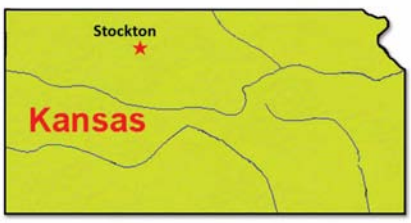
By Jeff Lamfers, KRWA Consultant

# Challenges for Stockton Wastewater Improvement Project: Force Main Odor Control and Beneficial Use of Lagoon Effluent

**Both draw-off pipes to the Effluent Pumping Stàon ar e equipped with screens to prevent solids from damaging the pump. The stàon is also equipped with an air pur ge system to clear the screens before pumping begins.**

Stockton, a community of 1,300 people, is located 45 minutes north of Hays, Kan. at the junction of U.S. highways 183 and 24. It is the county seat of Rooks County. Stockton is located in the South Solomon River valley, where the military supply trail from Fort Kearney (Nebraska) to Fort Hays crossed the river. Stockton was founded in 1872; many of the earliest settlers were cattle dealers. They originally named their new home "Stocktown," which was later changed to Stockton.

Stockton has a commission/manager form of government. City Manager Keith Schlaegel administers the daily affairs of the city and the commission sets policy. Stockton's city commission has five members with one acting as mayor. Services provided by the city include maintaining city streets, the electrical distribution system, water treatment and distribution, and wastewater collection and treatment. This article will document recent improvements the city has made to their wastewater treatment system and influent pumping station. There were many challenges to overcome for both the city and their consulting engineer and therefore, makes for a very interesting case study.




## Deciding Whether to Upgrade or Replace Existing Treatment Facilities

The city embarked on a project to upgrade their wastewater facilities due to several factors. First, the existing treatment plant was outdated and in need of major improvements. At the time, treatment was provided by a Smith & Loveless Oxigest activated sludge plant. Due to its condition and age, considerable funds were required to keep the plant maintained and running. Second, the plant struggled to meet current effluent limits for several parameters, including ammonia and E. coli not to mention stricter, future limits for nutrients such as nitrogen and phosphorous. Third, the permit for this facility also had a Schedule of Compliance requiring the city to undertake a study to determine why the plant effluent had elevated levels of selenium. Fortunately this problem was later found to be caused by laboratory error. And finally, the city wanted to eliminate all NPDES Permit compliance issues by eliminating discharge. Regardless of the treatment option, if all effluent can be used beneficially and not discharged to a receiving stream, EPA discharge limits become irrelevant. The most common form of beneficial reuse in Kansas is to irrigate the treated wastewater on cropland, sporting fields, parks, golf courses, etc. Although changing to non-discharging via irrigation eliminates the EPA discharge permit, a Kansas Department of Health and Environment (KDHE) permit is still required. However, it is much less stringent and well worth the time and effort.

**This wall mural by local artists Jenny Thayer-Wood and Kevin Thayer depicts the beginning of rail service to Stockton, KS in November 1885.**

Stockton retained the consulting firm of Evans-Bierly-Hutchison & Associates, P.A. (EBH). The city began working closely with Jim Kohman, P.E. of EBH's Great Bend, KS office. Initially, the city proceeded with their project voluntarily based on the aforementioned reasons. City staff and elected officials agreed that it was only a matter of time before KDHE would require such improvements anyway. Eventually, KDHE did include a timetable in the NPDES Permit Schedule of Compliance, requiring the city to complete construction and start operating their new or upgraded treatment system prior to July 1, 2014. While several options were considered, the chosen option was to design and construct a new, non-discharging waste stabilization pond (lagoon) with irrigation of effluent to eliminate discharge.

## Choosing a Location for Stockton's New Sewage Lagoon

The city tried to acquire the acreage needed for a new lagoon, just south of town and not far from their existing treatment plant. Unfortunately the city received no offers to purchase land, probably due to the fact the ground is good agricultural farm ground in the river valley. But a lagoon in that location would have also presented the problem of being in a floodplain. So the city began looking at land out of the river valley. One such site was the city's grass runway airport four miles south of town. Since the county was planning a new airport closer to Plainville, the city was considering abandoning their current airport site anyway; it could now be the location for their new lagoon. Advantages were that it was already city-owned and of sufficient size for the lagoon. Disadvantages were that it was almost four miles south of town requiring a long force main and at an elevation 200 feet higher than the city. Thus began the first of several challenges the city's engineer faced when designing the new pump station, force main and lagoon.

Because of the elevation difference between town and the new lagoon site, the force main would have a very high head (200 feet static, 380 feet pumping). The solution was to design a pumping system using two parallel units with each unit having two Smith and Loveless 75 hp pumps, pumping together in series. See the photo. Each side can pump 750 gpm against 200 feet static head. The wet well is preceded by a Vulcan stair-type bar screen to help prevent the pumps from plugging.

## Controlling Odors at Pumping Station and in Long Force Main

Long force mains are a concern as anaerobic conditions and objectionable odors can develop. In the absence of oxygen, anaerobic organisms will proliferate. These are the organisms that produce objectionable gases such as hydrogen sulfide and methane. These gases can cause human exposure issues, impede aerobic treatment and corrode concrete and metal such as steel and aluminum. In Stockton, this problem is compounded by the fact that sewage entering the city's existing plant was usually low in oxygen with odors already. Stockton's new force main is around 20,000 feet long (3.8 miles) and presently has eleven to fourteen hours of detention time at current average flows. Detention time is even greater at night. In order to control odors at the new sewage pump station and in the force main, EBH proposed an innovative odor control system using both oxygen ($O_2$) and ozone ($O_3$). There are no chemicals to purchase and store as oxygen can be derived from the atmosphere and ozone can be generated on-site using oxygen. Plus, the electrical requirements to do so are very low.

Ozone is a very powerful oxidant. Based on dosage and contact time, ozone is very effective at controlling the sulfate-reducing bacteria that cause hydrogen sulfide gas. Ozone reacts with both organic and inorganic matter in raw sewage very quickly as it is highly reactive. Ozone then breaks down into oxygen molecules, which results in higher dissolved oxygen (DO) concentrations. Research indicates

**Influent pump station must pump against a 200-foot head to the lagoon almost four miles from town. The Smith & Loveless 75 hp pumps are paired together and pump in series. Each pair of pumps can pump 750 gpm.**

**All three lagoon cells have concrete aprons such as this to prevent erosion problems. This is especially crìc al on Cell 3 where the water depth can vary from five feet to nine feet.**

that using both $O_2$ and $O_3$ together, results in more effective hydrogen sulfide control than either $O_2$ or $O_3$ can provide alone.

The equipment needed for such odor control requires using scrubbers to separate nitrogen gas from the atmosphere and concentrating the $O_2$ to 90 to 95 percent. The concentrated $O_2$ can then be used to produce $O_3$, but only at a small fraction of the overall $O_2$ concentration. $O_3$ is produced by allowing a high electrical voltage to pass through an air gap, breaking down the $O_2$ molecule and forming a 3-atom oxygen molecule – ozone. The unit Stockton is using can adjust the concentration of $O_3$ produced or turn it off so that only $O_2$ is produced. Because $O_3$ is such a strong oxidizer, it is rarely added by itself. While $O_2$ can be applied alone, $O_3$ is not added without $O_2$ also.

The best installations using $O_2$ and $O_3$ for odor control use a proprietary "infuser" device. The infuser causes the gases to be dissolved, making a supersaturated solution of either $O_2$ or $O_2 + O_3$. The solution is then injected into the force main to control hydrogen sulfide producing organisms while adding oxygen. The solution can also be added to the wet well and recirculated to produce an oxygen-enriched sewage, control odors and eliminate grease accumulation. So far, Stockton's odor control system is working well. Even with the long force main detention time, DO concentrations are typically around 0.5 to 1.0 ppm at the lagoon influent box. So far, objectionable odors have not been a problem at the pump station or lagoon. In addition the DO in the raw sewage entering the lagoon gives the biological treatment process a "jump-start" on breaking down incoming organic matter. Otherwise, there would be a much greater oxygen demand on Cell 1 and treatment would likely suffer at times.

## Treatment Using New Three-Cell Lagoon with Irrigation

The last component of Stockton's wastewater system upgrade was construction of a new 3-cell non-discharging lagoon with a design flow of 200,000 gpd. The new lagoon has a total surface area of 16.34 acres; it can be operated in either series or parallel. Cells 1 (northeast) and 2 (northwest) have a normal operating depth of five feet. These cells are primarily responsible for BOD and ammonia removal. Cell 3 (south) is used as a polishing cell. Since this cell will also be used as a holding cell before pumping to a nearby golf course holding pond, the water depth can vary between five to nine feet. All cells have a concrete apron for erosion control.

The city plans to irrigate 100 percent of the effluent from the lagoon. The effluent will be disinfected using a gas chlorination system and then pumped approximately 30,000 feet south to the Rooks County Golf Course located 4.5 miles north of Plainville. The effluent pump station can draw out of Cell 3 only. Effluent can be drawn from two different depths in Cell 3 in order to avoid concentrated algae near the surface during summer months. The suction lines to the pump are also equipped with screens to protect the pumps from solids, algae, etc. There is also an air purge system that can be used to clear the screens of solids before pumping.

The force main to the golf course holding pond will act as a chlorine contact chamber to ensure sufficient contact time to control pathogens. There

**These scrubbers are used to separate nitrogen so that high-purity oxygen remains. Some of the oxygen is then used to produce ozone on-site. Ozone and oxygen are usually fed together as each creates specific benefits. Ozone is effecv e at controlling sulfate-reducing bacteria that cause odors. Oxygen ensures anaerobic condions do not dev elop.**

are several taps along this line that allow for monitoring chlorine residuals. The city's permit requires monthly E. coli monitoring of treated effluent from Cell 3 prior to chlorination. It also requires weekly chlorine residual monitoring along the force main to the golf course. Weekly chlorine residual and E. coli monitoring are also required where the force main discharges into the golf course holding pond. The E. coli limit at this location is 262 colonies/100 ml. Meeting this limit should not be a problem due to the long chlorine contact time in the 30,000 feet of force main.

The total cost of this project was $5.4 million. Stockton was eligible for 15 percent principal forgiveness for all engineering and construction costs, and an additional 25 percent principal forgiveness for the cost of construction of those components considered "green design components". Stockton was eligible for green component principal forgiveness as the project eliminated all discharges from the city's wastewater treatment system, resulted in lower energy use and allowed the Rooks County Golf Course to use treated, disinfected effluent to irrigate as opposed to using local runoff and potable water from a nearby rural water district, as was the prior practice. Principal forgiveness totaled $1.8 million. The remaining balance of $3.5 million was financed by a KDHE Clean Water Fund Revolving Loan with an interest rate of 2.76 percent; the maturity is 20 years. As of June 2013, residential sewer rates were $34.25 per month.

**The effluent will be disinfected using a gas chlorination system and then pumped approximately 30,000 feet south to the Rooks County Golf Course located 4.5 miles north of Plainville.**

## Conference topics

If you are interested in learning more about this project, please plan to attend the session on Stockton's project at the 2015 KRWA Annual Conference & Exhibition in Wichita on March 24-26, 2015. Jim Kohman, EBH, and Jon Voss, City of Stockton, will be giving a presentation on this project at 1:30 PM on Wednesday, March 25 in Room 210 C. Make sure to bring your questions. I hope to see you there.

*Jeff Lamfers began work for KRWA in November 2008. Jeff has more than thirty years of regulatory experience in the oversight and operation of water and wastewater systems with the Kansas Department of Health and Environment. He is a graduate of the University of Kansas with a degree in Environmental Studies with an emphasis in aquatic biology.*