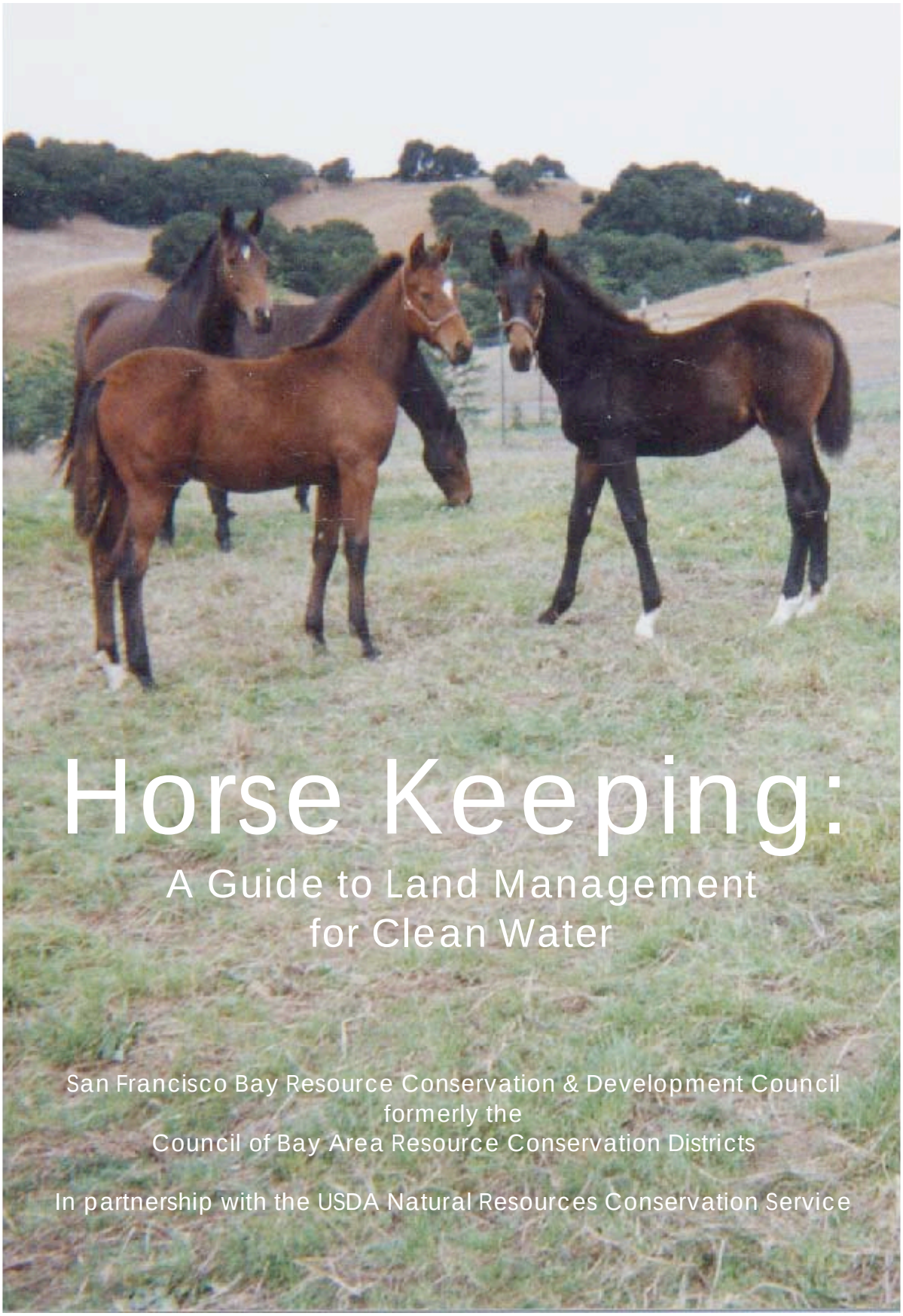

Horse Keeping:

A Guide to Land Management for Clean Water

San Francisco Bay Resource Conservation & Development Council
formerly the
Council of Bay Area Resource Conservation Districts

In partnership with the USDA Natural Resources Conservation Service

For more information about ordering this publication, contact:

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Council of Bay Area Resource Conservation District members include: Alameda Co. RCD, Contra Costa RCD, Guadalupe-Coyote RCD, Loma Prieta RCD, Marin Co. RCD, Napa Co. RCD, San Mateo Co. RCD, Southern Sonoma Co. RCD and Suisun RCD.

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- *Groundwork: A Handbook for Erosion Control in North Coastal California*. 1987. Marin County Resource Conservation District. Illustrations used.
- *Home*A*Syst: An Environmental Risk Assessment for the Home (NRAES-87)*, published by NRAES, the Natural Resource, Agriculture, and Engineering Service, Cooperative Extension, 152 Riley-Robb Hall, Ithaca NY 14853-5701. (607) 255-7654. <www.nraes.org>
- *Repairing Streambank Erosion*. 1997. Marin County Stormwater Pollution Prevention Program brochure.
- *Stream Care Guide*. 1989. County of Santa Cruz.
- Marin Coastal Watershed Enhancement Project. 1995. UC Cooperative Extension, Marin County. Fact Sheets adapted for use in this guide:
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Cover Photo: Oldenberg colts at Hawkwood Hill Farms, Sonoma County

Preface

THE HORSE HAS BEEN THE FUEL that stoked the fires of progress in time of peace and war throughout the centuries. When the need was greatest in the building of a new nation, or to carry supplies in time of war, the horse and mule responded to the call.

The horse has served as the early day equivalent of a tractor. They were our first example of rapid transportation and a true dependable friend. When all else failed they would be the food that served the top, or the bottom of the food chain.

The surge in population during the last century, with its need for increased quantities of water, along with the diminished status of the horse, has created a situation where the needs of our horse industry has become secondary and we have ended up with little political power.

So, understanding that the demographics have changed is tantamount to effecting change. Water was once a surplus commodity, is now in great demand and is the subject of lawsuits up to and including the Federal Government. Everyone wants "their share" of a safe, guaranteed-supply commodity.

The water we drink and the fish we eat require clean water, so cleaning up and maintaining available supplies of water is a job for all humanity.

The Council of Bay Area Resource Conservation Districts (RCDs) has prepared this manual as a road-map to help us be a *volunteer part of the solution, rather then a part of the problem*. Many times we see "edicts" handed down where industry has little or no input. In this undertaking the RCD is saying, "Here are graphic examples of typical problems and we would like to work with you to solve yours."

The time to look at your operation is now. The window of opportunity is open For us to manage our properties in a way to minimize or eliminate pollution. If we wait to see what happens, laws *will* be enacted that require us to make changes that may seem unfair and questionable.

Ken Brown
California State Horsemen's Association

Preface

LAND: THEY AIN'T MAKIN' IT ANY MORE, so said Will Rogers. With burgeoning population and suburban encroachment into previously rural areas there is increasing competition for scarce resources. At the same time, there is increasing attention by all levels of government to assure a clean and adequate supply of water and resource protection. Within the next decade the government intends to enforce more stringent regulation to assure clean water for the future.

Horsemen were amongst the original land conservationists is this country. We have a long tradition of respect for the environment, because it is the milieu in which we operate. We must now become proactive, taking the lead in developing Conservation Plans for our horse keeping facilities to be able to answer the challenges that will be coming to us in the future as regulatory enforcement ratchets down to the local level. Not all of our new neighbors will be livestock-friendly. Most certainly, few of them will understand that the equine is unlike most other animals in many ways.

The enlightened horse keeper should begin now to take a number of actions:

- Evaluate your property for possible impacts from sediments or nutrients into water bodies and remove any manure storage away from water bodies
- Immediately write down your manure management plan, so it is ready if challenged
- Begin a Conservation Plan that includes how you intend to modify your property if your current operations are within 50 feet of riparian corridors
- Photograph your current operation and anytime you make a change
- Begin a water monitoring data program for any creeks and seasonal drainage on your property, because you will need it sooner or later.

This manual will help you to do these things yourself. It is a treasure of resources that, when implemented, could save you time and aggravation in the future since the best defense is a good offense.

Happy Trails from Adda Quinn of EnviroHorse

Preface

THROUGHOUT THIS COUNTRY the rural landscape is in significant transition. The face of agriculture is being transformed with the resultant loss of the family farm and subsequent proliferation of impersonal agribusiness. The vast majority of our rapidly increasing population now resides in urban and suburban areas; these non-agricultural citizens are frustrated by the immitigable impact of pollution and sprawl. Caught between these two forces are small agriculturists, including equestrians.

Equestrians are becoming aware of an increasing burden. Our small farms are being consumed by population growth, but jurisdictions fail to zone for new small agricultural parcels so we can continue our lifestyle. As dense population centers with associated noise, pollution, vandalism, and other infringements move towards our fence lines we are told we have become a nuisance. Our farms are being reclassified as "recreational facilities" because we continue the tradition of sharing use of our agricultural properties with neighbors in town. After having struggled to assist with open space preservation and trail development we are told that our impact on these areas will limit our future usage.

Most dramatically, equestrians are now being asked to develop programs to limit our environmental impact. We are threatened with regulation as our urban and suburban neighbors continue to cover their landscape with high water runoff from hard surfaces; spread fertilizers on their vast tracts of artificial landscaping; pollute our waterways with poorly regulated petrochemicals, pet excrement, pesticides, herbicides, detergents, solvents, etc.; and pollute the air with various exhausts, particulate matters, and fumes.

I'm sure fellow equestrians will recognize my words as only a partial description of the problems we face. Many equestrians are concerned that efforts such as this guide are the beginnings of regulatory infringement that will continue to result in limitation of equestrian open space usage; however, this is not the case. Our friends from the Council of Bay Area Resource Conservation Districts, in partnership with the USDA Natural Resources Conservation Service, have prepared this guide to aid equestrians with the endeavor to lead their community toward responsible stewardship of open space resources. This guide has the potential to be used as a tool to demonstrate that equestrian agricultural land usage can continue as an integral component of the working landscape through voluntary programs with minimal regulatory intervention. Use this valuable tool judiciously.

Larry Gosselin DVM
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Introduction

This guide provides practical management information to San Francisco Bay Area horse owners on what they can do to help protect the environment. Whether a horse owner has one animal or operates a boarding facility, all equestrians play an important role in assuring that our watersheds are healthy and our creeks clean. Because of increasing pressures from human activity, all potential sources of environmental pollution are under critical scrutiny. Pollution can come from either point sources (e.g., a specific manufacturing plant) or non-point sources (e.g., livestock throughout a ranch).

All human activities, including livestock keeping, can potentially affect both land and water resources. Water resources include small seasonal drainages, creeks, ponds, and both near-surface and deep ground water. As rainwater flows across the land, it can pick up and transport pollutants such as chemicals, soil and animal wastes which can be deposited into our water resources. Degradation of water resources can affect our drinking water supplies, recreational areas and wildlife habitat, as well as cause flooding, property damage, and harm San Francisco Bay and coastal estuaries. What may appear to be a small action at the top of a watershed, can, in fact, have tremendous consequences for downstream neighbors. As a result, urban and rural communities are now working together to improve water quality through integrated watershed management programs. These programs seek to include a broad base of participants from urban, construction and agricultural sectors. Horse keeping activities, as a potential non-point source of agricultural pollution, will be increasingly scrutinized to assure that horses are not contributing to environmental degradation.

The purpose of this guide is to help horse owners take a look at the big picture and to evaluate how equine facilities might affect local natural resources. It advises evaluating your horse keeping facility to look for opportunities for improvement. It suggests that developing a Conservation Plan for a horse keeping property, which describes both short- and long-term management systems, can be used to prevent and reduce environmental degradation. Finally, it seeks to heighten awareness of the need to implement conservation measures to protect streambanks and water quality for humans and wildlife, prevent accelerated movement of soil from your property, and decrease bare soil where feasible in our increasingly urban setting. Its primary focus is on erosion control, stormwater runoff control methods, and manure management.

As our neighbors move closer to horse keeping facilities it will become more important to reduce flies and dust, and maintain good relationships in increasingly congested areas.

Conservation of our natural resources is a long-term commitment. While there are short-term practices that can be implemented immediately and make a

tremendous positive difference for the environment, many conservation projects are long-term efforts requiring thoughtful planning and careful implementation. It will be important to custom-tailor site-specific management practices to your property. Some practices may work; others may not. Consult with professionals to minimize mistakes. Learn what works from other horse facilities, and share your knowledge with friends. Making informed decisions will save money, time, and energy—leaving more opportunity to enjoy your horses.

How to Use this Guide

Whether you are planning a new facility, upgrading an existing operation, need to solve a specific problem, or want to improve your natural resources, this guide can assist you with identifying problems, and suggest proper management methods for a variety of problems horse keepers might encounter. Some conservation measures will be simple and easy to implement, while others are complex and require professional technical assistance.

This guide is presented in five chapters:

- **Keeping Horses and Protecting Water Quality (Chapter 1)** introduces water quality concerns, objectives of good management, and explains how to develop and implement a Conservation Plan.
- **Evaluate Your Horse Keeping Facility (Chapter 2)** is an overview of horse facility features and activities that are common sources of water quality concerns.
- **List of Conservation Measures (Chapter 3)** used in this manual are listed and noted throughout the guide in ***bold italic*.**
- **Conservation Measures to Improve Water Quality (Chapter 4)** covers specific measures to control erosion, manage stormwater runoff, and manage polluted water.
- **Resources Directory (Chapter 5)** includes a compendium of information, including how to obtain technical assistance, seeding recommendations; checklist for “winterizing” horse facilities; what facility operators should know about regulations and permits; what horse keeping managers should know about threatened and endangered species; how to measure progress using photographic monitoring techniques; how to monitor water quality using easy techniques; how to measure vegetative cover by estimating ***residual dry matter*** in pastures; suggestions for alternatives to pesticides; ways to improve songbird habitat; and a list of helpful publications and resources.

A glossary of terms is included in the back of the manual. Websites are included for reference. Website addresses frequently change, so search for keywords in a web browser or try the beginning words in a long website address.

Chapter 1

Keeping Horses and Protecting Water Quality

Healthy creeks and clean ground water reflect good land management and stewardship on the surrounding land. Good horse keeping management practices reduce potential pollution problems. It is important to be aware of the role that good horse keeping can play in the "big picture" of sustaining a healthy watershed.

Section 1.1 describes the water resources that we seek to protect—primarily surface water and ground water.

Section 1.2 presents three key objectives for horse keeping stewardship:

- Control erosion
- Keeping "clean" water clean
- Manage polluted water

Section 1.3 outlines WHY a Conservation Plan should be created and HOW to make one.

1.1 Protecting Surface Water and Ground Water Quality

Safeguarding our surface water (seasonal drainages, creeks, rivers, ponds, etc.) and ground water is an important part of horse keeping. Aquatic life is highly susceptible to pollutants from human activities. Beneficial uses of water, such as swimming, fishing, and drinking water can also be affected. Some environmental consequences of horse keeping activities that may contribute to water pollution are:

- Sediment from eroding areas such as overgrazed pastures, roads and trails, and bare soil in ***paddocks***, ***turnouts***, corrals and arenas
- Polluted water draining from manure piles and ***horse wash areas***
- Excessive nutrients (from horse waste) that wash off pastures during storms
- Removal of, or trampled vegetation at streamside areas that can lead to streambank erosion
- Removal of vegetation which filters and absorbs water and pollutants from runoff

Watersheds

Understanding the connection between land, creeks, ground water and management is a key to preventing problems. A watershed is an area of land that drains into a distinct creek, river, lake, bay or ocean. It includes all major and minor creeks, seasonal drainages, riparian corridors (the vegetated area next to streams), flood plains, and land that water flows over or through on its way to a bay or the ocean. Watersheds are named after the local creeks that drain them. It is important for landowners to know what watershed their property is located in to be aware of where water goes, who they are affected by, and who they might affect.

A healthy watershed will maintain high water quality

A healthy watershed will have clean creeks with cool water and a thriving riparian corridor, clean and abundant ground water supplies for drinking water and other uses, and stable, well-vegetated land. A healthy watershed will maintain high water quality, provide fish and wildlife habitat, control erosion, maintain dry season creek flows, reduce flash flooding, and provide safe drinking water from wells.

Both natural conditions and human activities within a watershed influence the condition of creeks and ground water. Changes in creeks may happen suddenly as the result of a storm event (causing new streambank erosion) or a sudden change in land use (such as clearing land for development). Other problems in the watershed may accumulate and take many decades to develop—such as a creekbed becoming filled with sediment (soil particles that are transported by, suspended in, and deposited by water). Excessive sediment coming from the upper watershed often deposits in flatter reaches of channels in the lower watershed which can cause flooding and can be expensive to dredge.

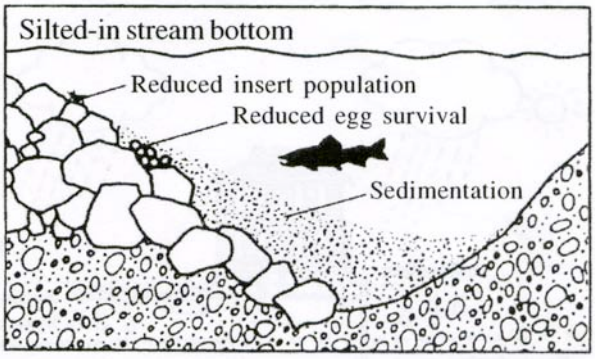
Healthy Creeks[1]

All creeks are important, whether they flow year-round (perennial), part of the year (intermittent), or just during storms (ephemeral). Even small seasonal drainages are important because they can carry water, soil, and pollutants into larger creeks.

In the San Francisco Bay Area, creeks should be managed so they are healthy for people and wildlife. Healthy creeks will have these characteristics:

- **Cool water** is critical for aquatic life. Cool water also helps reduce toxic levels of ammonia, which can come from decomposing horse waste and organic debris. Dense, overhanging vegetation helps keep water cool. Steelhead and salmon require water temperatures between 40º and 60º F.
- **Clean, clear water**. This means plenty of oxygen for fish and other aquatic wildlife to breathe. Suspended sediment, nutrients and salts from animal waste, fertilizers, sewage, and toxics such as metals, pesticides, oil, and grease degrade water quality and reduce the amount of oxygen available.
- **Thriving fish, amphibian, and aquatic insect populations**.
- **A variety of pools and riffles in streambeds** with abundant gravel and cobbles. Pools are depressions in the streambed with calm, deep water. Riffles are stretches of stream with moderate turbulence caused by water flowing over rocks. Pools and riffles are both important habitat areas for aquatic life. Gravel and cobbles are important for spawning and habitat for young fish.
- **A healthy riparian area** characterized by an abundance of native vegetation, minimal erosion, and some undercut banks for aquatic habitat. The riparian zone can provide food, cover, and water for deer, birds, and other wildlife.
- **A high water table.** Healthy creeks receive water percolating through soils in the water table. Acting like a sponge, the soil releases water gradually into creeks and other water bodies.
- **Clean ground water,** free of contaminants, that can be used for drinking water.

Manage horse access to small seasonal drainageways because they carry water and pollutants into larger creeks. Moving the fenceline to the left of this swale will help control erosion, keep creeks and ground water clean, and reduce muddy conditions that create problems for horses.



Too much sediment is a problem for aquatic life. When sediment fills in creek beds, it also fills in pools, eliminates shelter and fish spawning habitat, and diminishes food supplies for fish and aquatic insects. Some chemical compounds can bind to sediment—potentially creating toxic conditions for fish and other aquatic life. Courtesy of Stream Care Guide, County of Santa Cruz.

[1] This section is drawn from *Creek Care: A Guide for Urban Marin Residents*. Marin County Storm Water Pollution Prevention Program. 1998.

- **Water that can be used for contact and non-contact recreational activities.** Swimming, fishing and boating are popular water activities that depend on clean water.
- **Scenic beauty.** Whether in cities, suburban neighborhoods, rural areas, or parks, healthy creeks add to the scenic value of the landscape.

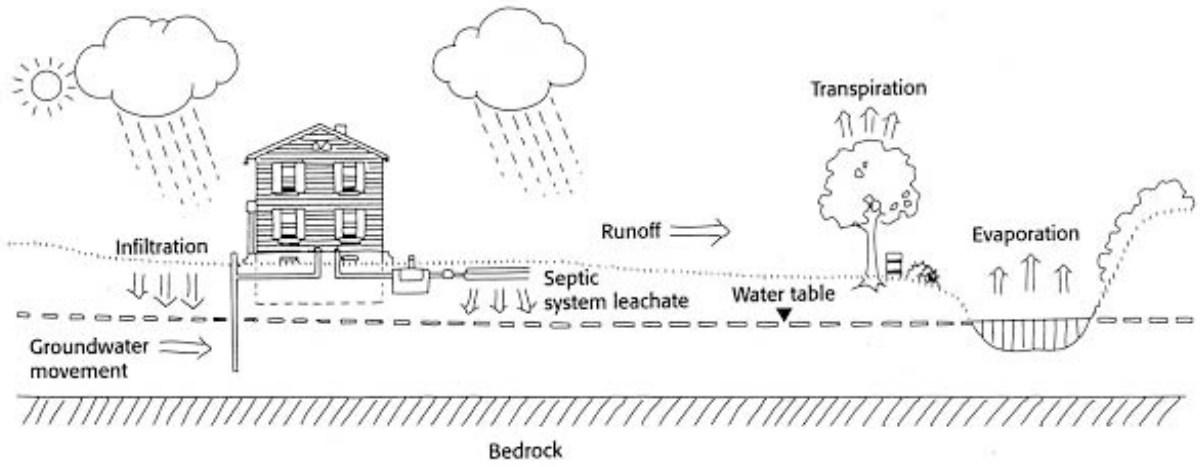
An Underground Link to Clean Ground Water

Ground water and surface water are interconnected. Water not only percolates downward; near-surface ground water also flows horizontally into surface water bodies. While ground water generally follows the same path as surface water, hillside slope is not always a reliable indicator of ground water flow.

Ground water is an important source of drinking water. As water soaks deeper and deeper into the ground, it infiltrates and recharges aquifers, the underground layers of porous rock and gravel that store water. Ground water moves through the earth as part of a dynamic flow system from recharge areas to discharge areas such as springs and wells.

The *water table* marks the boundary in which all pore space within it soil particles are saturated with water. Water tables fluctuate throughout the year and are usually highest in early spring.

Near-surface ground water is the water that collects within the soil zone, usually found at four to six feet below the soil surface and is generally most vulnerable to contamination from pollutants that leach downward through soil layers. This is important because near-surface ground water often feeds directly into creeks. Near-surface ground water should not be tapped for wells.



In the hydrologic cycle, water falls to the earth as rainfall and snow and returns to the atmosphere through transpiration and evaporation. Surface water, ground water, and near-surface ground water are interconnected and provide benefits to humans and wildlife. Your horse keeping activities can help or harm the natural resources on your property and those of your neighbors downstream. Source: *Home*A*Syst: An Environmental Risk Assessment for the Home* (NRAES-87).

The Soil and Water Connection

Different types of soils vary significantly in their capacity to hold water, the ability to percolate water, and the types of vegetation they can support. These characteristics are important because they affect the rate at which excessive nutrients, such as nitrogen from animal waste, are carried by surface flows overland and down through the soil layers. Rainfall that can not soak into the ground starts to flow overland as runoff. Surface runoff increases the erosion hazard and the possibility for sediment and manure to be washed into nearby creeks and seasonal drainages.

Soil types affect the land's ability to deal with runoff

The porosity, or infiltration rate, of a soil (ability of air or water to pass through minute surface openings) affects the rate at which rainfall can soak into the ground. Soil particle size influences how water moves through the ground. This may be a concern especially if the water table is relatively close to the surface. For example, sandy soils are the most porous soil and can absorb rainfall more quickly than other soil types. However, they may allow water to seep downward too quickly for effective filtration or decomposition of pollutants. Clay soils are the least permeable and absorb rainfall more slowly. However, water can still carry pollutants through the clay soils. In the summer, clay soils often shrink and form deep cracks that allow water to quickly percolate down into the soil many feet. Also, clay hardpans that underlie more porous soil will slow the downward flow of water and cause it to start moving horizontally beneath the surface, and water becomes "perched" upon the hardpan layer. Deep loamy soils support vigorous plant growth and deep roots are best for trapping and storing nutrients and other pollutants that percolate into the soil.

Soil compaction occurs when livestock grazes on wet soils. Grazing by large animals can cause compaction because their hooves have a relatively small area and therefore exert a high pressure. Soil particles are pressed together, reducing the pore space between them. Compaction restricts rooting depth, which reduces the uptake of water and nutrients by plants. Compaction decreases infiltration and thus increases runoff and the hazard of soil erosion.

The type of bedrock or sediment deposits below soil layers also influences how water travels into ground water aquifers. Shale, granites, and other impermeable types of rock impede the downward movement of water and pollutants. Other rock, such as limestone, can be highly permeable, allowing water to move freely into ground water. When bedrock is fractured, water can move through it vertically, laterally or unpredictably, spreading pollutants rapidly over long distances.

1.2 Stewardship Objectives

Practicing good *stewardship* can help keep horse facilities, creeks, and ground water clean. Stewardship means taking care of land and water resources on your property. Neighboring landowners can also work together to promote stewardship within their larger watershed.

Three basic stewardship objectives for horse keepers to remember are:

1. Control erosion – keep soil in place
2. Keep "clean" water clean
3. Manage "polluted" water

Each of these objectives is explained below. The management systems and conservation measures presented in Chapters 2 and 4 of this guide can help landowners meet these objectives. Not only do conservation measures help control erosion, manage stormwater runoff and prevent pollutants from reaching creeks and ground water, they also create healthier conditions for your horses.

Stewardship Objective #1: Control Erosion

Erosion occurs where soil is bare and unprotected from the forces of rainfall, flowing water, wind and gravity. While some sediment is needed to bring nutrients and substrate materials (mineral and/or organic matter that forms the streambed) to aquatic ecosystems, too much sediment causes problems and is considered a pollutant. Some soil erosion is caused by natural process. However, a great deal of erosion is "accelerated erosion" because the natural or "background" rate has been speeded up as a result of human activities. Some erosion problems may be relatively simple to solve, while others are complex.

Vegetation, geology, soil characteristics, steepness and length of slope, rainfall, and human activities (i.e., soil disturbance or alteration of natural drainages) all contribute in varying degrees to the erosion rate at a particular site. For this reason, it is important to know about the site characteristics present at each horse facility (see Section 1.2 on developing Conservation Plans).

Typical erosion areas at horse facilities

Humans can alter natural processes with livestock practices. Accelerated erosion can wash soil from areas of bare ground such as arenas, ***paddocks***, ***turnouts***, and overgrazed pastures. Severe erosion can form gullies, destabilize creek banks, and damage roads.

It is important to determine the cause of soil erosion. Accelerated erosion could be caused by uncontrolled concentrated flows from rain gutters, winter runoff from roads, removal of protective vegetation in pastures due to heavy grazing, livestock access to riparian areas when streambanks are saturated, or other ways.

Why is sediment a pollutant?

Too much sediment reduces the ability of creeks to carry floodwaters by filling in the creek bed. Sediment fills in pools, eliminates shelter and fish spawning habitat, and diminishes food supplies for fish and aquatic insects. It can be very expensive to dredge excess sediment from creekbeds, ponds and lakes.

Accelerated erosion can also pollute drinking water supplies because herbicides, pesticides, chemicals, and organic compounds can all bind to sediment—potentially creating toxic conditions for humans and aquatic life.

Basic Ways to Prevent Accelerated Erosion

To incorporate erosion control measures into your management systems, see Chapter 2. For specific details on conservation measures listed in ***bold italic***, see Chapter 4.

- ***Keep areas well vegetated*** and restore bare areas with vegetation. Plant roots, especially those of grasses, hold soil in place and help water infiltrate into the ground rather than run off. Vegetation also dissipates the force of rainwater hitting the ground, which detaches soil particles.
- ***Avoid concentrating water. Concentrated runoff can be highly erosive.*** Try to disperse runoff by spreading it out in a thin, shallow "sheet." Areas to watch are roads, roofs, compacted soil, and other impermeable surfaces that shed water quickly and increase the amount and velocity of runoff.
- ***Control horse access and human activities in vulnerable areas*** such as wetlands, creek banks, meadows and steep hillsides. Limit access, especially during wet periods.
- ***Manage pastures to prevent heavy grazing***. Avoid soil compaction and excessive removal of vegetation by timing the use of pastures and controlling the numbers of horses. Rotate pastures to allow them to rest from grazing, to allow grasses to regrow and mature so they will reseed.
- ***Use filter strips and riparian buffers*** near creeks. Maintain a strip of ***dense*** grass downslope of bare areas such as ***paddocks*** and ***turnouts*** to help trap sediment. ***Riparian*** buffers provide valuable wildlife habitat and should contain a variety of plants including grasses, forbs, shrubs and trees.
- ***Keep creek banks vegetated*** to hold soil in place, trap sediment, and provide valuable wildlife habitat. Grasses have fibrous roots that hold the soil in place. A good indicator of root mass in grasses is the above ground growth generally equals the below ground root system. Shrubs and trees have deeper roots that are either fibrous or taproots that will anchor the soil in place.
- ***Install kick boards*** or lay railroad ties or telephone poles around arena perimeters. These will help hold footing material in place and keep it from washing away.
- ***Properly construct and maintain roads, trails, and parking lots***. Protect earthen surfaces and drainage ***ditches*** from erosion by using properly designed drainage systems, including ***diversions*** and ***culverts.*** Use appropriate surfacing materials and techniques.
- ***Use proper construction techniques***. Revegetate areas disturbed by construction. During construction install and maintain ***silt fences*** or ***straw bale sediment barriers*** to trap sediment and slow the movement of water. Avoid soil disturbing activities just before and during the rainy season.

Stewardship Objective #2: Keep "Clean" Water Clean

Rainwater flowing across the land, or in channels or pipes, is called stormwater runoff. It is important to keep this "clean" water clean by diverting it away from areas that can be a source of "pollutants" such as a ***manure storage areas***, ***horse wash areas***, and other high-use areas. Keeping "clean" water clean is easier than managing and treating it once it becomes "polluted" with manure, sediment, or chemicals.

Keeping stormwater runoff away from areas with pollutants also promotes horse health. Reducing the amount of manure and mud will help eliminate insect and worm breeding grounds, reduce bacteria and fungi that cause horse disease and hoof problems, and improve footing. It will also reduce the amount of energy that horses spend trying to keep warm while standing in mud. Managing mud and manure can make tending horses more pleasant, as well as improve aesthetics for a facility, neighborhoods, and communities.

Avoid grazing directly in creeks so horse manure and urine as well as sediment from streambank trampling does not enter waterways to create conditions detrimental to drinking water supplies, recreational activities, and the environment.

Basic Ways to Keep "Clean" Water Clean

To incorporate these measures into your management systems, see Chapter 2. For specific details on measures listed in ***bold italic***, see Chapter 4.

- **Divert "clean" water around areas with pollutants.** Use ***berms***, ***grassed waterways***, ***under - ground pipelines***, or other methods. Consider where water will be diverted to, and make sure you do not cause new problems.
- **Locate buildings and confinement areas away from creeks, steep slopes, and floodplains**.
- **Minimize disturbance to wetlands, riparian areas and meadows**.
- **Limit impacts of grading, runoff from roofs and other impermeable surfaces**.
- **Maintain vegetation and replant bare areas.**
- **Control potential runoff from water troughs.**

Stewardship Objective #3: Manage "Polluted" Water

Stormwater becomes polluted if it picks up physical, chemical or biological elements as it flows through manured or bare areas. Polluted water must be managed to prevent it from reaching creeks and/or minimize leaching (moving downward into soil) into ground water. It is easier to minimize the amount of polluted water generated, rather than treat or dispose of it.

Manure and urine can add excessive nitrogen and phosphorus to creeks. These nutrients can enhance algae blooms. The algae's subsequent death and decay can consume much of the water's oxygen that is necessary for fish to breathe. High concentrations of ammonia from animal waste is toxic to fish and other aquatic life. Salts from horse waste can change the variety of insects that a stream can support. During the rainy season, salts and nutrients in manure can leach through soils into ground water. Pathogens in livestock waste may produce fecal coliform contamination levels that may potentially impact drinking water. Manage any polluted water generated by your facility so it does not impact downstream neighbors.

Basic Ways to Manage "Polluted" Water

To incorporate these measures into your management systems, see Chapter 2. For specific details on measures listed in ***bold italic***, see Chapter 4.

- **Keep the size of intensively used areas small** to help reduce the volume of polluted water.
- **Manage Manure**. Remove manure regularly—daily is best. Cover stored manure with a roof, tarp or other cover, and direct runoff away from the ***manure storage area***.
- **Use *filter strips* to trap sediment and manure** that washes off high-use and ***manure storage areas***.
- **Maintain soil moisture during the dry season** by sprinkling with water to enhance bacterial decomposition of nutrients. When soil moisture is maintained in arenas, paddocks, feeding areas and even pastures, the natural breakdown of urea will occur. If areas are maintained as absolutely dry, this discourages the natural process.[2]
- **A waste pond** can be designed to store water for safe distribution at a later time.

[2] Michael Rugg, personal communication. 2001. California Department of Fish & Game, Yountville, CA.

Table 1 lists potential pollutants and related impacts from typical horse keeping activities, the associated problems they can create, and the water quality tests available to determine the levels of the pollutants. More information on ***water quality monitoring*** is in Section 5.7 of the Resources Directory.

Table 1: Potential Pollutants, Impacts, and Water Quality Tests

Potential Pollutants from Horse Keeping Sources	**Problems created in creeks, ponds, and wetlands**	**Easy water quality tests available for landowners**
Sediment	Reduces water clarity so fish have a harder time finding food; leads to warmer water, and also settles into creek beds which degrades aquatic habitat; fills in creeks and ponds; kills fish eggs from suffocation due to sediment filling in air spaces around eggs. Also, pollutants adhere to sediment particles, such as metals (e.g., lead, mercury) and organic materials such as pesticides.	Visual observation
Nutrients from manure and other waste • Phosphorus from soaps and manure • Ammonia (decomposition of organic nitrogen such as urea and manure)	• Stimulates the growth of algae and other aquatic plants • Un-ionized ammonia is toxic to aquatic life even in very small concentrations	Colorimetric test kit to measure total nitrate and ammonia. Test pH with electronic meter or pH test paper. Also thermometer for temperature.
Salts from horse waste	Affects the kinds of aquatic organisms which can live in a stream	Electrical conductivity probe
Excess organic material (bedding, shavings with manure, runoff from manured areas)	Acts as a source of food for aerobic, decomposing bacteria which may deplete dissolved oxygen which adversely affects aquatic life	Electrical oxygen probe or colorimeter text kit for Dissolved Oxygen (DO)
Removal of streamside trees and shrubs	Creates warmer stream temperatures which reduces the amount of oxygen water can carry; decreases a source of terrestrial insects (fish food); removes deep binding root mass that stabilizes streambanks; and reduces wildlife habitat	Thermometer
Pesticides from fly sprays, etc.	Toxic to aquatic life	Lab analysis needed – no easy tests

1.3 Plan Conservation Improvements on Your Property

Develop and implement a Conservation Plan to help you enhance ranch aesthetics, reduce expenses related to the control of drainage and erosion, protect property and land values, and to keep the facility safe for people and horses. Important stewardship elements of a Conservation Plan for horse facilities are to: 1) control erosion, 2) manage stormwater to keep "clean" water clean, and 3) manage "polluted" water. Planning is important whether you have just one backyard horse or a large, commercial horse boarding facility.

Conservation planning is a natural resource problem-solving process. The process integrates ecological (natural resource), economic, and production (such as pasture) considerations in meeting both the horse owner's objectives and the public's resource protection needs. This approach emphasizes identifying desired future conditions, improving natural resource management, minimizing conflict, and addressing problems and opportunities. This section presents information on conservation plans and outlines steps to create such a plan.

What is a Conservation Plan?

A ***conservation plan*** is a document that is developed by a landowner who wishes to manage land and water resources on the property effectively. Generally help is obtained from a natural resource specialist. The planning process can help horse keepers to identify, assess, and develop ways to avoid potential water quality problems. A plan includes: a written and pictorial description of the features of the horse facility (an inventory of developed and natural features shown on an aerial photograph or scale drawing); an evaluation of problem areas and opportunities; a schedule of operation and activities needed to solve identified problems; and maintenance and monitoring activities. Plans demonstrate awareness and commitment to conservation and good land stewardship.

Who needs a plan?

Horse properties that have creeks or seasonal drainages that lead to creeks, or that have received complaints may need a plan to demonstrate how they will manage areas of concern. If you keep horses near drinking water reservoirs or in areas with endangered species, you may be required to submit a plan to show how the environment will be protected. Owners of horse facilities may need to prepare a comprehensive conservation plan that covers more than the items discussed below in order to meet the requirements of local ordinances or a county use permit.

How do I develop a plan?

Horse owners can gather information and develop a plan by following the five steps below. Assistance may be available from the Natural Resources Conservation Service (NRCS) and Resource Conservation Districts (RCDs). The Alameda County and Southern Sonoma County RCDs have developed a planning workbook that can be completed in conjunction with a planning course or as an

individual project. For further assistance, contact the NRCS, the local RCD, or UC Cooperative Extension, listed in Section 5.1 of the Resources Directory. Private consultants can also assist with developing detailed plans.

What does a plan look like?

A conservation plan can begin simply and need not be an extensive document. A plan can be handwritten and kept in a folder or a binder. It should include maps, site-specific soils and vegetation data, a record of decisions made for conservation improvements, and other reference materials. You'll want to update your plan to keep it current. A photographic record of what is done before and after imple menting a conservation plan would be helpful documentation if future questions arise.

Developing a Conservation Plan for Your Facility

The degree to which a conservation plan needs to be developed will vary according to the property description and intensity of land use. A horse facility with two flat acres, no creeks and two horses kept in small shelters with paddocks may only need to create a simple plan that diverts clean water from horse keeping and ***manure storage areas***, and describes manure management. However, a horse facility with many hilly acres experiencing natural gullying, or with many creeks on the property would be well-advised to develop and maintain a full ranch conservation plan. Thus, the facility manager is able to demonstrate to regulatory agencies concern for proper stewardship of the land and water resources.

The six steps for developing a conservation plan are listed below. Each of these steps is further explained in more detail.

1. Set goals for your operation
2. Inventory and map your resources
3. Identify, assess, and prioritize potential problem areas
4. Develop solutions
5. Properly schedule and install conservation measures
6. Maintain and monitor conservation measures

Step 1. Set goals for your operation

Set goals for an effective conservation plan. Some issues to address are:

- **Goals for your property or horse facility.** What type of operation do you currently have and how would you like it to function in 2 years, 5 years, or 10 years? What type of facilities do you currently have, and which do you plan to add? What type of conditions do you want to provide for your horses? Because the physical health, safety, and mental well-being of your horses are essential, proper housing, sufficient exercise, food and water, and regular veterinary care should be included. Make sure the goals work for you.
- **Conservation goals for land and water.** Would you like to learn more about natural resources on your property or in your area? List conservation concerns

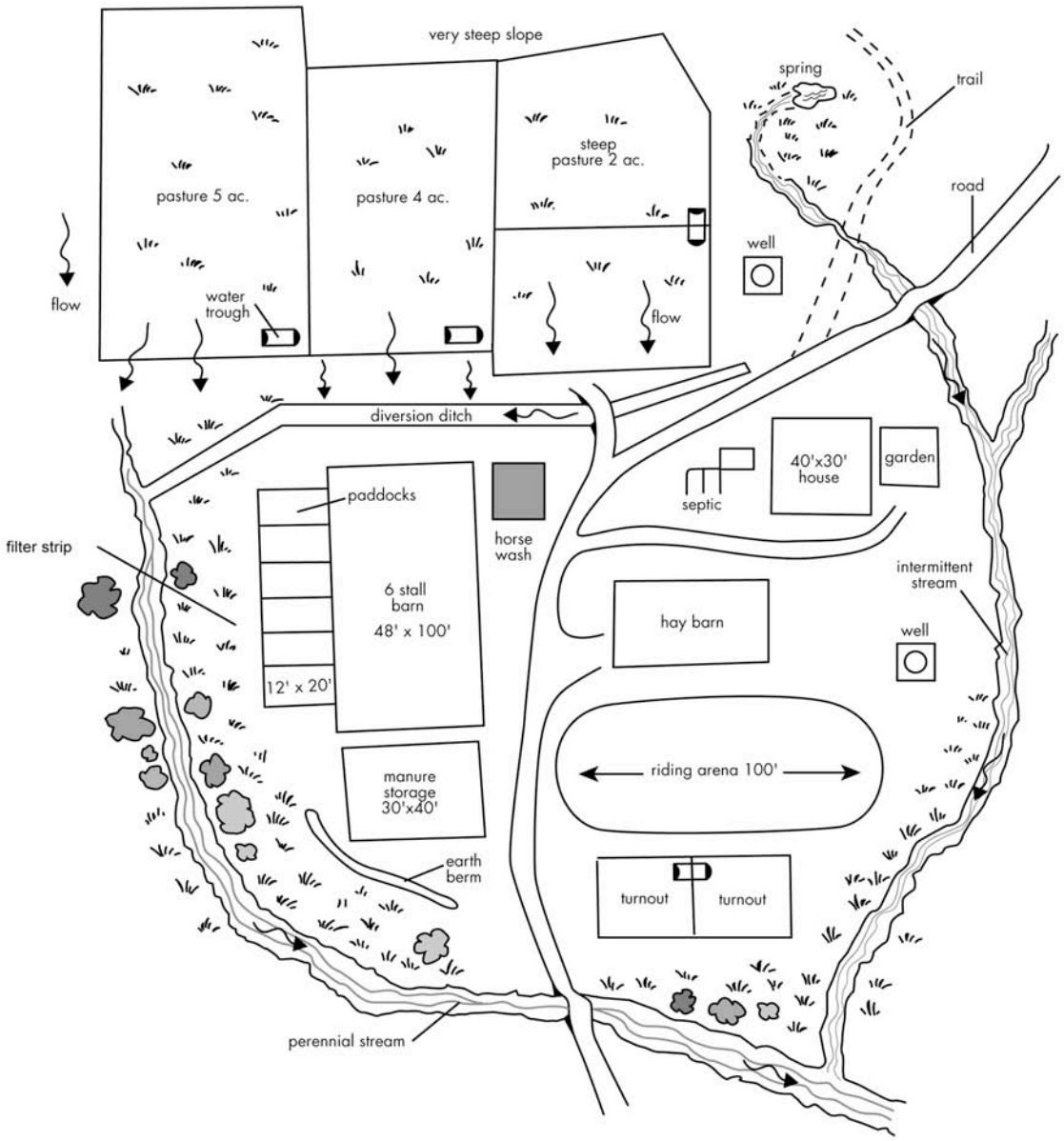
that you have such as reducing erosion, restoring a creek area, improving pasture productivity, or maintaining or improving a healthy ecosystem.
- **Financial feasibility.** Facility maintenance and improvement require time, labor, and money. Consider doing needed work in stages and set priorities. How much of the work can you do yourself? What help is available? Will you have a barn manager or employees for day-to-day operation? It is helpful to have contingency plans and funds for emergencies.

Step 2. Inventory and map your resources

A written resource inventory accompanied by a map is a record of your property and improvements. Use an aerial photograph or draw a site map on graph paper to accurately and easily plot various features. Choose a scale that fits the size of your facility, e.g., 1 inch=100 feet, or 1 inch=50 feet. This map can help you determine the approximate size of structures needed, which helps in developing cost estimates. Gather existing soils, topographic maps and aerial photos for an inventory of your facility. These maps and aerial photos are available from public agencies and private sources at reasonable costs (county planning departments, NRCS, US Geological Survey, etc.). After you have completed your map, you can add areas of conservation concern and possible future conservation measures. *(See Sample Site Plan diagram.)*

Items to include on your site map:

- **Natural water features** such as springs, creeks, seasonal drainages, wetlands, and ponds. Indicate drainage and stormwater runoff patterns, using arrows to indicate the direction of flow. Topographical maps or street maps that show local creeks can help you determine drainage patterns and identify your connection to a larger stream or that enters San Francisco Bay, another regional bay, or the ocean.
- **Water improvement projects** such as developed ***springs***, water ***troughs***, ***wells***, septic system drainfields, pipelines, and ***ditches***, as well as information such as flow rates, well depth, and dates of construction.
- **Property improvements** such as buildings, corrals, paddocks, arenas, ***fences***, pastures, roads and trails, ***bridges***, parking areas, and ***manure storage*** or ***composting*** areas, ***horse wash areas***, and other improvements.
- **Existing conservation measures** that protect soil and water resources.
- **Soil types.** Soil textures and soil depth are important for making management practice decisions. For example, steeper slopes generally have shallow soils that dry out earlier in the season. County *Soil Surveys* describe potential uses for the soil, general characteristics such as texture, erodibility, shrink/swell characteristics, water table, appropriateness for building sites and leach lines, infiltration rate, slope information, and suitability for growing plants, and contain maps (aerial photos) with the soils shown. Check with the USDA Natural Resources Conservation Service (NRCS), your local RCD, or a library to review a copy.
- Topography, terrain, and slopes can be described in your plan in general terms or with more detail if your land has been surveyed. Features to include on your



SAMPLE SITE PLAN – A site map shows natural features such as springs, creeks, winter swales, wetlands and ponds. Improvements are shown as well—wells, **water troughs, diversion ditches, berms,** *septic system drainfields, pastures,* **fencing, turnouts***, barns, arenas, and* **compost area***. A site plan is an essential part of a conservation plan.*

site map are steep slopes, low lying areas, rocky areas, landslides, and flood-prone areas. Contour lines show slope on topographic maps. Mapping tools, used with topographical maps, allow easy estimation of slopes and acreage. Topographic maps are available from local map stores, or http://topomaps.usgs.gov/, or http://www.topozone.com. Maps of landslide areas may be available for your region from the US Geological Survey, and often from NRCS or your local county planning department.

- **Vegetation and plant communities** differ in their requirements for moisture, shade, soil drainage, and soil fertility. Examples of plant communities in the San Francisco Bay Area include broadleaf evergreen woodland or forest, oak woodland, grassland, riparian (streamside forest), coastal scrub, and chaparral. If you need assistance in describing the wetland communities on your property, consult a US Fish and Wildlife Service "National Wetlands Inventory" map. These are available from the NRCS or your local RCD.
- **Wildlife habitat.** You may wish to note any important wildlife habitat areas or keep track of animal activity. Riparian habitats are especially rich in birds (both migratory and resident) and aquatic species. To find out if you have any threatened, endangered, or special status species on or near your property, contact the California Department of Fish and Game. For information on backyard conservation or wildlife habitat improvement projects, contact your local RCD.
- **Climate.** Average annual rainfall information is available from several sources such as local water districts, *Soil Surveys*, and the US Weather Service. The RCDs and NRCS have National Oceanic and Atmospheric Administration maps that show rainfall intensity. This is important for designing conservation measures (for example, how many inches per hour in a 25-year storm). A rain gauge and knowledge of local weather characteristics will allow you to monitor conservation measures during large storms. Talk to your family and neighbors to find out about any historical weather-related incidents on your property.
- **Ground water conditions** are important to know before installing wells or septic systems. Water districts, the local planning department or public health departments may have information on local ground water resources. Well records give an estimate of the depth to the water table at your property. Be sure to identify any near-surface ground water areas that may be vulnerable to contaminants.
- **Other natural resources information**. For information on geology, wetlands, air quality, or other features of interest, contact government agencies, libraries, and possibly the internet.

Look at your property as a whole to help develop priorities

Step 3. Identify, assess, and prioritize potential problem areas

Look at your property as a whole to help you develop priorities. Refer to Chapter 2: Evaluate Your Horse Keeping Facility to help identify common sources of water quality concern. Steps to consider:

- **Evaluate your water quality to see if you have a problem**. Check areas upstream and downstream of intensively used areas. Many water quality tests are simple to perform, by conducting self-testing from kits. See Section 5.7 of the Resources Directory for water quality monitoring information.
- **Identify potential problem areas** by taking a walk around your facility, preferably during or immediately after a heavy rainfall. Use the site map as a guide and take notes.

For example, draw arrows on the site map to show runoff and drainage patterns, note bare areas such as overgrazed pastures, shade areas of streambank erosion or where sediment deposits, and note areas where pollutants may be present (such as ***manure storage areas***, ***horse wash areas***, or runoff from intensively used or "high-use" horse keeping areas).

- **Assess situations and prioritize areas in need of attention.** During the monitoring or field visit did you discover specific water quality issues you need to address? Are they big problems? Are they related to controlling erosion or managing stormwater runoff?

  Set priorities for the areas you wish to tackle. Give high priority to problem areas that need immediate attention, and then address areas of lesser concern in stages or as part of a long-term strategy. Examples of situations needing immediate attention are where a ***manure storage area*** drains directly to a creek or runs off onto neighboring property, or an actively eroding streambank threatens property or structures.
- **Review your goals** and make sure the planned improvements help you achieve your goals. Revise your goals if necessary.

Step 4. Develop solutions

Select conservation measures that will help solve problems and achieve your goals. Chapter 4 of this guide describes conservation measures that are structural or management practices. Read through this guide, talk to other equestrians, ask questions at your local feed and stable supply stores, and seek technical assistance to determine what options will work best for you. Consult your local RCD or NRCS for assistance. Things to keep in mind include:

- **Conservation measures need to fit the unique conditions at your facility.** For example, if you have highly erosive soils, be sure that sediment is not picked up by runoff. If your streambanks are eroding, do not direct concentrated water flows into those areas. What works for others on their property may not work for you.
- **Conservation measures often work in combination.** Be aware of how they fit together, e.g., applying ***seed*** and ***mulch*** or connecting roof ***gutters*** and ***downspouts*** to a conveyance system that carries the runoff to an erosion resistant outlet at a creek.
- **Start at the source.** Seek solutions for smaller areas near the source of the problem. Sometimes minor changes in management techniques can produce the desired result at little or no cost. For example, empty ***manure storage areas*** before the winter, remove horses from a pasture when grass has been grazed down in order to allow for regrowth, or reseed a ***filter strip*** in the fall.
- **Include a manure management strategy.** Address manure collection, storage, spreading, use and/or disposal. Consider site-specific characteristics of your property and operation to determine what manure management systems will

work best. The strategy should include proximity of manure management locations to creeks, soil type, type of bedding material, number of horses, labor, equipment, and access.

- **Be aware of local, state, and federal regulations that apply to your projects.** Check carefully to be sure you have obtained all necessary permits before developing, expanding, or renovating a horse facility. You are responsible for being informed and for following regulations. See the Resources Directory, Sections 5.4 and 5.5 for more information on permits.
- **This will be a long-term process**. Some measures you may try, may not work. Your plan is a living document meant to change over time and be a record of important things you learn about the stewardship of your property.

Step 5. Schedule and properly install conservation measures

Schedule construction during the dry season, before the winter rains. Allow time to obtain permits. Careful installation will help your projects succeed.

- **Know when to seek professional design assistance.** Medium- to large-scale erosion control and drainage projects will likely require professional design to limit the hazard of washouts, flooding, and impact to neighboring properties. Conservation measures can fail or make problems worse if they are not properly installed. Extensive grading projects are likely to require permits and professional installation.

Careful installation will help your projects succeed

Step 6. Maintain and monitor conservation measures

Regular maintenance is crucial to the effectiveness of conservation practices. Is there room for improvement? What other conservation measures and management systems might help? Regular monitoring and maintenance will help your projects succeed. Remember to:

- **Monitor your project.** Maintenance may necessitate cleaning plant debris from gutters and pipe inlets, removing sediment from water conveyance structures, or mowing grass ***filter strips*** to keep the grass actively utilizing nutrients. The more useful monitoring takes place with a shovel and rain boots, walking the facility during and after a rainstorm to make sure all drainage is functioning properly. Make necessary repairs a part of your "winterization" effort. (See the Winterization Checklist in Section 5.3 of the Resources Directory.) A rain gauge will help you track rainfall amounts by storm, month, and year.
- **Be prepared,** especially after a series of storms when soils are fully saturated. This is when floods and most landslides occur. Have an emergency back-up plan and make sure that your employees and family know the plan. Have emergency repair materials on hand, such as burlap bags and sand, or straw

bales, and know the proper way to install temporary fixes. (See Section 4.1 for information on emergency repairs.)

- **Photographic monitoring** will show the results of your management decisions. (See Section 5.6 of the Resources Directory.)
- **Monitor water quality** of creeks that flow by the facility, with do-it-yourself water quality test kits, and record your efforts. (See Section 5.7 in the Resources Directory.)
- **Document your efforts** to protect natural resources. Record the implementation, maintenance, and monitoring of conservation measures. Record keeping will help you decide how to further improve conditions for your horses and water quality. Your documentation might help you meet local, state, and federal water pollution control requirements.
- **Adjust** your conservation plan based on the results of monitoring.

Chapter 2:

Evaluate Your Horse Keeping Facility

Keeping in mind our three key stewardship objectives, to 1) control erosion, 2) keep "clean" water clean, and 3) manage "polluted" water, we will now evaluate typical features and activities at horse facilities that are common sources of water quality concerns. For example, a ***roof runoff*** system includes the following conservation measures: ***gutters, downspouts***, and ***drainage*** to a ***filter strip*** or ***outlet***. The possible problem areas, as well as ways to manage water are discussed.

Horse owners can implement some management systems themselves. Professional design and installation assistance will be required for other systems. Specific conservation measures, in ***bold italic,*** are further defined in Chapter 4.

Typical places that can be problem areas at horse facilities are:

- **Section 2.1** Roof unoff
- **Section 2.2** High-Use Areas
- **Section 2.3** Manure Management
- **Section 2.4** Composting Horse Manure
- **Section 2.5** Horse Wash Areas
- **Section 2.6** Pasture Management
- **Section 2.7** Water Resources: Creeks, Ponds and Wells. Managing Septic Systems
- **Section 2.8** Design and Maintenance for Roads, Trails, and Stream Crossings
- **Section 2.9** Construction Management

2.1 Roof Runoff

Diverting roof runoff from horse keeping areas in order to minimize creation of mud will result in both healthier animals and cleaner surface water on your property.

Take a look during or after a storm to determine where the "clean" roof runoff drains from: barns, covered arenas, or other buildings. Observe whether or not water is causing erosion, creating mud, or entering areas that contain manure. For more details, see Chapter 4.2: Stormwater Management Measures, Roof Runoff Collection.

Management Strategies for Buildings

- Locate buildings on elevated ground or built-up pads. Slope the land gently away from building foundations. Locate new buildings well away from creeks and flood-prone areas. Avoid disturbing wetlands.
- Use ***gutters*** and ***downspouts*** to direct roof runoff away from erodible land or areas with manure such as ***paddocks*** and ***turnouts*** adjacent to or attached to barns. "Clean" roof runoff should not flow through areas where it can pick up pollutants.

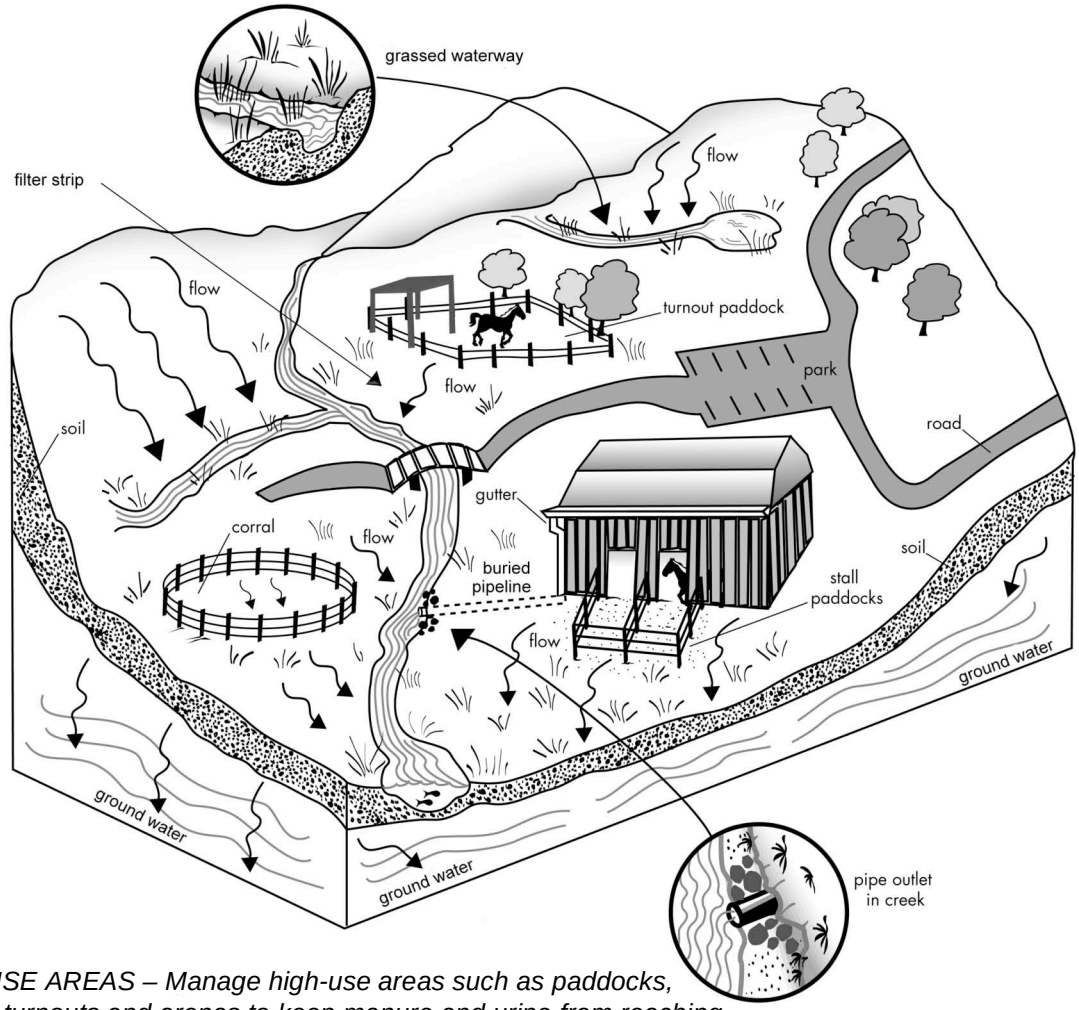
  Using ***gutters*** and ***downspouts*** is especially important for large barns and covered arena roofs that can shed considerable volumes of water during storms. This "clean" water should be directed via pipe or ***ditch*** to an outlet point that will not erode.
- If roofs do not have ***gutters***, slope roofs away from high-use and ***manure storage areas***.
- Install ***subsurface drains*** (perforated pipe) with gravel filled trenches below eves to collect standing water and direct it away from buildings.
- Divert water from surrounding slopes away from buildings. Install ***diversions*** or ***berms*** to direct water away from buildings. Convey water to a ***filter strip*** or ***grassed waterway***. Make sure the ***diversion*** or conveyance method does not cause erosion.
- Place ***energy dissipaters***, such as rock, at pipe outlets to prevent erosion.
- Revegetate areas that have been graded or disturbed to prevent erosion. Maintain ***grassed waterways*** and ***ditches***.
- Follow county regulations regarding creek or other setbacks, such as property line, well, or septic leach field setbacks, and obtain necessary grading permits.

2.2 High-Use Areas

In this guide, the term "high-use areas" refers to specific fenced areas of bare ground where horses are kept, confined, exercised, trained, or ridden. Examples of "high-use areas" are ***paddocks*** attached to stalls, ***turnouts***, circle pens, arenas, and livestock alleyways between paddocks and barnyards.

Because these high-use areas often lack vegetation, they can be subject to erosion. They are also likely to contain manure and urine that must be prevented from being carried by runoff into creeks. It is important to prevent leachate from accumulated manure from being carried into the creeks as runoff, or downward through soil into the ground water.

Mud and accumulation of manure in high-use areas can also pose health problems for horses, and make access difficult for people.



HIGH USE AREAS – Manage high-use areas such as paddocks, corrals, turnouts and arenas to keep manure and urine from reaching creeks, prevent leachate from being carried downward into the soil and ground water, and reduce erosion. Map the flow of drainage at your facility and look for ways to keep "clean water" clean. Consider using conservation measures such as **turnout paddocks** *and grass* **filter strips**.

Management Strategies for High-Use Areas

Consider location and size

- Locate high-use areas on higher ground with a slight slope for drainage (1-2%). Locate high-use areas away from low spots, drainages, floodplains, or areas that receive a lot of upslope runoff. If there are chronic drainage problems, facilities may need to be relocated.
- Limit the size of high-use areas to what is truly needed. The smaller the area, the less "polluted" runoff will need to be addressed.
- Locate high-use areas in flatter portions of the property. Avoid steep slopes (generally over 30% slope) that are susceptible to erosion.
- Use ***fencing*** to reconfigure the shape of the high-use area to suit the terrain. Follow county regulations that may require setbacks from creeks, wells, septic leach fields and property lines.
- Consider wind direction for dust control.

Maintain grass **filter strips** *adjacent to high-use areas such as arenas to help trap and filter sediment and manure that flow off of these areas.*

Maintain vegetation around high-use areas

- Develop and maintain a ***filter strip*** of dense grass between drainages (even small, seasonal ones) and high-use areas to trap and filter sediment from runoff. See Section 4.3 for more information on ***filter strips***.
- Reseed grass, if necessary. ***Seeding*** recommendations are in Section 5.2 of the Resources Directory.

A grass **filter strip** *will help trap sediment that may run off a horse paddock. Be sure to develop good drainage in high-use areas such as horse paddocks. Create built-up pads, use proper footing materials, and divert clean stormwater around paddocks to help reduce mud.*

Improve drainage in and around high-use areas

- Use base rock and sand to improve drainage in high-use areas and to improve the surface or footing. For horses' health, high-use areas should have well-drained surfaces. "Road base" which consists of a mixture of clay, sand and crushed rock (or gravel) may be needed as a foundation for horse comfort in stalls and small ***paddocks***. Too fine a surface may not allow water to infiltrate and can cause ponding.
- Create built-up pads by "crowning" (building up the center) the pads to promote runoff rather than ponding and infiltration.
- Place filter fabric underneath the drain rock in stalls and small ***paddocks*** to prevent the rock from mixing in with the soil and subsiding. It costs a bit more money up front, but works better in the long run. The alternative is to keep adding rock, which adds stability to the site, however, it could be an ongoing expence.

- Prevent "footing" material from washing off site. Footing that washes off high-use areas could become a form of sediment that should not be allowed to enter creeks and seasonal drainages. Kickboards, made of railroad ties, telephone poles, or boards placed around the perimeter help prevent footing from washing away.
- Use a ***diversion*** to route "clean" stormwater runoff around the high-use area.
- Locate shelters along the edges of ***paddocks*** rather than in the middle so roof drainage can be more easily controlled.

Manage manure regularly

- Regular clean up of manure, soiled bedding, and uneaten feed will minimize the amount of pollutants in high-use areas. Uncollected manure adds to mud problems because it absorbs water. Scrape or otherwise remove manure before winter. Evaluate the manure management element of your ***conservation plan***.

Keep paddocks, corrals, and arenas as dry as possible during the winter rainy season

- Plan horse traffic patterns to avoid wet areas and minimize the formation of areas without vegetation. Select drier areas for the location of gates and other high traffic uses.
- Consider using deep bedding to prevent horses from standing in mud. These bedding materials are usually wood products, up to a foot in depth and can be used in outdoor situations. Various commercial products are available. A filter fabric may be required beneath the deep bedding to keep it from being trampled into the soil. Kickboards placed around the perimeter help retain the bedding on-site. Be aware that wood shavings, once saturated, can produce sufficient amounts of tanolignic materials to create a toxic leachate, which can pollute runoff.
- Use rubber mats over "road base" with bedding materials to keep stalls and other high-use areas dry in the winter.
- "Scratches,"also known as "grease heel," "grease," "cracked heels," or "mud fever," is a dermatitis (inflammation of the skin) of the heel and rear side of the pastern area. It can develop or be aggravated when horses stand in muddy corrals for long periods without relief.[3]
- Use clean fill such as soil for low spots. Don't use manure. As an organic material, manure holds water and actually adds to mud problems.

[3] James, Ruth B., DVM. 1990. *How To Be Your Own Veterinarian (Sometimes): A Do-It-Yourself Guide For The Horseman*. North Carolina: Alpine Press.

- Consider using ground oyster shell or various commercial products to dry urine-soaked or wet areas.
- Plant grasses, shrubs, and trees around high-use areas to utilize excess water, and to help keep the area drier.
- Native trees and shrubs such as California bay laurel, toyon and coffeeberry continue to use water during the winter when deciduous trees are dormant. (Do not plant anything that is toxic to horses. If oleander, oaks, walnut trees, etc., are consumed, they will make horses sick). Trees work well on the north side of a high-use area where they will not block the sun's rays. Protect trees from damage by horses by using heavy fencing, or horses will push down the fence to eat the leaves and bark. Trees in paddocks may have problems because horses also like to scratch on tree trunks and long limbs. Compaction of soil within the trees' drip line can harm roots.

Weed References

For noxious weed information, visit the California Department of Food and Agriculture ENCYCLOWEEDIA:
http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia hp.htm

To learn more about noxious weed eradication in your county, visit the CALWEED Database, California Noxious Weed Control Projects Inventory:
http://endeavor.des.ucdavis.edu/weeds/

Practice dust control measures

- Keep areas as vegetated as possible.
- Plant native trees for windbreaks and dust screens. Keep horses away from plantings by installing conventional horse ***fencing*** or an electric fence.
- Sprinkle water on arenas and ***paddocks*** to keep down dust during the summer. This also helps degrade urine salts that could otherwise accumulate in arid western soils during the long dry summer.[4]

2.3 Manure Management

Proper manure management will help maintain a healthy environment for horses, provide a clean and safe working area for people, and protect water quality in creeks and ground water. Effective manure management can reduce waste volume, removal costs, fly breeding, and neighbor complaints.

Management Strategies for Manure Storage Areas

Develop and implement a manure management element for your *Conservation Plan*

- Be sure to include a description of the facility's plans for manure collection, storage, and use or disposal.
- Consider characteristics of your property and operation to determine what manure management strategies will work best. Take into account: proximity of manured areas and manure handling areas to creeks, runoff from surrounding slopes, soil type, presence of near-surface ground water, type of bedding

[4] Michael Rugg, personal communication. 2001. California Department of Fish & Game, Yountville, CA.

material, volume of material (manure and bedding), number of horses, availability of labor and equipment, and access for clean-out and storage areas.
- Develop storage options. Storage facilities could include covered bins, sheds, concrete pads with low walls, windrows, piles covered with plastic tarps, dumpsters, trucks, or covered garbage cans. One 1000-pound horse may produce 0.75 cubic feet per day of solid waste plus urine.[5] Remember to add the volume of bedding when sizing a storage facility.
- Develop options for manure utilization such as ***composting***, disposal, and land application. Determine the pasture or crops available to utilize nutrients in the manure or compost produced.
- Talk to your neighbors and local RCD. Your solution should be appropriate to your area. It may be possible to develop solutions for a neighborhood or even a region.

Clean up manure

- Clean up manure, soiled bedding, and uneaten feed from stalls and ***paddocks*** regularly. Daily removal is best, especially during the rainy season.
- Use proper tools and a convenient storage site to simplify clean up. Find a manure fork that works. Some carts are too big, while others are hard to push around or awkward to dump.
- Scrape or otherwise remove manure from high-use areas, such as corrals and arenas.
- Pick up or spread manure periodically if horses deposit it in one area.

Proper manure management is essential for horse owners. Manure cleanup, storage, and use are critical components of conservation planning and good stewardship.

Store manure and compost properly

- Store manure and compost away from creeks and wells.
- Make sure that the ***manure storage, compost area***, or disposal container is appropriately located and sized for loading and unloading and can handle the appropriate quantity of manure cleanouts. Loading ramps are useful if manure can be loaded directly into a dump truck or dumpster. If tractors will be used, be sure the facility is large enough and strong enough for the equipment.
- Locate the storage or ***composting area*** on a water-tight surface such as compacted clay,

Composting manure may be an excellent way to handle large quantities of manure and create a useful product. Be sure to calculate the waste volume and allow for equipment access. Proper stormwater management and drainage should be installed near composting areas.

[5] Livestock Waste Facilities Handbook. 1985. Midwest Plan Service – 18. Iowa State University, Ames, Iowa.

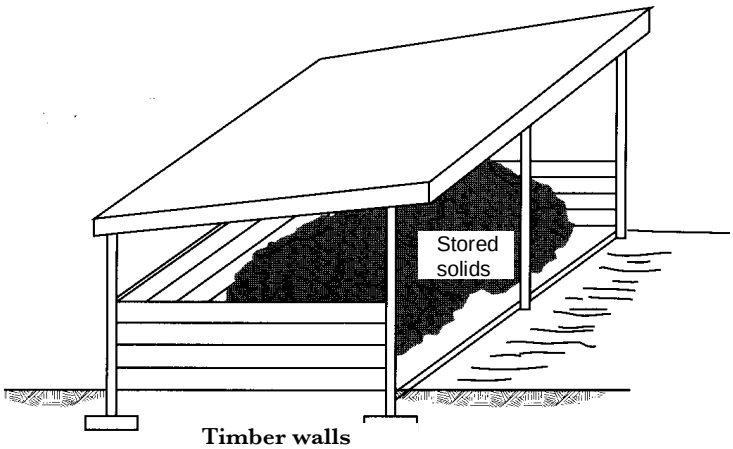
concrete, or plastic to reduce the potential for seepage of leachate (liquids high in salts and nutrients draining from manure piles) into ground water.
- Check regulations and required permits before grading for manure storage pads, especially when working around environmentally sensitive areas such as wetlands or streams.
- Install proper stormwater management and drainage measures (see Section 4.2) to route stormwater away from the area. Divert any runoff that leaves the ***manure storage*** or ***composting area*** to a ***filter strip***. Vegetation will utilize the nutrients in manure and help filter manure particles that are carried along in runoff.
- Use a ***cover,*** such as a tarp***,*** to protect stockpiled manure from winter rains. Shape piles in long rows, so that the width fits the size of the plastic sheeting used to cover the manure. Tie or weigh down edges and corners as necessary.
- Empty storage areas before the winter rains to reduce the volume of manure that must be contained.
- Take odor into account by considering prevailing winds, and distance to your neighbors.

Develop and implement a nutrient management element in your *Conservation Plan*

- Take into account your pasture's needs and determine the amount, placement, and timing of ***manure application or spreading*** to maximize plant growth and minimize the potential for polluting creeks and ground water.
- Have your soil analyzed by a laboratory *before* ***spreading manure*** to determine fertilizer needs, and establish a baseline for future monitoring. This is especially important if manure has been applied to the field for many years. Nutrients such as nitrogen and phosphorous are released over time (many years), so a field that has been used for manure disposal may already be quite high in nutrients and salts.
- Consider having a laboratory analysis of your horse manure to determine the total analysis. This will help ensure that ***manure application*** meets, but does not exceed plant nutrient requirements. For example, some of the nitrogen in manure may not be immediately available for plant use or additional fertilizer may be needed for specific nutrients.

Visual Inspections of Manure Storage Areas

Examine the condition of, and make any repairs to:
- Concrete – Cracks or openings, signs of infiltration, crumbling or rust
- Wood – Splitting, buckling or rotting
- Earthen containment walls – Settling, seepage, slumps, or animal burrows
- Wall alignment (vertical and horizontal) – Curves or bulges
- Foundation – Erosion or piping
- Liners – Tears



Stockpile manure on an impermeable surface. Size the manure storage area according to the amount of manure and bedding produced. The base must be a water tight surface to reduce the potential for seepage of leachate into ground water. The surface must be designed so it can be scraped with a shovel for small facilities, or a front-end loader for larger facilities. Cover the manure storage area so there is no liquid draining from the stack. A tarp or roof must drain away from the manure stack. Roof height should be a minimum of 7 feet, and also be designed to accommodate heavy equipment. Liquid from the manure may accumulate in the storage area and should be absorbed and removed with the bedding material. Empty the storage area before winter to reduce the amount of material to be stored.

Use compost and manure properly as a fertilizer and soil conditioner

- Properly calibrate your manure spreader to avoid over-application. Applying more manure than plants will utilize wastes nutrients. Excessive nitrogen and phosphorus in soils can be lost to ground water by leaching or to surface water through runoff.
- Apply manure and compost to actively growing pasture in the spring so nutrients will be utilized. Wait until after the winter rains when the ground is firm. Additional application in the fall before the winter rains will free up space in the ***manure storage area*** for the winter.
- Do not spread manure near creeks or on steep slopes where it can be carried to creeks by stormwater runoff.
- ***Compost*** bedding materials with manure before application. If undecomposed bedding is applied with the manure, soil organisms will use the available nitrogen to decompose the bedding—reducing the nitrogen accessible for plant growth.
- Use caution when spreading horse manure that has not been composted. Manure may contain weed seeds brought in with hay. Buy hay certified by the Agricultural Commissioner as "weed free," or compost horse

Never store manure near creeks. Rainwater running through this manure pile would run directly into the creek below to the left. Excessive nitrogen from manure feeds algae blooms that ultimately consume much of the oxygen in water. Ammonia from urine and manure can be toxic to aquatic life.

Local nurseries, landscapers, gardeners, agricultural operations, or community gardens may want manure. A hauler may be able to regularly pick up manure from neighboring horse owners. Manure should be composted before using in gardens.

manure to kill weed seeds. Also, spreading manure onto pastures may risk the spreading of internal parasites, if not composted.

- Incorporate manure or compost immediately into the soil by shallow disking or harrowing to increase nutrient availability for plants.
- Spread compost under the canopy cover (drip line) of trees, and be careful not to bury the root crown.
- Keep records of manure and soil tests.
- Keep records of manure and fertilizer applications, and the results of forage production.
- Give away or sell good quality composted manure.

Dispose of manure properly

Do not store manure near creeks or in places where runoff from manure piles can affect creeks or ground water.

- ***Compost*** manure into topsoil and use this valuable by-product to enhance your own property; give it away to local farmers with pasture, orchards, vineyards or annual crops; landscapers; community gardens; or sell it.
- Haul manure away for disposal. While this is usually a costly alternative, it may be the only one available for certain properties. If so, work with neighbors to encourage a local ***manure hauling*** system.
- Exchange, recycle or swap manure with others. The California Materials Exchange (CalMAX) links those looking for organic material or compost with stables providing horse manure. For more information, visit the website at http://www.ciwmb.ca.gov/calmax. Local programs such as the Sonoma Materials Exchange (SonoMax) is a free service helping local business find reuse and recycling opportunities. The goal is to reduce the amount of waste in landfills while giving business an opportunity to save on disposal costs. For a listing, contact: http://www.recyclenow.org/sonomax

2.4 Composting Horse Manure

Caring for your horses can require a considerable amount of time, energy and expense managing manure and soiled bedding. ***Composting*** manure decreases the volume of waste. It is easier to handle composed manure, and turns the waste into a usable product.

Composting Horse Manure: Turn Straw into Gold

For some horse facilities, ***composting*** horse waste may be an effective method to handle manure and stall waste generated by horses. ***Composting*** manure requires controlling conditions to speed up the natural process of decomposition. The benefits of ***composting*** include efficient manure management, reduction in manure volume by more than 50%, lower risk of surface and ground water contamination, and fewer odors. Compost heat kills worm larvae and reduces the parasite transmission between horses, as well as eliminates breeding ground for flies. Compost is a great soil conditioner—organic matter improves soil structure, drainage, and water retention. It also provides nutrients for plants, and the heat kills weed seeds and pathogens.

Compost basics[6]

Horse waste can be composted in numerous ways, although all methods require the same basic ingredients and conditions. Compost is created from a blend of nitrogen rich materials such as manure, carbon rich materials such as bedding, air, and water. Horse manure alone has close to the desired carbon to nitrogen ratio of 30:1. The compost material should be as wet as a wrung out sponge and well aerated to provide a favorable environment for the microbes that decompose horse waste. ***Composting*** requires one to three months depending on your method and management.

Different methods of ***composting*** include using bins and turning the compost by hand (for aeration) or long windrows that are either turned with equipment or passively aerated with perforated pipes running through them, that require mechanical blowers and pipes to force air through windrows or piles. It is

Manure is breaking down into **compost***, laid out in windrows for easy turning by tractor. Compost is curing at a different stage in each windrow, and new manure is constantly added to new windrows. Nitrogen-rich materials (such as manure), carbon rich materials (such as bedding), air, and water are used to create compost. Proper moisture and aeration are important. Turning horse manure into compost takes one to three months.*

Make **compost** *in bins or long windrows that are turned with equipment or aerated with perforated pipe. Piles should be less than 6-8 feet high.*

[6] Information drawn from: *On-farm Composting Handbook* (NRAES-54), Northeast Regional Agricultural Engineering Service Cooperative Extension, 1992. New York.

important to maintain proper height (lower than 6-8 feet) and moisture levels, especially during hot and dry conditions. Piles more than 12 feet high with less than 25-45 percent moisture content could spontaneously catch on fire.

Planning your composting project

The number of horses, labor and equipment available, space available, and management cost and time will determine whether ***composting*** will work for you and the method to use. To learn about ***composting*** options, talk with local certified Master Composters and Master Gardeners (who provide public assistance through the University of California Cooperative Extension) and visit horse facilities that compost. Also see the *Composting Horse Waste* Fact Sheet published by the Council of Bay Area Resource Conservation District's Equine Facilities Assistance Program. Contact your local RCD for a copy. (See Section 5.1 of the Resources Directory for contact information.) Private consultants may be needed to help you develop a large-scale system.

Factors to consider in planning your project:

- **Size**. Plan adequate room to handle the anticipated volume of horse waste plus equipment access. If you have a large operation, check with your local planning department before establishing a ***composting*** operation. Generally, horse waste can be composted and used on-site without a permit from the state although there may be notification, filing and record keeping requirements. Counties and local governments will probably require review of an operation plan.
- **Zoning regulations**. These may require setbacks from creeks or property boundaries. The regulatory aspects of ***composting*** are covered in Title 14, Division 7, Chapters 3.1 and 5.0 of the California Code of Regulations. County permitting departments may have requirements that need to be met.
- **Slope and drainage**. To prevent stormwater runoff from entering ***compost areas***, windrows and bins should be on flat ground or oriented up and down a very gentle slope (not across the slope where more water can drain into the pile). The surface area should be compacted or paved to prevent seepage, particularly in an area with sandy or gravelly soils or with a high water table. Any compost runoff should be directed to a ***waste pond*** or ***filter strip***.
- **Water supply**. A nearby source of water is often needed because ***composting*** may require additional water to maintain moisture content.
- **Wind**. Wind direction is important to consider for dust control and odors. For example, downwind neighbors may be affected when piles are turned.
- **Conservation Measures**. Be sure to include the same conservation measures as you would for ***manure storage areas*** (see Section 2.3, Manure Management).
- **Combustibility**. Under certain conditions, immature compost can undergo self-heating and spontaneous combustion from the heat generated by microbial decomposition. Confined storage, which traps heat, may exacerbate these conditions. Management plans should be developed to prevent this occurrence and contingency plans should be in place to respond appropriately if self-heating occurs.

2.5 Horse Wash Areas

Runoff from horse wash areas may contain soap and limited quantities of manure, chemicals and pesticides from horse health and grooming products that should not be allowed to reach nearby creeks or percolate into ground water.

Management Strategies for Horse Wash Areas

- Prevent wash water from percolating into permeable soils if there is near-surface ground water or a high water table. A storage ***tank*** for wash water may be necessary.
- Elevate the wash area with a built-up layer of crushed rock if the wash area is fairly flat. Wash water should drain away from the area to a ***filter strip*** or other vegetated area.
- Do not allow water from horse wash areas to flow into creeks, ponds or seasonal drainages.
- Keep the wash area free of manure and horse care products.
- Prevent wash water from flowing into storm drains (storm drains typically drain into creeks).
- Create a ***filter strip*** downslope of the wash area, or move the wash area to an area where a ***filter strip*** can be developed. Make sure the ***filter strip*** can accept the amount of wash water generated. Use ***berms***, or other conveyance measures, if necessary to contain and direct water to the ***filter strip***.
- Consider using ***constructed wetlands, grassed waterways*** or ***waste ponds*** as treatment areas for horse wash water.

A curb directs horse wash water away from the creek. Keep horse wash water out of creeks, seasonal drainages, and storm drains. Horse wash areas should be kept clean of manure and grooming products.

Use horse grooming and health care products properly

- Use a shut-off nozzle or low-flow nozzle at the end of the hose.
- Consider sponging off your horse to conserve water.
- Use plain water to rinse horses—avoid using soap as much as possible.
- Follow instructions, read environmental warnings, use only the recommended amounts, and clean up spills. Even biodegradable horse grooming and health care products can have a negative effect on water quality.

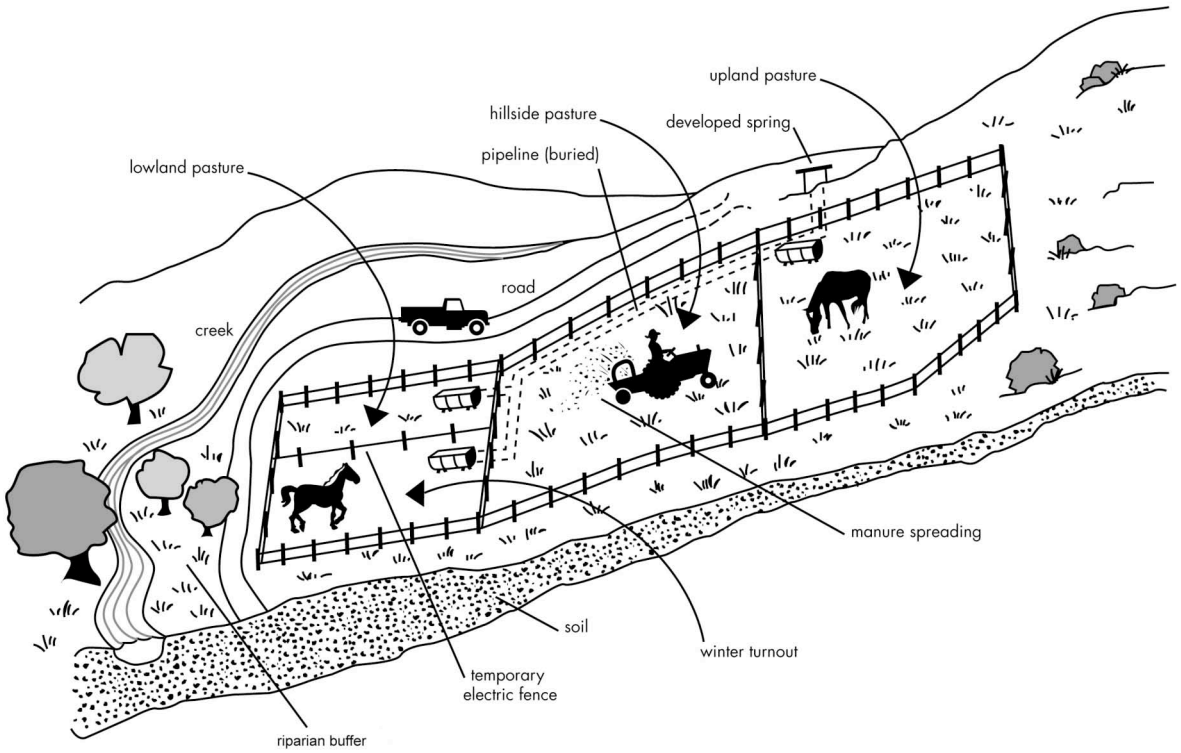
This horse wash area drains into a grass **filter strip** *(along the row of trees). The filter strip traps sediment, horse manure and other contaminants.*

- Use products that do not contain surfactants if wash water might eventually enter creeks. Surfactants, a group of chemicals that make detergents more effective cleaners, are extremely toxic to all aquatic life and can even impair the ability of young salmonids (steelhead and coho salmon) to adapt to ocean waters after they leave freshwater streams.

2.6 Pasture Management

When managing pastures, consider yourself in the business of growing grass. Grass will provide more forage for your horses and protect the soil from erosion. In healthy pastures, grass roots increase the soil's absorption of rainfall, storing moisture to prolong the growing season. In turn, a longer growing season produces more grass. Grass stems slow the rate of overland stormwater runoff. Slowing the rate and reducing the amount of runoff from hillside pastures may reduce drainage problems elsewhere on your property. A grass cover with little bare soil is ideal.

Horses can damage pastures quickly without ***grazing management***. Renovation of pastures is costly. Take care of what you have by controlled ***grazing*** and "resting" pasture so it has time to regrow.



PASTURES – Proper pasture management can include using **cross-fencing** *to promote uniform pasture use, controlling the number of horses and* **grazing distribution** *within pastures, controlling horse access to creeks, developing a* **spring** *as a new water source, and restricting pasture access during the wet season.*

Management Strategies for Pastures[7]

Control horse access to creeks and other water sources

- Control horse access to creeks to prevent manure and urine from being directly deposited in or near creek channels. ***Fencing*** to keep horses out of creeks may be necessary.
- Control horses ***grazing*** along creek banks to reduce trampling and erosion of banks that leads to sedimentation of waterways.
- ***Graze*** riparian areas seasonally when soils are dry enough to withstand the weight of the horses, to keep streambanks from being trampled and broken down.
- Provide horses with alternative sources of water if creek ***fencing*** is installed. Small pasture shelters may be necessary to provide a new source of shade and shelter.
- For crossings or water source, narrow horse access to a point at a creek where the channel can be armored or protected with gravel or other means.

Improve animal distribution to help reduce bare areas and control undesirable weeds.

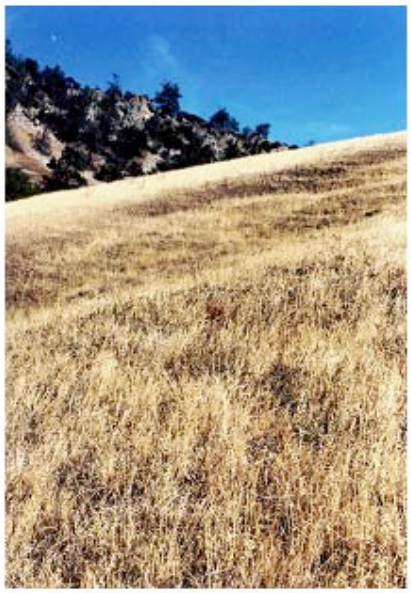
- Manage the number of horses and control ***grazing distribution*** to prevent heavy grazing.
- Develop and adjust a rotation ***grazing*** schedule to provide pastures with periods of ***grazing*** interspersed with periods of rest.
- Locate feed, salt, minerals, and water away from creeks. Regularly move the salt blocks to distribute ***grazing***. Place hay piles far apart with more piles than the number of horses being fed. This will minimize trampling from fighting horses and maximize distribution.
- Use ***cross-fencing*** (dividing up a pasture with fencing into smaller cells) to improve

Overgrazing occurs when plants are so heavily grazed that the root system dies back and plants eventually become less productive or die. A balance of grazing and pasture rest will prevent overgrazing, improve forage production, and keep weeds down.

Be sure to control horse access to vulnerable erosion areas such as a rill in a pasture. Repairing a problem early and installing temporary **fencing** *can help prevent the need for a more costly fix later (such as when a rill turns in to a gully).*

Overgrazed pastures lack plant cover and are susceptible to erosion. Keep horses out of highly erodible areas and **seed** *bare areas. Gully repair is likely to require professional assistance.*

[7] USDA, NRCS - California, Field Office Technical Guide, Prescribed Grazing, July 2000.



Adequate **"Residual Dry Matter"** *(RDM) leaves enough plant residue on the soil surface to protect against soil erosion, and leaves a sufficient seed source for annual pasture regeneration. RDM is measured in the fall, just before the winter rains. The minimum levels of RDM that should remain in a pasture is 800 – 1000 lb/ac in the San Francisco Bay area. This pasture has 900 lb/ac of RDM. Pasture production varies from year to year, with rainfall being a primary influence. Therefore grazing must* be monitored and grazing levels adjusted, each year

Residual Dry Matter *(RDM) is used as a tool to determine adequate erosion control on pastures. RDM is measured by clipping the grass in a ring, and measuring the weight of the dried grass. This site has 900 lb/ac of RDM. For visual estimates of RDM, refer to the "Residual Dry Matter Monitoring Photo-Guide" produced by Wildland Solutions.*

evenness of pasture use. ***Cross-fence*** pastures according to the terrain, soil wetness, and land sensitivity (e.g., steep slopes will erode more easily). Lowland pastures will probably stay green later into the summer and may be too wet to be grazed without damage in the winter. You may need to add alternative water sources for horses.

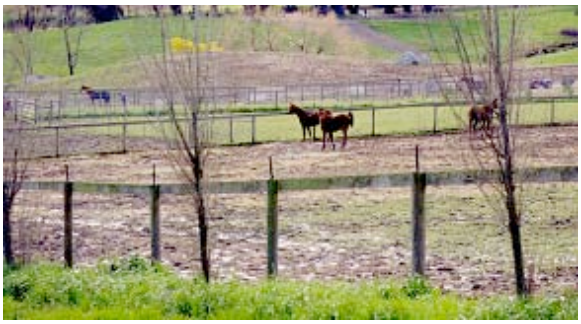
Portable electric fencing is easily installed and affordable, and can be used to define ***grazing*** areas if the horses are allowed to acclimate to the new fencing (temporary flagging helps to demarcate the fencing).

- Provide alternative sources of water by developing ***springs*** or extending an existing water system.
- Small pastures should be used for exercise rather than forage production.
- Maintain sufficient ***residual dry matter (RDM***) for pasture reseeding and erosion control. RDM is the amount of dry grass stems left behind after the grazing season has ended. Be prepared to move horses to another pasture or a ***paddock*** once target RDM levels are reached or exceeded. The rule of thumb is to leave 4 inches of grass stems in the pasture. See Section 5.8 of the Resources Directory for more information on RDM.

Properly manage pasture use

- Turn horses out for only a limited period of ***grazing*** each day to increase the duration of a pasture's use and to reduce soil compaction. ***Grazing*** when the soil is wet causes soil compaction. The soil particles are pressed together by

concentrated pressure from livestock hooves, reducing the pore space between soil particles. A dry soil is more resistant to compaction than a moist or wet soil. Compaction restricts rooting depth, which reduces the uptake of water and nutrients by plants. This affects the activity of soil organisms by decreasing the rate of decomposition of soil organic matter and subsequent release of nutrients. Compaction decreases infiltration and thus increases runoff and the hazard of water erosion.



Control winter access to soggy pastures to help prevent pollutants from leaching into the ground water and to keep horses out of the mud. Fence out springs and seeps.

- Feed horses before turning them out to reduce the ***grazing*** pressure on grasses.
- Remove or spread manure if it has accumulated in a particular area. This will promote plant growth and reduce parasite populations. Horses should not be forced to eat the forage where manure is deposited.
- Restrict use of wet pastures. Some pastures may be too wet to use during the rainy winter months. Confine horses to ***paddocks*** during this time and use pastures seasonally during the dry months.

Develop and use turnout paddocks

- Develop ***turnout paddocks*** in flatter portions of pastures, away from creeks. Turnout areas include exercise lots, pens, corrals, and small ***paddocks***. Follow the guidelines for high-use areas (See Section 2.2).

  Paddock size depends on the number of horses and other considerations. Keep ***paddocks*** to a minimal size to limit the amount of bare ground. General guidelines are a minimum size of 600-800 square feet per horse, with a slope of less than 5% and good drainage. Keep the paddock surface as dry as possible during the rainy season to reduce the possibility of polluted water from running off the area, and also be healthier for horses.

Turnout paddocks *(exercise lots, pens, corrals, and small paddocks) can be used to keep horses off wet pastures. This will help protect pasture soils and grass cover.*

- Preserve pastures by keeping horses in ***turnout areas*** when grass has been grazed down (less than 4-6 inches high).

Follow seasonal pasture management strategies

- Keep horses in ***turnout paddocks*** and off pastures when soils are wet.
- Give exuberant horses time in a ***turnout area*** during the rainy season before putting them on pasture. This will help horses release their energy and protect turf from being churned.
- Keep horses off steeper slopes when pastures are wet.
- ***Seed*** and ***mulch*** bare areas.

- Remove weeds as necessary and make sure that removal occurs at the proper time of year (this will vary by weed species).
- Monitor grass height and weed growth at the end of the growing season (late spring/early summer).

Watch gully formation and accelerated erosion

- Keep areas well vegetated to minimize soil erosion.
- Use ***fencing*** to keep horses out of highly erodible areas.
- Stabilize gullies as recommended by a professional. Options include headcut repair, ***check dams***, grading side slopes and revegetating. See Section 4.1 for more information on these conservation measures.
- ***Seed*** and ***mulch*** bare areas to protect the soil from erosion and maintain desired grass species. (See Section 5.2 of the Resources Directory for seeding recommendations.)

Grass Facts

Plants need energy for growth, maintenance, and reproduction. Green plants get energy from sunlight, *nowhere else!* Green leaves and stems act as solar energy collectors. Roots need the collected energy for growth and replacement. In general, large amounts of leaves and stems can provide energy for a large root system; small amounts of leaves and stems can only support a small root system. As a rule of thumb, the above ground portion of the plant is equal to the underground root system.

Severe grazing creates an imbalance between the energy provided by the plant's solar collector and the needs of the roots. If the solar collector is kept grazed, the root system will die back to match the energy available. Plants with small, shallow root systems will be far less productive or may even die. This is overgrazing. Overgrazing occurs plant by plant. Since horses are selective grazers, their preferred plants may be overgrazed even when the pasture as a whole looks ungrazed.

Adequate rest periods following grazing allow the plant to rebuild its solar collector and restore roots. The length of rest required will change as the growing conditions change. Grazing years should be planned to provide adequate recovery periods and minimize overgrazing of plants. Long periods of rest are sometimes damaging to individual plants and pastures if excessive thatch builds up. Balancing grazing and rest improves forage production and minimizes weed problems.[8]

[8]*How Grass Grows—The" REST" of the Story*. USDA Natural Resources Conservation Service.

2.7 Water Resources: Creeks, Springs and Wells. Managing Septic Systems

Water resources need special attention and protection. Healthy riparian areas along creeks and springs support a variety of plant and animal species, help control erosion, filter pollutants in runoff, and add beauty and diversity to the landscape. Creeks are vulnerable to erosion and other impacts from activities along streambanks. Creeks and smaller seasonal drainages transport pollutants downstream to lakes, larger streams and rivers, bays and eventually to the ocean. Every landowner can help maintain and enhance riparian areas. Springs provide water for wildlife and can be important sources of habitat for amphibians.

Wells tap into ground water for drinking water supplies and irrigation. Ground water resources are vulnerable to pollutants that can leach through the soil. Ground water also keeps dry-season flows (underground flows) in streams in some areas.

Restrict horses from creeks to help keep manure and urine from being deposited in creeks and minimize erosion on streambanks. Use **fencing** *to help manage horse access to riparian areas. Riparian areas can be grazed seasonally when streambanks soils are dry enough to withstand trampling.*

Management Strategies for Surface Waters

Control horse access to springs, creeks, seasonal drainages, and ponds

- ***Fencing*** can be used to keep horses out of riparian areas.
- Graze riparian areas, if necessary, only during the dry season.
- Design ***stream crossings*** to minimize erosion. For more information, see Roads, Trails and Stream Crossings in Section 2.8.
- Develop alternative water sources for horse confinement areas that are located away from creeks and springs. Conservation measures to consider are ***spring development*** with buried ***pipelines,*** and ***troughs,*** extending existing water systems, installing ***storage tanks,*** and utilizing **"**nose pumps**"** where the animal presses a trigger to release water**.**

An alternative water source is critical if horses are restricted from creeks. Be sure to locate water troughs away from creeks, drainages, and springs. Try using a "nose pump" that allows horses to pump their own water.

Manage runoff properly

- Set buildings, covered arenas, high-use areas, ***horse wash areas***, ***manure storage areas***, ***roads and trails*** back away from creeks.
- Prevent polluted runoff from reaching creeks and springs.
- Maintain a ***filter strip*** and/or ***riparian buffer*** between creeks and high-use areas.

- Control erosion to reduce the amount of sediment that fills ponds.

Monitor the creeks

- Landowners who wish to develop baseline data about the quality of water on their properties are encouraged to learn how to monitor their water resources. ***Water quality monitoring*** information is provided in Section 5.7 of the Resources Directory.
- Monitor water quality, especially during the rainy season.

Enhance riparian areas

- Create and maintain a ***riparian buffer*** along the creek to help slow and disperse surface runoff, settle sediment, and filter pollutants. Use native plants to enhance wildlife habitat. (See Section 4.3 Riparian Buffer, for more information.)
- Monitor and stabilize streambank erosion. Seek professional advice for severe erosion and problems on larger streams. These areas may require intensive "bioengineering" or "hard" engineered structures (such as rock riprap) to stabilize the streambank, as well as a ***riparian buffer***. Be sure to obtain required permits. For more information on streambank stabilization, see Section 4.1. For permit information see Sections 5.4 and 5.5 of the Resources Directory.
- Be aware of any habitat needs or areas for threatened or endangered species on your property. See Section 5.5 of the Resources Directory for more information.

Management Strategies for Wells

Keep well water free of harmful contaminants for the health of you and your livestock. Improperly constructed or older wells can create a pathway for fertilizer, bacteria, nutrients, pesticides, or other materials to enter your water supply and the ground water. Once in the ground water, contaminants can flow from your property to a neighbor's well, or from a neighbor's property to your well. After your water becomes polluted, the only options may be to treat water after pumping, drill a new well, or get water from another source. Time and money spent protecting your well water is a bargain compared to the loss of clean water and an associated decrease in property value.

Properly site wells

- Choose a location where surface water drains away from the well. Avoid placing wells in soil depressions.
- Be aware of how ground water flows. If you live in an area with a high water table (or if you have an existing shallow well), ground water often flows in the same direction as surface water. However, surface slope is not always a reliable indicator of ground water flow—meaning ground water may not always move downslope.
- Locate wells upslope of, and well away from, horse confinement areas, fuel tanks, septic fields, or pastures that may receive too much fertilizer.

- Check with your county permitting department for any well setback or well construction requirements and follow local regulations about the proximity of horse confinement areas to well heads.

Regularly test wells

- Establish a water quality baseline to help detect changes.
- Test wells annually for the four most common indicators of trouble: bacteria, nitrates, pH, and total dissolved solids. A more complete water analysis will tell you about its hardness, corrosivity, iron, sodium, and chloride content. In addition, you may choose to obtain a broad scan test of your water for other contaminants such as pesticides. Local conditions may warrant additional testing.
- Talk to your neighbors. If they have had their wells tested, they may be able to provide you with information on water quality in the area. In addition, county or state health departments may have records of water quality tests in your area.
- Have older, shallow wells periodically checked by a qualified well driller or pump installer. Wells older than thirty years are apt to be shallow and more poorly constructed. Older pumps are more likely to leak lubricating oil. Older wells usually have thinner casings that may be cracked or corroded.

  Older wells are more likely to provide a conduit for precipitation and runoff to reach the water table without being filtered through the soil. Wells have steel or plastic pipe “casings” to prevent the collapse of the well hole after drilling. the space between the casing and the sides of the hole are sealed with grout or bentonite clays and the well capped to prevent surface water from entering the well. The depth of the new seal depends on the soil type but should be at least twenty feet. Casing should extend at least 12 inches above the surface or 1 to 2 feet above the highest recorded flood level for the site. Contact county heath or permitting departments for local specifications.

Keep well areas clean and accessible

- Keep contaminants as far away as possible.
- Check nearby fuel tanks or septic systems on a regular basis.

Properly fill and seal unused and abandoned wells for safety, and to prevent waterborne pollutants from reaching ground water

- Contact a licensed, registered well driller or pump installer for this work. A permit is normally required to assure proper well destruction.

Management Strategies for Septic System Drainfields

Properly functioning septic systems depend on good dispersal of wastewater in the drain field and the ability of water to percolate through the soil at a steady rate.

Taking care of drainfields will enhance and preserve the ability of your septic system to break down potential contaminants (such as viruses, bacteria, nutrients, and organic waste) and keep them from contaminating ground water or nearby creeks.

- Keep drain fields covered with grass. Avoid planting trees and shrubs whose deep roots can damage pipes.
- Divert roof and surface runoff away from drainfields. Saturated soil is not effective for treating wastewater.
- Minimize activities that compact drainfield soils. Compaction decreases the ability of water to percolate through the soil, reduces the amount of oxygen available for waste-digesting microbes, and may shorten the life span of the drain field. Activities to watch include ***grazing*** and corrals directly over the leach field, particularly when soils are wet; vehicle use (which can also damage pipes); "high-use" horse activities; as well as paving, constructing buildings, and piling heavy objects.
- Nonstandard septic systems, such as mounds, at-grades, pressure distribution systems, sand filter, etc., can be especially fragile and should be well ***fenced*** for their protection. Local health or permitting departments can offer more specific advice.
- Follow local regulations about the proximity of horse confinement areas to septic leach fields.

2.8 Design and Maintenance for Roads, Trails and Stream Crossings

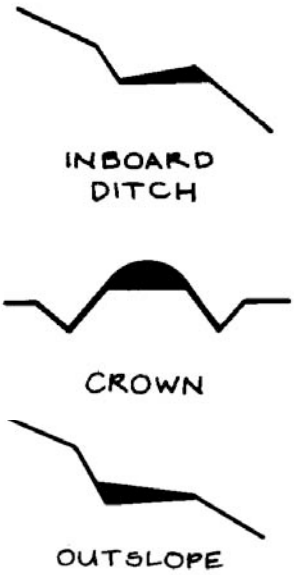
Proper road, trail and ***stream crossing*** design and maintenance will help control erosion. Improperly constructed or maintained roads can cause chronic erosion problems. Unsurfaced roads and horse trails can contribute sediment to creeks and can become dangerous or impassable for horses and vehicles. Even annual regrading of small washouts or eroded areas can contribute significant amounts of sediment to the nearest stream.

Develop longer-term solutions, such as a durable road base, compaction, and gravel surfacing to save time and money while reducing inconvenience, increasing safety, and controlling sediment from reaching creeks.

Management Strategies for Roads and Trails

Properly design and construct roads and trails

- Consider the type and amount of expected traffic, speed, loads, climatic conditions, and environmental resources in need of protection. Keep roads to a minimum, the fewer roads, the less maintenance and erosion. Follow sound engineering measures to insure that the road meets the requirements of its intended use and that maintenance requirements are in line with operating budgets. The *Handbook for Forest and Ranch Roads* is a good resource. To obtain this publication, call the Mendocino County Resource Conservation District at (707) 468-9223.
- Understand how roads are constructed and drained to help determine the appropriate strategy for your property. Roads are constructed to drain in three different ways:
  - **Insloped roads** are graded into the slope and drain to an inboard ***ditch***. ***Ditches*** provide surface drainage for the roadway and should be designed to protect the road surface from upslope runoff.
  - **Crowned roads** are higher in the middle and drain water off to both sides. Crowned roads require more initial grading and regular ***ditch*** maintenance.
  - **Outsloped roads** follow natural drainage patterns and runoff drains across the road in even sheets. Typically, outsloped roads are less expensive to construct and easier and cheaper to maintain. ***Culverts*** and ***ditches*** are not required except where the road crosses small drainages. The addition of large amounts of stormwater runoff from above outsloped roads may cause excessive erosion. Roads may have to be surfaced, regraded, or re-routed.



Roads are constructed to drain in three ways. Insloped roads are graded into the slope and drain to an inboard ditch. Crowned roads are higher in the middle and drain water off to both sides. Outsloped roads follow natural drainage patterns, and runoff drains across the road in even sheets. Outsloped roads are generally less expensive to construct and easier and cheaper to maintain.

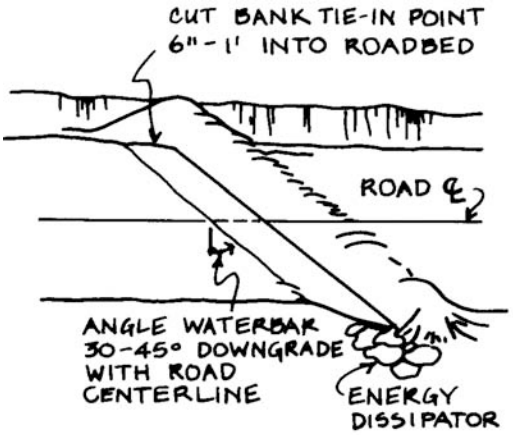
- Develop adequate cross drainage. Long stretches of inboard ***ditch*** accumulate a lot of water that can cause extensive gullying of the ***ditch***, destabilize the roadbed, and undermine the hillside. Some form of cross-drainage is required at regular intervals to channel runoff across the road to non-erodible outfalls, such as ***energy dissipaters***, on the outboard side. Even if a road has some cross-drainage, additional measures may be needed to help prevent washouts. Selecting a method to transport water across a road depends on road location, amount of use and maintenance, the volume of flow, and budget considerations.

A muddy swale is created by improper drainage from a road (uphill of this photo). A properly constructed and maintained road will help control erosion. Culverts and waterbars can provide **cross-drainage**. *Some roads may need surfacing with gravel, while others should be avoided during the wet months.*

Cross-drainage techniques to consider include:

- ***Culverts.*** Culverts are likely to need professional design to handle anticipated flow. Angle ***culverts*** about 30 degrees downgrade to assure proper water movement and prevent plugging and erosion at the inlet. Compact the backfill to prevent water from flowing through the road base. ***Culverts*** should be used in upland areas and avoided for ***stream crossings***, where ***bridges*** are more appropriate.

  Inlet and outlet design is important to prevent erosion. Inlet design must not allow "piping" (water flowing along the outside of the pipe) that could loosen the soil and wash out the pipe. ***Culvert*** outlets should extend at least two feet beyond the edge of the road and empty onto an ***energy dissipater*** (such as rock riprap). For outlets on steep slopes, use a ***lined waterway*** or ***underground pipeline*** to safely convey water to the base of the slope.
- **Rolling Dips** are dips in the grade of the road. Rolling dips are installed in a road bed to drain the road surface and prevent rilling and surface erosion, and are most frequently used on outsloped roads. To effectively direct runoff to the side of the road, the axis of a rolling dip should be angled about 30 degrees to the road alignment.
- **Waterbar.** This is a shallow ditch placed 30 to 45 degrees downslope across the road surface to control surface runoff on low use roads. The excavated material from the ***waterbar*** is piled in a rounded ***berm*** downslope of the waterbar to form an additional water barrier. ***Waterbars*** are a temporary and very effective means of breaking up surface flow on sloped portions of road. Often they must be reconstructed every year as they wear down.



Waterbars *are a temporary form of cross-drainage. To create a waterbar, dig a shallow ditch 30 to 45 degrees downslope across the road. Pile the excavated material in a rounded berm downslope of the waterbar. Waterbars need to be monitored and maintained throughout the winter.*

Waterbars work best on roads that receive little winter traffic. In a pinch, they can be constructed with hand tools. Installing a series of ***waterbars*** reduces the flow volume individual waterbars must handle. ***Waterbars*** can be reinforced with logs, gravel, or a mixture of soil and cement.

- Follow natural contours and slopes to minimize disturbance of drainage patterns. Avoid building roads on unstable slopes or at too steep of a grade. Grades normally should not exceed 10 percent slope except for short lengths. Minimize cuts and fills, and stabilize the side-slopes of all cuts and fills. Areas with geological hazards (such as old landslides) should be avoided.

  Set roads and trails back from creeks and maintain a ***riparian buffer.***

Maintain roads, trails, culverts, and ditches

- Go out during a storm, shovel in hand, when you can see drainage patterns and areas that require urgent attention.
- Check for erosion and drainage problems, particularly on road surfaces, ***ditches***, and cross-drainage structures. Often the main cause of soil erosion is from the power of concentrated runoff that roads and trails collect and channel.
- Look for ***ditches*** or ***culverts*** that are washed out, blocked with debris, or are causing downstream erosion at the outlet.
- Keep ***ditches*** vegetated with grass to help maintain stability.
- Keep ***ditches*** cleared of sediment. Vegetated ***ditches*** with a gentle slope of 2 to 6 percent will prevent sediment deposition and allow rapid drainage. For chronic sediment problems, address the erosion source.
- Keep inlets clear. Remove debris before the rainy season and check during and after storms. Look upstream for any material that could wash into the ***culvert***. Consider another method of cross-drainage or address the upstream source of debris if ***culverts*** plug after every major storm.
- Consider using ***trash racks*** to trap debris, if you can maintain them. While trash racks can help keep ***culverts*** open, unmaintained racks can cause more erosion problems than the original debris.
- Control upslope erosion sources to prevent sediment from filling cross-drainage ***culverts***.
- Install and maintain ***energy dissipaters*** at outlets.

A **rock-lined ditch** *is necessary along this steep road. Well-constructed and maintained ditches are key to the long-term stability of an insloped or a crowned road.*

Maintain and improve road and trail surfaces

- Regrade roads to smooth the surface and prevent rills from expanding.
- Provide adequate cross-drainage using ***culverts*** and ***waterbars.***
- Resurface roads and trails that have high traffic, chronic erosion problems, undesirable amounts of dust, or steep grades. For muddy roads, consider using a gravel road base laid over a layer of filter fabric to prevent the gravel from mixing with mud.
- Limit or avoid using certain roads and trails during the winter, particularly those on highly erodible soils.
- Limit side-trails where possible. Shortcuts, especially up steep slopes and across streams, can create highly erodible sections of trail. Encourage riders to stay on established trails.
- Sow grass seed on seldom-used roads and adjoining areas of exposed soil. ***Seeding*** should occur before October 15 to ensure adequate growth.

Roads not used in the winter can be "put to bed" for the season. This road has been seeded and will not be used again until the spring. Roads should be properly graded, seeded and mulched, to help prevent erosion. **Seeding** *should occur before October 15 to ensure adequate growth before the winter rains.*

Put abandoned roads "to rest"

- Grade, ***seed*** and ***mulch***, or use an ***erosion control blanket*** when putting roads to rest for the rainy season. Jute netting with a layer of straw underneath can also be used. Straw wattles (bundles) can also help with erosion control. (For information on ***erosion control blankets*** and straw wattles, see Section 4.1: Erosion Control – Gully Repair.) For roads with chronic erosion problems, laying roads to rest may be an appropriate strategy from an economic, environmental, or safety standpoint.

Stream Crossings

- Select an appropriate crossing (either a ***bridge,*** **rolling dip*****, ford,*** *or* ***culvert***). Select a crossing location that will least impact streambanks and riparian vegetation.

This stream crossing keeps livestock from trampling the streambanks. Stream crossings, such as **bridges***,* **fords** *and* **culverts,** *should be located and designed to minimize impacts to streambanks and riparian plants. Bridges work best on larger streams and have the least impact on aquatic life. Permits are generally required.*

  - ***Culverts*** should be properly sized and installed. They should follow the same alignment as the creek and exit at the same level as the channel downstream.
  - ***Fords*** may be required for crossing small seasonal drainages or where debris can clog ***culverts***. ***Fords*** should be surfaced with concrete to prevent erosion. ***Fords*** require site-specific engineering design. A correctly designed ***ford*** should require very little maintenance. If horses will use the ***ford***, be sure to roughen the concrete surface, when pouring the concrete, for traction.
  - ***Bridges*** are best for larger streams and where there is a lot of floating debris. ***Bridges*** have fewer impacts on aquatic life than other crossings.

- Remember ***ditches*** in the design process. Well-constructed and maintained ***ditches*** are key to the long-term stability of an insloped or a crowned road. Slope the sides of drainage ***ditches*** if possible to control erosion. ***Ditches*** on steeper slopes may need to be lined with rock. Steep-side ***ditches*** will erode more easily than those with 2:1 side slopes. Flat-bottomed ***ditches*** with a 1-2 foot wide bottom are less subject to scouring than V-bottom ditches. ***Ditches*** on steep slopes may require ***check dams*** for grade control (you may want to consult a professional for advice and design).
- Stream crossing references. Check these internet reference sites for additional information on designing stream crossings for fish passage:

  National Marine Fisheries Service
  http://swr.nmfs.noaa.gov/habitat.htm
  Click on Stream Crossing Guidelines

Washington Department of Fish and Wildlife
http://wdfw.wa.gov/recovery.htm
Click on Fish Passage Design at Road Culverts

- Obtain necessary permits. County, state, and federal ordinances regulate many aspects of road construction, reconstruction, and maintenance. Creek crossings will likely require a Streambed Alteration Agreement from the California Department of Fish and Game and can require permits from the US Army Corps of Engineers and the Regional Water Quality Control Board. County public works and building departments may have grading ordinances that describe how roads may be constructed and connected with existing public roads. Other state regulatory agencies with jurisdiction on road construction and related activities include the California Department of Transportation, California Department of Forestry and Fire Protection, and California Coastal Commission (for work in the Coastal Zone). See Sections 5.4 and 5.5 of the Resources Directory for more information on regulations and permits.

- Schedule construction and maintenance activities to minimize soil erosion and allow for revegetation of disturbed areas before winter rainfall. Although some soil moisture is advantageous for roadbed compaction, wait until winter runoff has slackened and soils have begun to dry in the late spring before beginning construction. Heavy equipment should not be used on wet soils. Prevent sediment from entering creeks during and after construction. After construction, revegetate road banks and disturbed areas before the winter rains. ***Seed*** and ***mulch*** for revegetation by October 15.

2.9 Construction Management

Proper construction is important whether building a new horse facility or making improvements at an existing facility. Appropriate installation of erosion control and drainage structures can help protect water quality and reduce future maintenance.

Construction Management Strategies

- Seek technical advice and professional design assistance. Drainage systems must be sized for water volume and velocity.
- Obtain the proper permits for grading and working in streams. See Sections 5.4 and 5.5 of the Resources Directory for more information.
- Avoid grading during the rainy season.
- Minimize disturbance along the edges of creeks.
- Be sure equipment operators fully understand the purpose and extent of grading. Flag-off special areas that you want to protect.
- Implement erosion control measures, such as ***seeding*** and ***mulching*** or installing ***erosion control blankets***, immediately following grading. Utilize emergency measures such as ***straw bale sediment barriers*** until permanent structures can be installed.
- Monitor and maintain all erosion control measures.

Chapter 3

List of Conservation Measures

A conservation measure is a specific treatment, such as a management decision, activity, practice, or structure, that provides a practical, effective, and economical means to prevent or reduce water pollution. Protecting creeks and water quality can create a healthier environment for horses by reducing mud and manure areas.

Table 2 lists conservation measures discussed throughout this guide in ***bold italic*** and identifies the main section(s) in which they are found. Note that conservation measures and suggestions in this guide rely extensively on the standards and specifications of US Department of Agriculture's Natural Resources Conservation Service.[9] Horse owners may need to seek professional assistance with some measures. Conservation measures with an asterisk (*) have an NRCS standard and specification with specific design criteria. Some standards and specifications have different names than used in this guide, which are marked with a footnote, and NRCS practice names are given at the end of the table. Visit the website: http://www.nrcs.usda.gov/technical/efotg/, or contact your local NRCS office for details.

[9] Conservation practices in this section are drawn from USDA Natural Resources Conservation Service *Field Office Technical Guide*. Davis, CA, 1986.

Table 2: Horse Keeping Conservation Measures

Conservation Measures	Section	Page Number
Conservation plan	1.1, 2.3	11, 24
Erosion control Conservation Measures	4.1	52
Seed [A]*	4.1, 5.2	52, 79
Mulch [B]*	4.1, 5.2	52, 80
Erosion control blanket [C]*	4.1	53
Gully repair	4.1	53
Check dam [D]*	4.1	60
Streambank stabilization [E]*	4.1	55
Emergency Erosion Control Measures	4.1	58
Sandbag	4.1	59
Sandbag pipeline drop inlet	4.1	61
Silt fence	4.1	61
Straw bale check dam	4.1	60
Straw bale sediment barrier	4.1	60
Straw bale waterbar	4.1	59
Road Related Erosion Control [F]* including Stream Crossing	2.8	40
Bridge	2.8	44
Ford	2.8	44
Culvert	2.8	41
Ditch	2.8	41
Waterbar	2.8	42
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Fence* or ***cross-fencing***	2.6	33
Grazing distribution [G]*	2.6, 5.8	33, 94
Rotation grazing [G]*	2.6	34
Spring development*	2.7	37
Storage tank [H]*	2.7	37
Trough*	2.7	37
Monitor grass growth	2.6	34
Residual dry matter; monitoring grass residue	5.8	93
Manure spreading [N]	2.3	27
Weed management	2.6	33

Natural Resources Conservation Service names for standards and specifications:

[A] Critical area planting
[B] Critical area planting – straw mulch
[C] Critical area planting – erosion control blanket
[D] Grade stabilization structure
[E] Streambank protection
[F] Access road
[G] Prescribed grazing
[H] Trough or tank
[I] Rock riprap
[J] Critical area planting – woody cuttings
[K] Waste management system
[L] Waste storage facility
[M] Nutrient management
[N] Waste utilization
[O] Composting facility

Chapter 4:

Conservation Measures to Improve Water Quality

Conservation measures offer options for making improvements at a horse facility and are designed to assist land users to effectively reduce sources of pollution at horse facilities. You have seen the list of conservation measures (Chapter 3) and references to these conservation measures in Chapter 2. Material in this chapter is designed to assist horse owner knowledge and understanding of how management practices function together within a facility. Now, we will discuss in detail how the items tie together.

This chapter is presented in three sections:

- **Section 4.1:** Erosion Control Conservation Measures
- **Section 4.2:** Stormwater Management Measures: Keep "Clean" Water Clean
- **Section 4.3:** Measures to Manage "Polluted" Water

4.1 Erosion Control Measures

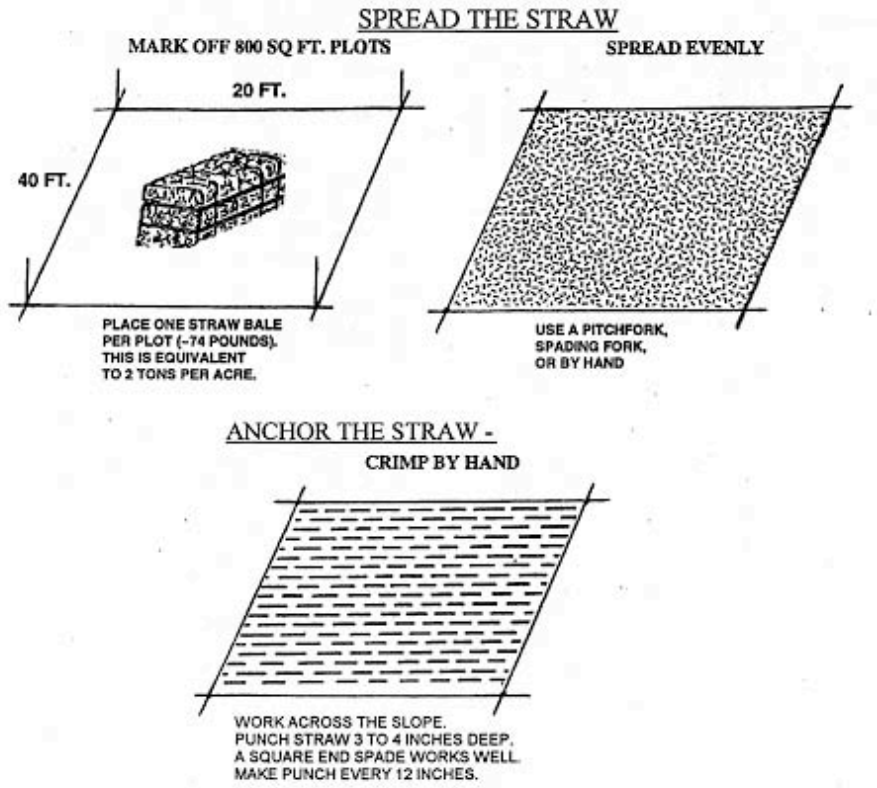
Erosion is easier to control in its early stages when revegetation or simple drainage improvements may be all that are necessary. Once eroded, soils are less productive, and can be more difficult to revegetate. Watch for accelerated erosion in vulnerable areas such as steep slopes and landslides, pastures, gullies, intensively used horse areas such as ***paddocks*** and ***turnouts***, streambanks, unsurfaced roads, road cuts, parking lots, and construction areas.

Seed and Mulch for effective Revegetation

*Straw mulch is being applied after tractor work was done to smooth out a gully. **Seeding** and **mulching** are effective and low-cost erosion control measures. When seeding and mulching bare areas, be sure to prepare the seedbed by removing weeds, and roughening the seedbed. Grass seed should be spread by October 15. Mulch should be weed free.*

Seeding and ***mulching*** provide effective revegetation.. ***Seeding*** is usually needed for ***filter strips***, ***grassed waterways*** and ***pastures***, as part of erosion control, or after construction. A complete seed mix and specifications are in Section 5.2 of the Resources Directory. ***Seeding*** and ***mulching*** tips to keep in mind are:

- Be sure to plant before the rainy season, generally by October 15.
- Properly prepare the seedbed. The area should be weed free. Have a firm seedbed that has been roughened by disking, harrowing, or a similar method. Or use a no-till drill to seed directly into existing grasses, which will minimize erosion.
- Legumes (clovers) must be inoculated with nitrogen fixing bacteria immediately before planting. This will help increase legume production and nitrogen fixation. (See Section 5.2, Legume Inoculation.)
- Maximize the use of native species.
- Do not use fertilizers with native grasses, as weedy annuals will compete for the extra nutrients.
- Use ***mulch***, preferably straw, after seeding. Crimp the straw with a shovel for small areas, or a tractor with tracks for large areas, to anchor it in place. Make sure straw is certified weed free. Rice straw is a good option because the weeds that grow with rice only survive in an aquatic environment.
- Straw wattles can be used to break-up the rainfall over long slopes.
- Keep the soil moist until the rainy season begins.
- Periodically mow or graze, and weed to control noxious weeds and reduce fire danger.
- Restrict human and horse access until grasses are well established.



Apply straw **mulch** *at a rate of two tons per acre (or one 74 pound bale per 800 square feet, at a uniform depth of 2 to 3 inches). Straw can be anchored by hand punching, or in larger areas, by using rollers, crimpers, or a disk.*

Gully Repair

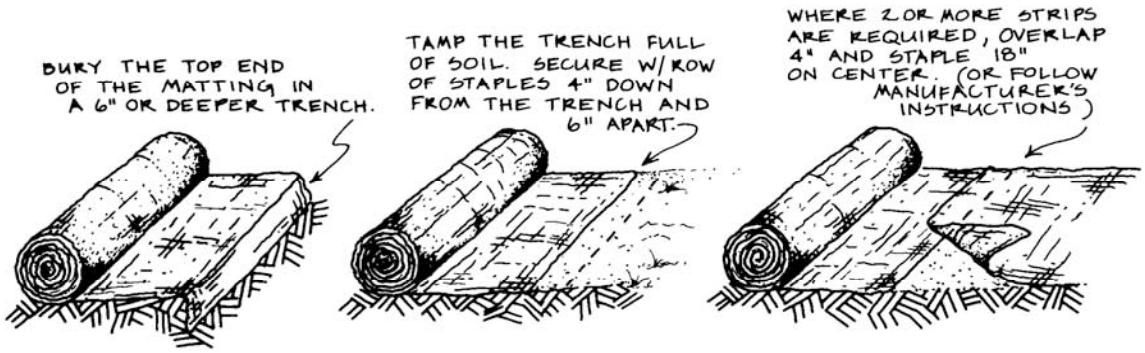
Certain highly erodible soils are particularly susceptible to gully formation. Gullies will deepen and widen if left unchecked. To develop an effective repair, determine what caused the gully to form. Any change in drainage patterns that concentrate water, such as ***ditches*** or road ***culverts***, are likely suspects and may be easy to remedy.

Steps to stabilize a gully include: 1) stopping the gully headcut, so it will not continue to move uphill, and 2) controlling the gully downcut so it will not continue to deepen and widen. Options for ***gully repair*** include one or more of the following: ***fence*** livestock out, install a ***grassed waterway*** or ***lined waterway***, line the headcut with rock to keep it from moving upslope, install rock ***check dams*** to stop downcutting, grade side slopes and ***seed*** and ***mulch*** the area. ***Erosion control blankets***, and straw wattles may also be needed. Avoid using ***erosion control blankets*** with plastic netting as birds and other small animals can become trapped in the mesh.

A gully headcut needs stabilization to keep it from moving upslope. Measures are also needed to control deepening and widening of the gully. Horses should be restricted from gullies as trampling can exacerbate erosion problems or damage repairs.

Erosion Control Blankets are effective tools for the prevention of erosion. Erosion control blankets are made from bio-degradable substances such as straw, coconut, or wood fiber, bonded in place with a variety of netting and stitch patterns. Erosion control blankets are placed onto prepared, seeded, soils to prevent washing away of the seed and erosion of the prepared seed bed. After the vegetation grows the erosion control blanket degrades over time until only the vegetation is left in place. The vegetation, once established, provides permanent erosion control. Erosion control blankets are available in a variety of sizes and grades. For photos and installation recommendations, search "erosion control blanket" on an internet search site for various vendors.

Straw wattles are man-made cylinders of compressed, weed-free straw (wheat or rice), 8 to 12 inches in diameter and 20 to 25 feet long. They are encased in jute, nylon or other photodegradable materials, and have an average weight of 35 pounds. They are installed in a shallow trench forming a continuous barrier along the contour (across the slope) to intercept water running down a slope. Straw wattles are used to increase infiltration, reduce erosion, and help retain eroded soil on the slope. Straw wattles should be effective for a period of one to two years, providing short-term protection on slopes where permanent vegetation will be established to provide long-term erosion control. Search "straw wattles" on an internet search site for various vendors.



Erosion control blankets *must be carefully installed to be effective. Make sure the upper end is securely tucked into a small trench. Blankets range from simple jute netting that works best if straw is laid underneath, to heavy duty coconut fiber. Avoid using blankets with plastic netting as birds and small animals can become trapped in the mesh.*

You will likely need technical assistance before attempting to repair a gully. *Groundwork: A Handbook for Erosion Control in Northern California* contains hands-on, practical advice. Contact the Marin County Resource Conservation District at 415-663-1170 to obtain or review a copy.

It is easier to stabilize a small or beginning gully than to repair a large gully system. Where is the runoff coming from? Can it be diverted? Should it go into an underground pipe? Or perhaps careful placement of rock and proper use of erosion control fabrics will make a successful project. Site specific recommendations are needed for gullies.

Rock **check dams** *are a common gully repair.* **Gully repair** *is site-specific, so obtain technical assistance. Be sure to acquire any permits from the county, California Department of Fish and Game, Regional Water Quality Control Board, and the US Army Corps of Engineers. Continue to monitor and maintain your projects after installation.*

Streambank Stabilization[10]

Evaluate and determine the cause of the problem. Streambank erosion may be caused in three ways or by a combination of the following processes:

Surface flow. Water flowing over the top of the ground usually causes steep, vertical bank erosion. Common sources include ***culverts***, driveways, ***ditches***, or drainage from roofs. Addressing the cause, either by redirecting or slowing the flow and dissipating its energy, will go a long way toward solving the problem.
Ground water. Water flowing a few inches to a few feet below the ground frequently surfaces (or "daylights") on a streambank before reaching the creek channel. This makes streambanks vulnerable to erosion. Although ground water flow can cause or exacerbate erosion, it can also be an asset if you plan to control erosion using vegetative methods. Check to make sure you are not indirectly contributing excess subsurface flow through irrigation.
Stream dynamics. Natural changes—such as big storm events or human activities—can cause the stream channel to adjust. For example, when areas are paved and vegetation is removed to construct buildings and roads, less water soaks into the soil and run-off is increased. This increases storm flows and contributes to flooding problems. Removing vegetation along a creek can reduce streambank stability. This can lead to streambank failure, particularly during major storm events.

Once you have determined the cause of the streambank erosion, you can plan, install, monitor and maintain your repair.

[10] This information was drawn from the Marin County Stormwater Pollution Prevention Program brochure, *Repairing Streambank Erosion*. 1997.

Determine if the site needs repair

Not all erosion is bad. Streams need to be able to adjust to events in the watershed by changing their shape. Undercut banks and fallen trees provide important habitat for aquatic life. Erosion should be controlled if it threatens a structure, road, utility pole, other property, or prime riparian habitat; is extremely active; or is caused by a human factors (such as a road).

Plant grasses and shrubs (preferably natives) on streambanks to reduce erosion. Streambanks with sparse cover are a common source of erosion. Eroding areas should be repaired if they threaten a structure, road, utility pole, other property, or prime riparian habitat; is extremely active; or is caused by a human-made change, such as a road.

When undertaking a **streambank repair** *project, take photos and make sketches of the site, seek professional assistance for major or complex repairs, incorporate native plants into projects, and be sure to obtain the proper permits. Monitoring and maintenance is critical during the first few years after installation.*

Document the site

If you repair the erosion site yourself, you will need information for calculating materials and getting permits. If an engineer or agency is helping you, this information will save them time and you money. Take photographs (and include a reference object such as a fence line or tree), sketch the site including measurements and any biological information you have, and note any observations you have of the situation.

Determine if this should be a cooperative project

If many of your neighbors have similar streambank erosion, consider working together. Benefits include sharing the permit and planning costs, building repairs that complement and even enhance each other, and, if done in conjunction with a local agency or group, may be eligible for private or government grant programs.

Determine if you need professional help

Consider professional help when the repair is major, and/or an ineffective repair could result in significant damage to a structure, road, or other valuable property; working space is limited; and county regulations and common sense dictate professional design. Civil engineers, biologists, and other restoration specialists can help design repairs. Ask the individual or firm if they have done this type of work before. When, where, and for whom? How do they plan to repair the site? How will they access the site? What type of equipment will be used? How long will the work take? What is the estimated cost of designing and constructing the repair? Can they assist you in obtaining

permits? Visit project sites that they have repaired, and discuss the project with the landowner.

Consider a range of design options

Find out what has worked in your area. Be sure **not** to constrict the channel. Keep fish and wildlife habitat in mind. (For stream crossing information, see Section 2.8 on Roads.) If salmon or steelhead passage is expected, follow ***culvert*** design guidelines by the California Department of Fish & Game and the National Marine Fisheries Service. Also, your local Resource Conservation District, or the Natural Resource Conservation Service are good sources of information. See Section 5.1 of the Resources Directory for contact information.

Incorporate native plants into the repair. The extensive root systems of some native plants can help with streambank stability. Even rock riprap can be interspersed with willows or other trees to enhance habitat. Willow wattle walls, brush mattresses, and other techniques described in *Groundwork: A Handbook for Erosion Control in Northern California* can stabilize streambanks completely with *live* materials, which is preferable.

Obtain necessary permits

Acquire permits before construction. Most stream repair work requires a Streambed Alteration Agreement from the California Department of Fish and Game. Most counties require grading or building permits for work in stream channels. Permits will likely be required from the US Army Corps of Engineers and the Regional Water Quality Control Board. See Sections 5.4 and 5.5 of the Resources Directory for permit information.

Install your project properly

Streams are a demanding and often unforgiving work place. Never underestimate the force of moving water. Pay attention to small details that will make the difference between a successful repair and a headache. Follow all permit requirements. Most work will need to be completed by October 15. See Section 2.8 for Stream Crossing references.

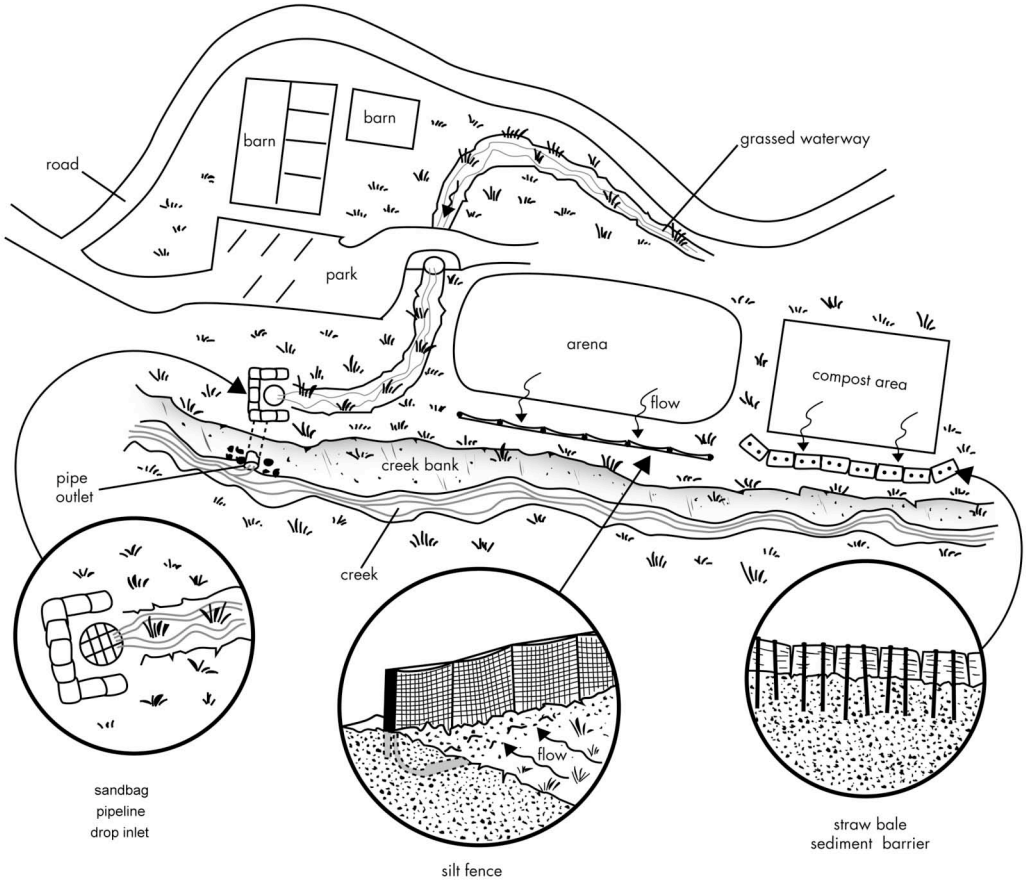
Monitor and care for your repair

Many failures are caused by small problems that could have been avoided if caught early. Check your repair before the winter rainy season, and during and after each storm. Establish a location where you can take “before” and “after” photos.

Emergency Erosion Control Measures

The emergency erosion control measures described in this section are temporary actions that property owners can install themselves. These measures are low-cost, and often do not require special expertise to design or install. However, they require constant maintenance and generally last only one season. They are designed to retain or divert stormwater runoff, reduce flood damage, stabilize overwhelmed drainage structures, or stop erosion. It is best to put in erosion control measures before the rainy season, although these measures can be installed anytime you notice a problem or potential problem.

All of these measures should be considered temporary until access, weather, time, or money allows more permanent solutions to be implemented. For example, straw bales usually rot after one year. Proper companion measures may also be necessary if the temporary fix fails (which often happens), and then creates a bigger problem. It is important to develop long-term solutions for erosion sites.



EMERGENCY MEASURES – Use emergency erosion control measures to divert stormwater runoff, reduce flood damage, stabilize overwhelmed drainage structures, or stop erosion. Temporary measures to consider are **sandbag pipeline drop inlets**, **silt fences**, *and* **straw bale sediment barriers**. *All require proper installation and maintenance, and should be replaced with permanent measures as soon as possible.*

Emergency measures must be properly installed and maintained. This will minimize the chance of failure and avoid causing greater problems on-site or on neighboring land. You may need to seek technical assistance from qualified consultants, Natural Resources Conservation Service, or your local RCD. Remember, each site is unique and some temporary measures may not be appropriate for your property.

During the winter, keep a close eye on drainage conservation measures and known problem areas. Immediate action can prevent problems from becoming larger or causing more damage. Be prepared to act quickly by keeping materials to construct emergency measures on hand. Materials commonly needed for emergency measures include straw bales, straw ***mulch***, ***sandbags*** and fill material, ***erosion control blankets***, plastic tarps, ***silt fence***s, steel t-posts or rebar, fence mending supplies, baling wire, rope, and rock.

These measures should not be put in creek beds, but in upslope areas. The following are emergency erosion control measures to consider.

Sandbags

These are used to direct runoff into ***culverts*** and ***drop inlets*** or other conveyance structure. Abut the ends of ***sandbags*** tightly against one another and overlap joints.

Sandbags can be used to direct runoff into **culverts** *and* **drop inlets**. *Be sure to abut the ends of sandbags tightly against one another and overlap joints.*

Straw bale waterbars

These are also used to divert water off road surfaces. Straw bales used as ***waterbars*** should be installed at a slight angle down the slope of the road. Straw bales should be placed in a trench at least 4 inches deep with the excavated material used to form an earthen ***berm*** against the uphill side of the bales. Drive rebar or t-posts through each bale and at least 1 to 2 feet into the ground. Angle the first stake toward a previously laid bale to force the bales together. Abut the ends of straw bales tightly against one another. Loose straw can be crammed between bales to help seal joints. Overlap joints by at least 15 inches if more than one row or layer of straw bales are used.

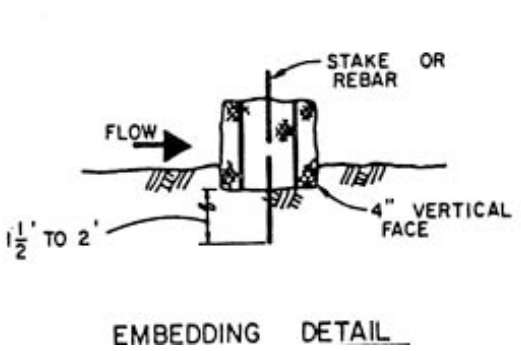
Straw bales are subject to damage by curious and hungry livestock and deer and may need to be protected with chicken wire.

A straw bale ***berm*** can also be used as an emergency ***waterbar***. To divert water, angle the ***berm*** and trench slightly down and across the slope. Place the excavated material in a ***berm*** on the downslope side of the trench. Protect the outlet from erosion with gravel. See Section 2.8 for more information on road and trail maintenance.

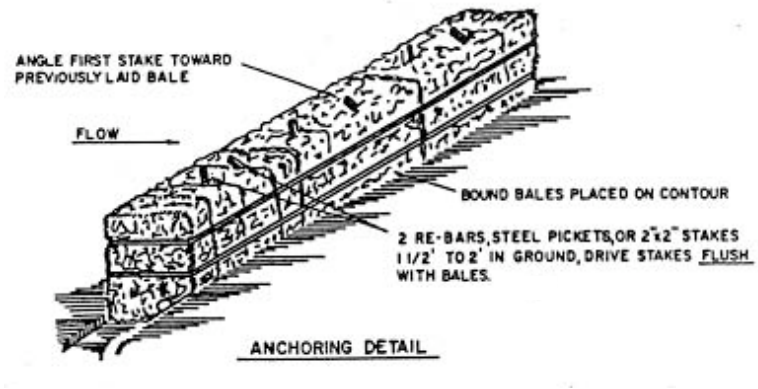
Straw bale sediment barriers

These are used to retain sediment while allowing water to infiltrate through.[11] Install and anchor straw bales as described (in ***straw bale waterbar***). Care should be taken so runoff does not backup behind the barrier and flow around the ends where the concentrated water can cause erosion.

A **straw bale sediment barrier** *retains sediment while allowing water to pass through. Bales need to be anchored with stakes or rebar. Be sure that water cannot flow around the barrier and cause downslope erosion.*



When using straw bales as a **waterbar** *or sediment barrier, place bales in a trench at least 4 inches deep. Drive two metal fence posts or re-bar for stakes through each bale and at least 1 to ound.*



Abut the ends of straw bales tightly against one another. Angle the first stake toward a previously laid bale to force the bales together. Cram loose straw between bales to help seal joints. If using two rows stacked (one atop each other), overlap the joints by at least 15 inches or more.

Straw bale check dam

These can be used to stabilize eroding gullies and ditches. ***Straw bale check dams*** in gullies and ditches are prone to failure and can cause worse erosion problems unless properly installed. Have them installed by an experienced person, or gather further information from NRCS.

Table 3. Straw bale check dam – design limits

Slope	Maximum Drainage Area	Maximum Slope Length Between Check Dams
0 – 15%	1 acre	200 feet
15 – 20%	½ acre	100 feet
>20%	Not Recommended	—

[11] Emergency barrier structures can typically contain the stormwater runoff from one acre and 100 feet of slope length for slopes up to 15 percent; or one-half acre and 50 feet of slope length for slopes greater than 15 percent.

Silt fences

As with ***straw bale sediment barriers***, the purpose of these structures is to settle out sediment in sheet flow, not concentrated flow, while allowing water to pass through. Again, care should be taken so runoff does not pond behind the ***silt fence*** and flow around the ends where the concentrated water can cause erosion. ***Silt fences*** less than 4 feet in height can be supported by sturdy wire fencing, such as woven wire, stapled to 4 x 4 wooden posts set at least 2 feet into the ground and four feet apart. Place the fabric on the upslope side of the fence and staple to the posts. At least 12 inches of the fabric and 4 inches of the wire should be buried in a 3-6 inch deep trench. Backfill and compact the trench.

Other types of fabric less than one-foot in height need to be supported by galvanized cable stretched between one-inch galvanized steel pipes driven at least three feet into the ground. The cable runs through sewn loops in the fabric. At least 12 inches of the bottom of the fabric is buried in a trench at least 6 inches deep and backfilled with compacted soil.

Sandbag pipeline drop inlet

Sandbags can be used to direct runoff into ***culverts*** and ***drop inlets***. Be sure to tightly abut the ends of the ***sandbags*** and overlap any joints.

4.2 Stormwater Management Measures: Keep “Clean” Water Clean

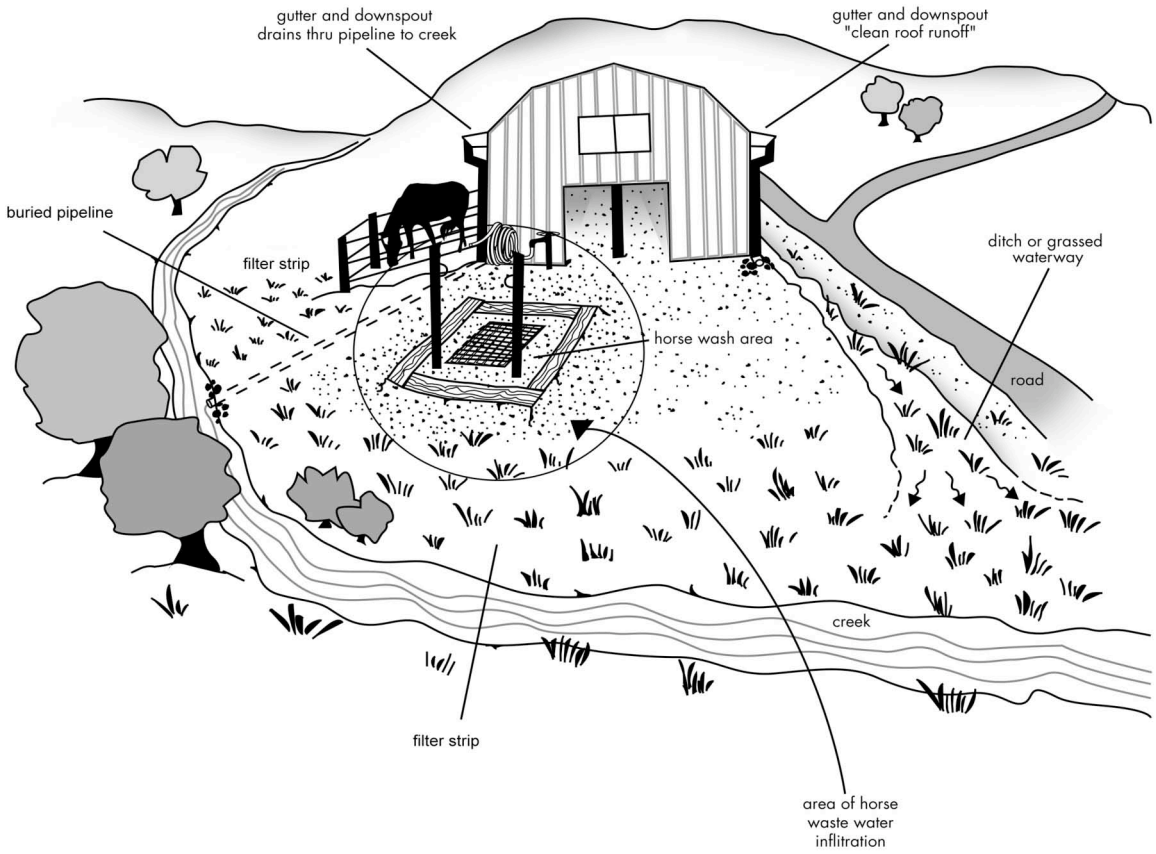
It is much easier to manage “clean” water than to treat water once it becomes polluted. Monitoring your water is a good way to see if you are keeping it clean. It is just as important to limit the impacts of smaller, more frequent storms, as it is to address the typical flooding and drainage problems that occur with larger storms. Runoff must be collected, or diverted, conveyed, and then safely discharged. Remember to incorporate erosion control into your stormwater management.

Conservation measures covered in this section include:

- Runoff Collection
- Runoff Diversion
- Runoff Conveyance
- Discharge Area

Roof Runoff Collection

Collection of runoff is required if rain that falls on roofs drains to areas where it may come in contact with horse waste or cause soil erosion. This is most commonly needed where ***paddocks*** are attached to stalls in a barn. Three conservation measures to consider are ***gutters***, ***downspouts***, and ***splash pads***.



STORMWATER MANAGEMENT – Managing runoff from roofs will help keep "clean" water clean. **Gutters** *and* **downspouts** *can direct clean stormwater away from bare or manured areas.* **Diversions** *or* **berms** *can direct water away from buildings. Buried* **pipelines** *can convey clean water to a creek. Polluted runoff from a* **horse wash area** *should flow into a* **waste pond** *or through a* **filter strip** *before it reaches a creek.*

Gutters

Size ***gutters*** to handle the volume of rainfall calculated for the roof size. ***Gutters*** should have sufficient support to withstand anticipated water. You may need to seek professional help for gutter and downspout sizing. ***Gutters*** may not be required if roof runoff does not drain into ***manure storage*** or animal confinement areas. In such cases, gravel ***splash pads***, vegetation, or ***subsurface drains*** along building foundations may be sufficient to control runoff and prevent erosion.

Downspouts

Fasten ***downspouts*** securely at the top and bottom, with intermediate supports if required. Protect downspouts from damage by animals and equipment.

Splash pads

When downspouts empty onto the ground, surface elbows should direct water away from the building and empty onto ***splash pads*** or other ***energy dissipaters*** to prevent erosion.

Runoff Diversion

Diverting "clean" water around horse keeping areas reduces the creation of "polluted" water that must be managed. ***Diversions***, ***berms***, and curbs can be used to divert "clean" stormwater runoff around buildings, high-use areas, and ***manure storage areas***.

Diversions

A ***diversion*** is a channel or ***ditch***, constructed across the slope, to divert excess water from one area to another. Selecting the proper type and size will depend on site-specific factors such as slope, soil type, and volume of water to be managed. For steeper grades or large flows, the ***diversion*** may need to be lined with rock or similar erosion protection.

A **diversion** *will direct "clean" stormwater runoff around buildings, high-use areas, and manure storage areas. Slope, soil type, and volume of water will determine the specific diversion size, type and design.*

Berms

A ***berm*** is formed by mounding earth materials, similar to building a curb, to redirect water from one location to another. In situations with limited space or where other uses prohibit the use of an open ***diversion ditch***, a compacted earthen ***berm*** can divert runoff into an ***underground pipeline***. Concrete or asphalt curbs, kickboards, and railroad ties can also be used to divert stormwater runoff.

In some cases, a ***grassed*** or ***lined waterway*** can serve as both the ***diversion*** and the means of conveyance used to transport water to the final discharge area such as a ***filter strip*** or ***sediment pond***.

Runoff Conveyance

Once runoff has been collected or diverted, it must often be routed, or conveyed, to the discharge area. To determine the proper type and size of a conveyance system, consider site specific and local factors including slope, soil type, and the volume of water to be managed. For some situations, it may be necessary to link several types of conveyance systems together in a series. For example, ***underground pipelines*** could carry water from a ***downspout*** to a ***grassed waterway*** that then empties into a creek. Be certain that collected and conveyed runoff is "clean" before finally emptying to a creek.

Erosion by the conveyance of water in channels is a prime concern. Large volumes of water with high velocities may require that waterways be lined to prevent erosion.

Conveyance structures include ***grassed waterways, lined waterways, drop inlets,*** and ***underground pipelines***. These are described below.

Grassed waterways *convey concentrated runoff along gradual slopes. They require professional calculations of water volume and velocity. Grass must be established before the waterway is ready to carry winter runoff. Upkeep is needed to maintain capacity, grass cover, and the outlet (or end point).*

Grassed waterway

A grassed water is a wide, shallow, flat-bottomed channel or ditch, with gentle side slopes that conveys concentrated runoff along gradual slopes without causing erosion or flooding. ***Grassed waterway***s generally work well with water velocities of 5 feet per second (fps). For channels with poor grass cover and little maintenance, the velocity should not exceed 3 - 5 fps. Water velocities over 5 cfs need a ***lined waterway***. A professional should calculate the volume and velocity for site-specific conditions. During construction, stockpile topsoil and re-spread where necessary to provide a seedbed for the grass. Excess earth should be spread where it will not interfere with flow into the waterway.

An **erosion control blanket** *can help stabilize the channel until the grass is fully established. It can also be used as an immediate repair for grassed areas that are damaged by horses, machinery, or erosion.*

Sufficient vegetation must be established in the waterway before it carries runoff from heavy winter rains. Seedbed preparation, time of ***seeding***, seeding mixture and rate, and fertilizer requirements are site-specific. Special protection such as a biodegradable ***erosion control blanket*** may be required to help stabilize the channel until vegetation is fully established. (Use heavy duty blankets in situations with flowing water. Avoid using blankets with plastic netting so that birds and small animals do not become trapped.) Supplemental irrigation will help establish grass sooner.

Maintenance is required to ensure waterway capacity, vegetative cover, and the outlet. Vegetation damaged by horses, machinery, or erosion must be repaired promptly. Give special attention to outlets and points where concentrated flow enters the ***grassed waterway***. Maintenance tasks should include checking for sediment accumulation and erosion, removing debris, and making necessary repairs.

Lined waterways

These have erosion-resistant linings of concrete, rock riprap, grouted rock riprap, mortared flagstone, or other permanent material that extend up the side slopes of the channel above the anticipated flow. The bare soil on both sides of the waterway above the permanent lining should be vegetated or otherwise protected. ***Lined waterways*** should be used if concentrated runoff requires a lining to control erosion (flows greater than five cfs); steep grades, prolonged base flow, or seepage may cause erosion; human or animal use of the area precludes using a ***grassed waterway***; high-value property or adjacent facilities warrant the extra cost to contain runoff in a limited space; or if soils are highly erosive.

In areas with flows greater than 5 cubic feet per second, steep grades, prolonged flows, highly erosive soils, or other special conditions, a **lined waterway** *should be used. Concrete, rock riprap, grouted rock riprap, mortared flagstone, or other permanent material will line the channel.*

Drop inlets

Drop inlets can be used to transfer channel flow into an ***underground pipeline***. Elevating the inlet above the channel bottom will cause water to pool up in the trap before entering the inlet. This ponding of water allows heavier suspended particles to settle. Inlets must be regularly checked and kept free of debris during and after storms.

Sediment basin

Sediment basins can be incorporated into the outlet design. Regular clean out of sediment must be performed. Other maintenance includes clearing debris and inspection during and after storms. Screens or ***trash racks*** may be required immediately upstream of the basin to stop debris before it can clog the inlet. Without maintenance, inlets and trash racks cease to function and structures can be undermined by water and cause erosion problems that may be worse than the original situation.

Underground pipelines

These are an effective way to convey water when space is limited and surface channels are not practical. As with all drainage structures, calculation of anticipated flow and proper sizing are crucial.

Be sure **underground pipeline** *is properly installed by compacting soil around the pipe, and installing cutoff collars, if needed, so water does not seep along the pipeline and wash away soil leaving an exposed pipeline susceptible to damage. Also be sure pipes are properly sized to handle flows.*

Rock **energy dissipaters** *reduce the velocity and energy of concentrated storm flows. They are used at the outlets of pipelines, culverts, or other conveyance structures. Calculate the size of rock needed and place rock carefully. Make sure dissipaters are in place before the rainy season.*

Discharge Area

"Clean" water can be discharged into another conveyance structure, a seasonal drainage, creek, ***constructed wetland***, or directed to a ***filter strip*** or pasture. Be sure to use ***energy dissipaters*** to control potential erosion.

Energy dissipaters

These are placed at channel outlets to reduce the velocity and energy of concentrated storm flows, prevent scour, and minimize downstream erosion. They may be needed at the outlets of ***underground pipelines***, ***culverts***, or where ***lined waterways*** discharge to unlined conveyances, e.g., a rock channel discharges into a ***grassed waterway***.

Rock is a common ***energy dissipater***. The type and size of an ***energy dissipater*** depends on local factors. Rock should be carefully and tightly placed over a filter fabric. Loose rock can wash away during high flows. Rock should be angular and large enough to withstand heavy flows.

4.3 Measures to Manage "Polluted" Water

"Polluted" water must be managed so that it does not reach creeks or leach into ground water. Conservation measures that can help utilize nutrients, or store waste water until it can be utilized are:

- Filter Strip
- Riparian Buffer
- Willow sprigging
- Constructed Wetland
- Waste Pond

Filter Strip

A ***filter strip*** is an area of grass designed specifically to trap sediment, horse manure and other pollutants before they enter surface water, such as a creek or a pond. Actively growing grass will use the nutrients in runoff that comes from a manured area. ***Filter strip***s can be developed downslope of high-use areas to trap sediment and manure that washes off of these areas.

Filter strips should be designed and maintained to transport a thin "sheet" of runoff slowly through the vegetation. A gentle slope covered with lush vegetation reduces flow. Thick, sod-forming grass works best to trap sediment. The slow movement of runoff through the vegetation provides an opportunity for sediments to be trapped by vegetation. Nutrients and other pollutants are utilized or degraded through microbial action in the soil.

Use grass **filter strips** *downslope of high-use areas such as turnouts, arenas, and horse wash areas to trap sediment and manure that washes off. Filter strips should be at least 20 feet wide and require annual monitoring and maintenance.*

Obtain professional assistance to determine the size of the strip necessary to treat the water, based on the suitability of the existing soil type, slope, rainfall data, and results of percolation tests. The width of the vegetative ***filter strip*** will be site-specific and depends upon slope, runoff volume, rate of infiltration, pollutants of concern, amount of pollutants, sediment size, and vegetation height and density. A flow-path length of 20 feet is minimal for most sediment removal. An additional 15 to 80 feet is needed to treat nutrients.[12] The key concept is to move water slowly through the vegetation. Too rapid drainage will not allow vegetation to utilize nutrients in the runoff or infiltration to reduce pollutants.

This **filter strip** *is designed and maintained to transport a thin "sheet" of runoff slowly through vegetation. A gentle slope covered with lush vegetation achieves slow flow. Thick, sod-forming grass works best to trap sediment.*

It is important to maintain ***filter strips***. Maintenance activities should include mowing ***filter strip*** grasses to encourage dense, upright vegetative growth; excluding horses and vehicular traffic to keep the land smooth for sheet flow and to avoid soil compaction; inspecting ***filter strips*** after storms, and taking other measures to promote "sheet flow" in the ***filter strip***; and reseed when necessary.

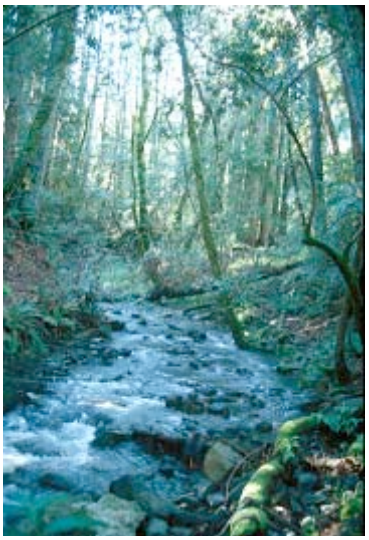
See Section 5.2 of the Resources Directory for ***seeding*** and ***mulch*** specifications.

Riparian Buffer

Riparian areas are located immediately adjacent to creeks. Unlike ***filter strip***s that are primarily grassed areas, ***riparian buffers*** have a dense mix of grasses, trees, and shrubs. These buffers enhance water quality, provide wildlife habitat, and have aesthetic value. Benefits of a buffer include:

- Dense grasses to trap sediment, promote infiltration, and slow runoff flows.

[12] USDA, NRCS - California, Field Office Technical Guide, Filter Strip. July 2000.



A **riparian buffer** *has a mix of trees, shrubs and grasses and is located adjacent to and upslope from creeks. The riparian buffer reduces excess amounts of sediment, organic material, nutrients, pesticides and other pollutants in surface runoff and reduces excess nutrients and other chemicals in shallow ground water flow. The buffer also creates riparian habitat and corridors for wildlife, as well as shade to lower water temperature to improve habitat for fish and other aquatic organisms.*

- Grasses, shrubs, and trees to utilize excess nutrients.
- Trees and shrubs help stabilize streambanks and create a shade canopy to cool water for aquatic life, reduce floodwater velocity and erosive power, and trap debris during floods. A diverse mix of grasses, shrubs, and trees that provide wildlife habitat for a wide range of mammals, reptiles, amphibians, birds, and invertebrates species. Connected stretches of buffers become wildlife corridors.
- A visual screen that also acts as a windbreak and helps capture dust.

Many riparian areas in the San Francisco Bay Area have been cleared of vegetation, or creek channels have been lined with concrete. This section outlines steps to enhance your existing ***riparian buffer*** or to restore a degraded buffer.

1. **Evaluate the existing riparian area to identify any repairs** (such as an eroding streambank or bare areas that need replanting) and management constraints (such as the need for livestock control ***fencing***, ***stream crossing***, and/or an alternative water source).
2. **Determine the minimum buffer width.** The width may vary a great deal depending on site conditions, vegetation, soil type, and landowner objectives. Generally, the wider the buffer, the greater the overall level of benefit. Although a narrow buffer provides more benefits than no buffer at all, wildlife habitat benefits will be reduced. Narrow buffers require careful consideration of slope and selection of vegetation to insure effectiveness. Greater width may be required for shrub and tree vegetation, on steeper slopes, or where sediment loads are particularly high. Some counties require setbacks from creeks.
3. **Consider slope when determining infiltration benefits.** Buffers with a gentle slope and even surface will allow water to flow slowly through the buffer in a thin layer as “sheet flow.” These buffers will have more infiltration than buffers in steeper areas where water flow is concentrated or even flows in tiny channels (rills). Riparian areas should not be graded to change the slope. Grading within riparian areas can require a permit from the California Department of Fish and Game and other agencies.

4. **Select appropriate vegetation.** The mix of grasses, forbs, shrubs, and trees will be dependent upon the benefits you want. Select native plant species to benefit wildlife. If flood control is a prime concern, plant a greater proportion of the buffer width to flood-tolerant trees and shrubs. If supplemental water is not available, choose plants that can survive the first few years without irrigation (such as grasses and willows). The following table lists vegetation types and benefits.

Table 4: Vegetation Type and Riparian Buffer Benefits[13]

Benefit	Grasses	Shrubs	Trees
Filter sediment	High	Low	Low
Utilize nutrients, microbes bound with sediment	High	Low	Low
Utilize nutrients, soluble (in water)	Medium	Low	High
Stabilize bank erosion	Low	High	High
Flood protection	Low	Medium	High
Habitat (range/pasture/wildlife)	High	Medium	Low
Visual diversity	Low	Medium	High

[13] From "How to Design a Riparian Buffer for Agricultural Land," *AgroForestry Notes* 4. 1997. M. Dosskey, D. Schultz, T. Isenhart. Iowa State University Department of Forestry.

Common native riparian trees in the San Francisco Bay Area can include willows, alders, box elder, California bay, Oregon ash, valley oak, coast live oak, black oak, Oregon oak, coast redwood, California buckeye, and big leaf maple. Common riparian shrubs can include California blackberry, elderberry, California hazelnut, coffeeberry, dogwood, ninebark, salmonberry, snowberry, spicebush, thimbleberry, twinberry, toyon, western azalea, and willow. Check with your local Resource Conservation District or native plant nursery for specific species that will thrive in your area.

5. **Develop an installation and maintenance plan.** An installation and maintenance plan is necessary to obtain successful buffer establishment and long-term benefits.

Installation Tips

- Use local knowledge to select the best plant species and spacing for each situation. Emphasize native species yielding quick establishment and good growth on the site. Contact your local RCD, UC Cooperative Extension, local chapter of the California Native Plant Society, or a seed supplier for planting ideas. See Section 5.1 of the Resources Directory for contact information.
- Install livestock control ***fencing*** before planting. Fencing should be set back from the creek to allow the creek to meander naturally.
- Conduct planting and repair work at the appropriate time of year. Grading should occur in the dry season and usually must be completed by October 15. ***Seeding*** and ***mulching*** should occur by mid-October, ***willow sprigging*** should

take place in November or early December when the plants are dormant, and container grown trees and shrubs should be planted between November and February. Planting should occur after the first storms and before soil is saturated during the winter.
- Irrigate and ***mulch*** to enhance tree and shrub survival. A temporary drip irrigation system (for the critical first three years) will help ensure plant success. Thoroughly composted manure makes good mulch.
- Incorporate existing trees and perennial vegetation into the buffer. Be sure not to plant inside the drip line of mature trees.
- Consider removing non-native exotic species that can crowd out existing and new native vegetation. Invasive non-native species to watch include giant reed (*Arundo donax*); periwinkle (*Vinca major*); Scotch, French, and Spanish broom; Himalayan blackberry; tree-of-heaven; bamboo; pampas grass; German and English ivy; acacia; and ice plant.
- Obtain required permits for grading and certain repairs. See Sections 5.4 and 5.5 of the Resources Directory for more information.

Maintenance Tips

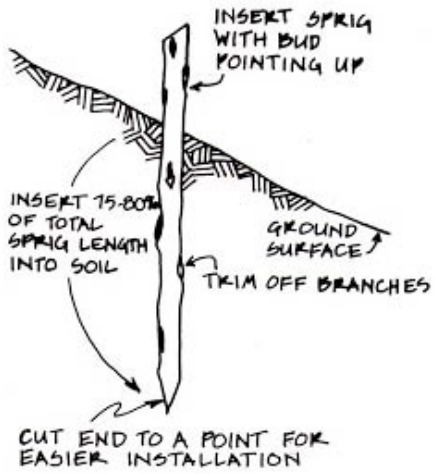
- Control weeds by mowing and ***mulching*** until trees and shrubs are large enough to compete on their own. This is typically required for the first two to three years after planting.
- Protect tree and shrub plantings from wildlife, such as deer, rabbits and mice, with short collars of plastic protective tubing, "gopher baskets," wire cages, or similar forms of protection.
- Check the irrigation system periodically to make sure it is functioning properly.
- Control livestock ***grazing*** of the buffer area. Once the vegetation is established, you may want to initiate a limited ***grazing*** regime in the buffer. The best time to graze is in the spring when the rains have subsided and the ground is firm.
- Replant areas where plants do not "take."
- Periodically mow grasses to help maintain vigorous plant growth and promote additional nutrient uptake.
- Do not apply fertilizers or manure, and limit pesticides and herbicides in the buffer zone.

6. **Develop alternative water sources for horses.** If horses are excluded from the creek, they will need another source of drinking water. Horses consume approximately 8-12 gallons of water per day. Alternative water options include ***spring development*** with buried ***pipelines,*** and ***troughs,*** or extending existing water systems. You may also need a ***storage tank***.

Willow Sprigging

Willows are an effective and inexpensive way to armor creek banks and gullies and to provide important wildlife habitat. Prune and shape willows to keep them from invading the creek channel and potentially causing flooding and bank erosion problems. Allow trees to grow tall to help shade out the lower growing vegetation.

Revegetating with willows is the easiest way to establish woody vegetation on a denuded creek bank. Adequate year-round water and sun are keys for willow establishment and survival. Even if a creek doesn't have year-round, above-ground flows, the ground water may be near enough to the surface to support willows.



Install **willow cuttings** *to armor creek banks and gullies in areas with plenty of sunlight. Cuttings should be 3/4 inch in diameter and planted at least two-thirds into the ground. Plant cuttings low enough on the bank where they will receive adequate moisture in the summer. Angle cuttings downstream so they will "go with the flow" of water. Timing is crucial—make sure cuttings are planted from November through January.*

Willows can be planted from dormant cuttings or "sprigs" following these steps:

1. Cut willows in the fall as soon as the leaves have dropped, and the ground is soft and wet. It is critical to plant willows as early as possible (November through January, or earlier with irrigation). This gives them a chance to develop good root systems before they sprout leaves in the spring. Planting too late is the most common cause of failure.
2. Willow cuttings should be at least 3/4-inch in diameter. Bigger is better. Cuttings should be at least 14 inches long.
3. Plant dormant cuttings by pushing the cut end into soft soil, or make a hole with a sharp stick or pick. If you make a hole, be sure to compress soil tightly around the cuttings. They may need to be pounded in with a hammer. To give plenty of area for root growth, bury at least two-thirds of the length of the cutting. Angle sprigs slightly downstream to prevent them from being undermined by storm flows.
4. Plant willows low enough on the bank to ensure adequate soil moisture during the summer. Even if streams or gullies have year-round water, willows that are planted too high are likely to dry out and die. Cuttings should not need water if they are planted in an appropriate area.

More on Willow Planting

How to Plant Willows … for Riparian Rehabilitation, is available at:
http://plant-materials.nrcs.usda.gov/technical/publications/riparian.html
Under Technical Notes, Select: Technical Note 23: How to plant willows and cottonwoods for riparian rehabilitation.

Constructed Wetland

Constructed wetlands "treat" waste from confined animal operations, surface runoff, and manure storage area leachate. Approximately two feet deep, these wetlands have water-loving plants that are capable of removing large amounts of nutrients from the water. Retention time and release rate will depend upon the size of the wetland and period needed to extract the nutrients.

Constructed wetlands must be professionally designed to handle the volume of waste or stormwater runoff, particularly the "first flush" that contains a high concentration of pollutants. Careful construction is required to ensure that the ground is properly prepared and permits may be needed.

Waste Pond

Horse manure is best handled as a solid.[14] If a ***waste pond*** is required by local regulation, then this overview of ***waste ponds*** can help in the planning stages. A waste storage pond collects runoff of polluted water and gives the manager control over the scheduling and timing of waste distribution over the land. Adequate storage gives flexibility to schedule ***manure application*** when spreading operations do not interfere with other necessary tasks, when weather and field conditions are suitable, and when pasture or crops can best use the nutrients in the waste.

Waste ponds *can be used to store polluted runoff. Waste from the pond is typically irrigated or spread on land. Pond maintenance will ensure proper functioning. A professional can assist with pond sizing. Trees and shrubs have been planted around this waste pond to screen it from the road.*

Pond location is important. It should be convenient to the operation with suitable soils that when properly compacted, will be impervious to seepage into the ground water. Various materials are available for ***pond lining***, such as compacted clay or geotextile fabric.

Utilization of the contents in the ***waste pond*** is commonly done by land application. This includes selecting the fields, scheduling ***manure application,*** designing the distribution system, and selecting necessary equipment. It also includes determining application rates and volumes, value of recycled products, and installation and management costs associated with the utilization process.

Pond sizing needs to done by a professional to take into consideration the required storage volume, storage period, and the type, estimated size, location, and installation cost of the pond. Permits are usually required for ***waste pond*** construction; contact local and state officials (see Sections 5.4 and 5.5 of the Resources Directory). Maintenance and protection of the pond are needed to ensure its longevity.

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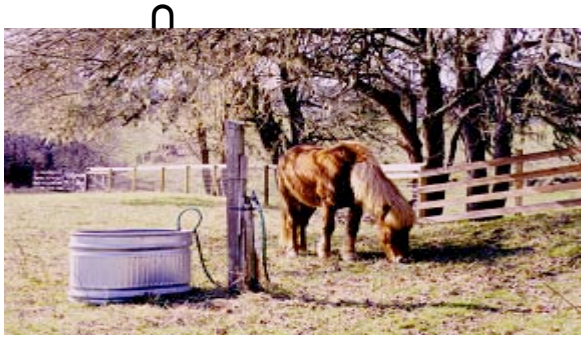
[14] *Feedlots Preliminary Data Summary.* December 31, 1998. EPA. Available at <www.epa.gov/ostwater/guide/feedlots/execsumm.pdf>



Chapter 5

Resources Directory

This Resources Directory provides technical background and contact information. Topics include:

- **Section 5.1:** Technical Assistance
- **Section 5.2:** Seeding Recommendations for Horse Facilities in the San Francisco Bay Area
- **Section 5.3:** Winterization Checklist
- **Section 5.4:** Regulations and Permits
- **Section 5.5:** Threatened and Endangered Species
- **Section 5.6:** Photographic Monitoring
- **Section 5.7:** Water Quality Monitoring
- **Section 5.8:** Guidelines for Managing Residual Dry Matter
- **Section 5.9:** Alternatives to Pesticides
- **Section 5.10:** Improving Songbird Habitat on your Horse Ranch
- **Section 5.11:** Helpful Publications and Resources

5.1 Technical Assistance

Technical assistance is available from the following organizations. Advice is offered as a free service from the RCDs, NRCS, and UC Cooperative Extension.

Resource Conservation Districts

Resource Conservation Districts (RCDs) have been helping landowners to apply conservation measures on Bay Area farms and ranches since the 1930s and can help equine facility landowners in a similar way. RCDs provide information, technical assistance, and implementation of natural resource conservation projects. RCDs work in partnership with the USDA Natural Resources Conservation Service. They are non-regulatory special districts governed by a local volunteer board of directors.

Check with your local RCD to learn about specific services provided in your area. RCDs offer workshops and courses for landowners, as well as one-on-one meetings. In the San Francisco Bay Area, nine RCDs are also part of the Council of Bay Area RCDs and work together on shared natural resource issues. The following RCDs participated in the Equine Facilities Assistance Program. To find other RCDs, visit http://www.carcd.org/

Marin County RCD
P.O. Box 1146
Point Reyes Station, CA 94956
Phone: (415) 663-1170
Fax: (415) 663-0421
http://www.sonomamarinrcds.org/

Alameda County RCD
1996 Holmes Street
Livermore, CA 94550
Phone: (925) 371-0154
Fax: (925) 371-0155
http://www.baysavers.org/

Southern Sonoma County RCD
1301 Redwood Way, Suite 170
Petaluma, CA 94954
Phone: (707) 794-1242, ext 3
Fax: (707) 794-7902
http://www.sonomamarinrcds.org/

San Mateo County RCD
625 Miramontes Street, Suite 206
Half Moon Bay, CA 94019
Phone: (650) 726-4660
Fax: (650) 726-0494

Contra Costa RCD
5552 Clayton Road
Concord, CA 94521
Phone: (925) 672-6522
Fax: (925) 672-8064

USDA Natural Resources Conservation Service

The Natural Resources Conservation Service (NRCS) is an agency of the US Department of Agriculture that provides technical assistance to land users and communities. The NRCS, in cooperation with Resource Conservation Districts, provides free technical information and assistance upon request that address concerns about natural resources such as animal waste management, rangeland, cropland, and watershed management. NRCS also provides free soil survey information, as well as information about local cost-share programs. NRCS offices for the counties participating in the Equine Facilities Assistance Program are listed below. To find offices in other areas, visit http://www.ca.nrcs.usda.gov/

Alameda County
3585 Greenville Road, Suite 2
Livermore, CA 94550-6707
Phone: (925) 371-0154
FAX: (925) 371-0155

Contra Costa County
5552 Clayton Road
Concord, CA 94521
Phone: (925) 672-4577, ext 3
FAX: (925) 672-8064

Marin and Sonoma Counties
1301 Redwood Way, Suite 170
Petaluma, CA 94954
Phone: (707) 794-1242, ext 3
FAX: (707) 794-7902

University of California Cooperative Extension

The University of California Cooperative Extension (UCCE) is part of a state-wide system of specialists and county-based farm advisors who work to bring the University's research-based information to Californians. UCCE's many teaching tools include workshops, demonstrations, field days, meetings, conferences, video programs, newsletters, and manuals. Several publications relate directly to horse keeping and are available from University of California Agriculture and Natural Resources Communication Services, (800) 994-8849. Contact your local office for information about workshops and assistance. Listed below are counties participating in the Equine Facilities Assistance Program. To find a local office in other areas, visit http://vcanr.org/ce.cfm

Marin County Cooperative Extension
1682 Novato Boulevard, Suite 150B
Novato, CA 94947
Phone: (415) 499-4204
Fax: (415) 499-4209
Email: cemarin@ucdavis.edu
http://cemarin.ucdavis.edu

Alameda County Cooperative Extension
1131 Harbor Bay Parkway, Suite 131
Alameda, CA 94502
Phone: (510) 567-6812
Fax: (510) 567-6813
Email: cealameda@ucdavis.edu
http://cealameda.ucdavis.edu

Sonoma County Cooperative Extension
133 Aviation Blvd, Suite 109
Santa Rosa, CA 95403
Phone: (707) 565-2621
Fax: (707) 565-2623
Email: cesonoma@ucdavis.edu
http://cesonoma.ucdavis.edu/

San Mateo County Cooperative Extension
625 Miramontes Street, Suite 200
Half Moon Bay, CA 94019
Phone: (650) 726-9059
Email: cesanmateo@ucdavis.edu
http://cesanmateo.ucdavis.edu/

Contra Costa County Cooperative Extension
75 Santa Barbara Road, 2nd Floor
Pleasant Hill, CA 94523-4488
Phone: (925) 646-6540
Email: cecontracosta@ucdavis.edu
http://cecontracosta.ucdavis.edu/

Private Consultants

Private consultants, such as engineers, construction contractors, and certified erosion control specialists, can provide a variety of services related to water quality management including planning, design, and construction of conservation measures. Lists of local consultants may be available from the local RCD or NRCS office.

Seed Suppliers and Native Plant Information

Some seed supply businesses and nurseries have agronomists and other specialists available to help you select the best seeds to suit your local conditions and needs. For native plant information try the following resources or visit the California Native Plant Society at http://www.cnps.org/

Harmony Farm Supply
3244 Gravenstein Highway North
Sebastopol, CA 95472
Phone: (707) 823-9125
Fax: (707) 823-1734

LeBallister's Seed
1250 Sebastopol Road
Santa Rosa, CA 95407
Phone: (707) 526-6733
Fax: (707) 542-9740

Native Revival Nursery
8022 Soquel Drive
Aptos, CA 95003
Phone: (831) 684-1811

Central Coast Wilds
114 Liberty St.
Santa Cruz, CA 95060
Phone (831) 459-0656
Fax (831) 457-1606

Larner Seeds
235 Grove St./P.O. Box 407
Bolinas, CA 94924
Phone: (415) 868-9407
Fax: (415) 868-2592

Elkhorn Native Plant Nursery
Struve Road (P.O. Box 270)
Moss Landing, CA 95039
Phone: (831) 763-1207
Fax: (831) 763-1659

Clyde Robin Seed Company
P.O. Box 2366
Castro Valley, CA 994546
Phone: (510) 785-0425
Fax: (510) 785-6463

S&S Seeds
P.O. Box 1275
Carpinteria, CA 93014-1275
Phone (805) 684-0436
Fax: (805) 684-2798

Pacific Coast Seed
6144-A Industrial Way
Livermore, CA 94550
Phone: (925) 373-4417
Fax: (925) 373-6855

5.2 Seeding Recommendations for Horse Facilities in the San Francisco Bay Area

Conservation Measures

You have evaluated your horse facility and come to the conclusion that excessive soil erosion is coming from a **pasture** or high-use area (**critical area**), such as paddocks, turn-out areas, roads, or a parking lot. Perhaps you need to convey water around a barn through a **grassed waterway**. Or maybe rainwater flows through a manured area, and you want to use a **filter strip** to reduce pollutants in the polluted water. The vegetation planted for these conservation practices will reduce soil erosion, increase infiltration, percolation, and ground water recharge.

These seeding recommendation mixtures are for general dryland (non-irrigated) purposes. Specific recommendations will vary based on site evaluation that would take into account rainfall, length of growing season, soils, etc. Since the San Francisco Bay Area has many micro-climates, your local USDA Natural Resources Conservation Service, UC Cooperative Extension Farm Advisor, or local seed supplier can help with specific suggestions. Different grass species are suitable for different purposes. Perennial grasses are deeper rooted and certain species are sod-forming (rather than bunchgrasses), which protects the soil from excessive erosion. Annual grasses provide a quick cover and reseed themselves each year.

Filter Strip

A grass filter strip is designed to treat runoff situated between high-use areas and environmentally sensitive areas, such as a creek, seasonal drainage or pond. The filter strip will reduce sediment, sediment adsorbed pollutant loading in runoff, and dissolved contaminant loading in runoff. Also, a filter strip will restore, create or enhance habitat for wildlife and beneficial insects.

A filter strip must be designed so overland flow (runoff) entering it must be primarily sheet flow. Concentrated flow must be dispersed into sheet flow, before entering the filter strip. The minimum width is 20 feet to reduce sediment. Additionally, to reduce dissolved pollutants in runoff, the minimum width is 30 feet. Local site criteria may require filter strip widths of up to 100 feet. *(Reference: USDA NRCS Field Office Technical Guide, Filter Strip.)*

Grassed Waterway

Imagine a gentle flat-bottomed ditch, fully clothed in grass, with gentle side slopes. This simple design is a grassed waterway—a designed channel that is mechanically shaped or graded with a bulldozer, and seeded with grass for the stable conveyance of runoff. The grassed waterway will convey runoff without causing erosion or flooding. As with all engineered conveyances, the grassed waterway must be designed to withstand the velocity of water anticipated. The site must be assessed to see if the waterway needs to be lined for higher water velocities with erosion control matting, rock or concrete. Grassed waterways

Seeding Recommendations

Note: Species in bold are native to California

Seed Mixture	Plant Characteristics	Lbs/Acre	Filter Strip	Grassed Waterway	Critical Area	Pasture
1. Berber orchardgrass[1]	Perennial grass	16	X	X		
2. **Creeping wildrye**[1, 2]	Perennial grass	30[3]	X	X		
3. 'Blando' brome	Annual grass	18	X	X	X	
'Zorro' annual fescue	Annual grass	10				
Rose clover[4]	Annual legume	9				
California poppy[5]	Annual wildflower	1				
Arroyo lupine[5, 6, 7]	Annual wildflower	1				
Crimson clover[4]	Annual legume	1				
4. **California brome**[1]	Perennial grass	25	X		X	
Blue wildrye[1]	Perennial grass	18				
California poppy[5]	Annual wildflower	1				
Arroyo lupine[5, 6, 7]	Annual wildflower	1				
5. Blando brome	Annual grass	25			X	
Annual ryegrass	Annual grass	24				
6. 'Berber' orchardgrass[1]	Perennial grass	4				X
Tetraploid perennial ryegrass[1]	Perennial grass	6				
Subclover[4, 7]	Annual legume	6				
Rose clover[4]	Annual legume	4				
7. 'Blando' brome	Annual grass	6				X
Rose clover[4]	Annual legume	6				
Subclover[4, 8]	Annual legume	6				

[1] Mulch must be used to provide initial erosion control when establishing perennials.
[2] Also known as beardless wildrye.
[3] Or use plugs at 1 foot x 1 foot spacing.
[4] Also see "legume inoculation" section below.
[5] Optional, use for color.
[6] *Lupinus succulentus,* also known as hollowleaf annual lupine.
[7] Lupine may be toxic to horses. Use only where horses do not graze.
[8] Use locally adapted varieties recommended by UC Cooperative Extension.

perform most dependably in areas where dense stands of sod-forming grass will permit anticipated water velocities.

The most critical time in successfully installing a grassed waterway is when vegetation is being established. Special protection such as mulch or an erosion control blanket is warranted at this critical period. Supplemental irrigation is optimal. The vegetation should be well established before large flows are permitted in the channel.

Critical Area

Critical erosion areas such as road cuts and fills, roadbeds, and gullied areas need to be stabilized to reduce damage from runoff. Seeding is used where vegetation is difficult to establish.

Plants should have the ability to provide adequate ground cover, canopy cover and root mass for erosion protection. High seeding rates are needed to insure adequate vegetative cover because these sites have been severely eroded or disturbed, have low fertility, and few resident seeds.

Pasture

It is time to reseed a pasture when horses excessively use one area of pasture, or selectively graze desirable plants and leave the less desired plants. Nearly all pastures have areas where horses concentrate such as around water and feed areas. Under continuous use, these are always overgrazed.

Installation Criteria

Timing: Plant before the rainy season, October 15th of the year.

Seeding rate: Seeding rates are for 100% Pure Live Seed (PLS), and are broadcast (by hand or broadcast seeder) rates. Seed bag "tags" tell the percent purity for PLS and germination rate. If seed bag tag states less than 100% PLS, increase the amount of seed in proportion to the percentage needed (germination x purity). Time since the date of seed test on the tag should not exceed 9 months.

Seedbed preparation: The area to be planted must be weed free and have a firm seedbed which has been previously roughened by disking, harrowing, or otherwise worked to a depth of 2 to 4 inches, except when planting no-till. No implement should be used that would create an excessive amount of downward movement of soil on sloping areas. Weeds and other debris that would interfere with seeding or maintenance should be removed.

Legume Inoculation: All legumes (clovers) should be "inoculated" before planting with a pure culture of nitrogen-fixing bacteria and prepared specifically for that plant species. This is done immediately prior to planting. The seeding rate does not include the weight of inoculant and seed coating.

Why: All legumes, including clover, have the ability (in cooperation with legume bacteria) to draw nitrogen from the air and store it in the small nodules that form on the roots. Studies have shown an increase in forage production and nitrogen fixation when seed is properly inoculated. On poorer soils, the clover seed may be a complete failure if not properly inoculated. The bacteria are helpful to young plants as roots begin to develop, increasing their chance to grow successfully.

How: Put seed on canvas, in tub or other container. Mix the inoculating culture with the seed and stir until the seed is well covered. Mix with grass seed selected. Prevent from drying out by sun or wind. Plant immediately.

Mulch: A straw mulch cover should be uniformly distributed over the seeded area within 48 hours following the seeding. Straw mulch should be applied at a rate of

two tons per acre (or one 74-pound bale per 800 square feet, at a uniform depth of 2 to 3 inches). Straw is the preferred mulch and needs to be anchored in place. Hand punching with a shovel or a square-end spade can work for small areas, whereby straw stands perpendicular to the slope and is embedded at least 4 inches into the slope, and punched about 12 inches apart. For larger areas, anchoring with rollers, crimpers, or disks can be used on slopes up to 3-to-1. Use of rice straw will minimize weed seeds, since the type of weeds that grow in the aquatic environment with rice will not survive on dry land sites. Use of wheat straw will result in less volunteer grain compared to barley straw. When using straw grown in the same county, use clean straw to minimize the spread of noxious weeds. Bales of native grass with seed are also a good option.

Irrigation: A sprinkler system is optimal for establishment and water should be applied during the establishment period. Maintain adequate moisture in the upper six inches of soil during the first four weeks, and then in the upper 12 inches thereafter until the rainy season.

Maintenance: Mowing should be performed for control of noxious weeds or for a firebreak. Periodic mowing can be performed to reduce rank growth and maintain desired species populations. Herbicides should only be used to control noxious weed species.

Limit traffic and do not use as a roadway. Limit livestock use. For filter strips and grassed waterways, eradicate or remove all burrowing rodents and immediately repair any damage caused by their activity.

Written by Lisa Woo Shanks and Dennis Moore
USDA Natural Resources Conservation Service

5.3 Winterization Checklist

Preparing for the rainy season while the weather is still nice can save a lot of time in the long run. Take time to inspect your facility before the rains start. Write and post a "winterization" checklist in your barn to help set priorities, organize work, and take action. It is important to check many of these areas throughout the winter, particularly during and after major storms. A sample list below covers management strategies discussed in this guide.

Buildings

- ❑ Inspect, repair, and remove debris from ***gutters*** and ***downspouts***. Make sure ***gutters***, ***downspouts*** and pipelines are connected.
- ❑ Clear debris from ***diversions***, ***pipe inlets***, grates, ***culvert***s, and ***trash racks***.
- ❑ Make sure ***energy dissipaters*** (such as rock) are placed at outlets.

High-Use Areas

- ❑ Replenish footing in high-use areas.
- ❑ Make sure kickboards are in place to help keep footing material in place.
- ❑ Clear debris from ***diversions*** and other drainage structures.

Manure Management

- ❑ Scrupulously clean out ***paddocks***.
- ❑ Remove all horse waste from ***manure storage areas*** by the fall.
- ❑ Cover ***manure storage areas*** and provide runoff controls. Make sure "clean" water is diverted from manured areas.
- ❑ Apply manure to pastures in early fall, and in spring when grasses are actively growing. Do not spread manure near creeks.

Pasture Management and Filter Strips

- ❑ Re-seed pastures and grass ***filter strips*** by October 15, if needed. Remove weeds regularly.
- ❑ Mow, maintain and/or reseed grass ***filter strips*** downslope of high-use areas.
- ❑ In the fall, check ***Residual Dry Matter*** (RDM) levels in pastures. (See Section 5.8 of the Resources Directory.)

Roads and Trails

- ❑ Clean out ***ditches***, ***culvert*** inlets, and ***trash racks***.
- ❑ Make sure ***waterbars*** and ***energy dissipaters*** are in place and functional.
- ❑ Check roads and trails after storms for any emergency repairs.
- ❑ Close roads and trails not essential for winter traffic. ***Seed*** and ***mulch*** seldom used roads or trails by October 15.

5.4 Regulations and Permits

Regulation Overview

Many federal, state, and local laws pertain to water pollution and its adverse effects on drinking water supplies, recreation, and aquatic life.

The federal Water Pollution Control Act of 1972, commonly called the **Clean Water Act** (CWA), is the nation's principal protection statute. The CWA delegates the process of setting water quality standards to the states, under the supervision of the Environmental Protection Agency. In 1987, Congress amended the Clean Water Act to include establishment of the **Non-Point Source Pollution Management Program,** requiring each state to develop a program to address this problem.

Division 7 of the California Water Code, commonly referred to as the **Porter-Cologne Water Quality Control Act**, covers water quality protection and management in California. Porter-Cologne designates the State Water Resources Control Board (SWRCB) as the state water pollution control agency. Nine Regional Water Quality Control Boards (RWQCB) establish and enforce water quality objectives to protect beneficial uses of water bodies.

Broadly protecting water quality, California's **Fish and Game Code Section 5650** declares it unlawful to deposit in, permit to pass into, or place where it can pass into water any substance or material harmful to fish, plant life, or bird life. This regulation applies as equally to horse owners as to an oil refinery.

Article 1 of the California Health and Safety Code's **California Safe Drinking Water Act** declares that every citizen of California has the right to pure and safe drinking water. In particular, Section 116995 covers pollution of drinking water by domestic animals.

Penalties for violations can include criminal misdemeanor charges, fines, abatement orders, and civil penalties, as well as the cost of legal fees, time and poor community relations. Enforcement agencies often lack the funds and personnel to search for violations, but they are required to respond to complaints. An agency's response to a complaint may include a site visit to assess the magnitude of the problem. A local or county agency may recommend and agree to specific mitigation measures. The California Department of Fish and Game and the RWQCB may recommend temporary emergency measures but refer violators to USDA Natural Resources Conservation Service or private consultants or engineers for permanent conservation measures.

Permit Overview

Federal, state, and local water quality or other environmental laws may apply to your project to develop, expand, or renovate a horse facility, or even to control streambank erosion. If you are working in or near streams, you likely need a permit. Consultants can help you navigate the permit maze. Here is a list of agencies and their regulatory requirements that may be applicable to horse keeping facilities. Also see Section 5.5 for threatened and endangered species.

US Army Corps of Engineers

The Corps of Engineers has regulatory authority under Section 404 of the federal Clean Water Act and Section 10 of the Rivers and Harbors Act. A 404 permit is required for work involving the placement of fill in any "waters of the United States" which includes wetlands as well as perennial, seasonal and ephemeral creeks. A Section 10 permit is required for projects affecting "navigable waters." Corps jurisdiction extends up to the ordinary high water line for non-tidal waters and up the high tide line (for dredge and fill) or mean high water line (for work or structures) in tidal waters. Most landowner projects should fall under the Section 404 Nationwide Permit Program. Pre- or post-project notification may be required. There is no filing fee and permit processing can take up to one year.

- Contact the San Francisco District Regulatory Branch at (415) 977-8462 or http://www.spn.usace.army.mil/regulatory/

California Department of Fish and Game

The California Department of Fish and Game (DFG) requires a Stream Alteration Agreement for projects that occur in or near creeks or streambanks. This permit is necessary for any work that will divert or obstruct the natural flow of water, change the bed, channel, or bank of any stream, or use any material from a streambed. DFG will review the application for compliance with the California Environmental Quality Act (CEQA). The application is $132 and turn-around time can be several months or longer. For permit information or assistance from DFG, contact a regional office or http://www.dfg.ca.gov/1600

- Central Coast Regional office is located in Yountville: (707) 944-5500
- Marine Regional Office is located in Monterey: (831) 649-2870
- A Marine Region field office is located in Menlo Park: (650) 688-6340

Regional Water Quality Control Board

For activities requiring a permit from the US Army Corps of Engineers, the RWQCB must issue a 401 Water Quality certification to ensure that the proposed activity will not violate State water quality standards. A filing fee is required and can be $500 or greater.

- For creeks and tributaries draining into San Francisco Bay, contact:
  San Francisco Bay Regional Water Quality Control Board
  (510) 622-2300 or http://www.swrcb.ca.gov/rwqcb2

- For creeks and tributaries that drain to the ocean in Sonoma County and north, contact:
  North Coast Regional Water Quality Control Board
  (707) 576-2220 or http://www.swrcb.ca.gov/rwqcb1
- For creeks and tributaries draining to the Pacific Ocean south of San Mateo County, contact:
  Central Coast Regional Water Quality Control Board
  (805) 549-3147 or http://www.swrcb.ca.gov/rwqcb3

California Coastal Commission

Development or activity in the coastal zone requires a Coastal Development permit. The coastal zone extends inland from approximately 500 yards in developed urban areas to five miles in undeveloped areas. "Development" includes the construction or alteration of any structure, grading, quarrying of rock, change in density or intensity of land use (including land divisions), and the removal of major vegetation. Contact your local county coastal program to see if you need a permit from them or the California Coastal Commission.

- Contact the Coastal Commission directly at (415) 904-5200 or http://www.coastal.ca.gov/

Bay Conservation and Development Commission (BCDC)

BCDC requires a permit for work within 100 feet of waters of San Francisco Bay or for levee maintenance.

- Contact BCDC at (415) 557-8778 or http://www.bcdc.ca.gov/

Joint Aquatic Resources Permit Application (JARPA)

The purpose of JARPA is **one** permit application form that consolidates federal, state and local permits and simplifies the permit process for applicants proposing construction, fill placement, and other development activities in or near aquatic environments and wetlands. The region covered by JARPA is the San Francisco Bay Area only.

The objectives of JARPA are to develop a single form to be submitted by applicants to the necessary permitting agencies; reduce paperwork and processing time for applicants; reduce violations by improving applicant knowledge of permit requirements; and reduce the number of permit revisions and delays due to permit sequencing.

In addition, an excellent "Guide to Creek and Wetland Project Permitting" from San Mateo County is available. Visit the website at:
http://www.abag.ca.gov/bayarea/sfep/projects/JARPA/JARPA.html

County and City Ordinances

Local cities and counties generally have regulations regarding grading, setbacks, zoning, building, horse density, discharge restrictions, stormwater runoff, odors, pests, and nuisances. Contact your city and county governments for more information.

California Environmental Quality Act (CEQA) Review

Landowners, as well as state and local governments must comply with the California Environmental Quality Act. The main purpose of a CEQA review is to identify and prevent significant potential environmental impacts. CEQA requires the preparation of an initial study and then a Negative Declaration or an Environmental Impact Report.

Some agencies, such as the California Department of Fish and Game, will review permit applications for CEQA compliance. For large projects, cities and counties may require a CEQA review. For more information, contact your city or county planning departments or the California Department of Fish and Game.

Permit Tips

These tips can help you with the often complex permit process.

1. **Find out if your project is regulated or requires a permit.** If you go ahead without the proper permits or without following permit approval conditions, it will very likely cost you time, money, and goodwill.

2. **Carefully select and design your site** to eliminate or reduce environmental impacts.

3. **Consult early with permitting and regulatory agencies** so their concerns can be addressed. Your local planning department may be able to give you a good idea of the permitting process.

4. **Have written descriptions and site plans available.**

5. **Learn the rules.** Study the regulations of those agencies that must approve your project.

6. **Pay attention to details.** Follow all the rules. Respond promptly to requests for information. Be on time for meetings. Do not cut corners.

7. **Be flexible.** While protecting water quality and creeks is a prime responsibility of agencies, they may be willing to consider alternative project designs that still meet your needs.

8. **Get everything in writing** to help prevent misunderstandings.

9. **Plan time for permitting and be patient, as well as persistent.**

5.5 Threatened and Endangered Species

The presence of, or habitat for threatened or endangered species can influence horse keeping management decisions. It is important not to harm any "listed"species such as the California red-legged frog, Alameda whipsnake, or salmon and steelhead. Some conservation measures may provide habitat benefits.

The federal Endangered Species Act of 1973 prohibits any action that could harm, harass, or further endanger a federally designated, endangered or threatened plant or animal species or the associated critical habitat. Similarly, the California Endangered Species Act of 1984 recognizes the importance of endangered and threatened species and their habitats.

The purpose of the federal Endangered Species Act is to preserve species so depleted in numbers that they are threatened with extinction. A species may be classified for protection as "endangered" when it is in danger of extinction within the foreseeable future throughout all or a significant portion of its range. A "threatened" classification is provided for those animals and plants likely to become endangered within the foreseeable future. The Act provides a program for listed species and the ecosystems upon which they depend. The Act also mandates federal agencies to cooperate with state and local agencies to resolve water resource issues relating to endangered species.

Protecting endangered and threatened species and restoring them to a secure status in the wild is the primary objective of the endangered species programs of the US Fish and Wildlife Service and the National Marine Fisheries Service. These federal agencies also cooperate with the California Department of Fish and Game.

To find out if you might have threatened or endangered species or their habitat on your property, contact the California Department of Fish and Game. A continually refined and updated computerized inventory of the locations and condition of the state's rarest plants, animals, and natural communities is available through the Natural Diversity Database at http://www.dfg.ca.gov/whdab/html/cnddb.html

You can order a text report and map of your county, general area or specific property; contact the Information Services staff at (916) 324-3812. It is helpful to know the name of the USGS 7.5' quad map that includes your location. (See Section 1.2, Inventory and map your resources.) Reports vary in cost depending on the number of records involved.

US Fish and Wildlife Service

The US Fish and Wildlife Service (USFWS) has regulatory authority to conserve, protect and restore animals and plants, and their habitat, that are in danger of extinction. If endangered species are affected by activities, the work must be in compliance with USFWS regulations. Information is available on their website: http://endangered.fws.gov/

National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) regulates the recovery of anadromous (ocean-going) species listed under the Endangered Species Act, such as salmon (coho *or silver*, and Chinook *or king*) and steelhead. NMFS is a part of the National Oceanic and Atmospheric Administration (NOAA), and provides expertise in the area of fish passage and fisheries restoration. NMFS identifies issues to protect, conserve and restore habitats vital to self-sustaining populations of salmonids in California. The agency operates under the authority of the Clean Water Act, California water rights, and authorities that influence adequate water for fish, Endangered Species Act, National Environmental Policy Act, and the Fish & Wildlife Coordination Act. For endangered species consultation or assistance to landowners for fisheries restoration efforts, call the National Marine Fisheries Service in Santa Rosa: (707) 575-6050, or visit their website at: http://swr.nmfs.noaa.gov/sro.htm

5.6 Photographic Monitoring

Photographic monitoring is a simple and convenient method for documenting improvements you have made to your horse facility. Photographs can be kept with your ***Conservation Plan***.

Take photographs of specific areas that are addressed in your Conservation Plan to document:

- Before and after conditions to show the short- and long-term effectiveness of conservation measures.
- Changes over time in the condition of natural resources and human-made features.
- Impacts of major events, fires, floods, landslides, etc.
- Sources of pollutants (e.g., manure or chemicals) and how they are transported by stormwater runoff or contained.
- Special management areas (such as creek habitat or oak woodlands).

Take photographs from the same permanent photo points such as a fence post or tree (or create a marker with a wood or steel post). You can return to these exact points at the same time of the year to document changes over time. You may want to take photographs annually or several times per year. For example, you may take photos to correspond with the winter rains (to show runoff patterns) and also during the summer to give a contrasting view. Be sure to record the date of the photograph.

Landscape photographs can show an overview of an area, and close-up photographs can be used to show specific characteristics of an area such as soil surface or plant cover. When taking landscape photographs, always include a permanent identifiable feature in the background such as a building, tree, fence, or rock outcrop. Anticipate possible view obstructions such as tree growth, additions of barns, etc.

For specific details on photographic monitoring, review the *Photographic Monitoring for Equestrian Facilities* fact sheet produced by the Council of Bay Area RCDs. Call your local RCD or the Council of Bay Area RCDs at (707) 794-1242, ext. 121 for a copy.

5.7 Water Quality Monitoring

Testing your surface water will help maintain a healthy environment for horses, fish and aquatic life, and human use. With inexpensive equipment and a little training, horse owners can monitor the quality of water on their property. This section presents an overview of monitoring.[15] For complete information on setting up your own monitoring program and obtaining test kits, contact your local RCD or the Council of Bay Area RCDs for a horse owners monitoring information packet.[16]

Water Quality Variables

The following is a description of the water quality variables and their measurements that are commonly tested by agricultural landowners and regulatory agencies.

Ammonia. Ammonia results from decomposition of manure and other organic debris by microbes, and is toxic to fish and aquatic invertebrates. Total ammonia is composed of two forms: ionized ammonia (NH_4^+), and un-ionized ammonia (NH_3). Of these two forms, the un-ionized $NH_3$is far more toxic. The percent of total ammonia in the harmful un-ionized form increases with higher water temperatures and pH values. Un-ionized ammonia can be lethal at concentrations of 0.025 parts per million (ppm.) Higher levels of ammonia are toxic to fish and other organisms. Ammonia is naturally produced by fish and is excreted primarily through their gills. Ammonia excretion is reduced if there are high ammonia levels in surrounding waters, causing high blood ammonia levels in fish. Fish respond to this increase in blood ammonia by reduced feeding that slows metabolic ammonia production. High blood ammonia levels increase a fish's need for oxygen, while at the same time reducing the ability of the fish's blood to transport oxygen. High ammonia levels can damage gills and ultimately kill fish.

Total ammonia can be measured with an electronic ammonia probe or colorimetric kit. Colorimetric kits are inexpensive and relatively accurate. They rely on chemical reactions in which chemicals bind, and then react with ammonia to form a colored product. The intensity of the color then gives a relative indication of the amount of ammonia present.

Conductivity. Conductivity is simply a measure of the capacity of water to transmit an electrical current. Conductivity is useful in detecting pollution from livestock urine due to the high concentration of salts in urine, and the fact that the salts persist much longer than ammonia. High salt concentrations in sur-

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[15] This information was drawn from the *Water Quality Variables and Water Testing for Rural Landowners* fact sheets prepared by the Marin Coastal Watershed Enhancement Project. 1995.

[16] *Simply the Facts on Animal Waste and Water Monitoring*. Fact sheet series. USDA Natural Resources Conservation Service and AmeriCorps. 1995.

rounding waters disrupt the balance of salts in a fish's blood. This causes stress, and for prolonged periods can kill fish. Conductivity is measured in micromhos per centimeter or μmhos/cm.

pH. pH is a measure of the hydrogen ion concentration and ranges in value for 0 to 14. A value of 7 is referred to as neutral, while values below 7 are called acidic, and above 7 are said to be basic or alkaline. The pH of water is influenced by water source, underlying soil, effluent discharges from agricultural, industrial, and urban sources, algae, and microbial activity. The pH of water is important because it influences the amount of total ammonia that is in the most toxic un-ionized (NH_3) form, as well as affecting a variety of chemical reactions and biological functions. High pH values increase ammonia toxicity because a greater percentage of the total ammonia is in the un-ionized form. Electronic meters, small battery operated pH pens, or a litmus paper which changes color according to different pH values can be used to measure pH.

Temperature. Temperature is important because it directly affects animals and also influences the physical characteristics of water and pollutants such as ammonia. Extreme temperatures have harmful effects on animal metabolism, feeding, growth, disease resistance, and reproduction. Cool water contains higher levels of dissolved oxygen than warmer water and has lower levels of toxic un-ionized ammonia. Temperature is measured with electronic and mercury thermometers. The optimum water temperature for steelhead is approximately 55-60^{o} F, well below the summer temperature of many local streams.

Dissolved oxygen. This is often referred to by the initials DO, and is a measure of the oxygen that is dissolved in water. DO is critical for all aquatic life, just like oxygen in air is essential to humans and other terrestrial organisms. Because DO makes up a very small percentage of water, changes as seemingly minor as 1 part per million (ppm) can have a large impact on aquatic life. At a water temperature of 50^{o} F, DO at saturation would typically be 11 ppm. When water temperature rises to 80^{o} F, DO can drop dramatically to 8.0 ppm, a 27% decrease. DO can be measured with a colormetric test kit or an oxygen probe.

Water flow rate. It is important to note water flow rate when monitoring because it influences the concentration of pollutants. Knowing whether water quality problems were detected following a rainstorm when flows are high, versus a drier period, can help to identify the source and magnitude of the problem. If pollutants are found during high flows when they are apt to be diluted, it is possible that pollutants will be more concentrated when flows are lower. Problems that are detected at low flows, when runoff from surrounding areas is also low, probably come from a source near to the stream. Water flow can be estimated as low, medium, or high. A more accurate determination can be made by calculating the volume of a given stream area and then measuring the flow rate through this pre-measured area.

Sediment. Excessive sediment from erosion can fill in gravel beds used by salmon and steelhead for spawning. This can make the beds unsuitable for spawning or smother developing eggs in the gravel. Sediment can also fill in deep pools that remain cool in the summer and provide habitat for young fish. Sediment can be measured by allowing a water sample to stand and measuring the amount of sediment that settles. Imhoff sediment cones or tall glass jars can be used for this purpose.

Where and When to Test

Testing at your upstream and downstream property boundaries (where water enters and leaves your property) will tell you how clean the water flowing into your property is, and whether or not conditions on your property are contributing to water quality problems. If water is more polluted at the downstream boundary, test water upstream on your property to find pollution sources. Check for problems near areas of high-use, manure storage, field applications of manure, and ***horse wash areas***. Also check tributary drainages to see if problems are coming from upslope areas. By actively monitoring the water quality conditions on the property, the monitoring results could be a helpful tool in your defense if a dispute arises.

Tests should be done at least monthly throughout the year (in areas with year round water) and more often in the rainy season. Because runoff from early rains can have high concentrations of animal waste that has accumulated over the summer, it is important to test after the first storm that causes runoff. Test immediately after significant storm events (1 inch or more of rain in 24 hours) as these storms pose big threats to water quality. It may be helpful to have a rain gauge at the facility to track the amount of rain in each major storm as well as the total annual rainfall.

Keep records to provide a comparison of water quality over the years. You should be able to detect changes that show the effectiveness of your conservation measures.

5.8 Guidelines for Managing Residual Dry Matter (RDM)

Understanding the life cycle of pasture plants will help you to keep them productive. Annual grasses and forbs (broad-leaf plants) dominate dryland (unirrigated) pastures in the San Francisco Bay Area. Annual plants grow from seed each year. Because their seeds germinate with the onset of fall and winter rains, weather has a great impact on the early growth of annual plants. The growth period continues through the winter and early spring.

In the late spring and summer, annual plants mature and die. The residue or dry plant material that is left on the ground not only provides a seed source for the following year's plants, it also protects the soil from erosion and decreases the potential for manure to be transported downstream. Managing dryland pastures dominated by annual plants is really about managing this residue or "***residual dry matter***" (RDM).

Managing RDM in pastures dominated by annual plants is the most effective way to improve the condition of the soil surface, increase its water holding capacity, increase plant productivity, and minimize the invasion of weedy plants. Mapping of pastures to show areas with varying amounts of ***residual dry matter*** will help determine where pasture distribution can be improved.

The amount of RDM left in horse pastures before the start of the winter rains to protect the soil will vary according to soil type, slope, and climate. For example, areas with erosive soils or steep hills require more RDM than flat, stable soil. The following guidelines represent a range of minimum levels for annual grassland sites in the San Francisco Bay Area.

RDM monitoring can involve actual measurement of plant residues or visually estimating plant residues based on appearance.[17] Clipping and weighing involves measuring patches or "quadrats" of plant residue and can be a time consuming method. Your measurements will be more accurate if you take more quadrat samples.

Minimum Recommended Residual Dry Matter (RDM)[18] to Protect Soil and Water Resources in the San Francisco Bay Area		
	Flat to Gentle Slopes (less than 30% slope) RDM	Steep Slopes (over 30% slope) RDM
San Francisco Bay Area	800 lb/ac	1000 lb/ac

[17] This information is drawn from the fact sheet *Vegetation Monitoring* produced by the Marin Coastal Watershed Enhancement Project.
[18] Wildlands Solutions Field Guide Series. 1998. *Residual Dry Matter (RDM) Monitoring Photo-Guide.*

Visual estimation can be done using the following descriptions:

- High RDM – Little or no patchy appearance. Unused plant matter averages three or more inches in height and small objects are hidden. Light grazing results in high RDM.
- Medium RDM – Patchy appearance with an average of 2 inches of unused plant matter and little bare soil. Small objects will not show at a distance of 20 feet of more.
- Low RDM – Less than two inches of unused plant matter. Small objects and areas or bare soil are visible at 20 feet or more. Heavy grazing results in low RDM.

For more information on conducting RDM monitoring, contact your local RCD or NRCS office.

Common Grazing Terms

Carrying capacity. The maximum number of horses a pasture will provide feed for, while leaving adequate vegetation for pasture regeneration and protection from soil erosion. Carrying capacity depends on the soil's fertility and potential for erosion, slope, climate, the length of the growing season, and management. Carrying capacity can vary from year to year due to weather and previous use.

Grazing distribution. Ideal grazing distribution results in pastures with a uniform cover of ***residual dry matter*** (RDM) remaining at the start of the winter rains to protect the soil surface from erosion and reduce the establishment of unwanted weeds. However, horses are selective grazers and will selectively graze immature forage, which results in spot grazing. Areas with short, new growth are repeatedly grazed while other areas mature past the point of being desirable forage. As desirable plants are grazed out, weedy species tend to increase. Good grazing distribution prevents horses from too heavily "overgrazing" their favorite grass. Even with the proper stocking rate, grazing distribution can be a problem in larger pastures.

Residual Dry Matter (RDM). This is the amount of plant residue left in the field after grazing, expressed in pounds per acre.

Rotation grazing. Moving horses to a fresh pasture after the old pasture has been grazed to the desired level.

Season of Use. Optimal pasture productivity depends on controlling "when" and "how long" horses have access to pasture. Year-round access to pastures may not be an option. When to have horses on pasture depends on soil moisture and amount of forage available. Horses can compact wet soil, making it harder for grasses to grow and can readily trample wet turf.

5.9 Alternatives to Pesticides[19]

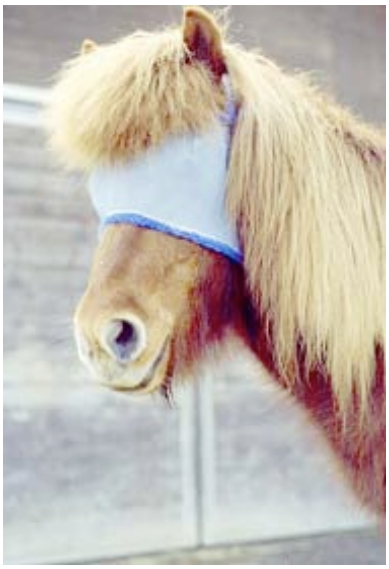
For most horse owners, insect control is a prime concern. Flies can carry diseases and cause problems such as conjunctivitis and wound infections. Biting flies, mosquitoes, and insects such as “no-see-ums” aggravate your horse and cause complications related to itching. Chemical fly sprays, as well as herbicides, fungicides, and other pesticides can severely impair water quality if direct application, airborne transport, or runoff carries the products to creeks.

Environmentally sensitive methods to reduce and manage the fly and insect population at your horse facility include reducing insect habitat, using beneficial insects, putting the local wildlife to work, and setting traps. Using these controls will help you reduce the use of insecticides. Plus, having fewer flies and chemicals will make your place healthier for you and your horses, and more pleasing for your neighbors.

What is Integrated Pest Management?

Integrated pest management is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, and modification of management measures. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment.

Check with University of California Cooperative Extension or your county agriculture commissioner for more information on alternatives to control undesirable plants or insects.



Use a fly mask to reduce the need for chemical fly control. Also, help control flies by eliminating breeding areas such as mud, manure, or soiled bedding. Managing manure and improving drainage can help create a better environment for horses.

Ways to reduce pesticide use

Address the source of the fly problem first

The crux of effective fly control is to identify and eliminate breeding areas. Virtually any situation that combines moisture and organic material (e.g., mud, manure, or soiled bedding) can support fly maggot development. Mosquito eggs only hatch in water. Contact your local mosquito abatement or vector control district if you have mosquito problems. Practicing sound manure management and having

[19] Adapted from *Fight Nature with Nature: Environmentally Friendly Insect Control for Horse Farms* by Alayne Blickle, Horses for Clean Water. 1999.

proper drainage will greatly reduce the amount of mud and water insects in which flies can breed.

Encourage beneficial insects, birds, and bats

- **Good bugs.** "Fly parasites" are gnat-sized, nocturnal wasps, which lay their eggs in the developing pupae of flies, thereby reducing or nearly eliminating the fly population. They do not harm humans or animals in any way—in fact, you won't even notice their presence. To find the parasites, try local garden stores, check the ads in horse publications, and look in farm supply catalogs. Discuss with the supplier the number of fly parasites and the frequency of release your conditions require to optimize effectiveness.
- **Helpful birds.** Encourage insect-eating birds to move into your barn area as an excellent means to reduce the flying insect population. Swallows are voracious insect eaters consuming up to 6,000 insects per day! Cliff swallows build mud nests when they arrive in spring. Help them along by providing puddles of water where they can gather mud. Screen off areas (using 1/2 inch or smaller wire mesh) where you don't want them. Nest boxes for bluebirds, tree swallows and violet-green swallows can be built or purchased. Nest box plans are available from the Natural Resources Conservation Service. Consult your local Audubon Society, birding organization, or wild bird store for more information. Also see *Steps to Improving Songbird Habitat at your Horse Ranch* in Section 5.10 of the Resources Directory.
- **Bat friends**. Bats eat nocturnal flying insects such as mosquitoes. One bat can eat up to 600 mosquitoes per hour, more than 5,000 per night. They also eat other agricultural pests. Bat houses can be placed on a barn, pole, tree, or the side of a house. The best habitat for bats is within a half mile of a stream, pond, or wetland. Bat houses need to be placed by early April, and it can take up to two years for a bat colony to find the house. Bat houses can be built or ordered through garden catalogs. Bat Conservation International is a good source for more information.

  Be sure to consult your veterinarian for recommendations on vaccinating your horses against rabies. Bat rabies accounts for approximately one human death per year in the United States.

Trap insects

Several types of simple insect traps can be useful for reducing the flying insect population. Flypaper is one of the easiest and cheapest. Pheromone traps are simple jars with one-way lids. A small amount of pheromone solution, a natural substance that attracts flies, is placed in the jar. The flies (and yellow jackets!) buzz into the jar, can't get out, and die. Traps are sold by different companies under various names. Check farm and horse supply outlets.

You can make your own bait jars to trap flies very cheaply and easily. Take an old mayonnaise or similarly sized jar and punch several holes through the lid. Put in

a few pieces of raw hamburger or fish and about an inch of water. Flies make their way into the jar and drown. This method can be smelly and attract other unwanted pests, as well as your dog!

Be cautious when using pesticides

No matter how much fly control you use, there are still likely to be some flies around, especially on hot, sunny days. Regular application of pesticides may still be necessary to control insects that bother horses, especially for those horses hypersensitive to insect bites. If you use chemicals:

- Consult your veterinarian for the type of fly spray recommended and the frequency of application.
- Read and follow instructions carefully to be sure you protect yourself, your horses, and the environment.
- Cover feed ***troughs***, mangers, and water devices to prevent contamination of feed and water. Do not spray inside feed storage rooms.
- Do not apply pesticides near creeks, rivers, lakes, ponds, or other aquatic areas.
- Watch weather conditions to avoid drift of chemical sprays onto other properties.

5.10 Improving Songbird Habitat on Your Horse Ranch

Fact sheet prepared by Point Reyes Bird Observatory
California Partners in Flight and the Riparian Habitat Joint Venture

Equestrians are people who love horses and enjoy being with them outdoors. Many stables or breeding facilities are located on large sections of land, often including creeks or sections of wooded habitat that could sustain a healthy population of native birds. These guidelines are beneficial for both birds and the horse owner, whether you have one horse or an entire stable.

The songbird-breeding season lasts from late March through August in California. During this period, songbirds are constantly busy building nests and raising their young. It is during this period that they are most vulnerable to predators, changes in vegetation and food supply. There are many steps that can be taken to make this time a productive one for birds on your land. We'd like to encourage horse and wildlife lovers to turn their stables into a productive place for bird populations. By providing habitat – especially natural nest sites and foraging areas – you can play an important role in ensuring healthy bird populations for the future. In turn, riding around your property will be more enjoyable with healthy habitat and birds to look at.

Preserve and restore existing "on ranch" native habitat

The best way to begin helping birds is by leaving and enhancing the native vegetation on and around your horse ranch. Native vegetation provides the best nest cover and feeding sites for breeding birds. The following are steps you can take to enhance the existing native habitat on your horse ranch:

- **Fence horses and livestock out of creeks, wetlands, lakes and ponds**—this will increase the native vegetation around creeks and streams which is crucial for breeding songbirds as well as to help reduce muddy areas around water sources that can cause horse ailments such as thrush, mud fever and scratches. Cost effective watering sources are available to supply your horses with water on dry ground.
- **Build water crossings** across creeks to enable horses to move between pastures without damaging the creek or other drainages.
- **Line pastures and driveways** with native trees, shrubs, and grasses to create habitat for birds. This will also eliminate wind, help control weeds toxic to horses such as star thistle, and provide shade for horses. Make sure these areas are ***fenced*** to prevent horses from entering these areas. When possible, connect these rows to existing habitat on creeks or other natural areas on your ranch.
- **Avoid non-native** trees and shrubs such as eucalyptus, tamarisk and broom, when designing your jumping, cross-country, and trail courses. Contact your native plant society for suggestions on native plants and shrubs appropriate to your area. For a list of native plant societies see PRBO's website at http://www.prbo.org/
- **Leave dead trees or dead limbs** for cavity nesting species such as woodpeckers, bluebirds, nuthatches, and titmice.
- **Provide nest material** such as grass clippings, leaf litter, and horsehair.

Manage Your Waste!

Runoff from manure piles, wash racks, and grooming areas can pollute the creeks and seasonal drainages on your ranch. This affects the birds and other wildlife that breed in streamside areas. The following are ways to safely manage your waste:

- **Keep manure** piles far away from creeks, ponds, lakes, and wetlands.
- **Reduce manure** piles by either ***composting manure*** or arranging for removal by local farmers, mushroom growers or other interested parties.
- **Make sure** wash rack drains are not emptying into creeks or other drainages.
- **Use non-toxic** and biodegradable products when grooming and bathing your horse.

Control Predators and Pests!

Eliminate stable pests such as mice, rats, and non-native birds such as house sparrows and starlings.

- **Use traps,** not cats, to control rodents in hay barns and tack rooms. Cats kill an estimated 4.4 million birds a day in North America. For more information see the Cats Indoors Program! at http://www.audubon.org/bird/cat/index.html
- **Keep grain** in sealed containers in designated feed rooms, and clean up spilled grain immediately to keep from attracting rodents.
- **Feed horses in feeders** and remove uneaten hay daily. This not only prevents grain and hay from attracting rodents and flocks of non-native birds to stalls and paddocks, it prevents mud accumulation in winter and can help prevent your horse from ingesting mud or dirt which can lead to sand colic.

Control introduced (non-native) predators:

- **Keep cats indoors**, especially during the songbird breeding season when vulnerable young birds are just out of the nest. Bells on the collar are not enough. Control mice and rodent populations by the methods suggested above, eliminating the need for stable cats.
- **Reduce feral cat** populations, don't feed strays, and spay and neuter all house cats.
- **Eliminate sources** of food such as open garbage, compost, and outdoor pet dishes that attract raccoons, opossums, jays, and stray cats.

Swallows

Barn and Cliff Swallows are insectivorous birds that like to nest under the eaves of roofs on barns and houses. Colonies of swallows provide the invaluable service of free, natural insect control. The large number of flies associated with stables is one of the reasons swallows choose to breed on so many barns. However, if you prefer not to have swallows, there are a few things that you can do to safely discourage them from nesting on your property.

- Discourage swallows from nesting on your house or barn **before** they get their nest started by eliminating space under eaves. You can place boards or a fine wire mesh (1/2 inch or smaller) at an angle to close up the space under roof overhangs.
- Designate one section of your barn or house to allow swallows to nest.
- Don't use Tanglefoot or other sticky substances to discourage the birds as it harms their feet and feathers.

5.11 Helpful Publications and References

Equine Facilities Assistance Program Fact Sheets

The following fact sheets were developed as part of the Equine Facilities Assistance Program. To obtain copies, contact the Council of Bay Area Resource Conservation Districts at (707) 794-1242, ext. 121, or your local Resource Conservation District.

Number 1: *Program Background*
Number 2: *Composting Horse Manure*
Number 3: *Conservation Measures to Reduce Non-point Source Pollution at Horse Facilities*
Number 4: *Photographic Monitoring for Equestrian Facilities*
Number 5: *Horse Paddocks: Designed and Managed to Protect Water Quality*
Number 6: *Controlling Yellow Starthistle*
Number 7: *Dryland Pasture for Horses*
Number 8: *Portable Backyard Garden*
Number 9: *Horse Manure Management*
Number 10: *Stormwater Runoff Management at High-use Areas*

Horse Owners Guide to Water Quality Protection brochure is also available.

Erosion and sediment control

Erosion and Sediment Control Field Manual. 1999. San Francisco Bay Regional Water Quality Control Board. 1999. Contact: Friends of the San Francisco Estuary at (510) 622-2419.

Groundwork: A Handbook for Erosion Control in North Coastal California. 1987. Liza Prunuske. Marin County Resource Conservation District. Contact Marin County RCD at (415) 663-1170 or: marinrcd@svn.net

Principles & Practices of Erosion Control. Santa Cruz County Resource Conservation District. Contact: Santa Cruz RCD at (831) 464-2950.

Repairing Streambank Erosion. 1997. Brochure prepared by Prunuske Chatham, Inc. for Marin County Stormwater Pollution Prevention Program.

Start at the Source: Design Guidance Manual for Stormwater Quality Protection. 1997. Tom Richmond and Associates. Bay Area Stormwater Management Agencies Association (BASMAA). New York: Forbes Custom Publishing.

Water resources/watersheds/riparian environments

Creek Care: A Guide for Urban Marin Residents. Martha Neuman. Marin County Stormwater Pollution Prevention Program. Contact MCSTOPP at (415) 485-3363.

Guide to Stream Project Permitting for the State of California. California Association of Resource Conservation Districts. Call (916) 447-7237 or contact http://www.carcd.org/

Riparian Buffers for Agricultural Land. 1997. Mike Dosskey, et al. Iowa State University. Department of Forestry. Agroforestry Notes AF Note-3.

Stewards of our Streams; Riparian Buffer Systems. 1997. Richard C. Schultz, et al. Iowa State University. University Extension Pm-1626a.

Water quality

California Rangelands website at UC Davis. Fact sheets on water quality and more. Search the web using keywords: California Rangeland Watershed Program Fact Sheets.

Simply the Facts on Animal Waste and Water Monitoring (for Landowners, Farmers, & General Public). A series of fact sheets from USDA Natural Resources Conservation Service and AmeriCorps. Contact the Council of Bay Area RCDs at (707) 794-1242, ext. 121.

Manure and waste management

California Materials Exchange (CalMAX): http://www.ciwmb.ca.gov/calmax

Good Horse Keeping—Managing Manure to Protect the Environment (video). 1999. King's Mark Resource Conservation & Development Area, Connecticut. Horse Environmental Awareness Program. Cost is $10. Call (203) 284-3663.

Horse Wastes and Composting. Adda Quinn. EnviroHorse. Contact: http://www.californiastatehorsemen.com/envirohorse.htm or email at envirohorse@yahoo.com

How to Compost and Use Horse Manure. Alayne Blickle. Horses for Clean Water Tipsheet. Contact http://members.aol.com/arblickle/

Livestock Waste Facilities Handbook. 1993. Midwest Plan Service. MWPS-18. Iowa State University.

Manure and Waste Management for the Horseowner. 1983. Division of Agricultural Sciences, University of California. Leaflet 21397. Call (800) 994-8849.

On-Farm Composting Handbook. 1992. New York: Northeast Regional Agricultural Engineering Service, Cooperative Extension. NRAES-54. (152 Riley-Robb Hall Ithaca, NY 14853-5701. Call (607) 255-7654 or email nraes@cornell.edu

Recommended Best Management Practices for Dairies and Other Animal Facility Operations in Region 1. 2000. California Regional Water Quality Control Board. North Coast Region.

The Rodale Book of Composting. 1992. Deborah Martin and Grace Gershuny, editors. New York: Rodale Press.

Equine facilities management and site planning

*Home*A*Syst, An Environmental Risk-Assessment Guide for the Home*. 1997. New York: Northeast Regional Agricultural Engineering Service. NRAES-87. Call (607) 255-7654 or email: nraes@cornell.edu

Horse Handbook, Housing and Equipment. 1971. Midwest Plan Service. Iowa State University. MWPS-15.

Horse Industry Handbook, A Guide to Equine Care and Management. 1993. Kentucky: American Youth Horse Council. Call (606) 226-6011.

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Glossary

Aquatic life. Plants or animals that require water and associated riparian habitat to live.

Clean water. Rainfall that has not come into contact with a pollutant such as horse manure, or picked up pollutants such as sediment.

Concentrated water. Water flow that has increased in volume and velocity due to either natural drainage or human-made diversion of drainage.

Conservation measure. Any management practice, activity, or structure to prevent or reduce water pollution and/or enhance natural resourcess.

Conservation plan. A set of decisions for a long-term management strategy to protect and enhance natural resources for a property. These decisions are recorded in a conservation plan, which documents decisions made and describes the schedule of operations and activities needed to solve identified problems. Maintenance and monitoring are also included.

Polluted water. Water that has become adversely affected physically, chemically, or biologically by chemicals or other additives, such as manure or sediment.

Contaminant. The impairment of water quality by waste to a degree that creates a hazard to public health through the spread of disease.

Creek. A watercourse smaller than a river. Used in this guide to cover all sizes and types of fresh water bodies such as rivers and streams. May or may not have year-round surface flow.

Diversion. A channel or structure to divert water at a non-erosive velocity to sites where it can be used or discharged at an erosion resistant outlet.

Downslope. Downhill.

Drainage. Movement of water downward through the soil or across land.

Erosion. The wearing away of land surface by wind or water. Occurs naturally from weather or runoff, but can be intensified or accelerated by human activity.

Ground water. Water stored underground that fills the spaces between soil particles or rock fractures. (Also see near-surface ground water.)

Horse facility. In this guide, the areas used in caring for horses (i.e., barns, paddocks, turnouts, arenas, etc.) whether for a single backyard horse or a larger boarding operation.

Horse waste. Manure, urine, used bedding, and spoiled hay.

Impervious/ impermeable surface. Any surface that cannot be easily penetrated by water, such as roofs, compacted soils, and paved areas.

Leachate. Liquid which has come into contact with or percolated through manure being stockpiled or stored; contains dissolved or suspended particles and nutrients.

Manure. In this guide, manure includes both the feces and urine from horses.

Near-surface ground water. Ground water just below the soil surface and above the normal water table due to water-saturated soils. As well as slowly moving downward, near-surface ground water generally flows in the same direction as the surface runoff above until it reemerges to the surface at a creek.

Nonpoint source pollution. The diffuse discharge of pollutants that can occur

over an extensive area, such as a pasture, as opposed to point source pollution that can be pinpointed to a specific location, such as an outlet at a sewage treatment plant. Nonpoint source pollution occurs as water from rainfall or snowmelt moves over and through the ground, it picks up and transports natural and human-created pollutants, eventually depositing them into surface and ground water.

Nutrient. The portion of any element or compound that can be readily absorbed and assimilated to nourish plants; examples include nitrogen and phosphorus. Even in small amounts these same nutrients can have a harmful effect on water quality. Horse manure can degrade water quality because it is rich in nutrients.

Organic material. Substance derived from living organisms (plants or animals).

Outlet. The area where water is discharged from a downspout, culvert, pipe, channel, or ditch.

Overgrazing. Severe grazing that causes a decrease in plant cover and correspondingly causes plant roots to die back.

Pollutant. The presence of a substance in such quantities that when it reaches a body of water, soil, or air, it is degrading in effect that it impairs their useful ness or renders them offensive.

Pool. A depression in the streambed used by aquatic life.

Residual Dry Matter (RDM). The amount of plant residue, expressed in pounds per acre, left in the field after being grazed.

Riffle. Sections of a stream with moderate turbulence caused by water flowing over rocks.

Rill erosion. Small, well-defined channels several inches deep that form when loose particles of soil and rock are transported downhill by water.

Riparian area. The area immediately adjacent to the banks of a creek, lake, or other waterbody. The riparian area is distinctly different from surrounding lands because of unique soil and vegetation characteristics that are strongly influenced by free or unbound water in the soil.

Riprap. Heavy rock used to protect soil from the erosive action of fast-moving water. Minimum size is typically 12 inches x 12 inches x 6 inches with a bulk specific gravity of 2.5 or greater.

Rolling dip. A shallow, rounded dip in the road to provide effective drainage where surface runoff is directed in the dip to the side of the road.

Runoff. Water from rain or other sources (for example, from a hose or a ***horse wash area***) that does not infiltrate into the ground but runs over the land surface and into creeks.

Seasonal drainages. Small, natural or human created swales, depressions, or drainages that carry water only after a rainfall.

Sediment. The soil material, both mineral and organic, that is suspended, is being transported, or has been moved from its site of origin by erosion and has come to rest on the land surface or at the bottom of creeks, ditches, reservoirs, or bays.

Sheet flow. A shallow flow of water that is spread uniformly over the land surface. Sheet flow will concentrate into rills and gullies.

Soil type. Soil is unconsolidated mineral and organic surface material with

specific physical, chemical, and biological properties to support plant growth. Soil is grouped into three basic types based on particle size: clay has small particles; silt/loam has medium size particles; and sand/gravel has large particles.

Stormwater runoff. Clean rain water that flows over the land surface without entering the soil.

Turnout. A high-use area where horses are "turned out" for exercise after being confined in stalls. Turnouts can be exercise lots, small paddocks, pens, or corrals. These areas are typically bare and not managed as pastures.

Upslope. Uphill.

Water quality. Describes the chemical, biological, and physical characteristics of water. The quality of water can limit its specific use or ability to support various beneficial uses such as water supplies for municipalities, industry, agriculture, recreation, and fish and wildlife habitat.

Watershed. Total land area that drains into a particular creek, river system, or bay. It includes major and minor creeks, seasonal drainages, hillsides, and floodplains. Watershed boundaries are defined by the ridges that separate drainage between watersheds.

Water table. The underground boundary below which all spaces between soil particles are saturated with water. Water tables fluctuate throughout the year but are usually highest in early spring.

Wetlands. Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions.

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Horse Keeping:

A Guide to Land Management for Clean Water

This is a manual for everyone who enjoys horses and is concerned with managing them in a way that protects our land and water resources. It is interesting, informative, and written so that even the layman with no prior knowledge of land management issues will be able to operate his facility in an environmentally friendly manner.

Joel Bartlett
Horseman and meteorologist

It was a pleasure reviewing this guide, *Horse Keeping: A Guide to Land Management for Clean Water*. When someone says to me, "There's no problem with backyard horse keeping," I disagree. The Sonoma County Horse Council found in the 1999 Horse Census and Economic Survey that the majority of horses in the county are in back yards. When you have over 14,000 horses in the County, the cumulative effect could be drastic to local water bodies. The information used in the manual comes from years of dealing with the same issues concerning the dairy industry.

I work as the equestrian representative on the Animal Resource Committee, a committee that deals with manure and pollution with agriculture producers. I contact the local horse owners who receive complaints from neighbors or agencies. This allows the producer to correct any problems before any fines are levied. During the rainy season one or two situations arise each month. This manual will allow the horse owners easy access to information for improving their horse keeping practices. It is essential to have a Ranch Conservation Plan.

I teach classes at Santa Rosa Junior College titled "Water Quality and Equine Facilities Planning" and "Animal Stewardship and Water Quality." I use the Ranch Plan Workbook from the Marin Coastal Watershed Enhancement Project, and the Water Quality Planning Course for Equine Facilities, created by Alameda County Resource Conservation District. I hope to use this *Horse Keeping* manual in my classes. It is ideal to have the information located in one convenient text.

The equestrian community should be thankful that individuals involved in horse keeping were asked to review this guide and to contribute to its content.

Michael Murphy
Sonoma County Horse Council

Horse Keeping: A Guide to Land Management for Clean Water

This is the label for the spine of a binder.

- Obtain a 1” binder with clear windows in the front, back, and spine.
- Cut out this label, and insert it in the spine of the binder.

Place the front cover in the front of the binder, and the back cover sheet in the back of the binder.