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Leverage Utility Management and Artificial Intelligence in Today's COVID-19 World

An Illinois water utility's ability to optimize water distribution network monitoring through artificial intelligence and automation gives it operational resilience to meet current and future challenges.

BY LEV GOLDBERG AND EMMA QUAIL

TODAY'S WATER workforce—operators, engineers, utility labor crews, laboratory technicians, and others—all work in proximity of contaminating agents every day, including *Cryptosporidium*, *E. coli*, *Salmonella*, viruses, and more. The recent outbreak and spread of the 2019 novel coronavirus, which leads to the disease COVID-19, has reinforced this realization and led to unprecedented effects on civil life, including the reorganization of life-home-work patterns through statewide shelter-in-place orders, the restructuring of plant and operational workflows, reduced or shuttered commercial and industrial operations, and diverse but economically adverse impacts on our cities.

The recent experience of a single mid-size water utility in northeast Illinois demonstrates how a proactive approach to automating water distribution network monitoring put it ahead of the sustainability curve, especially given today's social and economic turbulence. Life-changing events, such as COVID-19, can affect distribution system behavior by reshaping demand patterns that can cause unexpected operational events. Real-time intelligence, preparedness, and prevention are priceless in such a context.

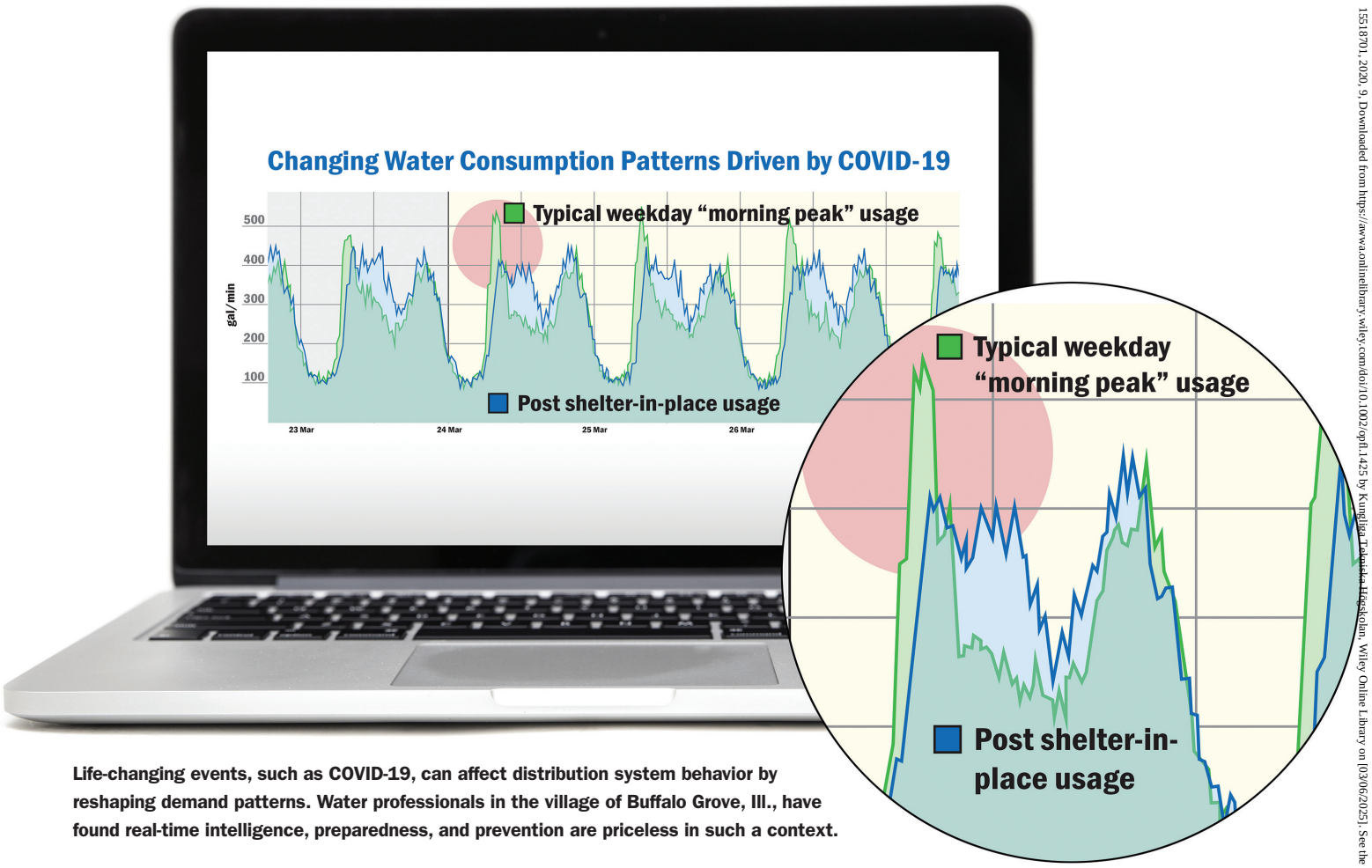
EMBRACING CHANGE

The village of Buffalo Grove is a suburban community about 20 miles northwest of Chicago, with a population of approximately 42,000 and about 12,000 water customers, of which 90 percent are residential and 10 percent commercial or industrial. Water is sourced from Lake Michigan, purchased from the Northwest Water Commission, and conveyed through four pump stations and 183 miles of largely cast-iron and ductile-iron pipe ranging in size from 4 inches to 24 inches in diameter. The average day demand is approximately 3.7 mgd. All water distribution system operations are monitored through a centralized 24-7-365 supervisory control and data acquisition (SCADA) system. The village also maintains an advanced metering infrastructure network that covers nearly 100 percent of customer meters.

In recent years, water loss has become a top priority for many local utilities as state regulatory pressures to lower and account for nonrevenue water have increased. To address this challenge, the village partnered with Aquify, a subsidiary of Exelon, to implement a central event management system in 2019 that combines 24-7 distribution network monitoring, sensors, and machine learning software (through a collaboration with TaKaDu, a global software provider of central event management solutions for the water industry). Establishing this platform entailed installing 10 multiparameter electromagnetic insertion probes to measure flow, pressure, acoustics, and temperature across four defined zones or district metered areas (DMAs).

This approach allows the village to measure inflows and outflows in a DMA as well as monitor minimum nightlines for nonrevenue water and leakage analytics. It's a long-term water loss control strategy that prioritizes leak detection dispatch and aligns decision making with budget allocation and pipe rehabilitation and repair.

In Buffalo Grove, the analytics software receives continuous data transmitted from the 10 insertion probes every six hours and one-minute reading outputs from the SCADA system installed at the utility's four pump stations and reservoirs. The data are then integrated into an artificial intelligence platform for analysis, monitoring, and event management. The figure on page 24 illustrates



Life-changing events, such as COVID-19, can affect distribution system behavior by reshaping demand patterns. Water professionals in the village of Buffalo Grove, Ill., have found real-time intelligence, preparedness, and prevention are priceless in such a context.

FIGURE: AQUIFY

the location of all 10 independent sensor locations and four SCADA points across all the zones or DMAs.

Like many municipal public works departments, Buffalo Grove had minimal staff and too much data.

"We operate with a lean staffing model and in recent years have been gathering more digital data from multiple sources," explains Mike Skibbe, Buffalo Grove's deputy director of public works. "But we don't have the staff to watch screens all day or analyze data in real time. With an opportunity to form a public–private partnership, use our partner's ability to monitor 24-7, and provide data analytics services, we're finally able to leverage the many systems and data streams we've invested in over the years."

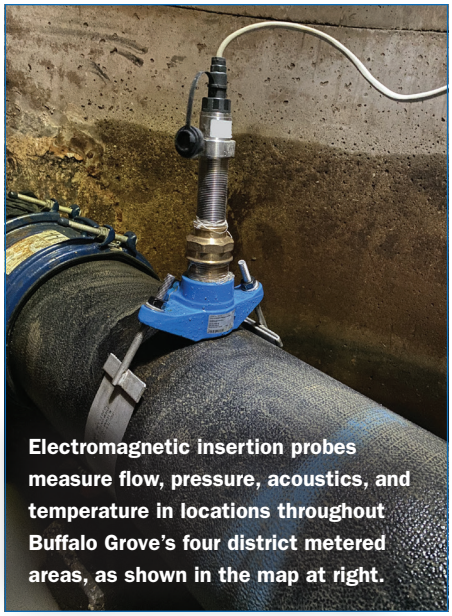
LIFE IN A PANDEMIC

In March 2020, the ripple effects of COVID-19 were felt nationwide when US shelter-in-place advisories were imposed to curb the spread of the virus. Like many public works departments, Buffalo Grove complied and reorganized priorities, adjusted work routines, and revised operational protocols to protect the community and safeguard employees. Administrative employees were required to work from home and minimize customer interaction through remote troubleshooting and service delivery. Critical operational field staff traveled independently instead of in groups to jobsites, complied with social distancing, and worked from assigned public works vehicles instead of going into the office.

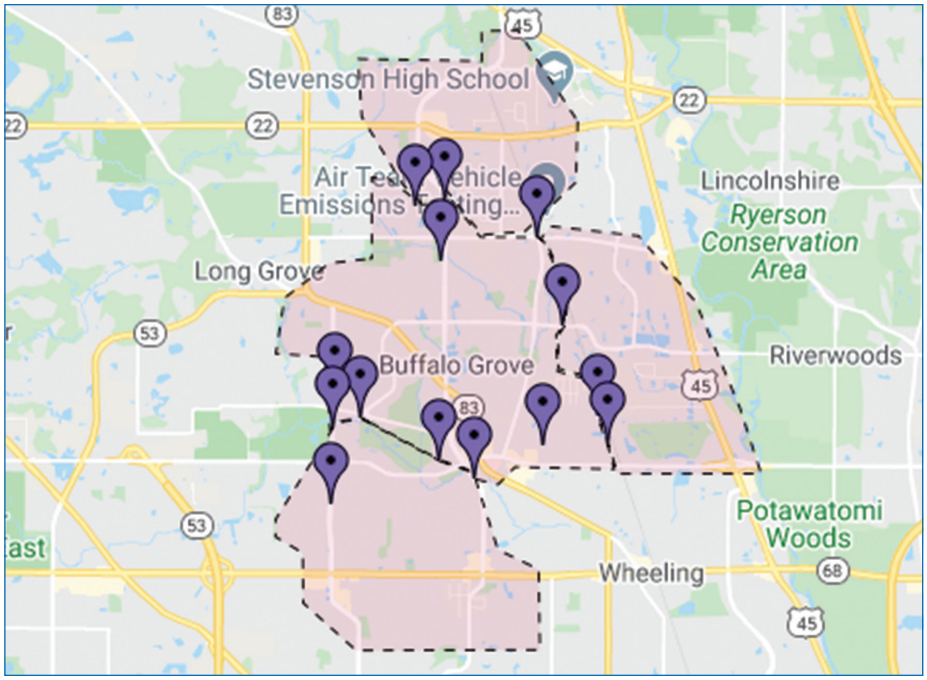
The village's demand patterns and water consumption behaviors changed considerably as businesses closed their doors and residents hunkered down in their homes. The village was able to leverage its new machine learning software and analytics platform to compare system performance pre-COVID-19 and during the shelter-in-place order. Notable trends were observed in daily demand patterns and nighttime averages in residential and nonresidential zones. The figure above illustrates how the typical weekday consumption profile flattened during the COVID-19 response to resemble a characteristic weekend curve. The blue line represents actual or current zonal flow, and the green line is the historically based pattern, based on system learning.

When the shelter-in-place advisory was implemented, the previously distinct early morning "rush hour" corresponding to preparation for commutes to work and school was less recognizable, and the new peak demand shifted spatially to reflect a decreased sense of urgency in meeting early morning commitments. Residents used water later in the morning, and consumption continued consistently throughout the day as laundry and dishwashers kept up with families living in quarantine. On the opposite end of the spectrum, nonresidential demand plummeted as nonessential businesses, factories, and warehouses dramatically reduced production or closed completely.

The data also provided visibility into other unexpected scenarios. For example, when the utility had no scheduled operations (and law enforcement routes may have been altered because of pandemic response), anomalies were detected that suggested unauthorized usage.



Electromagnetic insertion probes measure flow, pressure, acoustics, and temperature in locations throughout Buffalo Grove's four district metered areas, as shown in the map at right.



In addition to monitoring consumption patterns, the village was able to use the data analytics platform to estimate the impact of COVID-19 on billing revenues. The analysis determined that increased residential consumption and associated revenues would almost offset reductions in commercial consumption. Fortunately, Buffalo Grove relies predominantly on residential income because of its small percentage of commercial and industrial customers. Without continuous and intelligent data, the village would need to rely on its next billing cycle to run revenue comparisons in residential and nonresidential water demands, delaying weeks of critical administration planning and capital improvement work.

LESSONS LEARNED FROM COVID-19

Skibbe and Buffalo Grove administrators have been leading an effort to shift to data-driven decision making and data management best practices for many years. But he predicts COVID-19 will be a turning point for how utilities will be managed in the future.

"This is the time that local government will reinvent itself," he says. "There will be two types of communities: those that realize we need to adjust our service and staffing models and those that will try to continue operating in the same way we did yesterday. We still need to deliver clean and safe drinking water and reliable wastewater services, but we'll need to do these things without the same level of certainty regarding revenue, with potentially fewer staff, and with employees located in remote locations."

Remote monitoring is one area that has generated increased curiosity as social distancing rules have been implemented. Now, Buffalo Grove operators have fewer opportunities to work from control rooms, teams often split up, and some staff members spend extended multiday or weeklong (or longer) shifts working and sleeping in control rooms. The ability to monitor and ultimately manage critical resources from decentralized locations is a key component to any resilience plan. Buffalo Grove is addressing this need by using cloud-based software that displays continuous flow and pressure data and 24-7 remote monitoring support.

Limited resources are a major roadblock to implementing any of these new technologies. Although many of them have been on the market for years and are successfully deployed in other countries around the world, many US utilities simply don't have the resources to source, procure, integrate, manage, and monitor these systems. This is where Skibbe sees an opportunity.

"Using new public-private models can help utilities implement solutions at lower costs and with less risk while leveraging third parties to do the work they may not have staff to do," he says.

Adopting automated technologies for field and reporting processes will also escalate as a result of COVID-19 as utilities learn how to handle a combination of retiring operators; pressure to "do more with less" from administrations, governing boards, and councils; and new technologies that help utilities become more efficient. From leak detection, pressure monitoring, and valve exercising to field sampling and filling out regulatory compliance forms, there are many opportunities for utilities to improve workforce and process efficiency.