BEST MANAGEMENT WETLANDS PRACTICES (BMWPs) for AGRICULTURE

NH Department of Agriculture, Markets & Food (2019)

DEDICATION

This Best Management Wetland Practices (BMWP) Manual is dedicated to the BMWP primary author Michael Lynch. Mike has worked for the USDA Natural Resource Conservation Service (formerly the SCS) for 37 years and has recently retired. His co-worker, NRCS Resource Soil Scientist Karen Dudley, states:

> ***Mike is truly a fountain of knowledge when it comes to any aspect of soil conservation. What I admire the most about him is his ability to keep complex situations uncomplicated. NRCS can never fill the void that he will leave behind and the farmers of NH are losing one of their best technical resources*.**

The NH Department of Environmental Services Wetlands Bureau and the NH Department of Agriculture also highly value Mike's knowledge, assistance, and dedication over the many years in helping farmers, applicants, town officials, and state agencies. Your public service is greatly appreciated.

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CHAPTER I

Introduction

Agricultural lands can play a significant part in the abundance and the quality of New Hampshire's lakes, streams and wetlands. The term "water quality" is more than water clarity. Water quality encompasses the chemical, physical, and biological properties of water in lakes, streams and wetlands.

Many agricultural activities in New Hampshire may involve working in land which falls under the definition of 'wetlands'. According to New Hampshire Wetlands Law RSA 482-A, no person should excavate, remove, fill, dredge, or construct any structure in areas of wetlands without first obtaining a permit from the NH Department of Environmental Services (NHDES) Wetlands Bureau. The Wetlands Bureau has been charged by the legislature with protecting the State's submerged lands and wetlands from despoliation and unregulated alteration and operates under the provisions of RSA 482-A and the Code of Administrative Rules (Chapters Wt 100 through Wt 800).

Maintenance or improvement of existing crop or pasture land for continued agricultural use which impacts wetlands are under the NH Wetlands Bureau jurisdiction. Utilizing the Best Management Wetland Practices (BMWPs) for minimizing impacts in agricultural operations under Board permit process can ensure that minimum environmental impact will occur to wetlands.

This publication is primarily a reference and a planning tool to assist agricultural producers to become better informed about BMWPs for reducing soil erosion and sedimentation from agricultural operations that affect wetlands. When using this publication, it is important to remember that for every situation encountered, there may be more than one correct method to prevent or minimize erosion and sedimentation.

What This Handbook Is

This handbook describes BMWPs for protecting water quality and wetlands associated with farming operations. *A BMWP is a method or practice which, when installed or used, is consistent with efficient, practical, technically and environmentally sound animal or crop production practices. BMWPs are those practices best suited to preventing, reducing, or correcting agriculture-related problems.* (NPS report, October 1991). The BMWPs include a wide range of recommended techniques that, if used in combination with professional judgment, will provide protection for our wetland resources. This handbook is for farmers, agricultural professionals and others involved in agricultural land management. This handbook will help you understand, identify, design, and implement water quality protection measures while meeting other farm objectives.

This handbook will help you to:

- Understand how BMWPs work. It is more effective, cheaper, and easier to prevent pollution than to fix problems after they occur. When you understand the principles behind BMWP techniques, you will be able to anticipate and prevent problems before they end up costing you time and money.
- Decide which BMWPs to use. Farming activities are quite diverse, as are the site conditions upon which farming are practiced
- Apply BMWP principles, allowing you to use your own judgment along with this handbook to select the most appropriate and effective BMWPs for a particular site.

What This Handbook Is Not

BMWPs are not the same as regulations. Best management practices are procedures that, when used appropriately, will result in the greatest protection of the environment over the course of the operation.

Regulations describe required minimally acceptable practices. BMWPs may be required in some situations to obtain wetland permits; others may be voluntary, depending on the site. If the agricultural operation impacts wetlands or surface waters (by traveling across them), BMWPs are required and a NHDES wetland dredge and fill permit may be necessary. In addition, many towns with local wetland regulations, designated prime wetlands, and wetland setbacks may require local permitting if work is done in those areas.

This handbook focuses on water quality and wetland BMWPs. There are BMWPs that protect wildlife habitat, soil integrity and productivity, aesthetics, and other aspects of the agricultural operation. Although these values are important, they are not the primary focus of this manual.

How to Use This Handbook

The BMWP manual is most effective when used as a resource for planning an agricultural land management system. It provides information about why water quality is important and how to protect it. In addition, the BMWP manual provides tips and techniques that assist land managers with low-cost and effective methods for protecting water quality while constructing roads, stream and wetland crossings, maintaining ponds and drainage improvements. If you are new to BMWPs, it is best to read the publication all the way through to get a sense of the content, layout, glossary and other resources available.

The intent is to develop a conservation system comprised of one to several BMWPs that address a particular management concern while minimizing or eliminating impacts to wetlands. The chapters cover planning; access; field improvements; ponds, water supply and irrigation; stabilization and erosion control; and waste management systems. The manual contains a detailed set of standards and specifications for each BMWP that are referred to in the chapters.

Waivers

The manual is not intended to be comprehensive, but rather a set of BMWPs commonly used in New Hampshire which inevitably do not cover all eventualities. There are instances where a better, simpler, or more cost effective BMWP may be available to protect the wetland and/or water quality. In these instances, a waiver may be requested which may be granted at the discretion of the Wetland Bureau.

1. New Hampshire's Water Resources

New Hampshire has hundreds of lakes and ponds, large areas of forested and non-forested wetlands, and thousands of miles of streams and rivers. All these forest waterbodies, and the areas that drain to them, are connected by moving water. This BMWP handbook is designed to help protect them.

2. How Agriculture Affects Water Quality

Agricultural land management can directly impact water quality by affecting sediment, nutrients (phosphorus and nitrogen), bacteria and pesticides. Additionally, biotic impairments exist that may be attributed to any combination of those mentioned above. Pollutants, habitat loss, modified hydrology and/or any other factors may prevent establishment of plants and animals expected to be found in a particular water body.

Increased organic and inorganic nutrients

Applying nutrients in excess of a crop's requirements can result in the excess reaching surface or ground water through erosion or leaching.

Excess pesticides

Misapplied pesticides may reach surface or ground water.

Reduced soil infiltration capacity

This can occur any time the soil and/or surface is disturbed, removed, compacted, or otherwise damaged.

Increased soil erosion potential

The opportunity for soil to be carried away by runoff increases greatly when soil is exposed or fill is used.

Water flow diversion

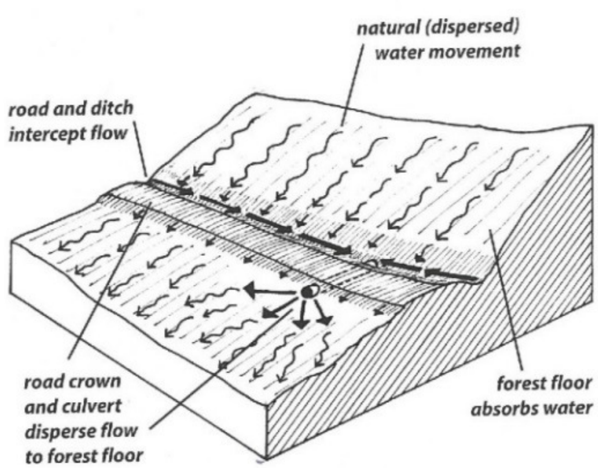
Roads and tillage patterns can block or intercept water moving over or through the soil. The more water that accumulates, the greater the chance that it will form a channel and start eroding soil.

Concentrated water flows

Roads, waterways, diversions, terraces, and their associated drainage structures can collect and funnel runoff, creating rills or gullies. In these situations, water erodes and transports exposed soil and associated contaminants.

Reduced benefits from vegetated buffers

Removing vegetative buffers and tilling to the edge of water courses reduces filtering and uptake of pollutants in runoff, reduces shade on the water's surface, reduces the amount of natural woody debris and eliminates leaf litter that is an important food source for aquatic life. In addition, the more open agricultural land in a watershed can increase the amount of water moving through the soil into streams, and in some instances, increase flooding.



3. How Agricultural BMWPs Protect Water Quality

Control water flow

- Plan how water moves within and around the harvest area and decide how water flow will be controlled.
- Control small volumes of water before they converge and accumulate into concentrated flows.

- Slow down runoff and spread it out. Many BMWPs work by directing small amounts of water into areas of undisturbed forest floor where it can be absorbed.

Minimize and stabilize exposed soil

- Limit soil disturbance and stabilize areas of exposed soil. These practices are most critical in and around riparian management zones (forest areas bordering water bodies) and in other locations where runoff has the potential to reach surface waters or wetlands .
- Protect exposed soil, which can erode very rapidly. Most of the sediment that ends up in streams near managed forests comes from exposed soil on roads, landings, and skid trails.
- Know where the riparian management zones are and how to protect their capacity to absorb and filter runoff.
- Using BMWPs during or immediately after the harvest prevents exposed soil or fill from eroding.

Maintain adjacent vegetation

- Stabilize stream channels and banks. By protecting the physical integrity of streams, BMWPs alleviate fish passage issues.
- BMWPs maintain the benefits that nearby trees and plants provide water bodies. Stream side vegetation shades the water, minimizing temperature changes. Live roots stabilize the banks and maintain the soil's physical and chemical properties. Trees along the banks drop leaf litter and woody debris that supply nutrients and provide habitat for plants and animals in the stream. Shoreland vegetation plays and important role in maintaining water quality.

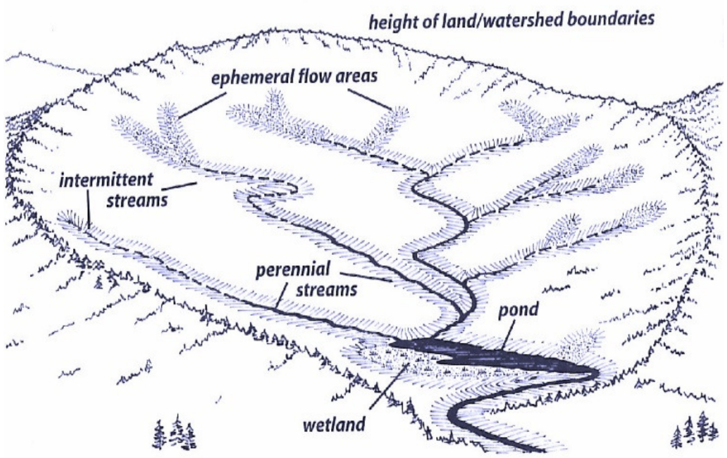
Handle nutrients and pesticides safely

- Proper handling and application guidelines are summarized in the Nutrient Management section of this manual.

WATERSHED

A **watershed** is all the land and waterbodies from which water drains to a given point. You can define a watershed for an entire lake, for a stream at a crossing site, or for a river where it reaches the ocean. Watersheds range in size from just a few acres (for a small stream), to thousands of acres (for a large river). All land is part of some watershed.

It is crucial to understand where water is coming from and draining to in the watershed where there is farming. The amount of open agricultural land at higher elevations can affect the amount and timing of runoff at lower elevations within the same watershed. When you know where, when, and how much water flows in the agricultural area, you will be able to determine the best locations for roads, the size of constructed swales and the size of any crossing and therefore what types of BMWPs you will need to control water movement.



The watershed of a pond.

In this manual, “waterbodies” includes streams, rivers, lakes, ponds, and wetlands, as well as coastal areas. These BMWPs are primarily for those areas where water is at or near the surface (streams, lakes, or wetlands), and where runoff can move directly into surface waterbodies. These waterbodies and related areas are defined and illustrated below.

EPHEMERAL FLOW AREAS

Ephemeral flow areas are small drainage areas that flow into streams, but have no defined, continuous channel. Examples are low-lying depressions, or swales with an intact forest floor. Soils in these areas may quickly become saturated during rainy periods, storms, or snowmelt.

Surface water flows in these low ephemeral areas over saturated soil without forming a channel. Water from ephemeral flow areas may carry sediment or other materials directly into streams. Ephemeral flow areas change in size in response to the soil and weather conditions, and are the proximate source of much of the water that enters small streams. Many ephemeral flow areas are wetlands.

STREAMS

Streams are natural water channels that:

- may flow year-round or only part of the year,
- have a defined channel and banks,
- are relatively continuous and connected with larger surface waters, and

- have a streambed where flowing water has exposed the mineral bottom of soil, sand, gravel, ledge, or rock.

Forest streams in New Hampshire vary widely in how much water they carry, how steep they are, the shape of the streambed or channel, how much area they drain, and when they flow.

Perennial streams

- generally flow year-round
- range from small brooks to large rivers

Intermittent streams

- flow only a few months of the year, or during wet seasons.

The **normal high water mark** is the place on the stream bank where the highest water levels typically occur, often during spring runoff. You can identify it from features like undercutting of the bank; a change in the type of vegetation; exposed roots that do not penetrate beyond a certain level; root scars; and water stains on rocks, stems, roots, or other vegetation.

WETLANDS

Wetlands are areas where soils are saturated or flooded at least part of the year, and where water-loving plants are often found. Wetland soils usually have developed special characteristics which reflect that water is at or near the surface sometime of the year.

Wet meadows are herb-dominated wetlands typically with non-woody vegetation less than 3 feet in height, saturated for long periods during the growing season, but seldom flooded. Wet meadows develop on predominantly poorly drained soils (NHDES Env-Wt 101). Wet meadows are typically managed areas that would otherwise revert to forested wetlands. Most wetland impacts covered by a NHDES Minimum Impact Agricultural permit are limited to wet meadows

Forested wetlands are dominated (or potentially dominated) by trees taller than 20 feet. Forested wetlands vary widely in their characteristics, often have relatively little water directly at the surface, and have indistinct borders. They may require considerable expertise to identify. Forested wetlands are often managed for timber, with roads and trails crossing them, and they may be considered for expanding the agricultural land base for farms. It is critical that they be evaluated by a professional soil or wetland scientist before being cleared for agriculture. The Minimum Impact Agricultural permit cannot be used for impacts to forested wetlands.

Bogs (non-forested or **open wetlands)** are not dominated by trees, though they may have some scattered trees, mostly less than 20 feet tall. They have water at or near the surface at least part of the year, and may have a more or less distinct border defined by the surrounding forest. The high water and organic content of wetland soils make them considerably weaker than upland soils and difficult to work in. The NHDES Minimum Impact Agricultural permit cannot be used to affect a bog.

Vernal pools are a type of wetland, typically forested, which provide specialized habitat for amphibians and reptiles and deserve special attention. They are small, seasonal wetlands that lack and inlet and outlet and lack fish populations. During the dry seasons they may only be recognizable as an isolated depression in the forest floor. A wide variety of other wildlife species also use vernal pool habitats, including several threatened and endangered species.

Separate guidelines for identifying vernal pool habitat are available from the NH Fish & Game Department (NHFGD), Non-game and Endangered Species Program. Further information regarding recommended practices for timber harvesting near vernal pools can be found in section 7.3 of *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire*, 2010.

Wetlands Characteristics:

Hydrology, or the presence of water in or above the soil;

Signs of wetland hydrology include:

- During most years, the area has ponding, flooding, or a water table within 12” of the soil surface for 14 or more consecutive days during the growing season (bud burst to leaf fall);
- Water stained (dark) or silt covered leaves;
- Lines of organic debris such as leaf litter on tree and shrub stems above soil surface;
- Water or silt stained plant stems;
- Swollen bases of tree trunks (an adaptation to wet soils);
- Exposed plant roots (an adaptation to wet soils).

Soils, which show observable features when saturated or flooded for long periods of time;

Signs in the soil include:

- Sphagnum moss on the surface;
- A thick upper layer of peaty to mucky organic matter;
- Soils mostly neutral grey in color directly beneath the dark topsoil or grey soils with rust colored (orange-brown and yellow-brown) splotches within 12" of the surface.

Vegetation, which is usually composed of a dominance of species suited to hydric (largely anaerobic) soil conditions. In an agricultural setting the mix and density of plants may be altered through management so observing similar adjoining sites may be necessary.

Signs in the composition of plant species include:

- More than half the plant species are those that grow most often in wetland soils. Plant species have been classified by the US Fish & Wildlife Service based on how frequently they occur in wetlands. The species are grouped into five categories, listed here from most to least wetland adapted:

Obligate Wetland Species

Species occur more than 99% of the time in wetlands.

Facultative Wetland Species

Species occur between 67-99% of the time in wetlands.

Facultative Species

Species occur equally in uplands and wetlands.

Facultative Upland Species

Species occur between 1-33% of the time in wetlands.

Obligate Upland Species

Species occur less than 99% of the time in wetlands.

4. What is Section 404 of the Clean Water Act?

Section 404 of the Clean Water Act defines *wetlands* as"...those areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.". Section 404 of the Clean Water Act lists specific agricultural and silvicultural activities which are exempt from regulation, even though these activities occur on "jurisdictional wetlands." The regulatory agency which administers Section 404 of the Clean Water Act is the U.S. Army Corps of Engineers (ACOE) in consultation with the U.S. Environmental Protection Agency (USEPA), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fishery Service and the U.S Natural Resources Conservation Service (NRCS). The NRCS can provide information on federal wetlands criteria, wetland determinations on agricultural lands, information on wetland soil characteristics, and interpretations and information on federal rules and regulations concerning administration of its programs. Activities within ACOE jurisdiction that are regulated by the NHDES may be permitted using the ACOE New Hampshire General Permit to minimize duplication by the two agencies.

5. What Farming and Forestry Activities are Exempt from Section 404 of the Clean Water Act?

There are basically two main provisions under Section 404 that must be satisfied for a farming activity to be exempt. Under Section 404(f)(1), a discharge is exempt only if it is associated with certain ongoing farming, silviculture, and ranching activities. Under Section 404(f)(2), known as the "recapture provision," the discharge continues to be exempt only if the activity does not bring an area of waters into a new use and impair the flow and circulation of the waters or reduce their reach. Exempt activities are: established (i.e., ongoing), normal farming activities such as: plowing, seeding, cultivating, harvesting and minor drainage for the production of food or fiber, maintenance (but NOT construction) of drainage ditches (the term "maintenance" includes removal of accumulated silt and debris, but does not include widening, deepening, realigning or extending the length of existing drainage ditches), construction and maintenance of irrigation ditches, construction and maintenance of farm or stock ponds (to provide water for livestock or irrigation as long as the size and location of the pond are proportionate to the quantity of water needed to support the principal farming operation) construction and maintenance of farm and forest roads~~,~~ in accordance with BMWPs. The list above is only a summary.

The full text of the federal law can be found in Section 404 of the Clean Water Act. Many clarifications and examples are found in the USACOE implementing regulations and interagency memoranda. ~~(~~For further details the following Internet address can be accessed: http://www.usace.army.mil/net/functions/cw/cecwo/reg with 404f.htm, sec404.htm, 33cfr323.htm#323.4, and cwaag.htm~~)~~.

To be exempt under Section 404 of the Clean Water Act, the farming or silvicultural activity must be part of an ongoing farming or silvicultural operation and cannot be associated with converting a wetland to agricultural or silvicultural production, or converting an existing agricultural or silvicultural wetland into non-wetland area. Wetlands which were hydrologically altered and converted to produce an agricultural commodity (meaning an annually tilled crop) prior to December 23, 1985, and which were or are used for commodity crop production and remain in agricultural use, are identified as "prior converted croplands" when designated by NRCS. Such wetlands are not under the jurisdiction of Section 404 unless the activities that resulted in the conversion involved the unauthorized discharge of dredged or fill material into wetlands or other waters. Agricultural wetlands which have not been used, managed or maintained for cropping purposes in the last five years are considered abandoned and generally are subject to regulation under Section 404. Areas that are inundated for longer than 14 days during the growing season are not prior converted but "farmed wetlands" and remain under Section 404 jurisdiction.

It is important to note that some activities exempted under federal regulation, such as construction of farm ponds or farm roads, may not be exempt under state and local regulations. Exempted activities under state wetlands regulations are summarized in RSA 482-A:3, IV(b) and NH Administrative Rule Env-Wt 308.01.

CHAPTER II

PLANNING

Farm management activities should follow a well-thought-out plan that protects soil and water resources. Landowners considering improving or maintaining~~,~~ access, filling, improving or developing water sources, or improving drainage to fields should consult their county conservation district, their local NRCS office or county extension professional, or a certified wetland scientist for assistance and an on-the-ground evaluation.

A variety of tools can help in evaluating the property and developing a plan for land management activities. These tools include aerial photography, soil surveys, soil survey maps, topographic maps, and property survey maps or tax maps.

Walk the property to identify areas of special concern such as streams, ponds, wetlands and nesting sites. Consider strategies to avoid sensitive areas and/or minimize the foot print of the proposed work. Establish objectives and priorities for the management activities.

Planning not only means identifying the management activities but also the timing of carrying out the activity. Timing is one of the most effective best management practices. Operating when the ground is dry, frozen, snow covered, or when the water levels are low, is an excellent way to reduce or eliminate erosion and sedimentation.

Plan to take additional precautions or even to suspend the management activity until conditions permit.

Site Evaluation

- Review the farm conservation plan and landowner objectives for the site.
- Identify on a map (topographic, aerial photo or county soil map) the following:
    - Property and field boundaries
    - Public roadways
    - Problem areas, wet and unstable soils, eroding slopes and or gullies, soils and limitations, stormwater runoff locations
    - Existing and planned farmstead and access road system
    - Areas to avoid (streams, wetlands, water bodies, steep slopes (>30%), unstable soils and flood plains)
    - Farmstead equipment maintenance, manure storage, pesticide and fueling areas
    - Existing and potential stream crossing locations, include estimates of drainage areas and land use
    - Existing and potential riparian buffers, natural and manmade
    - Other sensitive areas such as habitat areas of endangered or threatened species, known nesting sites, etc.

In order to minimize stream sedimentation, flow interruption, and disturbance of fish during sensitive seasons, carefully consider the time and duration of culvert installation and repair. In general, in-stream work should occur during low flow conditions and should be scheduled so that it doesn't coincide with fish migrations, spawning and egg incubation period. Consult with local fish or water resource biologists in order to plan for the best times to avoid fish mating and migration activities in a particular stream.

Planning Management Activities

- Make a tentative list of site specific BMWPs needed to protect water quality for proposed management activities in or adjacent to wetlands.
- Mark roads, stream crossings, wetland crossings and specific devices to be used. Take advantage of natural features that will make construction easier and drainage most effective.
- Consider weather and ground conditions when scheduling earth moving activities.
    - Avoid wet seasons and plan water crossings (installation or bridges and culverts) for summer months when water is low.
    - On wet sites and when working in or adjacent to wetlands, time operations to coincide with frozen ground.

CHAPTER III

ACCESS

Intent

By implementing the practices in this chapter, which are designed to protect wetland characteristics, functions and values, wetland impacts can be avoided and minimized. Typically, the wetlands affected by these practices are classified as Wet Meadow, and occur in an agricultural field and have hydric soils that are defined as soils that, in an undrained condition, are saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation. ***Additional jurisdictional wetland areas may include forested wetlands, intermittent streams, farm ponds or other areas that support and are necessary to an existing agricultural operation. The access would have to meet qualifying criteria that is set in rules and defined as Minimum.***

ACCESS ROAD

Definition

A travel way for equipment and vehicles constructed as part of a conservation system.

Purpose

To provide for an efficient transportation system for removing agricultural products while also protecting agricultural land and water quality, for agricultural access, or other needed agricultural management activities.

Conditions Where Practice Applies

Where area and volume to be harvested makes it necessary and economically feasible to install such a road system.

Guidelines

- A well thought out efficient transportation system will minimize the area disturbed and vulnerable to erosion.
- Keep the length of the truck road to a minimum. Have gravel or wood chips for about 200 feet prior to entering on a public highway to reduce the amount of mud on the highway.
- Road grades should be kept to 10% or less. Steeper grades are permissible for short distances. Long level sections are difficult to drain properly. Grades between 3% and 5% are desirable.
- Place roads on high ground with gentle grades. Avoid sharp curves. Fifty foot minimum radius for large trucks.
- Minimum road width is 10 feet for one-way traffics and 15 feet for two-way traffic. Increase the tread width by a minimum of 4 feet for trailers.
- Use a construction fabric underlayment in areas with potential seeps or spring time wet areas.
- Move surface water quickly off road surfaces and onto undisturbed land. Ditches should be used to efficiently divert water away from the road surface. Water entering a roadway should be moved under or away from the roadway before gaining sufficient

flow and velocity to erode ditches. Drainage ditches should not end where they will feed water directly into streams or other surface waters.

- Where necessary install cross drainage culverts to collect and safely transmit water flows from ditches and seeps under the access road to a safe outlet.

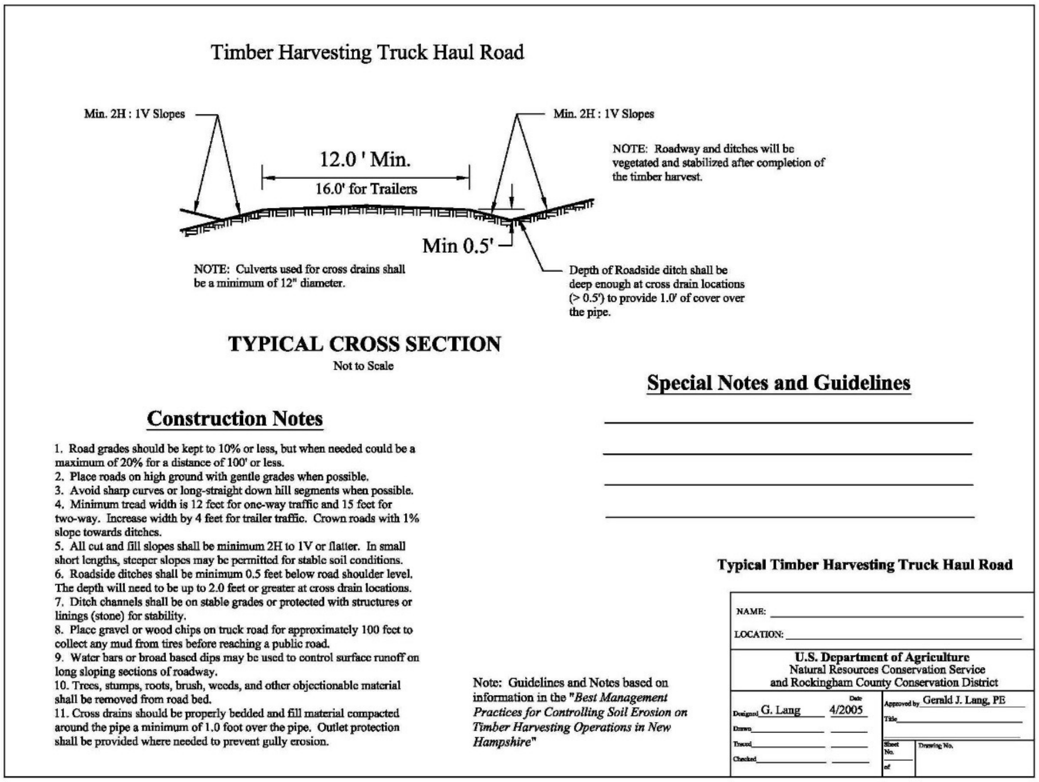
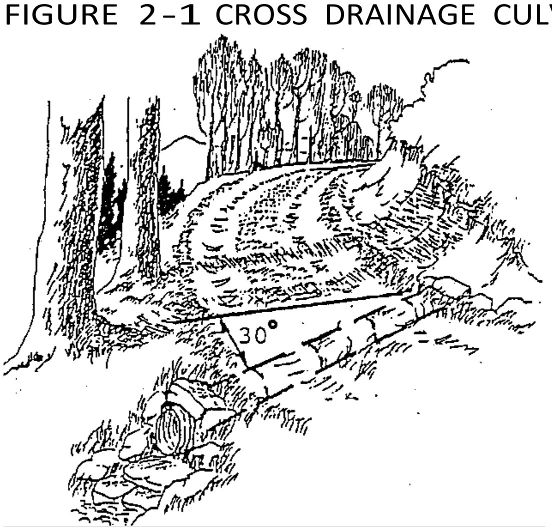
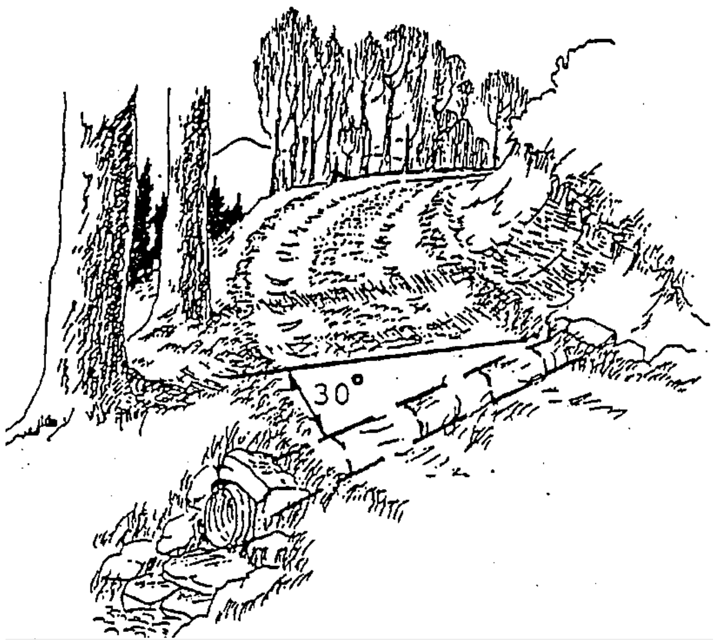


FIGURE 2-1 CROSS DRAINAGE CULVERT INSTALLATION





Source: BestManagement Practicesfor Erosion Control

- If streams must be crossed, do so by the most direct route and preferably at right angles to the stream. A bridge, culvert, or ford of acceptable design may be required.
- Road grades approaching stream crossings should be broken and surface water dispersed before it reaches the watercourse.
- Restrict vehicle traffic on soft roads during the wet season of the year.
- Restrict vehicle traffic during heavy rains.
- Check with the State of New Hampshire Department of Transportation or the local town officials to determine if a driveway permit is required.
- Vegetate exposed areas of soil that are subject to erosion.
- Restrict access where necessary to protect road. Install gate or other barrier to exclude traffic.
- Annual and after significant rain fall events inspect the road surface and drainage structure and repair and/or clean out as necessary.

STREAM CROSSING

Definition

A stabilized area or structure constructed across a stream to provide a travel way for people, livestock, equipment, or vehicles.

Purpose

- Provide access to another land unit
- Improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the stream
- Reduce streambank and streambed erosion.

Conditions Where Practice Applies

This practice applies to all land uses where an intermittent or perennial watercourse exists and a ford, bridge, or culvert type crossing is needed.

Criteria

Apply this standard in accordance with all local, State, Tribal, and Federal regulations, including flood plain regulations and flowage easements.

Identify significant cultural resources or threatened or endangered species that could be affected by the implementation of the practice.

Location. Locate stream crossings in areas where the streambed is stable or where it can be stabilized (see NRCS Conservation Practice Standard, Channel Bed Stabilization, Code 584). Do not place crossings where channel grade or alignment changes abruptly, excessive seepage or instability is evident, overfalls exist (evidence of incision and bed instability), where large tributaries enter the stream, or within 300 feet of known spawning areas of listed species. Avoid wetland areas.

Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.

Install stream crossings perpendicular to the direction of stream flow where possible. Fully consider the natural lateral migration pattern of the stream in the design. Avoid skews on all but the smallest streams.

Access Roads. Where the stream crossing is installed as part of a roadway, size the crossing according to NRCS Conservation Practice Standard, Access Road.

Width. Provide an adequate travel-way width for the intended use. Make "livestock- only" crossings no less than 6 feet wide and no more than 30 feet wide, as measured from the upstream end to the downstream end of the stream crossing, not including the side slopes.

Side Slopes**.** Make all side slope cuts and fills stable for the channel materials involved. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Stream Approaches. Blend approaches to the stream crossing with existing site conditions, where possible. Use streambank soil bioengineering practices as appropriate and feasible. Make the approaches stable, with gradual ascent and descent grades which are not steeper than 4 horizontal to 1 vertical (4:1), and of suitable material to withstand repeated and long term use. Make the minimum width of the approaches equal to the width of the crossing surface. Divert surface runoff around the approaches to prevent erosion. Direct roadside ditches into a diversion or away from the crossing surface. Configure the crossing approaches (gradient and curves) to properly accommodate the length and turning radii of vehicles using the crossing.

Rock. All rock must be able to withstand exposure to air, water, freezing, and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows. Use appropriate rock sizes to accommodate the intended traffic without damage to the livestock, people, or vehicles using the crossing.

Fencing. Exclude livestock access to the crossing through the use of fence and gates, as needed. Install cross-stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain, or other devices to allow the passage of floodwater and large woody material during high flows. Design and construct all fencing in accordance with NRCS Conservation Practice Standard, Fence, Code 382.

Vegetation*.* Plant all areas to be vegetated as soon as practical after construction. If completion does not coincide with appropriate planting dates for permanent cover, use a cover of temporary vegetation to protect the site until permanent cover can be established. Native or functioning-as-native plant species are preferred. Use NRCS Conservation Practice Standard, Critical Area Planting, Code 342, where vegetation is unlikely to become established by natural regeneration, or where acceleration of the recovery of vegetation is desired. In areas where the vegetation may not survive, use NRCS Conservation Practice Standard, Heavy Use Area Protection, Code 561.

Bridge Crossings

Design bridges in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. Design bridges with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics. Design bridges to fully span the stream, passing at least the bankfull flow where the design flow is not dictated by regulation.

Road Type	Storm Frequency
Forest Access Roads, Field Access Roads, Driveways, or Facility Access Roads	10 year - 24 Hour
Public Access Roads, Etc.	25 year - 24 Hour

Table 1

Design culverts to minimize habitat fragmentation and to minimize barriers to aquatic organism movement.

Do not use culverts where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent (100 horizontal to 6 vertical).

Evaluate the need for safety measures such as guardrails at culvert crossings.

Crossings should be adequately protected so that out-of-bank flows safely bypass without damaging the structure or eroding the streambanks or the crossing fill.

At least one culvert pipe should be placed with its entire length set six inches below the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics and water surface elevations.

Make the barrel length of the culvert adequate to extend the full width of the crossing, including side slopes, and inlet or outlet extensions. Unless an approved headwall design is used, stable side slopes should have a minimum combined horizontal protection length equal to 5 feet for every one foot of vertical embankment, except that neither upstream nor downstream bank will be steeper than 2H:1V. Culvert sections should be joined by water-tight couplers.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, new or used high quality steel, and any other materials that meet the requirements of NRCS Conservation Practice Standard, Structure for Water Control, Code 587.

Ford Crossings

The following criteria apply to all ford crossings:

Make the cross-sectional area of the crossing equal to or greater than the natural channel cross-sectional area. Make a portion of the crossing depressed at or below the average stream bottom elevation when needed to keep base flows or low flows concentrated.

Match ford shape to the channel cross-section to the extent possible.

Provide cutoff walls at the upstream and downstream edges of ford-type stream crossings when needed to protect against undercutting.

Evaluate the need for water depth signage at ford crossings.

To the extent possible, the top surface of the ford crossing should follow the contours of the stream bottom but in no case should the top surface of the ford crossing be higher than 0.5 foot above the original stream bottom at the upstream edge of the ford crossing.

Make the downstream edge of the ford crossing with a low-flow hydraulic drop less than 0.5 foot above the original stream bottom.

Concrete Fords

Use concrete ford crossings only where the foundation of the stream crossing is determined to have adequate bearing strength.

Use concrete with a minimum compressive strength of 3,000 psi at 28 days, with a ratio of water to cementitious materials of 0.50 or less. Use coarse aggregate of 0.75 to 1 inch nominal size. If designed for freezing conditions, use concrete with 4 to 8 percent air-entrainment.

Use a minimum thickness of 5 inches of placed concrete. Pour the concrete slab on a minimum 4-inch thick gravel base, unless the foundation is otherwise acceptable.

Construct toe-walls at the upstream and downstream ends of the crossing. Make the toe-walls a minimum of 6 inches thick and 18 inches deep. Extend the toe-walls in the stream approaches to the bankfull flow elevation.

Precast concrete panels may be used in lieu of cast-in-place concrete slabs. To the extent possible, the panels should follow the contours of the stream bottom in order to avoid potential problems with sediment accumulation. Use concrete units that have adequate reinforcement for transportation and placement.

Dewatering of the site and toe-walls is required during placement of the concrete to maintain the proper water/cement ratio. Flowing water will erode concrete that is not sufficiently hardened. The stream must be diverted or retained from flowing over the concrete for at least 12 hours after placement of the concrete. During construction, aquatic species must be removed from the construction area according to State protocols.

Rock Fords and the Use of Geosynthetics

Coarse aggregate or crushed rock ford crossings are often used in steep areas subject to flash flooding and where normal flow is shallow or intermittent. When the site has a soft or unstable subgrade, use geotextiles in the design of rock ford crossings.

Dewater and excavate the bed of the channel to the necessary depth and width and cover with geotextile material. Install the geotextile material on the excavated surface of the ford and extend it across the bottom of the stream and at least up to the bankfull flow elevation.

Cover the geotextile material with at least 6 inches of crushed rock. Use minimum 6-inch deep geocells, if geocells are used. Use durable geosynthetic materials and install them according to the manufacturer's recommendations, including the use of staples, clips, and anchor pins.

Design all rock ford stream crossings to remain stable for the bankfull flow. Compute channel velocities and choose rock size using procedures in NEH630; NEH654 TS14N; and EFH Chapter 16 (NEH650), Appendix 16A, or other procedures approved by the State Conservation Engineer.

Where rock is used for ford crossings for livestock, use a hoof contact zone or alternative surfacing method over the rock.

<u>Considerations</u>

Avoid or minimize the use of or number of stream crossings through evaluation of alternative trail or travel-way locations. Assess land user operations to consolidate and minimize the number of crossings. Where feasible, use existing roads.

Evaluate proposed crossing sites for variations in stage and discharge, tidal influence, hydraulics, fluvial geomorphic impacts, sediment transport and flow continuity, groundwater conditions, and movement of woody and organic material. Increase crossing width or span to accommodate transport of large woody material in the flow.

Design passage features to account for the known range of variation.

For culvert crossings, consider incorporating natural streambed substrates throughout the culvert length for passage of aquatic organisms (see Bunt and Abt, 2001, for sampling procedures). Natural streambeds provide passage and habitat benefits to many life stage requirements for aquatic organisms and may reduce maintenance costs.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. Design criteria are available in NEH Part 654, Technical Supplement 14N, Fish Passage and Screening Design; U.S Forest Service low-water design guidance (USFS, 2006); and stream simulation guidance (USFS,2008). Each State also has specific design criteria for culverts and stream crossings (e.g., MassDOT, 2010). See also Harrelson, et al. 1994, for stream reference site descriptions.

Where a stream crossing is installed to remove an existing barrier to the passage of aquatic organisms, consider using NRCS Conservation Practice Standard, Aquatic Organism Passage, Code 396.

Consider relevant aquatic organisms in the design and location of crossings to improve or provide passage for as many different aquatic species and age classes as possible.

Consider the habitat requirements of other aquatic or terrestrial species that may be affected by construction of a stream crossing. For example, a crossing may be designed with features that also promote safe crossing by terrestrial vertebrates.

Ford crossings have the least detrimental impact on water quality when their use is infrequent. Ford crossings are adapted for crossing wide, shallow watercourses with firm streambeds. If the stream crossing is to be used frequently, or daily, as in a dairy operation, a culvert crossing or curbed bridge should be used, rather than a ford crossing.

Locate stream crossings to avoid adverse environmental impacts and consider the following:

- Effects on upstream and downstream flow conditions that could result in increases in erosion, deposition, or flooding. Consider habitat upstream and downstream of the crossing to avoid fragmentation of aquatic and riparian habitats.
- Short-term and construction-related effects on water quality.
- Overall effect on erosion and sedimentation that will be caused by the installation of the crossing and any necessary stream diversion.
- Effects of large woody material on the operation and overall design of the crossing.
- Consider adding a well-graded rock riprap apron on the downstream edge

of concrete crossings to dissipate flow energy.

- Ford crossings should not be placed immediately downstream from a pipe or culvert because of potential damage from localized high velocity flows.

Plans and Specifications

Prepare plans and specifications for stream crossings in keeping with this standard. The plans and specifications must clearly describe the requirements for applying the practice to achieve its intended purpose.

As a minimum, include the following in plans and specifications:

- Location of stream crossing.
- Stream crossing width and length with profile and typical cross sections.
- Design grades or slopes of stream approaches.
- Design flow calculations.
- Thickness, gradation, quantities, and type of rock or stone.
- Type, dimensions, and anchoring requirements of geotextile.
- Thickness, compressive strength, reinforcement and other special requirements for concrete, if used.
- Vegetative requirements that include seed and plant materials to be used, establishment rates, and season of planting.
- Location, type, and extent of fencing required.
- Method of surface water diversion and dewatering during construction.
- Location of utilities and notification requirements.

Operation and Maintenance

Develop an operation and maintenance (O&M) plan and implement it for the life of the practice.

Include the following items in the O&M plan, as a minimum:

- Inspect the stream crossing, appurtenances, and associated fence after each major storm event and make repairs if needed.
- Remove any accumulation of organic material, woody material, or excess sediment.
- Replace surfacing stone used for livestock crossing as needed.

REFERENCES

AASHTO, 2010. American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Customary U.S. Units, 5th Edition, with 2010 edits; ISBN Number: 1- 56051-451-0

Bunte, Kristin; Abt, Steven R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel-and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. Gen.

Tech. Rep. RMRS-GTR-74. Fort Collins, CO:

U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 p. (http://www.fs.fed.us/rm/pubs/rmrs_gtr74.html)

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P, 1994. Stream channel reference sites: an illustrated guide to field technique. Gen.
Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p. (http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF)

MassDOT, 2010. Design of Bridges and Culverts for Wildlife Passage at Freshwater Streams. Massachusetts Department of Transportation, Highway Division. (http://www.mhd.state.ma.us/downloads/projDev/Design_Bridges_Culverts_Wildlife_Passage_122710.pdf)

CONSERVATION COVER

Definition

Establishing and maintaining permanent vegetative cover to protect soil and water resources.

Purposes

- Reduce soil erosion and sedimentation.
- Improve water quality.
- Enhance or create wildlife habitat.

Conditions Where Practice Applies

This practice applies on land to be retired from agricultural production requiring permanent protective cover, and on other lands needing permanent protective cover. This practice does not apply to plantings for forage production or to critical area plantings.

Criteria

General Criteria Applicable to All Purposes

Species should be adapted to soil, range site, and climate conditions. The New Hampshire USDA Plant Hardiness Zone Map can help determine proper species.

Species planted should be suitable for the planned purpose and site conditions. Use of invasive species should be avoided.

Seeding rates and methods should be adequate to accomplish the planned purpose.

Planting dates, planting methods and care in handling and planting of the seed or planting stock should ensure that planted materials have an acceptable rate of survival.

Only viable, high quality and adapted seed or planting stock should be used.

Legume seed should be inoculated with the proper Rhizobia bacteria before planting.

Site preparation should be sufficient for establishment and growth of selected species.

Timing and use of equipment should be appropriate for the site and soil conditions.

Vegetative manipulation will be accomplished by mechanical, biological or chemical methods, by prescribed burning, or a combination of the four. If burning is used alone or in combination with the other methods, Prescribed Burning, practice code 338, must be included as a planned practice.

All nutrients should be applied following the nutrient management requirements in the Field Office Technical Guide (FOTG).

Additional Criteria for Enhancing Wildlife Habitat

Planting/Establishment

Grasses, forbs, and legumes should be planted in mixes to encourage maximum plant diversity.

Management/Maintenance

Methods used should be designed to protect the soil resource from erosion. Maintenance practices and activities should not disturb cover during the reproductive period for grassland wildlife species.

Maintenance measures must be adequate to control noxious weeds and other invasive species. Coordinate invasive species management with the NHDES Exotic Species Program.

Considerations

This practice may be used to promote the conservation of wildlife species in general, including threatened and endangered species.

Where applicable this practice may be used to conserve and stabilize archeological and historic sites.

Consider rotating management and maintenance activities (e.g. mow only one-fourth or one-third of the area each year) throughout the managed area to maximize spatial and temporal diversity.

Where wildlife management is an objective, the food and cover value of the planting can be enhanced by using a habitat evaluation procedure to aid in selecting plant species and providing or managing for other habitat requirements necessary to achieve the objective.

Use native species when available. Consider trying to re-establish the native plant community for the site. If a native cover (other than what was planted) establishes, and this cover meets the intended purpose and the landowner's objectives, the cover should be considered adequate.

Plans and Specifications

Specifications for this practice should be prepared for each site. They should include, but are not limited to, recommended species, seeding rates and dates, establishment procedures, and other management actions needed to ensure an adequate stand.

Specifications should be recorded using approved specifications sheets, job sheets, narrative statements in the conservation plan, or other acceptable documentation.

Operation and Maintenance

Maintenance practices and activities should not disturb cover during the primary nesting period for grassland species in each state.

Exceptions should be considered for periodic burning or mowing when necessary to maintain the health of the plant community. Mowing may be needed during the establishment period to reduce competition from annual weeds. Noxious weeds will be controlled to prevent proliferation and spreading to adjacent fields.

Annual mowing of the conservation cover stand for general weed control is not recommended.

Any use of fertilizers, pesticides and other chemicals should not compromise the intended purpose.

Table 1

Seeding for Temporary Cover

Seed	Seeding Rates		Recommended Seeding Dates	Remarks
	Lbs/Ac	Lbs/1000 sq.ft.		
Winter Rye	112	2.6	8/15 - 9/5 for fall cover	Good for fall seeding. Select a hardy variety
Oats	80	2	4/1 - 7/1 8/15 - 9/15	Best for spring seeding. Early fall seedings will die when winter weather comes, but the dead material will provide protection.
Annual Ryegrass	40	1	4/1 - 6/1	Grows quickly but is of short duration. Use where appearance is important.
Sudangrass	40	0.9	5/15 - 8/15	Good growth during hot summer periods.
Perennial Ryegrass	30	0.7	4/1 - 6/1 8/15 - 9/15	Good cover, longer lasting than Annual Ryegrass. Mulching will allow seeding throughout growing season.

Table 2

Seeding for Permanent Cover

Type of Area and Conditions	Seeding Mixture from Table 3	
	Mowing Planned	No Mowing Planned
Borrow Areas, Roadsides, Dikes, Levees, Pond Banks, and other slopes and banks		
A. Well to excessively drained	1, 2, 3, 4, 5, or 8	3, 4, 5, 6 ,8 ,9, 10, 11, 12, or 13
B. Somewhat poorly drained	2	5 or 6
C. Variable drainage	2	5 or 6
Drainage Ditch and Channel Banks		
A. Well to excessively drained	1, 2, 3, or 4	9, 10, or 11
B. Somewhat poorly drained	2	
C. Variable drainage	2	
Diversions		
A. Well to excessively drained	2, 3, or 4	9, 10, or 11
B. Somewhat poorly drained	2	
C. Variable drainage	2	
Effluent Disposal		5 or 6
Gullied and Eroded Areas		3, 4, 5, 8, 10, or 11
Shorelines (fluctuating water levels)		5 or 6
Sod Waterways and Spillways	1, 2, 3, 4, 6, or 7	1, 2, 3, 4, 6, or 7
General Recreation Seedings, Picnic and Playgrounds, or Driving and Archery Ranges	1, 2, 15, 16, or 18	
Woodland Access Roads, Trails, and Landings		
A. Well to excessively drained		9, 10, or 11
B. Somewhat poorly drained		2, 5 or 6
C. Variable drainage		2, 4, 9, or 10

Table 3

Seed Mixtures for Permanent Seedings

No.	Mixture	Lbs/acre	Lbs/1000 sq.ft.
1.	Kentucky Bluegrass Creeping Red Fescue Perennial Ryegrass	20 20 5	.45 .45 .10
2.	Creeping Red Fescue Redtop Tall Fescue	20 2 20	.45 .05 .45
3.	Creeping Red Fescue Birdsfoot Trefoil 1/ Tall Fescue or Smooth Bromegrass	20 8 20	.45 .20 .45
4.	Tall Fescue Redtop Birdsfoot Trefoil 1/	20 2 8	.45 .05 .20
5.	Reed Canarygrass Redtop	20 5	.45 .10
6.	Reed Canarygrass Redtop Birdsfoot Trefoil 1/	15 5 10	.35 .10 .25
7.	Smooth Bromegrass Perennial Ryegrass Birdsfoot Trefoil 1/	15 5 10	.35 .10 .25
8.	Switchgrass (Broadcast)	10 (PLS) 2/	.25
9.	Creeping Red Fescue Crownvetch or Flatpea 1/ Tall Fescue or Smooth Bromegrass Redtop	10 15 (30) 15 2	.25 .35 (.70) .35 .05
10.	Creeping Red Fescue Redtop Crownvetch or Flatpea	20 2 15 (30)	.45 .05 .35 (.70)
11.	Birdsfoot Trefoil 1/ Crownvetch 1/ Creeping Red Fescue or Tall Fescue	8 15 20	.20 .35 .45
12.	Crownvetch or Flatpea 1/ Perennial Ryegrass	10 (30) 10	.25 (.70) .25
13.	Switchgrass Bluestem (Big or Little) Perennial Ryegrass Birdsfoot Trefoil 1/	5 (PLS) 2/ 5 (PLS) 2/ 5 5	.10 .10 .10 .10
14.	Tall Fescue Flatpea	20 30	.45 .70
15.	Creeping Red Fescue Canada Bluegrass or Kentucky Bluegrass	50 50	1.15 1.15
16.	Creeping Red Fescue Tall Fescue	50 30	1.15 .70
17.	Creeping Red Fescue Flatpea 1/	20 30	.45 .70
18.	Tall Fescue	150	3.5

1/ Inoculate legume seeds. Use four times recommended rate of inoculant when hydroseeding.

2/ (PLS) Pure Live Seed = (% Germination x % Purity) / 100

STRUCTURE FOR WATER CONTROL (Bridges and Culverts)

Definition

A structure in an access, irrigation, drainage, or other water management system that conveys water, controls the direction or rate of flow, or maintains a desired water surface elevation.

Purpose

Water control structures are installed to control the stage, discharge, distribution, delivery, or direction of flow of water in open channels, or water use areas. They are also used for water quality control such as sediment reduction or temperature regulation. These structures are also used to protect fish and wildlife and other natural resources.

Conditions Where Practice Applies

This practice applies wherever a permanent structure is needed as an integral part of an irrigation, drainage, or other water control system to serve one or more of the following functions.

- To provide conveyance for water over, under, or along a ditch, canal, road, railroad, or other barrier. Typical structures: bridges; culverts; flumes; inverted siphons; drop structures; or catch basins.
- Conduct water from one elevation to a lower elevation within, to, or from a ditch, channel, or canal. Typical structures: culverts; drops; chutes; turnouts; surface water inlets; head gates; pump boxes; or stilling basins.
- To protect pipelines from the entry of trash, debris, or weed seeds. Typical structure: debris screens.
- To control water table or removal of surface or subsurface water from adjoining land, to flood land for frost protection or to manage water levels for wildlife or recreational purposes . Typical structures: water level control structures; pipe drop inlets; or box inlets.
- To modify water flow to provide habitat for fish, wildlife, and other aquatic animals. Typical structures: deflectors, chutes; cold water release; or structures for pools and riffles.
- Water level control. Typical structures: structures for recreation or similar purposes, box inlets; pipe drop inlets; or drop structures.
- To control direction of channel flow resulting from tides and high-water or backflow from flooding. Typical structure: tide and drainage gates.
- To control the elevation of water in drainage or irrigation ditches Typical structure: checks dams.
- To control the division or measurement of irrigation water. Typical structures: division boxes or water measurement devices.

Does not apply to structural components of pipeline, subsurface drains, or grade-stabilization structures.

Considerations

General. Other general recommendations for individual component design can be used from the USDA NRCS Engineering Field Handbook where appropriate.

Downstream water volumes or peak discharge rates may be reduced from the installation of a water control structure depending on the size of the structure, drainage area, or pool area above the structure.

Structures installed in brooks and streams will impact water quality during installation. Structures may impact aquatic life by increasing water temperatures and lowering dissolved oxygen. However, any structure impounding water may have a positive long term effect on water quality due to reduced sediment transport.

Site Investigation. Adequate investigation should be made to ensure that sufficient land of suitable quality is available for the intended uses.

- The structure site is stable and, when the planned work of improvement is installed, will perform as intended.
- An adequate water supply is available.

Design Criteria

Structures should be designed on an individual job basis, or applicable USDA NRCS standard drawings should be adapted, to meet site conditions and functional requirements. They should be part of an approved and overall farm or system plan for an agricultural waste, irrigation, drainage, wildlife facility, channel improvement, or other water management system.

The design plan should specify the location, grades, dimensions, materials, and hydraulic· and structural requirements for the individual structure· Provisions must be made for necessary maintenance. Care must be used to ensure that the area's visual resources are not damaged. If watercourse fisheries are important, special precautions or design features may be needed to ensure continuation of fish migration.

If soil and climatic conditions permit, a protective cover of vegetation should be established on all disturbed earth surfaces. If soil or climatic conditions preclude the use of vegetation and protection is needed, non-vegetative means, such as mulches, gravel, or riprap may be used. In some places, temporary vegetation may be used until permanent vegetation can be established. The structure can be fenced to protect the vegetation. Seedbed preparation, weeding, fertilization, and mulching should comply with the vegetative BMWPs.

Hydrology. Peak flow and volume determination should be by approved USDA NRCS methods. The design discharge of an associated structure, the hazard class of overall design, or the discharge from the 10 percent chance (10-year frequency) rainfall, whichever is largest, should be used to design the water control structure. ·

Hydraulics. The capacity of structures should be based upon established NRCS methods.

The minimum spillway capacities should be in accordance with those stated in the Grade Stabilization Structure BMWP found in Chapter V.

Mechanical spillways should be used when flow is expected frequently or will occur for a duration of several days. Earth spillways may be used where vegetation can be established and maintained. A natural rock spillway may be used when it is durable under exposure to varying water and temperature extremes. Structures should be designed to be stable for the maximum velocity expected during passage of the design storm.

Structural. The structural design, quality of material, and the resultant construction should provide for a practice life expectancy consistent with the selected design frequency. The structural design should be based upon the local site conditions. Variable crest spillways (stop logs at inlets or control boxes) should be designed whenever practical to permit regulation of water levels. The high crest of mechanical spillways should be at least 0.5 feet below the crest of the earth spillway.

Culverts installed alone or in combination with earth spillways should safely carry the 1o·percent chance storm as a minimum. In no case will the culvert be less ·than 12 inches in diameter because of potential freeze-up.

Stilling basins or energy dissipaters should be installed at outlets of water control structures where needed to control erosion. Design should be based upon procedures found in the appropriate technical release for the type of structure used.

Earth Embankment. The design and construction of earth embankments should conform with the BMWPs for ponds or dikes.

Other. Design and construction should comply with state and local laws and regulations for dams and wetland disturbance.

Plans and Specifications

Plans and specifications for installing structures for water control should be in keeping with this BMWP and should describe the requirements for applying the practice to achieve its intended purpose.

Appropriate USDA NRCS New Hampshire Construction and Materials Specifications for conservation Engineering Practices should be used and noted on the plans. Copies of the specifications will be attached to the plan when appropriate and needed.

All required national, state and local permits will be secured before construction activities begin.

Operation and Maintenance

An O&M plan should be developed and provided to the landowner. This plan should consider the following general recommendations, as applicable.

- Remove any debris that may accumulate on or in the immediate area of the structure.
- Repair spalls, cracks and weathered areas on concrete surfaces.
- Repair or replace rusted or damaged metal and protect with paint as needed.
- Check all valves, gates, stop logs and other appurtenances for proper functioning. If worn or damaged, repair or replace following the manufacturer's recommendations.

- Check all timber or lumber sections for decay and other damage, especially sections in contact with earth or other materials. Repair damaged sections and apply protective coatings as needed.
- Immediately repair any .vandalism, vehicular or livestock damage to any earth fills, spillways, outlets, or other appurtenances.

Supporting Data for Documentation

Design Data. The following information should be recorded in the design and/or on the drawings, as applicable.

- Sketch of the area applicable to .the design of the water control structure.
- Intended purpose of the water control structure, that is, whether a stream crossing for an access road, or a control structure for a wildlife pond.
- Criteria used to design the structure, such as: storm runoff, seasonal use, etc.
- Survey notes taken to establish elevations needed for design.
- All computations to document the design of the structure.
- Any special considerations involved in the design.
- All dimensions of the structure to be installed for the site.
- Appropriate construction and material specifications.

Check Data. The following information should be recorded on the drawings to certify installation of the BMWP.

- Check notes to document that the structure was installed to the elevations required in the design.
- Dimensions of the structure installed.
- Exact location of buried components in relation to fixed points, such as drain tile.

CHAPTER IV

FIELD IMPROVEMENTS

Intent

By implementing the practices in this chapter, which are designed to protect wetland characteristics, functions and values, wetland impacts can be avoided and minimized. Typically the wetlands affected by these practices are classified as Wet Meadow, and occur in an agricultural field and have hydric soils that are defined as soils that, in an undrained condition, are saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation.

BEDDING

Definition

Plowing, blading, or otherwise elevating the surface of flat land into a series of broad, low ridges separated by shallow, parallel channels with positive drainage.

Purpose

To improve the drainage of surface water.

Conditions Where Practice Applies

This practice applies to areas with flat to nearly flat topography and with poorly drained soils.

Criteria

All planned work should comply with all federal, State and local laws and regulations, especially the Swampbuster regulations of the Food Security Act. Bedding should run in the direction of the available land slope. The velocity of water in the channels should be slow enough to prevent erosion during storm events. Beds should be shaped and cross-row ditches provided where required to provide free movement of water from the crown to the dead furrow. Crowns should provide a cross slope of not less than 0.3 percent. Soils must be of sufficient depth to provide a satisfactory root zone after bedding. Crown height, width, and maximum length of beds should be determined on the basis of site conditions and crop requirements. Parallel channels should be graded toward an outlet. An outlet, natural or constructed, must have sufficient capacity and depth to provide for removal of water from the parallel channels.

Considerations

Consider its effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge. Parallel channels may be shallow and side slopes steep or flat, based on the soil, crops grown, and local construction and maintenance methods. Areas where the rooting depth may limit plant growth after construction of the beds should be identified on the plan map. Consider practices that will mitigate off-site water quality impacts (i.e., wetland treatment areas, filter strips, buffer strips, etc.) If the bedding will exceed the depth of prior disturbance, this activity could affect significant cultural resources.

Plans and Specifications

Plans and specifications for bedding should identify the area where the practice will be applied, the direction of the channel drainage, the crown height, side slope, width, and length of the bed cross section, and location of the outlet.

Operation and Maintenance

The beds should be maintained to the planned height. Remove sediment from the channels as necessary to facilitate drainage and to prevent ponding. Maintain the outlet in a stable condition.

BRUSH MANAGEMENT

Definition

The management or removal of woody (non-herbaceous or succulent) plants including those that are invasive and noxious.

Purpose

- Create the desired plant community consistent with the ecological site.
- Restore or release desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality or enhance stream flow.
- Maintain, modify, or enhance fish and wildlife habitat.
- Improve forage accessibility, quality and quantity for livestock and wildlife.
- Manage fuel loads to achieve desired conditions.

Conditions Where Practice Applies

On all lands except active cropland where the removal, reduction, or manipulation of woody (non-herbaceous or succulent) plants is desired.

This practice does not apply to removal of woody vegetation by prescribed fire (use Prescribed Burning (338) or removal of woody vegetation to facilitate a land use change (use Land Clearing (460)).

Criteria

General Criteria Applicable to All Purposes

Brush management will be designed to achieve the desired plant community based on species composition, structure, density, and canopy (or foliar) cover or height. Brush management will be applied in a manner to achieve the desired control of the target woody species and protection of desired species. This will be accomplished by mechanical, chemical, burning, or biological methods either alone or in combination. When prescribed burning is used as a method, the Prescribed Burning standard (338) will also be applied. When the intent is to manage trees for silvicultural purposes, use Forest Stand Improvement (666). NRCS will not develop biological or chemical treatment recommendations except for biological control utilizing grazing animals. In such cases, Prescribed Grazing (528) is used to ensure desired results are achieved and maintained. NRCS may provide clients with acceptable biological and/or chemical control references. Follow-up treatment may be necessary to achieve objectives.

Additional Criteria for Creating the Desired Plant Community Consistent with the Ecological Site

Use applicable Ecological Site Description (ESD) State and Transition models, to develop specifications that are ecologically sound and defensible. Treatments must be congruent with dynamics of the ecological site(s) and keyed to state and plant community phases that have the potential and capability to support the desired plant community. If an ESD is not available, base specifications on the best approximation of the desired plant community composition, structure, and function.

Additional Criteria for Restoring or Releasing Desired Vegetative Cover to Protect Soils, Control Erosion, Reduce Sediment, Improve Water Quality or Enhance Stream Flow

Choose a method of control that results in the least amount of soil disturbance if soil erosion potential is high and revegetation is slow or uncertain leaving the site vulnerable to long-term exposure to soil loss.
In conjunction with other conservation practices, the number, sequence and timing of soil disturbing operations should be managed to maintain soil loss within acceptable levels using approved erosion prediction technology.

Additional Criteria to Maintain, Modify or Enhance Fish and Wildlife Habitat

Brush management will be planned and applied in a manner to meet the habitat requirements for wildlife species of concern as determined by an approved habitat evaluation procedure. Conduct treatments during periods of the year that accommodate reproduction and other life-cycle requirements of target wildlife and pollinator species and in accordance with specifications developed for Wetland Wildlife Habitat Management (644) and Upland Wildlife Habitat Management (645).

Additional Criteria to Improve Forage Accessibility, Quality and Quantity for Livestock and Wildlife

Timing and sequence of brush management should be planned in coordination with specifications developed for Prescribed Grazing (528).
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Additional Criteria to Manage Fuel Loads to Achieve Desired Conditions

Control undesirable woody plants in a manner that creates the desired plant community, including the desired fuel load, to reduce the risk of wildfire, facilitate the future application of prescribed fire.

<u>Considerations</u>

If chemical methods will be used, consider using Integrated Pest Management (595) in support of brush management. Consider the appropriate time period for treatment. Some brush management activities can be effective when applied within a single year; others may require multiple years of treatment(s) to achieve desired objectives. Consider impacts and consequences to obligate species (species dependent on the target woody species) when significant changes are planned to existing and adjacent plant communities. Consider impacts to wildlife food supplies, space, and cover availability when planning the method and amount of brush management. State issued licenses may be required when using chemical pesticide treatments. For air quality purposes, consider using chemical methods of brush management that minimize chemical drift and excessive chemical usage and consider mechanical methods of brush management that minimize the entrainment of particulate matter.

<u>Plans and Specifications</u>

Plans and specifications for the treatment option(s) selected by the decision maker will be recorded for each field or management unit where brush management will be applied.

Prepare brush management plans and specifications that conform to all applicable federal, state, and local laws. These documents will contain the following data as a minimum:

1. Goals and objectives clearly stated.
2. Pre-treatment cover or density of the target plant(s) and the planned post-treatment cover or density and desired efficacy.
3. Maps, drawings, and/or narratives detailing or identifying areas to be treated, pattern of treatment (if applicable), and areas that will not be disturbed.
4. A monitoring plan that identifies what should be measured (including timing and frequency) and that documents the changes in the plant community (compare with objectives) that will result.

For Mechanical Treatment Methods: Plans and specifications will include items 1 through 4, above, plus the following:

- Types of equipment and any modifications necessary to enable the equipment to adequately complete the job.
- Dates of treatment to best effect control
- Operating instructions (if applicable)
- Techniques or procedures to be followed

For Chemical Treatment Methods*:* Plans and specifications will include items 1 through 4, above, plus the following:

- Acceptable chemical treatment references for containment and management or control of target species
- Evaluation and interpretation of herbicide risks associated with the selected treatment(s)
- Acceptable dates or plant growth stage at application to best effect control and dampen reinvasion
- Any special mitigation, timing considerations or other factors (such as soil texture and organic matter content) that must be considered to ensure the safest, most effective application of the herbicide
- Reference to product label instructions

For Biological Treatment Methods*:* Plans and specifications will include items 1 through 4, above, plus the following:

- Acceptable biological treatment references for containment and management or control of target species
- Kind of grazing animal to be used, if applicable
- Timing, frequency, duration and intensity of grazing or browsing
- Desired degree of grazing or browsing use for effective control of target species
- Maximum allowable degree of use on desirable non-target species
- Special mitigation, precautions, or requirements associated with the selected treatment(s)

Operation and Maintenance

Operation*:* Brush management practices should be applied using approved materials and procedures. Operations will comply with all local, state, and federal laws and ordinances. Success of the practice should be determined by evaluating post-treatment regrowth of target species after sufficient time has passed to monitor the situation and gather reliable data. Length of evaluation periods will depend on the woody species being monitored, proximity of propagules (seeds, branches, and roots) to the site, transport mode of seeds (wind or animals) and methods and materials used. The operator will develop a safety plan for individuals exposed to chemicals, including telephone numbers and addresses of emergency treatment centers and the telephone number for the nearest poison control center. The National Pesticide Information Center (NPIC) telephone number in Corvallis, Oregon, may also be given for non-emergency information:
1-800-858-7384 Monday to Friday
6:30 a.m. to 4:30 p.m. Pacific Time
The national Chemical Transportation Emergency Center (CHEMTRAC) telephone number is: 1-800-424-9300

- Follow label requirements for mixing/loading setbacks from wells, intermittent streams and rivers, natural or impounded ponds and lakes, and reservoirs.
- Post signs, according to label directions and/or federal, state, tribal, and local laws, around fields that have been treated. Follow restricted entry intervals.
- Dispose of herbicides and herbicide containers in accordance with label directions and adhere to federal, state, tribal, and local regulations.
- Read and follow label directions and maintain appropriate Material Safety Data Sheets (MSDS). MSDS and pesticide labels may be accessed on the Internet at: http://www.greenbook.net/
- Calibrate application equipment according to recommendations before each seasonal use and with each major chemical and site change.
- Replace worn nozzle tips, cracked hoses, and faulty gauges on spray equipment.
- Maintain records of Brush/shrub control for at least two years. Herbicide application records should be in accordance with USDA Agricultural Marketing Service's Pesticide Recordkeeping Program and state-specific requirements.

Maintenance*:* Following initial application, some regrowth, resprouting, or reoccurrence of brush may be expected. Spot treatment of individual plants or areas needing re-treatment should be completed as needed while woody vegetation is small and most vulnerable to desired treatment procedures. Review and update the plan periodically in order to:

- incorporate new IPM technology;
- respond to grazing management and complex plant population changes; and
- avoid the development of plant resistance to herbicide chemicals.

REFERENCES

Branson, F. A, G. F. Gifford, K. G. Renard, R. F Hadley, and E. H. Reid, ed. 1981. Rangeland Hydrology, 2nd ed., Society for Range Management, CO.
Heady, H. F. and D. Child, 1994. Rangeland Ecology and Management, Westview Press, CO.
Holechek, J. L., R. D. Pieper and C. H. Herbel. 2000. Range management principles and practices, 5th edition. Prentice Hall, NJ.
Krausman, P. R., ed. 1996. Rangeland Wildlife. Society for Range Management, CO.
Monsen, S. B., R. Stevens, and N.L. Shaw, comps. 2004. Restoring Western Ranges and Wildlands, Volume 1. Gen. Tech. Rep. RMRS-GTR-136-1, USDA, Forest Service, Fort Collins, CO.
United States Department of Agriculture, Natural Resources Conservation Service. 2003. National Range and Pasture Handbook. Washington, DC.
United States Department of Agriculture, Natural Resources Conservation Service. 2008. General Manual: Title 190 – Ecological Sciences: Part 404 – Pest Management. Washington, DC.
Valentine, J. R., 1989. Range Developments and Improvements, 3rd ed. Academic Press, MA.
Vavra, M., W. A. Laycock, R. D Pieper, eds. 1994. Ecological Implications of Livestock Herbivory in the West. Society for Range Management, CO.

CHANNEL BANK VEGETATION

Definition

Establishing and maintaining vegetative cover on channel banks, berms, spoil, and associated areas.

Purpose

- Stabilize channel banks and adjacent areas and reduce erosion and sedimentation.
- Maintain or enhance the quality of the environment, including visual aspects and fish and wildlife habitat.

Conditions Where Practice Applies

This practice applies to establishing vegetation on channel banks, berms, spoil, and associated areas. This practice does not apply to grassed waterways, diversions, areas with protective linings, areas covered with water for an extended period of time, or areas where conditions will not support adequate vegetation.

Criteria

General Criteria Applicable to All Purposes
Streambank and Shoreline Protection (code 580) should be used when stabilization of the
Toe and/or Bank Hydrologic Zones is required before channel vegetation establishment. Areas to be planted will be cleared of unwanted materials and smoothed or shaped, if needed, to meet planting and landscaping purposes. Channel side slopes should be shaped so that they are stable and allow establishment and maintenance of desired vegetation. When slopes are modified for seeding, topsoil will be stockpiled and spread over areas to be planted as needed to meet planting and landscaping needs. Streambanks to be used for public access (fishing, swimming and related activities) will have side slopes no steeper than a ratio of 4 horizontal to 1 vertical (4:1).

Bank Stabilization Techniques. A combination of vegetative and structural measures will be used on slopes steeper than 3:1 to ensure that they are stable. When structural measures are used, an appropriate impact analysis will be conducted to verify needs and minimize potential impacts.

Species Selection. Plant material used for this practice should:

- Typically occur in the hydrologic zone into which they will be planted. See Figure 1 for hydrologic zone locations and descriptions.
- Be adapted, tested and proven cultivars, and native in the regions in which they will be used.
- Produce plant communities that are compatible with those in the area when mature.
- Be resistant to diseases or insects common to the site or location.
- Protect the channel banks and help maintain channel capacity.

Definitions and descriptions of hydrologic zones used for Channel Bank Vegetation:
Bankfull Discharge Elevation - In natural streams, it is the elevation at which water fills the channel without overflowing onto the flood plain.
Bank Zone - The area above the Toe Zone located between the average water level and the bankfull discharge elevation. Vegetation may be herbaceous or woody, and is characterized by flexible stems and rhizomatous root systems.
Overbank Zone - The area located above the bankfull discharge elevation continuing upslope to an elevation equal to two thirds of the flood prone depth. Vegetation is generally small to medium shrub species.
Toe Zone - The portion of the bank that is between the average water level and the bottom of the channel, at the toe of the bank. Vegetation is generally herbaceous emergent aquatic species, tolerant of long periods of inundation.
Transitional Zone - The area located between the overbank zone, and the flood prone width elevation. Vegetation is usually larger shrub and tree species.
Upland Zone – The area above the Transitional Zone; this area is seldom if ever saturated.
Note: some channels have fewer than four hydrologic zones because of differences in soils, topography, entrenchment and/or moisture regime.

Certified seed should be used, if available, for all seeded species.

Establishment of Vegetation. The species used, planting rates, spacing, and methods and dates of planting should be based on plant materials program trials or other technical guidance, such as local planting guides or technical notes. Identify, mark, and protect desirable existing vegetation during practice installation. Biotechnical slope stabilization practices (a combination of vegetative and structural measures using living and inert materials) are to be used when flow velocities, soils, and bank stability preclude stabilization by vegetative establishment alone. The existing vegetation will be cleared in a three-foot diameter around each site where container, balled, potted, plug, paper sleeve and bare root stock plantings are planted.
A suitable seedbed should be prepared for all seeded species. Compacted layers will be ripped and the soil re-firmed prior to seedbed preparation.
Seeds will be planted using the method or methods best suited to site and soil conditions.
Sod placement should be limited to areas that can naturally supply needed moisture or sites that can be irrigated during the establishment year.
Sod will be placed and anchored using techniques to ensure that it remains in place during the establishment period.
All disturbed areas will be mulched as necessary. Mulch will be applied and anchored according to the criteria in practice standard 484, Mulching.

Fertilization. Unless vegetation is established, where necessary, all fertilizers and soil amendments will be applied in accordance with soil analysis and plant

requirements, following the criteria in the Nutrient
Management standard (code 590).

Site Protection and Access Control.
Grazing animal access to planted areas will be controlled for a minimum of two growing seasons during the establishment period.
All areas to be grazed will have a grazing plan that meets the criteria in practice standard 528, Prescribed Grazing.
Grazing should be permanently excluded on high hazard sites, such as cut banks, areas of seepage or other potentially unstable areas.
Tree guards will be placed around landscaped areas as needed to protect against animal damage.

<u>Considerations</u>

Stable, overhanging banks that provide shade and cover for fish should not be disturbed.
Channel stabilization and streambank protection practices should be considered to facilitate establishment of channel vegetation.
A riparian functional assessment should be completed on live streams to determine channel condition.
In constructed channels, consider the size of vegetation at maturity so as not to restrict the capacity of the channel or conflict with surrounding uses. Vegetative practices should be designed to provide effective stability and cover. Stability will allow for indigenous vegetation to volunteer on the site.
Filter strips, riparian forest buffers and conservation cover applied in conjunction with channel vegetation will improve water quality and enhance wildlife habitat.
Providing plant species diversity will help combat disease and the overuse of a single species.
Where economically feasible and practical, irrigation of new plantings should be considered.
Protection of channel vegetation from upland sediment deposits resulting from wind and water erosion should be considered.
Provisions for safety and protection of human life and property should be considered in all aspects of design, application, and maintenance.
Consider economic and resource costs of practice failure or re-establishment.
Effects of vegetation on water budget components, especially on volumes and peak flows of runoff, should be considered.
Techniques to minimize sedimentation impacts from practice installation, such as sediment barriers, erosion control fabric, and biodegradable mulches, should be considered.
Effects of woody vegetation on stream temperatures and invertebrate populations should be considered.

<u>Plans and Specifications</u>

Plans and designs are to be prepared for specific field sites. The plan will identify site conditions, required permits, and include design drawings showing location of planned measures, cut and fill cross sections, requirements for site preparation, location of planned species, planting dates, planting methods, plant spacing, planting depth, mulching, fertilizer and irrigation requirements.
A management strategy protecting the site will be in place prior to the installation of Channel Bank Vegetation improvements.

Specifications will be completed for each hydrologic zone located within the channel.

<u>Operation and Maintenance</u>

Any vegetation removal will be restricted to periods having the least impacts on nesting wildlife.

REFERENCES

Bentrup, G., and J.C. Hoag. 1998. The Practical Streambank Bioengineering Guide - User's Guide for Natural Streambank Stabilization Techniques in the Arid and Semiarid Great Basin and Intermountain West.
Interagency Riparian/Wetland Plant Development Project. USDA-NRCS, Aberdeen, ID.
FISRWG. 1998. Stream Corridor Restoration: Principles, Processes, and Practices. Federal Interagency Stream Restoration Working Group (FISRWG).
Hoag, J.C. 1999. Riparian Planting Zones. View from a Wetland, No. 5. (1998-1999) Interagency Riparian/Wetland Project, Plant Materials Center, USDA-NRCS, Aberdeen, ID.

DIVERSION

Definition

A channel constructed across the slope generally with a supporting ridge on the lower side.

Purpose

This practice may be applied as part of a resource management system to support one or more of the following purposes:

- Break up concentrations of water on long slopes, on undulating land surfaces, and on land that is generally considered too flat or irregular for terracing.
- Divert water away from farmsteads, agricultural waste systems, and other improvements.
- Increase or decrease the drainage area above ponds.
- Protect terrace systems by diverting water from the top terrace where topography, land use, or land ownership prevents terracing the land above.
- Intercept surface and shallow subsurface flow.
- Reduce runoff damages from upland runoff.
- Reduce erosion and runoff on urban or developing areas and at construction or mining sites.
- Divert water away from active gullies or critically eroding areas.
- Supplement water management on conservation cropping or stripcropping systems.

Conditions Where Practice Applies

This applies to all cropland and other land uses where surface runoff water control and or management is needed. It also applies where soils and topography are such that the diversion can be constructed and a suitable outlet is available or can be provided.

Criteria

Capacity. Diversions as temporary measures, with an expected life span of less than 2 years, should have a minimum capacity for the peak discharge from the 2-year frequency, 24-hour duration storm.

Diversions that protect agricultural land should have a minimum capacity for the peak discharge from a 10-year frequency, 24 -hour duration storm.

Diversions designed to protect areas such as urban areas, buildings, roads, and animal waste management systems should have a minimum capacity for the peak discharge from a storm frequency consistent with the hazard involved but not less than a 25-year frequency, 24-hour duration storm. Freeboard should be not less than 0.3 ft.

Design depth is the channel storm flow depth plus freeboard, where required.

Cross section. The channel may be parabolic, V-shaped, or trapezoidal. The diversion should be designed to have stable side slopes.

The ridge should have a minimum top width of 4 feet at the design depth. The ridge height should include an adequate settlement factor (normally 10%).

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The ridge top width may be 3 feet at the

design depth for diversions with less than 10 acres drainage area above cropland, pastureland, or woodland.
The top of the constructed ridge at any point should not be lower than the design depth plus the specified overfill for settlement.

The design depth at culvert crossings should be the culvert headwater depth for the design storm plus freeboard.

Grade and velocity. Channel grades may be uniform or variable. Channel velocity should not exceed that considered non-erosive for the soil and planned vegetation or lining.

Maximum channel velocities for permanently vegetated channels should not exceed those recommended in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-Lined Open Channels (Sept. 1987).

When the capacity is determined by the formula Q = A V and the V is calculated by using Manning's equation, the highest expected value of "n" should be used.

Location. The outlet conditions, topography, land use, cultural operations, cultural resources, and soil type should determine the location of the diversion.

Protection against sedimentation. Diversions normally should not be used below high sediment producing areas. When they are, a practice or combination of practices needed to prevent damaging accumulations of sediment in the channel should be installed. This may include practices such as land treatment erosion control practices, cultural or tillage practices, vegetated filter strip, or structural measures. Install practices in conjunction with or before the diversion construction.

If movement of sediment into the channel is a problem, the design should include extra capacity for sediment or periodic removal as outlined in the O&M plan.

Outlets. Each diversion must have a safe and stable outlet with adequate capacity. The outlet may be a grassed waterway, a lined waterway, a vegetated or paved area, a grade stabilization structure, an underground outlet, a stable watercourse, a sediment basin, or a combination of these practices. The outlet must convey runoff to a point where outflow will not cause damage. Vegetative outlets should be installed and established before diversion construction to ensure establishment of vegetative cover in the outlet channel.

The release rate of an underground outlet, when combined with storage, should be such that the design storm runoff will not overtop the diversion ridge.

When a level spreader is used as the outlet of the diversion, the length should be one foot per CFS based the 10-year discharge with a minimum length of 5 feet and a maximum length of 30 feet. The entrance channel should not exceed a 1% grade for a minimum of 20 feet before entering level spreader. The outlet must convey runoff to a point where the discharge will not cause damage.

A level spreader should be constructed on zero percent grade to ensure uniform spreading of sediment-free runoff (converting channel flow to sheet flow). Level spreaders should be constructed on undisturbed soil (not on fill). A geotextile erosion stop should be placed vertically and at least six inches deep in a slit trench one foot in back of the level lip and parallel with

the lip. This erosion stop should extend the entire length of the level lip and after backfilling with tamped soil the geotextile should be trimmed so that the upper edge is flush with the soil surface. Earthen level lip spreaders should be protected to resist erosion with two overlapping strips of jute, mesh, or other specified erosion control fabric.
The design depth of the water surface in the diversion should not be lower than the design elevation of the water surface in the outlet at their junction when both are operating at design flow.

Vegetation. Disturbed areas that are not to be cultivated should be seeded as soon as practicable after construction.

Lining. If the soils or climatic conditions preclude the use of vegetation for erosion protection, non-vegetative linings such as gravel, rock riprap, cellular block, or other approved manufactured lining systems may be used.

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Considerations

A diversion in a cultivated field should be aligned and spaced from other structures or practices to permit use of modern farming equipment. The side slope lengths should be sized to fit equipment widths when cropped.

At non-cropland sites, consider planting native vegetation in areas disturbed due to construction.

Maximize wetland functions and values with the diversion design. Minimize adverse effects to existing functions and values. Diversion of upland water to prevent entry into a wetland may convert a wetland by changing the hydrology. Any construction activities should minimize disturbance to wildlife habitat. Opportunities should be explored to restore and improve wildlife habitat, including habitat for threatened, endangered, and other species of concern.

On landforms where archeological sites are likely to occur, use techniques to maximize identification of such sites prior to planning, design, and construction.

Plans and Specifications

Plans and specification for installing diversions should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose.

If underground conduits are located under diversion ridges, mechanical compaction or water packing should be required. Installation and backfill of conduit trenches should be made in advance to allow adequate settlement. Diversion ridges constructed across gullies or depressions should be compacted sufficiently to keep settlement within tolerable limits.

Topsoil should be stockpiled and spread over excavations and other areas to facilitate revegetation. Follow local standards and recommendations for seeding.

Operation and Maintenance

An O&M plan should be prepared for use by the client. The plan should include specific instructions for maintaining diversion capacity, storage, ridge height, and outlets.

The minimum requirements to be addressed in the O&M plan are:

- Provide periodic inspections, especially immediately following significant storms.
- Promptly repair or replace damaged components of the diversion as necessary.
- Maintain diversion capacity, ridge height, and outlet elevations especially if high sediment yielding areas are in the drainage area above the diversion. Establish necessary clean-out requirements.
- Each inlet for underground outlets must be kept clean and sediment buildup redistributed so that the inlet is at the lowest point. Inlets damaged by farm machinery must be replaced or repaired immediately.
- Redistribute sediment as necessary to maintain the capacity of the diversion.
- Vegetation should be maintained and trees and brush controlled by hand, chemical and/or mechanical means.
- Keep machinery away from steep sloped ridges. Keep equipment operators informed of all potential hazards.

SURFACE DRAINAGE

FIELD DITCH

Definition

A graded ditch for collecting excess water in a field.

Purpose

To drain surface depressions; collect or intercept excess surface water, such as sheet flow, from natural and graded land surfaces or channel flow from furrows and carry it to an outlet; and collect or intercept excess subsurface water and carry it to an outlet.

Condition Where Practice Applies

This standard applies to drainage ditches installed to collect water from a field less than 100 acres per ditch. It does not apply to surface drainage, main or lateral (608) or to grassed waterways or outlets (412). Applicable sites are flat or nearly flat and:

- Have soils that are slowly permeable (low permeability) or that are shallow over barriers, such as rock or clay, which hold or prevent ready percolation of water to a deep stratum.
- Have surface depressions or barriers that trap rainfall.
- Have insufficient land slope for ready movement of runoff across the surface.
- Receive excess runoff or seepage from uplands.
- Require the removal of excess irrigation water.
- Require control of the water table.
- Have adequate outlets available for disposal of drainage water by gravity flow or pumping.

Criteria

Drainage field ditches should be planned as integral parts of a drainage system for the field served and should collect and intercept water and carry it to an outlet with continuity and without ponding. Compliance with all applicable federal, state and local regulations and ordinances is required.
The landowner(s) should be responsible for obtaining and complying with all applicable permits.
Investigations. An adequate investigation should be made of all sites.
Location. Ditches should be established, insofar as topography and property boundaries permit, in straight or nearly straight courses. Random alignment may be used to follow depressions and isolated wet areas of irregular or undulating topography. Excessive cuts and the creation of small irregular fields should be avoided. State and locally listed prime and significant wetlands should be avoided.

On extensive areas of uniform topography, collection or interception ditches should be installed as required for effective drainage.
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Design. The size, depth, side slopes, and cross section area should:

- Be adequate to provide the required drainage for the site.
- Permit free entry of water from adjacent land surfaces without causing excessive erosion.

- Provide effective disposal or reuse of excess irrigation water (if applicable).
- Conduct flow without causing excessive erosion.
- Provide stable side slopes based on soil characteristics.
- Permit crossing by field equipment if feasible.
- Permit construction and maintenance with available equipment. Ditches may be trapezoidal, V-shaped, or parabolic in shape to fit the site conditions. When surface field ditches discharge into ditches of greater depth, the outfall should be graded back on non-erosive slopes of other protective measures should be provided.

Channel Vegetation. Vegetation should be established according to the recommendations in Conservation Practice Standard - 342, Critical Area Planting.
Spoil Placement. Spoil material should be spread and leveled so that the surface water can flow into the ditch. If the spoil is to be farmed, it should be spread so that farming operations will not be hindered.

Considerations

Water Quantity

- Effects on water budget components, especially relationships between runoff and infiltration.
- The effect of changes in the water table on the rooting depth for anticipated land uses.

Water Quality

- Downstream effects of erosion and yields of sediment and sediment-attached substances.
- Effects on the salinity of the soil in the drained field.
- Effects on the loadings of dissolved substances downstream.
- Potential changes in downstream water temperature.
- Effects on wetlands or other water-related wildlife habitat.
- Effects on the visual quality of downstream water courses.

Plans and Specifications

Plans and specifications for constructing drainage field ditches should be in keeping with this standard and should describe the requirements for properly installing the practice to achieve its intended purpose.

Operation and Maintenance

A site-specific O&M plan should be provided to and reviewed with the landowner(s) before the practice is installed. The plan should adequately guide the landowner(s) in the routine maintenance and operational needs of the field ditches. The plan should also include guidance on periodic inspections and post-storm inspections to detect and minimize damage to the drains and outlets.

SUBSURFACE DRAIN

Definition

A conduit, such as corrugated plastic tubing, tile, or pipe, installed beneath the ground surface to collect and/or convey drainage water.

Purpose

The purpose of subsurface drainage is to:

- Improve the soil environment for vegetative growth, reduce erosion, and improve water quality by:
  - regulating water table and ground water flows,
  - intercepting and preventing water movement into a wet area,
  - relieving artesian pressures,
  - removing surface runoff,
  - serving as an outlet for other subsurface drains, and
  - regulating sub-irrigated areas or waste disposal areas.
- Collect ground water for beneficial uses.
- Remove water from heavy use areas, such as around buildings, roads, and play areas; and accomplish other physical improvements related to water removal.
- Regulate water to control health hazards caused by pests such as live fluke, flies, or mosquitoes.

Conditions Where Practice Applies

This practice applies to areas having a high water table where the benefits of lowering the water table or controlling ground water or surface runoff justify installing such a system. This standard applies to areas suitable for the intended use after installation of required drainage and other conservation practices. The soil should have enough depth and permeability to permit installation of an effective and economically feasible system. In areas where an outlet is available, either by gravity flow or by pumping, the outlet should be adequate for the quantity and quality of effluent to be discharged.

Considerations

Subsurface drains are normally used to lower the water table in a certain area, or to serve as an outlet for small detention structures. Installation of drain pipes in less permeable soils may require an envelope of granular drain material to maximize effectiveness.

Clogging by tree roots and crushing by vehicular traffic are common causes of drain failures. Where subsurface drains may be subject to these conditions, heavy pipe or other precautions should be considered.

Consideration should be given to possible damages above or below the point of discharge that might involve legal actions under state or local laws. Consideration should be given to maintaining or enhancing environmental values.

Design Criteria

General. The planning and design of subsurface drains should be based on adequate onsite surveys and investigations. **Required Capacity**. The required capacity should be determined by applicable drainage coefficient or inflow rate obtained from one or more of the following:

- Application of a locally tried and proven co-efficient.
- Experience on similar sites and/or soils.
- Onsite measurement, investigation, or estimates.
- Application of Darcy's law to lateral or artesian subsurface flows.

Subsurface drains should be large enough to convey the required capacity to an adequate outlet. The minimum nominal diameter should be 4 inches. The size of the drain should be computed using Manning's Formula or design charts in Figures 3 1 and 3 2.

Depth, Spacing, and Location. The depth, spacing, and location should be based on site conditions and be such as to provide adequate drainage for the planned land use.

To provide adequate protection of the conduit, the depth of cover over subsurface drains should not be less than 2.0 feet in mineral soils, or 2.5 feet in organic soils. In organic soils the minimum cover applies after initial subsidence has taken place. Exceptions to the minimum depth of cover may be permitted within 50 feet of the outlet where the conduit is not subject to damage by equipment travel, or through minor depressions within 100 feet of the upstream end of individual or lateral lines.

Minimum Grade. The minimum grades for drains are as follows:

Drain Diameter	Minimum Grade
4 inches	0.1%
5 inches	0.07%
6 inches or more	0.05%

Where subsurface drains are installed in soil that contains a high percentage of silt and very fine sand that may be washed into the drain, the conduit should be placed on a grade that will result in a minimum velocity of 1.5 ft/sec for design flow, or an approved filter should be placed around the drain.

Maximum Grade Protection. On sites where topographic conditions require the use of drain lines on grades where design velocities will be greater than indicated in the table below, special measures should be used to protect the conduit. These measures should be specified for each job based on the particular conditions of the job site. The protective measures should include one or more of the following:

- Wrapping open joints of the pipe or tile with tar impregnated paper, burlap, or special fabric type filter material.
- Placing the conduit in a sand and gravel envelope or binding with least erodible soil available.
- Sealing joints or using a watertight pipe or non-perforated continuous tubing.
- Enclosing continuous perforated pipe or tubing with fabric type filter material or properly graded sand and gravel.

TABLE 3-1 -- MAXIMUM PERMISSIBLE VELOCITY WITHOUT PROTECTIVE MEASURES

USDA Soil Texture	Velocity—ft./sec.
Sand and Sandy Loam	3.5
Silt and Silt Loam	5.0
Silty Clay Loam	6.0
Clay and Clay Loam	7.0
Coarse Sand .or Gravel	9.0

Materials for Subsurface Drains. Subsurface drains include conduits of concrete, metal, plastic, or other materials of acceptable quality.

The conduit should meet strength and durability requirements of the site

Filters and Filter Material. Suitable filters should be used around conduits where required by site conditions to prevent sediment accumulation in the conduit. The need for a filter should be determined by the characteristics of the soil materials at drain depth and the velocity of flow in the conduit.

Not less than 3 inches of filter material should surround the conduit when using sand-gravel· filters. The filter should be designed to prevent the material in which the installation is made from entering the conduit. Not more than 10 percent of the filter should pass the No. 60 sieve and not more than 5 percent of the filter should pass the No. 200 sieve.

Artificial fabric or mat type filter materials may be used provided the effective opening size, strength, durability, and permeability are adequate to provide constant filtering of the soil to protect subsurface drain operation throughout the expected life of the system.

Envelopes and Envelope Material. Envelopes should be used around subsurface drains where required for proper bedding of the conduit, or where necessary to improve the characteristics of flow of groundwater into the conduit.

Materials used for envelopes do not need to meet the gradation requirements of filters, but they should not contain materials which will cause an accumulation of sediment in the conduit or render the envelope unsuitable for bedding of the conduit. Envelope 111aterials should consist of sand-gravel material, all of which should pass a 1.5 inch sieve, 90 to 100 percent should pass a No. 60 sieve, and not more than 5 percent should pass a No. 200 sieve.

Placement and Bedding. All 'subsurface drains, whether flexible conduit such as plastic or bituminized fiber or rigid conduits such as clay or concrete should be laid to a neat line and grade. The conduit should be placed and bedded as described in .ASTM F449 "Standard Recommended Practice for Subsurface Installation of Corrugated Thermoplastic Tubing for Agricultural Drainage or Water Table Control". Rigid drainage conduits such as clay or concrete drain tile will not need the 90 degree "V" groove in the trench bottom but all other applicable placement and bedding requirements will be adhered to.

Use of Heavy Duty corrugated Plastic Drainage Tubing. Heavy duty corrugated plastic drainage tubing should be specified where rocky soils are expected to be encountered during installation operations. This quality of tubing will also be specified when cover over the tubing is expected to exceed 10 feet or trench widths are to trench width "in the area of the tubing and at least 1 foot above the top of tubing.)

Auxiliary structures and Subsurface Drain Protection. The outlet should be protected against erosion and undermining of the conduit, entry of tree roots, damaging periods of submergence, and entry of rodents or other animals into the subsurface drain. A 10-foot minimum continuous section of pipe without open joints or perforations should be used at the outlet end of the line and should outlet at least 0.5 foot above the normal elevation of low flow in the outlet ditch. Corrugated plastic tubing should not be used for the outlet section.

The pipe and its installation should conform to the following requirements:

- Where there is a hazard of vegetation burning on the outlet ditch bank, the material from which the outlet pipe is fabricated should be fire resistant. Where the hazard of burning is high, the outlet pipe should be fireproof.
- Two-thirds of the pipe should be buried in the ditch bank and the cantilevered section should extend to the toe of the ditch side slope or the side slope should be protected from erosion. The minimum length of pipe should be 8 feet.
- Where ice or floating debris may damage the outlet pipe, the outlet should be recessed to the extent that the cantilevered portion of the pipe will be protected from the current in the ditch.
- Headwalls which are used for subsurface drain outlets should be adequate in strength and design to avoid washouts and other failures.

Watertight conduit strong enough to withstand the loads on it should be used where subsurface drains cross under other ditches. Conduits under roadways should be designed to withstand the expected loads. Shallow subsurface drains through depressional areas and near outlets should be protected against hazards of farm and other equipment, and freezing and thawing. Junction boxes should be used where more than two main lines join.

Where surface water is to be admitted to subsurface drains, inlets should be designed to exclude debris and prevent sediment from entering the conduit. Lines flowing under pressure should be designed to withstand the resulting pressures and velocity of flow. Auxiliary surface waterways should be used where feasible.

The upper end of each subsurface drain line should be capped with a tight fitting cap of the same material as the conduit or other durable material unless connected to a structure.

Construction Specifications

Inspection and Handling of Materials. Material for subsurface drains should be given a careful inspection before installation. Clay and concrete tile should be checked for damage from handling and where applicable from freezing and thawing prior to installation. Bituminized fiber and plastic pipe and tubing should be protected from hazards causing deformation or warping. Plastic pipe and tubing with physical imperfections should not be installed. A damaged section should be removed and a suitable joint made connecting the replaced and retained sections. All material should be satisfactory for its intended use and should meet applicable specifications and requirements.

Placement. All subsurface drains should be laid to line and grade and covered with approved blinding, envelope, or filter material to a depth of not less than 3 inches over the top of the drain · If the option to' install an impervious sheet over the drain is used, at ·1east 3 inches of blinding material must cover the sheet. No reversals in grade of the conduit should be permitted. Where the conduit is to be laid in a rock trench·, or where rock is exposed at the bottom of the trench, the rock should be removed below grade enough that the trench may be backfilled, compacted, and bedded; and when completed, the conduit should be not less than 2 inches from rock.

Conduit will be placed in such a way that maximum stretch does not exceed 5 percent.

Earth backfill material should be placed in the trench in such a manner that displacement of the conduit will not occur and so that the filter and bedding material, after backfilling, will meet the requirements of the plans and specifications.

When a filter is required, all openings in the subsurface drain should be protected by the filter, or the bottom and sides of the conduit are to be protected by the filter when the top of conduit as well as part of side filter material is to be covered by a sheet of impervious plastic. No portion of the conduit containing openings is to be left exposed under conditions which require the use of a filter.

When sand-gravel filter material is used, the trench should be over-excavated 3 inches and backfilled to grade with filter material. After placement of the conduit upon the filter material, additional filter material should be placed over the conduit to fill the trench to a depth of 3 inches over the conduit. A plastic sheet and friable soil can be used in lieu of filter material as the backfill over the subsurface drain when specified. The sand-gravel filter material should be a unified classification system mixture of sand and gravel within the gradation required by the base material in the trench.

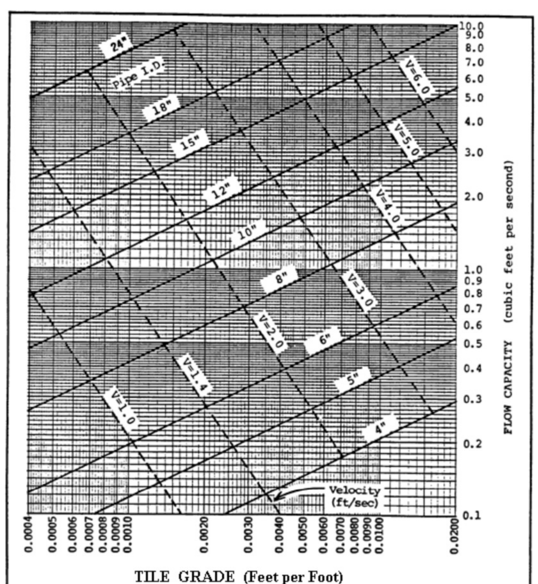
During installation and at the end of each day's work, the conduit will be protected from the entrance of soil or other debris.

The upper end of each individual subsurface drain should be blocked with a plug or cap of material of equal strength and durability of that of the conduit.

Materials. Subsurface drains include conduits of clay, concrete, bituminized fiber, metal, plastic, or other materials of acceptable quality.

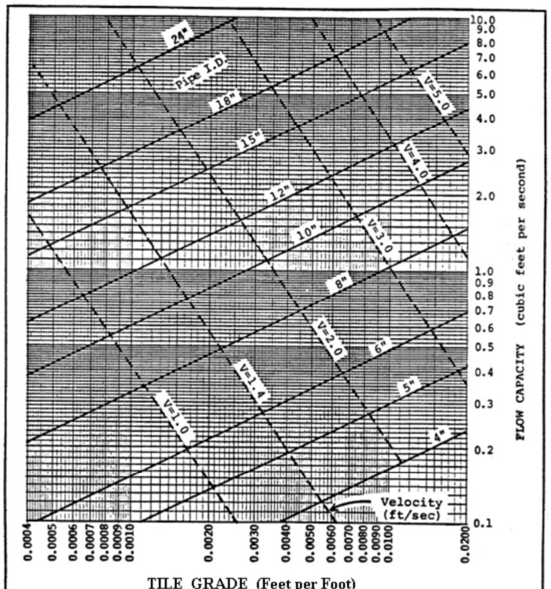
The conduit should meet strength and durability requirements of the site.

<u>Drain Chart – Smooth Pipe</u>



Drain Capacity Chart for Plastice Pipe (SDR, S&D), Concrete Pipe, and Smooth Inside Wall Polyethylene Pipe

<u>Drain Chart – Corrugated Pipe</u>



Drain Capacity Chart for Corrugated Polyethylene Pipe - 3" to 8" Diameter

Maintenance

Subsurface drains should be checked periodically to see that the outlet pipe of the drain is free flowing. The outlet ditch should be checked to see that erosion is not taking place. If the subsurface drain has a surface inlet, the inlet should be checked periodically to see that the inlet is not clogged with vegetation or debris. Repairs to the drain should be made promptly.

TERRACE

Definition

An earth embankment, channel, or a combination ridge and channel constructed across the slope.

Purpose

Terraces are constructed to (1) reduce a slope length, (2) reduce erosion, (3) reduce sediment content in runoff water, (4) intercept and conduct surface runoff at a non-erosive velocity to a stable outlet, (5) retain runoff for moisture conservation, (6) prevent gully development, (7) reform the land surface, (8) improve farmability, and (9) reduce flooding. An additional purpose of this practice is to maintain or improve water quality.

Conditions Where Practice Applies

This practice applies where:

- Water erosion is a problem.
- There is a need to conserve water.
- The soils and topography are such that terraces can be constructed and farmed with a reasonable effort.
- A suitable outlet can be provided.
- Runoff and sediment damages land or improvements downstream or impairs water quality.

Considerations

- Effects on the water budget, especially on volumes and rates of ·runoff, infiltration, evaporation, transpiration, deep percolation and groundwater recharge.
- Variability effects caused by seasonal or climatic changes.
- The type of outlet, time of water detention, topography, and geology of the site.
- Effects of snow catch and melt on water budget components.
- Potential for a change in plant growth and transpiration because of changes in the volume of soil water.
- Effects on the downstream flows or aquifers that could affect other water uses and users.
- The effect on the water table suitable rooting depth for anticipated land uses.
- Potential for water management to Supply alternate uses.
- Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.
- Effects of nutrients and pesticides on surface and groundwater quality.
- Effects on the visual quality of on-site and downstream water.
- Short-term and construction-related effects on the quality of on-site and downstream water.
- Effects on the movement of dissolved substances below the root zone and to the groundwater.
- Effects on wetlands and water related wildlife habitats.

Design Criteria

Spacing Terraces for Erosion Control. The maximum spacing should be determined by one of the following methods, but does not have to be less than 90 feet:

V.I. = o.7s + y or H.I. = (0.7s + y) 100/s

Where: V.I. = vertical interval in feet
H.I. = horizontal interval in feet
s = land slope in feet per 100 feet
y = a variable with values from 1.0 to 4.0

- Values of y are influenced by soil erodibility, cropping system, and crop management practices. A value of 1.0 should be selected for easily erodible soils with tillage systems that provide little or no cover during periods of intense rainfall. A value of 4.0 should be used for erosion resistant soils with tillage systems that leave a large amount of cover (1.5 tons of straw equivalent) on the surface. A value of 2.5 should be used where one of the above factors is favorable and the other unfavorable. Other values between 1.0 and 4.0 may be used according to the estimated quality of the above factors.
- The Universal Soil Loss Equation (USLE) - The spacing should not exceed the slope length determined for contour cultivation by using the allowable soil loss, the most intensive use planned, and the expected level of management.
- The horizontal spacing should not exceed 450 feet for land slopes up to 2%, 300 feet for land slopes of 2% to 4%, 200 feet for slopes of 4% to 6%, and 150 feet for slopes of 6% and over. These maximum limits may not be exceeded when making adjustments as indicated below. Spacing may be increased as much as 10 percent to provide better alignment or location, to adjust for farm machinery, or to reach a satisfactory outlet. Spacing may be increased an additional 10 percent for terraces with underground outlets. The spacing should be adjusted to provide for an even number of trips for anticipated row crop equipment and maximum opportunity for changing land forming, and erosion should be considered when determining the terrace interval.

Terraces on Noncropland. Maximum spacing will be governed by the capacity requirement.

Alignment. Terraces should be made parallel when feasible and as parallel as practicable in all cases. Curves should be long and gentle to accommodate farm machinery. Land forming, extra cut or fill along the terrace line, multiple outlets, variations in grade, channel blocks, and other methods are to be used to achieve good alignment capacity. The terrace should have enough capacity to control the runoff from a 10-year frequency, 24-hour storm without overtopping. For terraces with underground outlets, the capacity should be increased by the estimated 10-year sediment accumulation unless provisions are made to maintain the design capacity through maintenance. Terrace systems designed to provide flood protection or to function with other structures should have capacity to control a storm of a frequency consistent with the potential hazard involved. When the capacity is determined by the formula Q = AV and the V is calculated by using Manning's formula, an "n" value of 1.6 should be used.

Cross Section. The terrace cross section should be proportioned to fit the land slope, the crops grown, and the farm machinery used·. The ridge height should include a reasonable settlement factor. The ridge should have a minimum width of 3 feet at the design elevation. The minimum cross sectional area of the terrace channel for gradient terraces should be 8 square feet for land slopes of 5% or less, 7 square feet for slopes from 5 to 8%, and 6 square feet for slopes steeper than 8%. The opening at the outlet end of terraces should have a cross section equal to that specified for the terrace channel.

***Channel Grade**.* Channel grade should be determined by one of the following methods:

- Maximum channel grade in the lower reaches of the channel should not exceed 0.6 percent.
- Maximum channel velocity should be non-erosive for the soil and planned treatment. Maximum velocity for erosion resistant soils is 2 .5 ft/sec, for average soils 2.0. ft/sec, and for easily erodible soils 1.5 ft/sec.
- Velocities are to be computed by. Manning's formula using an "n" value of .03.
- Channel grades may be uniform or variable. Channel velocities should not exceed that which is non-erosive for the soil and planned treatment. For short distances and in upper reaches, channel grades or velocities may be increased to improve alignment.
- When terraces have an underground outlet, water and sediment will be ponded in the channel thus reducing velocities and allowing steeper channel grades near the outlet.
- Minimum grades are to be such that ponding in the channel due to minor irregularities will not cause serious damage to crops or delay in field operations.

***Outlets**.* All terraces must have adequate outlets.

- Vegetated outlets may be used for terraces. Such an outlet may be a grassed waterway or vegetated area. The outlet must convey runoff water to a point where the outflow will not cause damage. Outlets are to be installed and vegetated before terrace construction if necessary to provide a stable non-erodible outlet or to ensure establishment of vegetative cover. The water surface in the terrace should not be lower than the water surface in the outlet at their junction when both are operating at design flow.
- Underground outlets may be used on terraces. The outlet consists of an intake and underground conduit. An orifice plate, increased in conduit size, or other feature should be installed in each inlet as needed to control the release rate and prevent ·excessive pressure when more than one terrace discharges into the same conduit. The discharge, when combined with the storage, is to be such that a 10-year frequency, 24-hour storm will not overtop the terrace and growing crops will not be damaged significantly by standing water. The release time should not exceed 48 hours for the design storm. Shorter periods may be necessary for some crops depending on soil characteristics and water tolerance of crops to be grown.

The underground conduit should meet the requirements for a subsurface drain. Conduits must be installed deep enough to prevent damage from tillage equipment. The inlet is to consist of a vertical perforated pipe of a material suitable for the intended purpose. The inlet should be located uphill of the front slope of the terrace ridge, if farmed, to permit passage of farm machinery and, where necessary, provide for the anticipated accumulation of sediment and subsequent raising of the terrace ridge. The outlet of the conduit should have adequate capacity for the design flow without erosion. Blind inlets may be used where they are effective, usually in well drained soils.

Combination of different types of outlets may be used on the same system to maximize water conservation and to provide for economical installation of a more farmable system.

Vegetation. Steep back slope terraces (and steep front slope, if used) should be established to grass as soon as practicable after construction. The sod should be maintained and trees and brush controlled by chemical or mechanical means.

Plans and Specifications

Plans and specifications for installation of terraces should be in keeping with this BMWP and should describe the requirements for application of the practice to achieve its intended purpose. Construction specifications should be in accordance with the USDA NRCS New Hampshire Construction and Materials Specifications for Conservation Engineering Practices.

Installation

All dead furrows, ditches, or gullies should be filled prior to construction of the terrace or as part of construction. All old terraces, fencerows, hedgerows, trees, and other obstructions should be removed as necessary to install a farmable system.

The terraces should be constructed to planned alignment, grade, and cross section, plus the specified overfill for settlement and the channel should drain reasonably well.

Any ditch or depression at the bottom of the back slope should be filled and smoothed so that drainage will be away from the terrace and not parallel to it.

Provisions must be made where underground conduits are located under terrace ridges to prevent piping. Mechanical compaction, water packing, installation, and backfill or conduit trenches far enough in advance to allow adequate settlement are methods that can be used. The materials used for the inlet and conduit will be suitable for the purpose intended. Terrace ridges constructed across gullies or depressions should be compacted by machinery travel or other means sufficient to ensure proper functioning of the terrace. The surface of the terrace should be reasonably smooth and present a satisfactory finish.

Where it is necessary, topsoil is to be stockpiled and spread over excavations and other areas to facilitate restoration of productivity.

Where vegetation is required, seedbed preparation, seeding, fertilizing and mulching should comply with the practice standard for critical area planting.

Safety and Maintenance

As part of a conservation plan, a maintenance program should be developed to maintain terrace capacity, storage, ridge height, and the outlets. Each intake of underground outlets must be kept clean and sediment buildup redistributed so the inlet is in the lowest place. Inlets damaged or cut off by farm machinery must be replaced or repaired immediately. If the practice is on lands without a conservation plan, a maintenance program will be described as part of the design.

Terrace ridges, especially those with steep back slopes, can be very hazardous. For this reason, some farmers prefer steep· front slopes also thus keeping machinery away from the steep back slopes. All cut slopes and fills that are to be farmed must be no steeper than that on which farm equipment can operate safely. Any hazards must be brought to the attention of the responsible person.

LAND SMOOTHING

Definition

Removing ruts and other irregularities on the land surface by use of special equipment.

Purpose

Improve surface drainage, provide for more effective use of precipitation, obtain more uniform planting depths, provide for more uniform cultivation, improve equipment operation and efficiency, improve terrace alignment, and facilitate contour cultivation.

Conditions Where Practice Applies

This practice applies on areas where depressions, mounds, old terraces, turn rows, and other surface irregularities interfere with the application of needed soil and water conservation and management practices. It is limited to areas having adequate soil depth or where topsoil can be salvaged and replaced.

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation and groundwater recharge.
- Potential for changes in plant growth and transpiration because of changes in the volume of soil water.
- Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
- Effects on the use and management of nutrients and pesticides.
- Effects on downstream water quality.
- Effects on the visual quality of downstream water resources.

Design Criteria

The extent of rough grading required and tolerances of the finished smoothing job should be in keeping with the requirements of the planned cropping system.

Plans and Specifications

Plans and specifications for land smoothing should be in keeping with this BMWP and should describe the requirements for applying the practice to achieve its intended purpose.

Construction operations should be carried out in such a manner that erosion and air and water pollution are minimized and held within legal limits.

The land to be smoothed should be cleared of vegetative matter and trash.

Irregularities should be smoothed to the degree required for the planned use and the requirements of subsequent tillage, floating, or planning to be performed.

Where possible, the ground surface should be plowed or disked prior to smoothing.

At least three passes of a land plane or leveler should be made over the land to be smoothed. This should consist of one pass along each diagonal and the last pass generally in the direction of cultivation.

OBSTRUCTION REMOVAL

Definition

Removal and disposal of unwanted, unsightly or hazardous buildings, structures, vegetation, landscape features, trash, and other materials.

Purpose

To safely remove and dispose of unwanted obstructions and materials in order to apply conservation practices or facilitate planned use of abandoned mine lands, farms, ranches, construction sites, and recreation areas.

Conditions Where Practice Applies

On land where existing obstructions interfere with planned use and development.

Considerations

- Effects upon components of the water budget, especially effects on volume and rate of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Effects on the visual quality or downstream water resources.
- Short-term and construction-related effects on the quality of water resources.

Design Criteria

Rock piles, boulders, stones, fences, hedge rows, abandoned buildings and structures, trash, and similar obstructions that would interfere with planned use and .development should be removed. All debris such as broken concrete and masonry, structural steel and wood, stones, stumps, slash, and sterile or toxic soil material should be disposed of so that they will not impede subsequent work or cause damage to off site or other areas. Disposal should be by burning, burying, or removing to an approved land fill in an environmentally acceptable manner. All required gully shaping should be performed to specified dimensions and grades. Gully fills should be compacted to the required density. The cover over buried materials should be designed to be adequate for the planned use, treatment, and vegetation. Historical or archeological significant and scenic values should be identified and preserved as appropriate.

Plans and Specifications

Plans and specifications for obstruction removal should be in keeping with this BMWP and should describe the requirements for applying and achieving the practice purpose.

UNDERGROUND OUTLET

Definition

A conduit installed beneath the surface of the ground to collect surface water and convey it to a suitable outlet.

Purpose

To dispose of excess water from terraces, diversions, subsurface drains, surface drains, trickle tubes or principal spillways from dams (outside the dam area only), or other concentrations without causing damage by erosion or flooding.

Conditions Where Practice Applies

This practice applies where: (1) excessive surface water needs to be disposed of; (2) a buried outlet is needed for diversions, terraces, or similar practices; (3) an underground outlet can be installed that will safely dispose of excess water; and (4) surface outlets are impractical because of stability problems, climatic conditions, land use, or equipment traffic.

Considerations

- Consider effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Consider effects on the - volume of downstream flow that might cause undesirable environmental, social, or economic effects.
- Evaluate potential use for water management.
- Consider effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that would be carried by runoff.
- Consider effects on the visual quality of downstream water resources.
- Consider sediment-attached and construction-related effects on the quality of downstream water courses.
- Consider effects on wetlands or water-related wildlife habitats.

Design Criteria

Capacity. The underground outlet should be designed, alone or in combination with other practices, with adequate capacity to ensure that the terrace, diversion or other practices function according to the standard for the specific practice. For example, an underground outlet can be used in combination with a grassed waterway or a surface drain to carry part of the design flow. The capacity of the underground outlet for natural basins should be adequate for the intended purpose without causing excessive damage to crops, vegetation, or improvements.

Inlet. An inlet can be a collection box, a perforated riser, or other appropriate device. Its capacity should be adequate to provide the maximumdesign flow in the conduit. Flow-control devices should be installed as necessary. Perforated risers must be of durable material, structurally sound and resistant to damage by rodents or other animals. If burning of vegetation is likely to create a fire hazard, the inlet should be fire resistant. Blind inlets can be used where they are effective. Collection boxes must be large enough to facilitate maintenance and cleaning operations. The inlet must have an appropriate trash guard to ensure that trash or other debris entering the inlet passes through the conduit without plugging. It must also have an animal guard to prevent the entry of rodents or other animals.

Pressure-relief wells hall be designed and installed if needed to control pressure. If junction boxes and other structures are needed, they should be designed and installed in a manner that facilitates cleaning and other maintenance activities.

Hydraulics. Underground outlets should be continuous conduits, tubing, or tile. Joints should be hydraulically smooth, and the materials and methods used should be recommended by the manufacturer. If a pressure system is used, joints should be adequate to withstand the design pressure, including surges and vacuum. The maximum velocity must not exceed the safe velocity for the conduit materials and installation.

Lines should be adequate to carry the design flow when the outlet and all inlets are operating at design capacity. Capacity should be based on the pipe size or on other flow control devices to prevent water from the upper inlets from discharging through the lower inlets. The minimum conduit diameter should be 3 inches.

Materials should meet or exceed the design requirements against leakage and should withstand internal pressure or vacuum and external loading. Plastic, concrete, aluminum, and steel should meet the requirements specified in the applicable ASTM standard.

All materials specified for subsurface drains can be used for underground outlets. Conduits, however, can be perforated or non-perforated, depending on the design requirements.

Outlet. The outlet should be sufficiently stable for all anticipated flow conditions. It should be designed for the maximum anticipated water surface at design flow. A continuous section of closed conduit or a headwall can be used at the outlet. If a closed conduit is used, it should be durable and strong enough to withstand all anticipated loads, including those caused by ice. If fire is a hazard, the outlet should be fire resistant. All outlets near ponds, outlet channels, or streams where water is normally present must have animal guards to prevent the entry of rodents or other animals. Animal guards must be hinged to allow passage of debris.

Protection. Before the outlet is installed, all disturbed areas should be reshaped and regraded so that they blend with the surrounding land features and conditions. Visual resources must be given the same consideration as other design features. Areas that are not to be farmed or covered by structural works should be established to vegetation or otherwise protected from erosion as soon as practicable after construction.

Maintenance. Underground outlets should be maintained by keeping inlets, trash guards, and collection boxes and structures clean and free of materials that can reduce the flow. All leaks should be repaired promptly to ensure proper functioning of the conduit.

Animal guards must be inspected periodically and maintained in proper working order.

Plans and Specifications

Plans and specifications for installing underground outlets should be in keeping with this BMWP and should describe the requirements for installing the practice to achieve its intended purpose.

CHAPTER V

PONDS, WATER SUPPLY AND IRRIGATION

Intent

By implementing the practices in this chapter, which are designed to protect wetland characteristics, functions and values, wetland impacts can be avoided and minimized. Typically the wetlands affected by these practices are classified as Wet Meadow, and occur in an agricultural field and have hydric soils that are defined as soils that, in an undrained condition, are saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation.

Water Use Registration and Reporting Requirements

If your facility uses more than 140,000 gallons per week, you are required to register your facility and periodically report your monthly water use. Env-Wq 2102 Water Use Registration and Reporting Rules (https://www.des.nh.gov/organization/commissioner/legal/rules/documents/env-wq2102.pdf) describes these requirements.

The objective is to gather accurate data on the major uses of the state's water and the demands placed upon individual aquifers, streams and rivers. The registration process requires the completion of a form to provide basic information about the water user. The user must accurately measure and periodically report the volume of water used. Electronic reporting is available. A fact sheet is available at https://www.des.nh.gov/organization/commissioner/pip/factsheets/dwgb/documents/dwgb-22-31.pdf.

For more information, please contact the Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov, or visit http://des.nh.gov/organization/divisions/water/dwgb/index.htm.

POND

Definition

A water impoundment made by constructing a dam or an embankment or by excavating a pit or dugout.

In this practice, ponds constructed by the first method are referred to as embankment ponds and those constructed by the second method as excavated ponds. Ponds constructed by both the excavation and the embankment methods are classified as embankment ponds if the depth of water impoundment against the embankment at spillway elevation is 3 feet or more.

Purpose

To provide water for livestock, fish and wildlife, recreation, fire control, crop and orchard spraying, and other related issues.

Conditions Where Practice Applies

Site conditions. Site conditions should be of such that runoff from the design storm can be safely passed through: (1) a natural or constructed emergency spillway; (2) a combination of a principal spillway and an emergency spillway; or (3) a principal spillway.

Drainage area. The drainage area above the pond must be protected against erosion to the extent that expected sedimentation will not shorten the planned effective life of the structure. The drainage area should be large enough so that surface runoff and groundwater flow will maintain an adequate supply of water in the pond. The water quality should be suitable for its intended use.

Reservoir area. The topography and soils of the site should permit storage of water at a depth and volume that ensures a dependable supply, considering beneficial use, sedimentation, season of use, and evaporation and seepage losses. If surface runoff is the primary source of water for a pond, the soils should be impervious enough to prevent excessive seepage losses or should be of a type that sealing is practicable.

Considerations

Recommended Pond Size. A stockwater pond should provide 20 to 30 gallons per cow per day, or 20 cubic yards of water per cow per year with no inflow, or 1500 gallons per day (enough for 72 cows). A fire protection pond should provide storage of 100,000 gallons between two feet below full elevation and two feet above the bottom elevation. Check local fire departments and insurance regulations. Refer to the appropriate standard in the NH FOTG for Wildlife pond size criteria.

This BMWP establishes the minimum acceptable quality for the design and construction of ponds if:

- Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways, or railroads; or in interruption of the use or service of public utilities.
- The product of the storage times the effective height of the dam is less than 3,000. Storage is the volume, in acre-feet, in the reservoir below the

elevation of the crest of the emergency spillway. The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

- The effective height of the dam is 6 feet or less, and the dam is hazard class A. Drainage area is 640 acres or less.

The following are considerations for water quantity and quality.

- Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability of effects caused by seasonal or climatic changes.
- Effects on the downstream flows or aquifers that could affect other water uses or users.
- Potential for multiple use.
- Effects on the volume of downstream flow to prohibit undesirable environmental, social, or economic effects.
- Effects on erosion and the movement of sediment, pathogens, and soluble and sediment attached substances that are carried by runoff.
- Effects on the visual quality of onsite and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream water courses.
- Effects of water level control on the temperatures of downstream waters to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands and water-related wildlife habitats.
- Effects of water levels on soil nutrient processes such as plant nitrogen use or denitrification.

Design Criteria for Embankment Ponds

Permit. A dam permit is required from the NHDES Water Resources Division for 2 acre-feet or more of impoundment or an embankment height of 6 feet or greater. A wetland dredge and fill permit may be required from the NHDES Wetlands Bureau.

Fencing. All stockwater ponds should be fenced where cattle will have access to the pond area. Where the pond cannot supply a stockwater tank by gravity flow, a watering ramp of adequate width (no less the 12 feet) should be provided. The ramp should extend from the permanent water line to the anticipated low water elevation at a slope not steeper than 4 horizontal to 1 vertical.

Foundation cutoff. A cutoff of relatively impervious material should be provided under the dam if necessary. The cutoff should be located at or upstream from the centerline of the dam. It should extend up to the abutments as required and be deep enough to extend into a relatively impervious layer or provide for a stable dam when combined with seepage control. The cutoff trench should have a bottom width adequate to accommodate the equipment used for excavation, backfill, and compaction operations, and side slopes should not be steeper than 1:1.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage may create swamping downstream, (3) needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage control may be accomplished by (1) foundation, abutment, or embankment drains, (2) reservoir .blanketing, or (3) a combination of these measures.

Earth embankment. The minimum top width for a dam is shown below. If the embankment top is to be used as a public road, the minimum width should be 16 feet for one-way traffic and 26 feet for two-way traffic. Guardrails or other safety measures should be used where necessary and should meet the requirements of the responsible road authority.

Table 1. Minimum top width for dams

Total height of embankment	Top width
feet	*feet*
Less than 10	6
10 – 14.9	8
15 – 19.9	10
20 – 24.9	12
25 – 34.9	14
35 or more	15

For this BMWP, the maximum effective height of the dam is 6 feet.

The combined upstream and downstream side slopes of the settled embankments should not be less than 5 horizontal to 1 vertical, and neither slope steeper than 2:1. All slopes must be designed to be stable.

If needed to protect the face of the dam, special measures, such as berms, rock riprap, sand-gravel, soil cement, or special vegetation, should be provided.

The design height of the dam should be increased by the amount needed to ensure that after settlement, the height of the dam equals or exceeds the design height. This increase should not be less than 5 percent, except where detailed soil testing and laboratory analyses show a lesser amount is adequate.

Spillways

The criteria listed in Table 5-4 should be used to determine minimum spillway sizes and capacities and elevation of top of dam.

Principal spillway. A pipe conduit, with needed appurtenances, should be placed under or through the dam except where a rock, concrete, or other types of mechanical spillways are used or where the rate and duration of flow can be safely handled by a vegetated or earth spillway.

The crest elevation should not be less than 0.5 feet below the crest of the emergency spillway for dams having a drainage area of 20 acres or less and not less than 1 foot for those having a drainage area of more than 20 acres.

When design discharge of the principal spillway is considered in calculating peak outflow through the emergency spillway, the crest elevation of the inlet should be of such that the full flow will be generated in the conduit before there is discharge through the emergency spillway. The inlets and outlets should be designed to function satisfactorily for the full range of flow and hydraulic head anticipated.

The capacity of the pipe conduit should be adequate to discharge long duration, continuous, or frequent flows without flow through the emergency spillways. The diameter of the pipe should not be less than 6 inches. If the pipe conduit diameter is 10 inches or greater, its design discharge may be considered when calculating the peak outflow rate through the emergency spillway.

Pipe conduits under or through the darn should meet the following requirements.

The pipe should be capable of withstanding external loading without yielding, buckling, or cracking. Pipe strength should not be .less than that of the grades indicated in Table 5-5 for plastic pipe and in Table 5-6 for corrugated aluminum and galvanized steel pipe. The inlets and outlets should ·be structurally sound and made of materials compatible with that of the pipe. All pipe joints should be made watertight by the use of couplings, gaskets, welding, or caulking.

For darns 20 feet or less in effective height, acceptable pipe materials are cast-iron, steel, corrugated steel or aluminum, asbestos-cement, concrete, plastic, vitrified clay with rubber gaskets, and cast-in-place reinforced concrete. Asbestos-cement concrete, and vitrified clay pipe should be laid in a concrete bedding. Plastic pipe that will be exposed to direct sunlight should be made of ultraviolet-resistant materials and protected by coating or shielding or provisions for replacement as necessary.

Connection of plastic pipe to less flexible pipe or structures must be designed to avoid stress concentrations that could rupture the plastic.

Seepage control. Seepage control is to be included if (1) pervious layers are not intercepted by the cutoff, (2) seepage could create swamping downstream, (3) such control is needed to ensure a stable embankment, or (4) special problems require drainage for a stable dam. Seepage may be controlled by (1) foundation, abutment, or embankment filters and drains; (2) reservoir blanketing; or (3) a combination of these measures.

- The settled height of the dam exceeds 15 feet.
- The conduit is of smooth pipe larger than 8 inches in diameter.
- The conduit is of corrugated metal pipe larger than 12 inches in diameter.

Anti-seep collars and their connections to the pipe should be watertight. The collar material should be compatible with pipe materials. The maximum spacing should be approximately 14 times the minimum projection of the collar measured perpendicular to the pipe.

Closed conduit spillways designed for pressure flow must have adequate antivortex devices.

If needed to prevent clogging of the conduit, an appropriate trash guard should be installed at the inlet or riser.

A pipe with a suitable valve should be provided to drain the pool area if needed for proper pond management or if required by state law. The principal spillway conduit may.be used as a pond drain if it is located so as to accomplish this function.

Supply pipes through the dam to watering troughs and other appurtenances should have an inside diameter of not less than 1.25 inches.

Drainage Area

Table 2. Minimum auxiliary spillway capacity (New Hampshire Regulations)

Drainage area (Ac.)	Effective height of dam[1] (Ft.)	Storage (Ac-Ft)	Minimum design storm[2]	
			Frequency (Years)	Minimum duration (Hours)
20 or less	25 or less	< then 15	50	24
20 or less	6 or less	< then 50	50	24
	> then 6	> then 50	100	24
All others			100	24

1. As defined under "Conditions where Practice Applies".
2. Select rain distribution based on climatological region.

Emergency spillways. Emergency spillways convey large flood flows safely past earth embankments.

An emergency spillway must be provided for each dam, unless the principal spillway is large enough to pass the routed design hydrograph peak discharge and the trash that comes to it without overtopping the dam. A closed conduit principal spillway having a conduit with a cross sectional area of 3 square feet or more, and inlet that will not clog; and an elbow designed to facilitate the passage of trash is the minimum size and design that may be used without an emergency spillway.

The minimum capacity of a natural or constructed emergency spillway should be that required to pass the peak flow expected from a design storm bf the frequency and duration shown in Table 5-4 less any reduction creditable to conduit discharge and detention storage.

The emergency spillway should safely pass the peak flow or the storm runoff should be routed through the reservoir. The routing should start with the water surface at the elevation of the crest of the principal spillway or at the water surface after 10 days drawdown, whichever is higher. The 10-day drawdown should be computed from the crest of the emergency spillway or from the elevation that would be attained if 1 the entire design storm were impounded, whichever is lower. Emergency spillways should provide for passage of the design flow at a safe velocity to a point downstream where the dam will not be endangered.

Constructed spillways should be trapezoidal and should be located in undisturbed or compacted earth. The side slopes should be stable for the material in which the spillway is to be constructed.

Constructed spillways are open channels and usually consist of an inlet channel, a control section, and an exit channel.

Upstream from the control section the inlet channel should be level for the distance needed to protect and maintain the crest elevation of the spillway. The inlet channel may be curved to fit existing topography. The grade of the exit channel of a constructed spillway should fall within the range established by discharge requirements and permissible velocities.

Structural emergency spillways. If chutes or drops are used for principal spillways or principal emergency or emergency spillways, they should be designed to the principles set forth in the USDA NRCS Engineering Field Handbook, National Engineering Handbook, Section 5, Hydraulics, Section 11, Drop Spillways, and Section 14, Chute Spillways. The minimum capacity of a structural spillway should be that required to pass the peak flow expected from a design storm of the frequency and duration shown in Table 5-4 less any reduction creditable to conduit discharge and detention storage.

Visual resource design. The visual design of ponds in areas of high public visibility and those associated with recreational should be carefully considered. The underlying criterion for all visual design is appropriateness. The shape and form of ponds, excavated material, and plantings are related visually to their surroundings and to their function.

The embankment may be shaped to blend with the natural topography. The edge of the pond may be shaped so that it is generally curvilinear rather than rectangular. Excavated material can be shaped so that the final form is smooth, flowing, and fitting to the adjacent landscape rather than angular geometric mounds. If feasible, islands may be added for visual interest and wildlife value.

<u>Design Criteria for Excavated Ponds</u>

Runoff. Provisions should be made for a pipe and emergency spillway if necessary. Runoff flow patterns should be considered when locating the pit and placing the spoil.

Side slopes. Side slopes of excavated ponds should be stable and should not be steeper than 1 horizontal to 1 vertical. If livestock water directly from the pond, a watering ramp of ample width should be provided. The ramp should extend to the anticipated low water elevation at a slope no steeper than 3:1.

Perimeter form. If the structures are to be used for recreation or are located in high public view, the perimeter or edge must be curvilinear in form.

Inlet protection. If surface water enters the pond in a natural or excavated channel, the side slope of the pond should be protected against erosion.

Excavated material. The material excavated from the pond should be placed so that its weight will not endanger the stability of the pond side slopes and where it will not be washed back into the pond by rainfall. It should be disposed of in one of the following ways:

- Uniformly spread to a height not exceeding 3 feet with the top graded to a continuous slope away from the pond;
- Uniformly placed or shaped reasonably well with side slopes assuming a natural angle of repose for the excavated material behind a berm width equal to the depth of the pond, but not less than 12 feet;
- Shaped to a designed form that blends visually with the landscape;

- Used for low embankment and leveling; or
- Hauled away.

Plans and Specifications

Plans and specifications for installing ponds should be in keeping with this BMWP and should describe the requirements for applying the practice to achieve its intended purpose.

Foundation preparation. The foundation area should be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. If needed to establish vegetation, the topsoil and sod should be stockpiled and spread on the completed dam and spillways. Foundation surfaces should be sloped no steeper than 1:1. The foundation area should be thoroughly scarified before placement of the material. The surface should have moisture added or it should be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundations.

The cutoff trench and any other required excavations should be dug to the lines and grades shown on the plans or as staked in the field. If they are suitable, excavated materials should be used in the permanent fill.

Existing stream channels in the foundation area should be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Foundation areas should be kept free of standing water when fill is being placed on them.

Fill placement. The material placed in the fill should be free of detrimental amounts of sod, roots, frozen soil, stones more than 6 inches in diameter (except for rock fills), and other objectionable material.

Selected backfill material should be placed around structures, pipe conduits, and anti-seep collars at about the same rate on all sides to prevent damage from unequal loading.

The placing and spreading of fill material should be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill should be constructed in continuous horizontal layers except where openings or sectionalized fills are required. In those cases, the slope of the bonding surfaces between the embankment in place and the embankment to be placed should not be steeper than 3:1. The bonding surface should be treated the same as that specified for the foundation so as to ensure a good bond with the new fill.

The distribution and gradation of .materials should be of such that no lenses, pockets, streaks, or layers of material differ substantially in texture of gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material should be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones should be placed according to lines and grades shown on the drawings. The complete work should conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Moisture control. The moisture content of the fill material should be adequate for obtaining the required compaction. Material that is too wet should be dried to meet this requirement, and material that is too dry should have water added and mixed until the requirement is met.

Compaction. Construction equipment should be operated over the are.as or each layer of fill to ensure that the required compaction is obtained. Special equipment should be used if needed to obtain the required compaction.

If a minimum required density is specified, each layer of fill should be compacted as necessary to obtain that density.

Fill adjacent to structures, pipe conduits, and anti-seep collars should be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Fill adjacent to concrete structures should not be compacted until the concrete is strong enough to support the load.

Protection. A protective cover of vegetation should be established on all exposed surfaces of the embankment, spillway, and borrow area if soil and climatic conditions permit. If soil or climatic conditions preclude the use of vegetation and protection is needed, non-vegetative means, such as mulches or gravel, may be used. In some places, temporary vegetation may be used until conditions permit establishment of permanent vegetation. The embankment and spillway should be fences if necessary to protect the vegetation.

Seedbed preparation, seeding, fertilizing, and mulching should comply with instructions in technical guides.

Principal spillway. Corrugated metal pipe should conform to the requirements of Federal Specifications WW-P-402 or WW-P-405, as appropriate. Other pipe materials should conform to specifications suitable for the intended purpose. Anti-seep collars should be of materials compatible with that of the pipe and should be installed so that they are watertight. The pipe should be installed according to the manufacturer's instructions. The pipe should be firmly and uniformly bedded throughout its length and should be installed to the line and grade shown on the drawings.

Concrete. The mix design and testing of concrete should be consistent with the sand and requirements of the job. Mix requirements or necessary strength should be specified. The type of cement, air entrainment, slump, aggregate, or other properties should be specified if necessary. All concrete is to consist of a workable mix that can be placed and finished in an acceptable manner. Necessary curing should be specified. Reinforcing steel should be placed as indicated on the plans and should be held securely in place during concrete placement. Subgrades and forms should be installed to line and grade, and the forms should be mortar tight and yielding as the concrete is placed.

Foundation and embankment drains. Foundation and embankment drains, if required, should be placed to the line and grade shown of the drawings. Detailed requirements for drain material and any required pipe should be shown in the drawings and specifications for the job.

Excavated ponds. The completed excavation should conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Embankment and excavated ponds. Construction operations should be carried out in such a manner and sequence that erosion and air and water pollution are minimized and held within legal limits. All work should be conducted in a skillful and professional manner. The completed job should present a good appearance.

Measures and construction methods that enhance fish and wildlife values should be incorporated as needed and practical. Fencing and cover to control erosion and pollution should be established as needed. Appropriate safety measures, such as warning signs, rescue facilities, and fencing, should be provided.

Operation and Maintenance

An O&M plan should be developed and reviewed with the landowner or individual responsible for operation and maintenance.

IRRIGATION STORAGE RESERVOIR

Definition

A small storage reservoir constructed to regulate or store a supply of water for irrigation.

Purpose

To collect and store water until it can be used beneficially to satisfy crop irrigation requirements.

Conditions Where Practice Applies

This practice applies only to sites meeting all the following criteria and conditions:

- The existing water supply available to the irrigated area is insufficient to meet conservation Irrigation requirements during part or all the irrigation season;
- Construction of an irrigation pit is the most practical means of obtaining a needed additional supply of water;
- An adequate supply of good quality water is available for storage from surface runoff, stream flow, or from a subsurface source;
- Topographic, geologic 1 water table, and soils conditions at the site. are satisfactory for the feasible development of the irrigation pit; and
- If surface runoff enters the pit, the contributing drainage area is or can be protected against erosion so that normal sedimentation dos not materially shorten the planned life of the pit.

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Potential for irrigation water management.
- Effects on erosion and the movement of sediment, pathogens, and the soluble and sediment attached substances carried by runoff.
- Effects on the movement of dissolved substances to groundwater.
- Short-term and construction-related effects on the quality of downstream water courses.
- Potential for uncovering or redistributing toxic material.
- Effects on wetlands or water-related wildlife habitats.
- Effects on the visual quality of water resources.

Design Criteria

Capacity. Irrigation storage reservoirs should be designed to have a usable capacity sufficient to satisfy irrigation requirements in the design area throughout the growing season of the crop or crops being irrigated. In computing capacity requirements, due consideration should be given, where applicable, to groundwater inflow, surface runoff, precipitation, evaporation, and seepage. Additional capacity should be provided as necessary for sediment storage. The usable capacity of a pit that depends wholly on groundwater as a source of supply should be that part of the pit that is below the static water level.

Reservoir design. Irrigation reservoirs should be designed according to the criteria for excavated Ponds, above.

Outlet works. Suitable outlet works should be provided for the controlled release of irrigation water. The capacity of the outlet works should be no less than that required to provide the outflow rate needed to meet average period irrigation system demands.

DIKE

Definition

An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water.

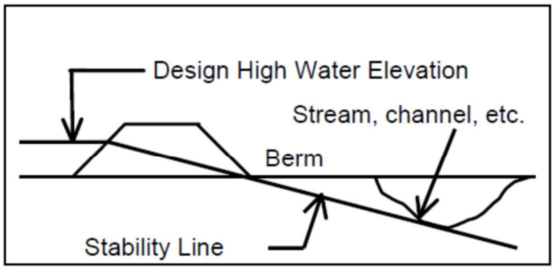


Figure 1

Purpose

To permit improvement of agricultural land by preventing overflow and better use of drainage facilities, to prevent damage to land and property, and to facilitate water storage and control in connection with wildlife and other developments. Dikes can also be used to protect natural areas, scenic features, and archeological sites from damage.

Conditions Where Practice Applies

Class I dikes are those constructed on sites where:

- Failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads, and high value land, crops, or other improvements.
- Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.
- Protection is needed to withstand more than 12 feet of water above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas.

Class II dikes are those constructed in highly developed and productive agricultural areas where:

- Failure may damage isolated names, highways or minor railroads, or cause interruption in service or relatively important public utilities.
- The maximum design water stage against the dike is 12 feet.

Class III dikes are those constructed in rural or agricultural areas where:

- Damage likely to occur from dike failure is minimal.
- The maximum design water stage against the dike is 6 feet for mineral soils and 4 feet for organic soils. (Exclude channels, sloughs, swales, and gullies in determining the design water stage.)

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, and transpiration.
- Potential for a change in rates of plant growth and transpiration because of changes in the volume of soil water.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Effects on the rate or volume of downstream flow to prohibit environmental, social, or economic effects.

- Effects on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
- Effects on the movement of dissolved substances to groundwater.
- Short-term, construction, and maintenance related effects on the quality of water resources.
- Effects on temperature of water resources to prevent undesired effects on aquatic and wildlife communities.
- Effects on wetlands or water-related wildlife habitats that would be associated with the practice.
- Effects on the visual quality of water resources.

A dam permit is required from the NHDES Water Resources Division for 2 acre-feet or more of impoundment or an embankment height of 6 feet or greater. A wetland dredge and fill permit may be required from the NHDES Wetlands Bureau.

Design Criteria - All Dikes

In locating dikes, careful consideration should be given to preserving natural areas, fish and wildlife habitat, woodland, and other environmental resources. If dike construction will adversely affect such values, concerned public agencies and private organizations should be consulted about the project.

Protection. A protective cover of grasses should be established on all exposed surfaces of the dike and other disturbed areas. Seedbed preparation, seeding, fertilizing, mulching, and fencing should comply with recommendations in local technical guides

If vegetation will not control erosion, riprap or other protective measures should be installed.

Maintenance. All dikes must be adequately maintained to the required shape and height. The maintenance of dikes must include periodic removal of woody vegetation that may become established on the embankment. Provisions for maintenance access must be provided.

Design Criteria - Class I Dikes

Location. Conditions to be considered in designing Class I dikes are foundation soils, property lines, exposure to open water, adequate outlets for gravity or pump drainage, and access for construction and maintenance. Mineral soils that will be stable in the dike embankment must be available.

Height. The design height of a dike should be the design high water depth plus 2 feet of freeboard or l foot of freeboard plus an allowance for wave height, whichever is greater. Design elevation of high water should be determined as follows:

- If dike failure is likely to cause loss of life or extensive high-value crop or property damage, the elevation of design high water should be that associated with the stage of the 100-year frequency flood or of the maximum flood of record, whichever is greater.
- If dike failure is unlikely to result in loss of life or extensive high-value crop or property damage, the elevation of

design high water should be that associated with the peak flow from the storm that will ensure the desired level of protection or the so-year frequency flood, whichever is greater.

- If the dike will be subject to stages from more than one stream or source, the criteria indicated should be met for the combination that causes the highest stage.
- If the dike will be subject to tidal influence as well as stream flow, the stream flow peak should be assumed to occur in conjunction with the mean high tide to determine the design high water depth.

The design height of the dike should be increased by the amount needed to ensure that the design top elevation is maintained after settlement. This increase should be not less than 5 percent.

Interior drainage. If inflow from the area to be protected by the dike may result in loss of life or extensive high-value crop or property damage, provisions should be included in the plans to provide interior protection against a 100-year frequency hydrograph, plus base flow, and an allowance for seepage, and may include storage areas, gravity outlets, or pumping plants, alone or in combination.

If inflow from the area to be protected by the dike is unlikely to result in loss of life or extensive high-value crop or property damage, storage areas, gravity outlets, or a pumping plant, alone or in combination, should be included in the plans and designed to handle the discharge from the drainage area based on drainage requirements established for the local area or the peak flow from the storm that will ensure the desired level of protection, whichever is greater.

In sizing outlet works in combination with available storage, the minimum design storm duration for interior drainage should be 10 days. If outlet works are designed using peak flood frequency flows without considering storage, the minimum design storm duration should be 24 hours.

Embankment and foundation. The embankment should be constructed of mineral soils, which when placed and compacted will result in a stable earth fill. No organic soil should be used in the dike. Soils must have high specific gravity and be capable of being formed into an embankment of low permeability. The design of the embankment and specifications for its construction should give due consideration to the soil materials available, foundation conditions, and requirements for resisting the action of water on the face of the dike and excessive seepage through the embankment and the foundation. The design of the embankment and the foundation requirements should be based on the length of time and height that water will stand against the dike.

Minimum requirements for certain features of the embankment, the foundation, and borrow pits are as follows:

Minimum top width of Class I dikes should be 10 feet for embankment heights of 15 feet or less and 12 feet for heights more than 15 feet. If-maintenance roads are to be established on the dike top, 'turnarounds' or passing areas should be provided as needed.

Side slopes should be determined from a stability analysis, except that an unprotected earth slope on the water side should not be steeper than 4 horizontal to 1 vertical if severe wave action is anticipated.

If dikes cross old channels or have excessively porous fills or poor foundation conditions, the landside toe should be protected by a banquette or constructed berm. Banquettes should be designed on the basis of site investigations, laboratory analysis, and compaction methods. The finished top width of the banquettes should not be less than the height of dike above mean ground. The finished top of the banquettes should be not less than 1 foot above mean ground and should be sloped away from the dike.

A cutoff should be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff should have a bottom width and side slopes adequate to accommodate the equipment to be used f or excavation, backfill, and compaction operations. It should be backfilled with suitable material placed and compacted as required for the earth embankment. If pervious foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to ensure stability of the dike should be used.

Ditches and borrow pits. Landside ditches or borrow pits hall be located so the hazard of failure is not increased. Ditches for borrow pits when excavated on the water side of dikes should be wide and shallow. Plugs, at least 15 feet in width, should be left in the ditches at intervals not greater than 400 feet to form a series of unconnected basins.

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow pit should be, see Table 1.

A drainage system should be used if necessary to ensure the safety of a dike. Toe drains, if used, should be located on the landside and should have a graded sand-gravel filter designed.to prevent movement of the foundation material into the drain.

Subsurface drains should not be installed, or permitted to remain without protection, closer to the landside toe of a dike than a distance three times the design water height for the dike. If subsurface drains are to be installed or remain closer than the distance stated, protection should consist of graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

Pipes and conduits. Dikes should be protected from scour at pump intakes and discharge locations by appropriate structural measures. A pump discharge pipe through a dike should be installed above design high water, if feasible, or be equipped with anti-seep collars. All conduits through a dike below the design high water line should be equipped with anti-seep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed water line should be equipped with a Dayton or similar coupling to prevent vibration of the pumping plant being transmitted to the discharge conduits.

Design Criteria - Class II Dikes

Design water stage. The maximum design water stage permitted is 12 feet above normal ground level exclusive of crossings at channels, sloughs, and gullies.

If the design water depth against dikes, based on the required level of protection, exceeds 4 feet the design should be based on at least a 25-year frequency flood. If this degree of protection is not feasible, the design should approach the 25-year flood level as nearly as possible, and planned fuse plug sections and other relief measures should be installed where appropriate.

Height. The design height of an earth dike should be the design water depth plus a freeboard of at least 2 feet or freeboard of 1foot plus an allowance for wave height, whichever is greater.

The constructed height of the dike should be the design height plus and allowance for settlement necessary to ensure that the design top elevation is maintained but should be no less than 5 percent of the design height.

Interior drainage. Provisions must be made for adequate drainage for the area to be protected by the dike.

Cross section. The minimum requirements for the cross section of the dike where 'fill is compacted by hauling or special equipment should be as follows, see Table 1.

If soils or water conditions make it impractical to compact the dike with hauling or special equipment, dumped fill may be used and should have minimum cross section dimensions incorporated in the fill as follows, see Table 1.

Side slopes of 3:1 on the waterside and 2:1 on the landside may be used instead of 2%:1 for both slopes.

The cross sections should be strengthened or increased as required to provide additional protection against floods of long duration. The top width should be not less than 10 feet if a maintenance road is planned on top the dike. 'Turnarounds ' or passing areas should be provided as required on long dikes.

The side slopes should be 3:1 or flatter on the waterside if severe wave action is expected or if a steeper slope would be unstable under rapid drawdown conditions. Side slopes should be 3:1 or flatter on both sides where permeable soils of low plasticity, such as SM and ML, are used in construction.

A banquette (or constructed berm) should reinforce the landside toe if a dike crosses an old channel or if excessively porous fill or poor foundation conditions justify such reinforcement. Such banquettes should be used if, during construction, the channel crossing is under water or saturated. The top width of the banquette should be equal to or greater than the fill height of the dike above the top of the banquette unless a detailed investigation and analyses show a different design is adequate.

Foundation cutoff. A cutoff should be installed if there are layers of permeable soils or layers creating a piping hazard through the foundation at a depth less than the design water depth of the dike below natural ground level. The cutoff trench should be of sufficient depth and width and filled with suitable soils to minimize such hazard.

Ditches and borrow pits. Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow should be, see Table 1.

A landside ditch or borrow pit should be far enough away from the dike to minimize any hazard to the dike because of piping through the foundation.

For dikes having design water depth of more than 5 feet, the landside ditch or borrow pit should be far enough away from the dike so that a line drawn between the· point of intersection of the design water line with the waterside of the dike and the landside toe of a dike meeting minimum dimensional requirements should not intersect the ditch or borrow pit cross section.

Pipes and conduits. The dike should be protected from scour at a pump intake and discharge by appropriate structural measures. A pump discharge pipe through the dike should be installed above design high water, if feasible, or else equipped with anti-seep collars.

Pipes installed through a Class I dike below the design high water with a dike height greater than 12 feet should meet the requirements for PRINCIPAL SPILLWAYS as found in NRCS TECHNICAL RELEASE 60 – Earth Dams and Reservoirs, except for the minimum size requirements. Pipes through all other dikes should meet the requirements for a principal spillway in NRCS Conservation Practice Standard, Ponds (378).

Drains. Drains should be used where necessary to ensure safety of dikes and should be located on the land side, have a graded sand- gravel filter, and the designed and installed in accordance with NRCS standards for such drains.

Field subsurface drains should not be installed or permitted to remain without protection closer to the landside toe of a dike than a distance three times the design water height for the dike. If such drains are to be installed or remain closer than the distance stated above, protection should consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

<u>Design Criteria – Class III Dikes</u>

The design criteria should be based on site conditions for mineral or organic soils as applicable.

Top width. Minimum top width is 4 feet.

Side slopes. Minimum side slope is 1:1.

Freeboard. The minimum freeboard is 1 foot plus wave height. The constructed height should be increased by this amount to ensure that the settled top is at design elevation greater than 5 percent height necessary to but not less foundation cutoff. A cutoff should be installed if necessary to ensure dike stability.

Ditches and borrow pits. Minimum berm widths between the toe and the dike and the edge of the excavated channel or borrow should be two times the depth of the ditch but not less than 8 feet.

Plans and specifications for constructing dikes should be in keeping with this BMWP and should describe the requirements for applying the practice to achieve its intended purpose.

Plans and Specifications

Table 1 – Minimum Design Criteria for Dikes

Classification	Material [1/]	Height (H) in Feet [2/]	Minimum Storm Design Frequency in Years	Minimum Freeboard in Feet	Minimum Top Width in Feet	Minimum Side Slope Ratio [3/] (H:V)	Berm Width in Feet
Class I	Earth	0 to 6	100	H/3	10	2:1	12
		>6 to 12	100	2	10	Note 4/	Note 4/
		>12 to 25	100	3	12	Note 4/	Note 4/
		>25	100	3	14	Note 4/	Note 4/
	Manufactured	0 to 8	100	H/4	N/A	N/A	Note 4/
		>8 to 12	100	2	N/A	N/A	Note 4/
		>12	100	3	N/A	N/A	Note 4/
Class II	Earth	0 to 6	25	H/3	6	2:1	12
		>6 to 12	25	2	8	2:1	15
	Manufactured	0 to 8	25	H/4	N/A	N/A	Note 4/
		>8 to 12	25	2	N/A	N/A	Note 4/
Class III	Mineral Soils	0 to 3	10	H/3	4	2:1	8
		>3 to 6	10	1	6	2:1	8
		>6 to 12	25	2	8	2:1	8
	Organic Soils [5/]	0 to 2	10	H/2	4	2:1	10
		>2 to 4	10	1	6	2:1	10
		>4 to 6	10	2	8	2:1	15

[1/] Earth includes rock. Manufactured materials are erosion resistant materials such as concrete, PVC and steel that provides the structural strength for the dike.

[2/] Height is the difference between normal ground elevation at the dike centerline and the design high water elevation. When determining normal ground elevation, exclude crossings of channels, sloughs, small low areas, small ridges, swales, or gullies.

[3/] Minimum side slope ratios are for compacted earth fill. Dumped earth fill without compaction will be flatter.

[4/] Side slope ratios and berm widths shall be determined by a stability analysis.

[5/] Organic soils are permitted only for Class III dikes 6 feet or less in height. Higher dike heights result in excessive settlement and decomposition.

IRRIGATION WATER CONVEYANCE

Definition

A pipeline and appurtenances installed in an irrigation system.

Purpose

The conservation objectives of this pipeline practice are to prevent erosion or loss of water quality or damage to land, to make possible the proper management of irrigation water, and to reduce water conveyance losses.

Conditions Where Practice Applies

All pipelines should be planned and located to serve as integral parts of an irrigation water distribution or conveyance system that has been designed to facilitate the conservation use of soil and water resources on a farm or group of farms.

All lands served by the pipelines should be suitable for use as irrigated land.

Water supplies and irrigation deliveries to the area should be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Considerations

- Effects on the components of the water budget, especially on rates of evaporation, transpiration; deep percolation, and groundwater recharge.
- Effects on downstream flows or aquifers that would affect other water uses or users.
- Potential for irrigation water management.
- Effects of installing the pipeline replacing other types of conveyances on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water.
- Effects on the movement of dissolved substances into the soil and on percolation below the root zone or to groundwater recharge.
- Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and wildlife communities.
- Effects on wetlands or water-related wildlife habitats.
- Effects on the visual quality of water resources.

Design Criteria

The design criteria for the following types of pipelines can be found in Section 2 of the USDA NRCS National Engineering Handbook and are a part of this practice.

- Aluminum Tubing, Plastic Tape Coated Asbestos-Cement
- Non-reinforced Concrete
- High Pressure Underground Plastic
- Low Head Underground Plastic
- Steel
- Reinforced Plastic Mortar

Plans and Specifications

Specifications should be in keeping with this BMWP and should describe the requirements for proper installation of the practice to achieve its intended purpose.

Construction should conform to plans and the 'New Hampshire Construction and Specifications for Conservation Engineering Practices.'

SPRING DEVELOPMENT

Definition

Improving springs and seeps by excavating, cleaning; capping; or providing collection and storage facility.

Purpose

Spring developments usually are made to improve the distribution or to increase the quantity and quality of livestock and wildlife water supplies, but may be made for irrigation if water in suitable quantity and quality is available.

Conditions Where Practice Applies

Developments should be confined to springs or seepage areas that appear able to furnish a dependable supply of suitable water during the planned period or periods of use.

The need for, and feasibility of, protection from flooding, sedimentation, and contamination should be considered in determining the suitability of a site for development.

Considerations

- Potential changes in surface water quantity, especially base flow. Factor is the removal of obstructions and vegetation in the spring area.
- No significant impact on water quality.

Design Criteria

Fracture and tubular springs where water issues from fractures, the individual openings should be cleaned and enlarged as needed to provide an increase in flow. The water from these individual openings should be collected and conveyed to a central sump or spring box by means of a tile or perforated pipeline or by a gravel-filled ditch. The collection works should be constructed an adequate distance vertically below the elevation of the openings to permit free discharge.

Where water issues from a single opening, such as solution channels found in soluble rock formations or tunnels in lava, the opening should be cleaned or enlarged as needed. A collection system usually will not be required, but a spring box or sump should be installed at an elevation sufficiently low that water will not pond over the spring opening to a depth that will materially reduce the yield.

Perched or Contact Springs. Perched or contact springs occur where impermeable layer outcrops beneath a water-bearing permeable layer. These springs should be developed by intercepting and collecting the flow from the water-bearing formation. Collection trenches are used for developing these types of springs.

Artesian springs. Artesian springs should be developed by removing obstructions, cleaning or enlarging joints or fractures, or by lowering the outlet elevation sumps and spring boxes should be located so as to hold ponding over the spring outlet to a minimum.

Collection systems. Where a collecting trench along the outcrop of the water-bearing formation is to be used, the trench should be excavated so that it extends into the impervious layer.

An impervious cutoff wall of well-tamped clay, masonry, concrete, or other suitable material should be constructed along the downstream side of the trench where needed to cause the flow to enter the collection system.

The collection system should consist of drain tile or perforated pipe not less than 4 inches in diameter, or wood box drain, enclosed in a sand-gravel filter. A crushed rock or gravel backfill, not less than 12 -inches deep; may be used in lieu of these types of drains. The collection system should outlet into a spring box.

Spring Boxes. Spring boxes should be of durable material and should have a tight, removable cover. The boxes should have a minimum cross sectional area of 1.5 square feet. The floor of the spring box should be not less than 6 inches below the outlet of the collection system.

Spring boxes for perched springs should be floored with concrete unless the underlying material is solid rock or other stable impervious material.

Outlets. The outlet pipe from a spring box should be placed not less than 6 inches above the floor of the box to provide a sediment trap. However, the outlet must not be so high as to cause a head on the spring that would reduce flow. The outlet pipe should be installed so as to ensure a water tight connection with the spring box. Measures required to protect the development from damage by freezing, flooding, sedimentation, contamination, and livestock should be included in the design.

Plans and Specifications

Specifications will be in keeping with this BMWP and will describe the requirement for proper installation of the practices to achieve its intended purposes.

All loose rock, sediment, travertine, logs, and vegetation that obstruct the free discharge of the spring should be removed and disposed of so that it will not endanger the spring development.

Collection trenches, drain tiles, perforated pipelines, sumps, and spring boxes should be constructed to the elevations and grades shown on the plans.

Crushed rock or gravel for collection systems and sand-gravel material for filters should be composed of clean, hard particles.

Construction operations will be carried out in such a manner that erosion and air and water pollution will be minimized and held within legal limits.

PIPELINE

Definition

Pipeline having an inside diameter of 8 inches or less.

Purpose

To convey water from a source of supply to points of use for livestock, wildlife, or recreation.

Condition Where Practice Applies

Where it is desirable or necessary to convey water in a closed conduit from one point to another.

Criteria

Capacity. For livestock water, the installation should have a capacity to provide seasonal high daily water requirements for the number and species of animals to be supplied. Minimum animal water requirements to be met are:

Dairy Cattle	25 Gallons per day per cow
Beef Cattle	20 Gallons per day per cow
Horses	12 Gallons per day per Horse
Sheep	3 Gallons per day per sheep
Goats	3 Gallons per day per goat

For recreation areas, the water capacity should be adequate for all planned uses. Typical examples are drinking water, fire protection, showers, flush toilets, and irrigation of landscaped areas. Additional water capacity will be provided for wildlife when applicable.

Sanitary protection. If water from the pipeline is to be used for human consumption, applicable state and local regulations should be met.

Pipe. All pipe must withstand the pressure it will be subjected to, including hydraulic transients, internal pressures and external pressures. As a safety factor against surge or water hammer, the working pressure should not exceed 72% of the pressure rating of the pipe and the design flow velocity at system capacity should not exceed 5 ft/sec. If either of these limits is exceeded, special consideration must be given to flow conditions and measures must be taken to adequately protect the pipeline against surge.

Steel pipe should meet the requirements of AWWA Specification C-200.

Plastic pipe should conform to the requirements of the following ASTM specifications, as applicable:

- D 1527 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe, Schedules 40 and 80
- D 1785 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
- D 2104 Polyethylene (PE) Plastic Pipe, Schedule 40
- D 2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
- D 2241 Poly(Vinyl Chloride) (PVC), Pressure-Rated Pipe (SDR)
- D 2282 Acrylonitrile-Butadiene-Styrene
- (ABS) Plastic Pipe (SDR-PR)
- D 2447 Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
- D 2513 Thermoplastic Gas Pressure Pipe, Tubing and Fittings

- D 2737 Polyethylene (PE) Plastic Tubing
- D 2672 Joints for IPS PVC Using Solvent Cement
- D 3035 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter
- AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe, 4 inches through 12 inches
- AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ inch through 3 inches
- Plastic pressure pipe fittings should conform to the following ASTM specifications, as applicable:
- D 2464 Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2466 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
- D 2467 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
- D 2468 Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe Fittings, Schedule 40
- D 2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
- D 2683 Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing
- D 3139 Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
- D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- Solvents for solvent-welded plastic pipe joints should conform to the following ASTM specifications, as applicable:
- D 2235 Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
- D 2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings
- D 2855 Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings

Rubber gaskets for pipe joints should conform to the requirements of ASTM F477, Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

Drainage. Valves or unions should be installed at low points in the pipeline so that the line can be drained as needed. Check valves should be installed as needed to protect groundwater quality or maintain a full pipeline. Pipelines installed on the surface should be adequately drained to prevent damage by ice and freezing during the winter.

Vents. Design should provide for entry and removal of air along the pipeline, as needed, to prevent air locking or pipe collapse. If parts of the line are above the hydraulic gradient, periodic use of an air pump may be required. Provisions should be made for pressure relief, air relief and vacuum relief as needed to protect the pipeline.

Joints. Watertight joints that have strength equal to that of the pipe should be used.

Couplings must be of material compatible with that of the pipe. If they are made of material susceptible to corrosion, provisions must be made to protect them.

Protection. When steel pipe is used, interior protective coatings should be provided in accordance with NRCS Conservation Practice Standard 430FF, Steel

Pipe. If a coal-tar enamel protective coating is needed for corrosion protection, the coating should meet the requirements of AWWA Specification C-203.

Steel pipe installed above ground should be galvanized or should be protected with a suitable protective paint coating, including a primer coat and two or more final coats.

Plastic pipe installed above ground should be resistant to ultraviolet light throughout the intended life of the pipe.

All pipes should be protected from hazards presented by traffic, farm operations, freezing temperatures, fire, thermal expansion and contraction. Other means of protection must be provided where the depth required for protection may is not possible due to shallow soils over bedrock or other reasons. Reasonable measures should be taken to protect the pipe from potential vandalism.

All valves and other appurtenances should be protected from livestock access.

Vegetation. Disturbed areas should be established with vegetation or otherwise stabilized as soon as practical after construction. Seedbed preparation, seeding, fertilizing, and mulching should conform to NRCS Conservation Practice Standard 342, Critical Area Planting.

Visual Resources. The visual design of pipelines and appurtenances in areas of high public visibility should be carefully considered.

Pipe Inlet and Outlet. The inlet of the pipe should be protected by the installation of a tee and vent pipe, screen or sediment trap. The pipeline should discharge into an approved watering facility. Livestock watering facilities should be in accordance with standard 614 – Watering Facility.

Testing. Pipelines should be pressure tested by one of the following methods:

- Before backfilling, fill the pipe with water and test at the design working head or head of ten feet, whichever is greater. All leaks must be repaired, and the test must be repeated before backfilling.
- Pressure test at the working pressure for two hours. The allowable leakage should not be greater than one gallon per diameter inch per mile. If greater, the defect must be repaired until the retest shows the leakage is within the allowable limits. All visible leaks must be repaired.

Backfilling. All backfilling should be completed before the line is placed in service. For plastic or copper pipe, the initial backfill should be of selected material, free from rocks or other sharp-edged material that would damage the pipe. The initial fill should be compacted around the pipe to a density approximately equal to the existing material. Deformation or displacement of the pipe should not be allowed during backfilling. Provisions for stabilization of disturbed areas and control of erosion during construction should be installed as necessary.

<u>Considerations</u>

No special considerations have been identified for this practice.

Plans and Specifications

Plans and specifications for installing pipelines should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose. If the pipeline is a component of a system that includes additional conservation practices, the information necessary to construct these additional practices will also be conveyed on the plans.

Operation and Maintenance

An O&M plan specific to the type of installed pipeline should be provided to the landowner. The plan should include, but not be limited to, the following provisions:

- Opening/closing valves to prevent excessive water hammer;
- Filling at the specified rate requirements;
- Inspecting and testing valves, pressure regulators, pumps, switches and other appurtenances;
- Maintaining erosion protection at outlets;
- Checking for debris, minerals, algae and other materials which may restrict system flow; and
- Draining and/or providing for cold weather operation of the system.

WATER WELL

Definition

A well-constructed or improved to provide water for irrigation, livestock, wildlife, or recreation.

Purpose

To facilitate proper use of vegetation on rangeland, pastures, and wildlife areas; to supply the water requirements of livestock and wildlife; to provide an adequate supply of water for conservation irrigation; and to provide for human use at recreation sites.

Condition Where Practice Applies

All irrigation wells should be planned and located to serve as a source of water for an irrigation water distribution or conveyance system designed to facilitate the conservation use of the soil and water resources on a farm or group of farms.

Irrigation wells are limited to geological sites where sufficiently large volumes of underground water are available at a rate that will permit practical irrigation of the land on which the water is to be used. Wells may be the only source of water or they may supplement other sources. The land on which the water is to be used must be suitable for the production of locally adapted crops grown under irrigation farming. The water must be of adequate quality to ensure that it will not materially reduce the productive capacity of the soil on which it is to be used. Wells are applicable on rangeland, pastures, cropland, and wildlife, and recreation areas where present water facilities are inadequate and the underground water supply is adequate in quantity and quality for the purpose to be served and can be developed at an economical cost.

Design Criteria

General. The suitability of the well site and the type of well installed should be based on detailed geologic investigations, including test well drilling, on ground water assessment studied made by local, state, or federal agencies, or on reliable local experience. The design should include ground water conservation measures, provisions for controlling contamination from one aquifer to another in the well, and method for obtaining a maximum supply of sediment-free water.

Well diameter. The diameter of the well should be adequate to meet the yield capacity of the information in the relation to the nature and extent of the water-bearing area and to permit the installation of a pump to deliver the needed amount of water to the projected lift elevation.

Casing and materials. Wells should be cased, but the lower sections passing through consolidated strata do not require casing.

Material should meet the requirements detailed under "Well Specifications."

The maximum depth for well casings should be based on critical collapse pressure as calculated by the Cleindeinst Equation in ASTM-F-480, appendix X2. Depth, as used in this standard, applies to the difference in static head between the inside and outside of the casing. This can be determined by measuring the static head or by using the total depth of the well.

Table 1. — Maximum depth of installation for plastic (SDR-PR) pipe

SDR	Material: PVC		ABS	SR
	Modulus of elasticity (E)			
	400,000	320,000	250,000	300,000
	ft			
13.5	985	785	615	735
17	475	380	295	355
21	245	200	150	185
26	130	100	80	95
32.5	65	50	40	50

Table 1 gives the depth limitations for polyvinyl chloride (PVC), acrylonitrile-butadiende-styrene (ABS), and styrene-rubber (SR) well casing pipes having different standard dimension ratios and module of elasticity.

Table 2 gives the dimension and maximum depth of installation for PVC Schedules 40 and 80 pipe constructed of material having a modules of elasticity equal to 400,000 lb/in.2. The factors give at the bottom of this table may be used in calculating depth limitations for ABS Schedules 40 and 80 pipe and other PVC classifications.

Figure 1 can be used in determining the maximum depth of plastic and fiberglass casings not covered by tables 1 and 2.

Table 3 gives the dimensions and maximum depth of installation for reinforced plastic mortar (RPM) well casings of various sizes and wall thickness.

Asbestos-cement and concrete water well casings should be limited to wells not greater than 500 ft. in depth.

Table 2. — Dimension and maximum depth of installation for Schedules 40 and 80 PVC plastic pipe

Nominal diameter	Outside diameter	Schedule 40: Minimum wall thickness	Schedule 40: SDR	Schedule 40: Maximum depth	Schedule 80: Minimum wall thickness	Schedule 80: SDR	Schedule 80: Maximum depth
in.	in.	in.		ft	in.		ft
2	2.375	0.154	15.4	650	0.218	10.9	1,960
2 ½	2.875	.203	14.2	840	.276	10.4	2,260
3	3.500	.216	16.2	550	.300	11.7	1,150
3 ½	4.000	.226	17.7	420	.318	12.6	1,220
4	4.500	.237	19.0	340	.337	13.4	1,010
5	5.563	.258	21.6	230	.375	14.8	740
6	6.625	.280	23.7	170	.432	15.3	660
8	8.625	.322	26.8	120	.500	17.3	450
10	10.750	.365	29.5	90	.593	18.1	390
12	12.750	.406	31.4	—	.687	18.6	360

Figure 1. - Maximum depth of installation for plastic (SDR-PR) pipe.

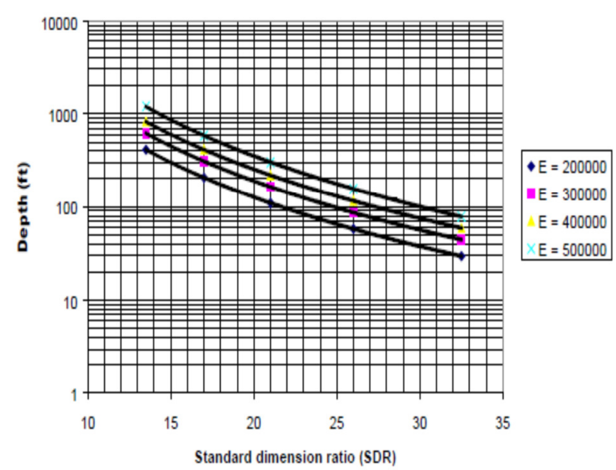


Table 3. — Dimension and depth limitations for reinforced plastic well casings

Diameter (*in.*)	Maximum depth (*ft*) 20	60	100	200	300	400	500	750	1,000
	Minimum wall thickness (*in.*)								
8	0.17	0.17	0.23	0.23	0.23	0.29	0.29	0.33	0.33
10	.17	.17	.28	.28	.28	.36	.36	.41	.41
12	.18	.19	.34	.34	.34	.43	.43	.46	.46
14	.19	.22	.32	.40	.40	.43	.46	.43	.43
15	.19	.24	.34	.34	.46	.46	.46	.46	.46
16	.20	.25	.36	.36	.46	.46	.46	.46	.46
18	.21	.28	.40	.40	.45	.45	.45	.52	.52
20	.21	.31	.42	.42	.45	.45	.45	.54	.54
21	.21	.33	.48	.48	.48	.48	.48	.57	.57
24	.24	.38	.48	.48	.57	.57	.57	.57	.57
27	.26	.40	.49	.49	.49	.62	.62	.62	.62
30	.29	.44	.49	.49	.49	.68	.68	.68	.68
33	.32	.44	.60	.60	.60	.75	.75	.75	.75
36	.35	.48	.65	.65	.65	.82	.82	.82	.82

Table 4, gives the minimum allowable thickness of metal casings. Table 5 gives the maximum depth of installation for steel casings.

Table 4. — Minimum thickness of metal casings for wells

Diameter	Minimum wall thickness Steel casing	Lightweight galvanized casing[1]
in.	*in.*	*in.*
[2]1	0.133	—
[2]1½	.145	—
[2]2	.154	—
[2]2½	.203	—
[2]3	.216	—
[2]3½	.226	—
4	.060	0.0322
4½	.060	.0322
5	.075	.0382
6	.105	.0382
8	.105	.0486
10	.105	.0486

[1]Casings having a different wall thickness can be used in the same well if the maximum allowable depth for each is maintained.

Screens. All wells constructed to recover water from consolidated aquifers should be equipped with manufactured screen sections, well points, or field perforated sections meeting the criteria stated below. The screen openings for aquifer material of near uniform size should be smaller than the average diameter of the aquifer material. The screen or slotted casing section must be protected with a device immediately above the intake section if necessary to prevent well stabilizer materials from entering the intake section area. For graded aquifer materials (of non-uniform gradation), the screen should be sized so that 25 to 40 percent of the aquifer material is larger than the screen opening. For wells in which a gravel pack envelope is used, the screen should have openings that will exclude at least 85 prevent of the gravel pack material. The length and open area of the screen should be adequate to maintain the entrance velocity of water into the well at an acceptable level, preferably less than 1/10 ft./s.

The position of the screen in the well should be governed by the depth of the aquifer below the ground surface and the thickness of the aquifer to be penetrated by the well. If practical, the top elevation of the screen should be below the lowest water level expected during pumping and be located opposite the most permeable area in the water-bearing strata.

Table 5. – Maximum depth of installation for steel casings

Wall (uncoated) thickness	4	5	6	8	10	12	14	16	18	24
	Outside diameter (*in.*)									
	4.500	5.563	6.625	8.625	10.750	12.750	14.000	16.000	18.000	24.000
in.	ft									
20 Ga (0.036)	80	40	25	–	–	–	–	–	–	–
18 Ga (0.048	180	100	50	25	–	–	–	–	–	–
16 Ga 90.060)	370	190	110	50	25	–	–	–	–	–
14 Ga (0.075)	720	380	220	100	50	30	20	–	–	–
12 Ga (0.105)	2,030	1,060	620	280	140	80	60	40	–	–
10 Ga (0.135)	–	–	1,340	600	310	180	130	90	60	–
8 Ga (0.164)	–	–	–	1,080	550	330	250	160	110	–
7 Ga (0.179)	–	–	–	1,410	720	430	320	210	150	–
3/16 (0.188)	–	–	–	1,650	840	500	370	250	170	70
7/32 (0.219)	–	–	–	–	1,340	800	600	400	280	110
1/4 (0.250)	–	–	–	–	–	1,190	890	600	420	170
9/32 (0.281)	–	–	–	–	–	–	1,280	850	590	250
5/16 (0.312)	–	–	–	–	–	–	–	1,170	820	340
11/32 (0.344)	–	–	–	–	–	–	–	–	1,100	460
3/8 (0.375)	–	–	–	–	–	–	–	–	–	600
7/16 (0.438)	–	–	–	–	–	–	–	–	–	960

NOTE: Based on the Cleindeinst Equation for Critical Collapse Pressure, using Poisson's ratio (u) of 0.30 and a modulus of elasticity (E) of 30,000,000 lb/in^2 $D = (2E/(1-u^2))(2.31/(SDR(SDR-1)^2)$

Filter pack. Sand or gravel packs should be used in wells constructed in fine materials of relatively uniform grain size to prevent the aquifer material from passing through the well screen or the perforated casing. The pack should be 3 to 12 in. thick and should consist of sand or gravel material having a D30 grain size 4 to 12 times the D30 grain size of the aquifer materials. Provisions should be made for centering the casing in the filter pack. Sanitary protection. Wells should be located a safe distance from sources of contamination. If sources are severely limited, a ground water aquifer that might become contaminated if adequately treated. Details pertaining to local water wells such as depth, type of construction, and vertical zone of influence, together with data on the geological formations, and porosity of subsoil strata, should be considered in determining the safe allowable distances. The recommended minimum horizontal distance between the water supply and the source of contamination is**:**

Source of Contamination	Minimum distance
	ft
Waste treatment lagoon	300
Cesspool	150
Livestock and poultry yards	100
Privy, manure pile	100
Silo pit, seepage pit	150
Septic tank and disposal field	100
Gravity sewer or drain (not pressure tight)	50
Gravity sewer or drain (pressure tight)	25

If possible, wells should be located in ground that is higher than any source of contamination or flooding. Drainage that might reach the source from areas used by livestock should be diverted. Wells must be readily accessible for maintenance and repair and be located a safe distance from overhead utility lines or other safety hazards. Each well should be provided with a water tight over or seal to prevent the entry of contaminated water or other objectionable material. The annular space around the casing should be at least 3 in. and should be filled with cement grout, bentonite clay, or other suitable materials to a depth that will seal off surface waters. A positive seal should be provided between the casing and the impervious material overlying the aquifer of artesian wells.

Plans and Specifications

Plans and specifications for wells should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purposes.

FENCING

Definition

A constructed barrier to animals or people.

Purpose

This practice facilitates the accomplishment of conservation objectives by providing a means to control movement of animals and people, including vehicles.

Condition Where Practice Applies

This practice may be applied on any area where management of animal or human movement is needed.

Criteria

General Criteria Applicable to All Purposes

Fencing materials, type and design of fence installed should be of a high quality and durability. The type and design of fence installed will meet the management objectives and site challenges. Based on need, fences may be permanent, portable, or temporary. Fencing should consist of acceptable designs, materials, and methods as described in NH eFOTG, Section IV, NH Fence Construction Specifications

Fences should be positioned to facilitate management requirements. Ingress/egress features such as gates and cattle guards should be planned. The fence design and installation should have the life expectancy appropriate for management objectives and should follow all federal, state and local laws and regulations.

Height, size, spacing and type of materials used will provide the desired control, life expectancy, and management of animals and people of concern. Permanent perimeter fencing should consist of the acceptable type defined by Table 1. When the fence is used for multiple species, the fence selection should meet the requirement of the limiting species. Permanent roadside fences should be constructed at least 15 feet from the road edge where snow plows or snow bank will compromise the effective life of the fence.

Live trees in good health may be used in place of posts or corners for smooth wire permanent perimeter fences when shallow soil depth to ledge/bedrock or other extreme soil conditions do not allow posts to be embedded to the appropriate depth. Wire **should not** be fastened directly to the tree or wrapped around the tree. Wire should be attached to a wood board or rolling j-bolt that is attached to the tree as described in NH Fence Construction Specifications. Informal approval by the NRCS field office staff is required prior to using trees as posts.

A minimum of 18” of clearance between the fence and any trees is required to prevent trees from growing into the fence during the planned lifespan of the fence.

When the intended use of the fence is to protect people from safety hazards, the fence should be a minimum of 60 inches above grade and disallow passage of a 6” sphere between any fence member. All openings should have gates that can be shut and fastened.

Considerations

The fence design and location should consider: topography, soil properties, livestock management and safety, livestock trailing, wildlife class and movement, location and adequacy of water facilities, development of potential grazing systems, human access and safety, landscape aesthetics, erosion problems, moisture conditions, flooding potential, stream crossings, and durability of materials. When appropriate, natural barriers should be utilized instead of fencing. Where applicable, cleared rights-of-way may be established which would facilitate fence construction and maintenance. Avoid clearing of vegetation during the nesting season for migratory birds. Fences across gullies, canyons or streams may require special bracing, designs or approaches. Fence design and location should consider ease of access for construction, repair and maintenance. Fence construction requiring the removal of existing unusable fence should provide for the proper disposal of scrap materials to prevent harm to animals, people and equipment.

Wire should normally be attached on the side of the post receiving the most animal pressure.

Treatment of wood posts with certain preservatives may not be allowed in certified organic systems. Producers should check with their certifying agency regarding requirements.

Plans and Specifications

Plans and specifications are to be prepared for all fence types, installations and specific sites. Requirements for applying the practice to achieve all of its intended purposes should be described.

The completed work is to be checked and documented using the NH-382 job sheet to verify that the practice is complete according to NRCS standards and specifications.

NRCS field staff should contact the state agronomist for inquiries relating to fencing for grazing systems and livestock exclusion, and the engineering staff for inquiries relating to safety fencing.

Operation and Maintenance

Regular inspection of fences should be part of an ongoing maintenance program. Inspection of fences after storms and other disturbance events is necessary to ensure the continued proper function of the fence. Maintenance and repairs will be performed in a timely manner as needed, including tree/limb removal and water gap replacement.

Electric fences should be checked regularly to determine the voltage of the fence. If voltage is not sufficient, determine the cause and correct it. Any vegetation in contact with the fence can cause decreased voltage. Vegetative growth beneath and around the electric fence should be controlled mechanically by grazing or mowing, or as a last resort, with chemicals. Remove and properly discard all broken fencing material and hardware. All necessary precautions should be taken to ensure the safety of construction and maintenance crews. Wire that is overstretched may break and recoil. Eye and hand protection should be worn.

REFERENCES

Bell, H. Bell, H.M. 1973. Rangeland management for livestock production. University of Oklahoma Press.
Heady, H.F. and R.D. Child. 1994. Rangeland ecology and management. Western Press.
Holechek, J.L., R.D. Pieper, and C.H. Herbel. 2001. Range management: principles and practices. Prentice Hall.
Stoddard, L.A., A.D. Smith, and T.W. Box. 1975. Range management. McGraw-Hill Book Company.
United States Department of Interior, Bureau of Land Management and United States Department of Agriculture, Forest Service.
1988. Fences. Missoula Technology and Development Center.
United States Department of Agriculture, Natural Resources Conservation Service. 2005. Electric fencing for serious graziers. Columbia, Mo.
United States Department of Agriculture, Natural Resources Conservation Service. 2003. National range and pasture handbook, revision 1. Washington, DC.
Vallentine, J.F. 1971. Range development and improvement. Brigham Young University Press

Table 1
Permanent Perimeter Fence Selection Criteria
Fence design and construction must meet the minimum requirements for controlling specific animal types.

Fence Type	Min. Height of Top Wire (Inches)	Suggested Spacing (Inches Above Ground Level)
Cattle		
3 Electrified HTS/HTA Wires	42	22, 32, 42 – min 2 hot
48" HT Woven Wire + 1 Top Wire	48	48
Wooden Boards	48	16, 32, 48
Cattle with Calves		
4 Electrified HTS/HTA Wires	42	12, 22, 32, 42 – min 3 hot
48" HT Woven Wire + 1 Top Wire	48	48
Wooden Boards	48	16, 32, 48
Bulls, Bison, and Feedlot		
7 Electrified HTS/HTA Wires	60	15 to 60 evenly spaced – min 3 hot
60" HT Woven + 1 Top + 1 Offset Wire	60	HTS/HTA wire offset inside at 32-48
Goats, Sheep, and Hogs		
6 Electrified HTS/HTA Wires	46	6, 12, 18, 26, 36, 46 – min 3 hot
48" HT Woven Wire + 1 Top Wire	48	48 (use offset at 12-24 w/hogs)
Horses, Llamas, and Alpacas		
4 Electrified Poly-coated HTS Wires	48	16 to 48 evenly spaced
4 Electrified HTA Wires	48	16 to 48 evenly spaced
48" HT Woven Wire + 1 Top Wire	48	48
Wood Boards	48	16, 32, 48
Deer		
96" HT Woven Wire	96	96
Chickens and Turkeys		
48" HT Woven Wire + 1 Top Wire	48	48
Safety		
60" HT Woven Wire	60	60
60" Chain Link	60	60

Abbreviations and specifications for use

HT = High tensile

HTS = 12.5 gauge high tensile smooth steel wire with class 3 galvanization or zinc-aluminum or better

HTA = 12.5 gauge high tensile smooth aluminum alloy wire

Top wire = (i) 2 twisted strands of 15.5 gauge high tensile wire with class 3 galvanizing (or better) with 4 point barbs on 5 inch centers, or (ii) electrified HTS/HTA placed at least 4 inches above woven wire.

Barbed wire should never be electrified or used with an electrified fence. Barbed wire or bare HTS wire should not be used for horses.

Based on the type of livestock, use the information in this table as the minimum criteria for fence purpose. More strands of wire and a different spacing may be required depending on the fence manufacturer's recommendations and landowner objectives.

With woven wire and board fences consider using one or more wires offset on the inside to prevent livestock from rubbing or leaning on fence. Offset wire should be electrified HTS, HTA, or polyrope/polywire. Offset wires should be a minimum of 6" away from the fence posts.

CHAPTER VI

STABILIZATION AND EROSION CONTROL

Intent

By implementing the practices in this chapter, which are designed to protect wetland characteristics, functions and values, wetland impacts can be avoided and minimized. Typically the wetlands affected by these practices are classified as Wet Meadow, and occur in an agricultural field and have hydric soils that are defined as soils that, in an undrained condition, are saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation.

FILTER STRIP

Definition

A strip or area of herbaceous vegetation situated between cropland, grazing land, or disturbed land (including forestland) and environmentally sensitive areas.

Purpose

- To reduce sediment, particulate organics, and sediment adsorbed contaminant loading in runoff
- To reduce dissolved contaminant loading in runoff
- To serve as Zone 3 of a Riparian Forest Buffer, Practice Standard 391
- To reduce sediment, particulate organics, and sediment adsorbed contaminant loading in surface irrigation tailwater.
- To restore, create or enhance herbaceous habitat for wildlife and beneficial insects.
- To maintain or enhance watershed functions and values

Condition Where Practice Applies

This practice applies:

- In areas situated below cropland, grazing land, or disturbed land (including forest land).
- Where sediment, particulate organic matter and/or dissolved contaminants may leave these areas and are entering environmentally sensitive areas
- In areas where permanent vegetative establishment is needed to enhance wildlife and beneficial insects, or maintain or enhance watershed function.

This practice applies when planned as part of a conservation management system.

Criteria

General criteria applicable to all purposes

Filter strips should be designated as vegetated areas to treat runoff and are not part of the adjacent cropland rotation.

Overland flow entering the filter strip should be primarily sheet flow. Concentrated flow should be dispersed.

State listed noxious weeds will not be established in the filter strip. Coordinate invasive species management with the NHDES Exotic Species Program.

Filter strip establishment should comply with local, state and federal regulations.

Additional criteria to reduce sediment, particulate organics, and sediment-adsorbed contaminant loading in runoff

Filter strip flow length should be determined based on field slope percent and length, and filter strip slope percent, erosion rate, amount and particle size distribution of sediment delivered to the filter strip, density and height of the filter strip vegetation, and runoff volume associated with erosion producing events. The minimum flow length for this purpose should be 20 feet.

Filter strip location requirements:

- The filter strip should be located along the downslope edge of a field or disturbed area. To the extent practical it should be placed on the approximate contour. Variation in placement on the contour should not exceed a 0.5% longitudinal (perpendicular to the flow length) gradient.
- The drainage area above the filter strip should have greater than 1% but less than 10% slopes.
- The ratio of the drainage area to the filter strip area should be less than 70:1 in regions with RUSLE-R factor values 0-35, 60:1 in regions with RUSLE-R factor values 35-175, and 50:1 in regions with RUSLE-R factor values of more than 175.
- The average annual sheet and rill erosion rate above the filter strip should be less than 10 tons per acre per year.

The filter strip should be established to permanent herbaceous vegetation consisting of a single species or a mixture of grasses, legumes and/or other forbs adapted to the soil, climate, and nutrients, chemicals, and practices used in the current management system. Species selected should have stiff stems and a high stem density near the ground surface. Stem density should be such that the stem spacing does not exceed 1 inch.

Additional criteria to reduce dissolved contaminants in runoff

The criteria given in “Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loading in runoff” also apply to this purpose.

Filter strip flow length required to reduce dissolved contaminants in runoff should be based on management objectives, contaminants of concern, and the volume of runoff from the filter strip’s drainage area compared with the filter strip’s area and infiltration capacity.

The flow length determined for this purpose should be in addition to the flow length determined for reducing sediment, particulate organics, and sediment-adsorbed contaminant loading in runoff. The minimum flow length for this purpose should be 30 feet.

Additional criteria to serve as Zone 3 of a Riparian Forest Buffer, Practice Standard 391

Except for the location requirements, the criteria given in “Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loading in runoff" also apply to this purpose.

If concentrated flows entering Zone 3 are greater than the filter strip's ability to disperse them, other means of dispersal, such as spreading devices, must be incorporated.

Additional criteria to reduce sediment, particulate organics, and sediment adsorbed contaminant loading in surface irrigation tailwater

Filter strip vegetation may be a small grain or other suitable annual with a plant spacing that does not exceed 4 inches.

Filter strips should be established early enough prior to the irrigation season so that the vegetation can withstand sediment deposition from the first irrigation.

The flow length should be based on management objectives.

Additional criteria to restore, create, or enhance herbaceous habitat for wildlife and beneficial insects

If this purpose is intended in combination with one or more of the previous purposes, then the minimum criteria for the previous purpose(s) must be met. Additional filter strip flow length devoted to this purpose must be added to the length required for the other purpose(s).

Any addition to the flow length for wildlife or beneficial insects should be added to the downhill slope of the filter strip. Vegetation to enhance wildlife may be added to that portion of the filter strip devoted to other purposes to the extent they do not detract from its primary functions.

Plant species selected for this purpose should be for permanent vegetation adapted to the wildlife or beneficial insect population(s) targeted.

If this is the only purpose, filter strip width and length should be based on requirements of the targeted wildlife or insects. Density of the vegetative stand established for this purpose should consider targeted wildlife habitat requirements and encourage plant diversity. Dispersed woody vegetation may be used to the extent it does not interfere with herbaceous vegetative growth, or operation and maintenance of the filter strip.

The filter strip should not be mowed during the nesting season of the target wildlife.

Livestock and vehicular traffic in the filter strip should be excluded during the nesting season of the target species.

Additional criteria to maintain or enhance watershed functions and values

Filter strips should be strategically located to enhance connectivity of corridors and non- cultivated patches of vegetation within the watershed.

Filter strips should be strategically located to enhance aesthetics of the watershed.

Plant species selected for this purpose should be for establishment of permanent vegetation.

Considerations

Filter strips should be strategically located to reduce runoff, and increase infiltration and ground water recharge throughout the watershed.

Filter strips for the purposes of wildlife/beneficial insect habitat or to enhance watershed function should be strategically located to intercept contaminants thereby enhancing the water quality of the watershed.

To avoid damage to the filter strip consider using vegetation that is somewhat tolerant to herbicides used in the upslope crop rotation.

Consider using this practice to enhance the conservation of declining species of wildlife, including those that are threatened or endangered.

Consider using this practice to protect National Register listed or eligible (significant) archaeological and traditional cultural properties from potential damaging contaminants.

Filter strip size should be adjusted to a greater flow length to accommodate harvest and maintenance equipment.

Plans and Specifications

Based on this standard, plans and specifications should be prepared for each specific field site where a filter strip will be installed. A plan includes information about the location, construction sequence, vegetation establishment, and management and maintenance requirements.

Specifications will include:

- Length, width, and slope of the filter strip to accomplish the planned purpose (length refers to flow length across the filter strip).
- Species selection and seeding or sprigging rates to accomplish the planned purpose
- Planting dates, care, and handling of the seed to ensure that planted materials have an acceptable rate of survival
- A statement that only viable, high quality, and regionally adapted seed will be used
- Site preparation sufficient to establish and grow selected species

Operation and Maintenance

For the purposes of filtering contaminants, permanent filter strip vegetative plantings should be harvested as appropriate to encourage dense growth, maintain an upright growth habit, and remove nutrients and other contaminants that are contained in the plant tissue.

Control undesired weed species, especially state-listed noxious weeds. Coordinate invasive species management with the NHDES Exotic Species Program.=

Prescribed burning may be used to manage and maintain the filter strip when an approved burn plan has been developed.

Inspect the filter strip after storm events and repair any gullies that have formed, remove unevenly deposited sediment accumulation that will disrupt sheet flow, re-seed disturbed areas, and take other measures to prevent concentrated flow through the filter strip

Apply supplemental nutrients as needed to maintain the desired species composition and stand density of the filter strip. Any use of fertilizers, pesticides and other chemicals to assure buffer function should not compromise the intended purpose.

To maintain or restore the filter strip's function, periodically re-grade the filter strip area when sediment deposition at the filter strip-field interface jeopardizes its function, and then reestablish the filter strip vegetation, if needed. If wildlife habitat is a purpose, destruction of vegetation within the portion of the strip devoted to that purpose should be minimized by re- grading only to the extent needed to remove sediment and fill concentrated flow areas.

Grazing should not be permitted in the filter strip unless a controlled grazing system is being implemented. Grazing will be permitted under a controlled grazing system only when soil moisture conditions support livestock traffic without excessive compaction.

GRADE STABILIZATION STRUCTURE

Definition

A structure used to control the grade and head cutting in natural or artificial channels.

Conditions Where Practice Applies

In areas where the concentration and flow velocity of water require structures to stabilize the grade in channels or to control gully erosion. Special attention should be given to maintaining or improving habitat for fish and wildlife where applicable.

Criteria

The structure must be designed for stability after installation. The crest of the inlet must be set at an elevation that stabilize upstream head cutting.

Dams are regulated by the New Hampshire Dam Bureau and may require a permit.

Embankment dams. Class (a) dams that have a product of storage times the effective height of the dam of 3,000 or more, those more than 35 ft in effective height, and all class (b) and class (c) dams should meet or exceed the requirements specified in Technical Release No. 60 (TR-60).

Class (a) dams that have a product of storage times the effective height of the dam of less than 3,000 and an effective height of 35 ft. or less should meet or exceed the requirements specified for ponds (378).

The effective height of the dam is the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section along the centerline of the dam. If there is no emergency spillway, the top of the dam is the upper limit.

Pond size dams. If mechanical spillways are required, the minimum capacity of the principal spillway should be that required to pass the peak flow expected from a 24-hour duration design storm of the frequency shown in table 1, less any reduction because of detention storage.

If the effective height of the dam is less than 20 ft. and the emergency spillway has a stable grade throughout its length with no overfalls and has good vegetation along its reentry into the downstream channel, the principal spillway capacity may be reduced but can be no less than 80 percent of the 2-year frequency, 24-hour duration storm.

If criteria values exceed those shown in table 1 or the storage capacity is more than 50 acre-ft., the 10-year frequency, 24-hour duration storm must be used as the minimum design storm.

Table 1. - Design criteria for establishing minimum capacity of the principal spillway for dams with storage capacity of less than 50 acre-feet.

Maximum drainage area for indicated rainfall*			Effective height of dam	Frequency of minimum design, 24-hour duration storm
0-3 in.	3 - 5 in.	5+ in.		
---acres---			ft	yr
200	100	50	35 or less	2
400	200	100	20 or less	2
400	200	100	20 - 35	5
600	400	200	20 or less	5

* In a 5-year frequency, 24-hour duration storm

Grade stabilization structures with a settled fill height of less than 15 ft. and 10-year frequency, 24-hour storm runoff less than 10 acre-ft., should be designed to control the 10-year frequency storm without overtopping. The mechanical spillway, regardless of size, may be considered in design and an emergency spillway is not required if the combination of storage and mechanical spillway discharge will handle the design storm. The embankment can be designed to meet the requirements for water and sediment control basins (638) rather than the requirements for ponds (378).

Full-flow open structures. Drop, chute, and box inlet drop spillways should be designed according to the principles set forth in the Engineering Field Handbook for Conservation Practices, the National Engineering Handbook, and other applicable NRCS publications and reports. The minimum capacity should be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 2, less any reduction because of detention storage. If site conditions exceed those shown in table 2, the minimum design 24- hour storm frequency is 25 years for the principal spillway and 100 years for the total capacity. Structures must not create unstable conditions upstream or downstream. Provisions must be made to ensure reentry of bypassed storm flows.

Toe wall drop structures can be used if the vertical drop is 4 ft. or less, flows are intermittent, downstream grades are stable, and tail water depth at design flow is equal to or greater than one-third of the height of the overfall.

The ratio of the capacity of drop boxes to road culverts should be as required by the responsible road authority or as specified in table 2 or 3, as applicable, less any reduction because of detention storage, whichever is greater. The drop box capacity (attached to a new or existing culvert) must equal or exceed the culvert capacity at design flow.

Side-inlet drainage structures. The design criteria for minimum capacity of open-weir or pipe structures used to lower surface water from field elevations or lateral channels into deeper open channels are shown in table 3. The minimum principal spillway capacity should equal the design drainage curve runoff for all conditions. If site condition values exceed those shown in table 3, the 50-year frequency storm should be used for minimum design of total capacity.

Island-type structures. If the mechanical spillway is designed as an island-type structure, its minimum capacity should equal the capacity of the downstream channel. For channels with very small drainage areas, the mechanical spillway should carry at least the 2-year, 24- hour storm or the design drainage curve runoff. The minimum emergency spillway capacity should be that required to pass the peak flow expected from a design storm of the frequency and duration shown in table 2 for total capacity without overtopping the headwall extensions of the mechanical spillway. Provision must be made for safe reentry of bypass flow.

Table 2. - Design criteria for establishing minimum capacity of full-flow open structures.

Maximum drainage area for indicated rainfall*				Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.	Vertical drop	Principal spillway capacity	Total capacity
---------acres---------			ft	yr	yr
1,200	450	250	5 or less	5	10
2,200	900	500	10 or less	10	25

*In a 5-year frequency, 24-hour duration storm.

Table 3*.* - ***Design criteria for establishing minimum capacity of side-inlet, open weir, or pipe-drop-drainage structure****.*

Maximum drainage area for indicated rainfall*				Frequency of minimum design, 24-hour duration storm	
0 - 3 in.	3 - 5 in.	5+ in.	Vertical drop	Receiving channel depth	Total capacity
---------acres---------			ft	ft	yr
1,200	450	250	0 - 5	0 - 10	-
1,200	450	250	5 - 10	10 - 20	10
2,200	900	500	0 - 10	0 - 20	25

*In a 5-year frequency, 24-hour duration storm.

Landscape**.** In highly visible public areas and those associated with recreation, careful considerations should be given to the landscape. Landforms, structural materials, water elements, and plant materials should visually and functionally complement their surroundings. Excavated material and cut slopes should be shaped to blend with the natural topography. Shorelines can be shaped and islands created to add visual interest and valuable wildlife habitat. Exposed concrete surfaces may be textured or finished to reduce reflection and to alter color contrast. Site selection can be used to reduce adverse impacts or create desirable focal points.

General

Earth embankment and emergency spillways of structures for which criteria are not provided under the standard for ponds (378) or in TR-60 must be stable for all anticipated conditions. If earth spillways are used, they must be designed to handle the total capacity flow indicated in Tables 2 or 3 without overtopping the dam. The foundation preparation, compaction, top width, and side slopes must ensure a stable dam for anticipated flow conditions. Discharge from the structure should be sufficient that no crop damage results from flow detention.

Necessary sediment storage capacity must equal the expected life of the structure, unless a provision is made for periodic cleanout.

The earth embankment pond structures are potentially hazardous and precautions must be taken to prevent serious injury or loss of life.

Protective guardrails, warning signs, fences, or lifesaving equipment should be added as needed.

If the area is used for livestock, the structures, earth fill, vegetated spillways, and other areas should be fenced as necessary to protect the structure. Near urban areas, fencing may be necessary to control access and exclude traffic that may damage the structure or to prevent serious injury or death to trespassers.

Protection. The exposed surfaces of the embankment, earth spillway, borrow area, and other areas disturbed during construction should be seeded or sodded as necessary to prevent erosion. If climatic conditions preclude the use of vegetation, non-vegetative coverings such as gravel or other mulches may be used.

Considerations

Water Quantity

- Effects on volumes and rates of runoff, evaporation, deep percolation and ground water recharge.

- Effects of the structure on soil water and resulting changes in plant growth and transpiration.

Water Quality

- Ability of structure to trap sediment and sediment-attached substances carried by runoff.
- Effect of structure on the susceptibility of downstream stream banks and stream beds to erosion.
- Effects of the proposed structure on the movement of dissolved substances to ground water.
- Effects on visual quality of downstream water resources.

Plans and Specifications

Plans and specifications for installing grade stabilization structures should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose.

Operation and Maintenance

An O&M plan should be developed and reviewed with the landowner or individual responsible for operation and maintenance.

The structure will be checked after every significant storm event for damage and repairs will be completed as soon as possible.

The vegetation will be maintained and mowed periodically to control woody vegetation on the embankment and spillway. Lime and fertilize as needed to maintain the vegetation.

GRASSED WATERWAY or OUTLET

Definition

A natural or constructed channel that is shaped or graded to required dimensions and established with suitable vegetation.

Purpose

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- to convey runoff from terraces, diversions, or other water concentrations without causing erosion or flooding
- to reduce gully erosion
- to protect/improve water quality.

Conditions Where Practice Applies

In areas where added water conveyance capacity and vegetative protection are needed to control erosion resulting from concentrated runoff and where such control can be achieved by using this practice alone or combined with other conservation practices.

Criteria

General Criteria Applicable to All Purposes

Grassed waterways should be planned, designed, and constructed to comply with all Federal, State, and local laws and regulations.

Capacity. The minimum capacity should be that required to convey the peak runoff expected from a storm of 10-year frequency, 24-hour duration. When the waterway slope is less than 1 percent, out-of-bank flow may be permitted if such flow will not cause excessive erosion. The minimum in such cases should be the capacity required to remove the water before crops are damaged.

Velocity. Design velocities should not exceed those obtained by using the procedures, "n" values, and recommendations in the NRCS Engineering Field Handbook (EFH) Part 650, Chapter 7, or Agricultural Research Service (ARS) Agricultural Handbook 667, Stability Design of Grass-lined Open Channels.

Width. The bottom width of trapezoidal waterways should not exceed 100 feet unless multiple or divided waterways or other means are provided to control meandering of low flows.

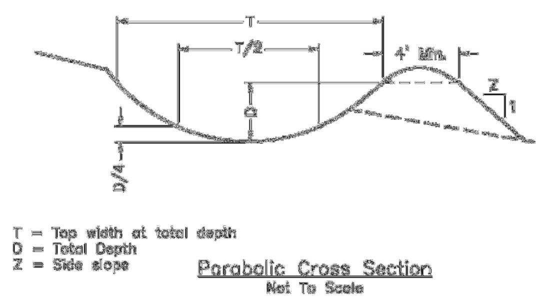
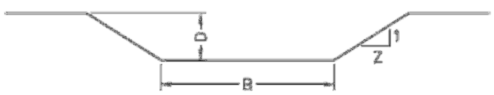


Figure 1

Side slopes. Side slopes should not be steeper than a ratio of two horizontal to one vertical. They should be designed to accommodate the equipment anticipated to be used for maintenance and tillage/harvesting equipment that will cross the waterway.

Depth. The minimum depth of a waterway that receives water from terraces, diversions, or other tributary channels should be that required to keep the design water surface elevation at, or below the design water surface elevation in the tributary channel, at their junction when both are flowing at design depth.

Freeboard above the designed depth should be provided when flow must be contained to prevent damage. Freeboard should be provided above the designed depth when the vegetation has the maximum expected retardance.



Trapezoidal Cross Section
Not To Scale

Figure 2

Drainage. Designs for sites having prolonged flows, a high water table, or seepage problems should include Subsurface Drains (NRCS Practice Code 606), Underground Outlets (NRCS Practice Code 620), Stone Center Waterways or other suitable measures to avoid saturated conditions.

Outlets. All grassed waterways should have a stable outlet with adequate capacity to prevent ponding or flooding damages. The outlet can be another vegetated channel, an earthen ditch, a grade-stabilization structure, filter strip or other suitable outlet.

Vegetative Establishment. Grassed waterways should be vegetated according to NRCS Conservation Practice Standard Critical Area Planting, Code 342.

When cuts are expected to exceed 6 inches, topsoil should be saved to spread on the newly constructed waterway to facilitate the establishment of vegetative cover. W here this is done, the waterway should be over excavated to allow for placement of topsoil without encroaching on the design cross section.

Seedbed preparation, time of seeding, mixture rate, stabilizing crop, mulching, or mechanical means of stabilizing, fertilizer, and lime requirements should be specified for each applicable area.

Establish vegetation as soon as conditions permit. Use mulch anchoring, nurse crop, rock, straw or hay bale dikes, filter fences, or runoff diversion to protect the vegetation until it is established. In waterways with design flow velocities greater than 3.0 feet per second, the flow of water should be diverted around or away from the waterway until the vegetation is established.

__**Considerations**__

Important wildlife habitat, such as woody cover or wetlands, should be avoided or protected if possible when siting the grassed waterway. If trees and shrubs are incorporated, they should be retained or planted in the periphery of grassed waterways so they do not interfere with hydraulic functions. Mid- or tall bunch grasses and perennial forbs may also be planted along waterway margins to improve wildlife habitat. Waterways with these wildlife features are more beneficial when connecting other habitat types; e.g., riparian areas, wooded tracts and wetlands.

Water-tolerant vegetation may be an alternative on some wet sites if the vegetation can be harvested during dry periods.

Use irrigation in dry regions or supplemental irrigation as necessary to promote germination and vegetation establishment.

Provide livestock and vehicular crossings as necessary to prevent damage to the waterway and its vegetation.

Establish filter strips on each side of the waterway to improve water quality where dikes have not been used.

Add width of appropriate vegetation to the sides of the waterway for wildlife habitat.

Plans and Specifications

Plans and specifications for grassed waterways should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose(s).

Operation and Maintenance

An O&M plan should be provided to and reviewed with the landowner. The plan should include the following items and others as appropriate.

A maintenance program should be established to maintain waterway capacity, vegetative cover, and outlet stability. Vegetation damaged by machinery, herbicides, or erosion must be repaired promptly.

The primary seeding should be inspected for at least two years after construction, after spring runoff, and after heavy rainfall events.

Reinforcement grass seeding and mulching should be completed when existing stands are less than ten plants per square foot. Lime and fertilizer should also be applied with reinforcement seeding. During the first two springs following establishment, top-dress with a minimum of 300 lbs. Of 10-10-10 fertilizer.

Check pH and apply lime according to soil test recommendations.

Seeding should be protected from concentrated flow and grazing until vegetation is established.

Minimize damage to vegetation by excluding livestock whenever possible, especially during wet periods.

Inspect grassed waterways regularly, especially following heavy rains. Damaged areas will be filled, compacted, and seeded immediately. Remove sediment deposits to maintain capacity of grassed waterway.

Landowners should be advised to avoid areas where forbs have been established when applying herbicides. Avoid using waterways as turn-rows during tillage and cultivation operations. Prescribed burning and mowing may be appropriate to enhance wildlife values, but must be conducted to avoid peak nesting seasons and reduced winter cover.

Mow or periodically graze vegetation to maintain capacity and reduce sediment deposition. Mowing should be completed after August 15th to allow nesting birds to leave.

Control noxious weeds.

Do not use as a field road. Avoid crossing with heavy equipment when wet.

LEVEL SPREADER

Definition

A level spreader is an outlet constructed at zero percent grade across the slope that allows concentrated runoff to be discharged at non-erosive velocities onto natural or man-made areas that have existing vegetation capable of preventing erosion.

Purpose

A level spreader changes concentrated flow into sheet flow and then outlets it onto stable areas without causing erosion. An example would be at the outlet of a diversion or a waterway.

Conditions Where Practice Applies

The level spreader is used where it can be constructed on undisturbed soils, where the area directly below the spreader is stabilized be existing vegetation, where the water will not re- concentrate immediately below the spreader, and where there is at least 100 feet of vegetated area between the spreader and state surface waters.

Considerations

Placement of the level spreader must allow the water flowing over the level section to leave the structure as a uniform, thin film of water. The structure should outflow onto naturally vegetated areas whenever possible. The creation of a uniform level lip for the water to spread over ·is critical.

Design Criteria

Length. The design length for a level spreader should be no more than 0.5 cfs. per foot of level section based on the peak rate of flow from the contributing designed erosion control or storm water management practice. The minimum length of the spreader should be 5 feet and the maximum length should be 50 feet.

Width. The minimum 11idth of the spreader should be 6 feet as· shown in Figure 1.

Depth. The depth of the level spreader as measured from the lip should be at least 6 inches.

The depth of the spreader should be uniform (See Figure 1) across the entire length.

Grade. The level spreader lip should be constructed on a zero percent grade to ensure uniform spreading of runoff. The last 50 feet of the channel leading into the level spreader should be constructed at a grade not exceeding 1%.

Vegetation. The spreader should be stabilized in accordance with the appropriate grass mixture selected from those found in the Best Management Practice for Seeding for Long-Term Cover. The spreader should be mulched if necessary for the establishment of good quality vegetation.

Outlets. Final discharge will be over the level lip protected with erosion stops and jute or Excelsior matting onto an existing stabilized area. The stabilized area should have a complete vegetative cover sufficient established to be erosion resistant.

Maintenance

The level spreader should be checked periodically and after every major storm to determine if the lip ·has been damaged and to determine that the design conditions have not changed. Any detrimental sediment accumulation should be removed. If rilling has taken place on the lip, then the damage should be repaired and re-vegetated. The vegetation should be mowed occasionally to control weeds and the encroachment of woody vegetation. Clippings should be removed· and disposed of outside the spreader and away from the outlet area. Fertilization should be done as necessary to keep the vegetation healthy and dense.

Construction Specifications

- Construct the level spreader lip on a zero percent grade to ensure uniform spreading of runoff.
- Level spreader should be constructed on undisturbed soil and not on fill.
- An erosion stop should be placed vertically a minimum of six inches deep in a slit trench one foot back of the level lip and parallel to the lip. The erosion stop should extend the entire length of the level lip.
- The entire level lip area should be protected by placing· two strips of jute or excelsior matting along the lip. Each strip should overlap the erosion stop by at" least six inches
- The entrance channel to the level spreader should not exceed a 1 percent grade for at least 50 feet before entering into the spreader.
- The flow from the level spreader should outlet onto stabilized areas. Water should not concentrate immediately below the spreader.
- Periodic inspection· and required maintenance should be performed.

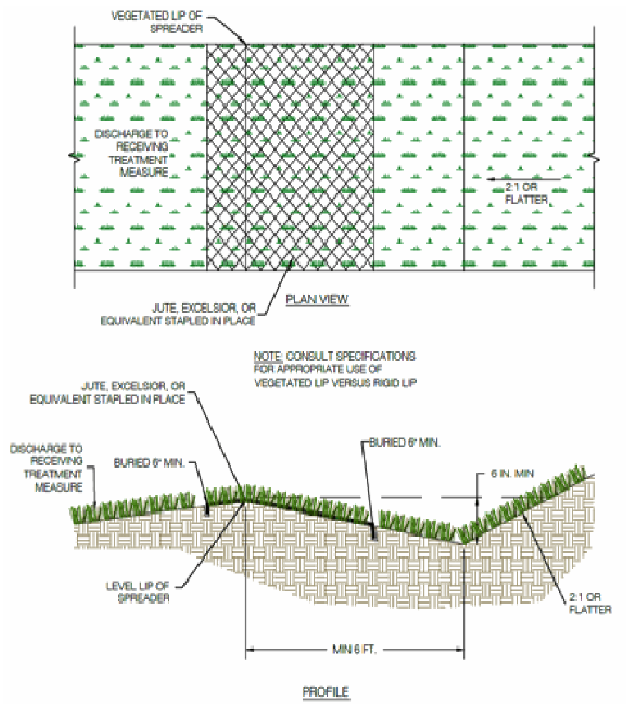


Figure 1

LINED WATERWAY OR OUTLET

Definition

A waterway or outlet having an erosion-resistant lining of concrete, stone, or other permanent material. The lined section extends up the side slopes to a designed depth. The earth above the permanent lining may be vegetated or otherwise protected.

Purpose

To provide for safe disposal of runoff from other conservation structures or from natural concentrations of flow, without damage by erosion or flooding, where unlined or grassed waterways would be inadequate. Properly designed linings may also control seepage, piping, and sloughing or slides.

Conditions Where Practice Applies

This practice applies if the following or similar conditions exist:

- Concentrated runoff is of such that a lining is needed to control erosion.
- Steep grades, wetness, prolonged base flow, seepage, or piping would cause erosion.
- The location is of such that use by people or animals preclude use of vegetated waterways or outlets.
- High-value property or adjacent facilities warrant the extra cost to contain design runoff in a limited space.
- Soils are highly erosive or other soil or climatic conditions preclude using vegetation.
- Installation of non-reinforced concrete or mortared flagstone linings, should be made only on low shrink-swell soils that are well drained or where subgrade drainage facilities are installed.

Criteria

Capacity. The minimum capacity should be adequate to carry the peak rate of runoff from a 10- year frequency storm. Velocity should be computed by using Manning's Formula with a coefficient of roughness "n" as follows:

Lining	"n" Value
Concrete	
Trowel finish	0.012 -.014
Float finish	.013 -.017
Gunite	.016 -.022
Flagstone	.020 -.025
Riprap	Determine from figure 1

Velocity. Maximum design velocity should be as shown in figure 2. Except for short transition sections, flow in the range of 0.7 to 1.3 of the critical slope must be avoided unless the channel is straight. Velocities exceeding critical should be restricted to straight reaches.

Waterways or outlets with velocities exceeding critical should discharge into an energy dissipater to reduce velocity to less than critical.

Cross section. The cross section should be triangular, parabolic, or trapezoidal. Cross section made of monolithic concrete may be rectangular.

Freeboard. The minimum freeboard for lined waterways or outlets should be 0.25 ft above design high water in areas where erosion-resistant vegetation cannot be grown adjacent to the paved side slopes.

No freeboard is required if vegetation can be grown and maintained.

Side slope. The steepest permissible side slopes, horizontal to vertical, should be:

Non-reinforced concrete:

Hand-placed, formed concrete

Height of lining, 1.5 ft or less ....Vertical
Hand-placed screened concrete or mortared in place flagstone

Height of lining, less that 2 ft ....1 to 1
Height of lining, more than 2 ft ....2 to 1

Slip form concrete:

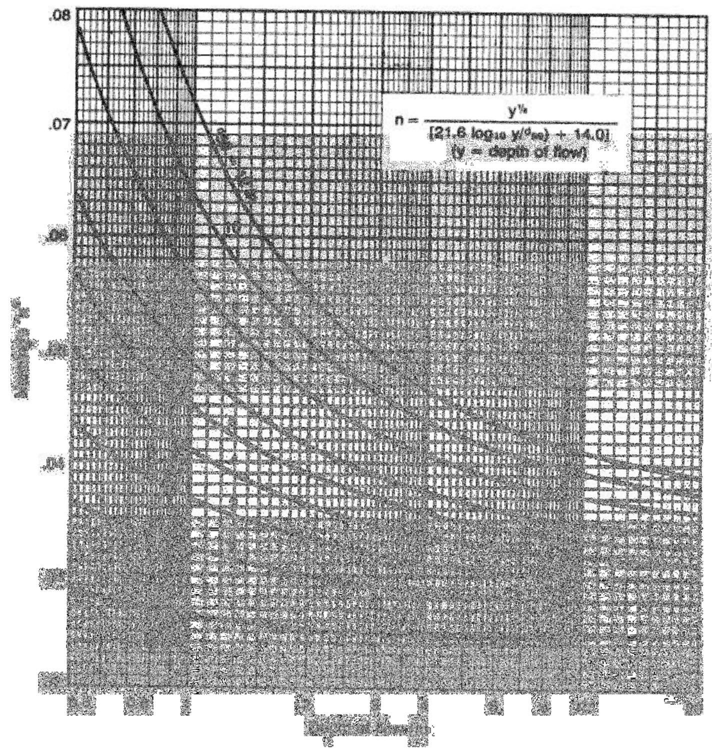
Height of lining, less than 3 ft ....1 to 1
Rock riprap ....2 to 1

Lining thickness. Minimum lining thickness should be:

Concrete.............4 in. (In most problem areas, minimum thickness should be 5 in. with welded wire fabric reinforcing.)

Rock riprap...........Maximum stone size plus thickness of filter or bedding

Flagstone............4 in., including mortar bed



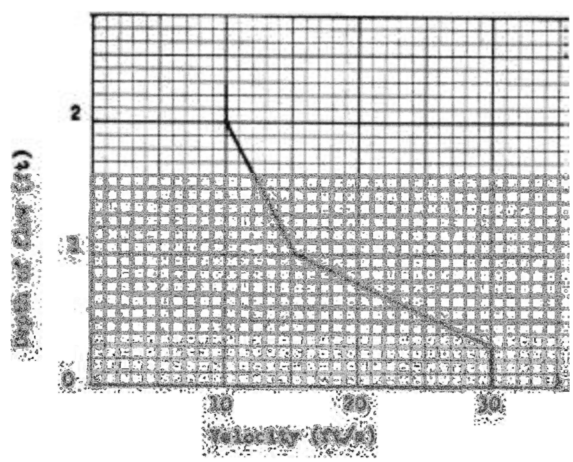


Figure 2 —Maximum velocity vs depth of flow.

Related structures. Side inlets, drop structures, and energy dissipaters should meet the hydraulic and structural requirements for the site.

Filters or bedding. Filters or bedding should be used to prevent piping. Drains should be used to reduce uplift pressure and to collect water, as required. Filters, bedding, and drains should be designed according to SCS standards. Weep holes may be used with drains if needed.

Concrete. Concrete used for lining should be proportioned so that it is plastic enough for thorough consolidation and stiff enough to stay in place on side slopes. A dense durable product should be required. Specify a mix that can be certified as suitable to produce a minimum strength of at least 3,000 lb./in.2. Cement used should be Portland cement, Types I, II, or if required, Types IV or V. Aggregate used should have a maximum size of 1-1/2 in.

Mortar. Mortar used for mortared in-place flagstone should consist of a workable mix of cement, sand, and water with a water-cement ratio of not more than 6 gallons of water per bag of cement.

Contraction joints. Contraction joints in concrete linings, if required, should be formed transversely to a depth of about one-third the thickness of the lining at a uniform spacing in the range of 10 to 15 ft. Provide for uniform support to the joint to prevent unequal settlement.

Rock riprap or flagstone. Stone used for riprap should be dense and hard enough to withstand exposure to air, water, freezing, and thawing.

Flagstone should be flat for ease of placement and have the strength to resist exposure and breaking.

Planning Considerations

- Effects upon components of the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Variability of the practice's effect caused by seasonal and climatic changes.
- Filtering effects of vegetation on the movement of sediment and dissolved and sediment attached substances will be evaluated.
- Effects on the visual quality of the water resources.
- Short-term and construction-related effects on the quality of water resources.

Operation and Maintenance

Provisions must be made for timely maintenance to ensure lined waterways function properly. Any buildup of debris or sediment must be removed promptly to avoid damage to the structure.

Plans and Specifications

Plans and specifications for constructing lined waterways or outlets should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purposes.

Specifications

The foundation area should be cleared of trees, stumps, roots, sod, loose rock, or other objectionable material.

The cross section should be excavated to the neat lines and grades as shown on the plans. Over excavated areas should be backfilled with moist soil compacted to the density of the surrounding material.

No abrupt deviations from design grade or horizontal alignment should be permitted.

Concrete linings should be placed to the thickness shown on the plans and should be finished in a workmanlike manner. Provisions should be made to protect freshly placed concrete and to ensure proper curing.

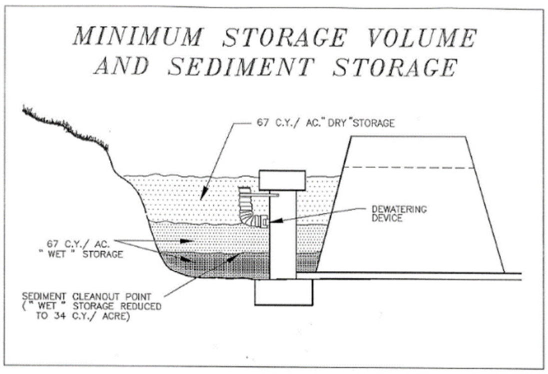
Filter, bedding, and rock riprap should be placed to line and grade and in the manner specified. Riprap should be placed so that it does not reduce the design section more than 10 percent.

Construction operations should be done in such a manner that erosion and air and water pollution are minimized and held within reasonable and legal limits. The completed job should be workmanlike and present a good appearance. All disturbed areas should be vegetated or otherwise provided with a cover to protect the areas against soil erosion.

SEDIMENT BASIN

Definition

A basin constructed to collect and store debris or sediment.



Source: Va. DSWC Plate 3.14-1

Scope

This standard applies to the installation of all basins where the primary purpose is to trap and store waterborne sediment and debris.

Purpose

To preserve the capacity of reservoirs, ditches, canals, diversion, waterways, and streams; to prevent undesirable deposition on bottom lands and developed areas; to trap sediment originating from construction sites; and to reduce or abate pollution by providing basins for deposition and storage of silt, sand, gravel, stone, agricultural wastes, and other detritus.

Conditions Where Practice Applies

This practice applies where physical conditions or land ownership preclude treatment of a sediment source by the installation of erosion- control measures to keep soil and other material in place or where a sediment basin offers the most practical solution to the problem.

Criteria

General. The design of dams, spillways, and drainage facilities should be according to NRCS standards for ponds (378) and grade stabilization structures (410) or according to the requirements in TR-60, as appropriate for the class and kind of structure being considered.

For basins constructed of concrete or other non- earthen material, designs will be based on criteria in appropriate ACI codes or ASTM guidelines.

The design and construction of sediment basins should comply with all state and local laws, ordinances, rules, and regulations.

The sediment basin should be located to obtain the maximum storage benefit from the terrain and for easy clean-out of trapped sediment or other detritus.

Earthen Basins

Size of Basin

The capacity of the sediment basin should equal the volume of sediment expected to be trapped at the site during the planned useful life of the basin or the improvements it is designed to protect. If it is determined that periodic removal of sediment will be practicable, the capacity may be proportionately reduced. The capacity of the sediment basin, as measured to the elevation of the crest of the auxiliary spillway or principle spillway if there is no auxiliary spillway, should be at least 67 cubic yards per acre of total drainage area or 0.5 watershed inches.

Temporary basins having drainage areas of 5 acres or less and a total embankment height of less than 4 feet may be designed with less conservative criteria if conditions warrant. The embankment should have a minimum top width of 4 ft. and side slopes of 2:1 or flatter. The length to width ratio should be 2 to 1 or greater. An outlet should be provided of earth, pipe, stone, or other devices adequate to keep the sediment in the trap and to handle the 10-year-frequencydischarge at the maximum design sediment elevation without failure or significant erosion.

Provisions should be made for draining sediment pools if necessary for safety and vector control. Fencing and other safety measures should be installed as necessary to protect the public from floodwater and soft sediment. Due consideration should be given to good visual resource management.

Spillway Design

Runoff should be computed by the methods outlined in: Chapter 2 of the Engineering Field Handbook, "Estimating Runoff", TR55, "Urban Hydrology for Small Watersheds", or other approved methods.

Runoff computations should be based on the soil- cover conditions expected to prevail in the contributing drainage area during the anticipated effective life of the structure. The combined capacity of the principle and auxiliary spillway should be sufficient to pass the peak rate of runoff from a 10-year frequency storm.

Principle Spillway

The principle spillway if used will be designed and installed according to criteria in NRCS Standard 378 - Ponds. The minimum capacity of the principle spillway should be 0.2 cfs per acre of drainage area when the water surface is at the crest of the auxiliary spillway. The principle spillway should have the capacity to handle the peak flow from a 10-year frequency storm event if no auxiliary spillway is provided. Provisions should be provided to gradually draw down the water level to its permanent level after each storm event.

An outlet should be provided including a means of conveying the discharge in an erosion-free manner to an existing stable stream or channel. Protection against scour at the discharge end should be provided if needed.

Auxiliary Spillway

Auxiliary spillways should not be constructed on fill. The auxiliary spillway cross section should be trapezoidal with a minimum bottom width of eight feet. The minimum capacity should be that required to pass the peak rate of runoff from a 10-year frequency storm event, less any reduction due to flow through the principle spillway.

When used the auxiliary spillway should be designed according to criteria in NRCS Standard 378 - Ponds for velocity limitations, erosion protection alternatives, and freeboard requirements.

Embankment

Sediment basins with embankment heights greater than 4 feet should be design and constructed according to NRCS Standard 378 - Ponds and state dam regulations.

Embankment heights less than 4 feet should be constructed with a minimum top width of 4 feet and side slopes of 2 horizontal to 1 vertical or flatter. Fill material should be suitable moist embankment soil material free of stones, roots, and vegetation. Compaction should be obtained by routing construction equipment over the fill material to get wheel compression. The base area of the embankment should be stripped of vegetation before construction begins.

Agricultural Waste Non-earthen Structures

Concrete and other similar type structures will be constructed on suitable foundation materials and meet the following storage and discharge design requirements as described in the Midwest Planning Service MWPS, Structure and Environment Handbook section for sediment basins:

- The basin will be a minimum of 2 feet deep and a maximum of 4 feet deep and have a length to width ration of at least 2 to 1.
- The outlet spillway will be designed for a minimum of 30 minutes detention time.
- The minimum designed detention volume will be that necessary to store the runoff from the impervious area entering the basin caused by a 10 year - 1 hour peak rainfall event.
- Provisions must be provided to remove accumulated sediment when 50% of available storage is filled such as a ramp or suction pumping.
- The principal spillway may be a perforated pipe, weir with baffle, or other engineer approved outlet and provisions must be provided for draining the basin for cleaning.

<u>Considerations</u>

- Consider the storage structure effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Consider the effects on downstream flows and aquifers that could affect other water uses and users.
- Consider the effects on volume of discharge flow on the environmental, social, and economic conditions.
- Consider the effects on the water table downstream and the results of changes of vegetative growth.
- Consider the effects on erosion, movement of sediment, pathogens, and soluble and sediment-attached substances that could be carried by runoff.
- Consider the effects on the visual quality of onsite and downstream water resources.
- Consider the effects on wetlands and water- related wildlife habitats.

<u>Plans and Specifications</u>

Plans and specifications for installing sediment basins should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose.

<u>Operation and Maintenance</u>

An O&M plan should be prepared for the Sediment Basin and any associated components or practices.

The sediment basin should be cleaned out when the volume is reduced by 50 percent. The elevation corresponding to the maximum allowable sediment level should be determined and marked on the structure for visual determination.

Sediment removed from the structure should be deposited on cropland or other appropriate land area.

The basin and associated components should be inspected periodically and repaired as needed. All vegetated areas will be maintained to prevent erosion problems.

Livestock should be restricted from access to the basin embankment, outlet channel, and pool area.

RIPARIAN FOREST BUFFER

Definition

An area of predominantly trees and/or shrubs located adjacent to and up-gradient from watercourses or water bodies.

Purposes

- Create shade to lower water temperatures to improve habitat for aquatic organisms.
- Provide a source of detritus and large woody debris for aquatic and terrestrial organisms.
- Create wildlife habitat and establish wildlife corridors.
- Reduce excess amounts of sediment, organic material, nutrients and pesticides in surface runoff and reduce excess nutrients and other chemicals in shallow ground water flow.
- Provide a harvestable crop of timber, fiber, forage, fruit, or other crops consistent with other intended purposes.
- Provide protection against scour erosion within the floodplain.
- Restore natural riparian plant communities.
- Moderate winter temperatures to reduce freezing of aquatic over-wintering habitats.
- To increase carbon storage.

Conditions Where Practice Applies

On areas adjacent to permanent or intermittent streams, lakes, ponds, wetlands and areas with ground water recharge that are capable of supporting woody vegetation.

Criteria

General Criteria Applicable To All Purposes

The location, layout and density of the riparian forest buffer will accomplish the intended purpose and function.

Dominant vegetation will consist of existing, naturally regenerated, or planted trees and shrubs suited to the site and the intended purpose.

All buffers will consist of a Zone 1 that begins at the normal water line, or at the top of the bank, and extends a minimum distance of 15 feet, measured horizontally on a line perpendicular to the water body.

Occasional removal of some tree and shrub products such as high value trees is permitted in Zone 1 provided the intended purpose is not compromised by the loss of vegetation or harvesting disturbance and state or local regulations allow the practice.

Necessary site preparation and planting should be done at a time and manner to ensure survival and growth of selected species.

Only viable, high-quality and adapted planting stock will be used.

Site preparation should be sufficient for establishment and growth of selected species and is done in a manner that does not compromise the intended purpose.

Plantings will consist of two or more species with individual plants suited to the drainage condition of individual planting sites. Plant type and species should be selected based on their compatibility in growth rates and shade tolerance. Select species that are common to the area and existing riparian zones or from a variety of plant lists, such as Table 1, located in Appendix A.

An adequate upstream or adjacent seed source must be present when using natural regeneration to establish a buffer.

Livestock should be controlled or excluded as necessary to achieve and maintain the intended purpose.

Harmful pests present on the site will be controlled or eliminated as necessary to achieve and maintain the intended purpose.

For optimal carbon storage, select plant species that are adapted to the site to assure strong health and vigor and plant the full stocking rate for the site.

Comply with applicable federal, state and local laws and regulations during the installation, operation (including harvesting activities) and maintenance of this practice.

Additional Criteria to Reduce Excess Amounts of Sediment, Organic Material, Nutrients and Pesticides in Surface Runoff and Reduce Excess Nutrients and Other Chemicals in Shallow Ground Water Flow

An additional strip or area of land, Zone 2, will begin at the edge and up-gradient of Zone 1 and extend a minimum distance of 20 feet, measured horizontally on a line perpendicular to the water body. The minimum combined width of Zones 1 and 2 will be 100 feet or 30 percent of the flood plain whichever is less, but not less than 35 feet.

Criteria for Zone 1 should apply to Zone 2 except that removal of products such as timber, fiber, nuts, fruit and forbs is permitted and encouraged on a periodic and regular basis provided the intended purpose is not compromised by loss of vegetation or harvesting disturbance.

Zone 2 will be expanded in high nutrient, sediment, and animal waste application areas, where the contributing area is not adequately treated or where an additional level of protection is desired.

A Zone 3 should be added to the riparian buffer when adjacent to cropland or other sparsely vegetated or highly erosive areas to filter sediment, address concentrated flow erosion, and maintain sheet flow. The Filter Strip standard (practice code 393) should be used to design Zone 3.

Concentrated flow erosion, excessive sheet and rill erosion or mass soil movement should be controlled in Zone 3 prior to establishment of the lower riparian forest buffer zones.

Additional Criteria to Provide Habitat for Aquatic Organisms and Terrestrial Wildlife

Width of Zone 1 and/or Zone 2 will be expanded to meet the minimum requirements of the wildlife or aquatic species and associated communities of concern.

Establish plant communities that address the target wildlife needs and existing resources in the watershed.

Buffers should be established or maintained on south and west sides of water courses and bodies insofar as practical. The buffer canopy should be established to achieve at least 50 percent crown cover with average canopy heights equal to or greater than the width of the watercourse.

For intermittent watercourses, the buffer should shade 85 percent of the area within 35 feet of the watercourse. (Note: Buffers for the smallest of intermittent streams may consist of shrubs).

Considerations

The severity of bank erosion, concentrated flow erosion or mass soil movement and its influence on existing or potential riparian trees and shrubs should be assessed. Watershed-level or contributing area treatment or bank stability activities may be needed before establishing a riparian forest buffer.

When concentrated flow erosion and sedimentation cannot be controlled vegetatively, consider structural or mechanical treatments.

Favor tree and shrub species that are native, non-invasive, or have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics and tolerance to locally used herbicides.

Tree and shrub species, which may be alternate hosts to undesirable pests, should be avoided. Species diversity should be considered to avoid loss of function due to species-specific pests.

Favor tree and shrub species that are native, non-invasive, and/or have multiple values such as those suited for timber, biomass, nuts, fruit, browse, nesting, aesthetics, and tolerance to locally used herbicides. Consider species that re-sprout when establishing new rows nearest to water courses or bodies. For detritus and large woody debris, use species that will meet the specific requirements of fish and other aquatic organisms for food, habitat, migration, and spawning.

Plants that deplete ground water should be used with caution in water-deficit areas.

Allelopathic impacts of plants should be considered.

The location, layout and density of the buffer should complement natural features, and mimic natural riparian forests. Avoid layouts and locations that would concentrate flood flows or return flows.

Consider the type of human use (rural, suburban, urban) and the aesthetic, social and safety aspects of the area to determine the vegetation selection, arrangement and management. For example, avoiding shrubs that block views and pruning low tree branches near recreation trails allows for ease of patrolling.

Plans and Specifications

Specifications for applying this practice should be prepared for each site and recorded using approved specification sheets, job sheets, technical notes, and narrative statements in the conservation plan, or other acceptable documentation.

Operation and Maintenance

The following actions should be carried out to ensure that this practice functions as intended throughout its expected life.

The riparian forest buffer will be inspected periodically and protected from adverse impacts such as excessive vehicular and pedestrian traffic, pest infestations, pesticides, livestock or wildlife damage and fire.

Replacement of dead trees or shrubs and control of undesirable vegetative competition will be continued until the buffer is, or will progress to, a fully functional condition.

As applicable, control of concentrated flow erosion and sediment deposition should be controlled by an adjacent filter strip.

Any removals of tree and shrub products should be conducted in a manner that maintains the intended purpose.

Any use of fertilizers, pesticides and other chemicals to assure buffer function should not compromise the intended purpose.

Any additional operation and maintenance requirements should be developed on a site- specific basis to assure performance of the practice as intended.

RIPARIAN FOREST BUFFER – NH SUPPLEMENT

Planted Riparian Buffers

Planting Densities

Initial plant-to-plant densities for trees and shrubs will depend on their potential height at 20 years of age. Heights may be estimated based on:

- Performance of the individual species (or comparable species) in nearby areas on similar sites, or
- Table 1 - Tree and Shrub Species for Riparian Areas, specifications for tree heights 20 years after planting.

Plant to Plant Spacing		
Plant Types & Heights:	**Plants per Acre**	**Spacing in Feet**
Shrubs less than 10 feet in height	1200 to 4500	3 to 6
Shrubs and trees from 10 to 25 feet in height	450 to 1500	5 to 10
Trees greater than 25 feet in height	200 to 1200	6 to 15

When establishing a planted buffer, a minimum of two rows of trees and one row of shrubs should be established alongside the water body for maximum shade, stabilization and nutrient uptake within the desired buffer width. The remaining area should be planted to meet natural regeneration requirements.

Plantings can be intermixed with open areas treated for natural regeneration and specific wildlife needs. These openings should not exceed 4,356 square feet (1/10 acres) in area. Open areas should not exceed 25% of the remaining planned riparian zone.

Natural Regenerating or Direct Seeded Riparian Buffers

Establishment Densities

A naturally regenerated riparian buffer is considered initially established when plant densities have reached the planted buffer recommended densities for trees and shrubs. A three growing season period is a reasonable amount of time in which to determine if natural regeneration would take place and be initially established.

Trees and shrubs are considered established when they begin to dominate herbaceous plants and undesired shrubs that are competing with it for nutrients, water and sunlight.

All areas immediately adjacent to the watercourse should have trees and/or shrubs growing near it. Open areas within the area designed as a buffer should not exceed 1/10th acre in size and should not exceed more than 25% of the total designated buffer area.

Preparation of Planting and Natural Regeneration Sites

Planting sites should be properly prepared based on the soil type and vegetative conditions listed in Forest Site Preparation, Practice Code 490. For sites to be tilled, leave a 3 feet wide untreated strip at the edge of the bank or shoreline. Avoid sites that have had recent application of pesticides harmful to woody species to be planted.

Fabric mulch may be used for weed control and moisture conservation for new plantings on all sites, particularly those with pronounced growing season moisture deficits or invasive, weedy species.

Buffer Width Benefits

Even minimum buffer widths provide some benefits to the stream ecosystem. In most instances additional width in excess of basic minimums provides less benefits for specific concerns the further the distance from the stream of water body. It is best to base buffer widths on a large array of concerns, including social and economic needs of the landowner as well as other non-water quality related concerns.

Range of Minimum Widths for Meeting Specific Buffer Objectives (Palone & Todd)	
Concern	Range of Widths (ft)
Wildlife	15 - 600
Flood Control	100 - 200
Sediment Control	50 - 200
Water Temperature	5 - 75
Streambank Stabilization	15 - 60
Nutrient Removal	50 - 200

The buffer width guide for selected wildlife species includes the sum of buffer widths on one or both sides of the water course or water body and may extend beyond riparian boundaries.

Buffer Width Guide for Selected Wildlife Species	
Species	Desired Width (ft)
Bald Eagle, cavity nesting ducks, heron rookery, sandhill crane	600
Common Loon, Pileated Woodpecker	450
Beaver, Dabbling Ducks, Mink, Salmonids	300
Deer	200
Lesser Scaup, Harlequin Duck	165
Frog, Salamander	100

Plant List

Table 1 lists woody plant species (tree and shrubs) commonly associated with and suited to riparian areas. Key attributes are listed for each plant to assist with the design process for establishing new buffers. In most instances selection of tree and shrub species to be used can be determined by evaluating existing areas that have some of the same characteristics of the site being re-established.

The following is an explanation of the terms used in Table 1:

- Shade Tolerance: The plant's capacity to grow in a shaded condition. H = can grow in the shade of an overstory; M = can grow in partial shade; L = needs full or nearly full sunlight.
- Shade Value: The density or fullness of shade provided by an individual plant's crown in a full leaf- out condition. H = provides full shade; M = a partially open crown that provides patchy or

incomplete shade; L = a very open crown that provides little shade.

- Nutrient Uptake: The plant's general capacity to use excess nutrients such as nitrate-nitrogen. H = can use large amounts; M = some excess nutrients used; L = plant is a low-nutrient user.
- Inundation Tolerance: General capacity of the plant to withstand standing water, low soil aeration conditions. H = can tolerate 10 or more days of inundation; M = can tolerate 2 - 10 day events; L = can tolerate 1 day or less of inundation.
- Soil Saturation Tolerance: The plant's capability to grow near or in saturated soil conditions. H = plant can withstand "wet feet"; M = some tolerance to saturated conditions; L = little or no tolerance to saturated soil.
- Drought Tolerance: The plant's capability to grow in droughty or dry soil conditions. H = plant can withstand or has physiology to survive droughty periods; M = some tolerance to drought or dry conditions; L = little or no tolerance to dry soil conditions.
- Aesthetics: A very general rating (H, M, or L) that indicates some aspect of the plant, e.g., flowers, special foliage characteristics, or plant part color that enhances the appeal or viewing of the planting.
- Native Species: "Y" indicates the plant is native to the state; "N" indicates it is introduced
- Sediment Deposition: Tolerance H = plant can withstand repeated, deep deposits of sediment; M =plant can withstand repeated, shallow deposits of sediment; L = plant can withstand little or no sediment deposits.
- Special Notes: (H) Trees have the ability to grow out over the water to catch sunlight. This increases leaf litter and insects fall into the water. (L) Trees have columnar form, with few branches thus being ideal candidates for natural large woody debris when tree naturally falls into the water. (R) Trees or shrubs exhibit ability to root from cuttings or natural limb layering. (W) Trees provide either wildlife cover or forage.

Table 1 - Tree and Shrub Species for Riparian Areas

Common and Scientific Names	Height at Age 10	Height at Age 20	TOTAL HEIGHT	1. Shade Tolerance	2. Shade Value	3. Nutrient Uptake	4. Inundation Tolerance	5. Soil Saturation Tolerance	6. Drought Tolerance	7. Aesthetics	8. Native Species	9. Sediment Deposition Tolerance	10. Special Notes
Tree (Conifer)													
White Pine (Pinus strobus)	10	24	100	M	M	M	M	M	M	M	Y	M	L
Hemlock (Tsuga canadensis)	8	20	70	M	H	M	L	L	H	H	Y	L	L/H
White Spruce (Picea glauca)	8	22	80	M	L	M	M	M	H	M	Y	L	
Black Spruce (Picea mariana)	8	22	70	M	L	M	H	H	M	M	Y	M	
Tamarack (Larix laricina)	10	32	60	L	L	M	M	M	L	H	Y	L	L
Northern White Cedar (Thuja occ)	6	18	60	M	M	M	M	M	M	H	Y	H	H/R
Tree (Deciduous)													
Red Maple (Acer rubrum)	10	25	60	H	H	M	M	M	M	H	Y	M	
Black Willow (Salix nigra)	12	30	60	H	M	L	H	H	L	L	Y	H	R
Bass Wood (Tilia Americana)	18	26	70	H	M	H	M	M	L	M	Y	M	
Grey Birch (Betula populifolia)	15	25	30	L	L	L	L	M	M	L	Y	L	
White Birch (Betula papyrifera)	15	34	70	L	L	L	L	L	M	H	Y	L	
White Ash (Fraxinus americana)	18	36	70	L	L	M	L	L	M	M	Y	L	
Black Ash (Fraxinus nigra)	16	30	60	L	L	M	H	M	L	L	Y	M	
Shrub													
Speckled Alder (Alnus rugosa)	6	12	20	M	M	M	M	H	M	L	Y	H	
Red Osier Dogwood	6	15	15	L	L	M	M/H	H	M	H	Y	H	
Alternate-leaf Dogwood (Comus alternifolia)	6	15	20	M	L	M	M	H	M	M	Y	H	
Pussy Willow (Salix bicolor)	6	12	12	M	L	M	H	H	M	M	Y	H	R
Nannyberry (Viburnum lentago)	5	9	30	M	M	M	M	M	M	M	Y	H	W
Witch Hazel (Hamamelis virginiana)	6	18	20	M	L	M	M	M	M	H	Y	M	W
Streamco willow	6	8	12	M	L	M	M	M	M	M	N	H	R
Bankers Willow	6	8	12	M	L	M	M	M	M	M	N	H	R

CHAPTER VII

WASTE MANAGEMENT SYSTEMS

Intent

By implementing the practices in this chapter, which are designed to protect wetland characteristics, functions and values, wetland impacts can be avoided and minimized. Typically the wetlands affected by these practices are classified as Wet Meadow, and occur in an agricultural field and have hydric soils that are defined as soils that, in an undrained condition, are saturated, flooded, or ponded long enough during a growing season to develop an anaerobic condition that supports the growth and regeneration of hydrophytic vegetation.

STORMWATER RUNOFF CONTROL

Definition

Controlling the quantity and quality of stormwater runoff.

Purpose

To control stormwater runoff to achieve one or more of the following:

- Minimize erosion and sedimentation during and following construction activities.
- Reduce the quantity of stormwater leaving developing or developed sites.
- Improve the quality of stormwater leaving developing or developed sites.

Conditions Where Practice Applies

This practice applies to sites where stormwater runoff causes or may cause undesirable downstream flooding, sedimentation or channel degradation and/or degradation of surface or ground water quality if left untreated. This practice may apply both to sites undergoing development as well as remedial work on already developed sites.

Criteria

General Criteria Applicable to All Purposes

Plan, design and construct stormwater runoff controls to comply with applicable federal, state, and local laws and regulations.

Develop a plan to reduce the impacts of stormwater runoff from the site based on an assessment of the downstream area. As applicable. Include in the plan practices or management activities that will reduce onsite erosion and offsite impacts from sedimentation, the quantity of stormwater leaving to levels that will not adversely downstream receiving channels, and quality of runoff leaving the site. Where appropriate delay construction until vegetation has been established.

Acceptable peak rates are dependent upon the capacity and stability of the receiving channel. Local regulations may specify acceptable discharge rates for different storm frequencies.

Runoff is controlled by slowing the release of runoff from the site. This can be accomplished by increasing infiltration onsite, lengthening the flow path of runoff or a combination of these methods.

All runoff control methods must include provisions to safely bypass runoff in excess of the design storm.

Additional Criteria for the Improvement of Water Quality. Runoff from developing areas can be contaminated with a variety of substances including sediment, oils, chemicals and trash. Runoff control systems must include provisions to reduce contaminates in the runoff leaving the site. This can include vegetated filtration areas and other biofilters, trash guards and settling areas that are readily accessible for cleanout. For runoff that is known to be contaminated with substances that may be particularly harmful to the water supply or fish and wildlife, additional measures may be necessary.

Additional Criteria for Erosion and Sediment Control. Control erosion on the site by limiting the amount and length of time that bare soil is exposed to precipitation. This can be accomplished by staging construction and only removing vegetation from a portion of the site at a time, revegetating areas incrementally during construction or using temporary seeding and mulching to stabilize areas until permanent vegetation can be established. Structural erosion control practices can also be installed to reduce the flow length and velocity of runoff to limit erosion.

When erosion cannot be stopped at the source, sediment laden runoff must be filtered or detained to allow sediment particles to settle out to acceptable levels before runoff is released from the site. This can be accomplished by sediment traps, sediment basins and other structures designed to detain or filter runoff. Refer to Conservation Practice Standard, (350) Sediment Basin for design requirements for sediment basins.

Considerations

Research has shown that the first runoff from a site is often the most contaminated. After this initial flush, less pollutants are available for removal and dilution lessens the impact.

Consequently treatment of this “first flush” of runoff is often sufficient to address the water quality concern. The exact amount of runoff to treat varies depending upon the surface and level of contamination. Determine the amount of runoff to treat based on appropriate research or experience.

Stormwater control practices can affect downstream hydrology. While this is the point of most stormwater control systems the effect of changing the peak rate and volume of runoff should be considered on downstream areas.

The effect of a single project should also be considered in context with other projects in the watershed to determine the cumulative effect. Generally peak rates of runoff should be kept at or below pre-development rates of runoff from the site for the 2 year 24 hour storm. For already developed areas consider reducing the peak flow from the current developed condition.

Design stormwater control practices to fit into the visual landscape as well as to function for runoff control. Since stormwater control practices are generally installed in public spaces, consider how the space will be used and the visual impact the practices will have.

If properly designed, stormwater control practices can be beneficial to wildlife. When possible use native vegetation to provide food and habitat for wildlife and pollinators. Since most stormwater control practices are in aquatic environments, they can inhibit the movements of aquatic organisms.

When designing these structures include provisions for the safe passage of aquatic organisms that may inhabit the site.

To be most effective, stormwater control should include a system of practices working together.

This might include detention along with infiltration areas and the maintenance of natural, undisturbed areas. However, it could also include managing the development of the site to limit the disturbed area, ensuring that revegation occurs in a timely manner and controlling where heavy equipment is allowed to travel on a site.

Large storms can quickly fill stormwater runoff practices with sediment that must be removed in order for the practices to function correctly. Consequently these practices should be designed for easy access and maintenance.

Plans and Specifications

Prepare plans and specifications for stormwater runoff control systems that describe the requirements for applying the practice according to this standard. As a minimum the plans and specifications should include:

- A plan view showing the extent of the practice.
- Where appropriate, cross-sections and/or profiles showing elevations and distances.
- Where appropriate, plans for structural details.
- Where appropriate, seeding requirements.
- Construction specifications that describe in writing site specific installation requirements for the stormwater runoff control systems.

Operation and Maintenance

Prepare an O&M plan for the operator. The minimum requirements to be addressed in the O&M plan are:

- Periodic inspections, especially immediately following significant rainfall events.
- Prompt repair or replacement of damaged components especially surfaces that are subjected to wear or erosion.
- Regular inspection of settling basins, trash guards and other practices to collect and remove accumulated sediment and debris.

REFERENCES

Bannerman, Roger, and E. Considine, 2003. Rain Gardens: A How-to Manual for Homeowners. University of Wisconsin Extension Publication GWQ037 or Wisconsin Department of Natural Resources Publication PUB-WT-776 2003. Madison, WI

U. S. Environmental Protection Agency. 2007. Developing Your Stormwater Pollution Prevention Plan. Washington, DC United States Environmental Protection Agency. 1999. Stormwater Technology Fact Sheet: Bioretention. Publ. EPA-832-F-99-012.

AGRICHEMICAL HANDLING FACILITY

Definition

The Agrichemical Handling Facility (AHF) is a permanent structure with an impervious surface to provide an environmentally safe area for the handling of on-farm agrichemicals, such as pesticides and fertilizers that are used in spraying operations of orchards, vineyards, and cropland.

Purpose

To provide for the containment and isolation of spillage from on- farm agrichemical mixing, loading, unloading, and rinsing operations in order to minimize pollution of the soil, water, air, plant, .or animal resources.

Conditions Where Practice Applies

This practice applies where current methods of mixing agrichemicals and rinsing equipment are polluting or can pollute the soil, water, air, plant, or animal resources.

Considerations

The following should be considered when designing an AHF:

- The availability of water and the distance to water sources for filing the spray equipment tanks, rinsing the sprayers, and rinsing chemical containers.
- On-farm traffic patterns and accessibility to chemical application areas and chemical storage.
- Soils and topography are suitable for construction of an AHF.
- Adjacent land uses and. visibility.
- The effects of chemical drift on surrounding areas due to prevailing winds.
- The need for a loading platform to facilitate the filling and/or rinsing of spray equipment.
- The need for a roof structure over the pad to reduce rainwater, storage requirements, or runoff problems.

Design Criteria

General. The AHF should include a watertight containment structure comprised of a concrete pad and sump, and all necessary equipment for pumping, transferring and storing contaminated water.

Measures should be designed to divert runoff from adjacent areas resulting from a 4 percent chance (25-year frequency), 24=hour duration storm event.

The AHF should be located outside the 100-year flood plain and wetland areas.

The AHF should be isolated from other buildings used to store feed, seed, petroleum products, or livestock and from residences; and located downwind of these buildings when possible.

Access should be a graveled or paved ramp with a maximum slope of 15 percent and a minimum length of 12 feet. All other areas around the pad should be established with vegetation.

All concrete materials should comply with the requirements of USDA NRCS National Engineering Handbook Construction

Specifications 31 and 32 or New Hampshire Construction Specification 32.

The containments volume of the combined pad and sump for the AHF covered with a roof should be 125 percent of the volume of the largest sprayer tank that will be located on the pad. A structure not covered with a roof should contain 12·5 percent of the volume of the largest sprayer tank located on the pad or the volume from a two-year frequency, 24-hour storm event, whichever is larger.

Methods for handling rainwater and snow melt runoff should be designed into the AHF.

The facility and all components should comply with applicable federal, state, and local laws and codes.

Pad. The pad should be a. concrete slab-on-grade with a positive slope of at least 2 percent (1/4 inch per f6ot) from all areas toward the sump.

The minimum length and width of the pad should be sufficient to accommodate the existing or anticipated equipment.

The required thickness and reinforcement of the slab should be designed for the wheel loads of the existing or anticipated equipment. Design should be based upon methods described in the ACI 360R code, "Design of Slabs on Grade" or other similar industry guides

The AHF pad and sump should be sealed with a chemically-resistant, non-vapor barrier forming coating to prevent contamination of the concrete surfaces. Surface preparation and coating application should be according to the manufacturer's recommendations.

The minimum slab thickness should be 5 inches and minimum reinforcement should be 10 by 10 gauge 6 inch by 6 inch welded wire fabric panels. Waterstops should be used between the pad and curb walls when constructed in separate pours.

Sump. The sump should be watertight · and constructed of non-corrodible material, large enough to allow access for cleaning, and should be covered with a corrosion resistant grating if installed under the pad or covered with impermeable material if installed on the outside of the pad. The sump should not be used for permanent storage of spillage or rinsate.

Roof. The roof, if provided, should cover the entire AHF and should extend sufficiently to limit the amount of precipitation reaching the pad

The minimum clearance between the lowest chord of the roof and the highest area of the pad should provide clear access for the spray equipment and should not be less than 10 feet. Enclosure supports should be located outside of the AHF.

The roof should be designed for the minimum loads contained in American Society of Agricultural Engineers (ASAE) Engineering Publication EP288.4 "Agricultural Building Snow and Wind Loads".

Pump. The pump should be corrosion resistant and permanently installed with provisions for protection during winter months.

A filter should be installed between the pump and sprayer or storage tanks.

Storage Tank(s). Storage tank(s) if used, should be permanently installed and above grade on the pad or on an adjacent pad.

The tank (s) should be constructed of non-corrosive material (s). The minimum storage volume of the tank (s) should be the larger of:

- one-fourth of the largest sprayer tank volume, or (2) volume equal to surface area -of pad times 25 gallons per square foot.

Piping. All piping necessary to transfer contaminated water between the sump, the pump, and the temporary storage tanks or sprayer should be permanently installed on the pad. Flexible piping may be utilized to transfer rinsate material from the sump discharge line, or temporary storage, into the sprayer.

All transfer piping carrying contaminated water should be completely exposed for its entire length.

All piping necessary to supply non-contaminated water to should be fitted with backflow prevention devices.

Plans and Specifications

The construction drawings for the AHF should comply with this BMWP. The following statement should appear on all construction drawings for the AHF's:

"Management of chemicals should be the responsibility of the owner/operator and should be in accordance with applicable federal, state and local regulations".

Plans and specifications should describe the site specific requirements for implementing this practice to achieve its intended use.

Operation and Maintenance

An O&M plan should be developed that is consistent with the purposes of this practice, its intended life, and the criteria for its design. It should address:

- Proper disposal/utilization of rinsate, exterior washwater, accumulated sediment and spillage wastewater in accordance with the pesticide labeling requirements and federal, state and local laws and codes.
- Winterization of the facilities.
- Periodic checks of the backflow prevention devices.
- 4. Inspections of the pad and sump for cracks and leaks, and deterioration of the sealant.
- Cleaning the sump and pad between different chemical mixing operations and removal of sediment accumulation from the sump, taking proper precautions to reduce worker exposure.
- Emergency response instructions in case of an accidental pesticide spill, exposure, fire, or other incident that could adversely affect environmental health.
- Posting of warning signs that hazardous chemicals are present.
- The owner or applicator will have appropriate applicators license or permits for chemicals used at the facility. The applicator will have and use all required personal protection equipment as listed on chemical labels.

Supporting Data for Documentation

Design Data. The following information should be recorded in the design and/or on the drawings, as applicable:

- A drawing showing the facility with contour information in relation to surrounding buildings, streams, brooks, well, etc.
- Detail designs for special components such as: curbs, hydrants, sump, pump configuration, stormwater diversion, etc.
- Calculations showing design and required storage capabilities of the facility.
- Erosion and sediment control measures as needed.

Construction Check Data.

The following information should be recorded on the drawings or on the design to certify, installation of the facility:

- Final surveyed elevations or depths and dimensions of the pad, curbs, sump, etc.
- Locations of buried pipelines· and power cables where installed as part of the facility.
- Check list of other components required in the design.

HEAVY USE AREA PROTECTION

Definition

Protecting heavily used areas by establishing vegetative cover, by surfacing with suitable materials, or by installing needed structures.

Purpose

This practice is used to stabilize urban, recreation or essential facility areas subjected to sustained heavy use by people, animals or vehicles.

Conditions Where Practice Applies

On agricultural or other areas subjected to sustained heavy use that require special treatment to protect the area from erosion or other environmental deterioration.

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, and transpiration.
- Effects on erosion and the movement of sediment, animal waste, and soluble and sediment-attached substances carried by runoff.
- Effects of changes in surface and groundwater caused by introduction of fertilizers for vegetated areas, and oils and chemicals associated with concrete and asphalt placement and other construction activities.
- Effects of changes in surface water caused by the runoffs from confined animal feeding areas.

Design Criteria

Drainage and Erosion control: Provisions should be made for surface and subsurface drainage as needed to dispose of runoff without erosion.

Base Course. All areas to be paved should have a 6-inch base course of gravel, crushed stone, or other suitable material.

Areas subject to automotive traffic should be designed for a wheel load of at least 4,000 pounds.

Surface Treatment. Asphalt -The thickness of the asphalt course, the kind and size of aggregate, type of proportioning of bituminous materials and the mixing and placing of these materials should be in accord with good highway practice for the expected loading.

Concrete. The quality and thickness of concrete and the spacing and size of reinforcing steel should be appropriate for the expected loading and in accord with sound engineering practice.

Gravel. Minimum thickness for gravel surface should be. 2 inches.

Other. Where other surfacing materials are used, such as cinders, bark, sawdust, etc., the minimum thickness should be 2 inches.

Structures. All structures should be designed in accordance with appropriate USDA NRCS standards and specifications or National Engineering Handbook recommendations.

Sprays and Artificial Mulches. Sprays of asphalt, oil, plastic, manufactured mulches and similar materials will be installed in accordance with the manufacturer's recommendations.

Vegetative Measures. Liming, fertilizing, seeding and sodding will be in accord with the forestry standards and specifications for recreation area improvement.

Construction Specifications

Specifications will be in keeping with this BMWP and will describe the requirement for proper installation of the practices to achieve its intended purposes.

Construction should conform to plans and the USDA NRCS New Hampshire Construction and Materials Specifications for Conservation Engineering Practices.

ROOF RUNOFF MANAGEMENT

Definition

A facility for collecting, controlling, and disposing of runoff water from roofs.

Purpose

To prevent roof runoff water from flowing across concentrated waste areas, barnyards, roads and alleys, and to reduce pollution and erosion, improve water quality, prevent flooding, improve drainage, and protect the environment.

Conditions Where Practice Applies

This practice applies where: (1) a roof runoff management facility is included in an overall plan for a waste management system; (2) roof runoff water may come in contact with wastes or cause soil erosion; and (3) barnyard flood protection or improved drainage is needed.

Considerations

- Effects of the components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Effects on downstream flows or aquifers that would affect other water uses.
- Potential use for water management to conserve water.
- Effects on erosion and the movement of sediment, pathogens, and soluble and sediment attached substances carried by runoff.
- The effects on wetlands and water-related wildlife habitats associated with the practice.

Design Criteria

Capacity. Design of roof runoff management facilities should be based on the runoff from a 10-year frequency, 5-minute runoff except that a 25-year frequency, 5-minute runoff should be used to design such facilities for exclusion of roof runoff from waste treatment lagoons, waste storage ponds, or similar practices.

Materials. Roof gutters and downspouts may be made of aluminum, galvanized steel, wood, or plastic. Aluminum· gutters and downspouts should have a nominal thickness of at least 0.07 and 0.05 inches, respectively. Galvanized steel gutters and downspouts should be at least 28 gage. Wood should be clear and. free of knots. A water-repellent preservative should be applied to the flow area of wood other than redwood, cedar, or cypress. Plastics should contain ultraviolet stabilizers. Dissimilar metals should not be in contact with each other.

Supports. Gutter supports should have sufficient strength to withstand anticipated water, snow, and ice loads. They should have a maximum spacing of 120 inches for galvanized steel and 81 inches for aluminum or plastic. Wood gutters should be mounted on fascia boards using furring blocks that are a maximum of 61 inches apart. Downspouts should be securely fastened at the top and bottom with intermediate supports that are a maximum of 10 feet apart.

Outlets. The water from roof runoff management facilities may empty into surface drains or underground outlets, or into the ground surface. When downspouts empty onto the ground surface, there should be an elbow to direct water away from the building and splash blocks or other protection should be provided to prevent erosion.

Protection. Roof runoff management facilities and outlets should be protected from damage by livestock and equipment. . Where appropriate, snow and ice guards may be installed on roofs to protect gutters and reduce the hazard to humans and animals below. Gutters may be installed below the projection of the roof line to further reduce gutter damage from snow and ice.

Plans and Specifications

Plans and specifications for installing roof runoff management facilities should be in keeping with this BMWP and should describe the requirements for applying the practice to achieve its intended purpose.

WASTE STORAGE POND

Definition

An impoundment made by excavation or earth fill for temporary storage of animal or other agricultural waste.

Purpose

To store liquid and solid waste, waste water, and polluted runoff to reduce pollution; to maintain or enhance quality of both surface and groundwater; and to protect the environment.

Conditions Where Practice Applies

This practice applies where: (1) an overall waste management system has been planned; (2) waste is generated by agricultural production or processing; (3) storage is necessary to properly manage the waste; (4) soils and topography are suitable for construction; and (5) the structure can be located, installed, and managed without polluting air and water resources.

Considerations

Location. Waste storage ponds should be as close to the source of waste and polluted runoff as practicable. Due consideration should be given to economics, the overall waste management plan, and health and safety factors. The ponds should be located where prevailing winds, vegetative screening, and building arrangement minimize odor and visual resource problems. Non-polluted runoff should be excluded to the fullest extent possible. Waste storage ponds should not be located on flood plains unless they are protected from inundation or damage from a 25-year flood event.

Solids Separation. To minimize frequency of solids removal from runoff storage ponds, direct polluted runoff through vegetative filter strips, low-gradient channels, or debris basins to remove readily settled solids. Settling facilities should have adequate capacity to store settled solids for a reasonable period, based on climate, equipment, and method of disposal. If animal manure, such as from dairy cows, is flushed into a storage pond, a solids separator may be provided for removing fibrous solids to facilitate pumping and irrigation.

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Effects on downstream flows or aquifers that would affect other water uses.
- Effects of installation demand on the water supply of the site.
- Effects on erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances translocated by runoff and seepage.
- Effects on the use and management of nutrients on surface and groundwater quality, particularly the on-site water supply for human and livestock consumption.
- Effects on the visual quality of on-site and the downstream water resources.

- Short-term and construction-related effects of this practice on the quality of on-site and downstream water courses.
- Effects on the movement of dissolved substances toward the groundwater.
- The effects on wetlands and water-related wildlife habitats associated with the practice.

Design Criteria

Soil and Foundation. Locate pond on soils of slow to moderate permeability or on soils that can seal through sedimentation and biological action. Avoid gravelly-soils and shallow soils over fractured or cavernous rock. If self-sealing is not probable, the storage pond should be sealed by mechanical treatment or by the use of an impermeable membrane. Do not construct to an elevation below the seasonal high water table unless considered as a special design.

Storage Period. Experience in New Hampshire indicates that the minimum storage period should be 180 days. Other periods of storage may be provided based on crops and cropping sequences, farm operations, available land upon which to spread where consideration is given to accessibility, and field locations with respect to off-site pollution potential, soil conditions, land slopes, weather restrictions and other related factors. Any design with a storage period less than 180 days should be considered a special design and reasons for the shortened period documented.

Design Storage Volume. The design storage volume equal to the required storage volume, should consist of the total of the following as appropriate.

- Manure, bedding
- Normal precipitation less evaporation on the surface area (at the design storage volume level) of the facility during the storage period. , wastewater, and other wastes accumulated during the storage period.
- Normal runoff from the facility's drainage area during the storage period.
- 25-year, 24-hour precipitation on the surface (at the required design storage volume level) of the facility.
- 25-year, 24-hour runoff from the facility's drainage area.
- Residual solids after liquids have been removed. A minimum of 6 inches should be provided for tanks and other structures, and 12 inches for ponds unless provisions are made to remove the residual solids on an annual basis
- Additional storage as may be required to meet management goals or regulatory requirements. .
- Freeboard, *Ponds - 12 inches; Structures - 6 inches*

Inlet and outlet. Inlets to storage ponds can be of any permanent · type designed to resist erosion, plugging, and damage by ice. If slurry and solid waste is stored, the inlet should be designed so that waste will be deposited near the center of the pond.

There should be no outlet that can automatically release storage from the design volume. An emergency spillway or additional storage should be provided to protect the facility from overtopping during a 25-year, 24-hour storm occurring when the design volume is filled for ponds with drainage areas. Spillway requirements, however, do not apply to waste storage ponds without drainage areas.

A dam permit is required from the NHDES Water Resources Division for 2 acre-feet or more of impoundment or an embankment height of 6 feet or greater. A wetland dredge and fill permit may be required from the NHDES Wetlands Bureau.

Earth embankment. The design height of the embankment should be increased by the amount needed to ensure that the design top elevation will be maintained after settlement. This increase should not be less than 5 percent. The minimum top width should be 8 ft. The combined side slopes of the settled embankment should not be less than 5 horizontal to 1 vertical.

For ponds with a drainage area, the minimum elevation of the top of the settled embankment should be 1 foot above the elevation of the water surface during the 25-year, 24-hour emergency spillway storm occurring when the design volume is filled.

For ponds without a drainage area, the minimum elevation of the settled top should be 1 foot above the design volume.

Disposal facilities. Waste should be removed from storage and used or disposed of at locations, times, rates, and volumes shown in the overall waste management plan without polluting the surface or groundwater. Waste may be liquid; slurry; or solid, and proper equipment must be available to remove and apply it to the land.

If polluted runoff is stored, liquids should be removed promptly to ensure that sufficient capacity is available to store runoff from subsequent storms. The maximum allowable emptying time should be based on the chance of overflow from subsequent storms and on the capacity of the disposal area.

Provisions should be made for removing solids from storage ponds to preserve the storage capacity. The method or removal must be considered in planning, particularly in determining the size and shape of the pond. For ponds built to store runoff and waste water, an entrance ramp having a slope of 4:1 or flatter may be used. For those built to store slurry and solid waste, some type of emptying facility must be provided. It may be a dock, a pumping platform, a retaining wall, or a ramp having a slope of 7:1 or flatter.

Protection. If the waste storage pond creates a safety hazard, it should be fenced and warning signs posted to prevent children and others from using it for other than the intended purpose. Vegetative screens or other methods should be used to shield the pond from public view and to improve visual conditions.

Vegetative. All exposed soil areas will be vegetated or protected by other measures to prevent erosion. Liming, fertilizing, seeding and mulching will be in accordance with the current standards and specifications for critical area planting.

Operation and Maintenance

Operation and maintenance should be in accordance with the requirements specified in the overall waste management plans. Refer to Chapter 13 of the USDA NRCS Agricultural waste Management Field Handbook for recommendations on operation maintenance.

Plans and Specifications

Plans and specifications for water storage ponds should be in keeping with this standard and should describe the requirements for applying the practice to achieve its intended purpose. Refer to USDA NRCS New Hampshire Construction and Materials Specifications for Conservation Engineering Practices for applicable construction specifications.

Foundation Preparation. The foundation area should be cleared of trees, logs, stumps, roots, brush, boulders, sod, and rubbish. If needed to establish vegetation, the topsoil and sod should be stockpiled and spread on the completed dam and spillways. Foundation surfaces should be sloped no steeper than 1:1. The foundation area should be thoroughly scarified before placement of the fill material. The surface should have moisture added or it should be compacted if necessary so that the first layer of fill material can be compacted and bonded to the foundation.

The cutoff trench and any other required excavations should be dug to the lines and grades shown on the plans or as staked in the field. If they are suitable, excavated materials should be used in the permanent fill.

Existing stream channels in the foundation area should be sloped no steeper than 1:1 and deepened and widened as necessary to remove all stones, gravel, sand, stumps, roots, and other objectionable material and to accommodate compaction equipment.

Foundation areas should be kept free .of standing water when fill is being placed on them.

Fill Placement. The material placed in the fill should be free of detrimental amounts of sod, roots, frozen soil, stones more than 6 inches in diameter (except for rock fills), and other objectionable material.

Selected backfill material should be placed around structures, pipe conduits, and anti-seep collars at about the same rate on all sides to prevent damage from unequal loading.

The placing and spreading of fill material should be started at the lowest point of the foundation and the fill brought up in horizontal layers of such thickness that the required compaction can be obtained. The fill should be constructed in continuous horizontal layers except where openings or sectioned fills are required. In those cases, the slope of the bonding surfaces between the embankment in place and the embankment to be placed should not be steeper than 3 horizontal to 1 vertical. The bonding surface should be treated the same as that specified for the foundation so as to ensure a good bond with the new fill.

The distribution and gradation of materials should be of such that no lenses, pockets, streaks, or layers of material differ substantially in texture or gradation from the surrounding material. If it is necessary to use materials of varying texture and gradation, the more impervious material should be placed in the center and upstream parts of the fill. If zoned fills of substantially differing materials are specified, the zones should be placed according to the lines, grades, and elevations shown on the drawings or as staked in the field.

Moisture Control. The moisture content of the fill material should be adequate for obtaining the required compaction. Material that is too wet should be dried to meet this requirement, and material that is too dry should have water added and mixed until the requirement is met.

Compaction. Construction equipment should be operated over the areas or each layer of fill to ensure that the required compaction is obtained. Special equipment should be used if needed to obtain the required compaction.

If a minimum required density is specified, each layer of fill should be compacted as necessary to obtain that density.

Fill adjacent to structures, pipe conduits, and anti-seep collars should be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers or plate vibrators. Fill adjacent to concrete structures should not be compacted until the concrete is strong enough to support the load.

Protection. A protective cover of vegetation should be established on all exposed surfaces of the embankment, spillway, and borrow area if soil and climatic conditions permit. If soil or climatic conditions preclude the use of vegetation and protection is needed, non-vegetative means, such as mulches or gravel, may be used. In some places, temporary vegetation may be used until conditions permit establishment of permanent vegetation. The embankment and spillway should be fenced if necessary to protect the vegetation.

Seedbed preparation, seeding, fertilizing, and mulching should comply with instructions in technical guides.

Foundation and Embankment Drains. Foundation and embankment drains, if required, should be placed to the line and grade shown on the drawings. Detailed requirements. For drain material and any required pipe should be shown in the drawings and specifications for the job.

Excavated Ponds. The completed excavation should conform to the lines, grades, and elevations shown on the drawings or as staked in the field.

Embankment and Excavated Pods. Construction operations should be carried out in such a manner and sequence that erosion and air and water pollution are minimized and held within legal limits. All work should be conducted in a skillful manner.

The completed job should present a finished appearance.

Measures and construction methods that enhance fish and wildlife values should be incorporated as needed and practical.

Fencing and cover to control erosion and pollution should be established as needed.

Safety. Design should include appropriate safety features to minimize the hazards of the facility. Ramps used to lower PTO powered pumping and agitation units into the facility to empty liquids should have a slope of 4 horizontal to 1 vertical or flatter. Steeper slopes at pumping/agitation ramps may be used to accommodate special unloading pumps or when the wheels of the tractor itself will not be on the ramp. Ramps that are roughened and used to gain access to the facility for periodic removal of accumulated solids should be appropriately graded to allow the safe traverse of operator's current equipment. Those used to empty slurry, semi-solid, or solid waste should have a slope of 8 horizontal to 1 vertical or flatter, unless special traction surfaces are provided or physical constraints do not allow.

Warning signs, fences, ladders, ropes, bars, rails, and other devices should be provided, as appropriate, to ensure the safety of humans and livestock.

For facility where constant traffic in and out is anticipated a ramp that is 10 horizontal to 1 vertical or flatter is recommended. Ramps designed for use by only four wheel drive vehicles may be as steep as 5 horizontal to 1 vertical.

A minimum of four warning signs, including one at each access point should be installed on all facilities. Ventilation and warning signs must be provided for covered waste holding structures, as necessary, to prevent explosion, poisoning, and asphyxiation. Warning signs should also be posted at all reception pits, hoppers and any other confined area that may contain harmful gases

Pipelines should be provided with a water-sealed trap and vent or similar device, if there is a potential, based on design configuration, for gases to enter buildings or other confined spaces.

Ponds and uncovered fabricated structures for liquid or slurry waste with walls less than 5 feet above ground surfaces should be fenced and warning signs posted to prevent children and others from using them for other than their intended purpose.

Above ground glass lined tanks, such as Slurry Store facilities, do not need to be fenced provided all other safety precautions are made. Fencing should be designed in accordance with the Fence BMWP.

WASTE STORAGE STRUCTURE

Definition

A fabricated structure for temporary storage of animal wastes or other organic agricultural wastes.

Purpose

To temporarily store liquid or solid wastes as part of a pollution-control or energy-utilization system to conserve nutrients and energy and to protect the environment.

Conditions Where Practice Applies

This practice applies where: (1) the structure is a component or an overall plan prepared according to the NRCS standard for waste management systems; (2) temporary storage is needed for organic wastes generated by agricultural production or processing; (3) the structure can be located without polluting air or water resources; (4) soils and topography are suitable for construction of the structure; and (5) a comprehensive nutrient management plan has been prepared.

Considerations

- Effects on the water budget, especially on volumes and rates of runoff, including snow melt, infiltration, evaporation, transpiration, deep percolation, and groundwater recharge.
- Variability influenced by seasonal climatic changes.
- Effects on erosion and the movement of sediment, pathogens, organic material, and soluble and sediment-attached substances carried by runoff.
- Effects of nutrients and on surface and groundwater quality, particularly the on-site water supply for human and livestock consumption.
- Effects on the visual quality of on-site and downstream water resources.
- Short-term and construction-related effects of this practice on the quality of downstream surface and groundwater.
- The effects on wetlands and water-related wildlife habitats. Design Criteria

Location. The following factors must be considered in selecting a site for waste storage structures: proximity of the structure to the source of wastes, access to the facilities, ease of loading and emptying wastes, appropriate health regulations, and direction of prevailing winds to minimize odors. The structure should be located a minimum of 100 feet from any well, spring, or underground water supply. Non-polluted runoff should be excluded from the structure to the fullest extent possible. Waste storage structures should not be located on flood plains unless they are protected from damage and inundation from a 25-year 24-hour flood event.

Environmental Protection. All disturbed land surfaces should be vegetated or otherwise stabilized to control soil erosion. The location, layout, and design of the facilities should be compatible with the surrounding landscape. Existing land farms and vegetation, along with land shaping and vegetative plantings, should be considered to minimize an adverse impact upon visual resources.

The structure should be designed, constructed, operated and maintained so as to prevent· any adverse impact on the quality of surface or groundwater.

Loading and Unloading. Adequate maneuvering space should be provided for operating loading and unloading equipment. Push-offs must be structurally sound and must be provided with railings, safety bars, or other devices to prevent humans, animals, and equipment from falling into the facility. Provisions should be made for removing liquids that accumulate from solid wastes or from precipitation.

Disposal Facilities. Equipment should be available for removing wastes from the storage structure, processing them for energy, or applying them to the land at the locations, times, and rates shown in the overall management plan.

Service Life and Durability. Planning, design, and construction should ensure that the structure is sound and of durable materials commensurate with the anticipated service life, initial and replacement costs, maintenance and operation costs, and safety and environmental considerations.

The structure should be planned, designed, and installed to provide a minimum service life of 10 years.

Size. Experience in New Hampshire indicates that the design volume of the structure should be large enough to store accumulated wastes, bedding, washwater and needed dilution water for a minimum of 180 days. Other periods of storage may be provided based on crops and cropping sequences, farm operations, available land upon which to spread where consideration is given to accessibility, and field locations with respect to off-site pollution potential; soil conditions, land slopes, weather restrictions and other related factors. The reasons for shortening the storage period should be documented in full. Energy production systems must also have a storage component that meets the minimum design storage requirements. Provisions should be made to ensure that outside runoff does not flow into the structure. If suitable provisions cannot be made; however, the anticipated volume of runoff likely to enter the structure over the storage period must be included in the design volume. The design volume must allow for any direct rainfall and snow minimum expected evaporation. A minimum of 6 inches should be provided for freeboard. In storage tanks, an allowance of at least 6 inches should be included in the design volume for solids accumulation. Data in Chapter 10 of the USDA NRCS Agricultural Waste Management Field Handbook or reliable local information can be used in determining the quantity of waste production.

The volume of washwater should be determined by actual measurement or estimated by a reliable method such as calibration of each faucet, hose, or spray nozzle and applying the rate of water use to the time of operation, or by Chapter 4 of the Agricultural Waste Management Field Handbook.

Structural Loadings Waste storage structures should be designed to withstand all anticipated loads. Loadings include internal and external loads, hydrostatic uplift pressure, concentrated surface and impact loads, water pressure due to seasonal high water table, and frost or ice pressure.

The lateral earth pressure should be calculated from soil strength values determined from the results of appropriate soil tests. If soil strength tests are not G'-Variable, use the minimum lateral earth pressure values indicated in Table 2 of the USDA NRCS Engineering Standards and Specifications for Waste storage Structures Section IV of the Technical Guide .

Lateral earth pressures based upon equivalent fluid assumptions should be assigned according to the structural stiffness or wall yielding as follows:

- Rigid frame or restrained wall. Use the values shown in Table 2 of the Waste Storage Structure standards and specification under the column "Frame Tanks," which gives pressures comparable to the at-rest condition.
- Flexible or yielding wall. Use the values shown in Table 2 under the column "Freestanding Wall," which gives pressures comparable to the active condition. Walls in this category are designed as a cantilever having a base thickness to height ratio not more than 0.085.

An internal hydrostatic load of 60 pounds per square foot for each foot of depth should be used for design. If heavy equipment is to be .operated within 5 feet of the walls, a surcharge (horizontal pressure) of 100 pounds per square foot on the wall should be added. Covers for waste storage structures should be designed to withstand both dead and live loads. The live load values for covers contained in ASAE EP378 (Floor and Suspended Loads on Farm Structures Due to Use) and in ASAE EP393 (Solid and Liquid Manure Storage), should be the minimum used. The actual axle load for tank wagons having more than a 2000-gallon capacity, should be used. If the facility has a roof, snow and wind loads should be as specified in ASAE8288 (Designing Buildings to Resist Snow and Wind Loads). If a waste storage structure is to serve as part of a foundation or support for a building, the total load should be considered in the structural design.

Potential uplift pressure should be eliminated by drainage or be included in the structural design (including buoyancy and flotation) structural design. The structural design should consider all items that will influence performance, such as design, analyses, methods, and assumptions; construction methods and quality control; and operational exposure, use, maintenance, and repair storage tanks may be designed with or without covers. Covers, beams, or braces that are integral to structural performance, must be indicated on the construction drawings. The openings in covered storage tanks should be designed to accommodate equipment for loading, agitating, and emptying and should be equipped with grills or secure covers for safety and odor and vector control.

Above ground waste storage structures should have adequate footings extending below the anticipated frost depth. Closures (gates) for above ground waste storage structures should be structurally adequate to support imposed loads.

Minimum requirements for waste storage structures are specified below:

Steel. AISC Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings.

Timber. NFPA National Design Specifications for Wood Construction.

Flexible membranes. Flexible membranes should meet or exceed the requirements of flexible membrane linings specified in the BMWP for Pond Sealing or Lining.

Coatings. Coatings should be approved in accordance with procedures in the National Engineering Manual.

Glass fiber reinforced plastic/resins and glass-fused steel. Products should be approved in accordance with procedures in the USDA NRCS National Engineering Manual.

Masonry concrete. ACI 531.

Reinforced concrete. See service life specifications in the Waste Storage structures engineering standards and specifications.

- Nonstructural concrete slabs.
- Reinforced Concrete. The minimum thickness of slabs for tanks should be 5 inches except for slabs cast on · plastic over sand where the minimum thickness should be 4 inches. The minimum thickness of slabs for stacking facilities should be 4 inches. The minimum reinforcement for slabs with a span of 30 feet or less should be equal to that of 10/10 gauge, 6" x 6" welded wire fabric. Slabs having a span greater than 30 feet should be provided with expansion joints at a maximum spacing of 30 feet or should have additional steel reinforcement.

Earthen Stacking Facilities. Earthen stacking facilities are to be located on soils of slow to moderate permeability; or on soils which will seal through sedimentation and biological action, mechanical or chemical treatment; or by the addition of an impervious blanket on permeable sites that cannot otherwise be sealed. Sites with a high water table, gravelly soils, and shallow soils over fractures or cavernous rock are to be avoided. The criteria for evaluating soil conditions can be found in Agricultural Waste Management Field Handbook.

Safety

Entrance ramps should be no steeper than 8 horizontal to 1 vertical. Warning signs, ladders, ropes, rails, and other devices should be provided, as appropriate, to ensure the safety of humans and livestock. Ventilation and warning signs must be provided for enclosed waste holding structures, as necessary, to prevent explosion, poisoning, or asphyxiation. Pipelines from enclosed building should be provided with a water-sealed trap and vent or similar devices to control gas entry into the buildings.

Operation and Maintenance

A written O&M plan should be developed and agreed to by the landowner or operator prior to the inspection and approval of the structure. A guide for the development of this plan is contained in Agricultural Waste Management Field Handbook.

Plans and Specifications

Plans and specifications for waste storage structures should be in keeping with this BMWP and should describe the requirements f or applying the practice to achieve its intended purpose.

Construction should conform to the plans and the USDA NRCS New Hampshire Construction Materials and Specifications for Conservation Engineering Practices.

SOILS/SITE REPORT - FIELD STACKING SITE EVALUATION

Date: ______________ **Landowner/User:** ________________________________

Town: ______________________ **Field Identification:** ____________________________

Manure Type: (Circle one) [**Dairy, Poultry, Beef**] **Planner:** __________________________

Soils/Site Evaluation					
Soil Property	**NRCS**	**Site 1**	**Site 2**	**Site 3**	**Site 4**
Depth to High Water Table	18" (6-18" with modifications)				
Depth to Bedrock	**30" (24-30" with modifications)**				
Slope	**8% Maximum**				
Permeability of Substratum (Least Permeable Horizon over 12" thick)	**2"/hr. or less**				
Floodplain	**Not in the 25-yr. floodplain**				

Setbacks from Resource Concerns						
Resource Concern	**NRCS**		**Site 1**	**Site 2**	**Site 3**	**Site 4**
	Upslope	**Downslope**				
Water Supply (Owners)	**100 '**	**300'**				
Water Supply (not Owners)	**500'**	**500'**				
Perennial Water Body	**100'**	**300'**				
Intermittent Water Body	**50'**	**200'**				
Public Water Supply <u>**a**</u>**/**	**500'**	**1000'**				
Property Line	**100'**	**200'**				
Neighbor's House	**500'**	**500'**				
Diversion Ditch	**25'**	**100'**				
Gully, ravine, swale	**25'**	**100'**				

Meets all NRCS Specifications?	**Yes**	**No**	**Approved?**	**Yes**	**No**
Modifications Required?	**Yes**	**No**	**Approved with Mods?**	**Yes**	**No**

Modifications Required

Setbacks from Resource Conserns that far exceed the Min. distances compensate for soil/site limitations: **Yes** **No**

<u>Other Modifications Required:</u>

Other Site Notes:

<u>a</u>/ Check with NH DES Source Water Protection Regulations for the Area.

APPENDIX A

Definitions

Anti-seep Collar. A plate or membrane, attached to the barrel running through an embankment of a pond that prevents seepage of water around the pipe.

Backfill. The operation of filling an excavation after it has once been made.

Barrel. The concrete or corrugated metal pipe of a principal spillway that passes runoff from the riser through the embankment, and finally discharges to the pond's outfall.

Berm. A horizontal strip or shelf built into an embankment or cut, to break the continuity of a long slope, usually for the purpose of reducing erosion, improving stability, or to increase the thickness or width of an embankment.

Best Management Wetlands Practice (BMWP) for Agriculture. A proven and accepted structural, non-structural, or vegetative measure which permits efficient farming operations while achieving the least possible adverse impact upon the environment.

Channel. A natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water.

Channel Erosion. The widening, deepening, and headward cutting of small channels and waterways, due to erosion caused by flowing water.

Conservation District. A governmental subdivision of the state of New Hampshire established along county boundaries and organized under RSA 430-B and defined in Chapter 432:9.

Conservation Plan. The information provided to a land user that includes guidance, alternatives, and decisions as needed to plan and apply resource management systems consistent with field office technical guides. Conservation plans are a result of carrying out the planning process with a land user. The plan contains a record of inventories, land uses, and treatment decisions provided to the land user.

Conservation Practice. Need in planning and programs for which developed. A measure commonly used to meet a specific carrying out soil and water conservation standards and specifications have been

Cooperator. An individual, group of people, or representative of a unit of government who has entered into an understanding, working arrangement, or cooperative agreement with a conservation district to work together in planning and carrying out soil and water resources use, development, and conservation on specific land area.

Conservation Plan Map. These include sketch, line, photographs, etc., used in providing and/or documenting conservation assistance.

Considerations. Constructive and helpful items for evaluation in the use of a BMWP.

Culvert. A closed conduit for the passage of surface water under or over a roadway, railroad, canal, or other impediment.

Dam. A barrier constructed across a watercourse for the purpose of (1) creating a reservoir, or (2) diverting water into a conduit or channel.

Design storm. A rainfall event of specific frequency and duration (e.g., a storm with a 2-year frequency and 24-hour duration) that is used to calculate the runoff volume and peak discharge rate for designing a BMWP.

Dike. A temporary berm or ridge of compacted soil that channels water to a desired location.

Drainage. A general term applied to the removal of surface or subsurface water from a given area either by gravity or by pumping.

Drainage Area. The contributing area to a single drainage basin, expressed in acres, square miles, or other unit of area.

Drain. Usually a pipe, ditch, or channel for collecting and conveying water.

Emergency or Earth Spillway. A depression in the embankment of a pond or basin that is used to pass peak discharges greater than the maximum design storm controlled by the pipe spillway of the pond.

Erosion. Wearing away of land by running water, waves, wind, ice, abrasion, and transportation.

Filter Fabric. Textile of relatively small mesh or pore size that is used to (1) allow water to pass through while keeping sediment out (permeable), or (2) prevent both runoff and sediment from passing through (impermeable).

Flood. Other water from a river, stream, watercourse, ocean, lake, or body of standing water that temporarily overflows or inundates adjacent lands and which may affect other lands and activities through stage elevation, backwater and/or increased ground water level.

Flood Control. The elimination or reduction of flood losses by the construction of flood storage reservoirs, channel improvements, dikes and levees, by-pass channels, or other engineering works.

Flood Plain. For a given flood event, that area of land adjoining a continuous watercourse which has been covered temporarily by flood water.

Flood storage. Storage of water during floods to reduce downstream peak flows.

Freeboard. The vertical distance from the top of an embankment to the highest water elevation expected for the largest design storm stored. The space is required as a safety margin in a pond or basin.

Grade. The inclination or slope of a channel, natural ground surface, usually expressed percentage of number of units of vertical rise of horizontal distance conduit, etc., or in terms of the (or fall) per unit.

Groundwater. Water filling all the unblocked pores of underlying material below the water table.

Headwater. (1) The upper reaches of a stream near its source; (2) the region where ground waters emerge to form a surface stream; or (3) the water upstream from a structure.

Hydraulics. A branch of science that deals with practical applications of the mechanics of water movement.

Hydrology. The science that deals with the processes governing the depletion and replenishment of the water resources of the land areas of the earth.

Hydric Soil. A soil that is saturated or flooded during a sufficient portion of the growing season to develop anaerobic conditions in the upper soil layers.

Impervious. A term applied to a material through which water cannot pass, or through which water passes with great difficulty.

Impervious Area. Impermeable surfaces, such as pavement or rooftops, which prevent the infiltration of water into the soil.

Infiltration. The downward movement of water from the surface to the subsoil is expressed in terms of inches/hour.

Invert. The floor, bottom, or lowest portion of the internal cross section of a conduit.

Land Grading and Slope Stabilization. The reshaping of existing topography in accordance with a plan which has been developed by engineering survey and layout.

Level Spreader. An outlet constructed at zero percent grade across the slope that allows concentrated runoff to be discharged as sheet flow at a non-erosive velocity onto natural or man-made areas that have existing vegetation capable of preventing erosion.

Outlet Protection. A rock lined apron or other acceptable energy dissipating material placed at the outlet of a pipe or paved channel and a stable downstream receiving channel.

Palustrine Emergent Wetland. Non-tidal vegetated wetlands dominated by herbaceous plants which include wet meadows, marshes, and fens.

Peak Discharge. The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

Peak Rate of Runoff. The maximum rate of runoff during a given runoff event.

Percolation. The downward movement of water through soil layers.

Permanent storage. The portion of a pond or infiltration BMWP which is below the elevation of the lowest outlet of the structure.

Permeability. The property of a material which permits movement of water through it when saturated and actuated by hydrostatic pressure.

Pervious. A term applied to a material through which water passes relatively freely.

Poorly drained soil. A hydric soil having the soil characteristics as defined in Env-Ws 1014.02 (18).

Precipitation. Any moisture that falls from the atmosphere, including snow, sleet, rain, and hail.

Principal or Pipe Spillway. A pipe structure normally consisting of a vertical conduit (riser) and a horizontal outlet conduit (barrel). It is used to control the water level and the discharge from a pond or basin.

Rainfall Data. The average depth, in inches, of rainfall occurring over a watershed or subwatershed for a given frequency and duration storm event.

Reach. Any length of river or channel. Usually used to refer to sections which are uniform with respect to discharge, depth, area or slope, o sections between gaging stations.

Recharge. The process by which water is added to the zone of saturation in an aquifer.

Recurrence Interval. The average interval of time within which a given event will be equaled or exceeded once. For an annual series the probability in any one year is the inverse of the recurrence interval. This a flood having a recurrence interval of 100 years (100-year frequency storm) has a 1 percent probability of being equaled or exceeded in any one year.

Release Rate. The rate of discharge in volume per unit time from a detention facility.

Retention. The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass.

Riprap. A combination of graded stone, cobbles, and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.

Riser. A vertical pipe connected to a barrel, extending from "the bottom of a pond that is used to control the discharge rate for a specific design storm.

Runoff. That part of the precipitation which reaches a stream, drain, sewer, etc., directly or indirectly for the duration of a particular storm.

Sediment. Particles of soil and rock origin transported, carried, or deposited by water.

Sediment Basin. A basin constructed to collect and store sediment or other waterborne debris.

Sheet Flow. Runoff which flows over the ground surface as a thin, even layer, not concentrated in a channel.

Silt Fence. A temporary barrier of geotextile fabric attached to supporting post and entrenched into the soil that is used · to intercept sediment laden runoff from small areas of disturbed soil.

Storm Runoff. The water from precipitation running off from the surface of a drainage area during and immediately following a period of rain.

Straw or Hay Bale Barrier. A temporary obstruction of straw or hay installed across or at the toe of a slope. It intercepts and detains small amounts of sediment from unprotected areas of limited extent and reduces runoff velocity down the slope.

Swale. A natural depression or wide shallow ditch used to temporarily store, route, or filter runoff.

Subsurface Drain. A conduit such as tile, pipe, or plastic tubing, installed beneath the ground surface that collects and /or conveys excess water in the soil.

Surface Detention. The storm runoff detained on the surface of the ground at or near where the rainfall occurred, and which will either run off slowly or infiltrate into the soil.

Surface Infiltration. That rainfall which percolates into the ground surface and which therefore does not contribute directly to the storm runoff flow.

Universal Soil Loss Equation (USLE). An empirical equation used for estimating soil loss and evaluating alternative land treatment measures.

Vegetated Swale. A natural or constructed broad channel with dense vegetation designed to treat runoff and 'dispose of it safely into the natural drainage system. Swales are designed to remove pollutants from stormwater runoff, increase infiltration, and reduce the erosion potential at the discharge point.

Velocity. A time rate of change of position. In hydraulics it is usually measured in feet or centimeters per second.

Very poorly drained soil. A hydric soil having the soil characteristics as defined in Env-Ws 1014.02 (17).

Wet Meadow. Herb-dominated areas typically with non-woody vegetation less than 3 feet in height, saturated for long periods of time during the growing season, but seldom flooded. Wet meadows develop on dominantly poorly drained or poorly drained soil conditions. Poorly drained conditions are defined by Env-Ws 1014.02.