Kansas WWTP Adopts Constructed Wetlands

Pilot plant proves the point.

El Dorado, KS, resolved recurring plant bypasses during wet weather events by incorporating constructed wetlands—the first for a municipal utility in Kansas—into the design of a new, three-mgd wastewater treatment plant (WWTP). Features of this treatment plant address operational issues sometimes facing communities elsewhere that are planning upgraded wastewater treatment facilities.

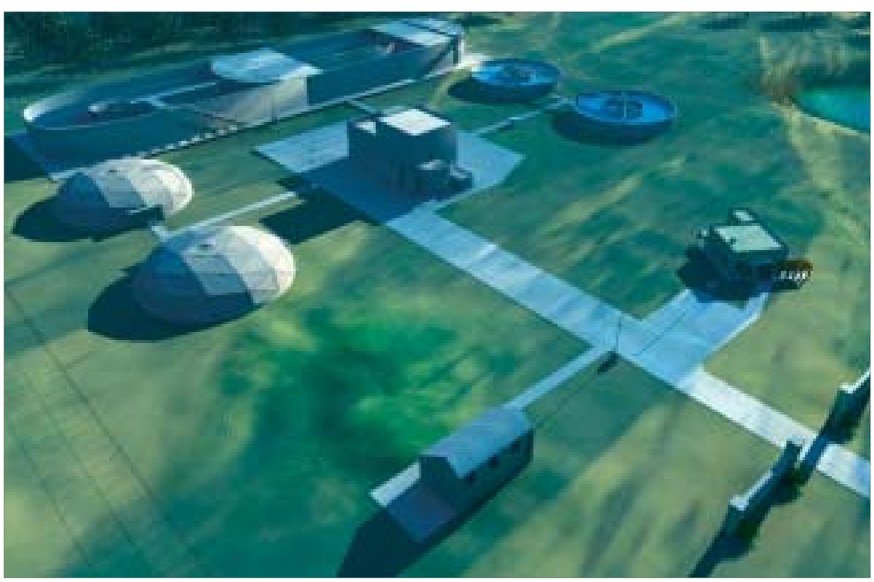
"Incorporating wetlands in the treatment process presented a sustainable feature that allowed the plant to be downsized at a savings of at least $3.5 million," explained John Bailey, P.E., Ph D, a vice president with Professional Engineering Consultants, P.A. (PEC, www.pec1.com), the municipality's consulting engineer. "Treatment capacity can cost $3.50 per gallon and, in this instance, the wetlands improve the treated effluent throughout most of the year."

The $10.3-million construction bid for the new plant opened up a whole new realm of service expectations. The new plant entered service across the Walnut River from a predecessor facility that discharged to the same receiving stream. The previous 1.75-mgd plant had operated since 1957 and underwent a significant upgrade in 1977. However, average daily flows by the late 1990s stood at 2.3 mgd and short-term inflows could surge to 14.0 mgd caused by infiltration along the aging, 55-mile collection system. The ensuing bypasses from the plant allowed sub-par effluent to reach the Walnut River. The problem continued even after the city relined the worst 300 of the system's 1,600 manholes, according to Kurt Bookout, El Dorado's Director of Public Utilities.

The plant's shortcomings brought on by growth and uncontrollable conditions, including regulations and climate, drew the scrutiny of the Kansas Department of Environmental Health (KDHE) and, by extension, the EPA. The stretch of the Walnut River receiving the plant's effluent below the Federal El Dorado Reservoir is designated as "Outstanding Natural Resource Waters" that are closely monitored by the state. Those short-term environmental impacts on the city's receiving stream, compounded by the planned use of federally contributed state revolving funds for plant financing, expedited the review process during the planning.

As is sometimes the case elsewhere, periodic ammonia levels were yet another issue the city needed to eventually address, as was the long-term disposal of biosolids. An earlier arrangement reached with the county landfill for biosolids was viewed only as an interim accommodation.

PEC therefore confronted a multitude of design issues related to long-term compliance, operational efficiency, and capacity to support the community's continued growth.



Aerial depiction of the plant showing various components.

Conclusions Tested First

A 1997 study prepared by PEC identified several treatment alternatives presented for review by the city and the state. PEC had concluded at that time that the utility could either modify the existing plant extensively with the activated sludge process supplemented with wetlands to enhance treatment, or build a new plant equipped with wetlands primarily used to capture and hold excess wet weather inflow. Either scenario would require about the same investment, the report stated.

The first theoretical scenario would modify the existing WWTP by utilizing existing primary, intermediate, and final clarifiers, trickling filters, rotating biological contactors, UV disinfection, and an extraneous holding basin. The existing influent pumping station would have capacity increased from 4.5 to 12.0 mgd (8,400 gpm) provided by three vertical dry-pit pumps with variable speed drives to match power consumption with the inflow volume. The process chain would gain a race track type of oxidation ditch with mechanical surface turbine aerators. Additional infrastructure would include two, 70-ft diameter center feed clarifiers and a new outfall cascade at the Walnut River.

With this scenario, sludge disposal remained unresolved, as did the need for a larger footprint to create the wetlands and a lack of any guarantee the upgrade would meet the future effluent quality, especially related to ammonia levels in winter. A new plant therefore made more sense—and would actually save dollars.

Once established and properly maintained, constructed wetlands would stave off bypasses and help polish the plant's effluent by a natural process to standards set by the NPDES permit. The Walnut River and its surrounding environment would gain lasting benefits.

Kurt Bookout at the new plant in El Dorado.

Convincing Needed

Although constructed wetlands have a history of success elsewhere in the United States, and even on a smaller scale in Kansas, KDHE took some convincing that manmade wetlands could make an effective contribution. A demonstration facility, as a pilot study, was therefore mandated and tested by PEC for three years at the previous plant site (See Table 1). The carefully monitored wetlands consisted of two, half-acre test cells that normally received partially treated effluent diverted from an intermediate clarifier.

Bookout immediately favored the approach because a local oil refinery had successfully operated a small wetlands to purge residual contaminants from industrial wastewater. A biologist by education, Bookout could foresee the merit in treating the municipality's sewage while gaining a solution to the chronic bypasses through a new plant. Environmental organizations rallied behind the concept and one group even made a sizable donation to the eventual large-scale project.

"We didn't just want to include the wetlands because it was a popular thing to do," Bookout emphasized. "We wanted wetlands because the concept fit our specific needs, enhanced our system's performance, and benefited the neighboring environment.

"We compiled a tremendous amount of data from the pilot wetlands over the course of several seasonal scenarios," Bookout said. "Being raised on a farm and having an agricultural background, I was confident we could manage a wetlands. I was amazed there were so many intricacies to managing a wetlands that we learned from the pilot wetlands."

According to PEC, which monitored the wetlands over the three years before applying them to the new plant, the pilot wetlands fully met expectations during the warmer seasons when the rainstorms most frequently occur.

"The rains in Kansas are normally in the spring, summer, and late fall," PEC's Bailey added. "The precipitation experienced in the winter is almost always in the form of freezing rain or snow that doesn't run off very fast. Thus, the wetlands are not normally needed during cold weather. That winter season also presents a period when the dead growth can be removed using either mechanical methods, or by burning them off. Doing so prevents decomposing material from contributing to built-up ammonia with the onset again of warmer, wet weather when outflow resumes from the cells."

Table 1. Expected Wetlands Performance as Proven by Pilot Plant Testing

Parameter	Effluent Quality	Percent Removal
BOD	5.25 mg/L	82.1
TSS	11.64 mg/L	69.2
Ammonia (N)	0.51 mg/L	85.8

Adopted Plant Design

The new plant was sized for three mgd average/six mgd peak daily flow and should serve the South-Central Kansas community's projected population of 14,000 residents through 2022.

Table 2. Influent Wastewater to Wetlands for New Activated Sludge Plant (Peak Flow Conditions)

Parameter	Value
Inflow to New WWTP Processes	
Flow	6.0 mgd
BOD	4.3 mg/L
TSS	56.4 mg/L
Ammonia	5.36 mg/L
Bypass Flow	
Flow	8.0 mgd
BOD	43.7 mg/L
TSS	56.4 mg/L
Ammonia	5.36 mg/L
Equivalent Flow to Wetlands	
Flow	0.23 mgd
BOD	31.4 mg/L
TSS	40.5 mg/L
Ammonia	3.85 mg/L
Temperature	10° Centigrade

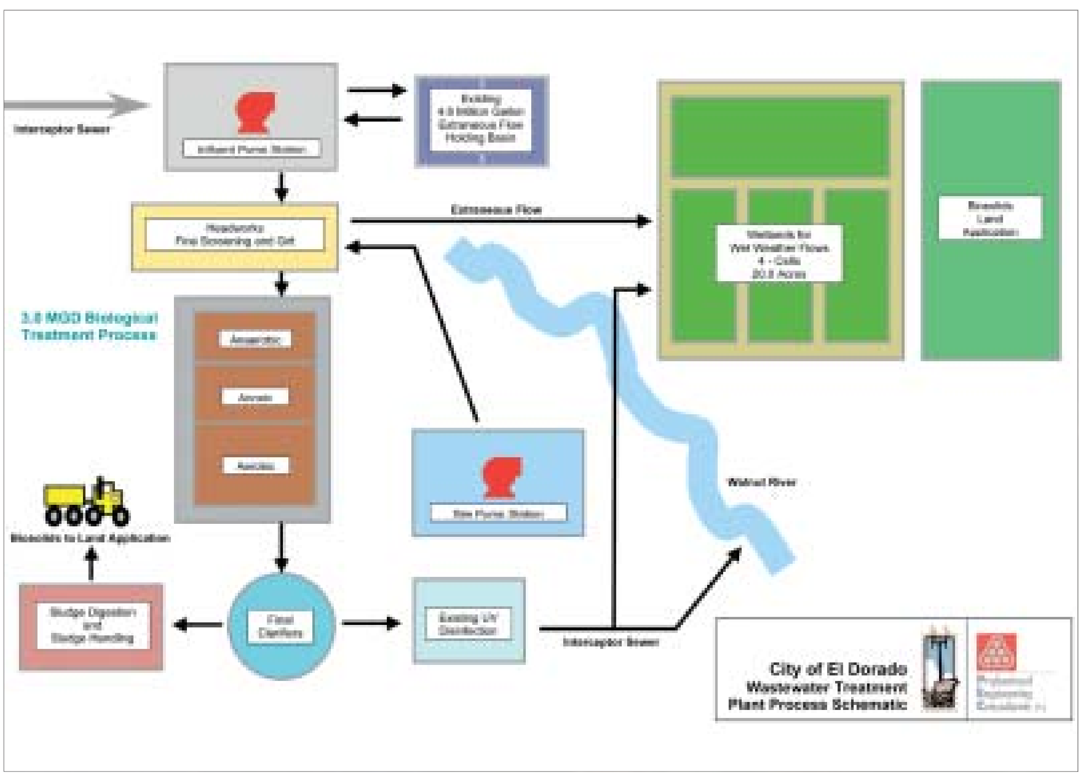
Developed on a portion of a 270-acre site, the plant is positioned on six acres, with 219 acres share-cropped and used for disposal of the plant's Type B dewatered sludge.

The 23.9 MG of total storage consists of the four, five-acre wetlands and the former plant's extraneous flow basin storage (See Table 2). Multiple cells allow an exchange of water between the wetlands and better management of their plant growth within each unit. The old plant's 4.6-MG storage basin—linked by a 24-in. transfer line across the Walnut River—provides interim retention for up to 2.3 days with the excess inflow diverted there gradually drawn back into the new plant for treatment.

The replacement plant reused the UV disinfection system and a new upgraded influent pump station serves the headworks, which are equipped with spiral screens and grit removal. The process architecture includes an activated sludge biological treatment basin, clarifiers, sludge dewatering centrifuge, and the post-aeration cascade where the treatment plant wetlands discharge polished effluent to the River.

PEC designed for loadings based on 204 mg/L for influent BOD; 263 mg/L for influent TSS; and 25 mg/L for influent ammonia. Effluent values used were 2005 to 2022 (projected objectives) and included treatment improvements of 30 mg/L raw BOD to 20; 30 mg/L maintained for TSS; ammonia reduction from 2.9 down to 1.5; 10 mg/L nitrogen and 200 CFU/100 ml for fecal coliform. The first month of operation achieved a fecal coliform count of zero, versus a limit of 200 mg/L.

PEC believes constructed wetlands could be used as treatment for extraneous flow in many regions, Bailey said. The most success will be achieved in the South, although the method has been used even in northern climates of the continent. This treatment plant and wetlands in El Dorado serves as an example for the rest of the United States. GE



Plant schematic.