

over the three studied hydrograph shapes. We attribute this trend to the high surface area of activated carbon. Again, using different types of activated carbons could increase their removal efficiency.

As previously described, the removal efficiency for all contaminants was consistently highest at the extremes of the rising and receding limbs of the hydrograph when the flow rates were least (and residence time high).

Thus, not surprisingly, this filter design may be most effective under baseflow conditions rather than storm flow events. These filters can be used under baseflow and storm flow conditions. However, the large volume of storm flow may rapidly expend the filter. Overall, further field-scale, long-term studies of these filters are required to determine the longevity of these filter materials; once adsorption sites are exhausted the filter will require replacement.

#### FIELD STUDY

The field phase of the research is taking place on two golf courses (Ridgewood Country Club, Waco, Texas, and Northland Country Club, Duluth, Minn.). The experiment in Waco is set up on a practice chipping green. The 8,000 square-foot green is 100 percent sand.

Water drains through a subsurface network of 4-inch perforated tile to an outlet containing a filter network. The filter has

## IMPACT ON THE BUSINESS

### Protecting water quality

A closed-loop bioremediation system was the answer to high contaminants found in a water way at The Rock Golf Club in Ontario. BY JASON WINTER

Planning for The Rock Golf Club and the resort began in 1998. It was marketed as Canada's first JW Marriott property and as one of the country's newest and exciting resort communities. Local residents, numerous environmental groups, and the Township of Muskoka Lakes raised many environmental concerns about the proposed use of land in a pristine region of Ontario.

The boom of new golf course construction in the Muskoka region during the 1990s, in conjunction with concerned citizens' questions about the new development, resulted in requests for several studies to be conducted to determine the health of the region's lands and lakes prior to this proposed development. In the end, the construction of The Rock was approved and a new standard was developed that would be the new environmental guideline that all new courses planned for construction in Canada would have to follow. Once the site plan agreement was in place and construction was underway, The Rock faced many challenges and continues to be under the watchful eye of adjacent landowners and the Township of Muskoka Lakes.

Water quality management continues to play a major role and is a major expense to the club as very aggressive monitoring of existing tributaries and management of stormwater ponds continues. During the first two years of operation, elevated levels of phosphorous were detected at Tributary B (one of five) that met "trigger" values and required investigation as to the source.

The site plan agreement had a condition in place stating that extensive water quality monitoring would have to continue for three years where no two consecutive "trigger" values were met or the monitoring cycle of three years would start over. With the high cost of monitoring water quality, the new golf course superintendent set out an action plan to identify and eliminate the source of contaminants. The primary goal of identifying these sources was to further show the commitment of the club to be

a steward of the environment, gain support and acceptance of the club from adjacent property owners and ultimately reduce the cost of testing and the start of a new three-year monitoring cycle. Investigations into the source of the contaminants were found upstream of Tributary B in an area where equipment washing had been taking place since the opening of the golf course. Situated close to a natural water course and riparian area, this practice of washing grass clippings from machinery proved to have an adverse effect on water quality.

With the source identified, the next step was to research ways to manage water used to wash equipment and find an appropriate and cost effective way to eliminate this contamination. Some of the systems researched included flocculation systems, a collection sump/solid separator system and the latest bioremediation closed-loop systems. With management company Marriott Golf committed to the environment and owner approval for funding, the choice was made to purchase the Mi-T-M closed-loop bioremediation system that would continually treat and recycle water throughout the season. Implementation of the closed-loop Mi-T-M system would ultimately reduce water consumption from an estimated 700 gallons per day to approximately 1,500 gallons per year.

The system was designed with both a solid separator and grass-clipping separator ahead of the five compartment filtration chambers. The chambers are designed to allow the introduced microbes to react and neutralize any contaminants in the water. This water is then pressurized through a pressure tank where the filtered water is again used to wash equipment.

The operation also needed a chemical storage area for pesticides and a safe mix/load area for the spray technician.

Funding was again approved for this state-of-the-art building to be constructed and further reduce the impact that a spill may have on the environment and water quality. The building

serves for both storage and mixing/loading purposes. It was constructed with a 6-inch perimeter sill, an impermeable sump with a capacity of 325 gallons and a 1 percent slope that would direct any spillage to the sump area and not out of the building. Other features implemented in the design of this building are a premixer and stainless-steel sink, which allow for safer product handling. These features further reduced the potential for chemical to splash onto the applicator as the sprayer is being filled directly with water from the irrigation system. Water from the irrigation system was plumbed into the building and regulated down to 50 psi so that many different applications and procedures could happen simultaneously, ultimately speeding up the mixing process. Building a structure with these features has allowed the applicator to get on the golf course much quicker than before and be more precise with the mixing. Chemical applications are completed quicker, thus reducing the visibility of the sprayer to the guests.

The results of both of these efforts have resulted in vastly improved water quality and have proven the club's commitment to preserving the environment.

The Rock is looking forward to continuing to improve its water quality in the future. Much of the work done is cost prohibitive for a lot of properties, but there are several less expensive alternatives that can result in successes similar to ours. Our continued efforts will focus on educating people in the community, neighboring property owners and government groups at all levels to help them understand that The Rock is fully committed to continuing its environmental efforts. GCI

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*Source: The Environmental Institute for Golf's online environmental resource, EDGE ([www.eifg.org/edge/](http://www.eifg.org/edge/)).*