CAFO Liner Requirements

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METHODS FOR SATISFYING CAFO LINER REQUIREMENT FOR EXISTING LAGOONS
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I. Purpose and Use of This Information

This material has been prepared by EPA Region 6 in order to briefly present examples of methodologies which might be used to satisfy the liner requirement for existing waste retention structures at Concentrated Animal Feeding Operation (CAFO) sites. It is not intended to be an all-inclusive listing. Methods other than those presented here may be sufficient to satisfy the liner requirement if those methods are based on sound technical principles and documented data.

There has not been an attempt to describe any procedure in detail; in practice it is expected that many of the specifics in these examples are part of well established practices in soil science and hydrology, and should be familiar to professionals in these fields. The use of "best professional judgement" is called for in a number of cases and is essential in performing any analysis of potential or actual movement of contaminants into and through the subsurface.

II. Liner Requirement in the CAFO Regulation

The liner requirement contained in the CAFO regulations is as follows:

====> CAFO REGULATIONS FOR LINER

The liner requirement must be satisfied as described above for all waste water retention structures, both existing and proposed. The methods for doing this may be somewhat different for these two cases because existing ponds present both advantages and disadvantages in the process of analyzing seepage rates.

The discussion that follows is designed as an aid for those cases where an existing lagoon site will be analyzed by an SCS engineer, a Professional Engineer or a qualified ground water scientist. In case the lagoon does not meet the criteria contained in the CAFO regulations, either by one of the methodologies described here or by another valid test, a low permeability liner should be installed as described in the regulations.

III. Satisfying the Liner Requirement for Existing Lagoons

A. General.

As indicated in the regulations, the liner requirement may be satisfied by either demonstrating that there is no significant leakage from the impoundment or by showing that any leakage would not migrate to surface waters. In either case, a general site investigation is needed to provide basic information on the physical nature of the site. This information will, at a minimum, supplement other data such as soils test information, and in a few cases may be the primary basis for judgement on the need for a liner.

If the documentation of no liner requirement is made on the basis of no significant leakage, then it must be shown that the in-situ materials meet the minimum criteria for hydraulic conductivity and thickness described for adequate animal waste retention structures in the Soil Conservation Service Technical Note 716.

- One method to do this is to demonstrate that samples of natural materials, taken in close proximity to the lagoon and representative of its composition, satisfy the requirements of Technical Note 716.

-Another method is to show that measured seepage rates from the lagoon do not exceed a maximum expected rate based on the goals of Technical Note 716.

-A third method involves testing of ground water quality at the site to determine that seepage rates have not been significant.

If the documentation of no liner requirement is made on the basis that leakage from the retention structure would not migrate to surface water then a ground water flow analysis must be performed.

These topics are treated individually in the discussions that follow.

B. Site Investigation:

Analysis of compliance with the liner requirement should include a general site investigation which consists of a visual inspection of the impoundment and surrounding area and the collection and assessment of pertinent literature, records and verbal information on the site. Although the site investigation may not, in itself, lead to a conclusion, it will provide information which is essential to a final determination.

Review of records and literature should include the following:

1. Review of published reports and maps on the ground water, geology and soils of the area as well as any other information that may help in assessment of the site.

2. Examination of any existing design and construction data for the retention structure, including information on a liner if one was installed.

3. Examination of existing information on water wells within 1000 feet. Lithologic driller's logs and depth to water may be important adjuncts to soil test information when determining the potential for leakage and direction of ground water flow.

Physical site inspection should focus on evidence of leakage from the lagoon and an evaluation of the natural conditions which might promote or retard leakage. The site investigation should include the following:

1. An inspection of the local topography and surface drainage. In many cases infiltration from lagoons moves directly downward toward the water table, but where lower permeability layers are present at shallow depths the leachate may spread laterally and even reach the surface. The flow of shallow ground water commonly tends to roughly parallel surface water flow directions or move toward nearby streams but may be radially from the lagoon if seepage rates are high and local slopes are gentle. For some perched water tables ground water flow direction is related to the inclination of the lower confining layer.

Seepage detected at the surface near the lagoon should be sampled and analyzed for nitrate, ammonia, chlorides and electrical conductivity, and flow volumes measured or estimated. The source of each contaminated seep should be explained, taking into account all potential sources of contamination at the site. If the probable source of a seep is a lagoon, it should be assumed that the lagoon is in need of a liner unless demonstrated otherwise. The area to be covered in the surface investigation may vary under different circumstances but should normally be no less than 300 feet from the lagoon.

2. A visual inspection for any other surface conditions in the area of the lagoon which suggest the likelihood of leakage from the lagoon. Features such as caves or other karst structures, thin soils over fractured bedrock or indications of soil instability should be noted and considered in the final decision.

C. Documentation of No Significant Leakage

For documentation of no significant leakage the CAFO regulations refer to Soil Conservation Service Technical Note 716. That document is a set of design and construction guidelines for considering seepage from agricultural waste storage ponds and lagoons. Although written as an aid for planning new waste retention structures much of those guidelines can be applied to existing lagoons. In particular, the methods for analyzing the suitability of soils for use in lagoons as described in that document and in the companion SCS Technical Note 717 can be used to determine whether there is potential for significant leakage from an existing lagoon.

Technical Note 716 says "Generally, soils that have a clay content exceeding 5 or 15 percent for ruminant or monogastric animal manures, respectively, will seal with a final hydraulic conductivity approaching 10-7 cm/sec" (page 2) and "Using a very conservative assumption that manure will reduce the permeability rate by at least one order of magnitude, a resulting k of 1 x 10-7 cm/sec is certainly tenable" (page 8). The hydraulic conductivity value of 10-7 cm/sec has widespread use as a design criterion for liner construction and is an appropriate value for this case.

Technical Note 716 describes soil characteristics and soil types which should, after the formation of a biological seal, meet the goal for hydraulic conductivity. To meet the no significant leakage requirement it will be sufficient to show that:

1. Soils at the site meet the criteria of Technical Note 716, or

2. Measured leakage from the lagoon does not exceed the amount that would occur for 1.5 feet of soil with a hydraulic conductivity of 1 X 10-7 cm/sec, or

3. Alternatively, it may be acceptable to demonstrate by the use of ground water quality analyses that no significant leakage is occurring.

a. Use of SCS Technical Note 716 for Soils Analysis

Soils analysis and the associated site investigation should be conducted as described in the Technical Note (see especially the sections labelled "Site investigation...Soil properties...In situ soils with acceptable permeabilities...When to consider a liner").

The Note does not specify the number or location of soil samples to be taken in the subsurface investigation but the following rules should provide a reasonable sampling process:

-A brief inspection of the soil properties at the surface should be conducted around the lagoon. If it appears that clay content and texture vary significantly, sample locations should be chosen to reflect the differing soil types. Where soils appear to be relatively uniform at least two samples should be taken at widely spaced points, preferably on opposite sides of the lagoon.

-Samples should be taken from auger holes, dozer pits or backhoe pits that extend at least two feet below the elevation of the lagoon bottom; the relative elevation of the lagoon bottom should be established by measurement.

-Samples should be taken as close as possible to the lagoon and preferably no more than 20 feet distant from the toe of the berm.

b. Measurement of Leakage from Lagoon

The no significant leakage requirement can be satisfied by demonstrating that the amount of leakage from the lagoon does not exceed the amount to be expected if the lagoon were sited over 1.5 feet of soil having a hydraulic conductivity of 1 X 10-7 cm/sec.

Methods which depend on water level measurements (such as the water budget method and the instantaneous rate method) will generally not be sensitive enough to be of use except to demonstrate that the structure is leaking heavily.

Seepage meters implanted into the bottom of the lagoon have been used successfully in the past in measuring leakage. One such device consists of a 5 inch diameter tube, the bottom of which is driven into the lagoon to a depth of 1.5 feet, and the top of which stands about 2 feet above the water level in the lagoon. This pipe is topped with a 1 inch diameter pipe which serves to amplify water-level changes in the larger pipe. The expected water level decline for 1.5 feet of soil at 10-7 cm/sec can be calculated by using Darcy's Law, with the assumption that the hydraulic head goes to 0 across the 1.5 foot thickness of soil. Measurements must be taken at several points to estimate an average leakage rate. The water level in the pipe should always stand well above the water level in the lagoon in order that any poor seals around the pipes will not result in false inferences of low seepage rates.

To maintain the integrity of the lagoon seal testing of lagoon bottom and sides should be done so as to leave the existing materials in place at the conclusion of the test if possible.

c. Sampling Ground Water for Contaminants

Evidence of no significant leakage may also come from sampling of ground water at the site. The low permeabilities required for liners and in-situ materials as described above should allow very little leakage of fluids from the lagoon and only low levels of contaminants from these sources should be detectable in ground water at the site. Lagoons that are properly lined or sited in sufficiently low permeability materials should not cause ground water to exceed Maximum Contaminant Levels established under the Safe Drinking Water Act. Evidence that these levels have not been exceeded indicates that the existing lagoon materials are acceptable.

The major ground water contaminant of concern from animal waste is nitrate. Although the lagoon fluids may contain a greater amount of ammonia than nitrate, conversion of ammonia to nitrate in the subsurface is common and all nitrogen in the ground water must be considered a potential donor toward the formation of nitrate. Where leakage from a lagoon has resulted in less than 10 mg/liter of nitrogen in the ground water it can be taken as evidence that the lagoon has no significant leakage.

It is essential to establish the direction of ground water flow at the site in order to collect samples down gradient from the lagoon. Normally this involves drilling holes and collecting ground water samples at no less than three points around the lagoon; one upgradient and two on the downgradient side where they will intercept any leakage. In many cases the direction of ground water flow can be initially estimated by topography or in some cases by published reports. Flow directions can then be more accurately established from water levels in the wells.

Some evidence should be presented to indicate that the lagoon has been in operation for a sufficient period of time to allow seepage to reach the sampling stations. Simple flow calculations based on depth to ground water and expected flow velocities in the saturated and unsaturated zones would suffice.

D. Documentation that leakage will not migrate to surface water

Much of the water that enters the ground moves toward nearby streams and is discharged to the surface within a few months or years. However, there are circumstances where a portion of the ground water moves downward into deeper confined environments where movement is extremely slow, water quality naturally tends to deteriorate and ground water is effectively lost to the surface environment.

As an example, in the gulf coast region a series of sedimentary layers which dip toward the Gulf of Mexico provide environments where leakage may not return to surface waters. Deep ground water flow in this area is typically toward the Gulf with movement to ever greater depths as it flows in that direction. In this same area a shallow ground water flow component moves toward surface discharge points in streams, lakes and springs.

In order to demonstrate that leakage will not move to surface water it is necessary to document ground water flow directions in three dimensions on regional, areawide and local scales, and to show that any leakage will not be brought to the surface through pumping wells. To do this will require a survey of published technical studies (including ground water level studies, computer model simulations, recharge and discharge studies, and other hydrologic and geologic reports) to establish the regional ground water flow regime. Local ground water flow directions must be determined on the basis of measured ground water levels, the degree of interaction between local topography and flow directions, evidence of surface water discharge etc. An analysis of the well pumpage in the area should be performed to assess the probability of movement of leakage into those wells. Finally, the regional and local information must be integrated to show that seepage will move into a confined environment where there will be no direct discharge to the surface.

Last updated on Wednesday, July 20, 2011