Appendix F

Voluntary Alternative Performance Standards for CAFOs

Introduction

The examples in this appendix are for informative purposes only. The examples assume, but do not guarantee, that the confined animal feeding operation (CAFO) meets all applicable federal, state, and local requirements.

The U.S. Environmental Protection Agency's (EPA's) long-term vision for CAFOs includes continuing research and progress toward environmental improvement. CAFOs, U.S. Department of Agriculture (USDA), land grant universities, state agencies, equipment vendors, and other agricultural organizations are now working to develop new technologies to reduce nutrient, pathogen, and other pollutant losses to surface water; ammonia and other air emissions; and groundwater contamination from animal manure. In the future, as those technologies are developed and improved, EPA believes that they could offer CAFOs the potential to match or surpass the pollutant reduction achieved by complying with the current requirements. EPA believes that some CAFOs will voluntarily develop and install new technologies and management practices equal to or better than the current requirements described in the CAFO rule of this manual in exchange for being allowed to discharge the treated effluent. (For the purposes of this appendix, the current technology controls required under the CAFO effluent limitation guidelines (ELG) described in the CAFO rule will be referred to hereafter as the *baseline* technology requirements.) That is why EPA has created the voluntary performance standards program for CAFOs.

This appendix presents an overview of the baseline requirements and the *voluntary performance* standards program, which includes a description of who can participate in the program, how participation in the program will affect existing CAFO National Pollutant Discharge Elimination System (NPDES) permits, and a step-by-step description of the requirements associated with program participation.

A. Overview of the Baseline Requirements

As described in the CAFO rule, the baseline production area requirements for all existing beef, dairy, heifer, veal, swine, and poultry CAFOs are the same. However, baseline requirements vary for new operations. A summary of the requirements is presented in Table F-1.

Table F-1. Summary description of baseline requirements

Existing and new large beef, dairy, heifer and existing large swine, poultry and veal CAFOs
1. Baseline requirements prohibit the discharge of manure and process wastewaters. 2. A CAFO may discharge when rainfall events cause an overflow from a storage structure designed, constructed, operated, and maintained to contain the following: • All manure, litter, and all process wastewaters including manure, wastewater, and other wastes accumulated during the storage period as reflected by the design storage volume • Direct precipitation from a 25-year, 24-hour rainfall event • Associated runoff from a 25-year, 24-hour rainfall event

B. Overview of the Voluntary Performance Standards Program

Under the voluntary performance standards program, existing and new Large beef, heifer, and dairy CAFOs and existing Large swine, poultry, and veal CAFOs are allowed to discharge process wastewater that have been treated by technologies that the CAFO demonstrates results in equivalent or better pollutant removals from the production area than would otherwise be achieved by the baseline requirements.

B.1. Program Participation

All CAFOs electing to participate in the program should have a good compliance history (e.g., no ongoing violations of existing permit standards or history of significant noncompliance). In most cases, participation will result in an individual NPDES permit addressing the site-specific nature of the alternative technology and establishing site-specific discharge limitations.

Program Benefits

CAFOs are expected to derive substantial benefits from participating in this program through greater flexibility in operation, increased goodwill of neighbors, reduced odor emissions, potentially lower costs, and overall improved environmental stewardship. EPA is considering other possible incentives to encourage participation in this program.

B.2. Pollutants of Concern

In general, all CAFOs applying for the voluntary performance standards program must design the treatment technology to achieve equal or less quantities of 5-day biochemical oxygen demand (BOD_5), total nitrogen (N) (ammonia, nitrite/nitrate, and organic N), total phosphorus (P), and total suspended solids (TSS) than the baseline system. EPA selected those parameters because of their high concentrations in manure-type wastestreams and their impact on surface water quality if not treated. In addition, many conventional wastewater treatment technologies, in the process of treating those four selected pollutants, will result in treatment and removal of other pollutants. To qualify for voluntary alternative performance standards, the CAFO may also be required to remove other specific pollutants, such as pathogens and metals, if such pollutants are present in the wastestream at concentrations that could affect surface water quality, as determined appropriate by the permitting authority.

B.3. Required Technical Analysis

CAFOs requesting site-specific effluent limitations to be included in NPDES permits must submit a supporting technical analysis and any other relevant information and data that would support such site-specific effluent limitations. For more information, see Section C of this appendix.

B.4. Validation of Equivalent Pollutant Reductions

The CAFO must attain the limitations and requirements of a permit on the basis of alternative technologies as of the date of permit coverage (Title 40 of the *Code of Federal Regulations* [CFR] section 412.31(a)(3). If those alternative limits will not be met as of the date of permit coverage, such as because of startup of certain wastewater treatment technologies, the permitting authority would need to incorporate a compliance schedule into an enforceable order that would establish milestones for implementing the alternative technologies and fully meeting the permit limitations. The permitting authority should consider whether it is appropriate to select a permit term that is less than 5 years to allow the permitting authority to evaluate whether the alternative technologies have resulted in the permit limitations being met.

If the permitting authority grants a request for voluntary alternative performance standards, the CAFO should, at a minimum, be required to take monthly effluent samples from the treatment system to verify continued permit compliance. The permitting authority may determine that the CAFO must take more frequent samples (such as during startup) or collect samples on a basis other than monthly (such as during all discharge events in the case of intermittent discharging technologies). CAFOs should be required to analyze for the following pollutants: BOD_5, total N, total P, and TSS. The permitting authority may also require a CAFO to monitor other pollutants regularly. If monthly pollutant discharges from the alternative treatment system are greater than specified in the NPDES permit, a CAFO could be subject to both state and EPA enforcement actions.

General versus Individual NPDES Permits

A general NPDES permit is written to cover a category of point sources with similar characteristics for a defined geographic area. The majority of CAFOs may appropriately be covered under NPDES general permits because CAFOs generally involve similar types of operations, require the same kinds of effluent limitations and permit conditions, and discharge the same types of pollutants.

Individual NPDES permits might be most appropriate for CAFOs that are exceptionally large operations, are undergoing significant expansion, have historical compliance problems, or have significant environmental concerns. Individual permits will generally include all the permit conditions contained in the general NPDES permit and some additional requirements specific to the permitted facility. Additional requirements could include liners and covers for manure and wastewater storage units and more frequent water quality monitoring.

B.5. Relationship to Existing NPDES Permits

EPA expects that most CAFOs will be subject to a general, rather than an individual, permit that requires compliance with the baseline effluent guidelines requirements. If a CAFO decides to pursue voluntary performance standards based on a treatment technology that allows a discharge, EPA expects the permit authority to require the CAFO prepare and submit an application for an individual NPDES permit. The application will include general information about the CAFO (e.g., ownership, responsible persons, location, receiving stream), waste characteristics, information about the treatment system including design and operational parameters, and expected effluent quality from the proposed treatment system. A CAFO may not discharge from the alternative treatment system until the permitting authority has issued an NPDES permit that allows the discharge.

C. Step-By-Step Requirements for Participation in the Voluntary Performance Standards Program

The voluntary performance standards program has two main requirements: the CAFO must estimate the pollutant discharge associated with the baseline system and must demonstrate that the alternative treatment technology achieves an equivalent or better reduction in the quantity of pollutants discharged from the production area. This section provides detailed recommendations for how such showings should be made, along with a description of the information that must be submitted to the permitting authority to obtain alternative performance standards.

C.1. Determining Baseline Pollutant

If a CAFO decides to participate in the voluntary performance standards program, the CAFO must conduct a technical analysis to estimate the pollutant discharge associated with the baseline[1] waste management system (e.g., anaerobic treatment lagoon). At a minimum, the technical analysis must include the information in the text box at right [see 40 CFR part 412.31(a)(2)].

In a limited number of circumstances, the calculated median annual overflow volume based on a 25-year period of actual rainfall data may be zero. In those instances, the permit authority may allow the CAFO to calculate an average overflow volume for the 25-year period.

One approach for estimating pollutant discharges is to use a computer simulation model, spreadsheet, or similar program. One can either develop a new model or revise an existing model that estimates pollutant discharges from waste management systems. The models can be used to evaluate site-specific climate and wastewater characterization data to project the pollutant discharge from a baseline system. The model should evaluate the daily inputs to the waste management system, including all manure, litter, all process wastewaters, direct precipitation, and runoff. The model should also evaluate the daily outputs from the waste management system, including losses due to evaporation, sludge removal, and the removal of wastewater for use on cropland at the CAFO or transported off-site. CAFOs can use the model to predict the median annual overflow from the storage system that would occur over a 25-year period. Next, the CAFO should use the overflow predictions, combined

Technical Analysis of Discharge

40 CFR part 412.31(a)(2) …The technical analysis of the discharge of pollutants must include

(A) All daily *inputs* to the storage system, including manure, litter, all process waste waters, direct precipitation, and runoff.

(B) All daily *outputs* from the storage system, including losses due to evaporation, sludge removal, and the removal of wastewater for use on cropland at the CAFO or transport off site.

(C) A calculation determining the predicted median annual overflow volume based on a 25-year period of actual rainfall data applicable to the site.

(D) Site-specific pollutant data, including N, P, BOD_5, TSS, for the CAFO from representative sampling and analysis of all sources of input to the storage system, or other appropriate pollutant data. (E) Predicted annual average discharge of pollutants, expressed where appropriate as a mass discharge on a daily basis (lbs/day), and calculated considering paragraphs (a)(2)(i)(A) through (a)(2)(i)(D) of this section.

with representative pollutant concentrations in the overflow, to predict the annual average discharge of pollutants (including nitrogen, phosphorus, BOD_5, and TSS) over the 25 years evaluated by the model. For the complete list, see 40 CFR part 412.31(a)(2)(i)(E).

Site-specific information that a CAFO should gather and input to the model to calculate the predicted annual discharge of pollutants from the baseline system includes the following [also see 40 CFR part 412.31(a)(2)]:

- Data on actual local precipitation from the past 25 years. Precipitation data are available from the National Weather Service and possibly a local airport. One can also obtain local precipitation data from EPA's Better Assessment Science Integrating point and Nonpoint Sources (BASINS) model at *http://www.epa.gov/OST/BASINS/b3webwn.htm*. State weather data are at *http://www.epa.gov/ost/ftp/basins/wdm_data/*. Historical weather can also be obtained from National Climatic Data Center.
- Soil type and permeability in drylot areas. Site-specific soil permeability data can be obtained from the local Soil Conservation District office.
- The rate of evaporation from the storage system (e.g., lagoon, pond, holding tank). Evaporation rate data are available from the National Weather Service or EPA's BASINS model website.
- The concentration of BOD_5, total N, total P, TSS, and other pollutants as required by the Director, measured in a representative sample collected from the waste management system.
- Starting volume in the waste management system based on process wastes and runoff collected since the last land application or waste management system pump-out or sludge cleanout or both.
- Projected total design storage volume to store manure, wastewater, and other wastes accumulated during the storage period as reflected by the design storage volume (see Chapter 5.3 of this document).
- Change in the waste management system's volume due to the estimated daily flow of process wastes.
- Change in the storage system volume due to direct precipitation and evaporation.
- Change in the storage system volume due to runoff from open lot areas.
- Change in volume due to waste management system pump-out or sludge cleanout and land application.

The model should calculate the net change in the volume of the liquid storage area daily and add it to the previous day's total. If the total volume is greater than the maximum design volume, the excess volume overflows. Also, CAFOs can calculate the mass pollutant discharge from the overflow by multiplying the overflow by the pollutant concentration (BOD_5, total N, total P, TSS) measured in the representative sample.

Examples 1 and 2 at the end of this appendix present the results of a technical analysis conducted for example dairy and swine CAFOs, respectively.

C.2. Demonstrating That an Alternative Control Technology Achieves Equivalent or Better Pollutant Reductions

EPA recommends that CAFOs follow the steps shown below to demonstrate that an alternative control technology will achieve equivalent or better pollutant reductions:

- Measuring volume or quantity of manure, wastewater, and runoff generation from production areas.
- Collecting samples of manure, wastewater, and runoff to determine raw or untreated pollutant concentrations for treatment system design using the same pollutant parameters as measured for a baseline.
- Preparing a conceptual design of the treatment system showing equipment sizing, operational requirements, and expected pollutant reductions by each treatment step.
- Estimating the volume and frequency of discharge from the treatment system.
- Estimating or measuring the concentration of the effluent from the treatment system.
- Results of pilot testing to verify the treatment system will achieve equivalent or better pollutant reductions than baseline for all required constituents (including BOD_5, total N, total P, and TSS) and to gather information for design of the full-scale treatment system. Any pilot testing needs to be related to representative/typical production and climate conditions expected at the CAFO. Therefore, multiple testing episodes or sites might be necessary to adequately capture the actual conditions at the CAFO. Consider on-site pilot testing to demonstrate that the proposed system will work at the CAFO.

Examples 1 and 2 summarize the methods that could be used by the example CAFOs to determine if an alternative treatment system performed equivalent to or better than the baseline system. In the examples, the permit authority would require the CAFO to continue to collect testing data until the alternative technology has been proven at the site. Thereafter, the CAFO might need to collect samples only frequently enough to demonstrate compliance with their NPDES permit limitations.

Can a CAFO Demonstrate Equivalency Using Practices Already in Existence at the Site?

Yes. If the practices already in place at the operation provide equivalent or better pollutant reductions than the predicted average annual pollutant discharge for the baseline requirements, the CAFO can apply for an alternative performance standard. Example 3 shows how data from an existing pollution prevention/treatment system were compared to the baseline system to develop site-specific permit limits for an egg production facility.

C.3. Obtaining an Alternative Performance Standard

The next step in participating in the voluntary performance standards program is to submit an application to the permitting authority along with the technical analyses, conceptual design, results of any pilot-scale testing and any other relevant data before constructing the full-scale treatment system. The permitting authority should review the application, technical analyses, and conceptual design, and then compare the pilot-scale testing results with the predicted annual average discharge of pollutants to verify that the proposed treatment system is reasonable, appropriate, and will likely achieve the predicted results. In addition, the permit authority should confirm that the quantity of pollutants discharged from the production area is equal to or less than the quantity of pollutants discharged under baseline. The Director has the discretion to request additional information to supplement the CAFO's application, including conducting an on-site inspection of the CAFO. 40 CFR § 412.31(a)(2)(E)(ii). Once an application is approved, a CAFO can proceed with detailed design and construction of the alternative control technology. After the treatment system's construction but before start-up [see 40 CFR part 412.31(a)(3)], the CAFO must obtain an NPDES permit specifying the discharge limitations. Also see Section B.4 of this appendix.

Footnotes

[1] Recall a baseline system at the CAFO is a system that meets the requirements as described in the CAFO Rule [see 40 CFR part 412.31(a)(1)].

Example 1. Whole Milk Dairy, Lancaster, Pennsylvania

Background

Whole Milk Dairy (WMD) is a Large CAFO in Lancaster County, Pennsylvania. WMD milks 1,200 dairy cows per day, plus manages 400 heifers and 400 calves. Milk cows are confined in a 550,000-square-foot-area containing three free stall barns, the milking parlor, and yard. Free stall barn alleys are cleaned three times a day (every 8 hours) using a flush system. Sawdust is used for bedding in the free stall barn. Silage is kept covered. All flush water, cow wash-water, and parlor cleanup and sanitation water is directed to the existing 3,351,252-cubic-foot manure holding lagoon.

All liquids in the holding lagoon are applied to crop land four times each year consistent with the site's NMP. Thus, the lagoon has 90 days of storage capacity. To help show the storage structure has adequate capacity, WMD assumes that the storage volume is never less than the accumulated sludge volume plus the minimum treatment volume. Although solids are periodically removed and thus more volume is available to store process wastewater, runoff, and precipitation, this conservative assumption reserves the sludge volume for the maximum amount of accumulated solids over the storage period.

Approximately 40 percent of the milk cow confinement area is paved or roofed. Precipitation from roofed areas drains onto the paved portion of the milk cow confinement area before being discharged to the manure holding lagoon. All paved areas have curbing to contain manure and precipitation. Unpaved areas have reception pits to collect manure and precipitation before discharge to the manure holding lagoon. Heifers and calves are managed on a non-paved 300,000-square-foot-dry lot that discharges to the manure holding lagoon. Any overflows from the lagoon might eventually reach a receiving surface waterbody (in this case, the Susquehanna River).

Summary of baseline overflow volume and pollutant loading calculations

Process Wastewater Generation:	25,857 ft^3/day (193,400 gal/day)
Sludge Volume (constant):	870,807 ft^3
Minimum Treatment Volume (constant):	1,530,000 ft^3
Total Existing Storage Lagoon Volume:	3,351,252 ft^3 (25 million gallons)
Volume in Lagoon at Start:	2,400,807 ft^3 (Sludge Volume + Minimum Treatment Volume)
Precipitation Volume (median):	40 in/yr
Evaporation Rate (median):	57 in/yr
Runoff (median):	17,033 ft^3/yr
Liquid/Solids Removal for Crop Application:	Completely dewater all lagoon liquids four times per year

Calculated baseline overflow volume method

Daily Accumulation of Lagoon Liquids (ft^3/day) = Process Waste (ft^3/day) + Runoff (ft^3/day) + ((Precipitation-Evaporation (ft/day)) x Lagoon Surface Area (ft^2)

Volume of Lagoon Liquids (ft^3) = Previous Days' Volume (ft^3) + Daily Accumulation of Lagoon Liquids Volume (ft^3/day)

Example 1. Whole Milk Dairy, Lancaster, Pennsylvania *(continued)*

If the Volume of Lagoon Liquids (ft^3) is greater than the following:

Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)], then

Overflow Volume = Volume of Lagoon Liquids (ft^3) - [Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)]; and

Volume of Lagoon Liquids (ft^3) is adjusted to the following:

[Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)] (the maximum volume of liquids the lagoon can store)

If it is a land application day:

The Volume of Lagoon Liquids (ft^3) = 0

Calculated Overflow Volume for WMD: 57,386 ft^3/yr (429,247 gal/yr)

WMD collected a representative sample of liquid from the storage lagoon to calculate the annual pollutant discharge of BOD_5, total N, total P, and TSS as a result of the overflow volume. The sample was collected from the top 12 inches of the lagoon surface because the majority of overflow will likely be attributed to that zone. The sampling results are shown below:

BOD_5:	600 mg/L	(5.0 lbs per 1,000 gallons)
Total N:	268 mg/L	(2.2 lbs per 1,000 gallons)
Total P:	208 mg/L	(1.7 lbs per 1,000 gallons)
TSS:	1,500 mg/L	(12.5 lbs per 1,000 gallons)

On the basis of the overflow and the measured concentration, the annual pollutant discharges from the lagoon were calculated by multiplying the flow by the concentration as shown in the example for BOD_5 below:

BOD_5: 600 mg/L x 3.785 L/gal x 429,247 gal/yr x 2.2 lbs/kg x 1 kg/10^6 mg = 2,145 lbs/yr

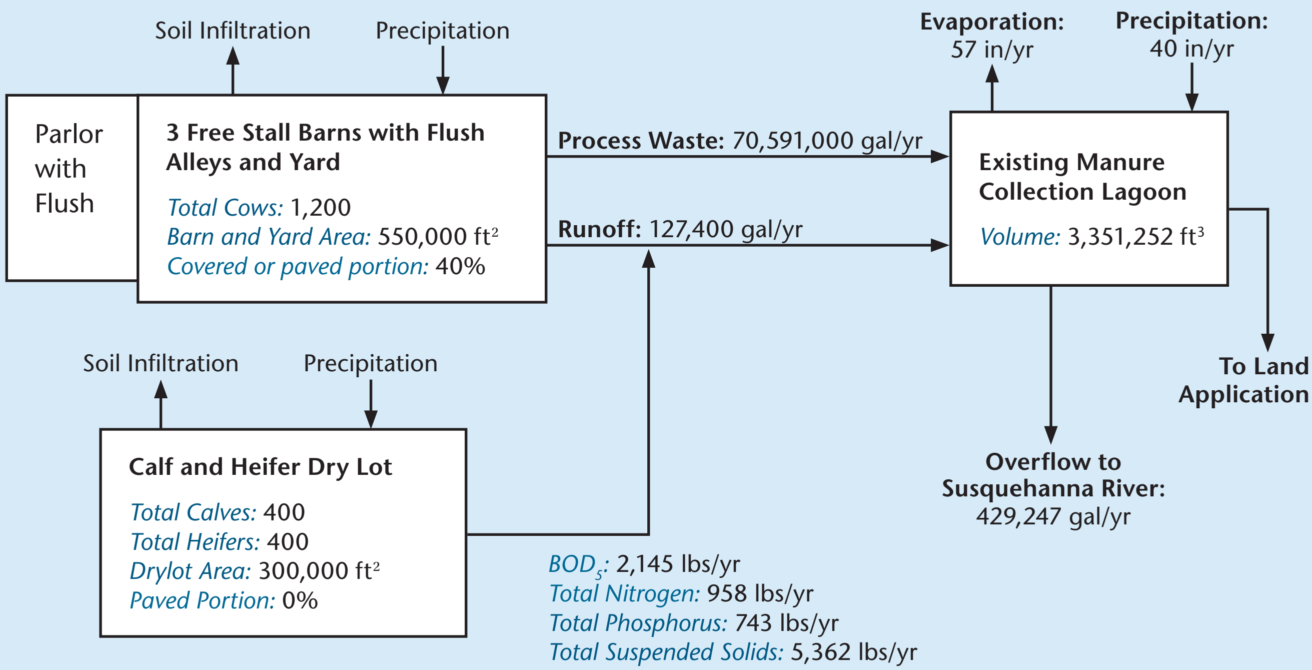
A summary of the pollutant loadings based on the overflow rate and concentration is shown below.

BOD_5:	2,145 lbs/yr
Total N:	958 lbs/yr
Total P:	743 lbs/yr
TSS:	5,362 lbs/yr

Example 1. Whole Milk Dairy, Lancaster, Pennsylvania *(continued)*

Diagram of baseline waste management system

The following figure is a block diagram of WMD summarizing the inputs and outputs from the manure storage lagoon and the overflows and pollutant loadings. Any overflows from the lagoon eventually reach a surface waterbody (in this case, the Susquehanna River).



Waste characterization and alternative treatment system evaluation

WMD in cooperation with its consultant, Tick Engineering, has decided to voluntarily pursue an alternative to its existing lagoon to have a constant discharge of treated water to the Susquehanna River. The treatment train it selected consists of primary clarification, aerobic biological treatment, and final polishing using an engineered wetland. Tick Engineering conducted pilot-scale testing of the system June 15 to November 15 at WMD using actual process wastewater. The conceptual design calculations and pilot-scale treatment test are summarized below.

Waste flow and characterization

Tick Engineering conducted a daily composite sample of manure, flush water, wash water, parlor cleanup and sanitation water and rainwater during a 7-day operational period in April 2003 to characterize the wasteload discharged to the storage lagoon. The combined volume of manure, flush water, wash water, parlor cleanup water and rainwater was also measured during the 7-day sampling period in April, 2003. The average daily flow to the lagoon, which included one day of rainfall was 176,410 gallons. Waste characterization data and calculated average daily loading to the treatment system are summarized below:

Example 1. Whole Milk Dairy, Lancaster, Pennsylvania *(continued)*

Pollutant	Concentration (mg/L)	Influent (lbs/day)
BOD_5:	1,701	2,496
Total N:	478	702
Total P:	74	109
TSS:	12,269	18,018

Daily pollutant loadings were calculated by multiplying the concentration for each constituent by the average daily flow as shown in the example below for BOD_5:

BOD_5 Loading: 1,701 mg/L x 3.785 L/gal x 1 kg/1,000,000 mg x 2.2 lbs/kg x 176,410 gal/day = 2,496 lbs/day

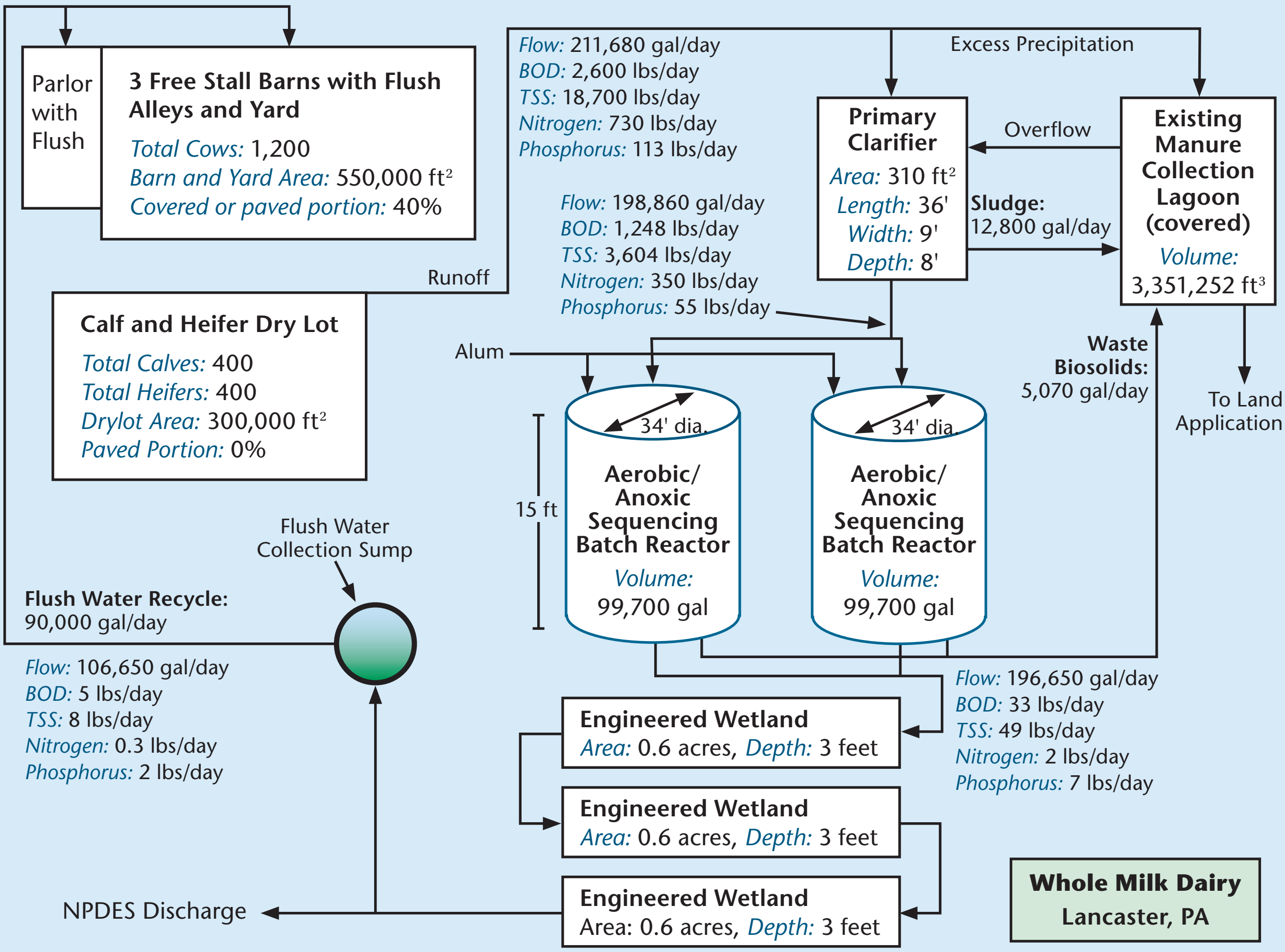
The treatment system design is based on a flow excess of 20% or 211,690 gallons per day. Flows greater than 211,690 gal/day will overflow back to the existing 3,351,252-cubic-foot lagoon. During dry-weather periods, excess water and direct precipitation from the lagoon will be pumped back to the beginning of the treatment system for processing. The following figure is a flow diagram showing the treatment equipment and sizes, flows in and out of each treatment unit, and the pollutant reductions by each treatment step. Note that WMD will have the capability of recycling nearly 90,000 gallons per day of treated effluent for manure flushing.

Alternative treatment system effectiveness

The average concentration of target pollutants measured in the effluent from the pilot-scale treatment system during the 6-month study is shown below. The calculated monthly loadings for the full-scale treatment system is based on an average daily flow of 176,410 gallons entering the treatment system minus a recycle flow of 90,000 gallons per day for manure flushing.

Example 1. Whole Milk Dairy, Lancaster, Pennsylvania *(continued)*

Diagram of alternative treatment system



Comparison of the baseline overflow to the discharge from the alternative treatment system

Pollutant	Baseline overflow (lbs/yr)	Treatment system discharge (lbs/day)
BOD_5:	2,145	1,830
Total N:	958	110
Total P:	743	730
TSS:	5,362	2,920

Conclusion: The loadings comparison clearly shows the proposed treatment system consisting of primary clarification, aerobic biological treatment and final polishing using an engineered wetland would achieve a quantity of pollutants discharged from the production area that is equal to or less than the quantity of pollutants that would be discharged using baseline treatment. Note: This analysis pertains to the technology-based requirements of the CAFO rules and does not include an assessment of whether a discharge would meet the state's water quality standards.

Example 2. KF Pork Producers, Davenport, Iowa

Background

KF Pork Producers (KFP) is a Large CAFO in Scott County, Iowa. KFP has 7,000 grower swine with an average weight of approximately 140 pounds. Swine are housed in a 57,400-square-foot-barn with 10 confinement pens. Manure is washed from pens daily using a flush system. All manure and flush water drains into storage tanks beneath the partially slotted concrete floor. Storage tanks are emptied daily by pumping the manure and flush water to an existing 3,931,800-cubic-foot manure holding lagoon.

KFP, in consultation with local residents, avoids de-watering the storage structure on weekends and holidays. Liquids in the holding lagoon are applied to crop land (to the maximum daily hydraulic loading) on the 7th, 14th, 21st, and 28th days of each month during the freeze-free period between April 21 and September 14, assuming that there has been no significant precipitation during the 3 days before the day of application. (The nutrient applications are tracked by KFP's NMP and are not further considered here.) KFP assumes that the storage volume is never less than the accumulated sludge volume plus the minimum treatment volume. Although there are times that solids are removed and more space is available for process wastewater, runoff, and precipitation, that conservative assumption reserves storage space for the maximum amount of accumulated solids over the storage period.

Summary of baseline overflow volume and pollutant loading calculations

Process waste generation:	8,356 ft^3/day (62,500 gal/day)
Sludge Volume (constant):	486,091 ft^3 (3.6 million gal)
Minimum Treatment Volume (constant):	661,500 ft^3 (4.9 million gal)
Total Existing Storage Lagoon Volume:	3,931,800 ft^3 (29.4 million gal)
Volume of Liquids and Solids in Lagoon at Start:	1,206,083 ft^3 (Sludge Volume + Minimum Treatment Volume + Accumulated Process Wastes Since Last Liquid Application)
Precipitation Volume (average):	26 in/yr
Evaporation Rate (average):	98 in/yr
Liquid/Solids Removal for Crop Application:	Land apply lagoon liquids to the maximum hydraulic loading of the crop land on days 7, 14, 21, and 28 of each month unless there has been precipitation in the past 3 days before the application day (That occurs between the freeze-free days between April 21 and September 14)

Calculated baseline overflow volume method

Daily Accumulation of Lagoon Liquids (ft^3/day) = Process Waste (ft^3/day) + [Precipitation – Evaporation] (ft/day) x Lagoon Surface Area (ft^2)

Volume of Lagoon Liquids (ft^3) = Volume of Lagoon Liquids from Previous Day (ft^3) + Daily Accumulation of Lagoon Liquids (ft^3)

Example 2. KF Pork Producers, Davenport, Iowa *(continued)*

If the Volume of Lagoon Liquids (ft^3) is greater than the following:

Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)], then

Overflow Volume = Volume of Lagoon Liquids (ft^3) - [Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)]; and

Volume of Lagoon Liquids (ft^3) is adjusted to the following:

[Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)]
(the maximum volume of liquids the lagoon can store)

If it is an application day (day 7, 14, 21, or 28 of the period between April 21 and September 14), the Volume of Lagoon Liquids (ft^3) = Volume of Lagoon Liquids (ft^3) - Max Hydraulic Loading (ft3)

Calculated Overflow Volume for KFP: 158,419 ft^3/yr (1,184,970 gal/yr)

KFP collected a representative sample of liquid from the storage lagoon to calculate the annual pollutant discharge of BOD_5, total N, total P, and TSS as a result of the overflow volume. The sample was collected from the top 12 inches of the lagoon surface because the majority of overflow will likely be attributed to that zone. The sampling results are shown below:

BOD_5:	1,650 mg/L
Total N:	270 mg/L
Total P:	102 mg/L
TSS:	3,000 mg/L

On the basis of the overflow and the measured concentration, the annual pollutant discharges from the lagoon were calculated by multiplying the flow by the concentration as shown in the example for BOD_5 below:

BOD_5: 1,650 mg/L x 3.785 L/gal x 1,184,970 gal/yr x 2.2 lbs/kg x 1 kg/10^6 mg = 16,280 lbs/yr

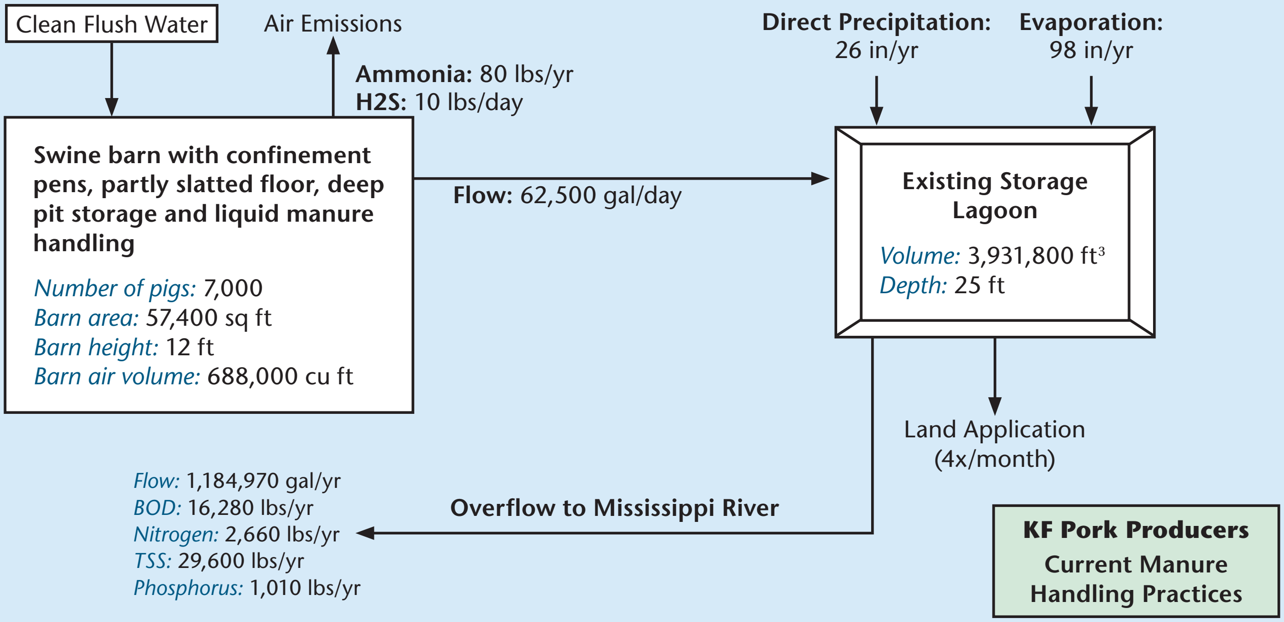
A summary of the pollutant loadings based on the overflow rate and concentration is shown below.

BOD_5:	16,280 lbs/yr
Total N:	2,660 lbs/yr
Total P:	1,010 lbs/yr
TSS:	29,600 lbs/yr

Example 2. KF Pork Producers, Davenport, Iowa *(continued)*

Diagram of baseline waste management system

The following figure is a block diagram of KFP summarizing the inputs and outputs from the manure storage lagoon and the overflows and pollutant loadings. Any overflows from the lagoon discharge to a surface waterbody (in this case, the Mississippi River).



Waste characterization and treatment system evaluation

KFP realized it was not cost-effective to haul excess nutrients in the liquid manure. KFP, in cooperation with its consultant, WB Engineering, conducted a whole-farm audit to determine if pollutant releases could be reduced at the facility by applying new technologies. WB Engineering examined discharges of pollutants from lagoon overflows, estimated air emissions of ammonia and hydrogen sulfide, and worked with KFP to determine if changes in swine feed rations could lower the amount of ammonia and P entering the manure. Finally, WB examined manure application rates to determine if more frequent removals of manure/sludge from the lagoon could provide additional storage capacity and less frequent overflows.

As a result of the whole-farm audit, KFP decided to further evaluate a new wastewater treatment system plus an off-gas treatment system for air removed from both the swine barn and manure pits. Changes in feed rations were not implemented on recommendations from both an animal nutritionist and the local agricultural extension agent, and additional application rates of manure to KFP's crop land would have exceeded nutrient requirements according to the facility's NMP.

The treatment train selected for KFP consists of primary clarification, a vibrating membrane filtration system, and final polishing using a biological trickling filter. For off-gas from the swine barn and manure pits, a biofilter using inorganic media was selected to remove ammonia and hydrogen sulfide. Pilot-scale testing of both the wastewater and air treatment system was conducted March 20 to September 20, 2003, by WB Engineering. Pilot 20 2003 by WB Engineering. A summary of the conceptual design calculations and pilot-scale treatment test results are below.

Example 2. KF Pork Producers, Davenport, Iowa *(continued)*

Waste flow and characterization

WB Engineering collected a daily composite sample of manure and flush water during a 7-day operational period in March 2003 to characterize the wasteload discharged to the storage lagoon. The volume of manure and flush water was also measured during the 7-day sampling period in April, 2003. The average daily flow to the lagoon was 62,500 gallons. Waste characterization data and calculated average daily loading to the treatment system for the target pollutants are summarized below:

Pollutant	Concentration (mg/L)	Influent (lbs/day)
BOD_5:	3,766	1,960
Total N:	753	392
Total P:	301	157
TSS:	11,863	6,174

Daily pollutant loadings were calculated by multiplying the concentration for each constituent by the average daily flow as shown in the example below for BOD_5:

BOD_5 Loading: 3,766 mg/L x 3.785 L/gal x 1 kg/1,000,000 mg x 2.2 lbs/kg x 62,500 gal/day = 1,960 lbs/day

The wastewater treatment system design is based on a flow excess of 20% or gallons per day. Flows greater than 75,000 gallons per day will overflow to the existing 1,500,000-cubic-foot lagoon. During dry-weather periods, excess water from the lagoon will be pumped back to the beginning of the treatment system for processing. Note that KFP will have the capability of recycling nearly 22,600 gallons per day of treated effluent for manure flushing.

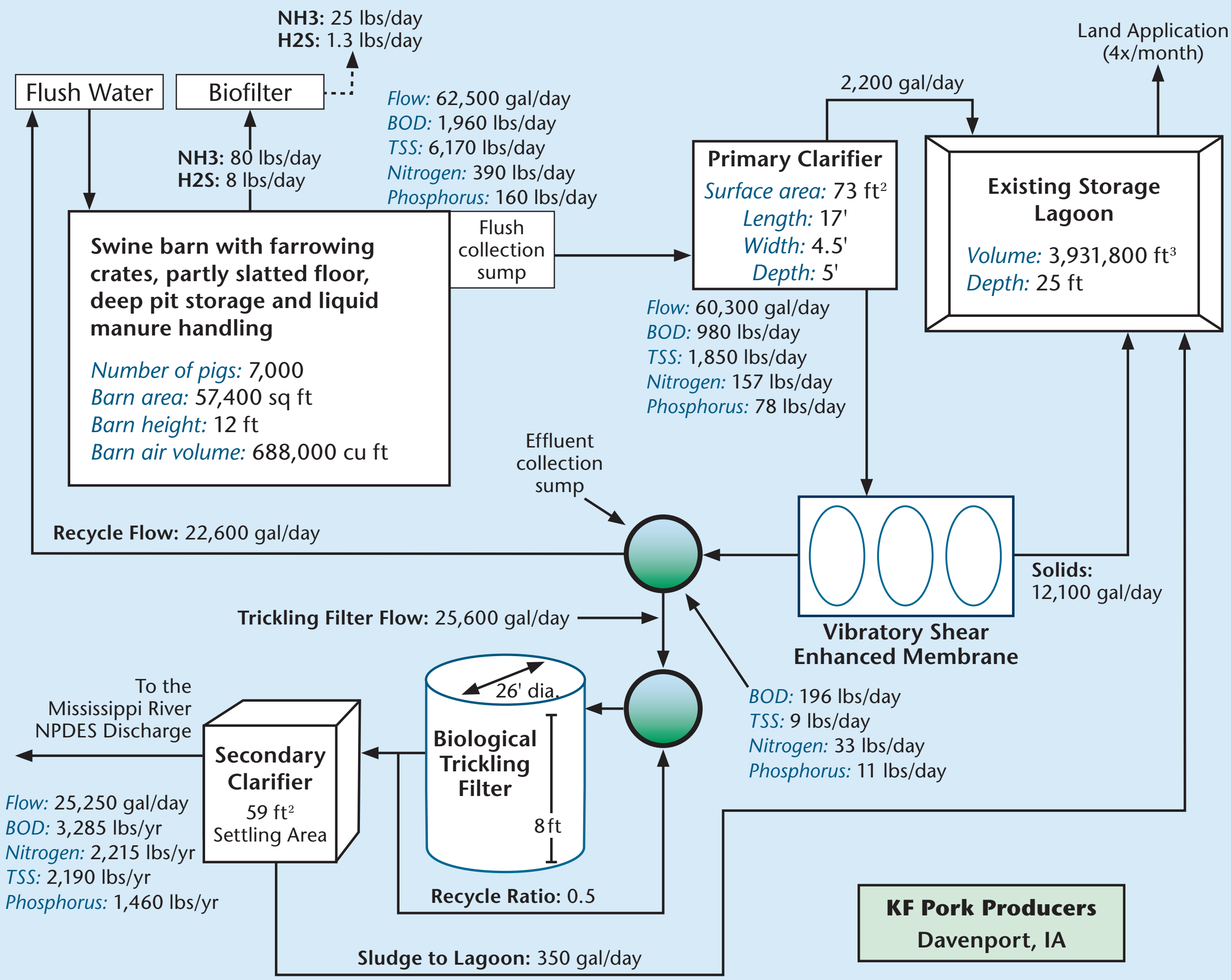
Off-gas from the swine barn and deep pit areas was characterized by collecting air samples from areas near the exit fans. The average concentration of ammonia and hydrogen sulfide measured in the off-gas was 54 ppm and 4 ppm, respectively. On the basis of a measured exhaust rate from all the exit fans for the barn and pit areas, WB Engineering estimates approximately 80 lbs/day of ammonia and approximately 10 lbs/day of hydrogen sulfide is emitted to the atmosphere. Design of the biofilter for treatment of off-gas was provided by BIOREM and consists of new fans and duct work to move air through a single discharge point and an in-ground biofilter to destroy ammonia and hydrogen sulfide.

Treatment system effectiveness

The average concentration of target pollutants measured in the effluent from the pilot-scale wastewater treatment system during the 6-month study is shown in the table below. The calculated monthly loading for the full-scale treatment system is based on an average daily flow of 25,250 gallons. The remaining 37,750 gallons of water that enter the treatment system is used for either recycle or contains concentrated treatment residuals that are discharged to the existing storage lagoon. KFP now has the additional flexibility to collect solids and concentrated nutrients from the existing sludge lagoon and haul them off-site for other uses.

Example 2. KF Pork Producers, Davenport, Iowa *(continued)*

Diagram of alternative treatment system



Comparison of the baseline overflow to the discharge from the alternative treatment system

Pollutant	Baseline overflow (lbs/yr)	Treatment system discharge (lbs/day)
BOD_5:	16,280	3,285
Total N:	2,664	2,215
Total P:	1,006	1,460
TSS:	29,602	2,190

Example 2. KF Pork Producers, Davenport, Iowa *(continued)*

The average concentration of ammonia and hydrogen sulfide measured in the off-gas from the biofilter during the 6-month pilot-scale treatment test is shown below. The biofilter removed approximately 70 percent of the ammonia and 87 percent of the hydrogen sulfide in the gas stream. The biofilter also eliminated all odors from the swine CAFO's off-gas.

Biofilter treatment results during the 6-month pilot test

Pollutant	Influent loading (lbs/day)	Gas flow (cfm)	Effluent loading (lbs/day)	Odor
Ammonia	80	23,000	25	None
Hydrogen Sulfide	10	23,000	1.3	None

Conclusion: Comparison of the pilot-scale testing results with the calculated overflow discharges indicates the proposed treatment system cannot achieve a quantity of pollutants discharged for all the targeted pollutants that is equal to or less than the quantity of pollutants that would be discharged under the baseline performance standards. Because the proposed treatment system cannot achieve the reduction for all target pollutants, the permitting authority denies the facility's request for an individual NPDES permit for operation and discharge of water from the proposed treatment system. If modifications to the treatment system can be made that lower the annual discharge of phosphorus, an individual permit might be considered.

KFP has still decided to install a new biofilter system to remove odors, ammonia, and hydrogen sulfide from its air stream to address complaints from neighbors regarding smells from the facility.

Example 3. Birvan Egg Farms, Okeechobee County, Florida

Background

Birvan Egg Farms (Birvan) is a Large CAFO in Okeechobee County, Florida. Birvan has 40,000 laying hens with an average weight of approximately 3 pounds. Birds are housed in a high-rise cage system. Manure drops from the cages to the floor below and is picked up by the wet flush system and transferred to the anaerobic digester. The anaerobic digester removes the majority of nutrients, $BOD_{5,}$ and volatile solids while generating methane that is used in the facility's boiler system. Effluent from the anaerobic digester is pumped through a vibrating membrane filtration system for polishing residual solids, BOD_5, and nutrients before land application of the polished water to a small grass field. All solids are hauled and sold off-site. Birvan elected to install an anaerobic treatment system rather than a holding pond because of space constraints and the lack of crop land to apply liquids and solids. The manure treatment system has been in operation since 1996.

Birvan calculated the overflow volume and loading from a baseline system (a liquid storage structure) that could have been installed at the facility and compared the results with the loadings being obtained from the existing treatment system.

Summary of baseline overflow volume and pollutant loading calculations

Estimated Storage Lagoon Volume if Constructed:	58,200 ft^3 (435 thousand gallons)
Process Wastewater Generation:	374 ft^3/day (2,800 gal/day)
Volume of Liquids and Solids in Lagoon at Start:	635 ft^3 (Sludge Volume + Minimum Treatment Volume + Accumulated Process Wastes Since Last Liquid Application)
Precipitation Volume (average):	61 in/yr
Evaporation Rate (average):	90 in/yr
Sludge Volume (constant):	5,900 ft^3
Minimum Treatment Volume (constant):	9,200 ft^3
Assumed removal rate:	2x per month from January 21 to December 9
Daily Accumulation of Lagoon Liquids (ft^3/day) =	Process Waste (ft^3/day) + [Precipitation - Evaporation (ft/day)] x Lagoon Surface Area (ft^2)
Volume of Lagoon Liquids (ft^3) =	Previous Days' Volume (ft^3) + Accumulation Volume (ft^3/day)

Calculated baseline overflow volume method

Daily Accumulation of Lagoon Liquids (ft^3/day) = Process Waste (ft^3/day) + [Precipitation - Evaporation (ft/day)] x Lagoon Surface Area (ft^2)

Volume of Lagoon Liquids (ft^3) = Previous Days' Volume (ft^3) + Accumulation Volume (ft^3/day)

Example 3. Birvan Egg Farms, Okeechobee County, Florida *(continued)*

If the Volume of Lagoon Liquids (ft^3) is greater than the following:

Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)], then

Overflow Volume = Volume of Lagoon Liquids (ft^3) - [Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)]; and

Volume of Lagoon Liquids (ft^3) is adjusted to the following:

[Existing Storage Lagoon Volume (ft^3) - Sludge Volume (ft^3) - Minimum Treatment Volume (ft^3)] (the maximum volume of liquids the lagoon can store)

Calculated Overflow Volume for Birvan 3,162 ft^3/yr (23,651 gal/yr)

Birvan collected a representative sample of liquid from the digester to calculate the annual loading of BOD_5, total N, total P, and TSS that would be discharged as a result of the overflow volume. The sample was collected from the top 12 inches of the digester surface because the majority of overflows will likely be attributed to this zone. The sampling results are shown below:

BOD_5:	1,500 mg/L
Total N:	750 mg/L
Total P:	100 mg/L
TSS:	3,200 mg/L

On the basis of the overflow and the measured concentration, the annual pollutant discharges from the storage system was calculated by multiplying the flow by the concentration as shown in the example for BOD_5 below:

BOD_5: 1,500 mg/L x 3.785 L/gal x 23,651 gal/yr x 2.2 lbs/kg x 1 kg/10^6 mg = 295 lbs/yr

A summary of the pollutant loadings based on the overflow rate and concentration is shown below.

BOD_5:	295 lbs/yr
Total N:	148 lbs/yr
Total P:	20 lbs/yr
TSS:	433 lbs/yr

Treatment system evaluation

Birvan has been collecting monthly samples for BOD_5, total N, total P, and TSS from the existing treatment system since early 1997. The measured monthly concentrations in the treatment system effluent and the total flow through the treatment system over the past 12 months are shown below.

Example 3. Birvan Egg Farms, Okeechobee County, Florida *(continued)*

Measured treatment system effluent concentration and total influent flow during the past 12 months

Month	BOD_5 (mg/L)	N (mg/L)	P (mg/L)	TSS	Total flow (gal)
June	20	3.3	0.6	14	83,800
July	21	5.2	0.8	15	83,200
August	13	1.6	0.7	10	84,600
September	8	0.8	0.6	9	83,900
October	9	0.6	0.4	7	84,200
November	18	3.5	0.6	13	84,700
December	13	2	0.7	11	84,300
January	6	0.7	0.4	9	82,900
February	8	0.7	0.4	8	83,900
March	19	1.8	0.8	13	84,700
April	20	4.2	1.2	15	85,100
May	7	2.7	0.8	14	84,300
Median	**13**	**1.9**	**0.6**	**12**	**84,250**

As shown in the figure below, the vibrating membrane filter generates a concentrated wastestream equaling 20% of the influent flow (16,850 gal/month). That concentrated wastestream is sent to a 10,000-gallon holding tank before off-site shipment. Effluent from the vibrating membrane filter enters a lift station where submersible pumps transfer approximately 45,000 gallons per month back to the layer house for manure flushing. According to a measured average flow rate of approximately 22,400 gallons per month at Outfall 001 and the concentration of pollutants in the vibrating membrane treatment system effluent, the following annual loadings to St. Lucie Canal were calculated and compared to the baseline overflow loadings.

Comparison of the Calculated Baseline Overflow Discharge to the Treatment System Discharge

Pollutant	Baseline overflow (lbs/yr)	Treatment system discharge (lbs/day)
BOD_5:	295	29
Total N:	148	4.2
Total P:	20	1.3
TSS:	433	27

Conclusion: The comparison shows that the existing treatment systems consisting of an anaerobic digester and vibrating membrane filtration system achieve better performance than the baseline system for all targeted pollutants. If water quality constraints for fecal coliform in the St. Lucie Canal make additional treatment necessary, Birvan is also considering increasing the temperature of the digester to make it thermophilic, a practice known to reduce fecal coliform in the effluent.

Example 3. Birvan Egg Farms, Okeechobee County, Florida *(continued)*

Diagram of existing treatment system