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VTS

Vegetative Treatment Systems MANUAL

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This project was funded, in part, by a CWA Section 319 grant from the U.S. Environmental Protection Agency through the Nebraska Department of Environmental Quality.

Contents

Introduction

Congratulations on the construction of your Vegetative Treatment System (VTS) for your open lot feeding area. You have demonstrated a commitment to your business by installing this system on your operation.

We want to help you get the best performance and longevity out of this investment. This manual contains information on how to do that, please read it carefully.

As you read this manual you will find information following a bold "NOTICE:" symbol. This important information is intended to help you avoid any problems with your system.

Managing this type of livestock waste control system, like any waste system, can seem challenging at first. Over time you will notice that the time spent managing the runoff water from your feeding area will diminish. Please contact your design professional for any questions about operating your new Vegetative Treatment System. Questions about operation and maintenance of your VTS should be directed to the design professional who designed your system and the Nebraska Department of Environmental Quality (main switchboard is 402-471-4288, ask for your regional inspector).

1.0
Safety

We encourage you to follow safe practices around your VTS. Some of these systems may have pump stations with moving parts. Follow the manufacturer's operating and safety procedures around the shafts, pulleys, and belts of the pump and motor.

Any place that manure is stored can be extremely hazardous particularly if the area is not ventilated. The decomposition of organic matter by microorganisms releases ammonia, methane, hydrogen sulfide, and volatile organic compounds that can deplete oxygen in the air. Under no circumstances should a pit, sump, or storage area where manure is present be entered without knowing the manure gas and oxygen concentration. Any pump station that contains manure must be considered a confined space and may contain dangerous gases. Entry into these systems is never appropriate because of these gases. Any repairs must be done from the outside.

Sediment basins and other structures with side slopes may be slippery (including wet grass) after a rain event. Make sure you have good footing when working on these slopes. In large structures it may be necessary to prepare for a self-rescue in case of an accident or entrapment (ropes, harness, and secondary egress).

Many electrical pump stations operate at high voltage and current, thus posing a risk of electrocution. Do not attempt repair of this type of equipment without proper training. All repairs of electrical components must be done by a licensed professional.

2.0
What is a VTS?

A Vegetative Treatment System (VTS) refers to a combination of treatment steps for managing feedlot runoff. VTSs are typically used on open-lot systems for beef and dairy cattle. The VTS first separates the solids from the liquids in runoff. A sediment basin is most commonly used to separate the solids from the runoff water. The runoff is then applied to a Vegetative Treatment Area (VTA) through a distribution system, where the runoff infiltrates into the soil, preventing it from leaving the farm. Storing water in the soil instead of a storage structure is what makes a VTA different from a conventional holding pond system (Figure1).

Once the runoff is in the soil, natural processes allow plants to use the nutrients. Perennial vegetation, such as a grass or a forage crop, is always used in a VTA. The VTA is used to treat runoff from a feedlot or barnyard by settling, infiltration, and nutrient use. A VTA is commonly confused with vegetative buffer (or filter) strips. A buffer strip is a narrow strip of vegetation (usually 30-60 feet wide), between cropland and a stream or other surface water. Runoff passes through the buffer with some "filtering" of pollutants, but no attempt is made to control solids or flow.

Once the vegetation in the VTA reaches the reproductive stage of growth, a haying operation removes the biomass. When the hay is removed, so are the accumulated nutrients. This is a key function of the VTA. Grazing is not appropriate as it simply reeposits and accumulates nutrients in the VTA. The hay crop can be fed back to the livestock, used as bedding, or transported off the farm. In essence the VTS works as a recycling system. The solid manure trapped in the sediment basin will be mechanically removed and applied appropriately to other crop fields on the farm or ranch.

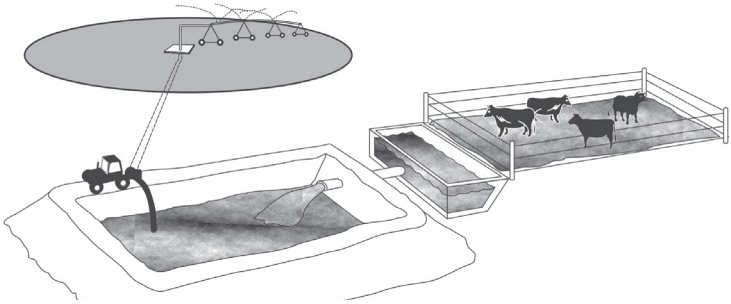
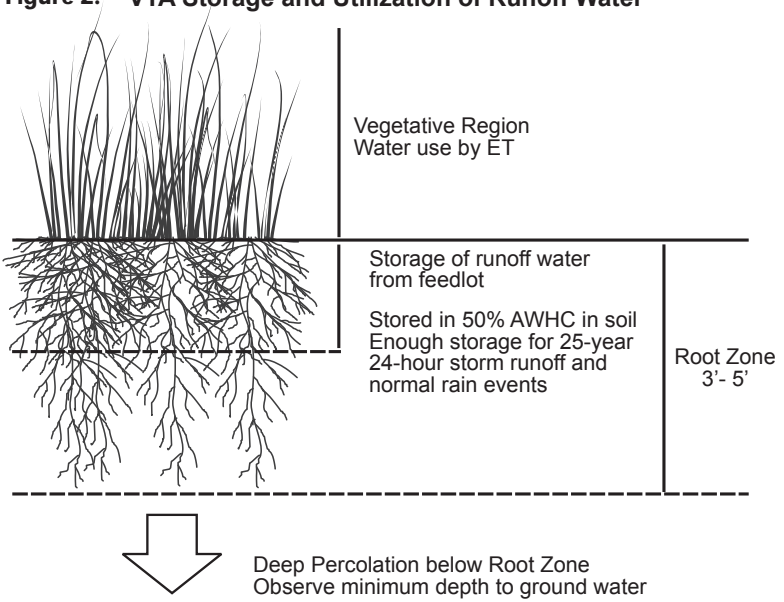


Figure 1. Conventional Holding Pond Runoff Storage System

A VTS is a potential alternative to a conventional holding pond. A VTA is not to be treated the same as land application ground. Because the root zone is used as the storage facility, a VTA must be intensively managed the same as a holding pond would be. The storage component of the VTA is 50% of the available water holding capacity (AWHC) of the soil in the plant's root zone (Figure 2). Just as a discharge from a pond is not desired, neither is a VTA discharge.

Figure 2. VTA Storage and Utilization of Runoff Water



3.0
VTS Components

Sediment Basin

A sediment basin may be referred to as a settling basin or debris basin. A sediment basin must never be confused with a holding pond or lagoon. They have completely different functions even though they may seem similar in appearance. Sediment basins generally don't meet the regulatory authority's permeability standards since most do not have constructed clay or synthetic liners.

A sediment basin pre-treats runoff water from a feeding area following a rain and runoff event. The basin captures the runoff water and slows the water velocity down to a point where most of the solids will settle and be removed from the liquid flow.

NOTICE: Removal of solids is critical to the performance of a VTA since the manure solids contain most of the nutrients. The sediment basin will contain these solids and accumulate them over time.

The water in the sediment basin will be managed with a control valve or pumping system. The sediment basin is designed to contain the 25-year 24-hour storm, accumulated solids, and provide freeboard. After a rain event, the producer should wait a minimum of 30 minutes after the runoff event has ended before releasing runoff water to the VTA to allow for sufficient solids settling. In practice, most producers wait a day to release liquids to a VTA.

Vegetative Treatment Area (VTA)

A VTA is commonly confused with a vegetative buffer or filter. A buffer or a filter is designed with vegetation to have brief contact with runoff water to filter some of the solids and nutrients contained in that water. Then the water is discharged. While this partial treatment is beneficial, it is generally inadequate for treating runoff from an open lot.

A VTA is designed to have longer contact periods between vegetation and runoff water so the water infiltrates into the soil and becomes trapped in the vegetation's root zone. Water stored in the soil's available water holding capacity will be utilized by the crop when the plants needs it. A VTA uses a perennial crop, such as cool or warm-season grass, that is effective at using large amounts of water and nutrients when the majority of runoff occurs, and has a long growing season. Annual forage or cash crops do not fit in this category, but perrenial grasses do. This type of vegetation has potential to have high yields if weather permits. The established root system allows nutrients to be stored in the root zone in the early spring and late fall when there is little or no plant growth. Vegetation selection is dependent on design parameters as well as what works well in your area. It is important to have a successful perennial that performs well in your VTA. If initial establishment does not provide a vigorous stand, try interseeding other species. In most cases the fittest will survive. Grasses that have a high tolerance to salts are the most suitable.

A VTA can be constructed using several different styles. Which system is built depends on the topography of the feeding area and distance to surface and ground water. The four most typical systems include a Sloped VTA, Level VTA, Vegetative Infiltration Basin, and a Sprinkler VTA. A system may also have more than one type of VTA. These types of VTA are discussed below.

Sloped VTA

A Sloped VTA refers to a treatment area that has a slight down gradient slope (0-4% grade) that uses gravity to distribute the runoff water through the vegetation (Figure 3). The runoff water can be delivered to a sloped VTA via a gravity basin outlet or a pump system. Uniform runoff application is achieved by directing the runoff water to move downhill in a sheet-flow manner. Care must be taken to prevent any concentrated flow areas, since they reduce the effectiveness of the VTA and increase the chance of a VTA discharge. In some designs, the tail water from the VTA can be captured in a recovery basin and returned to the feedlot sediment basin through a pumping system. These recovery systems help to avoid VTA discharges into surface water.

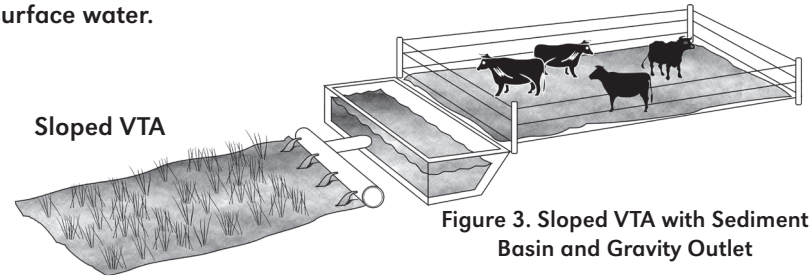


Figure 3. Sloped VTA with Sediment Basin and Gravity Outlet

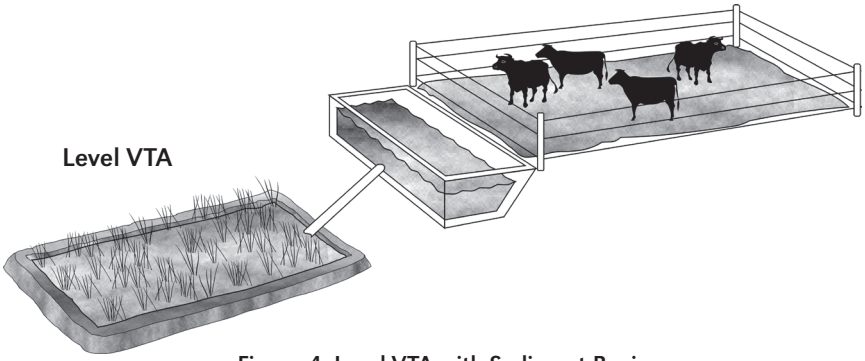


Figure 4. Level VTA with Sediment Basin

Level VTA

A Level VTA is a treatment area that is level or nearly level (0-1%) in all directions (Figure 4). This system uses a large capacity flood system to apply the runoff water evenly across the VTA and allow it to infiltrate into the soil.

Vegetative Infiltration Basin

A Vegetative Infiltration Basin (VIB) is similar to a Level VTA (Figure 5), except it will have the addition of sub-surface drain tile below the surface, usually about 3-4 feet, that collects the infiltrated excess runoff and transfers it to another VTA.

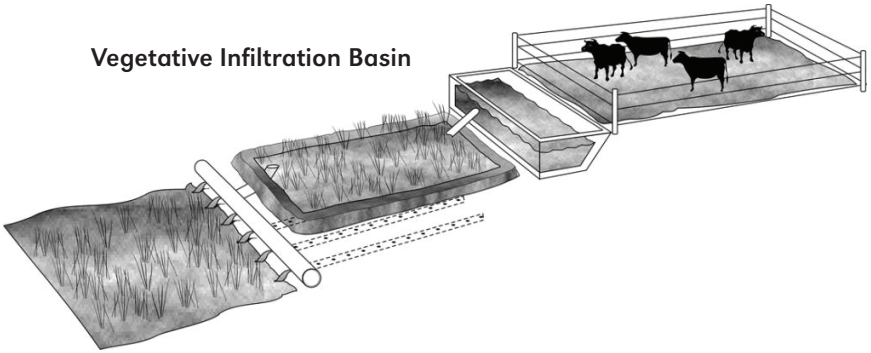


Figure 5. Vegetative Infiltration Basin with Sediment Basin and Sloped VTA

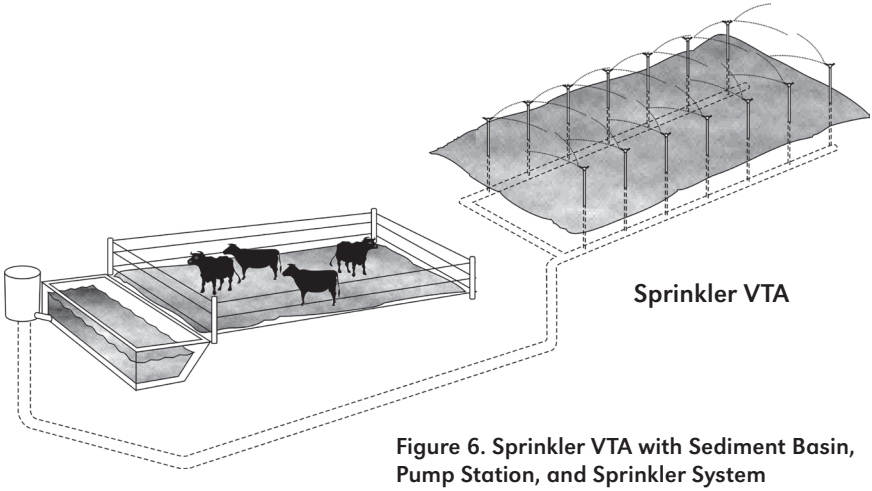


Figure 6. Sprinkler VTA with Sediment Basin, Pump Station, and Sprinkler System

Sprinkler VTA

A Sprinkler VTA uses a pump, filter, and sprinkler system to apply runoff water to a VTA (Figure 6). This system is generally used on a VTA that is up-gradient of the feedlot and cannot be graded for a Sloped or a Level VTA. It is also used in situations where the soils have an infiltration rate that is too high or too low to use a Sloped or Level VTA.

Additional Land Application Area (Crop Field)

In some treatment systems, a nearby crop field can be used for some runoff water application. Runoff water from the feedlot doesn't have to be applied to the VTA only. Additional crop acres can receive runoff water prior to or during the growing season. The runoff water can be applied through gravity irrigation pipe or a sprinkler system. The amount of runoff water applied should be determined by the farm's Nutrient Management Plan. Prior to applying this runoff water to a crop field, a sample of the runoff water needs to be taken and sent to a laboratory for testing of N, P, and K. Records must be kept of the approximate application volume so the nutrients can be credited in that crop field. Care must also be taken that feedlot water is not over-applied so as to impact surface water.

Clean Water Diversion

Clean water diversions are used in a VTS to prevent clean runoff water from entering the feed storage area, pens, or VTA. Since a VTA is sized for the amount of nutrients generated by the livestock and the volume of runoff water, it is best to treat runoff from the smallest area possible. Diversions are designed to manage the runoff from a 25-year, 24-hour storm event. It is critical to maintain clean water diversions, as their failure will certainly cause a failure of a VTS due to excessive runoff.

Control Valves

A VTS uses control valves in the sediment basin to manage the release of rain water runoff collected from the feedlot. Once the solids have settled out, the producer can release the water to the VTA at the appropriate time to maximize uniform distribution across the VTA. Control valves can also be used in the distribution system as a management tool on gated pipe. Surge valves have been used successfully to reduce the labor required to manage distribution of pump-applied runoff to a sloped VTA.

Distribution System

After the runoff water is collected in the sediment basin, a distribution system is used to apply the water to the VTA. Distribution systems can be comprised of basin outlets, pipes, irrigation gated pipe, concrete spreaders, sprinkler systems, or pumps and lift stations. The purpose of these systems are to empty the sediment basin and apply the runoff water in a uniform manner across the VTA.

4.0
Operation of Your Vegetative Treatment System

The different types of VTA use different methods of applying the runoff water, but the desired results are the same. The runoff water must be applied after each rain event and applied uniformly across the VTA so there is no over-application of nutrients in one area or a deficiency in another area. Adherance to these management practices will help maintain a healthy crop of perennial vegetation and encourage high yields without leaching nutrients below the root zone of the crop or allowing runoff to leave the VTA.

NOTICE: The sediment basin must be drained after each rain event where there was runoff, even the small storms. The challenging part of VTS management is applying these small amounts to the VTA in a uniform fashion.

Although VTAs are built (or designed) to contain runoff water from a 25-year, 24-hour rain event, this is not a regular occurrence. So, it is important to understand how to manage runoff from all rain events.

NOTICE: The VTA performs two functions; 1) To store the runoff water and its nutrients in the root zone of a perennial crop, and 2) To allow the plants to utilize the water and nutrients to produce forage that will be removed through a haying operation. Follow the Operation and Maintenance Plan included in the design of the VTS for proper runoff water sampling and VTA soil sampling.

NOTICE: The VTA can never have livestock on it. The vegetation must be removed by haying or green chopping only.

Sloped VTA

Sloped VTAs are typically divided into multiple Distribution Areas (DA) using border ridges. The amount of runoff to apply to these areas depends on the size of the rainfall events. The whole VTA is designed to store and utilize the 25-year 24-hour storm as the maximum one-time rain event. Managing the runoff application to individual DA is especially important for the typical smaller storm events.

NOTICE: It is critically important for the runoff application to be uniform across the DA and also uniform from top to bottom. This runoff management assures a long life span of the VTA and encourages plant vigor and yield, since the nutrients are spread evenly across each DA.

For example, an operator could apply Storm A's runoff to DA 1 & 2 on June 1st and Storm B's runoff to DA 3 & 4 on June 15th, when the storm events happened on May 30th and June 13th. Rotating the application of runoff from small storm events among DAs will help achieve uniform application of nutrients across the whole VTA throughout the year. To minimize the labor required to change gates in a DA rotation, multiple basin outlets from a gravity-fed sloped VTA or a series of surge valves or low pressure line valves in a pump-fed Sloped VTA may be utilized. Runoff water can be moved from one DA to another by opening and closing appropriate valves without adjusting gates. Runoff water must be applied uniformly across and among the DAs.

The amount of runoff water applied to the DA will depend on the amount of runoff water in the basin and the infiltration rate of the soil. After a storm event the infiltration rate of the soil will be slow, but infiltration will increase as soil dries. Judgment and experience are needed to determine the best time to apply runoff to the DAs. To start use the lower infiltration rate of the soil after a storm to encourage a more uniform application to the lower end of the DA and minimize deep percolation at the upper end of the VTA. If the runoff water is reaching the lower end of the DA too quickly, wait 24 hours for the soil surface to dry out slightly and the infiltration rate to increase. This should lengthen the application time for each DA and reduce the amount of gate changes per application. Consult your design professional for any specific concerns related to the operation and maintenance of your VTA.

Level VTA and VIB

Level VTAs (and VIBs) have fewer management options. Once runoff water is collected and solids have settled out in the basin, it is best to release the runoff water soon after the rain event (while the soil is still wet). The soil will have its lowest infiltration rate and this encourages uniform application across the VTA, especially after small storm events. It is important, however, not to inundate the level VTA with so much runoff that the vegetation is under water for an extended period of time.

Sprinkler VTA

Management of a Sprinkler VTS is similar to a sloped VTA in that application of runoff from the smaller or more typical rain events will have to be systematically moved around the VTA to achieve uniform application. If the sprinkler system is a towable or a mechanically moveable system, it will have to be moved to a new set or station before each application, or in a large storm it can be moved to multiple sets thoughout the whole application. The sprinkler nozzles are sized to match the average infiltration rate of the soil, so there should be minimal or no runoff. If some runoff appears soon after start up, shut the system down and wait 24 hours to try again. The infiltration rate should return after the rest period.

Additional Land Application Area

Crop fields adjacent to the VTA can be used as additional land application area (LAA) for the feedlot runoff water. These areas must be included in the Nutrient Management Plan. The amount of nutrients applied to the LAA must be included in the normal fertilization program of the field whether it is solid manure or commercial fertilizer. Follow proper procedures for sampling of the soils and manure to help determine the amount of feedlot runoff and fertilizer to apply.

Application of runoff is preferred during the growing season or prior to preplanting annual crops. These crop areas can be regularly used as part of the VTS, or only during periods following severe weather as emergency application areas.

Weather

Like all haying operations, the weather plays a critical role in deciding when to mow a VTA. It is best to hay when the grass is beginning the reproductive stage or in pre-boot. There must be a window of dry weather in the forecast so the hay has time to dry and the bales or stacks can be removed while the soils are dry. In times of continual wet weather, hay the VTA in portions. This way some part of the VTA will always be available to receive runoff water while the hay dries on the harvested portion.

The weather forecast also should be carefully watched to anticipate consecutive large rain events in a short period of time. The sediment basin is sized to capture the 25-year, 24-hour storm of the area. However, a second large storm event soon after the first could over-top the basin and cause an uncontrolled discharge. If the basin or basins are nearly full and the weather forecast predicts a high probability of a severe weather event, then an emergency application of the runoff water to the VTA or other crop fields may be necessary. This would add some capacity to the sediment basin and minimize the chance of the water overtopping and discharging to surface water.

Emergency Operation

Your VTS is designed to be capable of managing most runoff events. However, there will be rare occasions where the system may be overwhelmed by a storm larger than the system was designed to hold or a chronic wet period. In these the following actions are recommended:

1. Document precipitation daily.
2. If the VTA becomes saturated, try to minimize runoff.
3. Delay application to VTA until there is capacity in the soil to store the runoff water.
4. Apply excess runoff to land application cropland rather than forcing it on to the VTA.
5. If a discharge is imminent, contact the regulatory authorities.
6. After the application of runoff, repair any damage and maintian an empty sediment basin.
7. Follow emergency procedures in the Nutrient Management Plan.

Operation Checklist

1. Determine how much runoff is collected in the sediment basin. Inspect the system and prepare to apply runoff water.
   a. Gravity - use valves
   b. Pump - set to desired level

2. Determine or set distribution rate of sprinkler nozzles or pipe gates.

3. Determine number of gates/sprinklers to run and the area to which runoff is distributed.

   a. Run enough gates/sprinklers to empty basin quickly while still allowing runoff to infiltrate into the soil.
   b. Monitor area carefully.
      i. Determine the time needed to saturate soil.
      ii. Monitor area to prevent over application and undesired runoff from treatment area.
      iii. Rotate the application of runoff to different distribution areas or sprinkler sets for small storms; use all areas f or large storms; for chronic wet periods and the largest storms; it may be necessary to do multiple applications (all distribution areas twice).

4. Carefully record activities
   a. Which distribution areas received runoff?
   b. Estimate how much runoff was applied.
   c. Was distribution uniform?

5. Inspect structures after distribution
   a. Look for erosion or concentrated flow areas
   b. Maintain healthy vegetation

5.0
VTS Care and Maintenance

The life span of a VTS should range from 7-20 years, although the author believes a 30 - year life span is possible depending on the system desgin and quality of management. Common problems with a VTS are the poor distribution of runoff water and the erosion of small channels in the VTA that interrupt sheet flow which is necessary for poper function of the system. This can lead to an over-application and a build up of nutrients and salts that can comprise plant growth.

It is important for the producer to inspect the compnents of the VTA frequently and to repair damage as soon as possible. With good management and regular maintenance, a VTS should easily achieve a 7-20 year lifespan.

Overall Maintenance

For Vegetative Treatment Systems that have pumps and motors, follow the manufacturer's guidelines for operation and maintenance. Some pumps will require routine maintenance such as lubrication or adjustments of the packing glands. Maintain regular oil and filter changes for engines per manufacturer recomendations, or at least once a year with intermittent use. Establish and maintain good, sod-forming vegetation on border ridge or dike tops and side slopes of all components. Limit equipment traffic to the extent possible, especially during sensitive growth periods, and periods when the soil is wet to minimize rutting.

Remove trees and shrubs from structures.
Control weeds and annual grasses from VTA.

Repair defects (erosion, rodent damage, cracking, plugging, low spots, etc.) immediately. Contact the system designer for guidance on repairs.

Keep records of precipitation, releases, and maintenance. Use the forms provided. Other forms and records may also be needed for large CAFO.

Sediment Basin

Basin and outlet performance improves when there is little or no solid manure build-up that can reach the VTA. This build-up can reduce its performance and life span. They must be cleaned regularly with a pull-type blade, scraper, or loader. Removal frequency depends upon the situation, but the basin should be cleaned at least annually. The more frequent, the better. Many feedlots have found that monthly manure removal from pens minimizes mud (manure build-up) and maximizes feed efficiency. It is advisable to clean the sediment basin each time the pens are scraped. Manure solids removed from the sediment basin and pens cannot be applied to the VTA. They should be applied to cropland in compliance with a Nutrient Management Plan.

Take care to scrape only the settled solids and not the soil on the bottom of the basin (pull-type blades provide more control for minimizing soil removal). Grade the bottom of the basin after every cleaning to maintain a uniform slope toward the outlet. Uneven basin bottoms are more difficult to clean. Maintaining uniform basin slopes to the outlet will help minimize puddles of water trapped in pits or channels.

NOTICE: Do not hold water in a sediment basin longer than 96 hours, except in winter when the ground is frozen. Holding water longer than 96 hours no longer meets the definition of a sediment basin, and requires seepage control and liners. Dry basins allow solids to be harvested when it is convenient and the basin bottom is firm.
KEEP BASINS DRY.

Water should never be allowed to stay in a basin for more than 96 hours. VTS basins are not lined and thus do not control seepage. Failure to comply with a sediment basin's holding time may cause contamination of ground water. Additionally, holding water in a sediment basin longer than recommended creates challenges when solids are removed, because the basin foundation becomes saturated. Holding water in sediment basins for longer than 96 hours except in winter, may cause the regulatory authority to designate the basin as a holding pond and require a liner. This would greatly reduce the advantages of a VTS over a holding pond system. It is best to have a dry basin at all times so that solid manure harvesting can be done while the basin bottom is firm. Basins can hold winter snowmelt for longer than 96 hours, but only while the ground is frozen. Once the ground has thawed, even for a short period of time, the liquid should be distributed to

the VTA. In winter months, there are warm periods. Distribute runoff during these times even if only a few inches of soil has thawed in the VTA, rather than waiting until spring when the ground is completely thawed.

Odors may be a factor in the management of runoff water in these systems. New runoff water generally has less odor than runoff water that has been held in a sediment basin for several days. More care should be taken to minimize odors when a VTA is near a residence.

Basin components include underground outlets, (slotted risers), pump suction inlets, and trash screens. These require attention to ensure that they are functioning properly. Look for excessive settlement of soil around the basin outlet and underground pipes. If settlement occurs, it may indicate that water is running along the outside of the pipe, which could lead to catastrophic failure of the basin. These settled areas may need to be excavated and refilled in compacted lifts. Contact a design professional if this condition develops.

Remove any sediment and trash buildup, such as wood, twine, grass, and waste hay, from the trash screen and basin outlet. Also check the orifice plate or the entrance from the outlet to the main pipeline for debris. Repair or replace any damaged cleanouts and guard post assemblies.

Vegetative Treatment Area Establishment

After construction of the VTA, deep tillage is recommended to remove any compaction and any hardpan that was created during construction. This tillage should be done perpendicular to the flow of the water through the VTA. After breaking up this compaction, make several passes with a harrow to prepare a grass seedbed and a light grading to re-level the area. A cover crop should be established along with the seeding of the grass.

It is best that feedlot runoff water not to be introduced to the VTA until after the grass is fully established. If possible, plant the grass a year or two prior to construction of the sediment basins. In some cases the feedlot water can be diverted and applied to other crop fields or pastures until the grass is established in the VTA.

NOTICE: The grass must be planted perpendicular to the sheet flow of the runoff water. This cross-drilling is essential and MUST not be overlooked. All wheel traffic should be perpendicular to the water flow on a Sloped VTA.

VTA Maintenance

Once the grass or forage crop is established, it can be harvested as hay or green chop. The crop should be harvested when the vegetation is in the beginning of the reproductive stage or in pre-boot. If the weather forecast predicts extended rain when the grass is ready for harvest, mow only a portion of the VTA. This will leave a portion of the VTA ready for new runoff in case of rain. Finish the rest of the VTA once the first portion of the VTA's hay is removed.

NOTICE: Harvesting should be done when the soil conditions are dry. Vehicle traffic should be perpendicular to sheet flow of the runoff water. This will minimize wheel tracks that encourage concentrated flow areas. Delay the haying operations when there has been continuous rainfall even if the grass is ready. It is best not to risk creating deep wheel tracks in the VTA.

NOTICE: The windrower or mower should be set to leave a minimum of 6 - 8 inch stubble height. This height will encourage rapid re-growth and minimize damage to the plant's root system leading to higher yields. The regrowth is critical to a VTA's long service life.

After each haying event, inspect the VTA for erosion and concentrated flow areas. If it rains soon after baling the hay, carefully watch the runoff water traveling down the distribution area and look for signs of concentrated flow areas. If erosion appears in a VTA, the area must be repaired to maintain sheet flow. Haul in soil when the VTA is dry or frozen to repair the eroded channels and reseed the area.

It may be necessary to divert water around the patched area until a solid stand of grass is established. Geotextile products or mulch mats have been used successfully to repaired areas of a VTA until a sufficient grass stand is established.

Weeds, forbs, shrubs, and trees must be controlled to improve the quality and yield of forage. At first many weeds may be present and proper weed control will help encourage a healthier grass stand.

Once grass is established and the VTA is in full use, it may be useful to make notes on the health of the grass and the composition of the grass species (if seeded to multiple species), or take photos of the VTA annually. These photos and notes can help record the condition of the VTA over time. They can be used along with yield records to determine if the VTA is improving, sustaining, or degrading in condition.

NOTICE: Watch for any decline of plant vigor. Is the VTA getting too much runoff water and nutrients or not enough? Is there degradation of the grass stand from over-application near the pipe outlets or sprinkler nozzles? Do you see weeds that like nutrient rich soil? If so, you may have to fix leaky gaskets or gates and avoid applying to that area for a while. If the degradation is from lack of nutrients and water, investigate and determine why runoff water is not reaching that area. Nutrient buildup in the soil that degrades plant vigor may happen slowly over years, so be vigilant to minimize this.

Distribution System

Special attention needs to be afforded to the distribution system of the VTS. These components further separate the manure solids from the liquid runoff and deliver it to the VTA. Frequent inspections are required to make sure the system is performing correctly.

When a system uses irrigation gated pipe to distribute runoff water, make sure to use only good straight pipe that doesn't leak.

NOTICE: In low-pressure, gravity systems, leaky gaskets and gates can reduce flow and continuously over-apply water to small areas. Gated pipe must have good gates and gaskets for minimal leakage. Frequent inspection is necessary to identify missing gates or leaky gaskets.

Basin outlets or pump inlets must be inspected for trash buildup or damage. These structures can be damaged by the weather, livestock, or wildlife. Immediate repair must be completed before the next rain event if there is any damage or plugging of risers or pipes.

Sprinkler System

The pump, motor, and sprinkler system will require a rigid maintenance and inspection plan. Follow the manufacturer's guidelines for regular service and operation of the equipment. The pump, motor/engine, pipelines, suction inlets, pressure relief, air/vac relief valves, and sprinkler system should have a quick inspection for any damage or problems since the last operation. Any emergency shutdown or normal operating switches or gauges should be tested before use for function. After startup, a quick inspection for leaks at the pump station and then an inspection for normal sprinkler operation at the nozzles needs to be done.

After construction and periodically throughout the life of the sprinkler VTS, the underground pipeline should to be inspected for leaks. Indicators of leaking pipelines are settled trench fill, eroded trenches, standing water, or persistently wet soils in the trench line. Any leaks in the pipeline need to be repaired immediately. Open trenches should be refilled to prevent any further erosion. Open trenches must be closed before winter since the pipeline may be storing water and ice formation may damage the pipeline.

Winter Operation

The VTS is built for year-round operation. In the Great Plains, there is little moisture in the fall and winter compared to the spring and summer. However, there still will be some runoff collected in the sediment basins from snowmelt or rainfall during the winter months.

In a gravity VTS the control valve to the gated pipe must remain closed. Runoff will be collected in the sediment basin. When the weather is warm during the day, the water can be released to the VTA with the same management as during the summer. Even though the grass isn't growing, the nutrients will be stored in the root zone of the grass and used in the springtime.

In a system that uses a pump, the pump and above ground pipes will have to be winterized after each use during the winter. If there is no ice in the sediment basin and the weather is above 40 degrees F, the sediment basins should be emptied. Even though the soils in the VTA may be partially frozen, the amount of runoff water kept in the sediment basin should be minimal.

Most of the time there will be some runoff water in the sediment basin when the weather is below freezing. During this time of the year, the runoff water

may remain in the sediment basin for more than 96 hours. There really isn't anything to do with the ice until it melts. Once the ice melts and and part of the soil in the VTA thaws, it is time to release the water and have the basins ready for the spring rain storms. Do not attempt to remove the runoff water in the sediment basin until it is completely free of ice. Ice chunks can plug outlets or pump suction inlets.

Maintenance Record

Use the Maintenance Record form, which is included in this manual, to keep records of all major repairs or scheduled maintenance. These records can help keep the components of the VTS in working order for every rain event. Mechanical or structural failure of the VTS, that is not addressed prior to a rain event, could lead to a storage of runoff water in the sediment basin for more than 96 hours.

Maintenance Record

After the scheduled services are performed, record the date, VTS component, who performed the service, and the type of services performed in the boxes provided. Retain all maintenance receipts.

Maintenance Record			
Date	**VTS Component**	**Serviced By**	**Services Performed**

Maintenance Record

After the scheduled services are performed, record the date, VTS component, who performed the service, and the type of services performed in the boxes provided. Retain all maintenance receipts.

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Maintenance Record

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Maintenance Record			
Date	**VTS Component**	**Serviced By**	**Services Performed**

6.0 Event Checklist:

Check these items at every runoff event

Sediment basin and outlets	Yes/ OK	Recommended action
Record precipitation, depth of basin to nearest foot, time that basin emptying begins and ends and any occurrence of a VTA discarge.		Record on form.
Was basin dry before event?		Keep basins dry.
Is liquid flowing freely into outlet, sump or pipe to VTA, unobstructed by sediment accumulation?		Clean sediment basin.
Is the control valve fully operational, not leaking when closed, not seized, easy to turn, etc.?		Operate valve to full extents during high flow conditions, lubricate if possible, replace if leak cannot be stopped.
Is there evidence of over-topping or spillage of basin?		Repair by filling in eroded area and compacting with tractor.
Distribution System and VTA		
Is distribution across and down the length of the VTA uniform?		Adjust gates for uniform flow.
Are channels, gullies or erosion present in VTA?		Shovel-fill small ditches and gullies, pack and reseed. Larger gullies & preferential flow require re-grading of the VTA. Do small areas at a time.
For level spreaders, is accumulation on concrete causing uneven distribution?		Clean top of spreader.
For gated pipe systems, are there any leaky gaskets, gates or fittings, or plugged gates?		Stop runoff application and repair gates or gaskets.
For gated pipe, is there sediment build-up in the pipe?		Adjust gates to increase flow to pipes where the sediment is located or lower the grade of the gated pipeline to increase water velocity. Remove pipe plug and flush.
For level spreaders, has any settlement occured?		For settled spreaders, remove settled sections and replace.
Is vegetation free of weeds?		Spray herbicide for target weeds.
For sprinkler systems: are all nozzles operating and distribution uniform?		Shut down the pump and inspect or repair nozzles.
Is the vegetation ready for harvest?		Harvest the hay if the weather is appropriate.

Monthly and Annual Checklist

to be done after harvesting of vegetation

	Yes/ OK	Recommended Action
Walk all borders and berms. For sediment basin berms, clean water diversions, waterways, and VTA, is there any:		
Damage due to animals, such as burrowing, walking across wet VTA, etc.?		Control burrowing animals (trap/poison/bait) or fence-out wildlife.
Wheel track damage?		Repair immediately if minor damage. In most cases re-grading and reseeding of the VTA is necessary. All wheel traffic should be perpendicular to flow.
Seepage through berms?		Contact a design professional for assistance
Erosion damage?		Shovel in fill and seed for small damaged areas. Larger damage requires destruction of existing vegetation, regrading and reseeding (reconstruction) of damaged area
Sign of weak vegetation stands due to non-uniform flow?		If distribution system cannot be modified or adjusted to compensate, regrading and reseeding will be necessary.
Solids accumulation in the VTA just beyond distribution devices?		Outlet structure is not performing well, repair or improve. For sprinkler VTS, also check filter screens for damage.
Sign of weed pressure in VTA?		Apply herbicide to control unwanted weeds.
Sign that subsurface drain tile, perimeter drain tile or related structure is obstructed and not free flowing?		Unplug
Sign of over- or under-distribution of runoff, such as sour dock or related undesirable vegetation, or bare spots that do not support vegetation?		May be a sign of excessive solids; remove, re-grade and reseed area. Adjust distribution system to compensate. If soil is compacted, deep tillage may be necessary to restore infiltration. Take soil samples and check for high nutrient concentrations. Contact design professional for help if this occurs on a significant portion of the VTA. For an aging VTA, this may be a sign of end of life for the VTA.
Soil samples taken lately?		Soil samples should be taken annually. Test for sodium, phosphorus, and potassium. Keep records of the nutrient levels to monitor accumulations over time.

7.0 Contact List

Name **Phone**

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