Cost-Effective Plant Renovation Proves Itself

Innovative design combined with state-of-the-art wastewater treatment equipment and processes have played a key role in the effluent quality and energy efficiency achieved at the award-winning Fond du Lac Regional Wastewater Treatment Plant. Rather than build totally new facilities, this plant adapted existing elements to resolve bypass problems, to double hydraulic capacity, to comply with a stringent ammonia rule change and to improve the sludge management program, all at less energy usage than the much smaller earlier plant. Here's how they did it…

The $61-million renovation of the Fond du Lac (WI) Regional Wastewater Treatment Plant (WWTP) has earned an impressive string of awards for design and operational excellence, including recognition from the American Council of Engineering Companies (ACED), American Public Works Association, American Society of Civil Engineers and from Alliant Energy, the plant's electric utility.

Like other plants across the nation, the Fond du Lac plant has had to respond to ever more stringent water treatment standards since the US Clean Water Act emerged from Congress. With federal and state regulatory agencies emphasizing effluent quality, the city utility committed to producing a new generation facility with advanced treatment capabilities capable of delivering more efficiency and cost effective operations. The project was driven primarily by an impending rule change in the plant's discharge permit aimed at limiting ammonia effluent levels. Saddled with a treatment process incapable of compliance with the new ammonia rule, the utility elected to expand the scope of the upgrade to address other longstanding needs for more hydraulic capacity, improved energy efficiency; elimination of bypasses into Lake Winnebago during high rainfall; reduced operating costs and a better sludge management program.

All were accomplished by sound engineering solutions that applied advanced equipment to increase the plant's capacity and throttle the former bypass incidents. The plant's engineering delivered both initial and projected long-term cost savings. An estimated $20 million was achieved in original construction

costs and operating expenditures should decrease annually by $500,000, about 10 percent of the 2004 baseline planning budget.

MAJOR PROCESS CHANGES…

Strand Associates, Inc., the project's design consultants, based the upgrades on an average daily design flow of 9.84 million gallons per day and a projected BOD load of 22,500 pounds per day. The process train for the new facilities features advanced secondary sludge with primary clarification, single-stage nitrification, denitrification, separate storm flow clarification and chemical phosphorous precipitation. To eliminate chemical disinfection byproducts, UV disinfection was added to the process train.

The utility reduced the project's cost in several ways. First, new land acquisition was avoided by utilizing the same 22-acre site where the city began developing wastewater treatment facilities in 1929. An aspect of the new design enhances capacity in yet another way. Reusing two, 95-ft. dia. retired clarifiers not only added to the savings but serves dual uses. Reusing two, 95-ft. dia. retired clarifiers added to the savings and serve dual uses. In one role, the recycled basins can store peak flows during high rainfall events that exceed the 34 mgd hydraulic capacity of the final clarifiers. This equates to approximately three hours of storage at a sustained 16 mgd flow. In the past, some incidents allowed 2-mg of polluted water to bypass the plant's process and reach Lake Winnebago.

A more unique aspect beyond their role as storage occurs when the renovated plant's final clarifiers reach capacity. At that point, the primary clarifiers provide primary treatment and the flow thereafter diverts to the excess flow storage (existing aeration tanks). From there, it is recombined with the normal range of flow receiving biological treatment before UV disinfection.

Under average conditions, the process wastes activated sludge to the primary clarifiers for thickening with primary sludge at up to 28,500 pounds per day. It is then anaerobically digested in a four-unit thermophilic-mesophilic digestion (TPAD) system comprised of two thermophilic and two mesophilic digesters that produce Class A solids. Biogas off the digesters provides an energy source for the units along with a significant amount of the building's heating requirement. The mixed-flow of effluent can be

treated in series or parallel, or, converted exclusively to mesophilic operation. A commercial hauler delivers the Class A sludge with 25 to 27 percent solids, to area farm fields as a soil conditioner.

ENERGY-STINGY PUMPING AND AERATION…

Reducing energy usage was one of the major objectives of the upgrade. The result is a facility that uses less energy, despite having doubled the hydraulic capacity and pumping 50 percent more head. Influent-pumping and aeration are two of the more energy-intensive functions of this activated-sludge plant's treatment cycle. It was imperative, therefore to specify equipment that minimized energy use. After careful analyses, Xylem was selected to supply 26 Flygt brand pumps, ranging from 1.7- to 215-hp, and Sanitaire fine-bubble aeration equipment.
The Flygt recycle pumps, mixers and the more than 1900, 9-ins. diameter Sanitaire diffusers (five grids per tank) complement each other as the heart of the energy-efficient activated sludge process.

The plant's Flygt pumps and mixers operate in two capacities. Two, 85-hp pumps cover the low end of the influent flow range (up to 5 mgd) while four, 215-hp pumps in combination with the two smaller pumps provide the 50 mgd peak capacity for the pumping station. Variable speed drives minimize energy consumption by synchronizing the combination of pumps and their operating speed with the flow conditions. The energy-saving features of the self-cleaning N-pumps yielded the plant additional cost savings.

The Flygt equipment performs a variety of essential missions in the plant process. Mixers blend primary sludge with waste activated sludge to facilitate pumping and digestion in the anaerobic digesters. After the centrifuges dewater the final sludge, the ammonia laden centrate is pumped back to the head of the plant. Still others pump drainage from the primary sludge building sump as part of the plant's wastewater collection system, and the two, 1.7-hp pumps maintain a dry basement in the solids processing building. Six, 44-hp propeller pumps discharge the plant's treated effluent to Lake Winnebago while three, 27-hp propeller-type units pump stormwater collected in a segregated retention basin to the Fond du Lac River.

The Fond du Lac plant employs a clever treatment technique—using naturally occurring nitrates instead of oxygen from aeration--to supply a significant portion of the oxygen demand in the activated sludge process. This reduces the overall aeration requirement by about 25 percent.

Biological nitrogen removal is also achieved, in conjunction with full nitrification needed to comply with the permit limits for ammonia. This energy-saving process is accomplished by low-energy, ultra-low head Flygt pumps that transfer the nitrate recycle from the aeration zone into the anoxic zone. There, the nitrates “give up” their oxygen to the bacterial demand, considerably offsetting the need to mechanically aerate. The nitrogen gas produced escapes into the air. For the remaining aeration requirement, energy consumption is minimized by using state-of-the-art, high-efficiency blowers and Sanitaire air diffusers.

The city’s participation in an award-winning Shared Savings Program with Alliant Energy, the electric utility serving the area, qualified for a two million dollar loan at one percent interest. This program incentive quickly achieved mutual dividends.

Alliant Energy honored the Fond du Lac utility for adding advanced technology that saved 1.95 million kilowatt-hours of electricity and 188,140 therms of natural gas--enough to power 212 average-sized homes for one year. As with most shared-savings programs, electric utilities have found it less costly to encourage energy conservation measures than to build additional generation capacity.

The upgrades have reduced the municipal utility’s operating costs in other ways. Reliability, for one, is nearly taken for granted in the daily operations because of the equipment specified for the project. The process relies on proven—not exotic—equipment. The plant’s manpower requirement has been reduced from 15 personnel down to six on the one-shift operation, and overtime has run 20 percent less than the former level.

Most importantly, this extensively renovated plant performs its mission, according to John Leonhard, operations manager. BOD averages an annual 5 mgl, compared to the state 30 mgl requirement. TSS also averages 5 mgl, well below the 30 mgl state maximum. The plant maintains

phosphorous at a cost-effective threshold of 0.75 mgl compared to the 1 mgl state maximum. Leonhard credits the plant's award-winning lab as a key factor in maintaining the exemplary performance.

Completed ahead of schedule and under budget, this superbly engineered plant combines much of the new in process technologies with some old infrastructure to serve the Fond du Lac service area well into the future.