by Eric Patterson and Rachel Drain

Improving A Community's Drinking Water Quality:

Comprehensive Water Treatment Plant Upgrade Improves Water Quality For City Of Harrisonville, Missouri

For nearly 50 years, Lake Harrisonville has been a safe and reliable source of drinking water for residents of Harrisonville, a community of 10,000 in Cass County, Missouri.

Built and placed in service during the 1970s, the original Harrisonville Water Treatment Plant was designed with conventional treatment processes that met all Missouri and federal regulations for safety and health. However, for a variety of reasons, the raw water quality from Lake Harrisonville, the City's only source of drinking water, has always been highly variable and difficult to treat. With completion of an upgrade and expansion of the Harrisonville Water Treatment Plant, the City now can mitigate these treatment challenges and resolve taste and odor issues.

In addition to engineering design and planning, Burns & McDonnell provided bid-phase and construction management services for the upgrades. The project included collaboration with two members of the Harrisonville Board of Aldermen, who served on the City's selection committee from project initiation through completion.

Developing A Plan

In 2013, Burns & McDonnell conducted an evaluation to improve the water supply, treatment processes and distribution system while also developing options to reduce taste and odor issues. The City also asked Burns & McDonnell to develop a plan to expand the water supply and treatment capacity to 3.0 million gallons per day (MGD).

Testing confirmed that the raw water supply had high levels of methylisoborneol (MIB) and geosmin, taste- and odor-causing compounds released by algae. Testing was conducted

to evaluate several new treatment alternatives that would oxidize or adsorb these compounds.

The study evaluated the City's continuing reliance on Lake Harrisonville. The objective was to determine the firm yield, or the estimated maximum amount of water that can be supplied by a reservoir under specified conditions, of this 427-acre water resource. This needed to happen in its current condition and, second, after a planned sediment removal. The study revealed the lake has a firm yield of 1.4 MGD and is capable of meeting currently projected city demands, though the intake structures would require substantial upgrades in order to meet the maximum projected demand of 3.0 MGD. A range of options for alternative intakes were evaluated, including building a new intake closer to the dam and expansion of the existing intake.

Another significant element of the study involved evaluation of the treatment facility and steps that would be required to expand rated capacity from 2.4 MGD to 3.0 MGD, and to enhance treatment processes. Four options were identified as potential treatment alternatives:

- **Addition of different coagulant chemicals** to achieve higher removals of organic compounds within the existing treatment basins.
- **Injection of powdered activated carbon** (PAC) during treatment to absorb organic compounds causing taste and odor issues.
- **Injection of ozone** during treatment or pretreatment stages to take advantage of excellent disinfection and oxidation qualities.
- **Use of ultraviolet light and injection of hydrogen peroxide** as an oxidizing agent to remove metals, minerals and odors.

All four conceptual alternatives were subjected to rigorous bench-scale testing during preliminary concept development. The process evaluation included a performance-based assessment of the potential of each treatment alternative to improve water quality while reducing operating costs.

A continuous-flow, bench-scale unit was utilized for ozone testing that combined the reliability of pilot-scale testing with the cost-effectiveness of bench-scale methods. A number of factors were evaluated to determine the optimal ozone dose, including demand, decay, contact time (CT) credit for disinfectant values, and bromate formation curves. Various dosing approaches were tested for the proper balance to achieve disinfection, color reduction, taste and odor abatement, and oxidation goals.

Filter evaluations also emerged as a key component during this stage. These concluded that higher capacity backwash pumps and new underdrains would need to be added so that the filter media would remain clean. The recommended upgrades funneled into a larger facility plan establishing preliminary design criteria, a budget framework and construction schedule.

A regulatory compliance framework and hydraulic

evaluation of the water treatment plant were incorporated during preliminary design phase. Architectural, electrical, mechanical and structural condition assessments also were included.

Comprehensive Facility Upgrade

Based on the bench-scale testing results, ozone treatment of the raw water emerged as the optimal method to address taste, odor and color concerns. Pinnacle Ozone Solutions was selected as the equipment supplier and final design of the treatment train incorporated flexibility to add ozone treatment to the settled water stage, if deemed necessary in the future.

The team also proceeded with final phase design of the plant improvements, including a new chemical building designed to house chemical feed systems for sodium hypochlorite, ammonia, coagulant, polymer, fluoride via a saturator system, sodium thiosulfate and caustic. The building also was designed to house ozone equipment and new electrical panels.

A new electrical instrumentation and control system was another important upgrade to support continued reliability of plant operations and treatment processes. An emergency backup generator with enough capacity to run the whole plant was added on plant property. The existing filter building was renovated, including a glass barrier between the filters and the upgraded functional space for operator administration and lab testing that included air conditioning for operations staff comfort.

Within the site footprint, new exterior bulk storage tanks were added for storage of sodium hypochlorite and coagulant. New tube settlers were added to the primary settling basin as an important step to increase capacity of the plant. As part of this renovation, additional height was added to the basin to enable more efficient hydraulic flow.

The final design also featured a new chemical feed building with new points and injectors or static mixers connected via tubing bundlers to convey chemicals to the feed point in the treatment train. Other additions included a pad and access for the liquid oxygen (LOX) system and replacement of the stage 1 solids contact clarifier equipment.

Within the filter building, new filter media was added with new Leopold underdrains with slotted caps and air scour. A new EFI prefabricated pump station was installed on a new 0.1 million-gallon wet well featuring four new high-service pumps and two backwash pumps, all operated by energy-saving variable frequency drives.

Other site work included: yard piping; access roads and security gates; an exterior remodel of the filter building; and rerouting of site drainage.

Successful Completion

The $8.2 million project was constructed by KAT Excavation and completed in September 2018, well within the scheduled deadlines. In addition to providing enhanced water quality, the project provides the City with additional safety features to better protect operators working at the facility.

Harrisonville Water Treatment Plant

A number of cost-saving features designed into the plant will result in significant savings in operations and maintenance in coming years due to the use of more affordable, robust units that enable the City to avoid the expense of purchasing dual pieces of critical equipment while still providing needed redundancy. Additional cost savings for chemicals will be realized from the ongoing use of ozone that serves as a replacement for carbon dioxide and PAC.

Most importantly, the entire scope of new treatment processes, expanded capacity and more efficient equipment have resolved the nagging water quality issues that city residents have raised for years.

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Rachel Drain *is an environmental engineer for Burns & McDonnell. Rachel specializes in design, construction, and optimization of municipal drinking water treatment facilities, particularly in the areas of primary treatment, chemical systems, filtration, disinfection and ozone. Her experience includes projects addressing water treatment issues such as iron/manganese, disinfection byproducts, taste and odor, advanced oxidation and corrosion control.*