



GOLF &

CASE STUDIES IN WATER STEWARDSHIP



WATER

VOLUME II

AMERICAN SOCIETY OF GOLF COURSE ARCHITECTS

GOLF & CASE STUDIES IN WATER STEWARDSHIP WATER

VOLUME II

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1 Why an Update to "Golf and Water"?

The ASGCA Foundation published *Golf & Water: Case Studies in Water Stewardship* in 2016 to tell the story about golf's commitment "to strive to conserve and protect the world's most vital resource" (to quote the United States Golf Association's "Water Resource Center.") The case studies published in that first volume remain relevant, as the story of how golf design applies this philosophy to the craft continues to unfold.

But this is only part of the story. Golf course architecture protects this valuable resource by minimizing use as well as providing buffers, storage and water quality enhancements that ultimately improve the lives of people in surrounding communities and neighborhoods. Case studies about storm water management and water conservation are different stories cut from the same cloth: they work together to tell the story of how golf course design provides solutions regarding water, whether a course faces challenges with quantity or quality.

ASGCA has been receiving submissions since the publication of the first volume from members and partners about projects that show how creative these solutions are. So, it was time to feature those stories, alongside some that were published in the 2016 volume and have been updated.

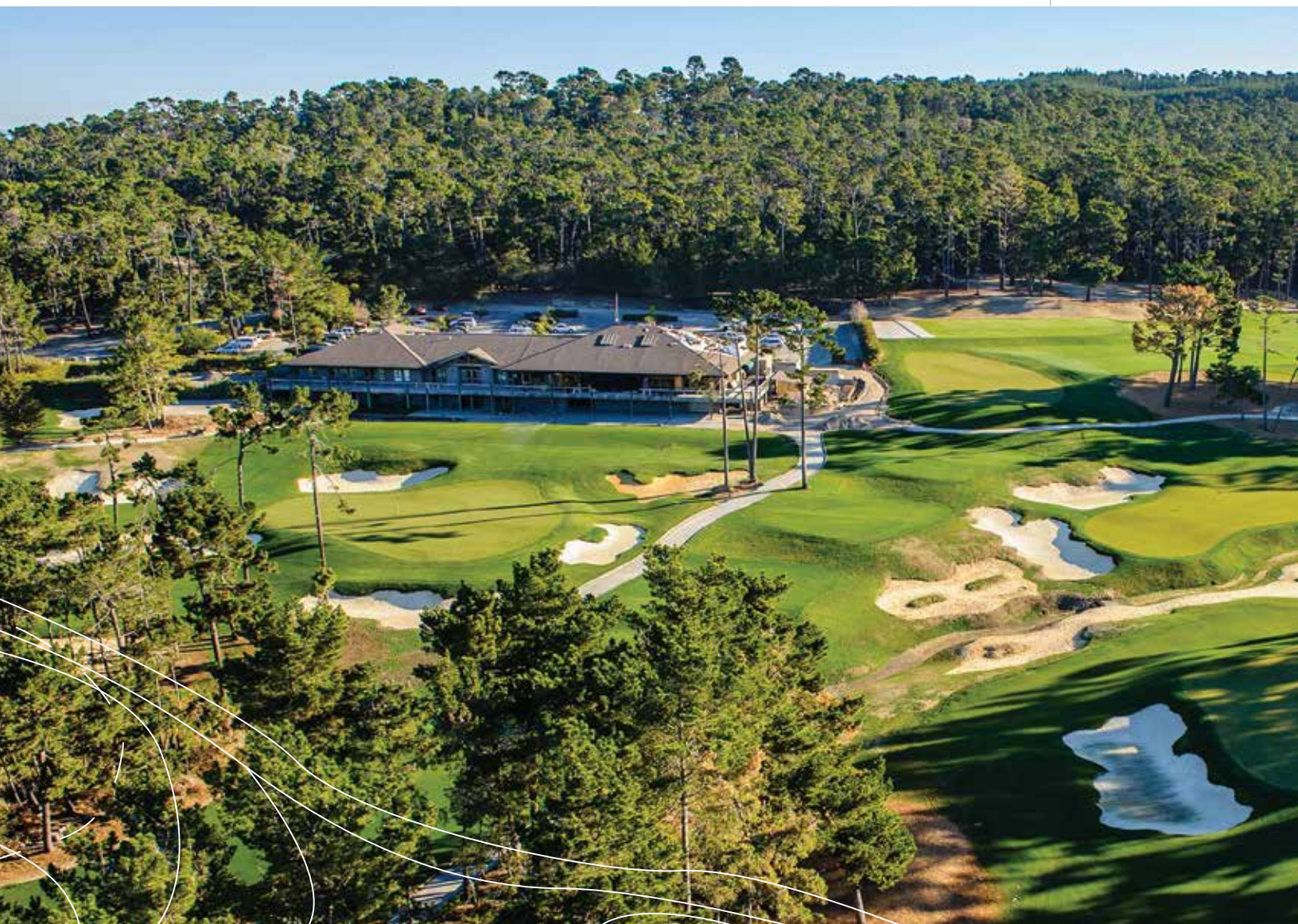
Whether you are involved with golf development—making decisions about how golf can fit into a community— or already know about golf's benefits to a community, the book is meant to inspire you to join others in the golf industry to look for more innovative paths to smart water stewardship.

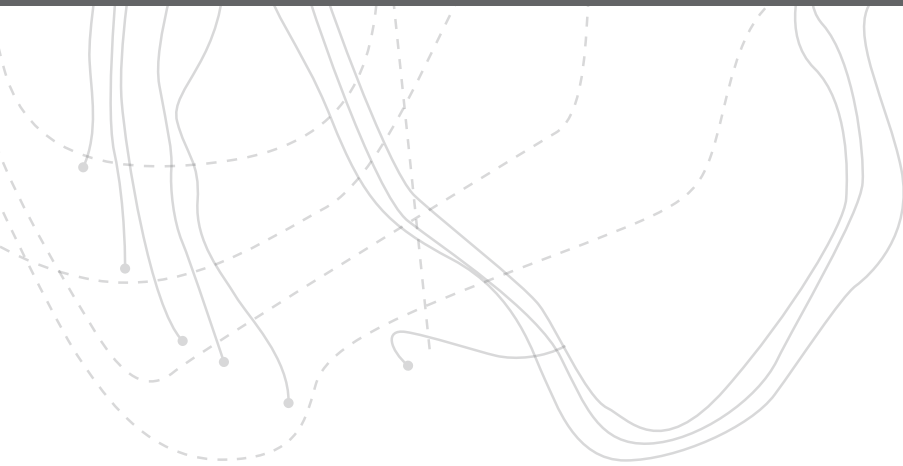
All open space is affected by a variety of environmental conditions. While we have tools to sculpt land and divert water, Mother Nature always has the final say in whether those changes are sustainable. Management of open space must be thoughtfully planned to maintain a proper balance for use and environmental function.

The golf industry is facing several challenges to address environmental concerns, and is proactively developing innovative solutions to these challenges. Record storms can affect arid and temperate regions with storm water management stress. Drought conditions are affecting areas of the United States where golf is played year-round. Providing water to golf courses can be expensive. Finally, water that is available for irrigation often is of poor quality with contaminants that affect the efficient and sustainable growth of healthy turfgrass.

All of these challenges have spurred the golf industry to develop innovative solutions to enhance its sustainability. While viable practices are being refined across all aspects of the game—including welcoming new audiences (especially families) to courses with redesigned layouts for time-crunched players, and many other non-traditional approaches—the solutions to the complicated challenges of water quantity, water management and water quality are some of the most compelling.

The cost of energy to pump water and the quality of water available for irrigation factor into water management





WATER – AN EXHAUSTIBLE RESOURCE

The design of a golf course is directly related to the complex issue of developing a comprehensive and project-specific water management strategy—irrigation, energy, water quality, turf species selection and care, and aesthetics. Water-related design considerations include identification and development of water sources; quality of available water and cost to purchase or deliver it to the site; physical features like topography, vegetation and soils; wetlands and wildlife habitat; strategic placement of turfgrass and native plantings; aesthetic expectations of target golfer audience (and related game experience, i.e., fast and firm); and many others. The design of the irrigation system must take all of these factors into account and must be compatible with the overall design of the golf course.

21%

**U.S. golf courses
reduced water use
by 21.8% from
2005 to 2013***

TOO MUCH OF A GOOD THING

On the flipside of water scarcity, expense, and quality is the management of extreme water events. Tidal surges at the coastlines, hurricanes that come ashore, summer mega-storms and winter melt-off can all cause flooding.

Golf courses are often at the frontlines of these extreme occurrences, serving as buffers for communities against flooding and to help with water detention. Innovative work is being done to help courses cope with too much water by implementing drainage, retention, re-engineering and related design solutions. Communities are turning to golf to help with management of ever-more frequent “hundred-year flood” events, and solutions have included the recreation and revenue provided by golf facilities that also function to absorb, channel and retain storm water.



*Golf Course Environmental Profile, Phase II, Volume I,
Golf Course Superintendents Association of America, 2015









WATER IS LOCAL

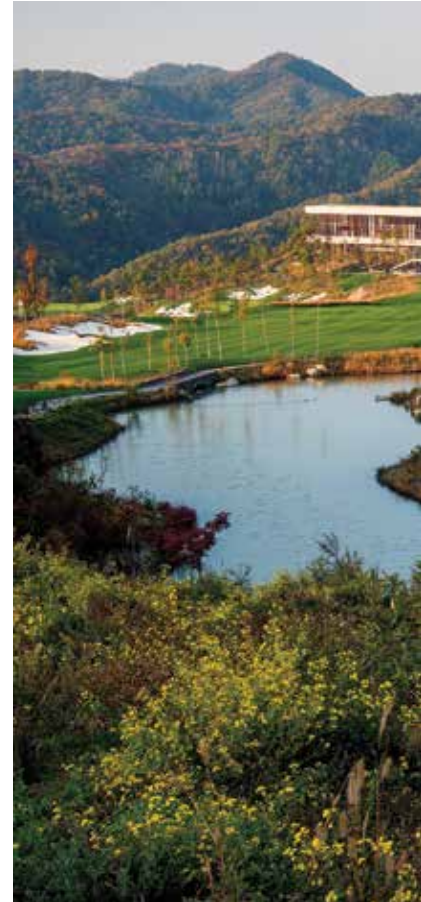
Water is an exhaustible resource. This has led many developers and operators to react to fundamental questions about water shortages, water inundation or water quality. Each course or development is unique, though, with the requirements it must meet, the local water jurisdictions, the expectations of the target golfer audience and the budget. The bottom line: water is the issue. Our efforts to manage, use and distribute water while providing additional environmental or habitat benefits are central to design.

The droughts in the western and southern parts of the United States are the most high-profile instances of areas where golf has had to adapt to drops in water availability.

How are facilities adapting to drops in water availability?

Facilities are managing by some combination of the following strategies:

-  Reducing consumption of water throughout the course footprint, whether by choosing to take some areas of the course out of a regular irrigation schedule or watering all turf less and developing fast and firm conditions
-  Renovating the irrigation system, which can take a number of different routes depending on budget and irrigation needs
-  Shifting to sources of reused water, where available
-  On new layouts, careful planning to determine the right amount, species and placement of turf varieties
-  On existing layouts, strategic removal of turfgrass and replacement with more drought-tolerant turf varieties and/or native vegetation
-  Replacement of existing turfgrass with varieties that are drought-tolerant or able to thrive on reused water



AN UPSIDE FOR PLAYERS TO USING LESS WATER

Golf in the U.K. has been played on naturally firm and fast layouts since the dawn of the game, and adherents to this style of play have always enjoyed its advantages. Some courses in the United States have adopted the approach to giving players a firm and fast playing environment, which can be achieved by using less water, and it is enjoying some popularity. Such conditions can require players to think more about strategy and approach, and can give an advantage to players who understand the value of shot-making. Firm and fast can create additional strategies, aiding the shorter player, allowing longer run-out of shots, providing the “bump and run” shots and placing higher premiums on nuanced grading and topographic features. And with thoughtful design, these conditions can place less value on the length and more value on strategic thinking, creating better engagement between players.



IRRIGATION TECHNOLOGY ADVANCEMENTS

The advances in the technology behind how water is applied to turfgrass go beyond the ability of operators to control how much water is applied and when. The combination of soil moisture sensors, wireless control boxes, pumping station energy use improvements and other design and function-oriented improvements have made the job of the irrigation designer a complex one.

EDUCATING PLAYERS AND OTHERS

Those outside the golf industry may not be aware of golf's commitment to water stewardship. The need to use less water on golf courses is well understood within the golf industry. Additionally, the ability of golf courses to provide water quality or management benefits is not fully recognized either. The advantages—environmental, economic and operational—are clear. More importantly, these changes are resulting in making the game more fun and interesting.

The story of how golf is dedicated to its sustainability by using water responsibly is one that should be shared with golfers where they play, and with people in communities that support golf through local media.

Additional resources for addressing solutions to water management in golf can be found in the “Acknowledgments” section at the end of this book.

Less Water/ Healthier Turf:

HOW TODAY'S IRRIGATION SYSTEMS PROVIDE VALUE

It may seem counterintuitive, but it is possible to save water, improve turf conditions and save money, all at the same time. It sounds too good to be true, but to see how it works, this article will dispel a few myths, and then show the math.

While most people realize that through efficient irrigation design there can be substantial water savings and improved turf quality, saving money can be a surprising addition to those benefits. To understand how this works, some simple math is required. But first, an old irrigation myth must be dispelled.

QUESTION:

If a golf course has more sprinklers, will it use more water?

ANSWER:

Not if the design is done properly to deliver higher irrigation uniformity and improved coverage.

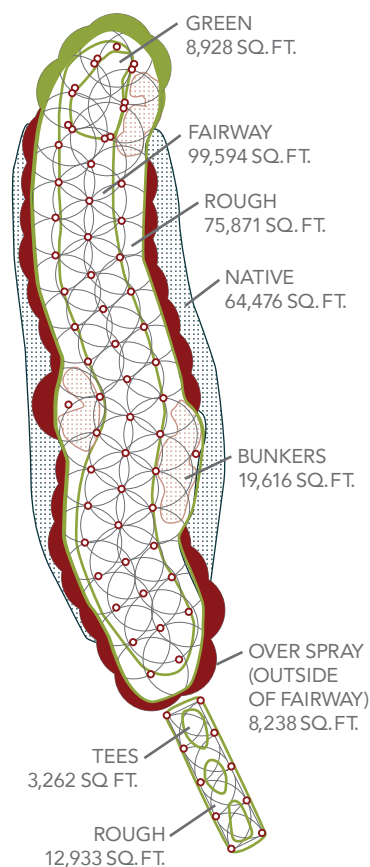
At right is a sample golf hole, irrigated in a seemingly simple way, with three rows of full circle sprinklers. Many people believe that having fewer sprinklers and getting the most area out of them by using full circles is the easiest, least expensive and best way to irrigate.

Actually, this "simple" design choice results in several irrigation issues that can be greatly improved upon. To achieve reasonable coverage in this layout, the full circle sprinklers must over-throw the desired grassing line by about 40%.

Doing so results in the red area or over-throw area that is beyond the desired grass line. This water is 100 percent waste, since we have no desire to irrigate those native areas.

In this sample par-4 hole (deemed to be typical), that over-throw area in red is almost 15 percent of the total sprinkler coverage area of the entire hole.

3-ROW COVERAGE PAR 4 SAMPLE



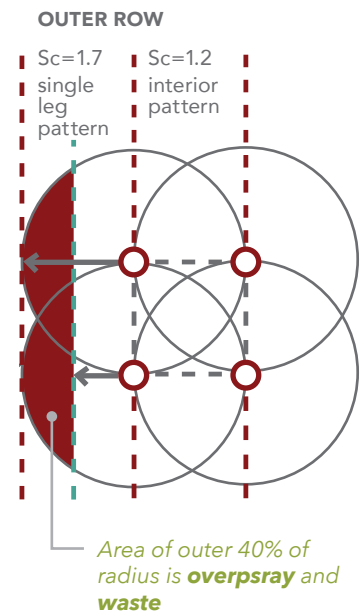
The next issue is a loss of irrigation uniformity due to the difference in the interior sprinkler pattern vs. the exterior sprinkler pattern. You can see that the interior pattern, where you have three or four sprinklers contributing to the coverage, provides excellent uniformity, and thus a very high Scheduling Coefficient (Sc) of 1.2 is achieved.

In the area on the outside of the outer rows, there are only one or two sprinklers (Single leg pattern) contributing to the coverage which results in less effective coverage, and in this case, a much lower Sc of 1.7. This difference in uniformity would require that in order to properly irrigate the turf between the outer row of sprinklers and the desired grassing line, the outer row of sprinklers must be irrigated approximately 40% more, compared to what is required to irrigate between the rows. ($Sc\ 1.7 / Sc\ 1.2 = 42\%$)

While this change improves the irrigation of the outer grassing areas, it increases the wasted water in those over-throw areas by approximately 40%, and now is also over-watering the interior pattern areas by 40%.

The result of this is a combination of wet and dry turf across the hole between the grassing lines. In a simple example on an average par-4 hole where the required irrigation was 0.25 inches per day, almost 6000 gallons of water is wasted, as well as the electricity to pump it. (An 18-hole equivalent golf course using this example would waste over 100,000 gallons of water per day.)

OVERSPRAY & WASTE



THE AGRONOMIC IMPACT

Being able to control irrigation inputs as finitely as possible offers many rewards associated with turf quality and budget savings beyond those related to water and electrical cost:

- 💧 Over-watering creates **more compaction**, which in turn requires more aeration and related additional labor expense.
- 💧 Disease pressures greatly increase as excess moisture is applied, resulting in **additional fungicide applications** (add cost of fungicide and labor to apply).
- 💧 Over-watering also creates the perfect environment for **higher weed population**, thus more herbicide cost and labor to apply.

The average American golfer is hooked on “wall-to-wall green,” and golf course managers tend to buckle under the pressure to produce it. The gold standard for agronomic excellence is to produce uniform green color while maintaining the perfect agronomic balance for healthy turf growth, enhance the environment throughout the property, and improve playability throughout the golf course... all while managing water responsibly and staying on budget.



HERE'S A BETTER DESIGN SOLUTION

Using the same sample par-4 hole, this example shows two rows of full circles down the middle, but effectively provides for one extra row of sprinklers, which allows a row of part-circle sprinklers down each outer grassing line, throwing only inwards (going from three rows in total to four rows).

First, this has eliminated 100% of the over-throw area and thus all the wasted water in those areas.

Next, because the sprinkler coverage is evenly uniform across the entire width between grassing lines, the coverage efficiency is greatly improved, yielding a Sc of 1.2, and eliminating the need for over watering any area to make up for under watering another.

These two changes will save over 100,000 gallons each day this golf course needs to apply .25 inches of irrigation, plus the electricity to pump it. Using an annualizing factor for seasons, a course such as this in the central US might save more than 12 million gallons of water per year, and almost 20,000 kWh of electricity to pump it.

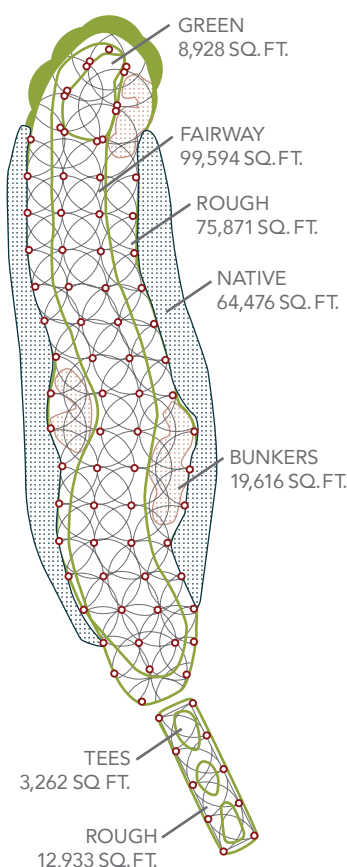
So what is the catch? Saving so much water and power must have a huge up-front initial cost. The actual cost in this example is the addition of 270 additional part-circle sprinklers. (The total sprinklers on the 18-hole plan would go from 1,242 to 1,512). The contractor bid includes a "per sprinkler added" total of \$400 each (all-in), so the total additional cost during construction would be \$108,000. However, this is immediately offset by the savings of water and electricity. Water in this example is from a city water supply at a cost of \$4.85 per 1,000 gallons, and electricity cost is \$0.11 per kWh.



In 10 years, about 125 million gallons of water will have been saved

Each year, these combined savings amount to \$61,775, giving a **total payback period on the extra sprinklers of only 1.75 years**. In 10 years, the cumulative net savings would be over \$500,000, and continue at almost \$62,000 per year. The savings of resources is not trivial; in those 10 years, about 125 million gallons of water will have been saved as well as almost 200,000 kWh of electricity.

4-ROW COVERAGE PAR 4 SAMPLE



Maybe the best outcome for a club is that the uniform coverage across the entire grassing area will provide greatly-improved turf grass, both aesthetically and from a golfing playability standpoint, which are attributes which golfers will appreciate.

An experienced superintendent can explain why this will also help to better maintain the turf grass and increase plant health, thus reducing the other maintenance practices required. Every course's turf grass and budget would see a benefit from having higher uniformity irrigation coverage.

Each golf course has its own unique circumstances and situation, and while some may only see half or less of this amount of cost savings, many others could see two to three times this amount.

Owners tend to appreciate the extra savings and profitability as well, with all this coming from just a slight change in irrigation design style and technique.

The combination of technological advances, development of sophisticated and common sense approaches to design and superintendent management skills is leading many courses to realize the benefits of using less water and energy to give golfers healthy turf and great playing conditions.

3

Case Study Introduction

EXAMPLES OF WATER STEWARDSHIP THROUGH DESIGN

Golf course architects have embraced the challenge to positively affect water use through innovative design solutions. Following are case studies that demonstrate some of these innovations.





Abacoa Golf Course

JUPITER, FLORIDA | ARCHITECT: JOE LEE, TECHNICAL PLANNING BY JOHN SANFORD, ASGCA

TAKEAWAYS

By utilizing 100 percent treated effluent to irrigate the golf course and 2,055-acre community, ground water aquifers are preserved for use by the Town of Jupiter's potable water system.

THE SITUATION

Abacoa was developed in the late 1990s as a mixed-use development on 2,055 acres on the western edge of Jupiter, Florida. Included in the development is a golf course, designed to retain effluent water in a reservoir located between the golf course and an "island" residential development.

How does a golf course designed as part of a planned community positively impact water usage in a mixed-used development?

THE APPROACH

Treated effluent water is received from the Loxahatchee River District into one of the lake systems on the course. Excess storm water is controlled by a weir on the 13th hole and flows into a mitigated wetland "slough" before entering the community drainage system downstream. Approximately 20 acres of connected lakes are lined to function as a reservoir for the effluent. The pumping system for the community is located on the course.

THE SOLUTION

The retained effluent is tapped for irrigation water for the golf course and for all green space in the community, including the landscapes of the community's 2,500 homes, the town center, a university, common areas and a spring training baseball complex. The design helps to maintain consistent water levels in the lakes, providing an aesthetic benefit to surrounding residential development. 100 percent of the irrigation needs of the community are covered by the water retained in the reservoir.

100%

100% of the irrigation needs of the community are covered by the water retained in the reservoir



Bonita Bay Club

BONITA SPRINGS, FLORIDA

THE SITUATION

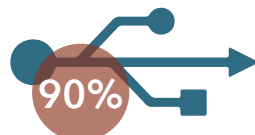
Three of the five championship courses at the Bonita Bay Club in Bonita Springs were designed by Arthur Hills, ASGCA Fellow, in the 1990s. The club achieved Audubon Cooperative Sanctuary Status in 1995, but was looking to extend its environmentally-sensitive practices to water conservation. Along the way, club management wanted to improve playability.

How can high-tech irrigation systems provide more efficient water delivery, saving water and electricity consumption, while improving playability?

THE APPROACH

Bonita Bay Club's Director of Golf looked for ways to more efficiently control the application of water, with the additional goals of reducing irrigation repairs while improving playing conditions for the club's diverse membership. The club choose a system which included intelligent control modules located at each sprinkler, eliminating field satellites and 90 percent of wire compared to traditional satellite control systems.

The design consisted of high-efficiency sprinklers, closer spacing and single-head control. The heads were run by advanced control software, providing targeted irrigation. The club installed the new system on one of the courses—the Marsh Course—to allow for system comparison.



Intelligent control modules eliminated field satellites and 90% of wire



THE SOLUTION

Fertilizer can be applied through the irrigation system, resulting in more effective response of fertilizer: better results with the same inputs. Smaller spray zones were installed on the tops of mounds, with each spray having a low-flow rotary spray nozzle to apply water to limited areas. Since the tops of mounds tend to dry out first, using rotary spray nozzles

Rotary spray nozzles save water by reducing the need to turn on the larger sprinklers

saves water by reducing the need to turn on the large sprinklers. Many times the superintendents don't turn on the large overhead

sprinklers because the rotary nozzles apply a small amount of water every day to keep the mounds looking good.

One of the advantages of this system is that each wire path has capacity for 750 stations with unlimited simultaneous application, allowing addition of stations of rotary spray nozzles anywhere on the course simply by locating the closest pipe and control wire (which could be as close as the nearest large sprinkler). When a new rotary mister station was connected to the control system, the central control software communicated with the new station immediately, eliminating the need to install a wire from the station back to the satellite.

2017 UPDATE

Since the initial publishing of this article, Bonita Bay has continued to replace the remaining irrigation systems on the property. An additional 36 holes have received new irrigation systems and pump stations. To this date, they have replaced 54 of 90 holes with state-of-the-art systems. Records show they continue to experience a 32-37 percent reduction in irrigation water used per acre of irrigated area. They are also enjoying more consistent playing conditions with the increased control and uniformity of the new systems.

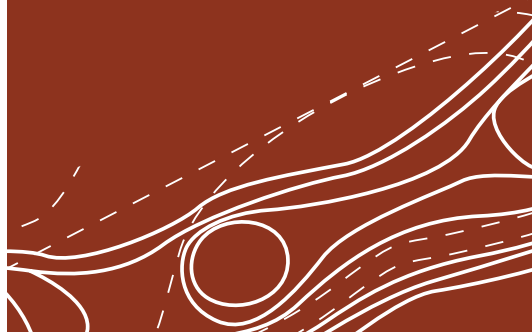
A big part of the decision for the members and maintenance staff to go to a two-wire system was the increased aesthetic value to the golf course. Not having above ground control boxes throughout the course and hundreds of thousands of feet of unnecessary copper wire was a plus. This opinion has not changed and they continue to install the intelligent system as they replace irrigation on the Bonita Bay properties. The maintenance staff is also enjoying the simplicity of the system and the lack of components necessary to maintain and service. With all the benefits associated with switching to a two-wire system, the members as well as the staff are ecstatic about the improvements they made and are proud to be a conscientious leader when it comes to conserving water and other resources.

32-37%
reduction in irrigation
water used per acre
due to state-of-the-art
irrigation systems



TAKEAWAYS

After 14 months of operation with the new irrigation system, the results are very positive. Comparing the water use at the Marsh Course to the adjacent Creekside course (which has the old irrigation system), the Marsh course used 32 percent less water, on a water-used-per-acre basis.



Sewailo Golf Club at Casino Del Sol Resort

TUCSON, ARIZONA | ARCHITECT: TY BUTLER, ASGCA

STORMWATER MANAGEMENT



THE SITUATION

The Pasqua Yaqui Nation developed the Sewailo Golf Club in 2013, as part of their existing Casino Del Sol Resort. The topography of the site consisted of a continuous flat plain sloping gently toward a dry wash along its northern boundary. The Black Wash conveys a tremendous amount of storm water during the monsoon season through the southwestern portion of Tucson and directly through the Pasqua Yaqui reservation. Because of the consistent nature of the site topography, monsoonal runoff was directed quickly and continuously to the wash. The resulting flash flooding not only directly impacted the property, but also impacted neighborhoods and streets in the adjacent reservation upstream of the resort.

Can a desert course capture and use monsoonal rainfall that flows into a regulated wash basin?



Location of the detention/retention basins and dry wash areas with flow indicated to Black Wash



○ THE APPROACH

The design team explored various options for capturing the large amount of runoff coming from regions south of the property. It was determined a **series of detention basins to capture as much runoff as possible** was the best solution. These detention basins would slow the pace of water entering the Black Wash, control the tremendous runoff through the golf course area and help alleviate flash flooding problems in the upstream portions of the wash in the adjoining neighborhood areas.

○ THE SOLUTION

The monsoonal runoff, which could be captured directly by the basins, was entering the golf course property from the south. Two large, deep detention/retention basins were constructed along the southern property

boundary. The Central Arizona Project water line bisects the property, so the design team was restricted from capturing any water conveyed along the CAP easement; however approximately 95 percent of water entering the property is captured. Each basin has a set outfall, and is connected to a dry wash, designed through the golf course which conveys water to the Black Wash.

An additional basin was designed and constructed in an area of the course directly adjacent to the adjoining reservation neighborhoods and acts as an outfall area for storm drainage from these neighborhoods. The depth of the basins allows for water detention during storm events, and water can flow continuously through the dry wash system only during the largest storm events.

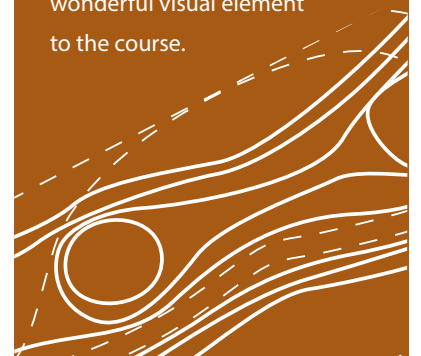
A series of smaller basins were constructed within the wash areas to help further slow the flow of water to Black Wash and alleviate flash flooding potential.

95%
of the water entering
the property is captured
in two detention/
retention basins



TAKEAWAYS

This effective storm water management system has not only made it possible to convert an otherwise ordinary desert landscape into an extraordinary golf landscape, but has helped make everyday conditions in the surrounding reservation neighborhoods more livable during the monsoon season. The depth of the basins allows for the retention of water that would otherwise continue to exacerbate flooding. Additionally, the dry washes add a vital strategic element to many holes, as well as a wonderful visual element to the course.





Charleston Springs Golf Complex

MONMOUTH COUNTY, NEW JERSEY | ARCHITECT: MARK MUNGEAM, ASGCA

THE SITUATION

In the 1990s, The Monmouth County New Jersey Park System implemented a regional Open Space Plan, with the goal of incorporating ecological considerations into the development and management of recreational facilities. The county earmarked part of a 600 acres parcel for two golf courses and practice facilities. Much of the site for the golf courses had been a former landscape nursery that was overgrown and barren of native vegetation. The site was segmented into three distinct parcels by Manalapan Brook and wetland tributaries. The development plan called for improving wildlife habitat through establishment of native plantings and corridors, to identify low impact irrigation solutions and address storm water management.

What is the best approach to designing championship golf layouts on land earmarked for cultivating endangered plant and wildlife habitats, and creating sustainable irrigation and storm water run-off systems to support recreation and habitat?



○ THE APPROACH

The golf course architect evaluated the land for surface water, agricultural soils and minimal forest cover. These features made the land inherently conducive to golf design, and therefore more economical to develop. The 36-hole golf course positioned each 18-hole course to sit between sensitive habitat and other recreational amenities. Severe limitations on ground water use—and the ecological requirements of the facility—pushed the architect to find ways to collect, retain and filter water for irrigation use and keep course runoff from leaving the site.

○ THE SOLUTION

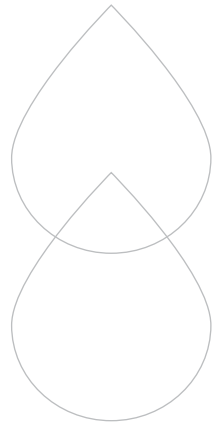
The team designed course grading, drainage and new pond configurations to collect and filter a large percentage of the course runoff. Intensive play areas flow into a series of created wetlands and water quality basins that treat the water prior to it being re-used for course irrigation. Drainage swales were designed to handle runoff and allow percolation to recharge the groundwater.

Energy conservation—one of the highest-cost aspects of the application of water—was achieved through use of a number of technological advances in geothermal heating and cooling. Water is conserved and protected through the use of drought tolerant grasses and a highly-efficient irrigation and fertigation system that minimizes the use of higher quality groundwater, reduces fertilization needs and minimizes runoff and leaching of potential pollutants.

Out-of-play areas were planted with a variety of native grasses and plants to attract wildlife and expand diversity. These open areas are strung together and connected to the wetlands and ponds to create corridors for wildlife movement through the site. Rather than grass, all ponds banks are a mixture of edge grasses and flowers.



Geothermal heating & cooling achieved energy conservation



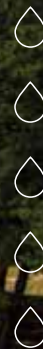
TAKEAWAYS

By embracing sustainability and ecological restoration strategies into the course design and operation, a process is initiated that will allow for the establishment of a variety of ecological functions in wetlands. Degraded land can be brought back to support wildlife, host recreational facilities and support water use and conservation in a number of ways. The way land is graded and treated can allow water to be detained, retained and filtered for groundwater recharging and use in irrigation systems, resulting in sustainable land for recreation and wildlife support.



Ole Miss Golf Course

OXFORD, MISSISSIPPI | ARCHITECT: NATHAN CRACE, ASGCA ASSOCIATE



THE SITUATION

A plan for renovation of the Ole Miss Golf Course, owned by the University of Mississippi, called for more efficient irrigation solutions. The source for irrigation was a small pond located on top of a hill fed only by a well, requiring nearly non-stop operation of a pump to draw water from it.

What's the best way to reduce energy consumption, practice water conservation and capture runoff while improving aesthetics for golfers at Ole Miss?

THE APPROACH

The nearby Oxford Airport and six of the 18 holes of the golf course at Ole Miss were found to drain more than 100 acres of watershed runoff through a large ditch crossing the 4th fairway and through a culvert under the adjacent roadway with no detention capability. The hilltop irrigation pond measured only a quarter acre, and didn't have any source of water other than what was pumped from the well. The renovation plan looked for ways to redesign the course that would allow for capturing runoff from the course and the airport, moving the irrigation pond to a location that would serve a detention function and replacing the deep well pump with one that would take advantage of retained water.

THE SOLUTION

The scope of the renovation of the golf course included drainage work throughout the course. Central to the drainage component was the creation of a new 3.85 acre lake in a large out-of-play area between the 2nd green, 3rd tee and 4th hole. This new lake area was also used to generate fill material for many of the new green complexes and bunkers included in the plan.

The objective for creating the new lake was threefold:

- 1 Converting this large grassy area to water would no longer require mowing
- 2 The new lake would serve as the new irrigation lake
- 3 The location of the new lake would allow the course to retain 100+ acres of watershed (including the Oxford Airport) runoff before it left the property and save that water to be re-used for irrigation—eliminating the need to use power running the existing well and reclaiming a great deal of irrigation runoff in addition to rainwater runoff.

TAKEAWAYS

Taking advantage of existing topography, and enhancing its ability to drain water to a low spot and retain it for irrigation use, has resulted in saving between seven and eight million gallons of water each year since renovation, as well as lower energy costs for pumping. The resulting aesthetic quality of a large mid-course lake is a welcome bonus.



*The new lake would allow the course to retain **100+ acres** of watershed runoff to be reused for irrigation*

Olivas Links Golf Course

VENTURA, CALIFORNIA | ARCHITECT: FORREST RICHARDSON, ASGCA

TAKEAWAYS

Olivas Links has returned to popularity and excellent conditions, and the targeted water reduction has been achieved year after year. Designing less turf area also requires careful selection of playable turf varieties that are drought-tolerant. Naturalized areas also benefit from planning for use of playable turf in roughs, and choosing other adaptable ground cover and drought-tolerant native plants. It is possible to design a course to use less water and to retain—or even improve—its pace of play.

THE SITUATION

A popular municipal course, about 60 miles north of Los Angeles, was suffering the effects of deferred maintenance, turf that was not thriving, poor drainage through floodplain and the need to adapt turf and non-turf landscape to a shared irrigation source that was made up of 100 percent reclaimed water.

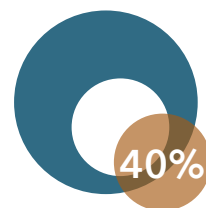
How can a municipal course reduce the amount of managed turf in areas of play, reduce the amount of water it uses for irrigation and introduce turf and out-of-play landscape plantings that will most effectively tolerate its reclaimed water source?

THE APPROACH

The golf course architect looked for ways to reroute the golf course that would allow for more efficient management of the layout: relocate the clubhouse so it wasn't in the floodplain, and eliminate east-facing opening holes and westerly-facing finishing holes to improve pace of play. Since the irrigation source was reclaimed water, it was important to look for drought-tolerant grass varieties and to reduce the total turfgrass footprint while maintaining strategic intent.

THE SOLUTION

The course borders the Santa Clara River, and design established a connection between the course and the river and its estuary to the ocean by relying on native plants and ground cover to form new landscape between holes and in open areas. Plantings that replaced turf also included a creative use of Kikuyugrass, a mainstay of California's coastal zones, which used as rough appears to drift off into the natural landscape as if there were no formal transition.



The re-routing resulted in nearly 40% less managed turf area

The course was also one of the first in the Western United States to be planted with salt-tolerant Paspalum, which thrives with higher salt content in irrigation water (which tends to be the case in reclaimed water). This species is also drought-tolerant. The re-routing resulted in a better diversity of holes of varying direction and nearly 40 percent less managed turf area. To accommodate future turf limit adjustments, several irrigation heads and lines that could be used if needed as the new course matured and areas of turf might be needed in lieu of the deeper natural areas. Pace of play was carefully weighed, with areas golfers would frequent being purposefully zoned with playable (and findable) roughs.

Poppy Hills Golf Course

PEBBLE BEACH, CALIFORNIA | ARCHITECTS: ROBERT TRENT JONES, JR., ASGCA FELLOW; BRUCE CHARLTON, ASGCA

THE SITUATION

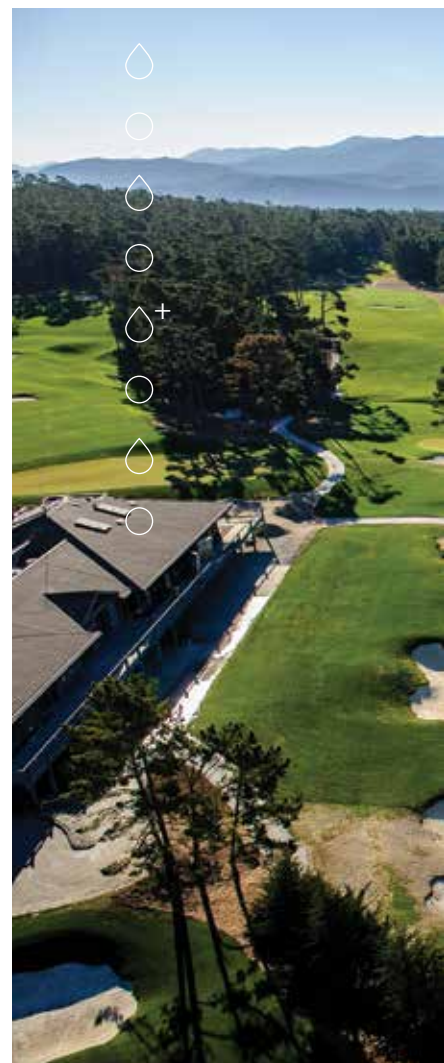
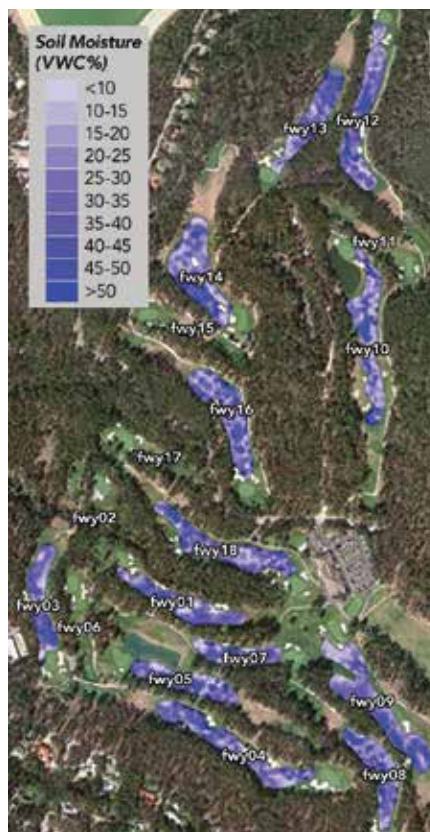
The Northern California Golf Association (NCGA) wanted to bring the 1986 Robert Trent Jones II design up to “modern standards,” improve playability (potentially attracting the return of championship tournaments) and conserve resources. Water conservation was a particular focus, as the course was facing higher costs and less availability of water due to state mandates.

What can current technology lend to the renovation of a popular course faced with the higher cost and diminishing availability of water?

THE APPROACH


Prior to renovation, a water audit was performed at Poppy Hills, looking to uncover ways to save water and use it more efficiently, while simultaneously improving the playing experience. “Water mapping” identified areas of the course that faced chronic problems (insufficient or inefficient irrigation, poor drainage, for example). Tree cover keeping nearby turf from thriving was also identified. In addition to turf that was stressed, turf that could be removed from selected playing areas (without compromising strategic intent) and from out-of-play areas was chosen for removal.

“Water mapping” identified areas of the course that faced chronic problems



THE SOLUTION

Water consumption was cut in a number of ways. The area of irrigated turf was reduced from 82 to 62 acres, while simultaneously lengthening the golf course from 6,875 to more than 7,000 yards—a modern standard for the championships the NCGA hopes to attract. The water mapping project identified areas to install sensors which measure current moisture content in the soil and provide information used in controlling individual sprinkler heads—which can adjust the degree of arc of water distribution—to ensure even, efficient irrigation only in the places where and when water is needed. This process also revealed that the mostly-clay soil profile of the layout was inhibiting drainage and keeping turf roots from penetrating deeper and, thus, surviving on less water. The entire course was sand-capped to address this issue.



Irrigated turf
was **reduced from
82 to 62 acres,**
while **simultaneously
lengthening
the course**

The course was re-grassed with turf varieties including a mix of shade- and moisture-tolerant fescues, rye and others which can acclimate to all the variables in the Monterey Peninsula weather cycles. Grasses were also chosen based on their ability to be mowed at a single height according to a simplified open mowing pattern, saving time and energy.

Out-of-play areas where turf was removed were seeded with grasses with a slightly higher, thinner wispy growth pattern to meet permitting requirements, and sandy areas were seeded with a drought-tolerant native mix including yarrow, poppy and several fescues which require no irrigation. Poppy Hills will be irrigated with tertiary sewage effluent water as part of a program that irrigates all seven Pebble Beach golf courses. Sand capping and drainage systems filter the water, which passes into naturally vegetated buffer zones that provide additional filtration.



TAKEAWAYS

New technologies—water mapping, soil moisture sensors and controllers that take sensor data and in turn manage sprinkler head operation—are available to help courses use less water and energy to manage their layouts, while giving golfers more consistent and enjoyable playing conditions.





The Preserve at Oak Meadows

ADDISON, ILLINOIS | ARCHITECT: GREGORY MARTIN, ASGCA

STORMWATER MANAGEMENT



THE SITUATION

Oak Meadows Golf Course lies within the Salt Creek watershed in eastern DuPage County 15 miles west of Chicago. It contains wetlands, ponds, prairies, old-growth oak-hickory forest, and a stretch of Salt Creek. Salt Creek is a meandering oxbow stream that runs from north to south through the forest preserve.

"The potential of this project encouraged the Forest Preserve District to pursue a more ambitious agenda for improved river ecology and preserve improvement. We're excited and hope our constituents will enjoy the significant benefits."

Ed Stevenson | Executive Director, The Forest Preserve District of DuPage County

After years of declining membership and decreasing profits, the club chose to sell the course to the Forest Preserve District of DuPage County in 1985.

A highly maintained, turf-based, for-profit golf course may not seem to fit within an agency founded on conservation. But the Forest Preserve District of DuPage County has a stated mission to "acquire and hold lands ... for the education, pleasure and recreation of its citizens." As such, over 100,000 golfers enjoy the District's three courses each year, and those rounds serve as a key introduction to the greater forest preserve system.

But Oak Meadows faced many challenges. Commercial and residential development upstream had increased the volume and intensity of floodwaters from Salt Creek, grounds maintenance practices had been reduced to "reaction and restoration," and continued market pressures and playability issues had compelled the Forest Preserve District to review potential improvements for this facility.



Over **100,000** golfers enjoy DuPage County's three courses each year



○ THE APPROACH

Ultimately, the vision for Oak Meadows renovation rejected the assumption that improving golf amenities requires sacrificing other aspects of the property. Instead, the plan encouraged the property to expand and improve habitat and hold more floodwater while providing more sustainable, flood-resistant golf operations. Beyond simply co-existing, the operation of the golf course and the environmental functions of the forest preserve would have a symbiotic relationship.

○ THE SOLUTION

To effectively meet the project objectives of sustainable golf and environmental benefit, the planning, design and permitting was coordinated with 19 separate agencies to ensure approval.

19

separate agencies were
coordinated to ensure
planning & design
approval

Additionally, three other agencies provided more than \$5 million in grants to accommodate their ambitions with project improvements. Construction lasted two years. Most vital to the success of the project was the Salt Creek reconstruction. Salt Creek was diverted through a temporary channel for 18 months to allow for the removal of two low-flow dams, creek realignment, stream-bed reconstruction [pools and runs] and bank erosion control techniques, as well as expanding wetlands and storm-water management. Ultimately, 27 holes was converted to 18 holes, moving four holes from flood prone areas to more upland positions, while other holes in close proximity of the creek floodway were raised above specified flood elevations. The remainder of the site was graded to allow Salt Creek to expand and contract during rain events or provide upland sanctuary.



TAKEAWAYS

The Preserve at Oak Meadows will provide significant environmental benefit and access to a beautiful and revived Illinois Landscape. Not only will The Preserve at Oak Meadows provide a great golf experience, but it will also be a high functioning, quality landscape by improving water quality, expanding wetlands, creating native sanctuary and providing increased storm water management capabilities.

Mostly, this purely Illinois landscape will perform as it should. The wetlands and storm-water management will function without fanfare, the water quality will be improved, and habitats expanded while wildlife accepts the benefit. This is the great value of golf: while golfers enjoy The Preserve, the wildlife and surrounding communities will reap the benefits.



Sand Hollow Resort

HURRICANE, UTAH | ARCHITECTS: JOHN FOUGHT, ASGCA AND ANDY STAPLES, ASGCA



THE SITUATION

A new 27-hole golf resort in the red sands of Southern Utah needed to reduce water and energy use. The designers were asked to utilize the latest in sustainable and efficient construction standards to minimize the course's environmental footprint.

What practices could be implemented to ensure this large golf facility in the Mojave Desert would conserve above average levels of water and energy, and maintain excellent playing conditions long-term?

THE APPROACH

The designers looked to take advantage of the natural characteristics of the land and soil, while utilizing gravity for pumping pressure, to save as many resources as possible.

THE SOLUTION

Through the utilization of the existing sands found on site for hole construction, including greens and bunkers, a minimalist build was achieved, and the need for drainpipe was eliminated due to the local soil's natural percolation characteristics. Another beneficial quality of the local soil was its inherent mechanism to store water within its profile, allowing the already drought-tolerant bentgrass and dwarf, low-mow blue grasses selected for the courses, to grow much deeper roots. Further, by taking advantage of an elevated position on the property for a two million gallon water storage tank, the entire irrigation system was designed to be driven by gravity, which completely eliminated the need for a traditional storage reservoir, and a costly electricity-driven pump station. Irrigation sprinklers were installed on a 60-foot triangular spacing, minimizing water use along the edges of the playable turf. A state-of-the-art weather station was added to this delivery system which recalculated nightly run times, ensuring appropriate rates were applied to minimize runoff, minimize transport of fertilizers to the surface water, and maximize the absorption of rainfall.



An elevated two-million-gallon water storage tank eliminated the need for a reservoir and electric pump station

TAKEAWAYS

By setting extremely high expectations for water and energy efficiency, while utilizing proven soil science, a high return on investment can be achieved by balancing upfront construction costs, and stabilizing management over the long term.



Due to the historic and ancient Paiute relevance of the site dating back to 1300 A.D., the designers were required (and happy) to work with area archaeologists to preserve sites deemed worthy of cultural significance.

Yintai Hongye Golf Club & The Yinhong #6 Golf Course

BEIJING, CHINA | ARCHITECT: RICK ROBBINS, ASGCA

TAKEAWAYS

Water conservation practices can be implemented at existing golf facilities through the close relationship between the irrigation designer and golf course designer so that both designs complement each other. Introduction of native grass zones, water detention basins and wetland development into the golf landscape are some of the tools that can be used. Agronomic practices can be altered to encourage firm and fast playing conditions, which enhances enjoyment for players and inherently reduces water use.

THE SITUATION

The golf development market is maturing in China; with fewer new courses, attention has turned to helping existing layouts run more effectively. In the case of Yintai Hongye Golf Club, the golf complex of 54 holes was developed specifically for the purpose of restoring a large tract of land that had been abandoned to a useful purpose. The site existed in a “feast or famine” water environment; a riverbed adjacent to the courses was generally dry due to its flow being diverted upstream for agricultural uses. The resulting dry surrounding areas, as well as the golf courses, were prone to flooding during significant rain events.

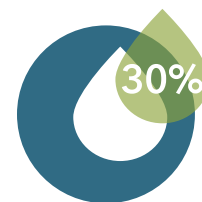
How can an existing 36-hole facility on the outskirts of Beijing adopt water usage BMPs, and develop its third 18-hole layout (which was constructed but not open) as a course that practices water conservation from Day One?

THE APPROACH

The golf course architect looked for ways to alter the golf course design and topography to allow for detention of storm water and creation of wetlands for water retention. An evaluation was made of several related items that would help store enough storm water to eliminate the need for use of ground water and make actual reductions in the quantity of water used for course irrigation. The architect wanted to produce a coordinated effort to achieve water efficiency by managing the work of the irrigation designer, irrigation manufacturer, golf contractor and golf superintendent so the watering system was designed, installed and operated efficiently. The basic design theme was to be evaluated to see where irrigation use could be reduced or completely eliminated.

THE SOLUTION

The irrigation system on all three courses was audited for efficiency and proper sprinkler head placement and operation. Agronomic practices were altered to encourage a “firm and fast” style of play to allow for rolling balls onto most greens and reduce the amount of daily water use. The design of the course was changed to include areas of native grasses in non-play sections and irrigation was removed from mature landscaped areas. These factors helped reduce water use by about 20% - 30% from before. Integration of wetland planting along lake and wetland edges improved water quality while the increase of wetland area helped increase storage.



These factors helped reduce water use by about 20%-30%

Snapshots

INNOVATIVE DESIGN SOLUTIONS

The examples on the previous pages only begin to tell the story of how design is helping facilities manage water efficiently.

Here are some more innovative design solutions to golf's water quantity and quality challenges.

4

◆ WILMETTE GOLF COURSE

WILMETTE, IL | ARCHITECT: GREG MARTIN, ASGCA

To effectively manage the flood frequency from a nearby river, golf course ponds were expanded to accommodate storm surges. These ponds were connected with a bio-swale that slowed fast moving rain events. Wetlands were introduced to provide active buffer systems and improve water quality.

◆ REID GOLF COURSE

APPLETON, WI | ARCHITECT: TODD QUITNO, ASGCA

The course helped the city meet new state and federal mandates for storm water ponds and flood control, and created a newly naturalized channel running through the course and four acres of new ponds. Reid became "a giant filtration system" that holds and cleans storm water before heading downstream.

◆ GEORGIAN BAY CLUB

ONTARIO, CAN | ARCHITECT: JASON STRAKA, ASGCA

Can a well-designed golf course benefit salmon and trout spawning streams? It can when the goal is to protect the waters of Georgian Bay on Lake Huron. The project identified new irrigation sources and positively impacted water quality, erosion management and water retention.

◆ PELICAN'S NEST CLUB

BONITA SPRINGS, FL | ARCHITECT: JAN BEL JAN, ASGCA

More than a mile of directional boring and trenching brings reclaimed water directly to the pump station where it is blended with well water that now contains excessive salts and minerals. Salts are monitored in real time so the superintendent can dilute the well water as necessary.

◆ FAZENDA BOA VISTA

PORTO FELIZ, BRAZ | ARCHITECT: THAD LAYTON, ASGCA

Through a series of interconnected lakes built in strategic locations around the golf course, on- and off-site storm water runoff is captured and filtered before being reused as irrigation. Created wetlands within the lakes have filled in with native aquatics that capture contaminants and provide habitat and a food source for the native wading bird population.

◆ HUNTING HAWK GOLF CLUB

GLEN ALLEN, VA | ARCHITECT: BILL LOVE, ASGCA

The golf course was designed to utilize existing topography and a system of both surface and sub-surface drainage to collect 95 percent of the rainwater that falls on the property. The collected rainwater is then stored in three man-made ponds incorporated into the design of the golf course as impoundments as well as buffers and habitat enhancement for a sensitive environmental area along an adjacent river. This drainage system and water resource management practices allow the golf course to be irrigated at up to 50% less than normal rates during periods of drought with rainwater supplying the only source for irrigation throughout the year.

◆ ROCK MANOR GOLF CLUB

WILMINGTON, DE | ARCHITECT: LESTER GEORGE, ASGCA

A municipal water plant housing the drinking water supply and development surrounded the course. Highway expansion significantly encroached on the course. Eventually, flooding of the Matson Run Watershed became a loss-of-life reality. The course was used to create new maintenance and floodwater attenuation, working around utilities and routing around a major interchange.

5 Irrigation Checklist

INSTALLING OR RENOVATING AN IRRIGATION SYSTEM? HERE'S HOW TO PROCEED.

Irrigation systems, whether being renovated or newly-installed, can help a golf facility realize significant water, energy, and labor savings. Just as every golf course is designed to fit the conditions of its setting, every irrigation system design is site-specific. **Here's what you need to consider when investigating options:**

- ◊ **A professional irrigation designer, golf course architect and/or an irrigation manufacturer** will provide guidance for a golf course looking to improve/replace an irrigation system.
- ◊ **Modern golf course irrigation systems include the following design criteria;** make sure your project includes these items:
 - **Modern, high-efficiency golf-quality sprinklers** are designed and installed at the correct sprinkler spacing for the sprinkler's operating parameters. Depending on climatic conditions, sprinkler spacing of 60-65 feet (18-20m) provides the best Distribution Uniformity (*a measure of sprinkler performance*).
 - **Sufficient operating pressure**, both at the pump station and on all elevations of the course to ensure sprinklers are operating at their intended design pressure.
 - **Weather station** – an on-site weather station will measure climatic conditions and provide real time information to the central control computer. Each sprinkler head and irrigation program can then be set to provide only the water needed.
 - **Rain sensors and soil sensors** will enable the operator to know when and if to irrigate.
- **A professionally-designed and sized pipe network** will ensure that the system operates efficiently during a watering cycle, minimizing pressure losses and maintaining safe flows (*water velocity*) which will result in a more efficient, longer lasting irrigation system.
- ◊ **Use individually controlled valve-in-head sprinklers.** With a valve-in-head system each sprinkler is operated only when required. By comparison, a "block" system has several sprinklers operating from a single remote valve. This wastes water because all the sprinklers in the block have to be operated for the same time and at the same time, even if only one small area of turf needs water.
- ◊ **Ensure proper irrigation coverage of the turf that matches the expectations of the owner or membership.** Through design, the layout of sprinklers should be such that spacing is uniform to maximize efficiency. Poor sprinkler spacing, and therefore coverage, results in wet and dry areas, and poor turf quality.
- ◊ **Automated computer-controlled irrigation software that communicates directly with each sprinkler should be used.** Each sprinkler can be automatically adjusted to match daily weather at your golf course.
- ◊ **Use reclaimed wastewater, RO water or other non-potable water sources when available.** Consider consulting a professional for assessing water quality and mitigation requirements.
- ◊ **Include a modern pump station if needed.** These are managed by computer PLC and variable frequency drives (VFD) on the motors and pumps for electrical efficiency. These stations also communicate with the irrigation system software to ensure that the irrigation system and pump station are operating efficiently in tandem. Include communication packages for monitoring at the control computer and online through the web.
- ◊ **Develop a regular sprinkler maintenance program.** A sprinkler that is tilted by over 5 degrees from its intended position can waste 15% or more water than designed. Routinely check and adjust your system to maximize results.
- ◊ **A "less expensive" irrigation system option will almost always sacrifice system efficiency and coverage on a per-acre basis.** Plan carefully and match your expectations and budget with your improvements. Your design professionals can help!

What's Next?

INNOVATIONS IN THE MAKING

Golf course architects have built a solid record of innovative solutions to help golf courses be stewards of water. The issues of water quality and quantity, as well as the cost of energy, will only become more complex.

Here are some new approaches to the management of water resources in golf:

- 💧 Water Collection / Retention / Reuse
- 💧 Water Quality / Management Enhancements
- 💧 Water Treatment Partnerships
- 💧 Focus on Energy
- 💧 Precision Turf Management

WATER COLLECTION/RETENTION/REUSE

Early in the design process, new golf courses can be planned for the collection and retention of rain water for irrigation use. However, development of these supplemental systems is dependent on whether there is sufficient annual rainfall. This requires a full understanding of regional climactic conditions so detention systems can be appropriately sized and incorporated into the design of the golf course. Mostly, a thorough analysis of the surface drainage patterns of rainfall and the design of collection systems to retain surface drainage to provide collection is necessary. These systems can lessen the need of more expensive/less sustainable water sources, reduce energy costs and, through careful planning, can contribute significantly to meeting the water requirements for irrigation during times of drought, as well as during normal and abnormal rain event conditions.

WATER QUALITY/MANAGEMENT ENHANCEMENTS

Additional project improvements can help improve water quality with well-located buffer strips and wetlands. Erosion control devices can be implemented to slow stream scour while providing habitat. Thoughtful integration of storm water and wetland enhancements can lessen flood impacts for upstream and downstream neighborhoods while establishing slow filtration of fast moving rain events.

WATER TREATMENT PARTNERSHIPS

Golf facilities can benefit properties beyond their borders by addressing their water needs while simultaneously providing benefit to their community. An historic golf club in California has purchased its irrigation water from the local water district for decades. However, due to years of drought and the ever-



increasing cost of procuring that water, an alternative source became a necessity. Effluent water was not a readily-apparent solution due to the distance from the municipal treatment plant (more than eight miles) and its capacity. Instead, the club is proposing to install a small treatment plant on the golf course property, harvesting waste-water from a nearby sewer line, treating the water for use on the golf course and sending the remaining waste downstream to its original destination. This process will provide all of the necessary water for the golf course and reduce the load on the municipal plant to the point where a planned expansion will not be necessary.



The use of water and the use of energy are intricately intertwined & conducting energy audits is a new focus area

FOCUS ON ENERGY

According to the EPA, “The use of water and the use of energy are intricately intertwined. The extraction, treatment, distribution, and the use of water followed by the collection and treatment of wastewater require a lot of energy; likewise, the production of energy—particularly hydroelectric and thermometric power generation—require a lot of water.” Conducting energy audits on the golf course—focusing on the irrigation pumping system’s central control computer and programming—is a new focus area for courses seeking to conserve water.

PRECISION TURF MANAGEMENT

The Poppy Hills case in this book is a look at how technology has driven the development of tools to more precisely monitor soil conditions. As the technology advances, superintendents will require less interpretation of data; these tools translate to more effective management of resources like water and energy, leading to healthier turf and better playing conditions with targeted inputs.

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For more background and research on water management on golf courses, please visit the following websites:

American Society of Golf Course Architects

◆ www.asgca.org

American Society of Irrigation Consultants

◆ www.asic.org

Golf Course Superintendents Association of America
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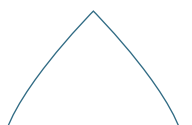
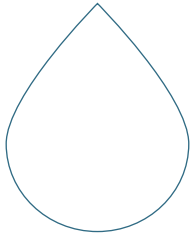
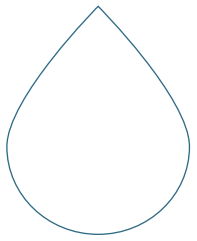
◆ www.gcsaa.org

Irrigation Association

◆ www.irrigation.org

United States Golf Association

◆ www.usga.org





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