From Model T to Lexus

Springfield Metro moves its wastewater management into the 21st century

By Christy Crites and Nate Davis

Imagine having learned to drive on a Model T, the most popular automobile of the 1920s. It featured a manual transmission and mechanical drum brakes, and for decades it was the only car in the garage. Then one day you get the keys to a new Lexus, and the latest automotive technology is suddenly at your fingertips. It's both an exciting opportunity and a challenging transition. Fortunately, most automobile drivers have been allowed to make that transition gradually over the years because literally hopping from a Model T into a Lexus would not be an easy leap.

The managers of the Springfield Metro Sanitary District (SMSD) are living such a leap. For 83 years they operated the Spring Creek Wastewater Treatment Plant, a facility that was built when the Model T still ruled the road. Decade after decade they squeezed every drop of treated water that they could from that plant. However, capacity limitations and more stringent regulatory requirements finally dictated that the plant had given all it could. In 2012, the district started the ignition on a brand new, state-of-the-art treatment plant.

Although it was the passage of time and changing conditions that led to the decision to build a new plant, the new Spring Creek Wastewater Plant is also a product of long-term planning and collaboration. The planners had the opportunity to start from scratch and use 83 years of lessons learned to guide the way while researching best practices for every aspect of the facility. From the outset, the engineering consultant worked with district staff to ensure a smooth transition not only in terms of operations but in culture as well. It was an enormous responsibility to take the wheel of a new 80 million gallons per day (MGD) plant with a sticker price of approximately $91,000,000.

The treatment process at the new Spring Creek plant provides a great deal of flexibility, allowing it to operate in a variety of configurations. In a CSO community where large fluctuations in flow are common, this has proven to be an efficient and beneficial solution.

The original Spring Creek plant served the Springfield community well for 83 years. Its manual operations have been replaced with a fully automated, state-of-the-art system.

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From manual shift to automatic

The former water treatment systems were almost completely manual. Operating data was collected by hand on a daily basis, and maintenance was tracked with a card catalog. Generations of staff members had learned their maintenance skills in a mechanical environment, where broken parts were identified after searching the works with a flashlight.

The new plant ushered in the digital age. Its Supervisory Control And Data Acquisition (SCADA) system includes over 4,000 input/output points to support plant operations. Familiar dials and switches were replaced by touchscreens. As a result, when maintenance issues arise today, the system immediately notifies staff of the problem and its exact location. The replacement part will usually be on hand, thanks to a computer maintenance and management system (CMMS) that is integrated into the plant operations.

Using integrated technology to operate the plant has resulted in levels of optimization, efficiency and flexibility that were impossible before, and those benefits can now be found throughout the entire facility.

Vertical loop reactors permit flexibility

The treatment process is designed to run in a modified activated sludge configuration (called the University of Cape Town process), which allows it to remove phosphorus and total nitrogen biologically. Now one of the largest nutrient removal facilities in the Midwest, the plant is well positioned to meet future regulatory requirements. Vertical Loop Reactors (VLRs) provide a combination of aeration and mixing in the system. Activated sludge rotates in a circular pattern around a horizontal baffle in the middle of each tank. On the surface of the tank, mechanical aerators provide both mixing energy and aeration, while on the bottom, diffused aeration is provided. This allows for ample turn down in the amount of dissolved oxygen delivered to any tank, and it lets the operators easily reconfigure the plant for differing volume demands.

The activated sludge reactors (six per train) can run anaerobic, anoxic and oxic processes. There is an internal recycle for phosphorous and nitrogen process control. The pipe and equipment gallery allows recycled substances to flow easily and without significant energy, equipment or structure requirements. The tank design and the vertical loop reactor design allow the operation to change the anoxic and oxic tank configurations.

Springfield is a large Combined Sewer Overflow (CSO) community that experiences fluctuations in flow that can vary from 12 MGD to 120 MGD in under an hour. The ability to adapt the process configuration accordingly allows staff to handle treatment efficiently. In the normal operating mode, influent enters reactor #1 and then flows to each successive tank through a gated opening in the reactor sidewall. A channel along the inlet or front side of the reactors allows reactors to be removed from service and provides operational flexibility as flows increase. The same channel also includes a storm peak flow operation option to protect vital biological constituents from washing away. In the storm flow mode, influent flow is diverted to reactor #5 preventing washout from the aerobic and anoxic tanks, while return activated sludge continues to be returned to reactor #1.

Return activated sludge is pumped from each secondary clarifier back to Reactor #1. The storm flow mode configuration is similar to a contact stabilization mode reactor configuration. The dissolved oxygen (DO) and oxygen reduction potential (ORP) are monitored for each reactor from #2 through #6. Aeration control is mechanical, and diffused air is based on one of these two parameters.

A unique design decision inserted a head box for the influent pumping station and brought three advantages. First, it allowed the pumps to operate more efficiently at a fairly constant head. Secondly, it greatly reduced the friction loss that would normally exist within a piping manifold and increased their service life. Finally, the head box eliminated the need for large valve vaults and several large diameter ductile iron pipe fittings, all of which resulted in a savings in both capital and energy costs.

Further efficiency and energy savings were brought about with variable-frequency drives (VFDs) on the pumps, blowers, and aerators. The drives were integrated into the plant's SCADA system to provide precise control over motor speed so that it can meet the needs of the current operation without wasting energy. The VFDs practically eliminate the flow spikes that cause operational problems in downstream processes by maintaining a more constant flow through the plant.

During planning, the district requested that the number of buried process valves be kept to a minimum. The design team responded with a 1,900-lf network of underground corridors. In addition to providing ready access to the valves, the corridors allow space to house equipment and provide weather-protected access between the key process areas and buildings. The staff uses golf carts to traverse the tunnels and can visually verify the operation of all valves in the system.

Hands-on training and an almost live rehearsal

The best way for SMSD staff to take full advantage of their new system's capabilities was to provide them firsthand experience with how the entire plant and treatment process would operate. They took multiple trips to facilities that were using similar equipment and technologies. The staff acquired the knowledge to make decisions on future operations with a complete understanding on the details of the final product.

Research and shared knowledge were major factors in preparing the district for the leap they would be asked to make. But for a staff who had honed their skills in the mechanical environment of the previous plant, hands-on experience before startup was invaluable. To familiarize the

staff with the process under almost live conditions, an effluent recirculation line was installed so that the plant could operate in a closed loop for two weeks prior to accepting sewage. This step helped the staff to identify and vet any operational bugs in the new system, and it allowed district staff to develop a comfort level with the equipment that they could not have gotten in a typical plant startup.

On July 16, 2012, at 8:30 a.m., flow was diverted to the new treatment facility, and the mixed liquor from the old plant was transferred to the new activated sludge process. By noon the following day the transfer was complete, and the new plant was treating all wastewater flow. The plant startup was problem free, and effluent quality was met from the very first day of operation.

Conserving energy and protecting investment

The district's journey is continuing as the plant progresses from functionality to optimization. The SCADA system is constantly collecting data so that staff can observe performance trends and determine optimal settings based on current conditions. They can monitor power consumption in every area of the plant and make informed decisions that will increase energy conservation. Better controls over maintenance and repairs will help to maximize their investment on equipment. When all was said and done, hopping into that Lexus after years behind the wheel of a Model T was not exactly an easy transition, but the 21st century ride gets smoother with every mile. CS

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