Appendix 4
BEST MANAGEMENT PRACTICES FOR HORSE PASTURES, PADDOCKS AND STABLES

A HORSE OWNER'S GUIDE TO PROTECTING NATURAL RESOURCES

BEST MANAGEMENT PRACTICES FOR STABLES AND PASTURES

If you own horses, this brochure will show how you can play a part in protecting and cleaning up water resources. You will learn a few simple best management practices (BMPs) specifically designed for landowners with horses. Armed with this new information, you can join the thousands of citizens, businesses, and communities working together for a cleaner environment.

Managing Waste and Protecting Water Quality

Manure management is a big challenge for horse owners, especially if you have several animals on a small parcel of land and no way of spreading or utilizing the manure. The following best management practices are designed to keep nutrients and soil out of waterways.

Manure management is a big challenge for horse owners

Store your manure properly.
Do not store unprotected piles of manure in places where runoff may enter streams, or flood waters may wash the manure away. Place a cover or tarp over the pile to keep rainwater out.

Try Composting
There are many benefits to setting up a small composting facility for your horse wastes. Composted manure makes an excellent pasture and garden fertilizer as long as it is not spread too heavily. What's more, it can be combined with yard waste and non-meat kitchen scraps. Horse owners should have no trouble giving away or selling properly composted horse manure.

Establish vegetative covers
A vegetative cover placed around buildings or on steeper slopes can help minimize erosion and absorb nutrients while improving the appearance of your property. In addition to avoiding costlier erosion controls, vegetative covers will provide animals with better traction during wet or icy conditions. Examples of commonly used covers include a combination of grasses, vinca and shrubbery.

Produced by the Massachusetts Department of Environmental Protection, Office of Watershed Management. Contact Eben Chesebrough at 508-767-2798 for more information. This brochure was adapted from the Maryland Department of Agriculture's "A Horse Owner's Guide to Protecting the Chesapeake Bay".

Keep animals out of streams

Designed stream crossings provide a safe, easy way for horses to ford streams. Fencing encourages horses to use the crossing instead of the streambed to navigate streams. This will allow vegetation to stabilize stream banks and reduce sediment pollution. Contact your local soil conservation district for assistance in designing crossings and other protection measures for your stream.

Manage water carefully

Manage water within your pasture to control potential nutrient runoff. This may require diverting surface and roof drainage runoff water away from pastures or paddocks. Also, take care to conserve water. Turn the hose off when shampooing horses instead of letting it run, and turn the water on low when rinsing a horse down.

Keeping your Pasture Green

Paddocks, riding rings, trails, and pastures are continuously disturbed areas, under constant physical stress from horses' hooves. Overgrazed pastures, in particular, expose patches of bare soil that can easily erode. Here are several management practices that can help minimize overgrazing in your pasture and help control erosion.

Select pasture sites carefully

If you are establishing a new pasture, select a site that is well drained and located on high ground. Avoid flood plains, drainage areas, and tracts with long, steep slopes. Remember, it is illegal to alter wetlands in any way without proper authorization. Contact your local soil conservation district for assistance in selecting an appropriate site.

Inspect pastures for problems

There are many ways to improve the performance of established pastures. For starters, conduct a visual inspection to pinpoint any existing or potential problems. Correcting erosion problems can sometimes be as simple as stabilizing a hill with railroad ties or moving a gate to high ground. Here are some common problems to look for:

- Patches of bare ground on slopes
- Small hills and gullies
- Sediment accumulations downslope

Test your soil

Establishing and maintaining a dense, vigorous sod that will withstand the constant trampling of horses is no easy chore. An inexpensive soil test from the Cooperative Extension Service can help you determine the type and amount of fertilizer needed for good pasture growth. This will also help prevent nutrient runoff from over-fertilized pastures and can improve your horse's nutrition. Pasture soil should be tested every two or three years to determine fertilizer and lime needs. A comprehensive fertilizer program can then be developed.

Reseed bare ground, rills and gullies

Bare areas should be leveled and smoothed as best as possible before seeding. The best time to reseed is either late winter/early spring or late summer. Tall fescue is a good seed choice.

Minimize spotty growth

Manure clumps are a major cause of spotty pasture growth and reduced grazing. On small parcels, manure should be picked up and removed regularly. Placing a piece of chain-link fence or other drag behind a tractor or truck can also break up manure. In addition to helping your pasture, breaking up manure piles on a regular basis can reduce parasite infestations.

Mow pastures to the proper height.

It is well known that horses graze selectively, consuming nutritious, young pasture grasses while leaving mature grasses and weeds to seed and spread. Proper mowing is the best way to control weeds and minimize spotty growth. Bear in mind that pasture grasses do best at about six inches.

Switch to rotational grazing

Heavily overgrazed pastures offer little feed for horses and may cause colic if soil is ingested while grazing. Moving livestock from one pasture to another during the growing season can minimize overgrazing. In small pastures, horses should be rotated to a fresh area about every two weeks. As a rule, one or two acres of well-managed pasture can support one mature horse during the grazing season with rotation, while four or five acres without rotation will support only one mature horse for the entire grazing season.

Set up a paddock system

A paddock system works especially well for landowners with limited pasture land (two acres or less). Paddocks or riding rings can be used for turnout when the pasture is excessively wet or dry, or when you want to reseed, fertilize, or rest the pasture. The paddock should be set up on high ground, using stone dust for the foundation. It should be surrounded with a hardy grass and, if possible, a trench to capture runoff. Riding rings, especially those being used as turnout areas, should be lined with a mixture of sand and sawdust to help protect the soil from erosion.

If you are unable to set up a paddock system, limit pasture grazing to a few hours each day during the hot, dry summer months.

Material Storage Safety Tips

Many of the chemicals found in barns – formaldehyde, paints, hoof oils, and pesticides to name a few – require careful handling and proper disposal. When using these chemicals, be certain to follow these common-sense guidelines:

- Buy only what you need, and use what you buy.
- Treat spills of hoof oils like a fuel spill. Use kitty litter to soak up the oil and dispose in a tightly sealed plastic bag.
- Store pesticides in a locked, dry, well-ventilated area.
- Whenever possible, select less toxic chemicals.
- Protect stored fertilizer, lime, and pesticides from rain and surface water.

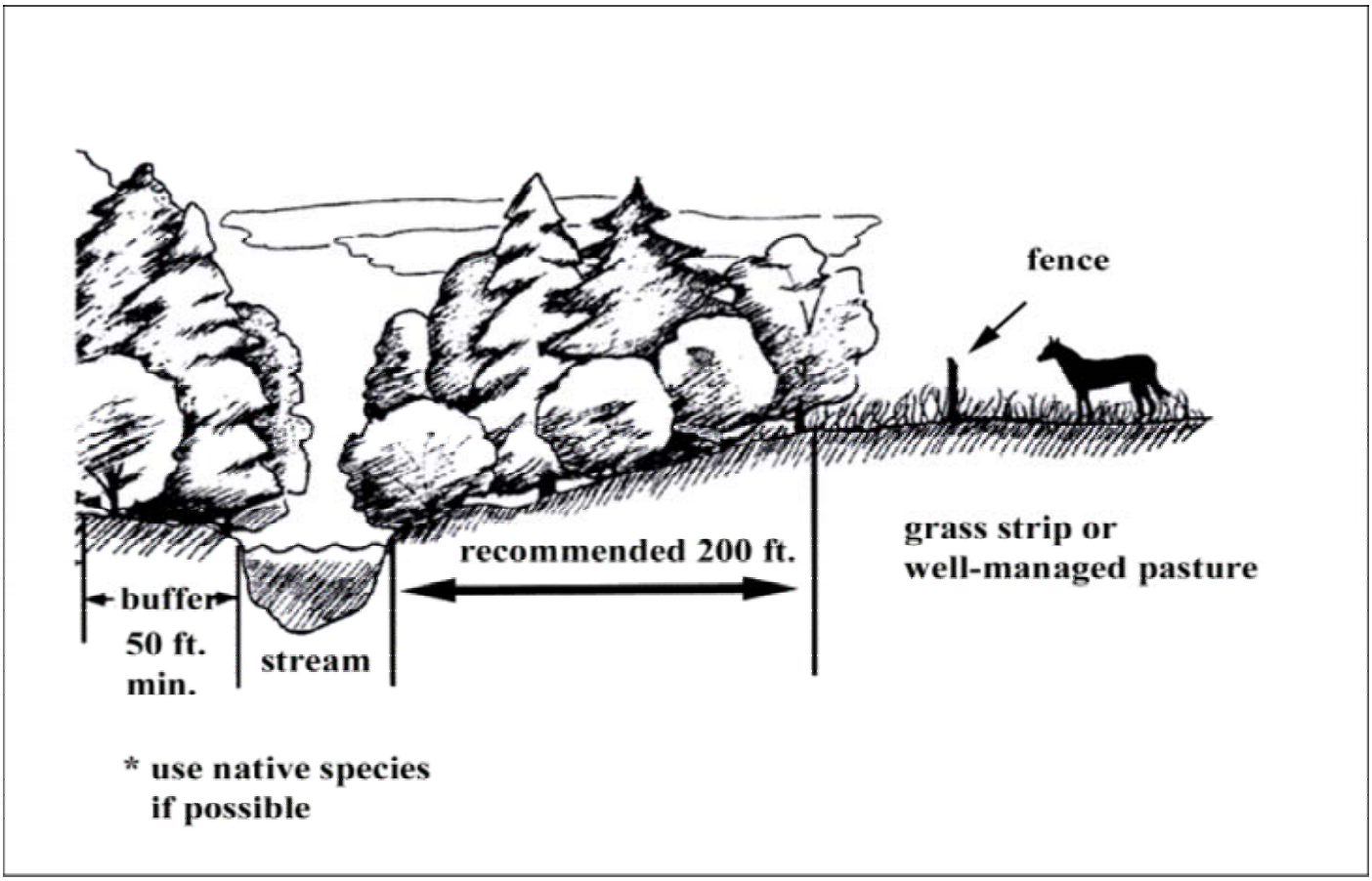
Agency Resources

Natural Resource Conservation Service (NRCS) works with farmers on issues relating to the best use of our natural resources. Find them in the phone book under federal government, US Department of Agriculture, Natural Resource Conservation Service.

Conservation Districts also work with farmers and livestock owners, often for smaller, non-commercial places, on similar land management assistance.

VEGETATED BUFFER STRIPS: SLOW THE FLOW TO PROTECT WATER QUALITY

Establishing vegetated buffer strips along lakes and streams is a simple and inexpensive way to protect and improve water quality on your property and in your community. Buffer strips consist of planted or naturally occurring vegetation, such as shrubs, trees, and plants. The vegetation serves as a filter, straining out sediments, nutrients, pesticides and other pollutants before they reach the water body. Buffer strips stabilize streambanks and shorelines, and prevent bank erosion and slumping. Runoff slows down and loses much of its erosional force when it passes through the strip of vegetation. Trees and shrubs along streams and lakes provide shade to keep water cool, improving habitat for aquatic organisms, and provide cover and habitat for wildlife. The wider the buffer strip, the greater its effectiveness. Strips between 50 and 200 feet wide may be required, based on soil type, size and slope of the pasture, and vegetative cover. A good rule of thumb is at least 50 feet wide, while keeping as much distance as possible between fencing and surface water.



Don't be discouraged if you have very small areas to work with. Any buffer strip is better than none at all!

Establishing a Buffer Strip

Buffer strips consist of planted or naturally occurring vegetation, such as trees, shrubs, legumes, or grasses. Establishing a natural buffer is the simplest and least expensive option. Simply determine how much land area you can devote to the buffer, and commit to stop mowing or removing vegetation from the area. With a little patience, plant material will naturally become established and grow. Plants establish themselves in succession, and it will probably take several years for trees and woody shrubs to develop in your buffer strip. The advantage of a natural buffer strip is that the native plants that do become established are adapted to local conditions, require no maintenance, and are a natural part of the ecosystem.

If the vegetation has been removed, or you wish to accelerate the development of your buffer strip, plant horse-friendly native trees and shrubs. Check with your local cooperative extension service, veterinarian, or consult a field guide of toxic plants to determine what is safe for your horses. If you can not restrict horses from the buffer strip, you may need to fence off saplings to prevent horses from nibbling tender leaves and shoots. While the trees and shrubs are being established, plant grasses and legumes to hold and stabilize the soil.

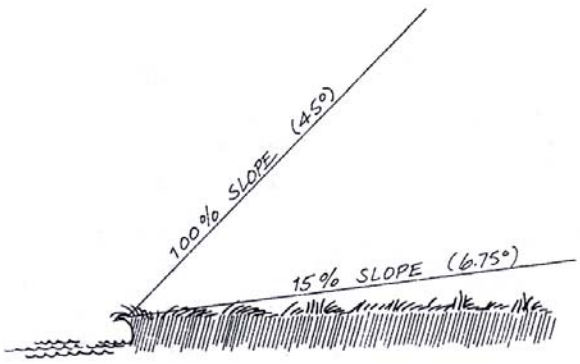
Regardless of what type of buffer strip you decide to encourage on your property, remember to:

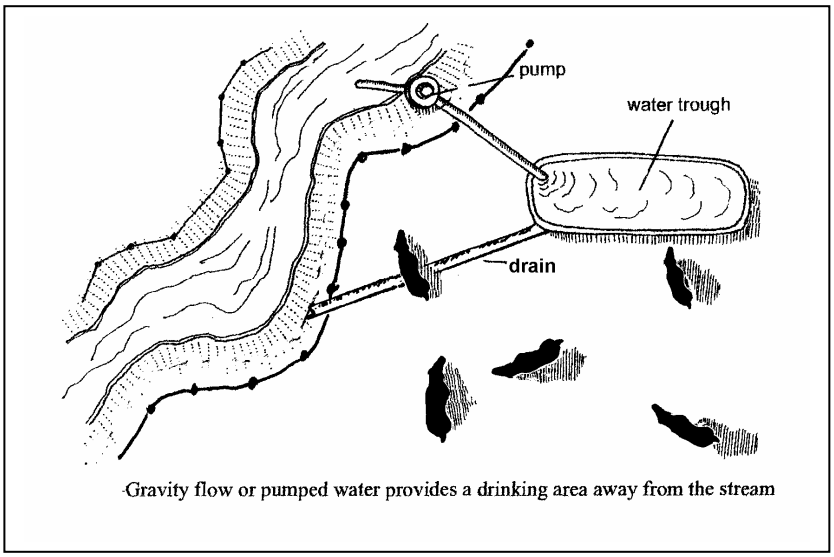
- Keep as much distance as possible between your field boundary and surface water.

Recommended Buffer Strip Widths Based on Slope

Slope of Land (%)	Minimum width of Buffer Strip (feet)
0	50
5	70
10	90
15	110
20	130
25	150

Source: Finley 1987 in *Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality.* Pennsylvania State University. 1996.

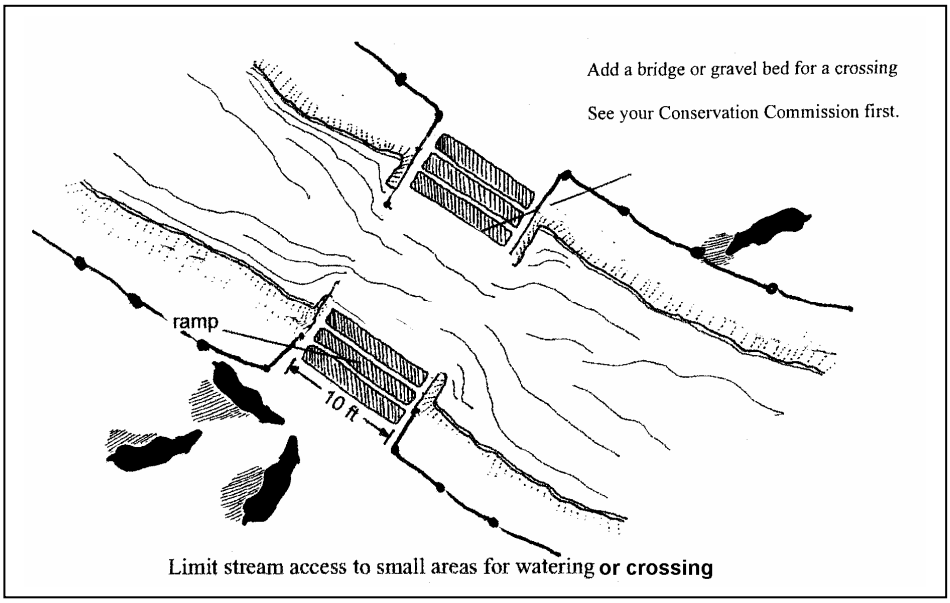




Gravity flow or pumped water provides a drinking area away from the stream

- If at all possible, restrict access to streams and lakeshores. Provide alternative water sources, such as filling a stock tank with a garden hose or installing an automatic waterer, to keep horses out of the stream.

- If horses must rely on stream or lake water for drinking, limit their access with fencing and construct a ramp fence system. Note: Contact your Conservation Commission first.



Limit stream access to small areas for watering **or crossing**

What else can you do to protect and improve water quality?

- Minimize hard or impervious surfaces on your property, and maximize pervious surfaces to encourage infiltration and reduce runoff.
- Maintain vegetation, preferably trees and shrubs, along steep slopes, drainage channels or ditches, and around all bodies of water.
- Do not apply manure in the buffer strip! Maintain a distance of at least 100 feet between areas of manure application and the nearest surface water body.
- Establish other grassed or vegetated strips between fields. These vegetated strips will intercept pollution, slow down the flow and velocity of runoff, and encourage infiltration.

References and Other sources of Information:

The Buffer Handbook: "A Guide to Creating Vegetated Buffers for Lakefront Properties." Developed by Phoebe Hardesty, Androscoggin Valley Soil and Water Conservation District and Cynthia Kuhns, Lake and Watershed Resource Management Associates, with funding provided by the U.S. EPA and Maine DEP. 1998

Establishing Vegetative Buffer Strips Along Streams to Improve Water Quality. (1996) Pennsylvania State University College of Agricultural Sciences. Ordering information online at **http://pubs.cas.psu.edu/Pubs**

Horse Owners Field Guide to Toxic Plants. (1996) by Sandra Burger and A. P. Knight. Breakthrough Publications.

http://neirtnt.ct.nrcs.usda.gov/horse
This link takes you to the Connecticut Horse Environmental Awareness Program (HEAP). The site contains a series of fact sheets, and educational resources on best management practices (BMPs).

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html
"Manure and Pasture Management for Recreational Horse Owners", a series of web sites by the University of Minnesota Extension Service. Includes plans for building a composting bin, detailed discussion of the composting process, information on pasture management, and an extensive list of additional sources of information.

http://ceinfo.unh.edu/aahr1050.pdf
This link takes you to the online version of the Good Neighbor Guide for Horse-Keeping: Manure Management, an excellent publication developed by the University of New Hampshire Cooperative Extension Service, New Hampshire Department of Environmental Services, and Natural Resources Conservation Service.

http://www.wisc.edu/farmasyst/worklink.html
Links to Farm and Home assistance addressing farm management and environmental management for homeowners.

http://www.nrcs.usda.gov
The Natural Resources Conservation Service is a Federal agency that works in partnership with the American people to conserve and sustain our natural resources.

Mud and Pasture Management

Mud, like manure, is a problem that every horse owner must contend with. Mud is unhealthy, unsightly, annoying, and difficult to avoid or control. Mud can cause very serious environmental impacts when it is near surface waters or drinking water supplies. Rainfall and runoff can carry contaminants from the mud into your favorite swimming hole or trout creek, making the water unpleasant and unhealthy for people and animals. Horses, like people, need clean, fresh water to drink. Horses that drink from streams and farm ponds that are not properly managed to avoid mud and contaminated runoff will be forced to stand in mud while they drink dirty water.

Mud creates a very unhealthy environment for the horse.

Mud harbors bacteria and fungi, which cause diseases such as thrush, scratches, rain scald, rot, and abscesses. It creates slippery footing, which will result in added wear and tear on shoes and hooves and can cause injuries from slips and slides. Horses who are fed on muddy ground can ingest dirt and sand particles, causing a serious digestive disorder known as sand colic. Mud is a breeding ground for certain kinds of insects that will bite both you and your horse.

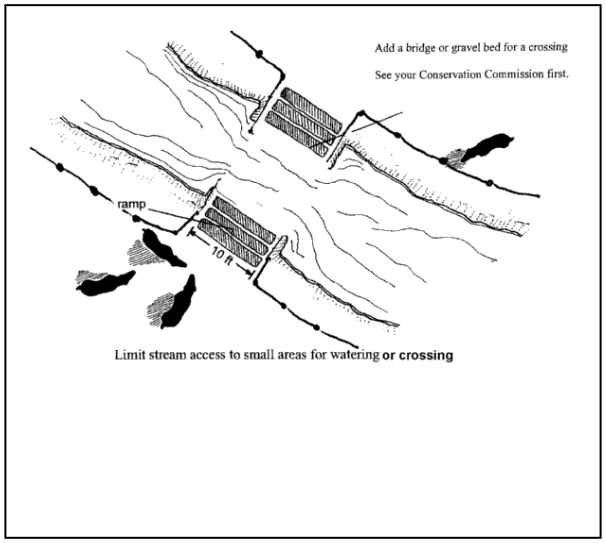
Mud is also inconvenient for horse owners. It makes chores difficult and unpleasant. Walking around in slippery mud makes it difficult to move from place to place, and treacherous when handling an unruly or energetic animal. Grooming becomes a nasty job when the horse is covered in mud.

What causes mud?

Some of the characteristics that make manure such a wonderful garden additive are also the reason why it contributes to spectacular mud. In order to make really good mud, we need a high organic content. If we start with a regular soil, or even pure sand; add plenty of organic material in the form of manure; pour on water from rainfall or downspouts; maybe add some hay for good measure; and mush it all together by stomping and chopping it with hard hooves, we'll have mud in no time. The organics from the manure will retain moisture for a long period of time, which is great for the garden but bad for making the mud go away.

Produced by the Massachusetts Department of Environmental Protection, Municipal Services Section, Western Regional Office, 436 Dwight Street, Springfield, Massachusetts, 01103. 413-784-1100, TDD 413-746-6620. October 2000.

What can I do?



Here are a few tips to help you minimize or eliminate mud problems on your small farm.

Fence horses out of streams, ponds, and wetlands. If the animals must cross these areas to get to pasture, build water crossings to limit their access to the resources. Ideally, you can provide access to drinking water from a clean groundwater source, with a garden hose filling a stock tank or an automatic watering system. Put these watering spots in dry areas away from surface water, so that the traffic will not create new mud. You can find great hints about this at http://www.netcnct.net/community/oacd/fs09stoc.htm.

Practice good pasture management. Re-seed bare areas and keep horses off until healthy growth reappears. In the spring, restrict horses onto the higher, dry pasture ground until lower pastures have dried up. Confine your horses to a sacrifice area during the winter and spring to avoid hoof impacts on frozen or soggy pastureland. Avoid over grazing -- manage pasture for healthy plant growth, with roots that will help hold soil in place.

Regularly pick up manure and hay. If you can do nothing else, do this. This is also important for your horse's health, eliminating disease-causing bacteria and fungi, parasites, and insect breeding grounds.

Eliminating the source of organic material that would convert soil into mud is the single most important activity you can do.

Reduce rainwater impacts. Check out where your barn's roof runoff, drains and downspouts empty onto the ground. Where needed, construct or rearrange them to divert rainwater and runoff from dumping onto the ground in high traffic areas near barn doors and feeding areas. Once you have done this, keep the gutters and downspouts clean to ensure that they can function properly. If storm runoff spills into your paddock, construct swales or diversions to redirect the water where it can be absorbed somewhere else.

Add suitable footing. You can remove existing mud with a tractor or backhoe, and replenish the area with suitable footing such as sand or small gravel. In high traffic areas it may be necessary to do this every few years, but it is very effective and well worth the trouble. In addition, implementing the suggestions above will greatly extend the mud-free life of the new footing. If you are planning to do this work near a wetland or surface water, be sure to check with your local conservation commission first.

By reducing the amount of mud on your farm, you will be creating a healthier, more secure home for your horses, a more attractive place for yourself and your family to live, and a cleaner, safer environment for everyone.

Additional resources:

http://www.agf.gov.bc.ca/resmgmt/fppa/pubs/environ/horse/horse.htm

"Environmental Guidelines for Horse Owners", another series of web sites by the British Columbia Ministry of Agriculture and Food. Extensive coverage of environmental issues for horse owners including manure management and storage as well as more general resource protection issues. The site also provides other references.

http://www.extension.umn.edu/distribution/naturalresources/DD7540.html

"Manure and Pasture Management for Recreational Horse Owners", a series of web sites by the University of Minnesota Extension Service. Includes plans for building a composting bin, detailed discussion of the composting process, information on pasture management, and an extensive list of additional sources of information.

http://www.netcnct.net/community/oacd/fs11manu.htm

One of a series of Small Acreage Fact Sheets by Oregon's Washington County Soil and Water Conservation District, including tips on controlling mud, good and bad environmental practices, and a year-round calendar of activities for sound farm and pasture management.

http://www.netcnct.net/community/oacd/fs09stoc.htm

More from Oregon's Washington County Soil and Water Conservation District about how to provide water for stock without impacting streams and surface waters.

Agency Resources:

Natural Resource Conservation Service (NRCS) works with farmers on issues relating to the best use of our natural resources. This includes pasture, manure and mud management for horse owners. You can find the number for your NRCS office listed in the phone book under federal government, US Department of Agriculture, Natural Resource Conservation Service.

Conservation Districts also work with farmers and livestock owners, often for smaller, non-commercial places, on similar land management assistance.

MANURE IMPACTS ON SURFACE WATER QUALITY

The quality of water directly impacts the quality of our lives. Contaminated water eliminates drinking water supplies for our horses and families, degrades our recreational water resources, and destroys wildlife habitat. Water that does not soak into the ground, whether from rain, snowmelt, a hose, or leaking pipes, is called runoff. Runoff picks up contaminants, such as nutrients, pathogens, and bacteria from manure and can transport them to the nearest water resource (lake, pond, wetland, stream, or river). Certain site conditions, such as steep and unprotected slopes, lack of vegetative cover, and proximity to receiving waters will encourage manure and contaminants associated with manure from entering surface water resources. Pollution carried by runoff is called nonpoint source pollution (NPS). Proper manure management and runoff management will protect or improve water quality on your property, and in your community and watershed.

Manure contains nutrients, such as phosphorous and nitrogen, and pathogens, including bacteria, viruses and parasites. These pollutants contaminate water resources and reduce recreational potential of lakes and rivers, destroy wildlife habitat, and eliminate drinking water supplies for people and livestock.

How does manure impact water resources?

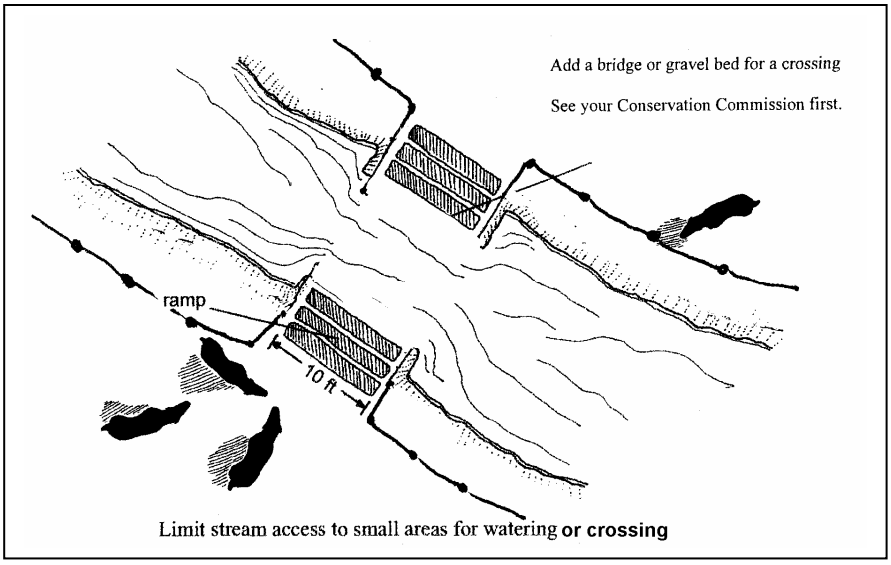
When manure is deposited in water resources, either directly or by runoff, it can negatively impact water resources. The nutrients contained in manure, phosphorous and nitrogen, can be carried by runoff to the nearest water body, such as a pond, stream or lake. The nutrients then fertilize aquatic weeds and accelerate weed growth in lakes and ponds. The aquatic plants deplete oxygen levels, reducing the amount of oxygen available for other aquatic species such as fish. When the weeds die, additional oxygen is required for decomposition, further stressing oxygen stores and aquatic life. Direct manure entry into the water resource can also cause oxygen starvation due to increased biological oxygen demand (BOD), and result in fish kills. Algae blooms are another result of excess nutrients in the lake or pond. Algae blooms further reduce oxygen in the water body, can turn the water an unsightly murky green, and generate an unpleasant odor. Eutrophication (accelerated weed growth) and algae blooms kill fish and make swimming and boating unpleasant.

When the pathogens found in manure, including viruses, parasites, and bacteria such as fecal coliform and *e. coli*, are deposited into a stream or lake, swimming areas and shellfish beds may be closed. Pet and livestock drinking water supplies may be contaminated.

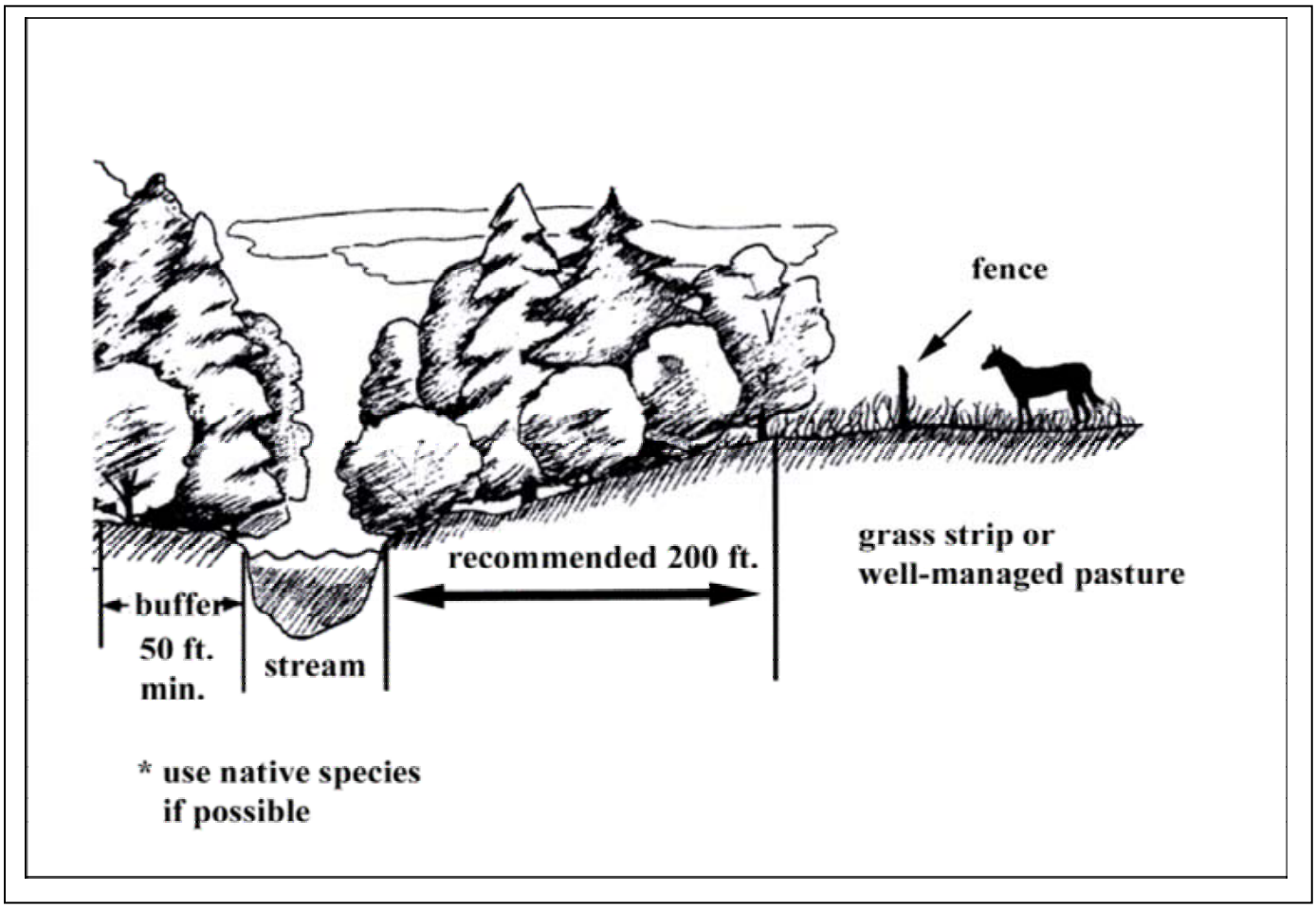
Produced by the Massachusetts Department of Environmental Protection, Municipal Services Section, Western Regional Office, 436 Dwight Street, Springfield, Massachusetts, 01103. 413-784-1100, TDD 413-746-6620. October 2000.

What Can I do To Protect Water Quality?

Prevent manure from being directly deposited in water resources. Keep horses out of streams, lakes, ponds and wetlands. If you can not completely fence your horse out of these areas, build water crossings to limit access as much as possible. (Note: Before installing anything in a waterbody you must contact your Conservation Commission.) Consider alternative water sources, such as troughs or an automatic watering system.



Establish a vegetated buffer strip between horses and any water resources. Don't be discouraged if you have a small area to work with. Any buffer strip is better than none at all!



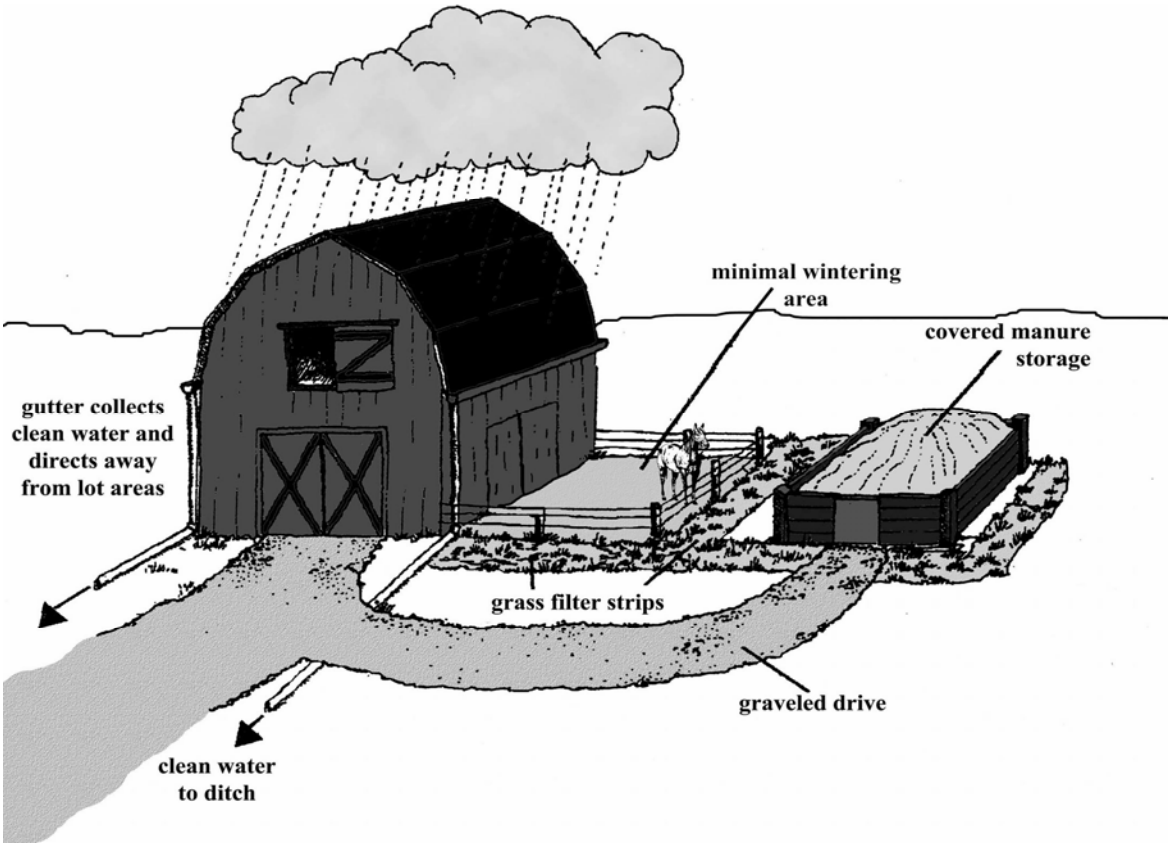
Manage your horse's manure. Proper manure management consists of containing manure, treating manure, and disposing of manure.

Contain: Pick up manure from stalls, paddocks and pastures on a daily or regular basis.

Treat: Composting manure is an effective way to transform waste into a valuable resource for your pastures and gardens. Maintaining a temperature of 135° to 160° will kill most pathogens, parasites and weed seeds. This means fewer flies on your property, reduced odors, and a reduced possibility of parasite infestation for your horse. Refer to the Composting fact sheet for more information.

Dispose: Composted manure is a valuable resource that can enhance the soil and fertilize your pastures and gardens. If you can rotate your pastures, composted manure can be spread in resting pastures during the growing season at no more than a ½ inch layer at a time. If manure is not composted, and you plan to spread it daily or routinely, spread manure on fields that will not be used for grazing, probably for at least a year. Composted manure can also be shared with horseless neighbors!

Minimize runoff. Encourage stormwater infiltration on your property to reduce runoff, and thus the transport of nutrients and pathogens to water resources. Small grassed depressions in your pasture can act as detention basins, capturing water, encouraging sediment and nutrients to filter out of the water, and encouraging infiltration. Roof gutters can direct rain and snowmelt to drywells or rain barrels. Divert storm runoff from high traffic areas and paddocks by constructing grassed swales or diversions.



Additional Resources:

http://neirtnt.ct.nrcs.usda.gov/horse

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http://ceinfo.unh.edu/aahr1050.pdf

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http://www.netcnct.net/community/oacd/fs00safs.htm

A series of Small Acreage Fact Sheets by Oregon's Washington County Soil and Water Conservation District, including tips on controlling mud, providing alternative water sources for livestock, good and bad environmental practices, and a year-round calendar of activities for sound farm and pasture management.

http://www.nrcs.usda.gov

The Natural Resources Conservation Service is a Federal agency that works in partnership with the American people to conserve and sustain our natural resources.

Small Acreage Factsheet # 11
Managing Mud and Manure

"I know two things about the horse and one of them is rather coarse." Naomi Royde Smith

Manure: Muck or Money?

Manure is "black gold." The manure from one horse is worth $150 in fertilizer per year! In the wrong place, however, manure may become a pollutant. Raw manure or manure attached to eroding soil can wash off the land and into the nearest stream. In the stream, manure nutrients and bacteria may cause algae blooms, kill fish, degrade shellfish beds, and pollute drinking water. Your farm's manure pile and muddy animal yard may cause only a small pollution problem, but small things add up. Read on to find out how to turn manure into an asset rather than a liability…

More Reasons to Manage Mud and Manure: Animal Health

Poor mud and manure management can be hazardous to your animals' health.

- **Raw manure and mud provide a breeding ground for flies.**
- **Accumulated mud and manure cause thrush, rain scald, and other diseases.**
- **Dried manure produces molds and causes respiratory problems in horses and cattle.**
- **Heavy manure applications overfertilize grasses. Animals that eat these grasses may suffer nitrate poisoning and grass tetany.**

Mud and Manure Management Problems and Solutions

The first step in managing manure is to identify areas on the farm that may need improvement. Here are some examples of *poor* mud and manure management:

- **Manure pile is uncovered and placed in a low area. Nutrients and bacteria can leach into the groundwater.**
- **Animals trample streambanks, get stuck in the mud, and cause soil erosion.**
- **Water tanks concentrate animal traffic and manure next to the stream.**

- **Roof gutters leak water onto the ground. Water creates muddy areas, picks up pollutants, and flows into the stream.**
- **Uphill drainage enters the animal yard and carries polluted runoff into the stream.**

You may already be practicing proper mud and manure management. Good for you! Here are some examples of *good* management:

- **Manure pile is moved into a covered facility for winter storage.**
- **Animals are fenced away from the stream. A buffer of shrubs and trees planted next to the stream helps to filter animal yard runoff.**
- **Water tanks are located in each paddock and away from the stream.**
- **Roof gutters, downspouts, and a tile divert rainwater away from the animal yard and into the stream. Muddy areas are replaced with an installation of road fabric and gravel.**
- **Uphill drainage is diverted away from the animal yard and into the stream.**

The "Scoop" on Manure

Here are the steps towards good manure management:

- **Collect manure every 1 to 3 days. You will reduce muddy areas, fly breeding sites, and polluted runoff by regularly removing manure. Use a shovel, manure fork, wheelbarrow, or tractor to collect raw manure from the stalls, animal yards, and pastures.**
- **Store and cover manure to keep nutrients from leaching away. If you have few animals, you may only need a watertight tarp to go over and under a small manure pile. Locate the pile on a site that's high and dry. If you have many animals, you may want to install a roofed storage structure with a watertight floor. The manure stack should have two to three walls to hold leached materials and to ease manure handling. Storage facilities should be located more than 100 feet from wetlands, streams, or ditches and above floodplains.**
- **Compost manure to produce a valuable resource. Composting has many benefits. It may reduce a manure pile to half its original size, produce a stable fertilizer, and kill animal parasites. For effective composting, build the pile dimensions to at least 3 feet tall by 3 feet wide, aerate the pile by turning it or inserting perforated pipes through the center, and water the pile until it is moist, but not saturated. You should not be able to wring water from a handful of compost. These steps should raise the temperature up to 131° F for at least three days in a row to kill worm eggs. Finished compost will smell earthy and feel cool to the touch.**
- **Stockpile manure during the fall and winter. The storage area should be big enough to store all the manure until it can be used as a fertilizer. Six months of storage, from October to April, will allow you to stockpile manure when soils are saturated or frozen and the potential for runoff is high. You can then spread manure in the spring, when plants are**

growing and can use the manure nutrients. See "Manure Storage Needed Per Animal" below for general guidelines on storing manure.

- Spread manure during the growing season. Spread manure or compost for use as a fertilizer on growing plants during the growing season. You'll need a tractor and manure spreader or a pickup truck and rake to spread manure. See "Acreage Needed Per Animal" for general guidelines for spreading manure.

Apply Manure to Match Pasture Needs

Spreading manure from one 1,000-lb. horse, one 1,000-lb. beef cow, three 150-lb. pigs, twelve 100-lb. sheep, six 100-lb. goats, or four 300-lb. llamas on one acre of pasture may provide the yearly phosphorus needs for pasture. Actual numbers will depend on a soil test, crop yield, and management conditions. Apply too much manure, and you run the risk of losing fertilizer dollars, raising forage nutrients to dangerous levels for animal health, and leaching nutrients and bacteria into water. Have you discovered that you don't have enough land? Consider giving away manure to your community, increasing your pasture production, buying or renting more land, or reducing the number of animals that you own.

Manure Storage Needed Per Animal

In general, you will need the following floor space to store the manure produced by an animal over a six-month period. The estimates are based on a 5-foot-high manure pile and average bedding.

Livestock	Area Needed Per Animal for 6 Months Storage
Horse	72 square feet
Cattle	72 square feet
Sheep	6 square feet
Pig	12 square feet
Goat	6 square feet
Llama	12 square feet

The actual space will vary according to the bedding used, animal weight, and height of the manure pile. Adapted from *Pollution Control for Horse Stables and Backyard Livestock* - U.S. Environmental Protection Agency (EPA).

Mud Matters

Mud can make chore time unpleasant, increase fly breeding areas, transmit diseases, create unsafe footing, and increase polluted runoff. Often the best protection against mud is prevention. Reduce the amount of rain that runs through your animal yard and you will reduce mud and polluted runoff. Tips to reduce runoff include:

- **Install Roof Gutters: Install roof gutters and downspouts to divert clean water from the animal yard. A 1-inch rain on a 20-foot by 50-foot roof will produce 620 gallons! Design gutters to handle the amount of rainfall in your area.**
- **Protect Downspouts: Protect downspouts from animal and equipment damage by using heavy polyvinyl chloride (PVC) pipe, a hot wire, or a permanent barrier. Empty downspouts into a stock watering tank, rain barrel, dry well, tile line, road ditch, or creek.**
- **Control Runoff: Locate new animal yards at least 100 feet from wetlands, ditches, and streams. Curb concrete animal yards or use an earthen berm around animal yards that are close to wetlands, streams, or ditches. Divert animal yard runoff away from wetlands, ditches, and streams and into a vegetated area that can filter the flow. Divert clean water above animal yards to wetlands, ditches, and streams. Close open ditches with a buried pipe to carry water past animal yards.**

You may not be able to eliminate mud, but you can reduce the amount of mud. Tips to reduce mud and potential pollution include:

- **Fence Animals: Fence animals away from wetlands, streams, or ditches. Rotate water tank areas to avoid mud and manure buildup.**
- **Use Sacrifice Areas: Move animals into a corral, run, or pen when pastures are wet in the winter or when grass is less than 3 inches high in the summer. These holding areas are called "sacrifice areas" because the grass is "sacrificed" to preserve cover in the pastures. Locate a new sacrifice area on high ground and at least 100 feet away from wells and open water. Maintain a 25-foot grass buffer around the sacrifice area to filter polluted runoff. Widen the buffer if the sacrifice area slopes or is located near wetlands, streams, or ditches.**
- **Install Firm Footing: Muddy areas are often found at barn entrances, lanes, gates, and loafing areas. You can install concrete in these areas. However, geotextile fabric and gravel will provide an all-weather surface at a third of the cost. Geotextile fabric allows water to drain down, but stops mud from working up through the gravel. Use a layer of geotextile fabric next to the soil, a 4- to 6-inch layer of 1.5-inch or smaller crushed rock in the middle, and a 2- to 3-inch layer of 5/8-inch or smaller crushed rock on top to provide a firm surface. In areas with less animal traffic, consider using up to 18 inches of hogfuel or wood chips for footing. Hogfuel decomposes and needs to be periodically replaced. Avoid using**

hogfuel near wetlands, streams, or ditches, as resin acids may leach into water.

- **Design Drainage: Slope the animal yard with a 4 to 6 percent grade and use a southern aspect for quick drying. Use tile drainage to reduce water in the animal yard and riding ring. Drain tile water into a buffer strip that can filter pollutants in runoff.**

A Year in the Life of a Manure Manager

January, February, March:

No manure is applied to frozen or saturated soils, to frequently flooded land, or on days when heavy rains are forecast. Manure is applied at low rates on land with well-drained soil and actively growing grass. In the Willamette valley and eastern Oregon, grass begins to grow in March and April, respectively.

April, May

Manure from the storage facility is tested for nutrients and applied to match plant needs. Manure buildup is removed from animal yards and is spread on pastures, cropland, and gardens. On annually tilled land, manure is applied and immediately incorporated to retain nutrients.

June, July, August

Manure is applied to pastures and hay ground to match plant needs. Irrigation is used to water-in nutrients using good irrigation water management. Some animals will not graze pastures with freshly applied manure. In this situation, the manager has two or more pastures to graze animals. If the manure has not been composted to kill parasites, the deworming program is continued.

September, October

This is the critical time of year for managing manure in an environmentally sound manner. Soil conditions produce nitrates that may leach into water with the first fall rains and continue through the winter. No manure is applied to annual crops where growth has slowed or stopped. Some manure may be applied to growing grasses or a cover crop, according to soil test recommendations.

November, December

No manure is applied. Manure pile is covered. Animal yards and pastures are scouted for problem areas that have runoff, standing water, or mud.

It's the Law

You are responsible for managing manure to protect surface water and groundwater. Federal and state laws forbid discharging animal wastes into water. Would you believe that manure management could increase your property values? If you are selling your property, manure facilities can be an asset under today's regulatory requirements.

Small Acreage Factsheet # 9
Managing Stockwater in Pastures and Streamside Areas

"The frog does not drink up the pond in which he lives." Indian Proverb

Times are changing...

At one time, livestock watered freely in ditches, ponds, and streams. Those days are over, as people understand how this practice can affect animal health, water quality, and wildlife habitat. It makes good sense to install a fence and an alternative watering system to protect surface water. Here's why:

- **Healthy Animals: An Oregon study showed that livestock prefer water from troughs over water from streams. Livestock gain up to 30% more weight on clean water and graze more efficiently when troughs are distributed throughout pastures. When animals loaf in streams, they are at greater risk from algae toxins and water-borne diseases. Muddy areas near streams may also increase foot rot, leg injuries, and stress.**
- **Clean Water: Clean water is essential to people, fish, and the environment. One study found five times more trout in streams with stable banks verses streams with eroded banks. When livestock deposit manure in or near water, the components of manure may be harmful: phosphorus increases algae blooms, ammonia kills fish, and coliform bacteria sickens or kills people with weakened immune systems.**
- **Wildlife Habitat: The trees, shrubs, and tall grass next to streams provide 74% of the food and 94% of the cover for Oregon wildlife. One study found 89 bird species on ungrazed banks compared to 2 bird species (grackles and starlings) on grazed banks. Without stream fencing, livestock may trample grass nests, wade through spawning beds, and muddy the water.**

The benefits of a fence and alternative watering system to protect surface water don't end on-site. The watershed is a big neighborhood where there will always be someone affected downstream. What's more, the law prohibits animal wastes from entering water and impacting those downstream. Many landowners are realizing the need for change and are looking at better watering alternatives that protect the health of their animals and the environment.

You Can Lead Livestock to Water…

There's no one right structural "fix" for watering livestock. Every situation is different and it takes planning to get the right solution for you. The first step is to find out how much water your livestock drink. Water use depends on animal size, reproductive status, and weather. Plan according to the number of animals that you have or anticipate to have.

Animal Average drinking needs*

- **Beef Cow: 12 gal/day**
- **Horse: 12 gal/day**
- **Pig: 8 gal/day**
- **Llama: 5 gal/day**
- **Sheep: 4 gal/day**
- **Goat: 4 gal/day**

***On hot days, animals may need twice as much water.**

Location, Location, Location: The location of the watering site determines herding behavior and drinking patterns. Here are some suggested watering locations:

- **In Each Pasture: Animals tend to drink one at a time if water is provided in pastures 10 acres or less in size. A flow rate of 2-6 gallon per minute will keep a 25-35 gallon tank full. Change the tank location along the fence line to allow sod to recover in former watering areas. A trough in each pasture will keep animals and manure on the grass and out of the lanes.**
- **Away From Feed, Minerals and Shade: Distribute these items through the pasture. This will discourage loitering in one area and disperse grazing. Provide water outside of the barn or livestock may stay in the barn on hot days and not pasture at all.**
- **More Than 100 Feet from Open Water: Animals concentrate manure and mud at watering sites. This can create "hot spots" for erosion and polluted runoff. Leave a healthy buffer between watering sites and watercourses.**
- **Less Than 500 Feet Between Water Sources: If water is far away or located outside the pasture, then animals will travel as a herd to the water and drink as a herd. In a herd situation, livestock will graze unevenly, concentrate in the watering area, and "boss" animals may prevent timid animals from drinking. If this situation can't be avoided, be sure to have enough space at the water source for 10 percent of the herd to drink at any time. Each drinking animal should have 20 inches of space at a circular tank and 30 inches at a straight tank.**

Stockwatering Options

There are a number of cost-effective options for the landowner with a small number of acres and animals. The following options are best when water and power sources are nearby.

Access Ramp/Water Gap to Streams and Ponds

An access ramp provides firm footing and easy access to water while excluding animals (when used with fencing) from trampling the adjacent streambank. It is the most basic improvement that can be made to a stream or pond. Ramps may still cause reduced water quality and animal health concerns. Ramp features include:

- **Gentle slopes, about 1 foot drop for every 6 feet of length**
- **Pit run gravel that's 1.5 feet thick and 10 feet wide**
- **Geotextile fabric or polygrid underneath gravel to prevent gravel from mixing with mud**
- **Fence to restrict animals to the ramp**

Water Hauling

A truck, with a storage tank and a removable stock tank in back, is a time-tested method. Water hauling features include:

- **Water source can be routinely relocated throughout pastures**
- **System is useful in rotational grazing**
- **Manure is evenly distributed**

Nose Pumps

Nose pumps are the lowest cost pumping system available. Animals provide the power by pushing a lever with their nose. Each stroke pumps about a pint of water from a hose in the creek to a holding bowl. Nose pump features include:

- **Capacity of 30 head of cattle or equivalent per pump.**
- **Water can be pumped 26 feet high or 125 foot run in a 1-inch hose or pipe.**
- **1-2 day training period for animals to learn system. (Small calves and others may be unable to use pump.)**
- **Flexibility to move pump from pasture to pasture. (Locate pumps away from creeks to buffer any manure or runoff problems around pumps.)**
- **Maintenance needed. Check daily. Protect from frost or remove in winter.**

Spring Development

Springs are formed when water moving through rocks or soil is forced out of the ground. These areas are easily developed. For more information, see *Protecting*

Water Supply Springs (AG473-15) **- A North Carolina Cooperative Extension Service publication. Spring development features include:**

- **Water that is often clean and cold. However, water can be easily contaminated.**
- **Watershed above spring that should be protected. Test water quality to be sure it meets animal health guidelines.**
- **Low cost compared to a pond or a well.**

Pipeline

Above ground or buried pipeline (such as rigid plastic, flexible plastic, and galvanized iron) provides an economical way to provide water if you have a well or are on a public water system. However, pipelines require more design considerations such as pipeline material, length, elevation differences, and water pressure. A one-way valve should be installed in the line to prevent back flow to your well or rural water system. Pipeline features include:

- **Flexibility to supply several paddocks, an ideal setup for the pasture manager. A hydrant, located where four paddocks meet, can supply all four with a garden hose. Pipeline can be placed along lanes.**
- **Underground pipe is easy to install with a ditch witch on most soils. However, stony soils can be a real chore that may require a backhoe.**
- **Pipe buried below the frost line and frost-free hydrants can provide water during cold weather.**
- **Maintenance is needed. Check daily. Drain at the end of the season.**

Make Your Own Water Tank

A low cost water tank can be made from a plastic 30 to 55 gallon barrel that is cut in half, installed with a float, and connected to a pipeline system. Make sure the previous content of the barrel was nontoxic. Locate the barrel close to the water source and on high ground to reduce mud. Place hoses in a manner that is safe for animals. Larger tanks can be made from used heavy equipment tires. For details on making used tire tanks, see *Trough (Used Heavy Equipment Tire)* - USDA Natural Resources Conservation Service design.

Here is a summary of watering systems:

Stockwatering Option	Impact on Animals and Water Quality	Cost (1993 Prices)
Surface Water Source: • Access Ramp	• Some animal health and production concerns • Reduced water quality	• $600, plus fence • $100/year maintenance
Surface Water Source: • Nose Pump	• Some training required • No negative effect on animal	• $350-450 per pump, plus

• Stream Powered Pump	health or water quality	fence • $50/year maintenance
Surface Water Source: • Stream Powered Pump (Hydraulic Ram, etc. have specific flow and elevation needs)	• Noisy • If return discharge avoids erosion and animal contact, no negative effect on animal health or water quality	• $500-1000, plus fence and trough • $50/year maintenance
Ground Water Source: • Nose Pump • Stream Powered Pump	• Some training required • No negative effect on animal health or water quality	• $350-450 per pump, plus fence • $50/year maintenance
Ground Water Source: • Plastic Pipeline	• No negative effect on animal health or water quality	• $1-2 per pipeline foot, plus troughs • $50/year maintenance
Ground Water Source: • Solar Powered Pump	• No negative effect on animal health or water quality	• $2000-6000 for solar equipment, tank, fence, and pad
Ground Water Source: • Spring Development	• No negative effect on animal health or water quality	• $700, plus fence and trough • $50/year maintenance
Ground Water Source: • Water Hauling	• No negative effect on animal health or water quality	• Cost of truck, tanks, and gas
Ground Water Source: • Wind Powered Pump	• No negative effect on animal health or water quality	$5000-6000 for windmill, tank, fence, and pad

Small Acreage Factsheet # 8
Managing Weeds in Pasture

"What is a weed? A plant whose virtues have not been discovered." Ralph Waldo Emerson

When to Fight Weeds

Some "weeds" are actually beneficial plants. In hayfields, dandelions extend the time needed to dry hay, but make good forage with almost as much protein as alfalfa. Along fence rows, sweet clovers and grasses may offer habitat for wildlife and beneficial insects. "Weeds" may also reduce erosion while a new forage crop is filling in.

On the other hand, some weeds *are* weeds. Vigorous weeds compete with forage plants for water, nutrients, light, and space. Weeds earn their reputation when they crowd out crops, hurt our pocketbooks, and harm the environment. Take direct action on:

- **New Weeds Invading Your Property: Use a quick tug, a shovel, or the appropriate spot-spray to remove a weed before it becomes established on your place. Be sure to remove it before it goes to seed.**
- **Perennial Weeds: Perennial weeds have a life cycle longer than two years. Once established, they are difficult to remove even with good pasture management.**
- **Poisonous and Noxious Weeds: These plants poison livestock, invade native plant communities, and destroy wildlife habitat. Take immediate action to remove these weeds.**
- **More Weeds than Forage: Control weeds before they make up 30 to 40 percent of the stand. Weeds can point to management problems such as overgrazing, lack of nutrients, or improper soil pH. Try improving your pasture management through rotational grazing, fertilization, and soil pH adjustments. Consider herbicides or renovation only after you have improved your pasture management. Renovation is a good time to control perennial weeds by planting an annual crop to clean up weeds.**

Look Before You Leap on Weeds

Identify Weeds: In wise weed control, the most important step is to correctly identify the plant. Many plants are harmless, while others increase fire hazard, increase soil erosion, poison animals, or take over! Knowing the plant species

and its traits can save you time, money, and peace of mind. Identify the plant with an identification guide such as:

- ***Weeds of the West* - edited by Tom D. Whitson**
- ***Gilkey's Weeds of the Pacific Northwest* - La Rea J. Dennis**
- ***Plants of the Pacific Northwest Coast: Washington, Oregon, British Columbia, and Alaska* - edited by Jim Pojar and Andy MacKinnon**

Monitor Weeds: Most small acreages can tolerate some loss due to weeds. If the weed doesn't warrant quick action, start a "weed watch" to see if weedy areas expand or shrink with improved pasture management. Consider drawing a weed map of your pasture to keep tabs on the weed population from year to year. If weeds make up more than 30 percent of the pasture, notch up your weed control.

An Ounce of Weed Prevention

Stop weeds from getting a roothold with the following practices:

- **Grow a Healthy Forage Sod: Up to 95 percent of your weed control can come from a thick, vigorous sod that prevents weed establishment and discourages soil erosion. Soil test, fertilize, clip, aerate, and irrigate pastures, if possible. Manage livestock grazing and keep animals off wet pastures.**
- **Seed Areas Around Troughs, Salt Blocks, Barnyards, and Roadsides: Open soil is an open invitation to weeds. New weeds often show up in these places. Consider seeding these areas annually.**
- **Clean Equipment: Brush or hose down equipment from weed-infested pastures before entering new pastures. Monitor cleaning areas for new weeds.**
- **Control Weed Seeds Spread by Floods: Weed seeds can float on water. Install seed screens on outlet pipes and control weeds near irrigation ditches.**
- **Quarantine Animals New to Property or Pastures: Animals can deposit weed seeds with their manure and start new infestations. If animals have been grazing a weed-infested pasture, keep livestock in the barnyard for a few days before moving them to a clean pasture. Before spreading manure, compost it to kill weed seeds.**
- **Buy Weed-free Seed: A pound of purchased seed can contain 400 weed seeds. If you ask to see the detailed seed label (and not just the one on the bag), it will list the weeds present by species. This way, you can "select" weed seeds already on your land and avoid planting seeds of something new.**
- **Buy Weed-free Hay: Grow your own hay, inspect grass stands prior to harvest, buy high-quality hay, or buy from a respectable source. By following these practices, you will bring less weed-contaminated hay to your property.**

- **Cooperate with Neighbors in Controlling Weeds: A neighboring field of weeds gone to seed can invade your property. Or your weed spray may drift and damage the fruit trees on your neighbor's property. Their problem is your problem and vice versa. Work together to solve weed problems.**

Stop Seeds at Their Source

Why stop weeds before they make seeds? Here are some startling statistics:

- **Longevity: In Denmark, 600-year-old seeds were found in a monastery. Scientists germinated 11 seeds! Although most grass seeds last less than ten years, broadleaf seeds can sprout after decades in the soil.**
- **Population Control: To survive, weeds have turned seed production into a fine art. One pigweed plant can produce 11 million seeds. Many plants "just" produce 100,000 seeds. One noxious weed is "one too many."**

A Noxious Weed Alert

Noxious weeds are an "explosion in slow motion." They are exotic plants that flourish in the absence of insects and diseases normally present in their native habitats. These weeds are aggressive and invade native plant communities, crowd out forage, destroy wildlife habitat, and increase erosion. Noxious weeds:

- **Comprise 8 to 47 percent of the total plants in most states**
- **Threaten two-thirds of the endangered species**
- **Invade western wildlands at the rate of 5000 acres per day**

Once noxious weeds are established, they are difficult to eradicate. Tansy ragwort, leafy spurge, gorse, yellow starthistle, spotted knapweed, scotch broom, Canada thistle, and purple loosestrife are examples of noxious weeds that have caused millions of dollars of economic loss. Contact the Oregon Department of Agriculture Noxious Weed Program at (503) 986-4621 or your local Oregon State University Extension Service office to identify and control noxious weeds in your area.

Wise Weed Control

Combine mechanical, biological, and chemical tactics to successfully control weeds:

Mechanical: Use your back or a tractor

- **Scout pastures and pull or hoe weeds. You can control an infestation before it starts and relieve your stress at the same time! Combine your scouting walks with feeding, moving irrigation pipe, and other chores.**

- **Clip to control weeds. Mow annual weeds before they produce seed heads. Mow perennial weeds twice a year over several years to exhaust root reserves. Mowing will control bull thistle, but can make musk or plumeless thistle harder to control. Disking and harrowing increase rushes or sedges that grow in wet soils. Know your plant and treat accordingly.**
- **Till to control annuals and some perennials. Tillage kills simple perennials that multiply by seed, but will spread creeping perennials that increase by creeping stems. Creeping perennials are the most difficult weeds to control. You may need to use a combination of continuous tillage, repeated mowing, and persistent herbicides to control an infested field.**

Biological: Work naturally

- **Plant forages adapted to your site. Forages adapted to the site conditions have the best chance to grow and compete with weeds. For example, perennial ryegrass will produce high quality pasture at a site with irrigation, high fertility, and well-drained soils. Tall fescue will grow in less ideal conditions, such as low fertility and dry soils.**
- **Use approved insects and diseases to check weeds. The natural enemies of a particular weed can be used to control weeds. However, natural controls take time to work, do not eradicate the target weed, and have erratic results. Tansy ragwort and St. Johnswort are noxious weeds that have been controlled biologically. For more information, contact the Oregon Department of Agriculture at (503) 986-4621.**
- **Graze sheep and goats on weeds and brush. Sheep and goats will eat leafy spurge and poison ivy, donkeys like thistles, and goats prefer woody brush like blackberries! Confine or tether animals to a small area, but watch out for soil erosion and poisonous plants when "mob" stocking.**

Chemical: Spray effectively and properly

- **Read the label. When pasture management fails to control weeds, use a herbicide selected for the identified weed. To select herbicides, see recommendations in the *Pacific Northwest Weed Control Handbook* at your local Oregon State University Extension Service office. Read the label when purchasing a herbicide and again before applying it.**
- **Calibrate your sprayer for the correct application. Too little won't work. Too much wastes money and harms the environment.**
- **Spray weeds under the right conditions. Most herbicides need time to dry in order to work so avoid spraying before a rainstorm. Check the label for temperature requirements because warm conditions can increase spray volatility and injure plants.**
- **Avoid drift problems. Herbicides can drift up to half a mile. Avoid damaging gardens, yards, and sensitive plants like tomatoes, grapes, and maple trees. Reduce drift by using low pressure, large nozzles, drift control agents, or non-volatile formulations such as amine salts rather than esters. Avoid spraying when it is windy.**

- **Spray weeds at the proper stage. A common mistake is to spray perennials too early. Systemic herbicides such as Roundup, 2,4-D, and Banvel should be used on perennials when plant sugars move down into roots. This occurs at bud stage and in the fall.**
- **Use the most environmentally friendly herbicide. Try choosing herbicides with short life spans, low toxicities to wildlife, and low runoff or leaching potentials. Spray in the evening when bees are less active. Dispose empty containers according to the label. Use anti-backflow valves on faucets and hoses to fill sprayer tanks. An anti-backflow valve will prevent the contents of a sprayer from accidentally entering a well or public water system.**

Poisonous Plants

Plants produce poisons so animals will avoid eating them. Most poisonous plants are unpalatable or few in number. For details on the habitat and toxic dose of poisonous plants, see: *Impacts of Common Toxic Weeds on Foraging Livestock* or *Western Washington Poisonous Plants* (for horses).

Take the following steps to prevent animal poisonings:

- **Inspect new pastures before turning animals in, especially in the spring.**
- **Provide adequate minerals as the lack of salt may produce strange cravings.**
- **Avoid overgrazing and lack of palatable forage.**
- **Avoid grazing wetlands and woodlands where many poisonous plants occur.**
- **Provide supplemental feed during drought when poisonous plants are often the only green plants in the pasture.**

If Your Animal is Poisoned

- **Isolate the animal and offer fresh water**
- **Take samples from the suspected plant to aid in diagnosis**
- **Call your veterinarian immediately**
- **Remove the plant from the pasture**

You can also call the National Animal Poison Control Center, a nonprofit service of the University of Illinois College of Veterinary Medicine, at 1-800-548-2423. There is a $30 charge for this service.