field report

BY BETSY REILLEY-MATTHEWS

A rapidly growing algal bloom eluded a Massachusetts utility's monitoring program and shook consumer confidence.

Particle Imaging and Analysis Instrumentation Minimizes Taste and Odor Complaints

SEEKING TO GUARD AGAINST ALGAL BLOOMS THAT TRIGGER WAVES OF CUSTOMER COMPLAINTS, THE BOSTON, MASS., WATER RESOURCES AUTHORITY RECENTLY INSTALLED A FLOWCAM,® WHICH SPEEDS IDENTIFICATION OF ALGAE TYPES AND PERMITS FASTER TREATMENT.

An algal bloom that occurred in the Wachusett Reservoir in central Massachusetts during the summer of 2004 caused a barrage of angry complaints at the Massachusetts Water Resources Authority (MWRA), in Southborough, Mass. The bloom, which had eluded the authority's monitoring program, triggered literally hundreds of phone calls at a facility that typically fields fewer than one such call per day. The bloom was treated successfully with copper sulfate; however, customers' confidence in their drinking water had been shaken. The incident sparked a top-to-bottom reassessment of MWRA's monitoring program and the purchase and installation of a new technology.

MONITORING THE OLD FASHIONED WAY

Historically, MWRA's monitoring program had involved two field technicians using a boat to collect samples, returning to the lab to concentrate the samples, preparing slides, and then visually identifying and enumerating the algal species using a microscope. The process is tedious, time-consuming, labor-intensive, and depends heavily on the skill and experience of the person doing the test. Because algal blooms can escalate quickly, testing must be performed consistently and with increasing frequency during spring and summer when more direct sunlight creates the ideal conditions for blooms to occur. MWRA was conducting manual testing about twice a

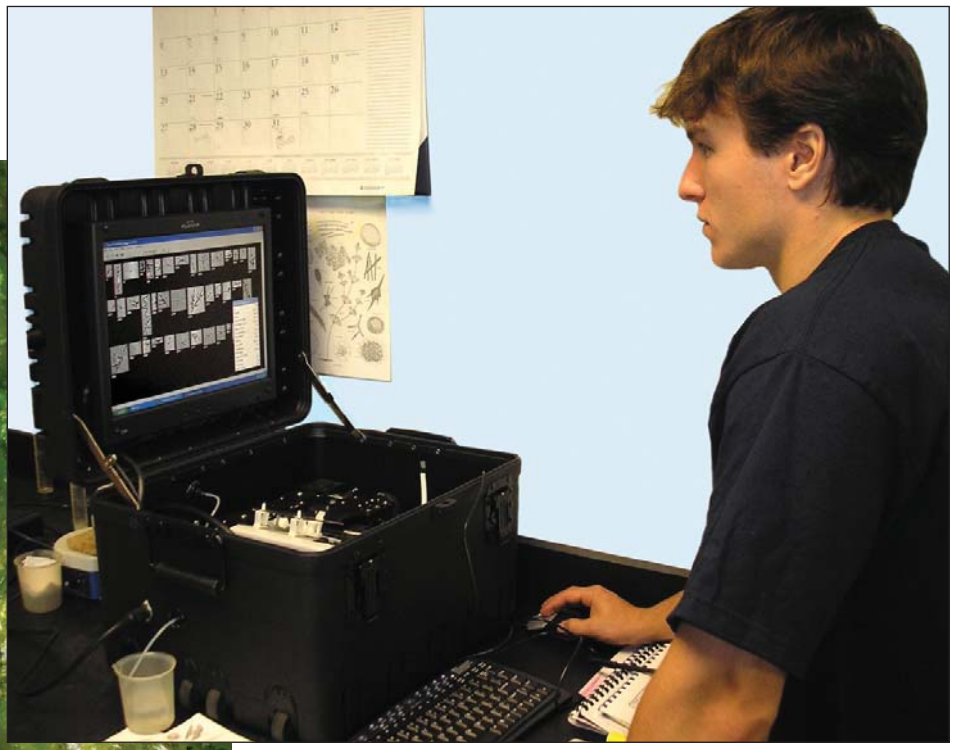
week, however, because some blooms can arise within a matter of days; a bloom could occur between sample rounds even if technicians successfully detected a problem algae.

Adding to the challenge is the fact that only five or six of the dozen or more species of algae inhabiting the reservoir actually pose a threat that warrants treatment. There are always algae in the reservoir, but the exact types and numbers must be known to determine whether there is a significant increase from typical levels. In some cases, the inability to quickly verify whether a bloom is in progress delays treatment until the degradation becomes obvious to everyone by its odor. By then, it's too late.

MONITORING MADE EASY

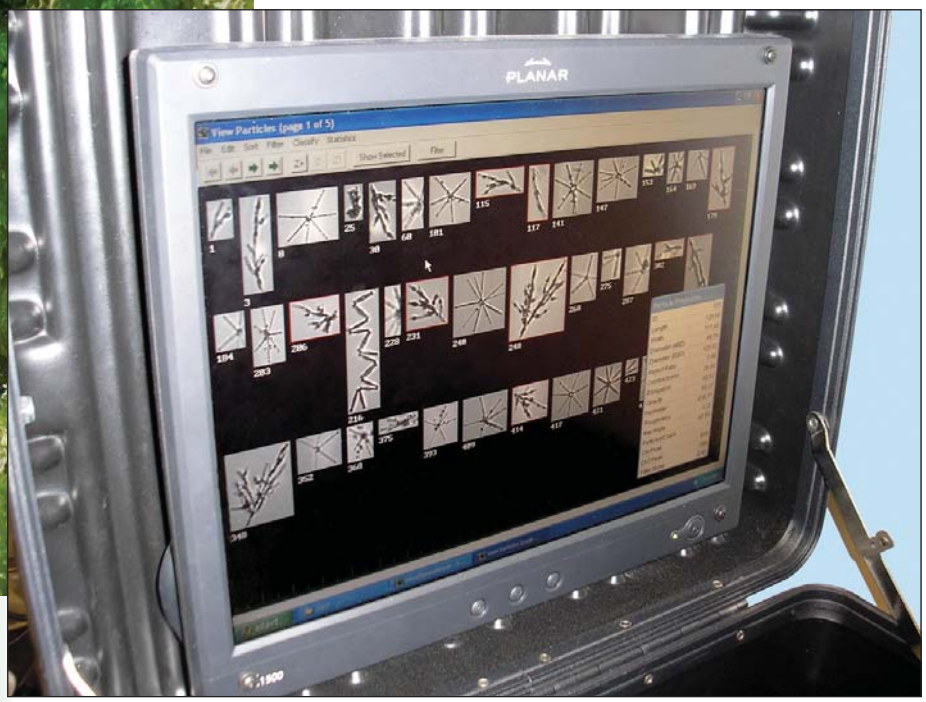
Determined to eliminate the threat of potential seasonal complaints from customers—and on a tip from a colleague managing wastewater discharge into Boston Harbor—officials at MWRA tested a FlowCAM.® The FlowCAM was a breakthrough particle-imaging and flow-cytometry system from Fluid Imaging Technologies in Yarmouth, Maine. The system takes high-resolution, full-color digital images of every particle and cell in a fluid sample. These images, along with their corresponding data sets, are saved in an interactive scattergram or in the company's proprietary Microsoft Excel spreadsheet-based system, Visual Spreadsheet,® for instant display and analysis. In addition to the actual image, the data for each particle and cell include traditional analytical parameters such as count, size, length, shape, and equivalent spherical diameter, plus a suite of advanced parameters that includes intensity, transparency, color, biovolume, compactness, roughness, and elongation. Although buoy-based monitors and other imaging instrumentation were considered, concern about their limitations in accurately detecting algal cells resulted in them not being chosen.

To use the FlowCAM, a water technician pours a sample into the unit's patented instrumentation. Scores of cells and particles automatically appear on screen in full color in seconds. Because the FlowCAM's imaging capabilities are triggered by a laser that excites the natural fluorescence of each algal cell (rather than merely photographing the sample at timed intervals), it is virtually impossible to overlook any algal cells. Once detected, a click on the individual image reveals its data set. The multistep process of preparing the sample for the microscope and the lengthy amount of time required to visually inspect and manually count the cells and particles using other technology are eliminated. By detecting and treating the algae before it escalates into a troublesome bloom, the problem can be treated using less copper sulfate at less cost long before any customers are affected.



PHOTOS: COURTESY OF THE MASSACHUSETTS WATER RESOURCES AUTHORITY, SOUTHBOROUGH, MASS.

Massachusetts Water Resources Authority intern Jason Lewandowski uses the FlowCAM to monitor for algae. With the automated instrumentation, a single technician can do in minutes what used to take days with a microscope and be more confident in the data when taking action.



Algal cell images are shown on the FlowCAM's screen. Because the FlowCAM's automated imaging capability features a laser to excite the natural fluorescence of each algal cell, it is virtually impossible to overlook even a single algal cell in the sample.

TAKING TECHNOLOGY TO THE FUTURE

The FlowCAM was originally used by oceanographic research scientists who were amazed by the capability of its optical system, for which it received a patent. Its image resolution provides unprecedented clarity, making visual inspection easier than with a microscope and identification and differentiation of one organism from another much more certain because of its many available parameters. For example, the FlowCAM allows a technician to take an *Asterionella* image and get a matching rating to find all the other *Asterionella* in the sample, obtaining a true count for comparison against a previous sample. MWRA is building an image library of every type of algae to promote rapid identification of each species. Because some algal colonies such as *Anabaena* can appear different from one another visually, it's important to be able to recognize variations. With reliable, consistent data, this equipment makes it possible to accurately compare algal levels from one sample to another. In addition, because the images are digital, they can be e-mailed to promote collaborative problem-solving among teams of water professionals.

In addition to monitoring for algal blooms, the system can be used by water and wastewater professionals who deal with other water quality issues on a daily basis. For example, when the hatch of a water storage tank at the MWRA blew off, protocols were triggered that included draining and refilling the tank and then performing a series of tests including coliform, color, odor, and turbidity before the tank could be returned to service. As test samples were run through the FlowCAM, very small, geometrically shaped particles were found that were suspected to be concrete sediments suspended in the new batch of water. This information led to the discovery that the tank had been improperly filled from a neighboring water tank rather than from the distribution system as was intended.

The FlowCAM can also be linked to an overhead projector for public meetings where actual images and data can be used to both educate and calm customers about the quality of their drinking water. At MWRA, the FlowCAM is also being used to assess the presence of particles throughout the water treatment process.

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