Horse Owners & Facilities | Technical Handbook

Managing Stormwater Runoff

watershed

protection

ordinance

equine

BEST MANAGEMENT PRACTICES

County of San Diego

Preface

The County of San Diego has developed this Equine Best Management Practices (BMPs) Implementation Manual to assist horse owners and facilities with managing stormwater runoff.

Stormwater runoff that passes through the storm drain system in San Diego County does NOT go to a wastewater treatment plant. It is released into creeks, lakes, and the ocean without treatment. When water washes over the ground it picks up bacteria from horse manure carrying it through the watershed. All sources of pollution are prohibited from leaving your property and entering streets or storm drains. Only rainwater is allowed in the streets and storm drains.

We hope you find this manual to be a useful supplement to the Watershed Protection Ordinance and the Equine Ordinance. The helpful topics included in this manual are in the Table of Contents on the next page.

Professional civil engineers and/or geotechnical engineers should be consulted as necessary in accordance with the Professional Engineers Act, particularly for any BMP with a surface ponding depth of more than one foot. Depending on the type and extent of grading and improvements, County permits and/or engineering studies may be required. Examples include (but are not limited to) Grading Permits, Building Permits, Drainage Studies, Water Quality Studies, and Storm Water Pollution Prevention Plans (SWPPPs).

Visit http://www.sdcounty.ca.gov/pds/bldgforms/index.html for information on business and building permits.

This manual focuses on post-construction permanent BMPs. Separate temporary BMPs may also be required during construction. For more information, refer to:

- County of San Diego Watershed Protection Ordinance https://www.sandiegocounty.gov/content/sdc/dpw/watersheds/ordinance.html
- Equine Ordinance https://www.sandiegocounty.gov/pds/advance/Equine.html
- California Stormwater Quality Association (CASQA) website www.casqa.org
- Livestock and Land website www.livestockandland.org
- Natural Resource Conservation Service www.nrcs.usda.gov
- County of San Diego LID Handbook https://www.sandiegocounty.gov/content/sdc/dpw/watersheds/susmp/lid.html

Table of Contents

Composting

Composting is a highly recommended BMP for manure management. It is relatively simple and low cost and can be scaled up or down depending on the size of the facility.

PURPOSE AND BENEFITS

The purpose of composting is to manage the decomposition of manure to create a valuable soil amendment full of beneficial microbes, organic matter, humus, nutrients and moisture. Benefits include the following:

- The decomposition process of composting reduces the volume of manure by 50% or more.
- The heat generated during composting kills pathogens, parasites and weed seeds, minimizes odors and eliminates breeding grounds for flies.
- The compost generated from manure can be used as a soil conditioner to greatly improve plant and crop health.
- Compost-amended soil retains moisture better, reduces erosion, stabilizes slopes, and acts as a filter for excess nutrients and pollutants that can impact surface and ground water.

Source: farmsandstables.com

LOCATION

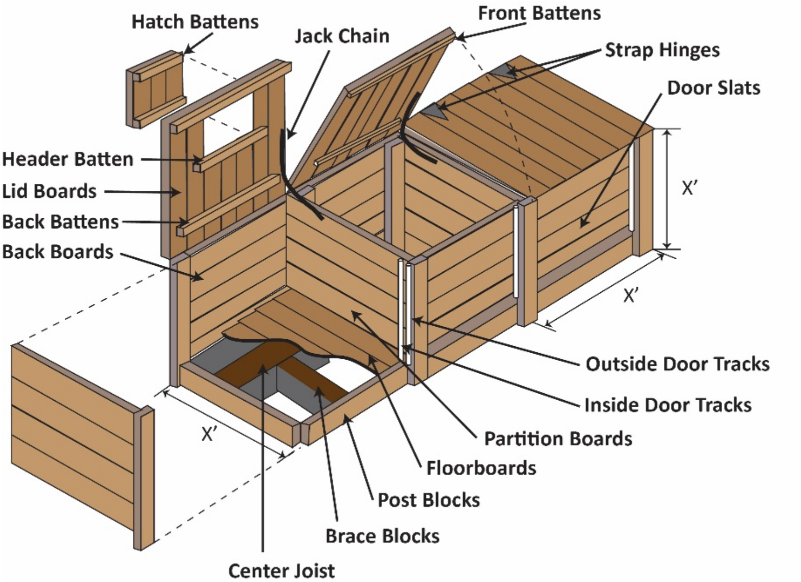
Prevent compost sites from causing pollution of stormwater runoff by covering and keeping them at least 25 feet away from receiving waters, wells, property boundaries, and other sensitive areas. Compost piles can be placed on compacted soil or on a semi-impervious or impervious surface. The ground around the compost area should slope away at 2-4% to stop runoff from coming into contact with the compost material. Keep piles away from steep or highly erodible slopes. If necessary, use structures to divert run-on around the compost area. Compost bins are best covered with a roof or lid to manage moisture, minimize evaporation and prevent overwatering from extreme precipitation events.

TYPE AND SIZE

There are several different composting methods that can be used depending on the size of the equine facility.

Bins

These small-scale operations are ideal for managing the waste of four (4) or fewer horses. Three or more bins can function together in the system. Utilizing multiple bins allows new material to be stored in one bin, composted in another, and cured in a third unit. Composting is best done in batches, with material in a filled bin remaining separate from new manure until it is ready for curing and use. Bins 5 feet wide, 5 feet tall, and 5 feet long or larger are recommended and will allow enough mass to achieve higher temperatures important to the composting process and destruction of pathogens, parasites and weed seeds. Bin systems are typically the lowest cost of the various composting options, unless using forced aeration.



Piles

When working with a large amount of material, long, narrow piles called windrows can be used. It is recommended that the windrows not be higher than 6 feet or wider than 14 feet, but they can be as long as necessary. Turning and aeration can be done with a tractor bucket or front-end loader, or a specialized piece of equipment called a windrow turner. Windrow turners can be self-propelled or run off the PTO of a tractor. If a windrow turner is purchased, this method would be the highest cost system.

While turning and aeration is best done on a minimum of a weekly basis for several months, windrowed manure in an appropriate, dedicated area of land is a better management practice than a large unmanaged pile, even if it can't be turned and aerated. Provided the initial recipe mix is suitable, and moisture content is maintained by watering, a windrowed, managed manure pile will slowly break down over a period of 12 to 18 months or longer. This passive system is not an efficient use of space nor guaranteed to kill pathogens, but can be used as an alternative to unmanaged piling and will slowly produce compost.

Vermicomposting

Vermicomposting is another option for composting horse manure using worms. It can be an effective method of composting, but is space intensive, worms must be purchased, and it is less forgiving than microbial composting. If space is available and the process is well-managed, the worm castings produced are an outstanding soil amendment.

Forced Aeration

Forced aeration is typically only used for large facilities, but is an effective way to manage the composting process. Piping and blowers can be used on both bins and windrow methods. Forced air from the blower/s increases the oxygen content of the composting material and facilitates more rapid decomposition and better management of the process. These systems require little or no turning and can be constructed and maintained simply for a lower cost, or be more complex and purchased from a commercial supplier, which may be considerably more expensive.

HOW TO COMPOST

Step 1: Choose Site Location

- The composting site should be flat and compacted or semi-permeable or impermeable surface. Windrow systems are best on about a 2% grade, with windrows orientated lengthwise up and down the slope.
- Keep the site away from the path of water run-on, or if this is not feasible, construct a berm to divert run-on around the pile as well as a berm to prevent runoff.
- Keep the site at least 25 feet from a waterway and 50 feet from animal pens, and shade or a location without direct sun is best.
- The composting site should be near a hose or watering source, and if forced aeration is being considered, near a source of power.

Step 2: Choose a Composting Method

Select one of the composting methods described above, based on the size of the facility, amount of manure generated, and budget. Also consider existing resources onsite. Is there a tractor with a bucket? Paved, covered area already available? Maximizing existing onsite resources can minimize costs.

Step 3: Collect the Necessary Ingredients

- Carbon materials or “bulking agent” (straw, hay, bedding, wood shavings, woodchips, or leaves)
- Nitrogen materials (manure, but also grass clippings, plant trimmings, etc.)

Step 4: Blend Ingredients

Blend the ingredients evenly to achieve best results. The ratio of the ingredients will impact the effectiveness and speed of the composting. This is called the “recipe mix.” The ideal carbon to nitrogen ratio (C:N ratio) for composting is between 25:1 and 30:1. A general guideline is to mix one cubic yard of pasture manure with three cubic yards of bulking agent. Stable manure generally composts well on its own, due to the presence of straw, wood shavings and similar materials used for bedding. Some additional bulking agent may be required, depending on the manure/bedding mix and system chosen. Since every horse farm or stable is different, adjustments are inevitable to achieve the right recipe mix. The ideal moisture content is 50-60%, and supplemental water will be required to maintain this range.

Step 5: Cook Compost

Composting is most efficient at temperatures between 120˚F and 140˚F. These higher temperatures will kill most weed seeds, pathogens and parasites. To ensure these pathogens and seeds are destroyed, maintain an internal temperature of 131˚F for three days or longer in an enclosed or bin system, and 131˚F for 15 days or longer if composting in an open windrow. The windrow will need to be turned five times or more during this period of 15 days or longer.

Source: Florida Department of Environmental Protection

Monitor and document the temperature of the middle of the pile once per day during the most active phase when temperatures are highest. This can be done using a compost thermometer with a 3-foot probe (available online and in some gardening stores). Internal temperature is also a good indicator of C:N ratio, porosity, oxygen content and moisture. After the active phase, temperature monitoring can be reduced to three times a week.

Turning the pile will generally speed up the composting process and can be done as frequently as daily or as little as once a week after the most active phase. Turning also helps mix the ingredients, maintain porosity in the pile, and increase oxygen content. Regularly turning a pile with the right recipe mix reduces odors.

Test water content by squeezing a handful of compost. The ideal compost is as damp as a wrung-out sponge. Add water as needed or turn the pile more frequently if it is too wet.

Step 6: Cure Compost

Over time, the compost will cool and become more earthy smelling. It will look dark brown or black, be earthy smelling, homogeneous and crumbly. This is a sign that the compost is finished actively composting. Now it should be cured in place or at another location. Curing takes one to three months, but it’s okay to use the compost right after the active phase as well. Depending on the system, the active phase of composting will typically take 8-12 weeks.

Step 7: Use Compost

The finished compost material can be used for gardens or crops and has a multitude of benefits. Apply at approximately 20-30%, tilling 1-2 inches into the top 6-8 inches of soil.

Source: https://www.flickr.com/photos/29278394@N00/2457055952

Troubleshooting

Symptom	Problem	Solution
Compost has bad odor	Not enough air	Turn pile more often or increase forced aeration duration/frequency
Compost has bad odor and is soggy	Not enough air and too wet	Mix in dry ingredients like leaves or straw
Compost has ammonia smell	Too much manure/recipe mix imbalanced	Add bulking agent
Pile is dry inside	Not enough water	Add water in light, even applications until desired moisture content is achieved
Pile is damp and warm (but not hot) in the middle only	Pile may be too small	Add more raw ingredients to increase the pile size to a minimum of 5'x5'x5'
Pile is damp and smells earthy/musty, but is not getting hot	Pile has too much carbon	Add more manure
Pile has flies	Fresh manure exposed or not blended well	Cover with a layer of shavings, leaves, straw or woodchips
Excessive fly breeding	Pile is too moist or not hot enough	• If too wet, mix in dry ingredients such as shavings or straw. • If not hot, balance with an additional nitrogen source such as more manure, and turn the pile. In all cases, keep piles covered with a layer of bulking agent or finished compost.

Direct Land Application

Spreading of manure with appropriate BMPs is an alternative manure management practice to composting. It involves the collection and spreading of manure over a large vegetated area or an area to be planted. If not done correctly, the manure can have a significant *adverse impact on animal health as well as cause pollution of stormwater runoff*. Fresh manure contains more pathogens than composted manure.

MANURE GENERATION

Knowing the amount of manure produced is important in order to determine the number of acres over which it can be spread. One single horse will typically produce about 50 pounds of manure per day and have a bulk density of about 35-45 pounds per cubic foot (but this can vary depending on bedding used, moisture content, and other factors). This means that each horse will generate about 9 tons, or 15-20 cubic yards of manure per year.

AVAILABLE AREA

Only spread and blend manure into existing soil. Do not spread manure over recently spread manure. Do not spread un-composted manure in areas where animals graze or walk, as pathogens from this un-composted material can be easily transferred to other animals.

Based on average manure generation rates, each horse will require about an acre a year for direct land application. This is a general rule of thumb, but will vary depending on soil conditions and vegetation planned for the plot, as well as the analysis recommended below.

TESTING

Manure can provide nutrients to crops and valuable organic matter to soils. Both the soil and manure should be tested in a lab to determine nutrient and organic matter content. This will help formulate the most appropriate agronomic rate (tons or cubic yards of manure per acre) for spreading based on soil and crop requirements. Testing can also indicate whether or not horse feed contains persistent pesticides such as Clopyralid, in which case manure is not suitable for direct land application.

For more information on laboratories see: https://attra.ncat.org/attra-pub/soil_testing/search_results.php?State=CA

Erosion Controls

Erosion control measures protect the surface of the soil and prevent soil from becoming detached because of rainfall, runoff, or wind. These measures can be used for any disturbed area, although certain measures may be more appropriate than others depending on the level of activity in that area.

SLOPE VEGETATION/STABILIZATION

Slopes are a critical source of erosion since they are far more prone to erosion than flat areas because water moves with more force down a slope. Slopes can also pose difficulties with establishing and maintaining vegetation. To prevent erosion, use hydro-seeding, compost blankets, soil binders, and Rolled Erosion Control Products. Composted manure also helps to stabilize slopes and can be applied on the surface or tilled into the soil, if possible.

Hydroseeding

Hydroseeding is an effective method of slope stabilization. A mixture of wood fiber, seed, fertilizer, and stabilizer is applied evenly across the slope and irrigated until vegetation establishes. A composted manure and seed mixture can also work well.

Source: Projar via Creativecommons.org

Step 1:

Select the appropriate hydraulic seed mixture based on site conditions (soil, site topography and exposure, season and climate, vegetation types, maintenance requirements, sensitive adjacent areas, water availability, and plans for permanent vegetation). For detailed help, contact a consultant or a hydroseed installer.

Step 2:

Prepare the soil on the slope by scoring or cutting up the surface. This will give the mixture something to adhere to.

Step 3:

Apply the hydroseed in either a single or multi-step process.

Single-step Process

A hydraulic matrix that contains seed and compost is applied. The seed rate is increased to compensate for all seeds not having direct contact with the soil.

Multi-step Process

The hydraulic seed is applied first. Next it is covered with either mulch or a Rolled Erosion Control Product (see the next section).

Rolled Erosion Control Products (RECPs)

RECPs (geotextiles and mats) can also be effective measures for slopes but are typically used on smaller slopes due to high cost and difficulty of installation.

Source: California Department of Transportation

Step 1:

Select the appropriate RECP. They may have limitations based on soil type or slope gradient; it is best to consult the manufacturer for proper selection.

Step 2:

Prepare the slope by removing roots, stumps, loose rocks, and other large debris. Loosen the top 2 to 3 inches of topsoil and ensure the RECP will have complete, direct contact with the soil.

Step 3:

Seed the slope prior to RECP installation for erosion control and re-vegetation. For turf reinforcement application, seeding is often specified after mat installation.

Step 4:

Install check slots as required by the manufacturer.

Step 5:

Install the RECP following the manufacturer's directions. These will typically be as follows:

- Start at the top of the slope and anchor the blanket in a 6-inch deep by 6-inch-wide trench. Backfill the trench and tamp the earth firmly.
- Unroll the blanket downslope.
- Overlap the edges of adjacent parallel rolls by 2 to 3 inches and staple every 3 feet.
- When blankets have to be spliced, place them end over end with 6 inches of overlap. Staple through the overlapped area about 12 inches apart.
- Lay blankets loosely and keep direct contact with the soil. Do not stretch the blanket.
- Staple blankets enough to anchor the blanket and keep contact with the soil. Place staples down the center and staggered with the staples along the edges. Follow manufacturer's directions on the recommended staple pattern.

Compost Blankets

Compost blankets, when applied between 3 to 4 inches thick, are also among the most effective slope stabilization methods. Compost blankets can help with vegetation establishment, weed suppression, and erosion control. Use in conjunction with hydroseeding to prevent erosion and leaching of nutrients to surrounding areas.

Step 1:

Prepare the slope by removing roots, stumps, loose rocks, and other debris larger than 2 inches in diameter. Prepare the soil surface on the slope by roughening it.

Step 2:

Apply the compost uniformly between 3 to 4 inches thick using a bulldozer, skid steer, manure spreader, pneumatic blower, or hand shovel.

Extend the compost blanket 3 to 6 feet over the top of the shoulder of the slope or use a compost sock or compost berm at the top of the slope.

Soil Binders

Several types of soil binders are available, but they are more temporary than hydroseed and need to be reapplied after each storm event. One benefit to these soil binders is that they cure within 24 hours of application, making them effective even when applied shortly in advance of a forecasted rain event.

Source: USDA

Step 1:

Select the soil binder for application based on soil texture, expected pedestrian or vehicular traffic, and humidity. The soil binder must be environmentally benign. Get the Material Safety Data Sheet (MSDS) or Safety Data Sheets (SDS) from the manufacturer to ensure non-toxicity.

Runoff from poly-acrylamide (PAM) treated soils should pass through a sediment basin or other sediment control BMPs before discharging to surface waters.

Step 2:

Prepare the slope by roughening embankment and fill areas. Follow the manufacturer's recommendation for pre-wetting of the application area.

Step 3:

Follow the manufacturer's directions for application rates. Often, more than one treatment is necessary.

MULCHING AND COMPOST AMENDMENTS

Application of mulch or compost to disturbed soils will reduce erosion by protecting exposed soils from washing away during rainfall. If properly tilled in, compost can amend the existing soil to increase infiltration and promote plant growth.

Step 1: Select the Amendment

Choose compost if it's possible to till an amendment into the slope's soil or mulch if it can only be applied on the surface.

Step 2: Amend Soil if Possible

Amend compost into soil at a rate of 15% to 30% by volume.

Step 3: Apply Mulch if Soil Cannot be Amended

Evenly distribute the mulch across the soil surface. Mulch can be applied at a depth of 2 to 3 inches.

Step 4: Apply Mulch over Amended Soil

A 3-inch mulch layer can be applied over the top of the amended soil layer.

DIKES, BERMS, AND SWALES

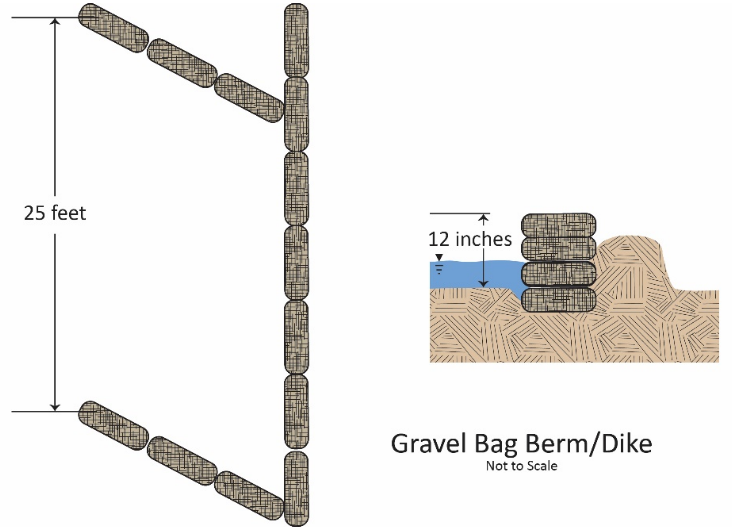
Berms, dikes and swales can be used to divert runoff from sensitive areas (slopes, paddocks, or arenas) or to a BMP.

The berms and dikes discussed in this section are intended to be used at the tops of slopes to prevent small amounts of runoff from flowing uncontrolled down the slope.

Consultation with a licensed engineer is required for:

- Other types/locations of berms or dikes,
- If a berm or dike is observed to be overtopping, or
- If a berm, dike or swale is greater than 1 foot in height/depth.

Gravel Bag Berms and Dikes



Step 1:

Build the berm or dike with gravel bags with a maximum height of 12 inches.

Step 2:

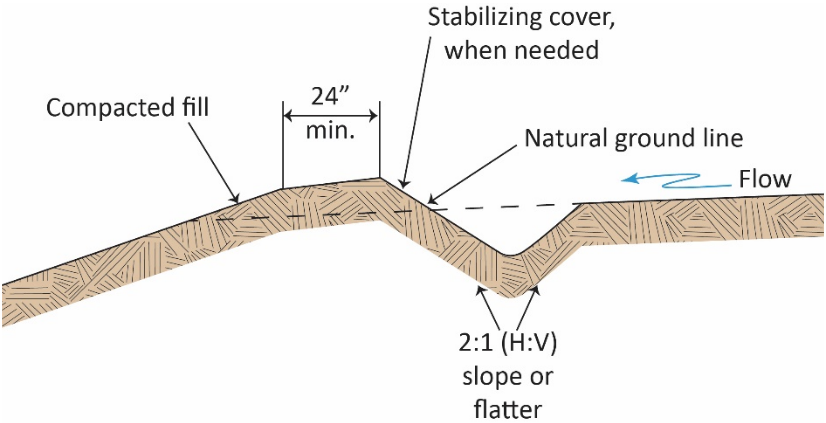
Make sure the berm or dike is draining to an outlet. Regularly monitor the outlet for erosion. If necessary, add velocity dissipation to the outlet area.

Step 3:

Gravel bag check dams are recommended at 25-foot intervals along the length of the berm or dike.

Swales

Swales work best when no more than 5 acres drain to a swale. Typically, swales are at least 2 feet wide at the bottom and 12 inches deep with side slopes of 2:1 horizontal to vertical or flatter. For best results, swales are laid at a grade between 1% and 5%.



Swale
Not to Scale

Step 1:

Remove all obstructions (trees, stumps, etc.) and other material that would potentially impede the flow through the swale area.

Step 2:

Dig the swale and compact any fill material along its path.

Step 3:

Make sure the swale is draining to an outlet, and not ponding along the way. Regularly monitor the outlet for erosion. If necessary, add velocity dissipation to the outlet area (see the next section).

Step 4:

Stabilize the swale using seed, mulching, or Rolled Erosion Control Products. For further protection, install velocity dissipation.

VELOCITY DISSIPATION

Runoff through channels or at pipe and swale discharge points can be slowed using velocity dissipation devices. For locations with significant erosion or velocities in excess of 5 feet/second, velocity dissipation measures should be designed by a licensed engineer. A licensed engineer should also be consulted for velocity dissipation at outlets to pipe larger than 36 inches in diameter.

Channels or Runoff Courses

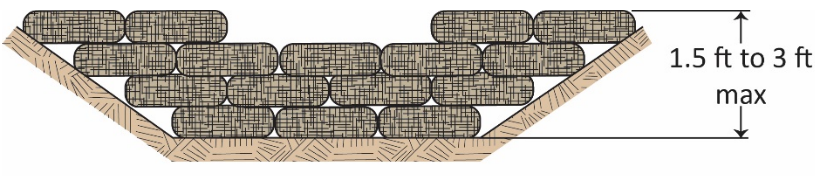
Gravel bags (check dams) installed perpendicularly across existing earthen drainage channels or runoff courses reduce the velocity of flowing water thereby reducing erosion to the channel.

Step 1:

Woven polypropylene or burlap bags are recommended with a burst strength of at least 300 pounds per square inch. Typical bags are 18 inches in length, 12 inches in width, and 3 inches thick, with a weight of approximately 33 pounds. The recommended fill material is 0.5 inch to 1 inch Class 2 aggregate base.

Step 2:

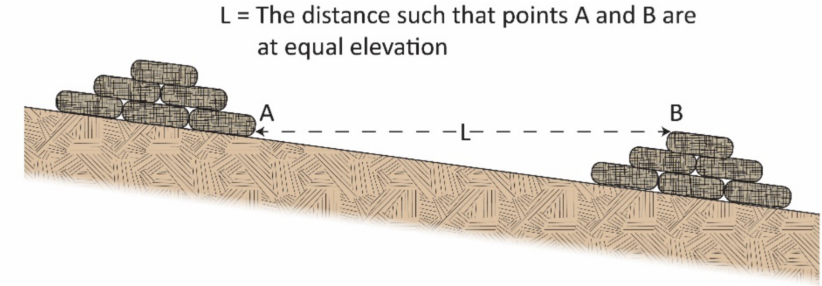
Place the first check dam about 10 feet from the outfall of the channel. Construct the check dam by stacking bags across the channel, shaped as shown in the drawing below. Do not stack bags higher than three feet.



Gravel Bag Check Dam Elevation
Not to Scale

Step 3:

Place the next check dam upstream of the first such that the toe of the upstream dam is at the same elevation as the top of the downstream dam. See the drawing below. Place other check dams as necessary.



Pipe and Swale Discharge Points

Rip rap can be used at discharge locations for pipes and swales.

Source: https://www.flickr.com/photos/87297882@N03/16741737886

Step 1:

The recommended minimum size for the rip rap apron is 10 feet wide and 10 feet long. Rip rap is most effective when installed on a flat or slightly pitched area and should never be installed on a steep slope. A concrete sill can be installed if necessary to prevent the rip rap from migrating downstream.

Step 2:

The recommended size of rip rap is “No. 2 backing” installed at least 1.1 feet thick. Installing a filter blanket underneath the rock will increase the effectiveness and longevity of the facility.

Sediment Controls

Sediment control measures trap soil that has been detached by rainfall, runoff, or wind. Sediment can fill in streams and block sunlight that organisms need to live. Sediment control measures function by filtering or settling particles out of the water. These measures should not be used as the primary method of limiting sediment discharge from the site, but rather in combination with appropriate erosion control measures.

DUST CONTROL

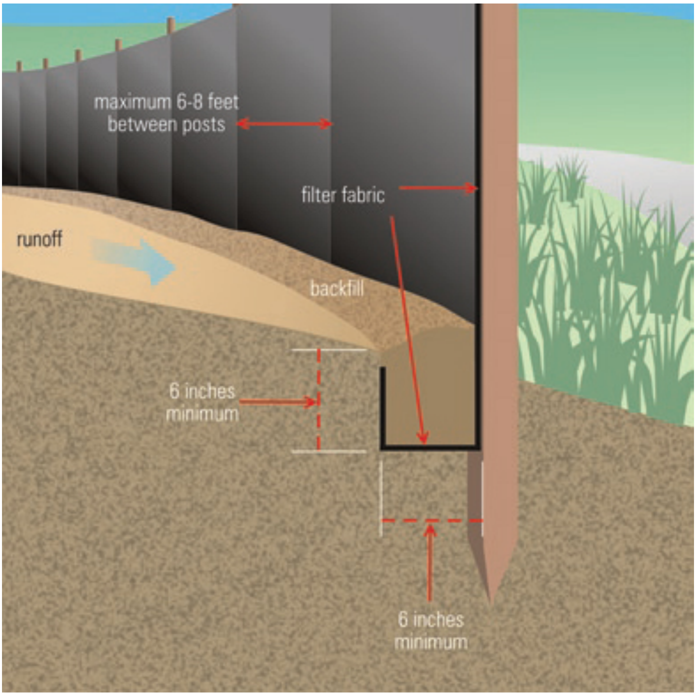
Applying water to dry exposed soil areas such as fields, arenas, pens, or dirt roads will prevent or alleviate nuisance dust created by wind or riding activities. Reducing dust in the air can improve animal health and prevent sediment from filling in streams and blocking sunlight that organisms need to live.

Organic products such as lignosulfonate and synthetic products can also be used to suppress dust. These products can be installed either by direct application to the ground or by mixing the product into the top layer of the soil.

Lignosulfonate can effectively be applied at a rate of 0.5 gallons per square yard. For synthetic solid suppression products, check the label for application rates. Products will need to be re-applied over time, particularly in areas with high vehicular, pedestrian, or equestrian traffic.

SILT FENCING

A silt fence is typically made with a synthetic mesh that allows water to filter through but prevents soil or other materials from passing through.



Source: U.S. Environmental Protection Agency (EPA)

Step 1: Fence Line

Begin by placing stakes to 8 feet apart.

Step 2: Trenching

Silt fencing needs to be partially buried. This prevents water from running under the fence and helps anchor the fence. Dig a trench 8 to 12 inches deep along the fence line.

Step 3: Fence Stakes

Drive each stake at least 12 inches into the ground at the bottom of the trench.

Step 4: Attach the Silt Fence

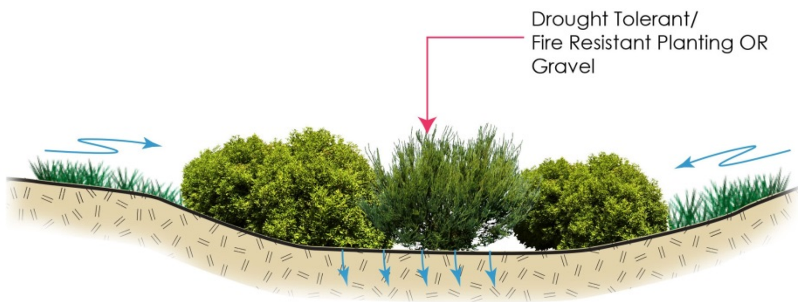
Roll out the silt fence one section at a time. Place the fence material on the side of the stakes facing where water will flow from. (See image above). Leave an extra 8 to 12 inches of material to fold away from the fence as a flap. Attach the material to the stakes using a heavy-duty staple gun and apply 3 to 5 staples per stake. Point the bottom flap up in the direction where water will come from.

Step 5: Backfill and Compaction

Fill the trench in front of the stakes to hold the bottom flap in place.

Infiltration

Infiltration is an effective way to reduce the volume and pollutant content of stormwater runoff. Feasibility is limited by the soil characteristics and available space (compared to the tributary drainage area). The recommendations in this manual are for informal gravel infiltration depressions. Design of formal infiltration trenches and basins should only be performed by licensed engineers.



Infiltration Depression Detail
Not to Scale

LOCATION

Infiltration depressions are best located at least 50 feet away from wells, slopes and building foundations. Infiltration depressions are not suitable for areas with high clay content soil or high ground water. Depressions need to be designed to allow water to be safely conveyed if the facility becomes clogged or overwhelmed.

SIZING

In order to be effective, the size of the infiltration facility is based largely on the tributary drainage area. Although this manual provides some general guidance, it is intended only for use with small drainage areas. A licensed engineer should be consulted if the area draining to the facility is larger than 1 acre.

The following steps describe how to size a gravel infiltration depression.

Step 1: Identify the Area

Identify the area (in acres) that drains to the proposed infiltration facility. This includes all areas that will contribute runoff to the proposed facility, such as pervious areas (pastures, pens, arenas or dirt/gravel roads), impervious areas (such as roofs, paved roads, parking lots, etc.), and could even include off-site areas beyond the limits of the property.

Step 2: Determine Appropriate Storage Volume

Size the facility to capture and infiltrate the runoff from a typical rain event (approximately 0.6 inch). This storage volume must be contained within the void space of the infiltration facility. This is typically 40% of the total facility volume.

Based on 0.6 inch of precipitation and a 40% void ratio, for tributary areas that are completely impervious (roofs, concrete, asphalt, etc.) the facility size would be 5,500 cubic feet per acre. For pervious tributary areas (pens, arenas, dirt roads/trails, pastures, etc.) which generate less runoff, the facility volume would be 2,000 cubic feet per acre. For areas with a mixture of pervious and impervious, the facility would be sized by prorating between the two values based on percent impervious.

For more information on how to calculate the appropriate volume see http://www.surfrider.org/coastal-blog/entry/calculate-rainwater-harvesting-potential-area-needed-to-absorb-it

Step 3: Determine the Depth and Surface Area

Infiltration facilities rely on the ability to infiltrate runoff into the native ground, therefore effectiveness is based largely on the surface area. Even if adequate storage volume is provided, inadequate surface area will result in ponded water within the facility of an extended period. This can lead to pest and safety issues. To ensure adequate surface areas, a maximum depth of 1 foot is recommended for infiltration facilities.

Inspection

If the facility takes longer than 72 hours to drain, it requires repair or replacement under the direction of a licensed engineer.

Landscaped Depression

Landscaped depressions filter and remove pollutants from stormwater runoff by collecting flow and allowing it to pass through a soil matrix and nutrients to be taken up by plants. They will also improve water quality and add aesthetic appeal to your property.

Source: Euclid Creek Watershed Program, cuyahogaswcd.org

LOCATION

The ideal facility location is at least 50 feet away from wells, slopes and building foundations. Design the landscaped depression to safely convey flow that exceeds the capacity of the facility. Construct landscaped depressions in locations that are accessible for long-term maintenance purposes.

DESIGN

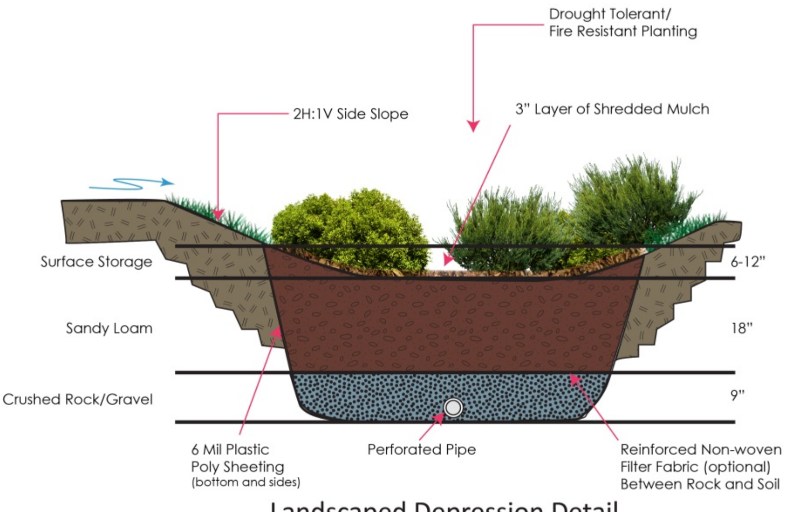
The key design features of landscaped depressions are the:

- Surface storage area;
- Soil matrix; and
- Sub drain system.

The optimum depth of the surface storage reservoir is 6 inches - 12 inches. The surface storage reservoir is best vegetated with species that can survive without irrigation and are also capable of surviving when periodically inundated with ponded water. It is also recommended that the surface storage area include a controlled overflow in case the landscaped depression fails or is overwhelmed in a large storm event.

The ideal soil matrix consists of an 18-inch layer of sandy loam on top of 9 inches of crushed rock/gravel.

The perforated PVC sub drain is typically 3 or 4 inches in diameter. The perforated pipes extend across the entire bottom of the landscaped depression and connect to a cleanout prior to discharge from the facility. It is best when the discharge pipe leaving the cleanout is a solid pipe that discharges overland somewhere within the property. Rip rap energy dissipation can be provided at the discharge location.



Landscaped Depression Detail
Not to Scale

SIZING

Sizing of the facility is dependent on drainage area. Consult a licensed engineer if there is an area larger than 1 acre draining to the facility. The surface area of the landscaped depression is usually approximately 4% of the total area draining to the BMP.

INSTALLATION

Step 1:

Excavate to the desired depth and remove native soil.

Step 2:

Install 3-inch perforated PVC underdrain throughout the bottom of the facility and connect to a cleanout structure that will allow for inspection and maintenance.

Step 3:

Place the crushed rock/gravel to a depth of 9 inches. Cover with filter fabric.

Step 4:

Place 18 inches of planting soil lightly compacted. Over-compaction during construction can cause significant damage.

Step 5:

Plant vegetation and water it at the end of each day for fourteen days following the planting.

Step 6:

Apply two to three inches of fine shredded hardwood mulch or shredded hardwood chips.

MAINTENANCE

The landscaped surface storage area will need regular care including trimming, weeding, and removal of dead vegetation. Inadequate maintenance can lead to clogging of the soil matrix, which can reduce the effectiveness of the BMP. This can also lead to standing water which can become breeding grounds for mosquitos. If standing water is observed more than 72 hours after a rain event, the soil matrix may need to be replaced and a licensed engineer should be consulted.

Capture and Re-Use

Capture and re-use of stormwater can reduce pollution to receiving waters by reducing annual runoff volume. Rain water can be collected and stored in containers and used for irrigation.

CAPTURE POTENTIAL

Cisterns and rain barrels can be connected to roof downspout drains to capture rain water for reuse. The capture potential is the volume of rain water that the system can capture. This region typically receives 12 to 15 inches of rainfall per year. The potential annual capture volume is determined by multiplying the annual rainfall depth by the area over which the system will capture runoff.

RE-USE POTENTIAL

The primary use for captured rain water is irrigation of existing on-site vegetation. Irrigation rates vary based on the type of vegetation. Turf grass used for lawns typically need 0.5 inch of irrigation per week. The irrigation rate multiplied by the area of vegetation will determine the volume of the potential for re-use.

Detailed methodology for calculating irrigation needs is published in the Water Use Classifications of Landscape Species (WUCOLS) guide created by the University of California in cooperation with the California Department of Water Resources. http://ucanr.edu/sites/WUCOLS/

STORAGE SIZING

The required storage is based on the relationship between the capture potential and the re-use potential. The optimal storage volume is an amount that can be captured from a typical rain event (approximately 0.6 inch) and then used for irrigation within a 1 to 2-week period.

SYSTEM COMPONENTS

A capture and re-use system includes six basic parts:

- **Catchment Surface**: the collection surface from which precipitation runs off
- **Gutters and Downspouts**: structures to channel water from the roof to the tank

- **Leaf Screens, First-Flush Diverters, and Roof Washers**: devices that remove debris and dust from the captured rain before it enters the tank
- **Cistern(s)**: storage areas
- **Delivery System**: system to get collected water to the end use by either gravity feed or pump
- **Treatment/purification**: devices to filter or otherwise treat the water if re-purposed for drinking

INSTALLATION

Step 1: Determine Catchment Surface

Runoff can be captured from any roof surface. Figure out which roof surface(s) to use for rain water capture.

Step 2: Calculate Number of Downspouts

Having an inadequate number and size of downspouts can cause spillage or over-running. In general, every 1 inch of downspout diameter can drain 1,200 square feet of roof area.

Step 3: Determine Cistern Location

Locate the cistern on level ground. It is recommended for the cistern to sit on a tank pad or foundation capable of supporting the cistern when full.[1] Ideally, the pad consists of a compacted soil layer, covered by a level layer of sand such that the tank load will be distributed evenly.

Depending on the cistern location, 4-inch PVC or polyethylene piping can be used to convey water around the building to the cistern.[2]

Step 4: Install Gutters and Downspouts

Gutters are to be installed with slope towards the downspout and the outside face of the gutter lower than the inside face to encourage drainage away from the building wall.

Use a mosquito-proof screen to seal and cover the rain barrel or other water-saving container. Mosquito-proof screen is a very fine mesh, usually 1/16 of an inch. Ideally, screening would also be placed where

---

[1] A gallon of water weighs 8.34 pounds.
[2] http://www.motherearthnews.com/homesteading-and-livestock/rainwater-harvesting-system-zmaz03aszgoe.aspx?PageId=4#ArticleContent

the gutter meets the downspout to prevent mosquitos from entering the barrel through downspout.

Step 5: Connect to the Cistern

There are several options for devices to connect the downspout(s) to the cistern. Some include leaf screens and first flush diverters. Follow the installation instructions for the selected connector.

Storage of water in systems that can be accessed by mosquitoes is discouraged. If holding water in a cistern for longer than 72 hours, some type of effective mosquito prevention should be used (screening, etc.)

Source: shutterstock.com

Additional Resources

Texas Rainwater Harvesting Manual

http://www.twdb.texas.gov/publications/brochures/conservation/doc/RainwaterHarvestingManual_3rdedition.pdf

How to Estimate Roof Rain Downspouts

http://www.ehow.com/how_7869842_calculate-gutter-downspout-capacity.html

Silt Fence Installation

http://www.doityourself.com/stry/how-to-install-a-silt-fence