A STREAM runs through it

by Shandor Szalay

A suburban Philadelphia course looks to stream restoration to solve flooding and erosion problems and enhance course value.

Many golf courses have small streams running through them. These water features have the potential to either wreak havoc with course operations or become key course assets that enhance play and course value.

At Whitford Country Club in suburban Philadelphia, course managers had long been dealing with recurrent flooding problems and increasingly severe erosion from a small stream, Colebrook Run, which bisects the course. Over the years, portions of the stream had filled in with sediment and, as a result, flooding began to occur more frequently. In one location, flood waters would frequently run over the stream banks and flow down the 6th fairway. The 6th and 11th greens were also frequently inundated, causing significant down time, frequent course closures, and diverting staff away from other critical course maintenance activities. Accrued sediment was also frequently clogging the intake structure that Whitford uses to fill its irrigation ponds. In other locations, including the signature 4th green, worsening stream erosion threatened key course assets.

Through the years, course managers had implemented small bank-stabilization projects, but the stream seemed to eventually migrate around these measures and continued to erode. After years of escalating costs, reduced revenues from course closures, and failed stream stabilization projects, Whitford decided to take a radically different approach. Ron Rottman, the club's general manager, says the club had reached a breaking point. "The creek was eroding into the 4th green. The left side of the 4th green was going into the creek. The creek was at ground level on 6. Something needed to be done. If you keep putting Band-Aids on something you never fix the problem. It made sense to fix the problem once instead of fixing it 10 times."

The new approach involved a comprehensive redesign of the entire channel system, about 4,000 feet in total, rather than the piecemeal approach that had typified previous attempts. After several years of design development by another firm, Whitford retained AKRF, an environmental design firm specializing in natural channel design. AKRF worked with Whitford throughout the design, regulatory approval and construction process.

LEVERAGING ENVIRONMENTAL BENEFIT. During the design process, Whitford managers also uncovered the potential to secure state funding to partially offset project costs. Since the project would take an environmentally friendly approach to fixing the stream, it was eligible for funding through a grant program administered by the Pennsylvania Department of Environmental Protection (PADEP) called Growing Greener. Whitford applied for the Growing Greener grant and was awarded $400,000 to support project implementation. According to Chotty Sprenkle, watershed specialist with the Chester County Conservation District (CCCD), the organization that sponsored and administered the Growing Greener Grant, the reduction in bank erosion, which contributes harmful nutrients to local streams, combined with the club's willingness to install tree and shrub plantings along the creek banks, made the project an attractive investment.

FLUVIO-WHAT? Prior to design work, the project design team first sought to understand the behavior of the stream as an entire system, by applying the principles of fluvial geomorphology, a branch of science that focuses on the behavior of river systems. By looking at historical aerial photographs, designers discovered Colebrook Run once flowed through agricultural lands and appeared to have been straightened along the margin between two fields. Since most streams naturally meander, many of the erosion problems experienced by the club were probably due to the natural processes of a straight stream returning to a meandering form over time. Additionally, the turf grasses lining the stream edge offered little erosion resistance to slow the rate of erosion.

In some areas, undersized bridge or culvert crossings contributed to the erosion problems by accelerating stream flow through the bridge opening. During high flows, the bridges also slowed upstream flows, causing sediment to pile up.

Project designers also discovered the flooding and erosion problems were closely linked. As banks eroded in the upstream areas of the course, sediment from the eroding banks would be carried by the flow to lower portions of the course. Since the gradient of the stream flatted toward the lower end of the course, much of the eroded bank sediment was deposited in these areas. Over time, sediment buildup reduced the size and depth of the channel, causing the stream to flood with increasing frequency.

DESIGNING FOR MULTIPLE OBJECTIVES. The design strategy evolved from a solid initial understanding of the stream and its behavior over time. The design

Boulder toe stabilization was implemented around the 4th green to prevent additional erosion, while enhancing the aesthetics of the hole.

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team worked with the club to set final design goals for the project, which included reducing erosion and flooding in key areas, improving course aesthetics, maintaining playability and improving in-stream and stream-side habitats.

To address the design goals, the design approach included several interwoven design elements. First, the project team designed continuous bank stabilization measures using stacked boulders within the upper areas of the stream. These features would eliminate bank erosion and thus reduce the potential for additional sedimentation within the lower areas of the course.

Next, the team redesigned the channel system in the lower two thirds of the course. Most critically, the stream bed was lowered by several feet and a floodplain was added at a lower elevation, creating flood storage throughout once flood-prone areas. Within the lower areas of the course, the team designed the new stream channel with natural meanders, pools and riffles, and step/pool structures to mimic the natural pattern exhibited by healthy streams. Where possible, native grasses, shrubs and trees were planted along the banks to improve erosion resistance.

In the far downstream end of the project, the team rerouted

Prior to project implementation, frequent flooding caused frequent course closures, diverted maintenance resources, and damaged key course assets. This image depicts stream side flooding of the 6th green bunker and approach after a rain event in 2005.

about 1,000 feet of the stream through an unused open field. This allowed for the creation of a broad forested floodplain to reduce course flooding and improve in-stream habitat for aquatic life.

The team also redesigned several bridge and culvert crossings, including a vehicular crossing near the club's maintenance facility. This structure was replaced with a bottomless, modular arch culvert to promote fish passage. The new structure also reduced downstream flow velocity, reducing the potential for bank erosion, while matching the course aesthetics using a concrete form liner. Elsewhere, cart and footbridges were replaced to account for the new stream elevation and floodplain.

The team also redesigned the club's irrigation intake structure. The new structure provided an adjustable weir and was located within a designed pool structure. The pool structure was designed to provide sufficient flow to move sediment, thus eliminating the potential for clogging. Finally, the team designed two pocket wetlands to treat and detain runoff from the club's maintenance facility.

NAVIGATING REGULATORY CHALLENGES. The project required numerous local, state and federal approvals. At the local level, the team secured a floodplain consistency letter from

the township. The letter required mapping of the floodplain boundaries before and after the project to demonstrate the project would not increase downstream flooding. The project also required a tree-mitigation plan from the township and a review of the stormwater management design. An approved erosion-and-sediment-control plan was required from CCCD. At the state level, the project required an National Pollution Elimination Discharge (NPDES) program permit for Stormwater Discharges Association with Construction Activities an a Water Obstruction and Encroachment Permit, both issued by PADEP. Finally, the project required a Nationwide permit from the US Army Corps of Engineers.

BUILDING A NEW STREAM. Project construction occurred during fall/winter 2009 and spring 2010 and was carried out by Frontier Golf (Jones Mills, Pa.). The project was implemented during cold weather months to minimize conflict with course operations.

During construction, Frontier also worked with Whitford to develop a plan to reuse the excavated sediment generated by lowering the creek to rebuild the course's aging driving range. This reduced project costs by eliminating the need to haul material off site.

PROJECT OUTCOMES. Since the project was installed in 2009, club management and members have been very pleased with the investment. As the plantings have grown in, the project has become an indistinguishable part of the course. "You wouldn't know if the project was installed three years ago or thirty years ago" says head golf pro Mike Ladden. "I can say that not one of our members would question the $1 million investment we made now that the project is completed."

The club has reduced down time due to flooding problems. "If we hadn't done the project, we would probably have lost 14 days of operation due to flooding this year alone" says Ladden. "Now we can do the things that need to be done instead of shoveling silt off of the 6th green."

In addition to reducing flooding and erosion, the redesigned stream channel has also added interest and challenge to several holes, for instance bringing water into play on the approach to the 6th green and enhancing the 4th green with boulder walls. "The project has enhanced the overall feel of the golf course," says general manager Ron Rottman

The project is also an environmental success story CCCD's Sprenkle is eager to tout as an example project. "We're hoping it's a trend, because the golf course community is easy to work with."

KEYS TO SUCCESS AND THE NEXT STEPS. Three years after project implementation, the Whitford staff is focused on protecting its investment through vegetation maintenance and project monitoring. The club is conducting a 5-year monitoring effort designed to evaluate the performance of the project and so far the monitoring results are very favorable. **GCI**

Contributor Shandor Szalay was the AKRF project manager on this project.