Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

VEGETATED TREATMENT AREA

CODE 635

(ac)

DEFINITION

An area of permanent vegetation used for agricultural wastewater treatment.

PURPOSE

This practice is used to accomplish the following purpose:

- Improve water quality by using vegetation to reduce the loading of nutrients, organics, pathogens, and other contaminants associated with livestock, poultry, and other agricultural operations

CONDITIONS WHERE PRACTICE APPLIES

This practice applies where:

- A vegetated treatment area (VTA) can be constructed, operated and maintained to treat contaminated runoff from such areas as feedlots, feed storage, compost areas, solid manure storage areas, barnyards, and other livestock holding areas; or to treat process wastewater from agricultural operations.
- A VTA is a component of a planned agricultural waste management system.

CRITERIA

General Criteria Applicable to All Purposes

Vegetated treatment areas shall comply with all applicable laws, rules, regulations, and permit requirements including those applicable to the discharges of waters to the state.

Flows leaving a Vegetated Treatment Area that is built, operated, and maintained according to this standard are not considered process wastewater by New York State Department of Environmental Conservation (DEC).

Size the total treatment area for the VTA on both the contributing site water runoff and vegetation nutrient balances.

- Water balance is the soil's capacity to infiltrate and retain runoff within the root zone. Base the runoff determination on the most restrictive soil layer within the root zone regardless of its thickness. Use the soil's water holding capacity in the root zone, infiltration rate, permeability, and hydraulic conductivity to determine its ability to absorb and retain runoff.
- Nutrient balance utilizes the nutrients from the waste runoff to meet the nutrient removal in the harvested vegetation considering volatilization, soil adsorption, denitrification, organic matter deposition, and allowable percolation. Base the nutrient balance on the most limiting nutrient (i.e. nitrogen or phosphorus).

Evaluate the site for nitrogen leaching using the Nitrogen Leaching Index.

- On sites with a Leaching Index greater than 10 and soil hydrologic group A, select either a different site, replace the in-situ soil, or modify the soil properties to lower the soil hydrologic group to a B, C, or D classification.
- On sites with a Leaching Index greater than 10 and soil hydrologic group B, C or D, a VTA may be used by increasing the treatment area by 10 percent for each index value of 1 over 10.

Evaluate the site for phosphorus loading using the Morgan P soil test procedure or equivalent. Collect composite samples (six cores per acre prorated based on the size of the site) from the full root zone (6 to 8 inches). Soils with phosphorus results which are greater than 80 pounds per acre Morgan P or equivalent are not acceptable. Soil may be removed and replaced to achieve an acceptable P level.

Divert uncontaminated water from the treatment area to the fullest extent possible.

Establish permanent herbaceous vegetation in the treatment area. Permanent herbaceous vegetation shall be designed to achieve a minimum stand density of 85 percent ground cover within one year. Use grasses, legumes, and other forbs adapted to the soil and climate. Select species to meet the current site conditions and intended use. Selected species will have the capacity to achieve adequate density, vigor, and yield to treat contaminated runoff before discharge into a receiving surface water or wetland. Complete site preparation and seeding at a time and in a manner that best ensures survival and growth of the selected species.

Select vegetation that will withstand anticipated wetting or submerged conditions. Harvest vegetation as appropriate to encourage dense growth, maintain an upright growth habit, and remove nutrients and other contaminants that are contained in the plant tissue.

Exclude all livestock, including grazing, from the VTA.

Design the VTA based on the need to treat the runoff volume from the 25-year, 24-hour storm event from the agricultural animal management facility. Infiltrate a portion or the entire volume of the design storm, based on management objectives. Where required by specific water quality criteria, store the non-infiltrated portion of the design volume for utilization or treatment.

Apply discharge into and through vegetated treatment area as sheet flow at design depth of no greater than 0.5 inches. To encourage sheet flow across the treatment area, provide a means to disperse concentrated flow, such as a ditch, curb, gated pipe, level spreader, or a sprinkler system. Complete land grading and install structural components necessary to maintain sheet flow throughout the treatment area.

Vegetated treatment areas must have a minimum flow length of 100 feet. Limit the natural or constructed slope of the VTA from 0.3 to 6 percent. Install provisions to remove standing water on slopes flatter than 1 percent. The minimum entrance slope to the VTA is 1 percent. Slopes greater than 6 percent may be used where the soils saturated hydraulic conductivity is above 1.4 micrometer per second (0.2 inches per hour). Increase the length of the VTA by 20 feet for each percent of slope greater than 6 percent. Confirm that the VTA will not erode.

Use NRCS Conservation Practice Standard (CPS) Code 632, Waste Separation Facility, to pre-treat influent with waste separation (i.e., settling basin and filter screens) to reduce organic loading and nutrients to levels that are tolerated by the VTA and to prevent excessive accumulation of solids in the treatment area.

Utilize inlet control structures to control the rate and timing of inflow during normal operations and to control inflow as necessary for operation and maintenance.

Site the VTA to ensure that the lower edge is no closer than 25 feet flow path from the nearest receiving surface water body and the entire treatment area is 100 feet or more from a well.

Where the required separation distance from the receiving surface water cannot be achieved, construct a berm to hold the 25-year, 24-hour runoff to block the flow path from the water body.

Locate VTAs outside of floodplains. However, if site restrictions require location within a floodplain, provide protection from inundation or damage from a 25-year flood event, or larger, if required by regulation.

Install VTAs where the water table is either naturally deep or artificially lowered so that the infiltrated runoff does not mingle with the groundwater at the bottom of the root zone. Maintain a minimum 2 feet of soil depth to groundwater table. The water table must not be closer than 2 feet from the bottom of unlined distribution trenches. Subsurface drainage within the VTA is not allowed. Subsurface drainage may be used to lower the seasonal high water table to an acceptable level provided the subsurface drain lines are at least 10 feet away from the VTA boundary or at least 1/2 the NY Drainage Guide recommendation tile spacing for the specific soil type recommendation, whichever is larger.

A minimum of 2 feet of soil depth is required between the bottom of unlined distribution trenches and bedrock. Maintain a minimum of 2 feet of soil depth between bedrock and the surface of the treatment area.

Unless soil moisture can be maintained to prevent drying and cracking, do not plan infiltration areas where soil features such as cracking will result in preferential flow paths that transport untreated runoff from the surface to below the root zone.

Ensure that appropriate erosion control measures and sheet flow control measures (i.e., gravel spreaders) are adequately addressed over the entire length of the VTA.

Additional Criteria for Runoff from Concentrated Livestock Areas

A VTA will be installed only in conjunction with a Comprehensive Nutrient Management Plan (CNMP). Source reduction to remove manure solids from the barnyard is an essential design and maintenance component for the continued functioning of the treatment area.

1. Influent Pre-treatment
    - A constructed settling basin shall have sufficient capacity, at a minimum, to store the runoff computed for 15 minutes duration at the peak inflow rate resulting from a 2-year, 24-hour rainfall event. Any basin outflow shall be disregarded in computing minimum storage. Additional storage capacity, based on frequency of cleaning, shall be provided for manure and other solids settled within the basin. When the basin is cleaned after every significant runoff event, additional storage equivalent to at least 0.5 inch from the concentrated livestock area shall be provided. If only annual cleaning of the basin is planned, additional storage equivalent to at least 6 inches from the concentrated waste area shall be provided.
2. Size of Vegetated Treatment Area
    - N loading from a barnyard will not exceed 500 pounds of N per acre of treatment area per year.
    - Minimum hydraulic dimensions shall be based on the routed peak outflow from the concentrated waste area or settling facility, based on a 25-year, 24-hour rainfall when storage is provided, but in no case less than the peak flow from a 2-year, 24-hour rainfall event when storage is not provided.
    - The flow length of a VTA shall be sufficient to provide at least 15 minutes of flow through time and any adjustments required for slopes over 6 percent. Table 1 gives flow velocities and minimum flow lengths for a VTA relative to the average land slope, for barnyard runoff treatment for various slopes as calculated using Manning's formula. Shallower depths would result in lower velocities and shorter flow lengths, with corresponding wider flow widths.

TABLE 1

VTA 15 minute flow length at maximum 0.5 inches of flow depth for barnyard runoff (Manning n = 0.24)

Average Land Slope (%)	Avg. Flow Velocity at 0.5 inch depth (feet/sec)	Flow Length (feet)
2	0.11	100
4	0.15	135
6	0.18	165
8	0.21	189 (229 min*)
10	0.24	212 (292 min*)
12	0.26	232 (352 min*)

** Adjusted length for extra slopes over 6 percent*

- Install mechanisms, where needed, to prevent continual flows into the VTA.

Additional Criteria for Treatment of Milking Center Wastes

Milking Center Waste VTAs apply to operations with 75 cows or less.

1. Influent Pre-treatment
   - Design measures to sufficiently handle all inputs from milkhouse waste stream.
   - A 3-day dosing or a 7-day maximum alternating VTA that allows alternating use and resting are required for systems producing greater than 300 gallons per day and all milking parlor applications.
   - Provide a settling tank that will exclude floating milk fats from the treatment system and provide a minimum 3-day storage capacity.
   - Pumping and gravity dosing will not be done from the settling tank.
2. Size of Vegetated Treatment Area
   - Provide a minimum of 10 square feet of treatment area per gallon per day of wash water.
   - Either use a flow meter, or estimate volume as 4 gallons per cow per day for milkhouse operations and 8 gallons per cow per day for milking parlor operations.
   - The effluent flow path shall be a minimum of 300 feet to the nearest receiving surface water as measured from the top of the VTA.

Additional Criteria for Treatment of Bunk Silo Leachate

1. Influent Pre-treatment
   - Use source control to reduce leachate volume and solids loadings to treatment area.
   - A VTA will be used only when concentrated low flows have been controlled and eliminated from the treatment area.
   - The amount of low flow collection will be monitored and adjusted to prevent a large kill zone from developing.
2. Size of Vegetated Treatment Area
   - Provide 1/3 acre of VTA for each one acre of contributing watershed area.
   - Effluent flow path shall be a minimum of 300 feet as measured from the top of the VTA to the end of the active treatment area.

Additional Criteria for Treatment of Compost Pad Runoff

1. Influent Pre-treatment
   - Compost and/or compost ingredients on pad shall be less than 70 percent moisture or have positive control of any leachate, such as roofs or tarps and/or leachate collection systems to insure that no leachate flows from the compost or ingredients.
   - A pad will only discharge effluent to the VTA when a precipitation event is occurring.
2. Size of Vegetated Treatment Area
   - Provide 1/3 acre of VTA for each acre of compost pad contributing watershed area.

- If effluent is collected and released then use Table 1 to determine flow length of the VTA.
- Effluent flow path shall be a minimum of 300 feet to the nearest receiving surface water as measured from the top of the VTA.

Additional Criteria for Calf Hutch Area Runoff

1. Influent Pre-treatment
   - Calf hutch layout and bedding amounts will provide no opportunity for liquid discharge without precipitation.
   - Collection systems will be installed as needed to insure that continuous discharges from the calf hutch area are eliminated.
   - A calf hutch area will only discharge effluent to the VTA when a precipitation event is occurring.
2. Size of Vegetated Treatment Area
   - Provide 1/3 acre of VTA for each acre of calf hutch contributing watershed area.
   - If effluent is collected and released then use Table 1 to determine flow length of the VTA.
   - Effluent flow path shall be a minimum of 300 feet to the nearest receiving surface water as measured from the top of the VTA.
   - An alternative size, for a long row of calf hutches, will be a VTA parallel to the pad 1/2 the flow path length of the contributing watershed area. Effluent flow path length to the nearest receiving surface water, measured from the bottom of the VTA, shall be 3 times the flow path distance through the linear calf hutch contributing watershed area of the VTA.

Additional Criteria for Pressure Dosing Systems

Distribute the effluent over the VTA through sprinkler irrigation or other pressure dosing system. Match the application rate of sprinkler nozzles to the most restrictive soil infiltration rate or other factors to prevent effluent application from discharging from the VTA.

CONSIDERATIONS

VTA Siting Considerations

- On-farm traffic patterns
- Accessibility to the milk house wastewater components
- Adjacent land uses and visibility
- Location and height of air vents to avoid the odors that may be prevalent in the pipeline
- Visual aesthetics to blend the system into the surrounding landscape
- Site, soil, and environmental factors
- Locating the VTA where prevailing winds will minimize odors and other aesthetic problems for neighbors
- Requiring more than 2 feet of soil depth where groundwater concerns are identified by the N index or where fractured bedrock or limestone is close to surface

Influent Pre-treatment Considerations

- Pre-treating overland flow influent with solid/liquid separation to reduce organic loading, odor generation, and maintenance requirements; site a settling facility before the pump station when waste is pumped to a VTA.

Size of VTA Considerations

- VTA sizing may be based on the Vegetated Treatment Area N-Loading calculator posted on the NY Field Office Technical Guide.
- Additional nutrient and infiltration design guidance in Vegetated Treatment Systems for Open Lot Runoff, (Koelsch, et. al., 2006). Consider that this manual was developed in a region with less

annual precipitation and more annual evaporation than New York State, and where VTA's typically include total collection of water in an irrigation lagoon.

- In general, longer, narrower treatment areas are preferable to shorter, wider areas. Use a serpentine or switchback VTA to provide a greater length of flow, if adequate treatment length of flow to provide the desired reduction of pollutants is not available.
- Install VTA on the contour and provide sufficient width to pass the routed peak or peak flow at a depth of 0.5 inches or less.
- Consider additional field level spreading mechanisms at 50 feet intervals to facilitate redistribution of the effluent flows to sheet flow. Direct contaminated effluent to a waste storage facility during excessively wet or cold conditions.
- Install fences or other measures to exclude or minimize access of the VTA to humans, vehicles or animals.
- Install a berm around the lower end of the VTA to contain excess runoff that may occur. Install a pumping system at the bottom of the VTA to either recirculate the effluent to the top of the VTA or transfer to a waste storage facility.
- Effluent from the VTA may be stored for land application, recycled through the wastewater management system, or otherwise used in the agricultural operation.
- Provide more than one vegetated treatment area to allow for resting, harvesting vegetation, maintenance, and to minimize the potential for overloading.

Vegetation Considerations

- To maximize nutrient uptake, use warm and cool season species in separate areas to ensure that plants are actively growing during different times of the year.
- During the vegetation establishment period, consider a temporary mechanism to divert flows from the VTA. In some cases, a temporary mechanism may be used to intermittently distribute flow on various portions of the VTA without adversely affecting the vegetation.
- Consider suspension of application to the treatment area when weather conditions are not favorable for aerobic activity or when soil temperatures are lower than 39° F. When soil temperatures are between 39° F and 50° F, consider reducing application rate and increasing application period while maintaining a constant hydraulic loading rate.

For Bunk Silos, Barnyards and Calf Hutch Areas

- To remove solid materials from the influent, consider using added storage and/or solid settling and skimming, such as a 3 tier screen system.
- Provide additional storage in the basin collection area to minimize or eliminate discharge into the VTA during rainfall events. Delay application until rainfall has ended to improve infiltration and nutrient uptake.

For Milking Center Wastes

- Consider source control to remove as much milk, debris, and manure from the waste stream as possible. Special consideration must be given when high Biological Oxygen Demand (BOD) loading and high solid contents are present. These conditions will occur when waste milk is dumped into the waste stream or manure from milking parlor floors is washed into the waste stream. Additional settling capacity and more frequent clean out will be required with high solid waste.
- Provide more than one vegetated treatment area to allow for resting, harvesting vegetation, and maintenance, and to minimize the potential for overloading.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice to achieve its intended use.

As a minimum include:

- Critical construction perimeters, necessary construction sequence, vegetation establishment requirements, level spreader mechanism requirements, associated practices, and agronomic nutrient removal.
- Plan view showing the location of the VTA and pertinent adjacent land use information.
- Details of the length, width, and slope of the treatment area to accomplish the planned purpose (length refers to flow length down the slope of the treatment area).
- Herbaceous species, seed selection, and seeding rates to accomplish the planned purpose.
- Planting dates, care, and handling of the seed to ensure that planted materials have an acceptable rate of survival.
- Site preparation sufficient to establish and grow selected species.
- Show details of influent collection, pretreatment, storage and transfer systems.
- Describe the temporary influent diversion measures proposed to enable vegetation establishment.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for its design.

Include the following items as appropriate:

Influent Pre-treatment O&M

- Inspect and maintain the pre-treatment system and evaluate the source for volume and concentration changes.
- Inspect and clean out influent pre-treatment systems at regular intervals. Inspect and clean out influent pre-treatment systems exposed to surface runoff after each rain event.
- Inspect, clean, and repair effluent spreader and redistribution devices regularly and after storm events to address gullies, and prevent concentrated flow.

Vegetation Area O&M

- Inspect and repair vegetative treatment areas after storm events to address gullies, reseed disturbed areas, and prevent concentrated flow.
- Control undesired weed species, especially state-listed noxious weeds, and other pests that could inhibit proper functioning of the VTA.
- Conduct maintenance activities only when the surface layer of the VTA is dry enough to prevent compaction. Routinely dethatch or aerate a treatment area used for treating runoff from livestock holding areas in order to promote infiltration.
- Maintain or restore the treatment area as necessary by periodically grading or removing excess material when deposition jeopardizes its function. Re-establish herbaceous vegetation. Apply supplemental nutrients and soil amendments as needed to maintain the desired species composition and stand density of herbaceous vegetation.
- Monitor any tile outlet used to lower the water table.
- For a VTA with a slope less than 1 percent or where a containment berm is built, the site shall be inspected to ensure vegetation is not stressed by inundation. Excess water shall be removed according to the nutrient management plan.

- Soil test every 3 years and evaluate the P level in the lower 1/3 of the VTA to the full extent of the root zone (12 inches). Monitor all treatment areas to maintain optimal vegetative growth and environmental protection. Ensure that neither excess phosphorus is accumulating in the soil profile, nor excess nitrogen is leaching below the root zone.
- Annually check the rate of nitrogen being applied to vegetation treatment area plant species, for silage leachate, size of the kill zone is an indicator of excess loading. If too large of a kill zone exists reduce loading rate.
- Manage the VTA to maintain vegetative treatment effectiveness throughout the growing season. Time the harvest of the VTA plants so vegetation can regrow to a sufficient height to effectively treatment effluent late in the growing season. Providing rest periods to maintain an aerobic soil profile. Storage with periodic dosing or alternating treatment areas may be desirable.

REFERENCES

USDA NRCS, National Engineering Handbook, Part 651, Agricultural Waste Management Field Handbook.

Koelsch, R., B. Kintzer, and D. Meyer. (ed.) 2006. Vegetated Treatment Systems for Open Lot Runoff - A Collaborative Report. USDA NRCS.

“Vegetated Treatment Systems for Open Lot Runoff, a Collaborative Report”. https://socwisconsin.org/wp-content/uploads/2016/04/NRCS_2006_VTACollaborativeReport.pdf

EPA Process Design Manual “Land Treatment of Municipal Wastewater” October 1981.

EPA Process Design Manual “Land Treatment of Municipal Wastewater Effluents” September 2006.

Wright, P.E., L.D. Geohring, and S.F. Inglis. 2005. Effectiveness of low flow collection of silage leachate and vegetative filter area for CAFO farms. Final project for EPA sponsor agreement X-982586-00, Biological and Environmental Engineering Department, Cornell University, Ithaca, NY. 36.

Faalkner, J.W., W. Zhang, and L.D. Geohring. 2007. Evaluating vegetative filter areas for treating agricultural wastewaters. ASABE Paper #07-2243, ASABE, St. Joseph, MI.

Kim, Y.J., L.D. Geohring, J.H. Jeon, A.S. Collick, S.K. Giri, and T.S. Steenhuis. 2006. Evaluation of the effectiveness of vegetative filter strips for phosphorus removal with the use of a tracer. Journal of Soil and Water Conservation 61(5);293-302.

The New York Nitrate Leaching Index http://nmsp.cals.cornell.edu/publications/nindex.html

The New York VTA Sizing Spreadsheet Vegetated Treatment Area N loading calculator spreadsheet found in the FOTG, Section IV, Table of Contents.