Sewage Sludge Disposal Guidance for Iowa Municipal Wastewater Treatment Lagoons Cleanup or Closure

Iowa Department of Natural Resources
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The objective of this guidance is to describe regulatory requirements for sewage sludge disposal from municipal wastewater treatment lagoons. The requirements and regulatory guidelines regarding sewage sludge sampling and analysis, disposal practices and site restrictions are the same whether you do lagoon sludge cleanup or lagoon closure. However, different from lagoon sludge cleanup, wastewater lagoon closure could involve a revision of the city's NPDES permit due to a change of wastewater discharge. Lagoon closure may involve other DNR's sections than the wastewater section due to lagoon structure demolition and solid waste disposal.

Land application of sewage sludge from a municipal wastewater lagoon is subject to sewage sludge regulations in 40 CFR Part 503, Standards for the Use or Disposal of Sewage Sludge, and IAC 567-67, Standards for the Land Application of Sewage Sludge. This guidance is only applicable to municipal wastewater lagoons. It does not apply to industrial wastewater lagoon sludge disposal or closure.

When a permittee plans to decommission a wastewater lagoon, all the sewage sludge in the lagoon must be removed and properly disposed of within two years after the lagoon ceases to receive wastewater unless the permittee intends to retire the lagoon in place through other sludge disposal methods such as surface disposal or site reclamation.

1. Preliminary Analysis Before Lagoon Sludge Removal

Sludge quantity and quality must be evaluated prior to sludge removal. If there is any pollutant in the sludge exceeding the allowable pollutant concentration, land application may be prohibited. The preliminary analysis also provides important nutrient concentrations for calculating the agronomic nitrogen rate and is directly related to the initial determination of the required application area. Costs for lagoon sludge cleanup can be quite significant. The preliminary analysis of sludge quantity and sludge quality is very important for sludge disposal cost development. If sludge disposal options, other than land application are being pursued, additional sludge characteristics may be needed during the preliminary analysis.

1.1 Sludge Quantity Before Dewatering

Use a sludge judge to determine the lagoon sludge depth. Develop a grid system to check the total depth of the sludge at the bottom of the pond. Be sure not to include liner material in the sludge samples. Estimate the approximate amount of lagoon sludge in the pond based on the following equation.

Equation 1:

To determine total sludge amount, you need to know percent solids (TS%) of your sewage sludge. The percent solids is the weight of dry solids divided by wet sludge times one hundred.

$$\begin{aligned} &Total\ sludge\ dry\ metric\ tons \\ &= sludge\ depth\ (in) \times sludge\ area\ (ac) \times 27{,}154\left(\frac{gal}{ac * in}\right) \times 8.34\left(\frac{lbs}{gal}\right) \div 2{,}205\left(\frac{lbs}{ton}\right) \times TS\% \\ &\div 100 \end{aligned}$$

Sludge area in the mid-depth of the sludge layer is used in Equation 1.

1.2 Sludge Composite Sample

One composite sample is recommended in the sludge preliminary analysis. The number of sludge samples is based on the whole area of treatment ponds. A minimum number of three samples is required for ponds 0.5 acres or less, and four or more for ponds larger than 0.5 acres. One additional sample per acre is required for ponds larger than four acres. All samples from ponds are composited (mixed) to be one sample for lab analysis. Liner material should not be included in the sample. Send the composite sludge sample to the lab for analysis of the following parameters.

Parameters for analysis are (dry weight):

- Total solids
- Volatile solids
- pH
- TKN (%)
- Ammonia-N (%)
- Phosphorus (%)
- Potassium (%)
- Pollutant concentrations (mg/kg), As, Cd, Cu, Pb, Hg, Mo, Ni, Se, Zn
- Fecal Coliform (MPN/gram)
- PCBs (if the ponds were built before 1984)

Pollutants must meet the following ceiling concentration for land application (IAC 567-67.8(2), 40 CFR 503.13). If any one of the metals is above the ceiling concentration, the biosolids cannot be applied to land. If PCBs' levels are over 50 mg/kg, biosolids cannot be applied to the land and are considered a hazardous waste.

Table I. Ceiling Concentrations

Metal	Ceiling concentration in mg/kg dry weight
Arsenic	75
Cadmium	85
Copper	4300
Lead	840
Mercury	57
Molybdenum	75
Nickel	420
Selenium	100
Zinc	7500

1.3 Available Nitrogen in Sewage Sludge and Land Application Area

Bulk sewage sludge shall not be applied at rates above agronomic rates unless it is applied to reclamation sites when authorized by the permitting authority. When sewage sludge is applied to agricultural lands, it is applied at the rate at which it supplies no more available nitrogen than the vegetation or crops can use during the growing season. Therefore, sewage sludge is applied at an agronomic rate for nitrogen.

A procedure is shown here to illustrate how to estimate the land application area for lagoon sewage sludge based on agronomic nitrogen rate. You are recommended to seek assistance from your local agricultural extension agent and soil scientist to determine the rate of application and land area. This is because the agronomic rate could differ widely depending on such factors as the total and available nitrogen content in the sewage sludge, nitrogen losses under different climate, nitrogen carryover from previous application period, available nitrogen already present in the soil, and yield goal of the crop or vegetation in your particular field.

Because the lagoon sludge cleanup is not likely conducted on an annual basis, nitrogen carry over from previous year's biosolids application will not be considered in this document. But, if the land where the lagoon sludge will be applied has biosolids application within two years prior to the current, the background nitrogen from previous applications and carryover need to be considered.

Most of the nitrogen in sewage sludge is in two forms: ammonia nitrogen and organic nitrogen, which is TKN.

TKN=Ammonia Nitrogen + Organic Nitrogen

Plants cannot use organic nitrogen. Soil microorganisms must mineralize it into ammonia form before plants can take it up.

The ammonia nitrogen is immediately available for plant uptake. When sewage sludge is applied to the surface of the land, a portion of the ammonia nitrogen present in sewage sludge can volatilize into the atmosphere and be lost.

Ammonia nitrogen will convert to nitrate nitrogen by soil microorganisms in a process called nitrification. Plants can also take up nitrate nitrogen. Unlike ammonia nitrogen that can be firmly held in the root zone by cation exchange processes and will not leach, nitrate nitrogen is very mobile in soils and can leach below the root zone of not taken up by plants.

Step 1: Estimate the amount of available nitrogen in the sewage sludge

Equation 2:

$$Available\ Nitrogen\ \left(\frac{lbs}{ton}\right) = [TKN\ (\%) - Ammonia\ Nitrogen\ (\%)] \times 4^{*} + Ammonia\ Nitrogen\ (\%) \times 20^{**}$$

*4 is the organic nitrogen mineralization factor. Due to the anaerobic environment of lagoon sludge, mineralization factor of organic nitrogen is assumed to be similar to anaerobically digested sludge.
**20 is the factor for ammonia loss via volatilization. Lagoon sludge is required to be injected or incorporated to meet vector attraction requirements, therefore a volatilization factor of 20 is used.

The factors above provide the calculation in pounds of available nitrogen in a dry ton of solids.

Equation 3:

$$Total\ Available\ Nitrogen\ (lbs) = Available\ Nitrogen\ \left(\frac{lbs}{ton}\right) \times Total\ Sludge\ (tons)$$

Step 2: Figure out how many acres are needed for land application of sewage sludge

Equation 4:

$$Acres = \frac{Total\ Available\ Nitrogen\ (lbs)}{Nitrogen\ needed\ by\ crops\ or\ vegetation\ per\ acre\ \left(\frac{lbs}{acre}\right)}$$

1.4 COORDINATION WITH IOWA DNR

Notify Iowa DNR field office at your region where your land application site(s) is going to be. Field office may visit the site in order to understand the site conditions, verify whether the management practices for sludge land application are met and discuss possible scenarios with individuals working on the project. A list of land application management practice requirements for Class II sludge (IAC567-67.8(2)) is shown below:

- ✓ Sewage sludge must not harm threatened or endangered species or result in the adverse effect to their critical habitat when applied to land.
- ✓ Sewage sludge shall be applied to a rate that is equal to or less than the agronomic nitrogen rate.
- ✓ Sewage sludge shall not be applied to soils classified as sand, loamy sand and silt per USDA soil classification.
- ✓ Land application sites shall have soil pH maintained above 6.0 unless crops prefer soils with lower pH conditions.

- ✓ Sewage sludge shall not be applied to land where the cumulative pollutant loading rates in IAC 567-67 Table 4 have been reached.
- ✓ The sewage sludge shall not be applied to ground with greater than 9 percent slope unless approved by the department.
- ✓ If the sewage sludge is applied to land on which the soil loss exceeds the soil loss limits established by the county soil conservation district, injection or incorporation of sewage sludge within 48 hours of application is required.
- ✓ Sewage sludge shall not be applied to the land that is 35 feet (10 meters) or less from an open waterway. If sewage sludge is applied within 200 feet, but no closer than 35 feet, from a stream, lake, sinkhole or tile line surface intake downgradient of the land application site, it shall be injected or applied to the surface and mechanically incorporated into the soil within 48 hours of surface application.
- ✓ Sewage sludge application on frozen or snow-covered ground that caused sewage sludge entering a wetland or waters of the U.S., as defined in 40 CFR 122.2 is not permitted.
- ✓ If the sewage sludge is applied to land subject to flooding more frequently than once in ten years, the sludge shall be injected or applied to the surface and mechanically incorporated into the soil with 48 hours.
- ✓ Sewage sludge shall not be applied within 200 feet of an occupied residence or any well. The distance may be reduced to a minimum of 35 feet when a written agreement and an approved farm management plan to address management practice are in place.

2. Sludge Final Sampling, Disposal and Reporting

The final sampling of the lagoon sewage sludge is done after dewatering of the lagoon and before the sewage sludge is removed. DNR does not have a specific rule about how the lagoon liner is dealt with in the lagoon decommissioning practice, but the lagoon liner is not recommended to be mixed with lagoon sewage sludge and be disposed together. A common disposal alternative for lagoon liner is to send it to landfills. Coordination with Iowa DNR Solid Waste Section is highly recommended for lagoon liner disposal.

2.1 Sewage Sludge Quantity After Lagoon Dewatering

The estimated dry solids amount from the preliminary analysis may be different from the dry solids amount measured after the lagoon is dewatered. Due to the sludge quantity estimated after dewatering being more accurate, it should be used as the sludge quantity for final lagoon sludge disposal.

Measure the sludge depth after the lagoon is dewatered. Re-measure the sludge area again after the sludge layer is all exposed. Test the percent solids of the dewatered sludge. Re-calculate the total amount of sludge using the same equation in §1.1, Equation 1.

2.2 Sludge Sampling Number

The minimum number of samples required per 40 CFR 503 and IAC 567-67 rules is in Table II below, based on the total amount of sludge as determined in §2.1 as above. This is the minimum numbers of sampling based on the total sewage sludge that will be removed from the lagoon. The overall requirement is that the sampling must represent any potential variability of the sludge quality in the lagoon. Therefore, more samples than what is listed in Table II may be required depending on representativeness of the samples.

Table II. Minimum Sampling Number

Amount of Sewage Sludge (metric tons)	Number of Samples
Greater than zero but less than 290	1
Equal to or greater than 290 but less than 1,500	4
Equal to or greater than 1,500 but less than 15,000	6
Equal to or greater than 15,000	12

2.3 Pathogen

Compliance with pathogen reduction standards is demonstrated by taking a set of seven individual samples (per sampling numbers according to Table II) that are analyzed for fecal coliform using the most probable number [MPN] method [SM 9221 E-2011 or SM 9222 D-2011]. The geometric mean of those seven samples must be less than two million MPN per gram of total solids (dry weight basis). Measure the geometric mean of seven samples taken over 2-week period sufficiently close to the time of sludge disposal. The geometric mean must be calculated using all valid sample results collected during the 2-week period. The geometric mean formula is as follows:

Equation 5:

$$Geometric\ Mean = \left(\sqrt[7]{Sample\ 1 \times Sample\ 2 \times Sample\ 3 \times Sample\ 4 \times Sample\ 5 \times Sample\ 6 \times Sample\ 7}\right)$$

2.4 Pollutant Concentrations

Results of pollutant concentrations conducted from the preliminary analysis in §1.2 can be used for final results if only lagoon dewatering activity happens between the preliminary analysis and the final analysis of sewage sludge.

2.5 Lagoon Sewage Sludge Reporting

Within six months after the lagoon sludge project is done, the permittee shall send a sludge disposal report to the Iowa DNR biosolids coordinator and the field office for the final lagoon sludge results and the land application sites. The report shall include the following information:

1. The concentration of fecal coliform.
2. The concentration of each pollutant listed in Table 1 and 3 in IAC 567-67.
3. What is the total amount of lagoon sludge that has been land applied?
4. Location and area of each land application site.
5. The date and time and amount of sewage sludge applied to each site.
6. Description of how the sludge is applied to land and whether it is incorporated or injected. In order to meet vector attraction reduction (lagoon sludge should be incorporated or injected in soils to fulfil VAR requirement per IAC 567-67.8(1)c(9) or (10)).

3. Lagoon Decommissioning Plan

When the wastewater lagoon is going to be decommissioned, the permittee will be required to submit a lagoon decommissioning plan to the DNR's NPDES permit section and the DNR biosolids coordinator before sludge removal from the lagoon begins. The plan should include, but not be limited to, the following areas.

- When will the wastewater lagoon be decommissioned and where will the wastewater be sent to?
- What is the proposed timeline to discharge pond effluent, lagoon dry out, sludge removal and sludge disposal?
- What is the planned disposition of the lagoon outfall after decommissioning? Will the existing NPDES permit for the wastewater lagoon be modified? If so, has the permit update request been sent to the NPDES permit section?
- The results of the quantity and quality of lagoon sludge from the preliminary study, as described previously in Section 1.
- What will be Lagoon sludge disposal method, i.e. land application, surface disposal, incineration, landfill, or landfill?
- If land application is selected, follow instructions in Section 2 of this document. A lagoon sludge final report (see subsection 2.5 above) needs to be submitted to DNR within six months after the lagoon sludge is disposed of. This is in additional to the lagoon decommission plan.
- Will the lagoon structure be demolished and how it will be abandoned?
- Will the lagoon liner be destroyed and how will it be disposed of?
- If the lagoon will be kept in place, what will be the new usage of the lagoon?

If the permittee plans on reserving the lagoon as a reclamation site, or any beneficial reusing sludge in place, please contact DNR biosolids coordinator for further coordination with the EPA. If the permittee wants to send lagoon sewage sludge to landfills, please coordinate with DNR biosolids coordinator for further coordination with the DNR Solid Waste

and Contaminated Sites Section.

4. REFERENCES

1. Standards for the Use or Disposal of Sewage Sludge, 40 CFR 503, February 19, 1993
2. Standards for the Land Application of Sewage Sludge, IAC 567-67, February 9, 2022
3. Iowa Wastewater Facilities Design Standards, Chapter 18C-Wastewater Treatment Ponds, May 20, 1987
4. Decommissioning or Relining Domestic Wastewater Ponds, Minnesota Pollution Control Agency, October 2010
5. Wastewater Treatment Plant Closure-PUB2568, Missouri Department of Natural Resources, February 1, 2019
6. Closure of Septic Tank and Lagoon Systems Fact Sheet, Nebraska Dept. of Environment and Energy, September, 2022
7. Closure of Wastewater Treatment Plants, Indiana Dept of Environmental Management, IDEM Fact Sheet WOWQ031315

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