

GCM

golf course management

Protecting the pools

A unique natural feature gets
plenty of attention at a
Hawaiian golf course PAGE 58

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Some of the anchialine pools at
Kohanaiki Golf and Ocean Club
in Kailua Kona, Hawaii

Protecting Kohanaiki's pools

The superintendent at a Hawaiian layout faces a unique environmental challenge.

Few golf course superintendents will ever encounter the unusual environmental challenges we face at Kohanaiki Golf and Ocean Club, located on the "Big Island" of Hawaii just north of Kailua-Kona. But the details of how director of agronomy Brian Tanner, ponds and near-shore manager Steven Rose and I preserve the property's indigenous anchialine pools may interest many.

An 18-hole Rees Jones design, Kohanaiki is bordered to the south by the Kaloko-Honokohau National Historic Park, to the north by the O'oma property and Kona International Airport, to the east by Hualalai Mountain and to the west by the Pacific Ocean coastline. The 450-acre property includes the 100-acre golf course and 500 planned home sites. The course's 100 maintained acres are planted entirely with SeaDwarf seashore paspalum.

Kohanaiki, which is registered in the Audubon International Silver Signature Program, has approximately two miles of coastline — presently one of the hottest surfing spots on the island as well as a local favorite for camping during designated times. Future development of the shoreline will include paved roads, parking areas, bathroom and shower facilities, designated camping sites and a historical interpretive center.



Above: A preserved ancient Hawaiian artifact site, or ahu, overlooks the 12th hole at Kohanaiki Golf and Ocean Club.

Right: Anchialine pools, which maintain a connection to the sea through tubes or fissures in lava rock, are a unique feature on the Kohanaiki property. **Photos courtesy of Kohanaiki Golf and Ocean Club**

Patrick J. Ringenberger



Setting the historical stage

In addition to the anchialine pools that are the focus of this article, the property boasts many natural and historical features. These include Hawaiian ahu, burial and artifact sites; an ancient donkey corral; and two historic trails. On our 17th hole, there is a forced carry over an ancient donkey corral, which once aided families in transporting materials through a division of land — called ahupua'a — from the mountain to the ocean. In an earlier time, the men would travel from upland to the ocean to fish and gather goods along the coast. When they had goods to send back up the mountain they would pack up the donkeys and let them out of the corral, and the donkeys would follow the trail back up the mountain until they reached the homestead where they would be fed. Conversely, when the women had fruits, vegetables and other goods they would send the donkeys back down the mountain trail to the corral.

One of the site's historic trails is called the Mamalahoa Trail and is located inland. The other, the Ala Kahakai Trail, is coastally located. Both were used to travel from one ahupua'a to the next.

An anchialine pool primer

Anchialine pools are a unique feature on the Kohanaiki property — one of the few places in the world where they exist. They can be found throughout the state of Hawaii, but are most abundant on the west coast of the Big Island of Hawaii. Some accounts say anywhere between 600 and 700 ponds can be found on this coast. At Kohanaiki, we have 210 confirmed anchialine ponds, ranging in size from a coffee cup to an Olympic-size swimming pool.

The term anchialine comes from the Latin terms *anchi* (near) and *halos* (the sea). Containing a mix of salt water and fresh water, these ponds are located in coastal regions where depressions in lava or limestone exist. They maintain a connection to the ocean through lava tubes or fissures in the rock rather than on the surface, and

the water level in these pools fluctuates with high and low tide.

Anchialine pools are home to a vast array of flora and fauna, some of them rare or endangered. Remembering that these ponds are connected to the ocean is also very important because anything that comes in contact with them could ultimately find its way out to sea, affecting all ocean life. Seven species of hypo-

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On Kohanaiki's 17th hole, there is now a forced carry over this ancient donkey corral.



Top: Pictured is one of two historic trails that have been preserved in the design and construction of Kohanaiki.

Below: Ancient natural lava flows exist around the entire Kohanaiki property.

geal shrimp as well as multiple types of snails exist in these anchialine systems and migrate with the tides. The most common shrimp, the opae'ula or red shrimp, can live up to 15 years.

Many native and introduced fish species inhabit these ecosystems, although the introduced species now pose a threat to the natural balance of these ponds. Tilapia, which were introduced as a food and bait fish, and mosquito fish, which were introduced to control mosquitoes, are now prevalent and feed on the shrimp, snails and other native species.

Coastal avian species that use these pools for foraging and nesting habitat include the endangered a'e'o'or Hawaiian stilt, as well as black-crowned night heron, Pacific golden plover, ruddy turnstone, wandering tattler and Hawaiian duck.

This abundance allowed ancient Hawaiians to survive in an otherwise harsh environment. The ponds provided water for bathing and aquaculture (producing fish for both food and bait). Both native and alien plant species also thrive in these ponds. Most of the native plants found in and around these ponds had some sort of cultural use, whether for medicines, food, textiles or construction material. As stewards of the property, we need to ensure that we not only protect these natural and historic resources, but we also preserve them or restore them to their natural state.

Restoring and maintaining these ponds is an ongoing project: Rose, the ponds and near-shore manager, has developed and implemented a restoration and management plan with the assistance of a foreman and a staff of 10 employees. The plan's main focus is returning these pools to their natural state by monitoring and removing any alien or invasive plant species, including mangrove, pickle weed, kiawe and fountain grass.

Maintaining the pools

The Kohanaiki golf course was planned and constructed to meet the county's requirement for preventing stormwater runoff from entering the anchialine pools and surrounding areas. Sand-based features such as the greens and tees had to be

constructed so that pesticides and fertilizers would not leach into the groundwater.

Engineers used an "envelope" design for the greens and tees on the holes that are adjacent to the ocean and anchialine ponds (holes 12 through 17) to capture and filter all runoff before it is released back into the groundwater and aquifer. Constructing the envelope for the greens involved the following steps:

- A gravel base of 1.5-inch minus-grade rock material was laid over the subgrade to an average depth of 4 inches.
- Trenches were dug into the gravel base for the drainage tile.
- The entire green (including trenches) was covered with 30-mil PVC liner, and 3/8-inch pea gravel was placed in the bottom of the trenches.
- 4-inch corrugated drain tile was placed into the trenches and covered with more 3/8-inch pea gravel.
- The entire green was covered with 3/8-inch pea gravel to a depth of 4 inches.
- A 12-inch layer of USGA mix covered the entire area.

Enveloping the tees involved slightly different steps:

- All tees were sloped (1 percent, from front to back), with a drainage tile at the back of each.
- 4 inches of 1.5-inch minus-grade material was placed over the subgrade.
- A 30-mil PVC liner covered the entire tee surface and was topped with 4 more inches of 1.5-inch minus-grade material.
- Each tee was then covered with a 10-inch layer of topsoil followed by a 6-inch layer of USGA root zone mix.

Each hole (12 through 17) has its own drainage basin to capture the runoff and sand-based root-zone leachate from the drainage tiles and direct it to wet wells.

From the wet wells, submersible pumps transfer the drainage water to 4-foot by

6-foot dry wells that are located about 500 to 600 yards inland and approximately 10 feet higher in elevation. At the bottom of each dry well is a 4-inch layer of activated charcoal held in place with a permeable fabric.

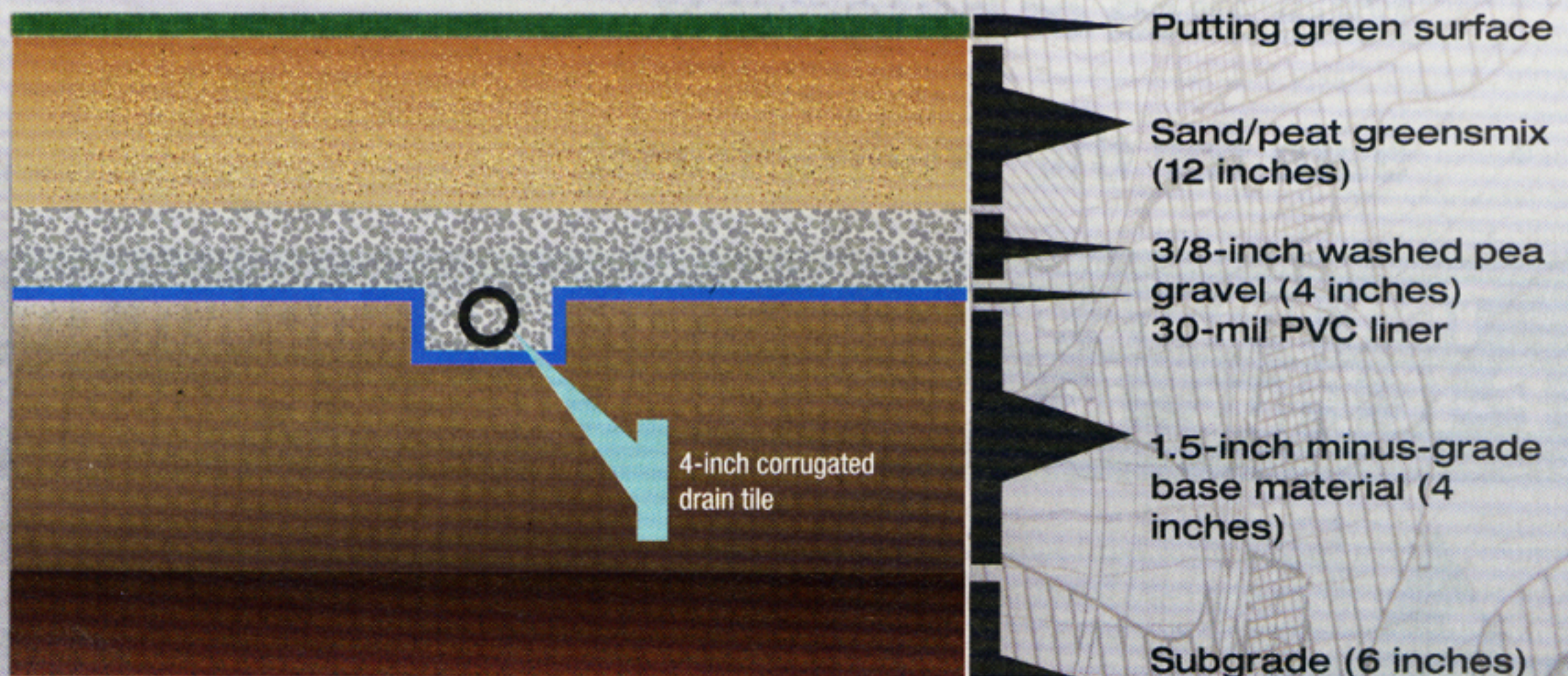
Great care was taken to ensure that the wet wells, which range in depth from 12 to 16 feet, are water-tight. Each has one float that is set at a level to activate the pump and another float that is connected to an alarm system that sets off a red indicator light if the pump has failed to start or the water level is otherwise too high.

Inputs and practices

Irrigation water is supplied from eight brackish water wells through a reverse osmosis system that reduces the water's TDS from 15,000-16,000 ppm to 2,000-3,000 ppm. These numbers can be manipulated for the desired water quality. The site's two irrigation lakes have 45-mil PVC liners to protect



A PVC liner (left photo) goes down before drain tile (center photo), "choker" layer and greens mix are installed (details in illustration below). Drainage from holes 12 through 17 goes to wet wells (right photo) before being pumped to inland dry wells.





This view of Kohanaiki's No. 12 and the tees for No. 13 shows the proximity of the golf course to the ocean and the anchialine pool complexes.

the surrounding environment.

Using best management practices and integrated pest management, we apply products curatively rather than preventively. We don't use fertigation at Kohanaiki because of the risk to the anchialine pool complexes from sprinkler head overthrow or drift. To prevent buildup or runoff of fertilizers or pesticides, we use granular slow-release coated products, and liquid products are applied at lower rates with higher frequency.

On its path to becoming an Audubon International Silver Signature Course, Kohanaiki worked with Audubon International and Kaloko-Honokohau National Park to develop a natural resource management plan. Following a strict risk assessment procedure, only nine fungicides, seven insecticides and 12 herbicides were approved for use at Kohanaiki. Audubon International also helped identify three types of special management zones.

The water quality is monitored quarterly by three separate entities: Kohanaiki (for Audubon International), the National Park System and the state of Hawaii. All three test for any signs of unwanted substances in both groundwater and surface water at nine different sites.



Leo Feser Award candidate

This article is eligible for the 2012 Leo Feser Award, presented annually since 1977 to the author of the best superintendent-written article published in *GCM* during the previous year. Superintendents receive a \$300 stipend for articles. Feser Award winners receive an all-expenses-paid trip to the Golf Industry Show, where they are recognized. They also have their names engraved on a plaque permanently displayed at GCSAA headquarters.

Setting an example

This type of system — or multiple variations of this system — could be used on other golf courses throughout the world. Waterways, wetlands and aquifers need to be monitored and protected to keep natural resources pure for both the golf course and our neighbors that utilize the land around us. Growing concerns about water use worldwide have taken golf course stewards down the road of using such alternative irrigation water sources as saltwater, brackish water and effluent/grey water.

As superintendents, we need to remember that our most important assets are those that are naturally occurring. Monitoring and protecting these areas should be priority No. 1.

Patrick J. "P.J." Ringenberger is the GCSAA Class A superintendent at Kohanaiki Golf & Ocean Club in Kailua-Kona, Hawaii, and a 17-year member of the association.