By Jeff Lamfers, KRWA Consultant

Using Effluent Structures with Multiple Draw-off Pipes to Produce Better Quality Effluent

This photo shows the valves that control each of the draw-off pipes. The one on the left controls the upper pipe. The one on the right controls the lowest pipe. And the middle one controls the middle pipe. It is a good idea to exercise these valves periodically so they will work when needed.

It can be challenging for many discharging lagoon systems in Kansas to meet effluent limits for Total Suspended Solids (TSS), especially during warmer summer months. Discharging lagoon systems in Kansas typically have a TSS limit of 80 mg/l (monthly average). Many systems have no problems meeting TSS limits three out of four quarters every year. But many times, the third quarter (July-September) and the fourth quarter (October-December) have problems meeting this limit. So, why can compliance with TSS limits be a seasonal problem? To better understand the answer to that question, we need to understand the biological processes that occur in a municipal lagoon.

In KRWA's lagoon workshops, we always stress the importance of the relationship between bacteria and algae in a lagoon. These two life forms rely on each other to live, multiply and provide what's needed to break down incoming raw sewage. Facultative bacteria have two requirements to survive: a food source and oxygen. Their food source is organic material and nutrients in sewage. A byproduct of their activity is carbon dioxide. But where do they get the oxygen they require? That is where algae come in. Algae are plants that go through a process known as photosynthesis to survive and multiply. Algae take in carbon dioxide given off by the bacteria and produce more algae in the presence of an energy source such as sunlight. The byproduct of this process is oxygen which is then used by the facultative bacteria. As long as both organisms have what's needed to survive and multiply, all is well and the breakdown of sewage occurs.

These are the three samples collected from each of the draw-off pipes. The one on the right, which exhibits the most intense green color, was collected from the upper pipe. While the other two are very close in color looking at the photograph, the one in the center is actually a little lighter green color and was collected from the middle pipe. The sample on the left was collected from the lowest draw-off pipe. If collecting samples that day, I would suggest using the middle draw-off pipe for your sample.

But the question becomes, can you ever have too much of either organism in your lagoon? In the case of bacteria, probably not. But algae are another story altogether. Wastewater in a lagoon is a perfect environment to grow algae, especially during the summer months. Wastewater is rich in nutrients like nitrogen and phosphorous needed by all plant life, including algae, to survive. In theory, all treatment and breakdown of raw sewage in a lagoon should occur in the primary and secondary cells. Once flow reaches the final, polishing cell, there is little organic matter and nutrients left.

Again, in theory, algae are supposed to die off in the final cell, so the lagoon produces a clear effluent free of solids and algae. Unfortunately, that is rarely the case. And this is especially true during the summer months. As I mentioned earlier, algae need sunlight to survive and multiply. So during the summer months, the concentration of algae in a lagoon is at its maximum due to long days, more direct overhead sunlight, fewer cloudy days and warm water temperatures. This can then adversely affect effluent quality, especially the algae concentration in the lagoon discharge.

One idea that has been promoted over the past 20 or so years is to provide lagoons with the ability to draw effluent from different depths of the final cell. Why would this be important? Again, remember algae require sunlight to survive and multiply. So typically, you should find the highest concentration of algae near the surface of a lagoon. However, at lower depths where sunlight cannot penetrate, usually there will be lower algae concentrations. Consequently, engineers have been designing effluent structures that allow drawing effluent from various depths. Typically, these lagoons will have two to three different draw-offs, often depending on the total depth of the final cell. Engineers have also started designing final cells with a greater water depth than the primary or secondary cells. Hopefully, that should give the operator more flexibility in finding that "sweet spot" at the right depth that provides a clearer effluent than what you find near the surface.

This photo shows the draw-off pipes as they enter the effluent structure. The upper pipe is on the left. The middle pipe is next. And the lowest pipe is still under water. This is where samples should be collected for visual inspection by using either a sampling stick or bucket and rope.

So typically, you should find the highest concentration of algae near the surface of a lagoon.

Over the years, many discharging lagoons have either been built with this draw-off design or modified so that such is available. However, I am often surprised that many operators do not understand the purpose of multiple draw-offs and how that can help produce a better quality effluent. One such system whose lagoon is equipped with multiple draw-off pipes is the city of Moran. The city has a three-cell discharging lagoon. The first two cells have a typical 4-5 foot water depth. However, the final cell has a 7-foot water depth and three draw-off pipes in the effluent structure. According to the city's lagoon blueprints, the upper pipe is 1-foot below the water surface, the middle pipe is almost three feet below the surface and the lowest pipe is almost four feet below the surface.

What we found was that the upper pipe by far had the greenest color and thus, more algae which could contribute to high effluent TSS.

I recently met with the city's operators and we collected individual samples in clear glass mason jars from each of the three draw-off pipes. See the photographs. On the day we met and collected samples, it was very windy. That may have provided more mixing of the final cell than on a calm day. In short, strong winds may not promote the idea of having individual layers within a lagoon with almost all of the algae near the surface. What we found was that the upper pipe by far had the greenest color and thus, more algae which could contribute to high effluent TSS. The second greenest sample was the lowest pipe. But the pipe that provided the least amount of green color and algae was in the middle. While I realize this is somewhat surprising, it should be noted that, as least visually, there really wasn't that much difference in green color intensity between the two lower draw-off pipes. And the strong winds could have contributed to our findings. Regardless, I encourage all systems that have effluent structures with multiple draw-off pipes to experiment and conduct this same visual test to find which draw-off pipe produces the least green effluent which then hopefully has a lower TSS concentration.

I encourage operators with such an effluent structure design to conduct such tests, if possible, on calm days or even after several days of cloudy weather. Finally, to generalize, most such designs were meant to use lower draw-off pipes during the summer months and upper or middle pipes during the winter. Please note, however, that this doesn't always hold true. The best way to take full advantage of such a design is to conduct the visual test described in this article. And if I can be of help, please feel free to call or email me. I can be reached at either 913-850-8822 or jeff@krwa.net.

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.