# The Cincinnati GAC Experience

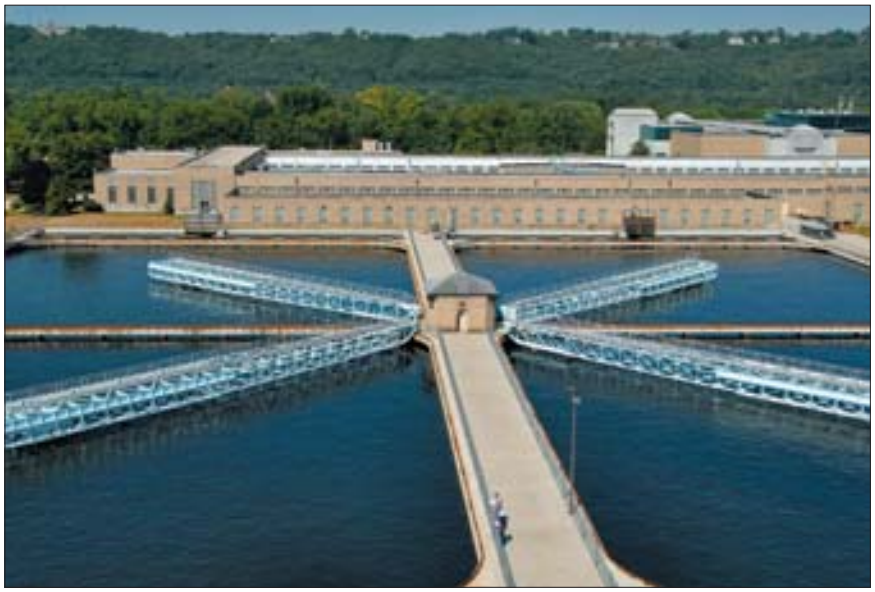
## Improving water quality and public trust in Ohio.

By Gary Westerhoff, Kristen Atha, and Richard Pohlman

In December 1978, when Richard Miller became director of Cincinnati Water Works (now Greater Cincinnati Water Works [GCWW]), he spearheaded the creation and implementation of a vision that would provide Water Works customers with the quality of water they desired at a price they could afford and would be willing to pay.

While THMs in drinking water were a significant concern at the time, so was the vulnerability of water from the Ohio River, the system's primary raw water source, to a broad spectrum of contaminants from upriver discharges from chemical industries and river transportation of coal, grain, and chemical products. For many chemicals, the health effects, either individually or synergistically, at the concentrations present, had not been established.

*Operating gallery in the GCWW filter building.*



*View looking over the GCWW clarifiers with filter building and GAC building in the background.*

The 175-mgd post-filtration granular activated carbon (GAC) facilities with on-site GAC regeneration were placed in service in 1992. Today, the wisdom of taking this bold action continues to be demonstrated by the multiple benefits being achieved. The system is a foundation for the current vision, "The Greater Cincinnati Water Works will be the standard for excellence in the water utility industry," and its mission, "To provide our customers with a plentiful supply of the highest quality water and outstanding services in a financially responsible manner."

## Benefits of GAC

In spring 2008, 16 years after the GAC facilities were placed in service, the authors interviewed former GCWW Director, Richard Miller, present Director, David Rager, System Superintendent of Water Quality and Treatment, Debbie Metz, and Assistant Supervisor of Water Quality and Treatment, David Hartman, to evaluate system performance and to identify the benefits being achieved.

As they explained, the philosophy behind Cincinnati's use of GAC in drinking water treatment was twofold:

- It is better to remove contaminants by adsorption with GAC instead of adding chemicals that might have unintended consequences.
- Science is continually identifying additional chemicals in the drinking water supply, often in minute concentrations. While evidence may be lacking that many may pose no significant threat to public health, removing them as an additional benefit of treatment for other purposes is advantageous.

One primary objective for installing

*GCWW assistant treatment superintendent Larry Moster with Kristen Atha in front of GCWW GAC building.*

the GAC system was to provide an effective barrier for periodic spills of potentially health-hazardous chemicals in the Ohio River. While this has been achieved, numerous other significant benefits have been realized, including:

**"Peace of Mind."** Near the top of the list of key benefits is peace of mind of the system leaders and operators regarding their responsibility to protect the health of their drinking water customers. As Hartman expressed, "we can't analyze every bit of water" being delivered into the distribution system, "but we have confidence in the knowledge, from thousands of analyses over many years, that GAC provides a significant barrier to organic contaminants that might be present in the raw water supply."

**High Level of Public Trust.** GCWW has used its GAC treatment approach to protecting public health as a foundation for building a high level of confidence and trust among elected officials, the media, and customers. According to Director Rager, this foundation has enabled GCWW to successfully communicate the value of water and service being provided and has supported a financially sound rate structure to ensure sustainable operations.

**Reducing TOC and THM.** TOC is the measure of organic contaminants (e.g., natural organic substances, insecticides, herbicides, other agricultural chemicals) in water and, as such, is a non-specific indicator of water quality. Importantly, it is also an indicator of the concentration of disinfection by-product (DBP) precursors available to form harmful DBPs during the chlorine disinfection process. Through adsorption, GAC reduces TOC and hence, DBP precursors, and ultimately reduces the level of DBPs formed during water treatment.

The post-filtration GAC treatment system achieves more than a 50 percent TOC reduction, maintaining TOC at a level of below one mg/L. As a result, the GAC system can be operated to achieve a THM of less than 50 µg/L, achieving compliance with drinking water regulations.

**Savings from Reduced Chorine Use.** By reducing the organics in treated water, the GAC treatment system substantially reduces the amount of chlorine required in the system. Experience indicates a reduction of about 60 percent, which, in itself, represents a savings of about $200,000 in current annual operating costs.

**Eliminates the Need for Chloramines.** There is concern that nitrogen-containing DBPs resulting from the use of chloramines are more toxic than the DBPs formed by the use of free chlorine. GCWW can successfully use free chlorine as its disinfectant while maintaining low levels of DBP formulation because of the reduction in precursors afforded by the GAC treatment.

**Improved Control of Taste and Odor.** Another significant benefit of GAC treatment is its effectiveness at reducing taste and odor in drinking water. Taste and odor result from three sources: MIB, geosmin, and high concentrations of chlorine. The GAC system with downstream chlorination permits biological activity in the sand filters, resulting in sustained biological removal of 80 percent of the MIB and 50 percent of the geosmin. The "odor threshold" prior to GAC ranges on a scale from one to nine (average two to three), but after GAC and before chlorine addition, it is close to zero.

**Improved Turbidity and Cryptosporidium Removal.** As filtered effluent passes through the 11.5-ft deep GAC contactors, additional solids are removed, resulting in decreased turbidity as well as improved removal of Cryptosporidium.

**Facilitates Biologically Active Filters Ahead of GAC Treatment.** Relocating the point of chlorine disinfection to downstream of the rapid media filters and GAC treatment results in biologically active filter systems. This facilitates some removal of TOC before water is applied to the GAC, increasing GAC adsorption efficiency.

*GCWW GAC multiple-hearth regeneration system in the GAC building.*

*Gallery level in the GCWW GAC contactor building.*

## Pharmaceuticals

Vast quantities of daily-used pharmaceuticals, including prescription and over-the-counter drugs, personal care products, and veterinary drugs, are entering many drinking water supplies, raising questions about the potential human health effects of long-term exposure to minute concentrations of these chemicals. The GAC treatment process used in Cincinnati is effective at removing trace levels of these compounds.

In March 2008 a news release, "AP Probe Finds Drugs in Drinking Water," was highlighted on "Good Morning America" and CNN, describing how drug residues are found in many raw water supplies. Subsequently, interviews of local water system managers were featured on local newscasts. Most satisfying to Cincinnati political and GCWW leaders, it received positive coverage on the topic.

When the local ABC channel ran several reports on the AP release and Cincinnati drinking water, they reported that "none of these compounds (drug residues) get to you because of three words—granular activated carbon." Another local TV station reporter offered in his report that "the carbon filtration system we have is considered the gold standard nationally and around the world." This investigative reporter reinforced the decision made some two decades earlier of the value of paying the higher costs associated with GAC treatment, stating "everybody now thinks it's worthwhile".

Regardless of the outcome of ongoing research evaluating potential health implications of small concentrations of pharmaceuticals in drinking water, the positive media coverage that GCWW received is an example of the trust and confidence gained by providing the GAC barrier to remove a wide spectrum of organics from Cincinnati's water supply.

## Costs

The 175-mgd post-filtration GAC facilities with on-site GAC regeneration were placed in service in January 1992 at a cost of about $63.9 million (1992 dollars), including construction and engineering. The average estimated cost of amortized construction and operation was estimated at six cents per day, or $5.40 per quarter, for the average household single-family customer.

Now, after 16 years of operation, the actual cost of treating water with GAC is less than 20 cents per 1,000 gal, which equates to about $5.00 per quarter for a single-family household for both debt service and operations. To put it in perspective, the quarterly average cost for a single-family household with a 5/8-in. meter is $53.83. These numbers confirm that GCWW is achieving its original vision—to provide customers high quality water at a price they can afford and are willing to pay.

Over recent decades, advancements in water science analysis and health studies have resulted in increasing federal and state drinking water regulations. Clearly, with more regulations on the horizon, drinking water system leaders are considering their system's effectiveness to meet existing and probable future regulations while providing the highest quality of water that meets their customer's desires at a reasonable cost they would be willing to pay. As they evaluate treatment options applicable to their system, it is important that they recognize that their customers' perception of the quality of the water they receive also reflects their confidence and trust in their water system leaders. Such trust and confidence among elected officials, news media, and customers provides the foundation for communicating the value of water and developing support for adequate financial resources.

The GCWW's nearly two decades of experience illustrates how one system approached the integrated issues of protecting public health, meeting and in some cases exceeding government regulations, satisfying customer expectations, and securing community trust and confidence. This experience has demonstrated the effectiveness and viability of the use of GAC post-filtration treatment to provide a barrier for a high level of removal of organic compounds from the water supply. GE

*Mr. Westerhoff, P.E., BCEE, is chairman emeritus of Malcolm Pirnie, Inc. Ms. Atha is an associate of Malcolm Pirnie, Inc. Mr. Pohlman is the supervisor of treatment for Greater Cincinnati Water Works. For further information go to www.pirnie.com.*

***Kristen Atha and Gary Westerhoff at the operating level of the GCWW GAC contactors.***