on their own during the busy summer months. Irrigation efficiency and mowing quality improved immediately after the project was complete. The improved irrigation efficiency helped to conserve water, improve playing conditions and enhance turfgrass quality. Over the course of the season, labor dedicated to hand watering fairways was reduced significantly.

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