

Better Data Leads to Revised Lagoon Standard



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The American Society of Agricultural and Biological Engineers (ASABE) recently revised Standard ANSI/ASAE EP403.4 -- Design of Anaerobic Lagoons for Animal Waste Management. This is the first substantial revision to the standard since 1986. The most important changes were to the sludge accumulation

factors for swine and poultry manure treatment lagoons. The current factors for all types of manure are given in Table 1. Accumulation rates for pullet and layer farms were combined into one poultry factor. The new combined value is 12 percent higher than the old pullet rate and 28 percent lower than the old layer rate. The accumulation rate for swine lagoons was reduced 55 percent.

Although small on paper, these changes could greatly alter the design of manure handling systems used by pork and poultry producers. Let's step back and look at how lagoons function.

A lagoon is a large, earthen basin used to treat and store organic liquids and slurries. Lagoons are divided into three volumes stacked on top of each other – sludge storage, treatment, and effluent storage (Figure 1). Freeboard (empty storage space) above the effluent storage protects the lagoon embankments from overtopping during storms.

Organic solids settle to the bottom of the lagoon, and are digested at the top of the sludge layer. Further treatment takes place in the liquid portion of the treatment volume. The treatment volume is sized using a volumetric organic loading rate – the daily amount of organic matter fed to the lagoon, divided by the treatment volume. The design rate depends on a number of factors -- chiefly the desired level of treatment and climate.

When a lagoon is brand new, the liquid volume available for treatment is equal to the treatment volume plus the sludge storage volume. But as solids break down and become sludge,

the sludge layer grows and the liquid volume above it shrinks.

As seen in Figure 2, it is hard to find a sludge layer at all during the first year or so after manure is added to the lagoon. Then, sludge suddenly appears, and growth is rapid for the next 3 or 4 years. After about five years, accumulation slows to a steady rate. Once the liquid volume reaches a critical level, sludge accumulation accelerates again, and the lagoon quickly fills with sludge. The treatment volume is sized so that the critical value occurs after the design organic loading rate is reached.

Lagoons are designed to reach their design organic loading rate in 15 to 20 years. How large a volume is set aside for sludge storage is determined by the sludge accumulation factor. If the standard accumulation rate is increased, as it was for pullet farms, the required sludge storage volume increases. If the rate is reduced, as it was for swine, design sludge storage is smaller. Smaller sludge storage means smaller lagoons. Larger sludge storage means larger lagoons. Construction cost is partially dependent on lagoon size.

The standard accumulation factors shown in Table 1 imply that sludge growth is linear, but a number of studies leading to the sludge accumulation model shown in Figure 2 confirm that growth is not linear. Does not mean that the standard is wrong? No. If the stable growth stage lasts a long time, accumulation over the long haul appears linear. And with a 20 year design life, steady growth should last at least 15 years. The values given in Table 1 are linear approximations of the complex curve.

The microbes living in lagoons do not know or care about changes in standards. They will continue to digest solids the same as they always have.

A long term study of lagoons conducted in Oklahoma uncovered an interesting fact. Lagoon microbes do not like to be bothered. Contrary to what you might think, removing a little sludge every year actually makes the sludge accumulate faster. The factors given in Table 1 are based on undisturbed sludge. Mess with the sludge blanket, and the lagoon may fill up long before 20 years have passed.

Manure Type	Sludge Accumulation Factor	
	m ³ sludge/kg TS added	ft ³ sludge/lb TS added
Poultry	0.00202	0.0324
Swine	0.00137	0.0219
Dairy	0.00455	0.0729

Table 1. Sludge Accumulation Estimates (from ANSI/ASAE EP403.4 -- Design of Anaerobic Lagoons for Animal Waste Management).

To learn more about lagoon function and design, check out the revised OSU Fact sheet F-1736, Lagoons for Livestock Waste Treatment. To review research on sludge accumulation conducted right here in Oklahoma, read Transactions of ASABE. 53(2):529-536: Sludge Accumulation in Two Anaerobic/Facultative Lagoons Treating Swine Manure from Breeding Farms in Oklahoma. Both can be found at the **Waste Management Engineering website**, <http://osuwastemanage.bae.okstate.edu>.

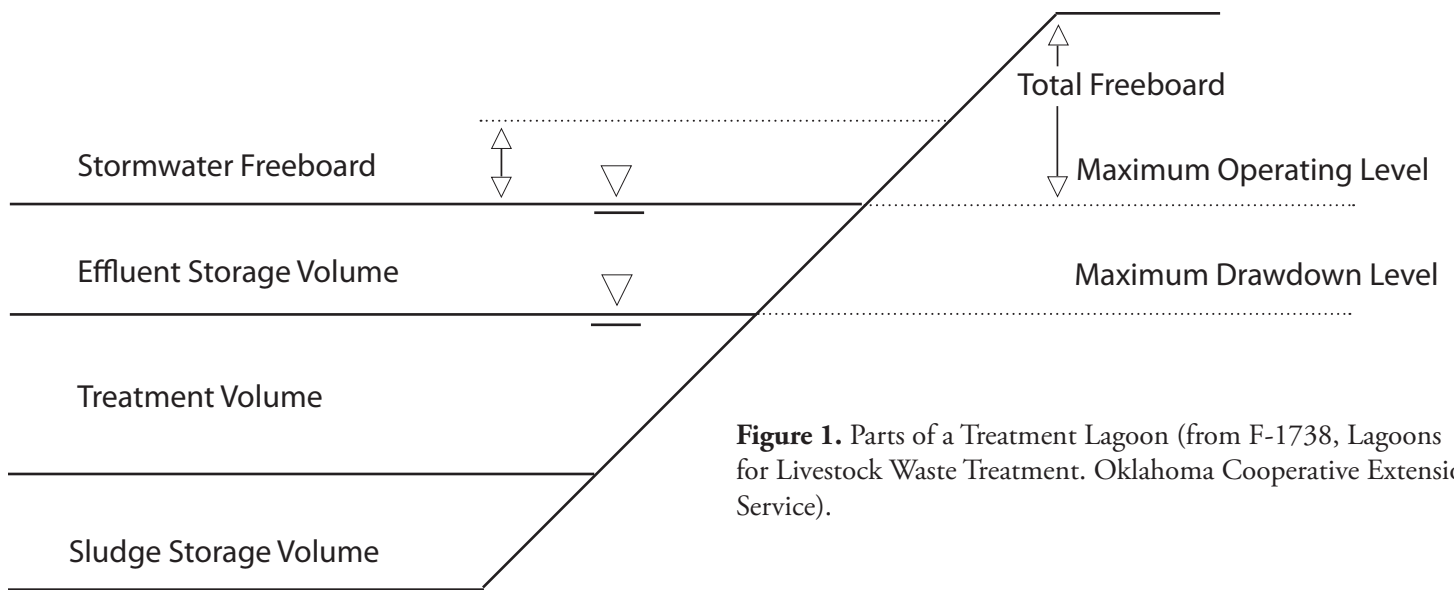


Figure 1. Parts of a Treatment Lagoon (from F-1738, Lagoons for Livestock Waste Treatment. Oklahoma Cooperative Extension Service).



The pictures above are of lagoons used in a long-term sludge accumulation study in Oklahoma.

Picture at left: Lagoon OK1 located near Tecumseh, OK. **Picture at right:** Lagoon OK2 located near Poteau, OK.

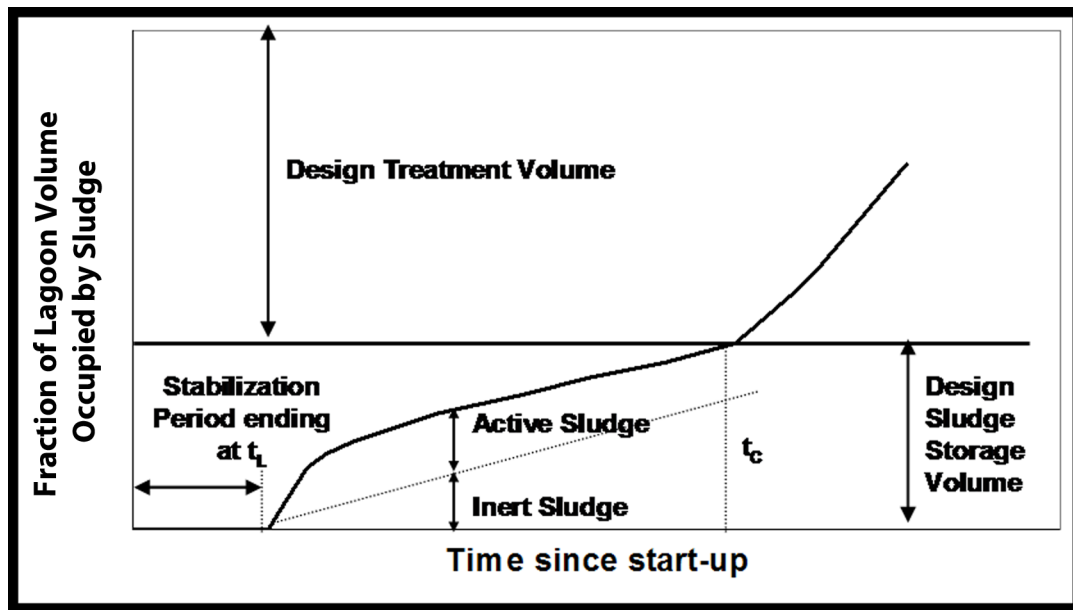


Figure 2. Complex Sludge Accumulation Model (from Hamilton, D.W. 2010. Sludge accumulation in two anaerobic/facultative lagoons treating swine manure from breeding farms in Oklahoma. Trans. of ASABE 53(2):529-536).