By Charlie Schwindamann, KRWA Wastewater Tech

Contributors To Short-Circuiting in Wastewater Stabilization Ponds

One of the advantages of wastewater lagoons for treatment of domestic wastewater is that lagoons usually require fewer staff hours and have lower operating costs than other types of treatment systems. However, this doesn't mean that lagoons can be neglected. Lagoons, sometimes referred to as ponds, are designed so that the wastewater enters and leaves the lagoon through inlet and outlet pipes. Modern designs place the inlet as far as possible from the outlet, on opposite ends of the lagoons, to increase detention times and to prevent short-circuiting. Some lagoons have more than one inlet to provide for better control such as operating in series or parallel. Outlets are designed depending on the method of discharge. Outlets often include structures that allow the water level to be raised and lowered.

Because of design issues or problems with sludge accumulation, sometimes the lagoon systems do not operate as intended. Inadequate treatment results when wastewater leaves one cell of the system too soon. This is called short-circuiting. It's my opinion that short-circuiting is the major reason that some Kansas lagoon systems fail to meet the system's discharge permit limits. There are several contributors to short-circuiting. These include design, sludge accumulation and Inflow and Infiltration.

Influence by design

Most of the wastewater stabilization ponds designed and constructed in the mid-1960's, to even some as late as the 1990's, were designed when the issues with short-circuiting of the wastewater in treatment systems were not completely understood. The older systems had the influent pipes placed to the center of the cells and had the transfer pipe from cell to cell in the center of the dikes. These discharging systems may even have discharge structures in each cell of a two-cell system. See Diagram A. This same design was sometimes even applied to three-cell systems. See Diagram B. To correct short-circuiting due to design requires a licensed engineer to design the change and then obtain approval from the Kansas Department of Health and Environment (KDHE). Changes in design are not uncommon for older lagoon systems, especially when the system is upgraded or repaired. Most lagoons designed today have the piping inlets and outlets to the cells at opposite corners. This arrangement allows for the greatest detention time, thus allowing for the maximum treatment time in the cell.

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Problems with excess sludge

Excess sludge accumulation is another common contributor to short-circuiting in wastewater stabilization ponds. Indicators of possible excess sludge include if the system periodically fails discharge permit limits or BOD and TSS in the effluent increase over several years. Because of the design, some systems can handle more sludge than others. A rule of thumb is that sludge removal is warranted when the system has an excess of 25 percent sludge accumulation. Some systems may determine that sludge should be removed at 20 percent depending on the design and capacity of the lagoons. Remember KDHE regulations for the minimum design standard for a 3-cell lagoon is 120 days of detention time. If the capacity of the lagoon cells has been reduced by 25 percent that means the system has 90 days of detention time. Although most systems have more than the 120 days design capacity, some do not. I have conducted sludge profiles (measurements) where the capacity of the first cell was reduced by more than 33 percent but the system still met discharge limits. Performing a sludge profile ever five to ten years is one way to determine when sludge will need to be removed. Theoretically if the system is ten years old and sludge accumulation is only six inches, it will take another ten years before it reaches twelve inches. In this case, excessive sludge buildup is not likely to be an issue. There are several systems that perform a sludge profile every year and have the records. Those wastewater systems are developing contingency plans to fund the removal when that is necessary.

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Diagram A: Wastewater lagoons designed and constructed in the mid-1960's had the influent pipes placed to the center of the cells, and had the transfer pipes from cell to cell located in the center of the dikes. These discharging systems may even have discharge structures from each cell in a two-cell system.

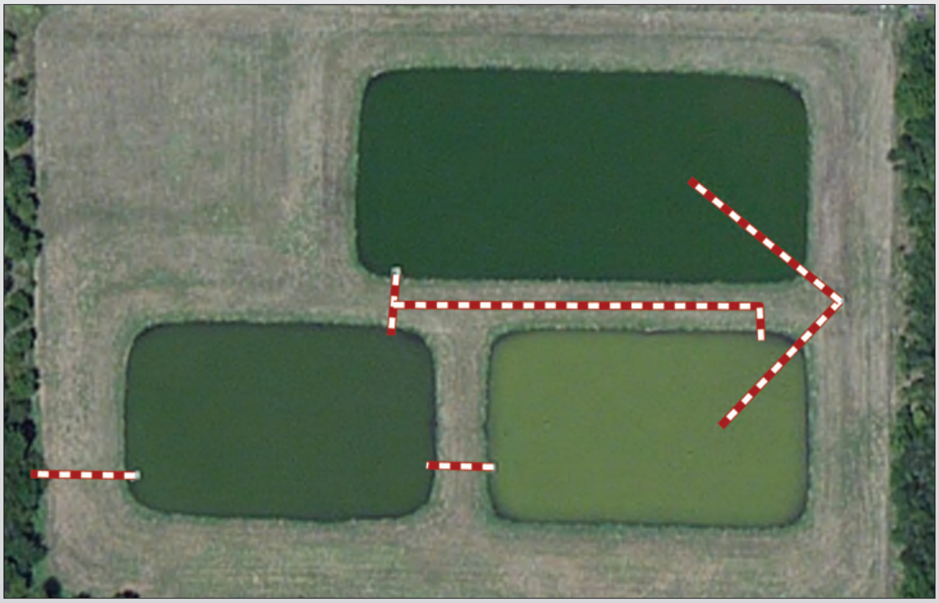

Diagram B: Due to the design, some older 3-cell systems also have piping to the middle of the cells.

Inflow and infiltration

Excessive Inflow and Infiltration, commonly called I & I, can also cause short-circuiting. Take for example a lagoon that is designed for 0.2 MGD or 200,000 GPD. Note, the design capacity of the lagoon is found on every system's permit. If normal flow is in the 120,000 GPD range, the system is fine. But if the flow during a rain event increases significantly to more than 500,000 GPD, then the flow is more than double the design capacity. This excess flow will reduce the time to properly treat the waste and the system could fail permit limits. The increase of flow that causes short-circuiting may only be slightly higher than the design capacity. Operators should check the flow daily to determine if there is excessive flow. I have seen discharge monitoring reports where the influent BOD was < 5 and effluent was 18 BOD. This may sound okay but it means that much higher BOD wastewater could have been, and in all probability was, discharged before the sample was taken. This could have adverse affect on the receiving stream.

Failure to meet discharge permit limits could be due to a combination of all the mentioned contributors.

Recently, I was at system in western Kansas. The system has failed its permit limits on occasion. The lagoon design has the influent pipe to the center of Cell #1; the discharge from this cell is on the northern end to Cell #2 and the discharge pipe from Cell #2 to Cell #3 is also on the northern end of Cell #2; the effluent structure is on the southwest corner of the final cell. I measured sludge accumulation of 24 percent in Cell #1 and 12.5 percent in Cell #2 and 13 percent in Cell #3. There also is a flow meter from the lift station and it has been calibrated. The design flow is 0.531 MGD and actual flow average is 0.209 MGD. There are days when flow increased to 0.309 MGD but that is still far below design. I believe the combination of sludge accumulation and the design of the lagoons has caused the short-circuiting and failure of the system's permit limits. Removing excess sludge from the cells may allow this system to meet permit limits. Eliminating the sludge accumulation and changing the piping, and reducing the I & I should allow the system to meet discharge permit limits.

Another issue of short-circuiting that I have seen is that of plugged pipes between cells. The plug could be in the influent structure pipe causing the flow to go to the second cell, bypassing the first cell or between cells – bypassing a cell or even two cells. This is why I suggest that operators go the lagoons daily or at minimum of three times per week. Don't just drive around but stop and look in each structure. If the operator becomes familiar with how the lagoon system is supposed to operate, the operator will recognize if there is an issue with a plugged pipe, excess odor or other needed repairs. Unfortunately, I have been to systems that the operators tell me they go out and look at the lagoons all the time. When I go out to their systems lagoons I can see the dikes need to be mowed. Surprise! There is no evidence of tire tracks through the areas of tall grass. No, the operator is not checking the lagoons as should be done.

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Kansas Rural Water Association has conducted many sludge profiles. KRWA does not charge for that service. I encourage anyone interested in learning more about lagoon operation and maintenance or any other wastewater treatment issue to email me at charlie@krwa.net or Jeff Lamfers at jeff@krwa.net or call the office at 785-336-3760.

Charlie Schwindamann has been Wastewater Tech at KRWA since September 1999. Charlie holds Class II Water and Class I Wastewater Operator certification. He is a member of the Marysville, KS City Council.