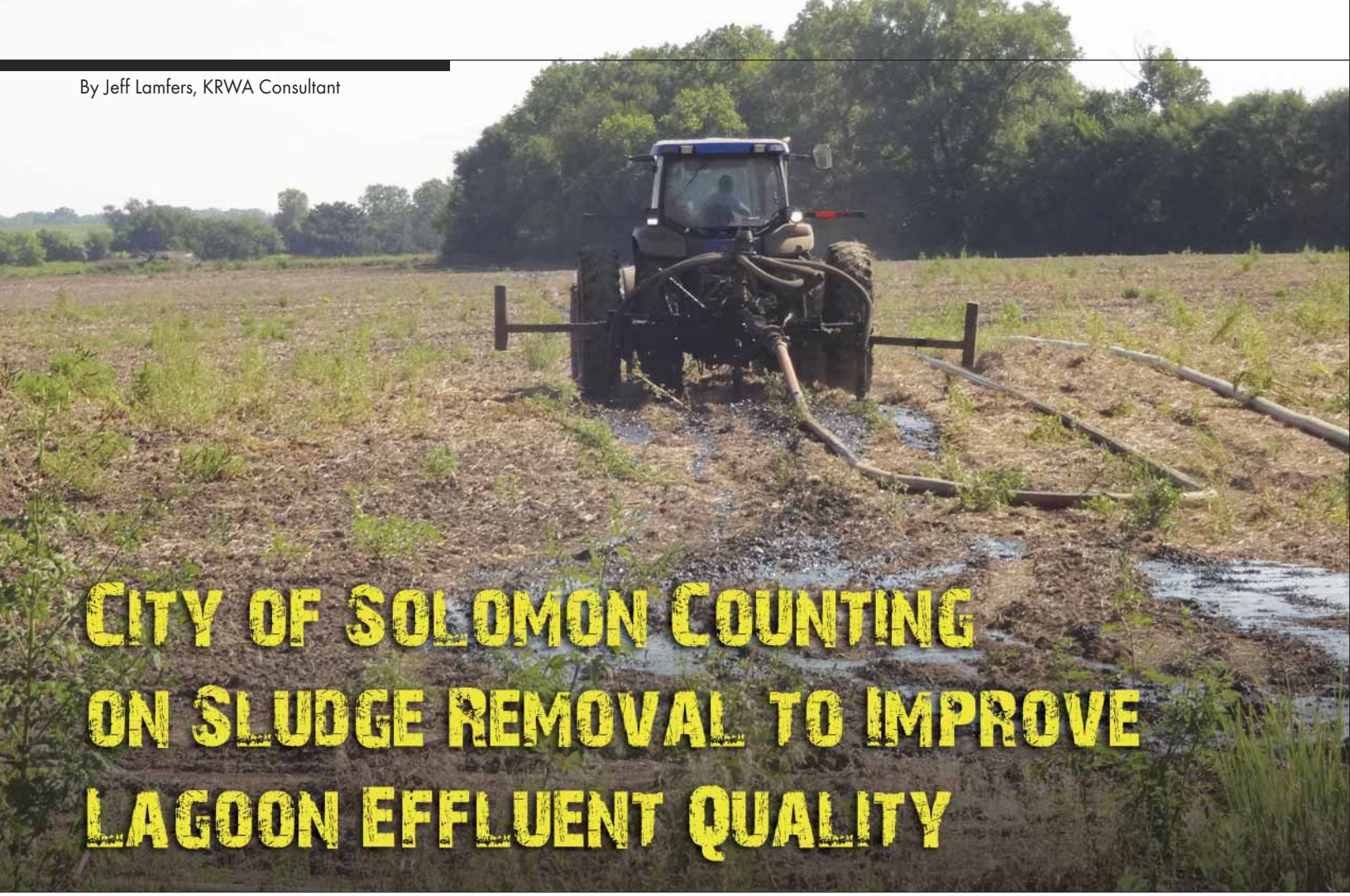
By Jeff Lamfers, KRWA Consultant



City of Solomon Counting on Sludge Removal to Improve Lagoon Effluent Quality

Solomon's City Council and City Superintendent had known for several years that they had a problem with their four-cell, discharging lagoon. Dating back to at least 2015, the lagoon effluent would often exceed permit limits for Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS). Consequently, the city was referred to the Kansas Rural Water Association by KDHE in June 2016 due to these violations.

KRWA staff worked with the city and provided recommendations to bring the lagoon back into consistent compliance with effluent limits. Recommendations included operating their two primary cells in parallel to better distribute organic loading, using the lower draw-off pipe in their effluent structure and operating the lagoon to discharge constantly, not intermittently. Other possible causes for the violations were also considered such as short-circuiting, organic loading higher than design parameters and possible poor sample collection techniques. But none of these recommendations or issues made a difference in effluent quality. The lagoon continued to exceed limits.

Measuring sludge depths in cells 1A and 1B

In May 2018, Charlie Schwindamann with KRWA met with Dan Britt, City Superintendent, and measured sludge depths in the first two cells. Both cells (Cells 1A and 1B) are equal in surface area at 2.9 acres. KRWA did not pursue measuring sludge depths at first as they were hoping that excess sludge was not a problem. Also, of all the options being pursued to improve effluent quality, sludge removal was by far the most expensive option. It was found that both cells contained excess sludge, but probably not unexpected for a lagoon that had been in service for many years. Cell 1A contained 16.5 inches of sludge with most of that being heavy, inorganic material that doesn't decompose. Cell 1B contained 12.6 inches of sludge. The overall average loss of treatment capacity for both cells was 20 to 25 percent. And please note that measuring sludge levels is not an exact science. It is basically a way to provide information to see if, in fact, excessive sludge might be a problem.

This tractor is surface-applying sludge. Notice the hose connected directly to the spreader on the tractor. Fortunately, the site was close enough to the lagoon that sludge could be pumped directly and not have to be hauled by tanker trucks.

In my opinion, excessive sludge can cause a couple of problems in lagoons. First, as already mentioned, sludge can take up volume within a lagoon and reduce treatment capacity from a hydraulic standpoint. Secondly, sludge on the bottom of a lagoon is broken down by anaerobic digestion (in the absence of free oxygen). Anaerobic

This photo shows Cell 1A after some sludge was removed. Notice the build-up of sludge in the corner around the influent pipe.

This is the small bulldozer with a modified blade that was used to collect the sludge slurry and move it toward a pump for ultimate removal. During the day as the sludge started to dry in Cell 1A, wastewater would be pumped from Cell 1B over to Cell 1A to keep the sludge in liquid form so it could be pumped.

digestion results in the production of gases such as methane, carbon dioxide and hydrogen. But another byproduct is ammonia. Ammonia is a form of nitrogen that like any nutrient, can stimulate excessive plant growth. And I think that happens in many lagoons with excessive sludge. Most lagoons that have excessive sludge also have more than normal algae growth. And while a lagoon needs algae as it is the major oxygen source for facultative bacteria to break down incoming organic matter, too much algae can present problems. The most obvious problem is that suspended algae in the last cell can end up in the effluent and cause TSS violations. Also, the die-off of large algae blooms places more organic loading on the lagoon cells as it will decompose just like incoming organic matter.

Consequently, KRWA staff recommended that the city consider sludge removal to improve effluent quality. It should be noted that KRWA staff want to ensure that sludge removal will likely improve effluent quality before offering such a recommendation. Unfortunately, there are a few lagoon systems over the years that have removed sludge and

An intermediate booster pump was used to pump sludge to the land application site. It was located downstream of the pump powered by a tractor power-takeoff located at the corner of the cell being desludged.

And chemicals do not work! I have worked with several cities that have spent considerable sums of money over several years, and there was still excessive sludge. One system even had more sludge at the end of the treatment period than when it started.

effluent quality did not improve. Also, recommending sludge removal is taken very seriously as it is a very expensive process as the city of Solomon soon discovered.

Sludge removal methods

There are several methods for removing sludge from a lagoon. Some work very well, and some do not. The main methods include:

1. Removing most of the water off of the top of a cell and then removing the remaining sludge slurry by using equipment to push the slurry to a corner and removing by pumping;
2. Removing sludge using a floating dredge with an extended auger lowered to the bottom of the cell;
3. Removing sludge by pumping off the top water and then allowing the sludge to dry sufficiently so it can be removed as a solid;
4. Elimination of sludge by using chemicals such as enzymes, biocatalysts, etc.

Based on my experience, the only removal option I would consider is the first one. The other three have severe limitations. Even during hot Kansas summers, drying sludge rarely results in sludge being removed as a dry cake. And chemicals do not work! I have worked with several cities that have spent considerable sums of money over several years, and there was still excessive sludge. One system even had more sludge at the end of the treatment period than when it started.

Selection of Nutri-Ject Systems, Inc. as the city's contractor

The city of Solomon began the process of selecting a contractor to remove sludge. After interviewing several, the city chose Nutri-Ject Systems, Inc. of Hudson, Iowa. Nutri-Jet is one of the leading biosolids (sludge) contractors in the Upper Midwest. They specialize in the removal and land application of solids from wastewater and water treatment facilities. They also excel in helping wastewater systems comply with state and federal regulations. Nutri-Ject recommended removing sludge as a slurry, using a small bulldozer to collect sludge in each cell, and then pumps and grinders to transport the slurry to the land application site. The land application site was just across the road from

This photo shows the pump located at the corner of a cell powered by a tractor. Sludge is directed to a grinder pump and then the intermediate booster pump before reaching the application site.

The photo below shows the land application site once sludge has been applied. Once the ground has dried sufficiently, the farmer will come in, disc the area and then plant crops. Notice the tractor land applying far off in the distance. Hopefully, the farmer's crop yield will be improved due to the nitrogen available in the sludge.

the lagoon and was owned by a local farmer. The bid for sludge removal, land application and testing of both the sludge and soil at the application site was $150,000. This bid also included Nutri-Ject using sludge and soil test results to complete EPA's Part 503 Standards for the Use or Disposal of Sewage Sludge forms.

Complying with EPA's Part 503 Land Application Regulations (40 CFR Part 503) as it applies to one-time applications from lagoons

I want to touch briefly on the Part 503 sludge regulations as they do apply to even one-time land application projects like desludging lagoons. Fortunately, the requirements for lagoons are scaled down considerably from what

This grinder pump was used to grind rubber and plastic products in the sludge so that such materials do litter the land application site.

is expected of larger, activated sludge plants that apply sludge to land application sites on a routine basis. The main reason these regulations are less encompassing is that the sludge from a lagoon that has been in service for 20 to 30 years should be pretty well digested. Hence, they are less likely to contain excessive levels of pathogens or to attract vectors such as flies, mosquitoes, rats, etc.

In July 2012, KDHE returned management of the 503 sludge program for mechanical plants to EPA. However, KDHE retained the 503 sludge management program for wastewater lagoons in Kansas. The 503 regulations are designed to protect public health and the environment from pollutants that may be present in sludge. However, both EPA and KDHE encourage the land application of sludge because of its soil conditioning and fertilizing properties. When sludge is land applied, KDHE requires that appliers comply with the following:

- Management Practices such as using relatively flat sites with little slope, staying away from nearby waterways, tributaries, etc. and taking precautions if applied when the ground is wet.
- The site restriction requirements under the Pathogen Reduction section. This section restricts sludge application on crops grown for direct human consumption. It also regulates how soon after sludge application that crops can be harvested or livestock graze.
- The Ceiling Limits for the listed nine heavy metals.
- Sludge must be applied at the Agronomic Nitrogen Rate or less. If not using KDHE's default application rate of two dry tons/acre or less, then the agronomic application rate must be calculated and used. This calculation must be made before applying sludge so that nitrogen is not over-applied. The agronomic rate is designed to provide the nitrogen the next crop needs while minimizing the amount of excess nitrogen that can percolate into groundwater.

The forms KDHE recommends using for reporting the Part 503 information and data can be found on their website at https://www.kdhe.ks.gov/1078/Domestic-EPA-503-Sewage-Sludge. Another helpful reference is EPA's "A Plain English Guide to the EPA Part 503 Biosolids Rule". This guidance document can be found at https://www.epa.gov/biosolids/plain-english-guide-epa-part-503-biosolids-rule.

One of the benefits of the city Solomon selecting Nutri-Ject is that they do an excellent job of completing the Part 503 forms. Nutri-Ject determined that approximately 1.750 MG of sludge needed to be removed and applied over a 70-acre site. The approved loading rate that they calculated was 61,500 gallons/acre. Another helpful benefit is that Nutri-Ject calculated the monetary value of the nitrogen applied to the

Such information can be very helpful when trying to convince a nearby property owner to allow a wastewater system to apply sludge on their land.

This small bulldozer pushes the sludge slurry to a corner to be pumped to the application site. This must be done over and over to get as much sludge as possible to the pump for removal.

farmer's field. Interestingly, the total value of nitrogen in the sludge was slightly less than $1,700. Such information can be very helpful when trying to convince a nearby property owner to allow a wastewater system to apply sludge on their land.

KDHE's guidance document for desludging lagoons by dredging

One final suggestion if your system is considering sludge removal and land application is to review KDHE's Guidance Document for dredging lagoons. It can be found at https://www.kdhe.ks.gov/DocumentCenter/View/9383/Desludging-Lagoon-Guidance---Dredging-PDF. Some of the more critical issues addressed in this document include the following:

- How to determine the best method for removal and ultimate disposal.
- How to select a suitable land application site.
- How to continue providing wastewater treatment during the sludge removal project. Please note that routing raw sewage directly to a cell being desludged is not an acceptable practice and will not be approved by KDHE.
- Making sure that all valves, stop plates, etc., are in working order so that cells can be isolated and that the remaining cells can provide adequate treatment during sludge removal.
- Preventing damage to the clay liner on the dikes and bottom of the cell during sludge removal.
- Best practices for re-establishing biological processes in a lagoon cell once sludge has been removed and the cell placed back in service.
- Necessary contacts must be made with KDHE's district offices before and after the sludge removal project is completed. Wastewater utilities must obtain permission to remove part of the lagoon system from service. Systems may be required to submit an Incident Report Form similar to what is used when reporting sewage bypasses.

Finally, I think it is essential to report back from the city on how the sludge removal project went. So once the project was completed, I visited with Superintendent Dan Britt. The project began with equipment setup in mid-August. The project took a few more days than usual due to mechanical problems. But according to Dan, set-up usually only takes a couple of days. According to Dan, once the contractor started removing sludge, they got a minimum 90 percent removal of sludge from Cells 1A and 1B and finished by September 2, one day after the deadline the city requested. The farmer wanted to plant wheat and asked that the project be completed as close to September 1 as possible. The most difficult areas to remove sludge were in the corners of the cells and around the piping. During the project, the city received no complaints of odors, flies, etc. It probably helped that the farmer got in shortly after sludge application to disc in the sludge and plant his wheat crop. The 70 acres available to the city for land application was more than enough land to dispose of the removed sludge properly. The city's only additional expense was putting in a culvert under the nearby road so they could run a hose from the pumping station on the lagoon dikes to the tractor at the land application site on the other side of the road. Overall, Dan was very satisfied with how Nutri-Ject managed the project and the service the city received. And as Dan said, the best thing that happened is that it didn't rain the entire time sludge was removed!

Once the removal project was completed, the city pumped some wastewater from Cells 3 and 4 back to Cells 1A and 1B to hasten their recovery. Adding some treated wastewater back to cells while they are filling helps by providing the bacteria and algae needed to get those cells operating again from a biological standpoint. Dan reported that both cells are already showing a green color due to algae.

Now that the sludge removal project has been completed, the city, KRWA and KDHE will closely monitor future effluent test results to see if effluent quality has improved and whether the lagoon has returned to compliance. If, in the future, your wastewater system is anticipating the need to remove sludge and would like technical assistance, please feel free to contact me or any other KRWA staff. I can be reached at jeff@krwa.net or 913-850-8822.

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.