NATURE AREA REVEGETATION MANUAL

For

Salt Lake County, Utah

Prepared For

Salt Lake County Division of Parks and Recreation
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INTRODUCTION

SECTION 1: INTRODUCTION

1.0 GOAL STATEMENT

The high rate of population growth within Salt Lake County (the County) has placed an increased level of pressure on the County to provide passive recreational activities in "natural" settings. The County is currently in the planning stage for developing several nature area parks that will emphasize passive non-consumptive outdoor recreation activities such as walking, hiking, jogging, biking, bird watching, and nature appreciation.

Because the existing condition of many of the sites being developed by the County has been previously disturbed or are in various states of disturbance, there is a need to return these areas to a more "natural" condition. Therefore, the goal of this manual is to provide the County with guidance on the specific application of effective methods of revegetating natural areas.

The primary objectives of revegetation efforts are visual aesthetics and stabilization of the soil. Wildlife habitat is a secondary goal. An emphasis on the use of native plants has been provided wherever possible. However, numerous introduced plant species and cultivars (plant varieties specifically developed for a certain application) have been developed that meet particular objectives of revegetation more effectively than many native species. The introduced species and cultivars are generally less expensive, have greater availability, and provide more effective function in revegetation than many of the native species.

1.1 SCOPE OF DOCUMENT

This manual 1) defines and describes the vegetation cover types in order to establish baseline conditions and therefore, general objectives for revegetation efforts; 2) presents prescriptions for implementation, planting, and maintenance of revegetated areas by various cover types, including information on site and seedbed preparation, planting, erosion control, irrigation, weed management, maintenance, and monitoring; 3) presents visual prescriptions for revegetated areas by cover type; and 4) establishes specific revegetation prescriptions for each cover type.

Information is provided on general strategies for revegetation (Section 3) as well as specific prescriptions (Section 4). These two levels of information are presented separately to accommodate those persons interested in understanding more about reclamation and revegetation in general as well as those who wish to know specifically what techniques and materials to use for reclamation of a specific cover type. The latter persons may skip over the background information and proceed directly to the cover type prescriptions.

Unless otherwise identified (e.g., herbicide application), this manual is intended for use by persons with no specialized training. However, those implementing revegetation procedures should be knowledgeable about the methods and techniques they intend to use prior to implementation.

Every effort to provide an appropriate level of accurate information has been made. However, the user must recognize that environmental variation will occur. Not all variations can be anticipated over the wide range of potential project types. Therefore, the user should obtain competent assistance under such circumstances if necessary. Assistance may be obtained from within the County administration, university extension agencies, federal government agencies, and private consulting organizations.

1.2 USER GUIDE

This revegetation manual has been organized into four sections. The user should become familiar with the manual organization and information contained in each section.

Section 1: This is the introductory section containing background information on the breadth and depth of the manual. It orients the user to the manual and indicates the short-term and long-term revegetation objectives.

Section 2: This section describes the general growth regions of concern for Salt Lake County. It also contains descriptions of the thirteen cover types that occur in the county.

Section 3: This section presents background information and general discussions that apply to all cover type revegetation efforts. Topics include site preparation, seedbed preparation, seeding, planting, erosion control and site stabilization, irrigation, weed management, maintenance and management of revegetated areas, and monitoring/remediation.

Section 4: This section comprises the focus of the document. In this section specific prescriptions are provided for each of the thirteen cover types targeted by this manual. Any reclamation and revegetation aspects that are unique to a given cover type will be addressed and discussed in this section. Where unique measures are not necessary, this section references the appropriate portion(s) of Section 3.

1.3 OBJECTIVES

1.3.1 SHORT-TERM REVEGETATION

- Immediately stabilize the disturbed areas through mulching and runoff and erosion control as well as initiating new vegetation (if required).
- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures as appropriate.

1.3.2 LONG-TERM REVEGETATION

- Immediately stabilize the disturbed areas by mulching, runoff and erosion control, as well as initiating new vegetation. Adequate surface roughness will exist to reduce runoff and to capture rainfall and snow melt.
- Control and minimize surface runoff, erosion, and sedimentation through the use of diversion and water treatment structures as appropriate.
- Restore primary productivity of the site and establish vegetation that will provide for natural plant and community succession.
- Establish a vigorous stand of desirable plant species that will limit or preclude invasion of undesirable species, including noxious weeds.
- Produce and maintain an aesthetically pleasing, colorful natural area.
- Provide valuable habitat to target wildlife species.

1.4 GENERAL DISCLAIMER

The use of trade/brand names or company names in this document does not indicate endorsement, either explicit or implied, by ECOTONE Environmental Consulting, Inc. or Salt Lake County, nor does it imply approval of products to the exclusion of others that may be suitable. Similarly, no discrimination is intended. Such names or products are mentioned only for the purpose of educational information.

This manual does not provide engineering prescriptions or recommendations on how to address unique soil engineering or hazardous waste situations, nor does it give explicit guidance on how to ensure that all revegetation activities are in compliance with federal, state, and local government regulations. The user should ensure that he/she is fully informed on the application of appropriate regulations. Similarly, the user should use their own professional discretion in applying the prescriptions contained in this manual.

SECTION 2:

VEGETATION GROWTH REGIONS
and
COVER TYPES

SECTION 2: VEGETATION GROWTH REGIONS and COVER TYPES

2.0 INTRODUCTION - GROWTH REGIONS

Development of revegetation products has been somewhat dependent on the geographic area of interest. Plant growth regions have been identified to delineate areas with similar environmental characteristics. A plant growth region designates a geographical area in which characteristic plant associations have developed due to the relative uniformity of the environmental conditions, including climate, soil, and topography.

Because the County is located in a transitional area between the Great Basin and the Rocky Mountains, two plant growth regions are relevant to this manual and include the Great Basin Intermontane, Great Salt Lake Area, and the Central Rocky Mountains, Wasatch Mountains Area (Thornburg 1982). Elevation within the County ranges from 4,200 feet to over 11,000 feet. The average annual precipitation varies from 12 inches to over 30 inches. Precipitation occurs primarily in winter in the form of snow. The least amount of precipitation occurs during summer and fall. Average annual temperature is 50°F. The frost-free period ranges from 120 to 140 days.

2.1 COVER TYPE DESCRIPTIONS

2.1.1 UPLANDS

2.1.1.1 Mixed Conifer

Areas with more than 30 percent forest cover, of which 70 percent or more is conifer, are included in the mixed conifer cover type. Conifers present within this cover type include Douglas-fir (*Pseudotsuga menziesii*), white fir (*Abies concolor*), subalpine fir (*A. lasiocarpa*), Engelmann spruce (*Picea engelmannii*), and aspen (*Populus tremuloides*). Occasional limber pine (*Pinus flexilis*) and lodgepole pine (*P. contorta*) occur within this type at low frequency. On the dry south- and west-facing slopes, the primary tree species within this cover type is Douglas-fir. Shrub species typical of the dry mountain brush and sagebrush cover types dominate the shrub understory. On northeast slopes, Douglas-fir is replaced by subalpine fir and Engelmann spruce and understory species such as bracken fern (*Pteridium aquilinum*), western coneflower

(*Rudbeckia occidentalis*), slender wheatgrass (*Agropyron trachycaulum*), sticky geranium (*Geranium viscosissimum*), common dandelion (*Taraxacum officinale*), mountain snowberry (*Symphoricarpos oreophilus*), western yarrow (*Achillea millefolium*), false-hellebore (*Veratrum californicum*), mountain ash (*Sorbus scopulina*), blue elderberry (*Sambucus cerulea*), and nettleleaf gianthyssop (*Agastache urticifolia*). Total vegetal cover is moderately dense to dense (65 to 90 percent).

2.1.1.2 Mountain Brush

Two general types of mountain brush occur within Salt Lake County: dry and wet mountain brush. Dry mountain brush occurs on west- and south-facing slopes at lower elevations and consists of areas dominated by stunted Gambel oak (*Quercus gambelii*) and occasional bigtooth maple (*Acer grandidentatum*). Mountain big sagebrush (*Artemisia tridentata vaseyana*) and mountain snowberry are also primary shrubs. Other shrubby species include curl-leaf mountain mahogany (*Cercocarpus ledifolius*), snowbrush ceanothus (*Ceanothus velutinus*), serviceberry (*Amelanchier* sp.), and Woods wildrose (*Rosa woodsii*). Understory species in the dry mountain brush are typical of the sagebrush cover type. Total vegetal cover ranges from moderate to dense (45 to 75 percent).

Wet mountain brush occurs in areas with more favorable soil moisture and deeper soils, usually on north-facing slopes at lower elevations. Bigtooth maple, Woods wildrose, chokecherry (*Prunus virginiana*), and mountain snowberry are the primary shrubby species. Mountain ash, Rocky Mountain maple (*Acer glabrum*), and Scouler's willow (*Salix scouleriana*) occur in isolated clumps in the wetter mesic sites. Typical understory species include Oregon grape (*Mahonia repens*), mountain lover (*Pachystima myrsinites*), Wheeler bluegrass (*Poa nervosa*), mountain brome (*Bromus marginatus*), slender wheatgrass, nettleleaf gianthyssop, bluebells (*Mertensia* sp.), heart-leaved arnica (*Arnica cordifolia*), geranium, and thickstemmed aster (*Aster integrifolius*). Total vegetal cover is moderately dense to dense (65 to 90 percent).

2.1.1.3 Sagebrush

The sagebrush cover type occurs at lower to mid-elevation foothills on dry, well-drained slopes. It may also occur on valley bottomland terraces where the soil is non-alkaline. Groundcover ranges from moderate to moderately dense (50 to 75 percent). Shrub species present in this cover type include Wyoming sagebrush (*Artemisia tridentata wyomingensis*), mountain big sagebrush, rubber rabbitbrush (*Chrysothamnus nauseosus*), mountain snowberry, antelope bitterbrush (*Purshia tridentata*), and broom snakeweed (*Gutierrezia sarothrae*). Gambel oak may be sparsely scattered within this type. Grass and forb species include prairie junegrass (*Koeleria pyramidata*), bluebunch wheatgrass (*Agropyron spicatum*), western wheatgrass (*A. smithii*), spike trisetum (*Trisetum spicatum*), Idaho fescue (*Festuca idahoensis*), basin wildrye (*Elymus cinereus*), Indian ricegrass (*Oryzopsis hymenoides*), elk sedge (*Carex geyeri*), Wheeler bluegrass, mountain brome, geranium, arrowleaf balsamroot (*Balsamorhiza sagittata*), nettleleaf gianthyssop, sulfur-flowered buckwheat (*Eriogonum umbellatum*), western coneflower, and Rocky Mountain penstemon (*Penstemon strictus*).

2.1.1.4 Upland Alkali Scrub

Areas of upland alkali scrub occupy internally drained areas and mudflat areas on low lake terraces that are better drained. Shrub species are similar to those found in the lowland alkali scrub areas except that rubber rabbitbrush is present, greasewood (*Sarcobatus vermiculatus*) occurs with greater dominance, and iodinebush (*Allenrolfea occidentalis*) is no longer present or is present at reduced levels. Other typical shrubs include broom snakeweed, Gardner saltbush (*Atriplex gardneri*), basin saltbush (*A. tridentata*), and shadscale (*A. confertifolia*). Understory and intershrub areas support such species as saltgrass (*Distichlis spicata*), cheatgrass (*Bromus tectorum*), pickleweed (*Salicornia* sp.), Indian ricegrass, Salina wildrye (*Elymus salina*), fleabane (*Erigeron* sp.), clasping pepperweed (*Lepidium perfoliatum*), thistles, and wheatgrass (*Agropyron* sp.). On the average for both types of alkali scrub, shrub density ranges from 20 to 80 percent cover. Intershrub groundcover ranges from 35 to 55 percent.

2.1.1.5 Upland Meadow

Areas of upland meadow occur on the rolling foothills, lake terraces, and alluvial fans, within improved and/or irrigated pasture lands, and in intershrub areas of the lower level lake terraces. The dominant grass species vary with location and condition. Typical grasses include bluebunch wheatgrass, western wheatgrass, quackgrass (*Agropyron repens*), tall wheatgrass (*A. elongatum*), foxtail barley (*Hordeum jubatum*), orchardgrass (*Dactylis glomerata*), needle-and-thread (*Stipa comata*), smooth brome (*Bromus inermis*), and Kentucky bluegrass (*Poa pratensis*). In some areas, saltgrass (*Distichlis spicata*), cheatgrass, Japanese brome (*Bromus japonicus*), and/or reed canarygrass (*Phalaris arundinacea*) approach codominance.

In disturbed areas, there is an increase of weedy forbs such as whitetop (*Cardaria draba*), Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), Scotch thistle (*Onopordum acanthium*), Canada horseweed (*Conyza canadensis*), chicory (*Cichorium intybus*), western lettuce (*Lactuca ludoviciana*), poverty weed (*Iva axillaris*), houndstongue (*Cynoglossum officinale*), and rough cocklebur (*Xanthium strummarium*). Scattered Woods wildrose, dog rose (*Rosa canina*), or Russian olive (*Elaeagnus angustifolia*) may occur. Usually these shrubs form no more than a 15 percent overstory and range from 3½ to 10 feet tall. This cover type may have been disturbed by past agricultural and earth-moving activities. Groundcover averages 80 percent. Where livestock is present, grassland areas are typically moderately to heavily grazed.

2.1.1.6 Disturbed, Fallow Agricultural

Species comprising areas of fallow agricultural land are often similar to those of the upland meadow cover type. If the fallow land had been an improved pasture, species would include tall wheatgrass, intermediate wheatgrass (*Agropyron intermedium*), Kentucky bluegrass, orchardgrass (*Dactylis glomerata*), and meadow fescue (*Festuca pratensis*). Red clover (*Trifolium pratense*) may also occur. In areas with disturbed soils, weedy species occur and include cheatgrass, curlycup gumweed (*Grindelia squarrosa*), aster (*Aster* sp.), Mexican summer cypress (*Kochia scoparia*), and goosefoot (*Chenopodium* sp.). Vegetative groundcover ranges from moderate to dense (45 to 90 percent).

2.1.2 WETLAND AND RIPARIAN

2.1.2.1 Lowland Alkali Scrub

On the old lake plains and alluvial flats, lowland alkali scrub vegetation occurs in topographically elevated positions above areas of alkali wet meadow or mudflat/playa. Shrub species include iodinebush, rubber rabbitbrush, broom snakeweed, Gardner saltbush (*Atriplex gardneri*), basin saltbush (*A. tridentata*), shadscale (*A. confertifolia*), and black greasewood. Average shrub height is 2.5 feet. Intershrub areas are typically vegetated with such species as alkali bluegrass (*Poa juncifolia*), alkaligrass (*Puccinellia* sp.), foxtail barley, squirreltail (*Sitanion hystrix*), scratchgrass (*Muhlenbergia asperifolia*), saltgrass, and alkali sacaton (*Sporobolus airoides*). In better irrigated or subirrigated areas, smooth brome, timothy (*Phleum pratense*), and other pasture grasses occur in the understory. Within this cover type, Russian olive and tamarisk (*Tamarix ramosissima*) trees are found adjacent to ditches and fencelines.

2.1.2.2 Riparian Forest

The riparian forest cover type is easily identifiable from the dominant tree overstory, typically of cottonwood species (e.g., *Populus fremontii, P. angustifolia, P. x acuminata*). Other tree species may include Siberian elm (*Ulmus pumila*) and lesser trees such as boxelder (*Acer negundo*) and Douglas hawthorne (*Cratageus douglasii*). This cover type generally has an average crown cover of 45 percent. Trees are up to 120 feet tall. An intermediate riparian shrub layer may be present.

There are two phases within this cover type. The dry riparian forest has understory species similar to those described for the dry riparian shrub cover type or upland meadow cover type. Where soil moisture is greater, the wet riparian forest has understory species similar to those identified for wet riparian shrub cover type and/or the fresh wet meadow cover type.

2.1.2.3 Riparian Shrub

Riparian shrub areas have a dominant overstory of woody mid-sized shrub species. Shrub height is typically around 7 feet. This cover type is associated with streams and rivers as well as the banks of drainage and irrigation ditches. Vegetal cover ranges from 80 to 100 percent. There are two phases based on the degree of soil moisture. The dry phase supports such shrub species as Russian olive, boxelder (*Acer negundo*), Woods wildrose, and dog rose. Understory species are typical of the upland meadow cover type. This phase occurs with greater frequency in the valley bottom.

In contrast, the wet phase may occur in the valley bottom but it also occurs along drainages in the lower foothills and mountains. Shrub species may be similar to those in the dry phase; however there is an added component of more hydrophytic species, including sandbar willow (*Salix exigua*), tamarisk, Douglas hawthorne (*Cratageus douglasii*), red-osier dogwood (*Cornus stolonifera*), mallow ninebark (*Physocarpus malvaceus*) or Rocky Mountain maple. The understory in the wet phase has species typical of the wet meadow cover type.

2.1.2.4 Wet Meadow

The wet meadow cover type occupies topographic swales and positions where the land surface is in proximity to the water table and may intersect the water table during the early portion of the growing season. Based on the degree of alkalinity/salinity, the wet meadow cover type has two phases: fresh and alkali wet meadow. Vegetal cover for each phase is typically 60 to 100 percent.

Species in the areas of fresh wet meadow may include redtop (*Agrostis stolonifera*), Baltic rush (*Juncus balticus*), annual rabbit's-foot grass (*Polypogon monspeliensis*), saltgrass, reed canarygrass, Nebraska sedge (*Carex nebrascensis*), water sedge (*C. aquatilis*), three-square bulrush (*Scirpus pungens*), showy milkweed (*Asclepias speciosa*), foxtail barley, curly dock, scratchgrass, lambsquarters (*Chenopodium album*), coast-blite goosefoot (*C. rubrum*), tall tumblemustard (*Sisymbrium altissimum*), and western lettuce.

Typical species for areas of alkali wet meadow include saltgrass, scratchgrass, alkaligrass, foxtail barley, Mediterranean barley (*Hordeum hystrix*), five-hook bassia (*Bassia hyssopifolia*), saltmarsh dodder (*Cuscuta salina*), seaside arrowgrass (*Triglochin maritimum*), Pursh seepweed (*Suaeda calceoliformis*), lambsquarters, coast-blite goosefoot, tall tumblemustard, and western lettuce.

2.1.2.5 Marsh

In marsh areas, water covers the ground surface for a longer portion of the growing season than in the wet meadow cover type. Surface water depth ranges from 1 to over 6 inches deep but is not deep enough to check growth and survival of emergent plants. The increase in the amount and duration of saturation produces a decrease in salinity through dilution. Dominant species vary depending on the degree of salinity. Species include cattails (*Typha latifolia* and *T. angustifolia*), common threesquare (*Scirpus pungens*), hardstem bulrush (*Scirpus acutus*), alkali bulrush (*S. maritimus*), common reed (*Phragmites australis*), spikerush (*Eleocharis* sp.), and annual rabbit's-foot grass as well as species common to the fresh wet meadow cover type. Vegetal cover is typically over 70 percent.

2.1.2.6 Mudflat/Playa

The playa/mudflat cover type occurs in the topographically lowest positions which typically have internal drainage. Water typically will pond following precipitation events or runoff; due to the high clay content of the soil, the surface ponds water readily. The water depth is generally less than 4 inches deep. As such, this cover type may be an open water site during portions of the year. Most of the ponded water is removed through evaporation. Because of this, mudflat/playa areas tend to be highly saline/alkaline. This cover type supports limited vegetation (5 to 35 percent cover). When present, vegetation typically occurs around the outside margins of the mudflat area and consists of saltgrass, alkaligrass, seepweed, and pickleweed. Scattered (generally <20 percent) iodinebush shrubs may also occur within this cover type.

2.1.2.7 Aquatic Bed

Aquatic bed includes areas of ponded water less than 6.5 feet deep that support underwater or floating-leaved plants due to the non-moving environment. Areas of aquatic bed occur within the existing canals and ditches as well as slack-water areas of the Jordan River. Species include watercress (*Nasturtium officinale*), arrowhead (*Sagittaria* sp.), duckweed (*Lemna* sp.), and pondweed (*Potamogeton* sp.). Due to seasonal water fluctuations, areas that support aquatic bed vegetation may have marsh vegetation later in the growing season.

2.1.2.8 Open Water/Riverine

The open water/riverine cover type is characterized by unvegetated water and includes areas of flowing water as well as ponded water. Typically, open water areas have water over 6.5 feet deep. Ponded water may be less than 2 feet deep, but does not support (unlike areas of aquatic bed, wet meadow, or marsh) underwater, floating-leaved, or emergent plants. Examples of this cover type include the Jordan River, shallow ponds, streams, and water in ditches, canals, and streams.

2.2 WETLANDS AND SPECIAL AQUATIC SITES

2.2.1 DEFINITION AND CHARACTERISTICS OF WETLANDS

Wetlands are a subclass of special aquatic sites, which are a subclass of waters of the U.S. Definitions for these terms were taken from the Federal Register (1986). **Waters of the U.S.** include the territorial seas; interstate waters; navigable waterways (such as lakes, rivers, and streams), special aquatic sites, and wetlands that are, have been, or could be used for travel, commerce, or industrial purposes; tributaries; and impoundments of such waters. All channels that carry surface flows and that show signs of active water movement are waters of the U.S. Similarly, all open bodies of water (except ponds and lakes created on upland sites and used exclusively for agricultural, industrial, or aesthetic activities) are waters of the U.S. (33 CFR 328.3(a)).

Special aquatic sites are "geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values" (40 CFR Section 230.3). Special aquatic sites include sanctuaries and refuges, wetlands, mud flats, vegetated shallows, coral reefs, and pool and riffle complexes (40 CFR Part 230 Subpart E).

Wetlands are "those areas that are inundated or saturated with surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions" (33 CFR 328.3(b)).

Jurisdictional wetlands are "[t]hose wetlands which are within the extent of U.S. Army Corps of Engineers (COE) regulatory overview" (33 CFR 328.1 and 2). For an area to be identified as a jurisdictional wetland, the area must exhibit positive indicators of wetland hydrology, hydrophytic vegetation, and hydric soils. Those wetland areas that do not meet the three parameters are non-jurisdictional wetlands and are not directly subject to the federal Clean Water Act (CWA) Section 404.

The *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) describes methods and technical criteria for determining the presence or absence of hydrophytic vegetation, hydric soils, and wetland hydrology and, therefore, the occurrence of jurisdictional wetlands.

2.2.2 SCOPE OF WETLANDS REGULATIONS

Many of the wetland and riparian cover types described in Section 2.2.2 are protected under Section 404 of the federal CWA as waters of the U.S. The objective of such protection is "to restore and maintain the chemical, physical and biological integrity of our Nation's waters." Therefore, a major intent of the CWA is to minimize water quality degradation through avoiding wetland losses and by minimizing losses where avoidance is not possible. Therefore, specific activities that could degrade wetlands and water quality, including the discharge of dredge and/or fill into wetlands, are regulated by the COE. As of 17 September 1993, regulatory authority also extends to excavation and dredging of waters of the U.S. Stream channels are also protected under the State's Stream Alteration Permit program.

The COE and/or Environmental Protection Agency (EPA) can impose severe penalties for violations of the 404 permitting program. If the County intends to perform any activities that involve excavation or discharge of dredge or fill material into or near wetlands and/or special aquatic sites, the County will need to coordinate with the COE and obtain an appropriate permit prior to such impact.

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SECTION 3:

GENERAL REVEGETATION PRESCRIPTIONS

SECTION 3: GENERAL REVEGETATION PRESCRIPTIONS

3.0 INTRODUCTION

This section describes general revegetation methods and procedures common to all nature area situations and cover types. The following procedures may be implemented by the County agency or a County-authorized subcontractor. Volunteer effort may prove a cost-effective means of seed collection, site preparation, and planting. Information presented in this section has been compiled from several relevant sources. These include Vallentine (1971), Thornburg (1982), NPI Reclamation Services (1985), USDI-BLM (undated), Johnson et al. (1990 and 1993), Vogel (1987), Collins (1990), and Hansen et al. (1991).

3.1 SITE PREPARATION

Site clearing consists of removing large shrubs and trees and stockpiling available topsoil for later use. In this document, the term "topsoil" refers to any soil material suitable for plant growth, not just the "A" horizon commonly referenced in other reclamation and revegetation manuals. An adequate amount and quality of topsoil is essential for the establishment of vegetation.

The absolute minimum disturbance to "natural" or desirable vegetation should occur during site preparation. Minimizing disturbance during site clearing reduces soil loss and enables rapid recovery as native plants can reestablish from reserve seed and plant materials in the soil. Vegetative diversity can be heightened by allowing natural recovery of reclaimed areas due to the presence in the soil of seed species not commercially available or difficult to establish from seed.

3.1.1 SITE CLEARING

Removal of competing vegetation is important to seeding and planting success. For large areas, revegetation projects may require brush removal, topsoil removal and storage, and rough grading. For small areas, site clearing may consist of scalping all vegetation and organic matter down to bare mineral soil in an area 20 inches square. Individual planting sites can also be sprayed with *Roundup*™ (glyphosate) or other appropriate herbicides one or more weeks prior to planting to remove undesirable plant species.

3.1.1.1 Brush Removal

Excessive amounts of vegetation and soil must be removed within the minimum area possible to allow for revegetation activities. Disturbances sometimes can be limited to the removal of stems of weedy plants without requiring soil removal. Minimizing topsoil loss during vegetation removal is more critical in areas where topsoil is limited, typical throughout most of the arid West. The value of incorporating live vegetation into the soil as mulch is also more important in more arid regions.

3.1.1.1.1 ***Large Brush***. Woody vegetation greater than 2 inches in diameter, such as small trees and large shrubs, can be removed with a tree spade for subsequent reuse if the species are desirable. However, some species have extensive root systems. Successful salvaging of deep-rooted shrubs and trees may be limited if much of the root system is left behind. Alternately, removal may be accomplished with a Hula dozer, which is typically equipped with four removable digging teeth. The Hula dozer is a multi-purpose piece of equipment for use in large areas. It can remove brush and small trees, clear rocks, dig contour trenches, and be used for road or trail construction. Angling the blade can result in less soil contact and ground disturbance than using the cutting edge for raking brush.

A brush rake should be used when practical for uprooting and piling large quantities of brush and slash. Brush rakes consist of several curved teeth attached vertically to a heavy-duty frame and they often have replaceable tops to protect the rake teeth. This machine works best in dry or sandy soil (Vallentine 1971) and is superior to a standard dozer blade because it minimizes soil disturbance and loss. During vegetation removal the soil filters through the rake and is not scraped into the brush piles. The brush rake may be attached to a standard dozer blade; more typically, however, they replace the blade.

3.1.1.1.2 ***Small Brush***. Grasses, forbs, and all woody vegetation less than 2 inches in diameter should be incorporated or mulched into the soil during topsoil removal. This will increase the seed source of native species, provide a natural mulch into the soil, and reduce topsoil loss which often results following brush removal. However, noxious weeds should not be incorporated into the soil. Mulching can be accomplished by chopping with a brush chopper or shredding with a rotary mower. A rolling chopper ('Rotoclear') has been successfully used to grind up large shrubs and aspen trees into the soil. This machine shows particular promise for use along linear features such as roads and pipeline corridors.

3.1.1.2 Topsoil Removal, Handling, Hauling, and Storage

Topsoil benefits vegetation establishment by providing increased water and air infiltration, improved nutrient status, higher quantity of essential soil microorganisms, and a supply of native seed. In general, areas with topsoil produce better vegetation diversity, productivity, and cover; therefore, they provide better erosion control and lower sediment yields than areas without topsoil.

Because of its potentially large impact on the success of revegetation efforts at a site, each reclamation site should be evaluated to determine the availability and volume of topsoil salvage required. This evaluation should be conducted by a person with training and/or experience with topsoil management and revegetation. Collected soil samples should be submitted to a reliable soils lab for analysis. Such analysis will detect whether or not the soil contains factors that would negatively influence revegetation success.

3.1.1.2.1 *Topsoil Removal.* Topsoil salvage is critical in areas of limited topsoil, particularly in arid and semi-arid areas. Topsoil should be removed and handled separately from subsoil materials (materials not suitable for revegetation). Soil stripping depth and locations should be staked. Topsoil should be stripped to provide for sufficient quantities to be respread to a depth of at least 6 to 12 inches over the disturbed areas to be revegetated.

In areas where deep soils exist, at least 12 inches of topsoil should be salvaged. Where soils are shallow to bedrock or have a stony subsoil, topsoil should be salvaged to the extent practicable.

3.1.1.2.2 ***Topsoil Handling.*** Do not handle topsoil when it is wet or such handling will produce excessive soil compaction. Handling the soil when it is relatively dry will avoid this problem. Topsoil should not be replaced when the soil is frozen or under conditions of high wind. If topsoil must be handled under windy conditions, procedures to minimize dust emissions (see Section 3.5) may be necessary. Topsoil can be windrowed, stockpiled or directly hauled from borrow or salvage areas.

3.1.1.2.3 ***Topsoil Hauling.*** Topsoil hauling can be cost prohibitive, particularly over distances greater than 500 feet. Scrapers move soil less expensively than dozers; however, they require higher mobilization costs. As indicated in Hansen et al. (1991), dozers and loaders are economical only for large volumes of soil and only when haulage distances range from 100 to 200 feet and 200 to 500 feet, respectively. Trucks or scrapers are more economical means of transport for distances of 700 feet or more. Scrapers cost less than trucks for distances between 700 feet and 1,300 feet. The cost is similar for these two methods when distances are more than 1,300 feet. In general, topsoil hauling should only be used on larger scale revegetation projects where heavy grading is involved.

3.1.1.2.4 ***Topsoil Storage.*** Topsoil should be stored separately from subsoil materials and protected against erosional loss through mulching if left for longer than 1 month. The soil material should be relatively free of debris that might limit vegetation establishment (e.g., rocks greater than 4 inches in diameter, weeds, etc.). If necessary, stones should be removed from the salvaged topsoil with a tractor-mounted stonepicker. Rapid redistribution of topsoil should enable better use of the seed and plant propagules in the topsoil, thus encouraging rapid recolonization by native species. If left for more than one growing season, the topsoil stockpiles should be revegetated. Such revegetation should help maintain soil microflora and microfauna. Stockpiles should be marked and vehicular traffic should be excluded from them.

3.1.2 ROUGH GRADING

In areas requiring grading, the ground surface should be contoured to approximate the existing topography or the desired topography depending on specific project objectives. Dozers and scrapers would be appropriate for larger projects involving extensive grading. Otherwise, most rough grading can be accomplished with smaller equipment including front end loaders, backhoes, trackhoes, etc.

3.2 SEEDBED PREPARATION

During seedbed preparation, one works the residual topsoil, salvaged topsoil, or respread topsoil on the soil surface to provide an effective seedbed and optimize germination, growth, and seedling establishment. The ideal seedbed for direct seeding is very firm, but not compacted below the seeding depth; is well pulverized and has friable soil on top; does not have a cloddy or puddled surface; is free from live resident plant and weed competition; and contains moderate amounts of mulch or dead plant material within the soil surface. Soils that lack one or more of these characteristics should be modified prior to planting (Vallentine 1971, Hansen et al. 1991). Seedbed preparation improves soil aeration, erosion control, and potential for adequate contact between the seed and soil; increases water infiltration; reduces excessive soil compaction; and provides a looser, cooler, more moist soil for seed germination. An effective seed bed consists of topsoil, applied and cultivated, on top of a subsoil having minimal subsurface compaction.

3.2.1 SUBSURFACE SCARIFICATION

Subsurface scarification should only be implemented on larger projects involving major earth grading activities. Prior to topsoil respreading, soil compaction should be tested across the disturbance areas to be reclaimed. On slopes less than or equal to 3:1, some form of surface scarification such as chiseling or cross-ripping is often necessary to reduce compaction. If not eliminated, compaction will hamper the interface between topsoil and subsoil, which will hamper infiltration, impede root penetration, and decrease the adhesion of topsoil to the subsoil on a slope.

Ripping the subsoil should occur to a minimum depth of 18 inches. A scarification depth between 2 to 3 feet is preferable. Ripping is ineffective in shallow soils over bedrock. Ripping can be accomplished by a drawbar-mounted single or double toothed ripper attached to a bulldozer. Adjacent ripped furrows should be spaced at distances no greater than the tooth penetration depth. As an alternative, a chisel plow can be used to scarify to a depth of 12 inches. Chisel plows have curved shanks mounted along toolbars with spring loaded clamps. The spring clamps enable each shank to clear obstacles independently.

Less compaction usually occurs from equipment on steeper slopes, and effective ripping is not feasible. Subsoil surfaces on these slopes should be left as rough as possible to improve the retention of topsoil. Do not rip or chisel excessively wet areas; this would further compact the soil.

3.2.2 TOPSOIL REPLACEMENT AND FINAL GRADING

Topsoil replacement and final grading are required for revegetation of both large and small areas where grading has taken place. Depth of topsoil necessary for vegetation establishment is likely to vary with soil types. If suitable topsoil is deficient in areas being disturbed, material should be borrowed from other areas--preferably areas already disturbed. High haulage costs usually restrict sources of suitable soil to nearby locations.

3.2.2.1 Topsoil Respreading and Firming

In preparation for seeding, at least 6 to 12 inches of topsoil should be evenly respread. The depth of topsoil or suitable soil necessary for vegetation establishment depends on the quality of subsoil and environmental conditions and should be based on a site- specific determination. Areas of highly saline or toxic subsoils may require deeper topsoil dressing. Drier sites also benefit from deeper topsoils.

The seedbed should be prepared to a depth of 3 to 4 inches. If the topsoil is loose, it should be compacted to reduce the erosion potential and provide a firm and friable seedbed. If tracked vehicles cause ridging, this indicates that the soil needs to be firmed. Firming should occur using a cultipacker, roller, or similar implement. These machines also roughen the soil surface. Preparing steep slopes can be effectively accomplished by walking a tracked vehicle up and down the slope. This is known as cat-tracking.

Cultivation and land preparation activities on steeply sloping areas should be accomplished along the contour. This should minimize the potential for erosion. On steep slopes (greater than 40 percent), topsoil replacement and seedbed preparation may be difficult or impossible. In such areas, hydroseeding and hydromulching should occur until satisfactorily revegetated. If the steeper slopes cannot be reached by a hydroseeder, then the seed should be hand-broadcast and mulched by hand.

3.2.2.2 Topsoil Scarification

If necessary, bare soils should be scarified to loosen soil and eliminate compaction that may result during topsoil replacement. The rough surface created by scarification helps hold seeds, mulch, and moisture. Scarification of dry soils is most effective because it shatters the compacted surface layer. As with subsurface scarification, topsoil scarification should be done along the contour (i.e., parallel to the slope or topographic contour lines).

3.2.2.2.1 ***Primary Tillage.*** Heavily compacted topsoils at accessible sites should be ripped (chiseled). The section on Subsurface Scarification (3.2.1) describes the equipment used for this procedure. Topsoil scarification, however, should be limited to the depth of the topsoil--typically no more than 12 inches. When scarifying the topsoil, care should be taken not to bring undesired subsurface material to the surface. The chisel plow is effective in preparing seedbeds for broadcast seeding.

3.2.2.2.2 ***Secondary Tillage.*** If primary tillage (ripping or chiseling) results in a cloddy surface[1], then secondary tillage will be necessary. Secondary tillage consists of disking or harrowing using a rubber-tired tractor. Disking is accomplished by pulling gangs of disks adjusted to the required penetration depth of the topsoil. Disking should be used as secondary tillage if ripping has left large clods. This method should be implemented on relatively dry soils; however, discs are prone to breaking when preparing rocky soils. Sites should be disked on the contour (i.e., parallel to the slope or topographic contour lines).

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[1] Do not confuse the presence of clods with a "roughened" seedbed. The former hinders vegetation establishment; the latter creates microhabitats (due to small changes in elevation) that encourage establishment of a diverse array of native vegetation.

Harrowing is another means of removing clods formed by primary tillage. Harrows consist of spikes, tines, or various scarifying tips attached to gangs. Again, harrowing is ineffective for preparing rocky sites. Spring harrows or field cultivars resemble light-duty chisel plows as described previously and are more durable than spike tooth harrows. For rougher sites, blanket or English meadow harrows are more effective (Hansen et al. 1991). These machines resemble a section of chain-link fence in which the ends of the links protrude into the soil at different depths. As with scarification and tillage methods, harrowing should be done along the contour.

Chaining is the only viable means of topsoil scarification in areas where slopes are steeper than 3:1. For this method, a slope chain (a length of lead chain with a weighted slope wheel and scarifying chains connected by swivels) is dragged across a slope by a truck or tractor, which operates on a road or bench above the slope. Several passes across the slope are usually necessary. The length and number of attached scarifying chains along the lead chain is determined by the slope length. Each scarifying chain has pairs of spikes (6-inch steel) or other devices welded to it at right angles. As with other methods, slope chaining is relatively ineffective on rocky or compact soils. In addition, this method is limited to areas where access above the slope to be chained is available or possible.

On small areas where grading does not take place, rototilling must be used to provide at least secondary tillage. The smallest jobs can be accomplished using a hand-operated power rototiller. On slightly larger areas, a tractor mounted rototiller is appropriate. The same concepts described above also apply to these smaller areas.

3.2.2.2.3 ***Timing of Topsoil Scarification.*** Because seeding is most effective in the fall, site preparation should occur just before seeding. Lighter scarification of topsoil should occur no more than 1 week before seeding. If delays due to heavy rain or early snow halt seeding operations until spring, then scarification of the topsoil and seeding may still occur without losing the effectiveness of deeper ripping of the subsoil.

3.2.3 SOIL AMENDMENTS

3.2.3.1 Purpose of Soil Amendments

Soil amendments are chemical treatments that promote plant growth. Treatments may be applied to relieve unfavorable conditions such as salinity, acidity, or alkalinity or to ensure an adequate nutrient supply. The use of soil amendments depends on the plant species and site conditions as well as the desired productivity and cover. Soil tests will identify the need for amendments and the nutrients that are deficient. If applied injudiciously, however, undesired side-effects may occur. For example, nitrogen may improve the growth of a desired species but it can also promote weed growth and competition for light, nutrients, and moisture.

Fertilizer is a common amendment. Its application ensures an adequate supply of nutrients to meet the needs of numerous plants that are rapidly and concurrently trying to become established and as well as the needs of soil microflora that are decomposing mulch. Nutrient deficiencies are most serious in areas that have no topsoil. Nitrogen and phosphorous are the most commonly deficient nutrients. These are followed by potassium and sulfur and occasionally certain micronutrients. Potassium and sulfur deficiencies typically occur in coarse to moderately coarse, well-drained soils that have little organic matter and low cation exchange capacity. Because the nutritional needs differ between establishing and existing stands of vegetation, one must adjust the amount and type of soil amendments based on the vegetative growth stage.

Soil pH can limit plant growth due to its influence on the solubility of essential plant nutrients. As a rule of thumb, humid sites in montane areas are susceptible to acidic conditions (i.e., a low soil pH) while sites in many lowland areas with poor infiltration and drainage are often liable to exhibit alkaline conditions (high pH).

3.2.3.2 Effectiveness of Soil Amendments

According to Hansen et al. (1991), the effectiveness of soil amendments depends on several factors. These include precipitation, soil texture, soil pH, season of application, incorporation into the soil, and composition of the fertilizer. Most fertilizer recommendations are based upon research on the nutritional needs of crops grown under sustained, high-yield management systems. There is a small but growing body of knowledge on the nutritional requirements of native species under reclamation conditions. As a general rule, grasses have the highest nitrogen requirements. Further, nitrogen application can favor cool-season grasses, which are a major component of seed mixes in northern areas of Utah. Phosphorus additions benefit many forbs and woody plants. Because woody species often have lower nutritional requirements than herbaceous species, the ratio of nutrient elements in fertilizers can be adjusted depending upon the relative proportions of life forms in the area being fertilized.

3.2.3.3 Application Rates

As previously indicated, soil amendment rates, including fertilizers, should be site-specific and based on an analysis of the soil. A competent soils lab, one experienced with Utah soils and familiar with the best analytical procedures for this state, should perform the analyses. Based on the results, an initial fertilizer rate should be specified for native species. This rate should be continually adjusted based on observations of native plant establishment under different soil fertility and site conditions.

3.2.3.4 Fertilizer

Hansen et al. (1991) indicate that in the absence of site-specific data for the initial fertilization needs of native species, one should apply a fertilizer ratio of 3:4:0.8 of nitrogen:phosphorous:potassium (N/P/K) at a rate of approximately 60 lbs of elemental nitrogen, 80 lbs of elemental phosphorus and 16 lbs of actual potassium per acre. Alternately, one may apply a ratio of 3:9:1 of $N/P_2O_2/K_2O$. These recommendations have a higher ratio of phosphorus than is often used.

Nitrogen is a mobile nutrient and can be leached from the soil. Because of this, a slow-release form such as sulfur-coated urea or urea formaldehyde should be used. From 50 to 75 percent of the nitrogen added to the soil should be in the slow-release form. Nitrogen is also readily used by both weeds and desirable plants. Where weeds are a potential problem, only apply limited nitrogen rates or apply nitrogen only when the seeded species are growing most rapidly and nitrogen utilization by weeds is least likely. Sulfur and micronutrients can also be added if local conditions warrant. As always, fertilizer rate should be adjusted as needed for each site, based on the performance of the native vegetation.

3.2.3.5 pH Neutralizers

Rather than using a soil amendment, areas with alkaline or acidic soils should have vegetation seeded or planted that is adapted to those site-specific conditions when this is practical. Doing so will save the expense of using soil additives to neutralize or change the pH. If use of such plants is not practicable, pH neutralizers should be used.

3.2.3.5.1 ***Low pH Soil.*** For soils with low pH (less than 5.5), amendments of limestone (i.e., calcium and magnesium carbonates) will improve the soil and correct the pH problem. Unfortunately, however, the effect is only temporary. The amount of limestone additive, and its effectiveness, depends on soil chemical and physical factors. Limestone additives should generally have a neutralizing efficiency of greater than or equal to 65 percent. A smaller particle size will also increase limestone's effectiveness. Limestone is most effective when 90 percent of the material passes through a #8 soil sieve.

3.2.3.5.2 ***High pH Soil.*** Alkaline conditions (a pH above 7.5) generally occur in arid regions, particularly where soils are saline. Treatment is expensive and involves a combination of applying gypsum (calcium sulfate) and leaching with water. More preferable is the use of seed from native species adapted to these sites. Proper soil drainage should encourage long-term reductions in soil pH and should always be considered if gypsum is used.

3.2.3.6 Mulch

See Section 3.5 for a thorough discussion on mulching practices. When straw mulch is used, additional nitrogen fertilization should occur to encourage rapid decomposition and minimize the potential tie-up of nitrogen by microorganisms decomposing the mulch. Mulches with a high cellulose content such as wood chips, sawdust, and straw generally require more follow-up nitrogen for microbial decomposition than mulches with leaves, roots, and partially decomposed organic matter.

3.2.3.7 Incorporation of Soil Amendments

Soil amendments may have low solubility or high solubility. Additionally, they may be incorporated deep into the soil or applied at the soil surface.

3.2.3.7.1 ***Low Solubility Amendments.*** The nutrient phosphorus is more available to plant roots if phosphorous-containing compounds are incorporated into the soil. This is best accomplished by applying fertilizer prior to ripping or disking. Soil preparation activities then mix the fertilizer into the soil. Likewise, limestone should also be incorporated into the soil. For steep slopes that are not accessible to equipment, fertilizer should be applied to the topsoil before it is respread. Take care to ensure that the fertilizer is well-mixed into the soil; otherwise, extreme conditions or localized nutrient deficiencies may adversely affect young seedlings.

3.2.3.7.2 ***Water Soluble Fertilizers.*** Water soluble, granular fertilizer is most commonly applied by mechanically broadcasting it on the soil surface. Alternately, it can be applied by banding with seed drills if a separate hopper and dispenser are used. Do not apply fertilizer in the same row as the seed because the fertilizer may "burn" the seeds. Also, avoid mixing fertilizer and seed for application with a hydroseeder. Use this method only after careful consideration because fertilizer may fasten to the coat of fluffy seeds. This can cause osmotic stress during germination as the seed dries or it may hasten fungal growth. Therefore, the practice of mixing seed and fertilizer is not recommended. On very wet, montane sites, the order of mixing should be as follows: water, fertilizer, and then seed. Apply this mixture within 30 minutes to avoid damage to the seed.

3.3 SEEDING

In smaller disturbed areas, seed dispersal from adjacent undisturbed vegetation can be an effective mechanism in revegetation. With short-term storage and rapid replacement, topsoil can provide an additional source of seeds and propagules. However, these mechanisms are not usually sufficient for controlling erosion and providing rapid soil stabilization with vegetation. In addition, the residual plant species may not be desirable and/or the residual species may not conform to project objectives. Therefore, direct seeding is usually required to hasten the reestablishment of native vegetation that will meet specific project objectives.

Except for the fallow agricultural land seed mix, the tables presented in Section 4 have been designed for seeding relatively small areas (< 1.0 acre). If seeding occurs in areas larger than 1.0 acre, the seed mix(es) used should have fewer wildflower species and have a reduced wildflower seeding rate. The seeding rate for grass species should be increased proportionally for large areas.

Much progress in direct seeding technology for the arid and semiarid West has been made in the past 10 to 15 years. However, most research has been directed at seeding introduced species rather than native species. This is because native species vary considerably in size and shape. In addition, they are often difficult to use with the equipment standardly used for seeding introduced species.

Proper seeding has several important components (i.e., species selection, seed use and storage, seeding methods, seeding rates, proper season, and other aspects to improve seed establishment). Failure to implement any one of these components properly could cause the whole revegetation process to fail. Nurse crops, or temporary crops used to reduce site erosion while the desired vegetative cover develops, are discussed in Section 3.5, Erosion Control and Site Stabilization.

3.3.1 SPECIES SELECTION

Criteria to determine appropriate seed species should include consideration of the following aspects:

- Species must be adapted to site conditions, including the seasonal and total available moisture, soil restrictions that may be present (i.e., high alkalinity/salinity) and climate.
- Planting material should be available, reasonably priced, and of good quality (or purity and viability in terms of pure live seed, PLS).
- Barring extenuating circumstances, the use of native species is preferred (Thornburg 1982).
- Mixtures of species should be used rather than single species to provide diversity and improve revegetation success. Additionally, species should not be overly aggressive, thereby reducing species diversity.
- Selected materials should readily establish from seed and have good potential for self-propagation.
- Seed should be free of noxious weeds and meet quality requirements of state laws. In addition, selected species should not pose potential weed problems to adjacent lands.
- Legume species (plants in the pea family such as clover) purchased commercially must be properly inoculated with nitrogen-fixing bacteria in order to enhance the development of nitrogen-fixing root nodules.

Inadequate revegetation, to the point of revegetation failure, can occur if species are selected and used in ignorance of one or more of the above factors. The general lack of knowledge regarding adaptability and proper use has limited the use of native species in the past. However, our understanding of the basic growth requirements and adaptations of such species is rapidly increasing and will continue to improve the success of revegetation efforts.

3.3.1.1 Availability

In the past, a limitation to the use of native species has been the unavailability of rhizomes, roots, tubers, bulbs, etc. As indicated in Appendix A, there are now numerous companies that specialize in or provide seed or plant material for native species. With adequate planning, however, most species can be procured for revegetation. Up-front planning prior to revegetation activities is often necessary to ensure a sufficient quantity of quality stock. Many planners and operators are interested in using natives but have been unable to find commercially available quantities in the past. Such people should contact local seed companies, who can often supply them directly or broker them from other suppliers. The partial list of local vendors presented in Appendix A is not intended to be exhaustive or indicate any preference over companies not listed.

3.3.1.2 Seed Quality

Seed specified and used for revegetation efforts should be measured by Pure Live Seed (PLS) weight. PLS indicates the proportion of live seed of the desired kind present in a seed lot. This measure prevents the amount of trash or empty seeds from affecting seeding rate calculations. Hansen et al. (1991) recommend that all seed be tested by a certified seed analyst in an accredited seed testing laboratory. Testing should occur within 18 months for grass seed; 9 months for forbs and shrubs, and 6 months for all seed crossing state lines. Each species should be furnished with a tag which clearly lists the following information:

- Botanical name
- Common name
- Collection location and elevation
- Pure seed (percent)
- Inert matter (percent)
- Other crop seed (percent)
- Weed seed (percent)
- Noxious weed seed (percent)
- Germination (percent)
- Hard seed (percent)
- Date tested
- Lot number
- Net weight
- Name of seed testing laboratory
- Name and address of the seed company

The seed mix must not contain noxious weed seeds nor wet, moldy, or otherwise damaged seeds.

3.3.1.3 Selection for Cover Type Seed Mixes

A series of seed mixes (in Section 4) have been developed for each cover type based on the above criteria. Most of the species in these mixes are best propagated by seeding, others by transplants. If some varieties of seed are not readily available or reasonably priced at the time of implementation, substitutions may be made. However, substitutions should be approved by a vegetation specialist familiar with native species in the project area.

3.3.2 SEED USE AND STORAGE

For best results, use seed relatively soon after purchase and do not store seed for any length of time unless proper facilities are available. Such facilities will be cool (at room temperature or below but above freezing) and dry.

3.3.3 SEEDING METHODS

There are two general methods of applying seed: broadcast application or drilling. Which method is appropriate depends on the topography, time of seeding, site accessibility, and seedbed characteristics. Equipment availability should not be a factor in selecting a seeding method other than in extreme circumstances. Seed coverage relates to the seeding method used. Recommendations for seed coverage are presented below.

3.3.3.1 Broadcast

On steep sloping sites (greater than 3:1), extremely rocky sites, remote or inaccessible sites, or areas too small to effectively drill seed, the seed mix should be broadcast applied. Because it is less efficient, higher seeding rates are necessary for broadcast application. Seed should be applied at a rate of at least twice the drilled rate. Care should be taken to ensure uniform coverage of an area, otherwise excessive seed would be wasted and spotty coverage would result in bare areas susceptible to erosion. This can be facilitated by not attempting to broadcast seed on windy days.

Following application, broadcast seeding requires raking, chaining, harrowing or cultipacking to ensure seed coverage where possible. Hand raking is generally the best method for covering seeds broadcast on steep slopes and in small areas. It may well be the only method by which to ensure adequate seed coverage. Broadcasting into a rough seedbed, followed by harrowing or cultipacking can result in a variable range of seed placement depths and allows for better establishment of small-seed species. Germination and seedling establishment are somewhat slower although diversity is higher than in drill seeded areas.

Broadcast application may be done by hand seeding or by machines such as rotary seeders, air blast seeders, or hydroseeders. Hand seeding is effective for small areas. Distribution of the seed mixture is enhanced by mixing equal volumes of seed and rice hulls. The rice hulls provide a visual aid to indicate the areas that have received seed. They also prevent small seeds from settling out.

Machine broadcast seeding is effective for larger areas. The device used for this operation is a seed container that has a spinner plate or propeller device attached to the bottom. As the device spins, it throws seeds in all directions as a vehicle passes over the area to be seeded. Precise calibration of the seeding rates for such devices is difficult. Hansen et al. (1991) indicate that calibration should be accomplished by measuring one acre and spreading the specified amount of seed. Seeders can occasionally become clogged, particularly when trashy or fluffy seeds are used. Therefore, the seeder must be continually monitored for stoppage or uneven dispersion.

Hydroseeding is a form of machine broadcast seeding. This method uses a pressurized spray of water containing seeds and other materials such as mulch and tackifier. This method is generally used on steep, inaccessible slopes (e.g., slopes with gradients of 40 to 50 percent), in areas where access is otherwise restricted, or when very small seeds are used.

There are several drawbacks to hydroseeding. First, seeds can be damaged from the mechanical action of the machine. Second, hydroseeding is fairly expensive. Third, it is dependent on local water supplies. Finally, it may produce uneven revegetation results because the seeds are not buried. As such, seeds may have poor soil contact and could dry out, which would reduce seed viability and impede germination. However, hydroseeding is suitable and appropriate for areas with adequate and dependable moisture during the germination period.

The spray should be comprised of a hydromulch/seed/tackifier mixture. As with other forms of broadcast application, hydroseeded areas should have seed applied at twice the rate of drilled seed. Adding 200 to 400 lbs/acre of fiber mulch to the slurry helps cushion and minimize damage to the seed from the rotating stirring paddles. In addition, fiber mulch typically has a green dye and therefore provides a visual guide to the operator to help ensure even coverage. Large quantities of fiber mulch should not be applied with the seed because the fibers prevent good seed-to-ground contact, and subsequent wetting and drying of the thick layer of fiber may shrink and pull the young seedlings from the ground.

Fluffy seed may require additional mixing and wetting in order to be seeded. However, the water and seed slurry should be applied within two hours after mixing, otherwise seed coats could become too soft and seed damage may occur.

If hydroseeding fails, the slopes should be covered manually with biodegradable erosion control blankets with seed incorporated into the matting. The blanket should be staked firmly to the soil surface and installed according to manufacturer's specifications.

3.3.3.2 Drilling

The preferred seeding method is drilling, but it must be accomplished along the contour of the slope. If not, water can flow down the drill rows and create erosion problems. Drilling may be used for large or small areas (>1.0 acre) depending on the type of equipment used. Drilling seed improves seed coverage, allows reduced seeding rates, provides accurate seed metering and calibration, and can be used to seed into stubble. However, drilled rows can be aesthetically unappealing and can result in increased competition from the concentration of seeds in the row. The slope of the land and soil rock content may limit the use of drill-type equipment. Drilling cannot occur on slopes steeper than 3:1.

3.3.3.2.1 ***Drilling Equipment.*** The most functional machine for drill seeding reclaimed areas is the rangeland drill, or specific modifications of that device. This is particularly true if the soil is rocky or contains other large debris as the machine is heavy duty, has high clearance and a reinforced frame. The rangeland drill has independently suspended furrow disks. The depth of the furrow can be controlled by using different sized depth bands. Multiple seed boxes can be used for metering different sized seeds and attachments can be used for applying fertilizer. Drag chains or pipes cover the furrows and drilled seed.

The drill should be capable of handling fluffy or trashy seed; this is usually accomplished by mechanical revolving teeth that clean the delivery path in the bottom of the seed box. The rangeland drill produces less satisfactory results in revegetation efforts because it plants the seeds in wider-spaced rows, which provide less effective erosion control.

There are benefits to both broadcast and drill seeding that may be realized by using a seeder/cultipacker. The Brillion seeder is a precision seeder. This machine has a seeder box mounted above and between two cultipackers. According to Vallentine (1971), each roller has metal wheels with a shallow groove around the perimeter. The first roller packs the seedbed and forms 0.5-inch deep grooves spaced 2 to 4 inches apart. The seeds are dropped into this groove. As it splits the ridges created by the front roller, the second roller covers the seed and presses soil around it. The Brillion seeder operates most effectively on relatively rock-free, well-prepared, topsoiled areas. It provides excellent control of seed depth and avoids or lessens the appearance of distinct drill rows, which is problematic with the rangeland drill. However, the brillion seeder is ineffective on excessively compacted soils as well as on uneven terrain.

3.3.3.2.2 ***Equipment Calibration.*** The proper amount of seed must be drilled per unit area. To do so, seeding equipment must be calibrated. In general, one should comply with the owner's manual, which generally indicates settings for desired rates. Field calibration should be performed to verify the setting because seed size and field conditions can affect the amount dispersed. The customary way to do this is to add only enough seed to drill a few acres and then note the amount of seed used to drill only one acre. The calibrations can then be adjusted as needed.

3.3.3.2.3 ***Planting Depth.*** The ideal seeding depth ranges considerably among plant species, and differential seed size may be a problem when drilling seed. Larger seeds often need to be planted deeper whereas very small seeds may be planted too deep to germinate. Drilling tends to plant all seeds at the same depth unless concerted efforts are made to place small seed in different boxes and alternate drill seed depths between rows. Drilling favors large seeded species such as grasses and usually produces a less diverse stand of vegetation than can be established from broadcast seeding or drilling at different depths. Drill-type equipment should be preset to plant seed at depths of ¼- and ½-inch as appropriate for the type of seed (see seed mix tables in Chapter 4). The drill machine should also have agitators to prevent seeds from becoming lodged in the seedbox (Thornburg 1982).

3.3.4 SEEDING RATES

The seeding rate is determined by seeding method, seed size, and seedling vigor and adjusted to the severity of the site (Thornburg 1982). Final application rates should be adjusted based on PLS specifications from the seed source as described under Seed Quality. In general, the seeding rate should increase for unfavorable sites. Seed mixture rates may also be varied to enhance the probability for maintaining the natural balance of species. It is important to note that watershed protection must be emphasized when reclaiming disturbed areas.

After completion of seedbed preparation, the seed mix(es) should be applied according to the appropriate rates and planting depths. Broadcast seed should be applied at twice the rate of drilled seed to ensure adequate distribution and seedling establishment. This doubled rate should also be used for seeding in harsh sites and critical areas. Doing so allows sufficient seed per unit area to overcome poor seed germination and high seedling mortality. A higher seeding rate also helps to improve the chance of success by ensuring greater likelihood of seed dispersal to microsites conducive to proper growth.

3.3.5 SEASON OF ESTABLISHMENT

Seeding should occur shortly after site preparation, and site preparation should be completed just before the seeding "window." This should allow the maximum amount of time possible for seeding. If a crust has reformed on the soil, secondary tillage may need to be repeated (see Section 3.2.2.2 on Topsoil Scarification) prior to seeding. Bare soil that is not seeded in a timely manner may develop weed problems that may be costly and or difficult to control. Therefore, seeding should be done at the earliest appropriate time. Seeding dates depend on weather conditions; however, there are general recommendations regarding optimal and alternate seasons for establishment of seed.

3.3.5.1 Optimal Season

Generally, the optimal time to establish plants from seed is before the season receiving most dependable precipitation (Thornburg 1982). In Salt Lake County, this would mean seeding in the fall. If possible, seed should be planted after mid-September but prior to snow accumulation to avoid seed germination and breaking of dormancy and to prevent seedling frost damage. Seeding during the fall (September 15 to November 15) allows the seeds to settle during the winter. It also allows stratification and germination to occur during the cooler months. Seeds should germinate in the spring while there is still sufficient moisture. Fall seeding has less associated risk than spring or summer seeding. Therefore, as much area as possible should be planned for seeding during the fall.

3.3.5.2 Alternative Seasons

Seed may be planted in early spring (prior to mid-May), provided the soil is not frozen or covered with snow. Seeding in early spring is less effective because sites may be too wet to work the soil with heavy equipment. By the time conditions are dry enough to access for spring seeding, part of the soil moisture will have been lost. Additionally, some seeds require cold stratification in order to germinate. Such seeds may be unable to germinate until the following year. If an area will be seeded during the early spring, the seedbed should be prepared during the fall, if possible. Alternately, site preparation during the spring can help dry out sites more quickly. Awarding contracts and ordering seed materials well in advance of seeding will ensure prompt start-up of the spring seeding operation.

Seeding in late spring is another alternative but is less desirable because a lack of spring moisture may result in poor germination, emergence, and survival. Irrigation provides alternate opportunities for establishment of seed in late spring or early summer. However, even with irrigation, mid- to late summer seeding is not recommended as the weather is generally too hot and too dry. This places additional stresses on young, germinating seeds. As a result, seedling establishment is reduced, even with supplemental irrigation.

3.3.5.3 Seasonal Timing and Species Composition

To some degree, the time at which seeding occurs can influence the plant composition of the area being revegetated. For example, grasses generally germinate and establish more readily than woody species. In fact, grass seedlings may limit or prohibit establishment of shrub seedlings. Since grasses can be quite aggressive, forbs or woody plants could be seeded a growing season before the grasses. However, this is only an appropriate method in areas where erosion is not a concern.

3.3.6 OTHER ASPECTS PERTINENT TO SEED ESTABLISHMENT

3.3.6.1 Seed Coverage

Proper seed coverage by soil is a key factor determining success of the seeding operation and one of the most frequently observed reasons for seeding failures. Broadcast seed that is not covered with soil is subject to high mortality due to insufficient or unreliable soil moisture. Therefore seed should be covered by hand raking or by using a spike-toothed harrow or similar equipment. Unlike broadcast seeding, drilling lightly covers the seed.

3.3.6.2 Watering

Supplemental watering to aid in seedling establishment should generally not be needed if seeding is accomplished in the fall. However, seeding done in late spring or early summer or during periods of extreme drought may require irrigation to achieve success. A portable, above-ground irrigation system may be used. More detail on supplemental irrigation is presented in Section 3.6.

3.3.6.3 Weeds

Weeds are exotic non-native species that are undesirable for one or more reasons. Generally, weeds are aggressive and out-compete native and more desirable species. Weeds generally do not look natural and often present noticeable deviations from our expectations of natural area vegetation. Weed establishment in the Salt Lake Valley is increasing at alarming rates due to termination of agricultural activities and disturbances due to commercial, industrial, and residential development. Development of nature areas and construction of park facilities could hasten the migration and establishment of these unwanted plants. Thus, the County will need to take action in regard to control of weeds. See the Weed Management (Section 3.7) for a thorough discussion on weed control.

3.4 PLANTING

The use of plants or plant parts is a viable alternative or supplement to establishing plants from seed; however, the initial cost of doing so is higher. This is due to the greater initial labor and plant material costs. For this reason, transplanting is usually limited to specific situations. Thornburg (1982) indicated that the use of containerized plants can be justified by survival rates.

Because transplanting uses plant materials that are at a more developed growth stage, it provides a more rapid and successful means of establishing vegetation than direct seeding. This can be particularly true for areas where natural precipitation is low or inconsistent. For example, areas receiving less than 9 inches of annual precipitation may be unable to ensure seed germination and establishment from direct seeding. Further, some trees and shrubs are very difficult to establish from seed. Under such circumstances, transplanting may be a necessary or desirable method of vegetation establishment--particularly for highly visible areas. Planting objectives for several cover types (see Chapter 4) include the establishment of a groundcover comprised of grasses and forbs and an overstory of shrubs and/or trees. Therefore, both seed and plantings will be required in these situations.

3.4.1 SPECIES SELECTION

Use of appropriate ecotypes and cultivars for the plant growth regions is important to revegetation success. Species selection for planting must consider many of the same criteria important for seeded species (see previous section).

3.4.2 PLANTING MATERIALS

Planting pole, sprig, bareroot, or containerized stock are standard procedures for establishing woody materials. Use of mature native transplants is an optional method for intensively landscaped areas. Planting sod or vegetation plugs is a standard method for establishing grasses and grass-like plants such as bulrushes and cattails. Exhibit 3-1 shows examples of how and how not to plant stock. Exhibits 3-2 and 3-3 show how to correctly plant small-caliper stock.

3.4.2.1 Pole

Pole plantings involve cutting one- to six-inch diameter sapling-sized cottonwood trees (preferably salvaged from areas to be disturbed) and transplanting them into excavated holes. This technique was described by Swenson (1988) and successfully used by the County at the Riverbend Golf Course and Redwood Nature Park areas. The technique involves identifying source plants in the fall, winter, or early spring (i.e., prior to mid-April). The saplings should be cut-off at the ground or at some height above the ground such that the desired diameter is obtained. All lateral branches should be pruned off the pole leaving on the terminal sprig.

The area to be planted should also be identified prior to cutting. Site conditions such as depth to the water table and soil texture should be assessed to determine the appropriateness of the site conditions. Receiving areas should have a relatively shallow water table (i.e., within four feet of

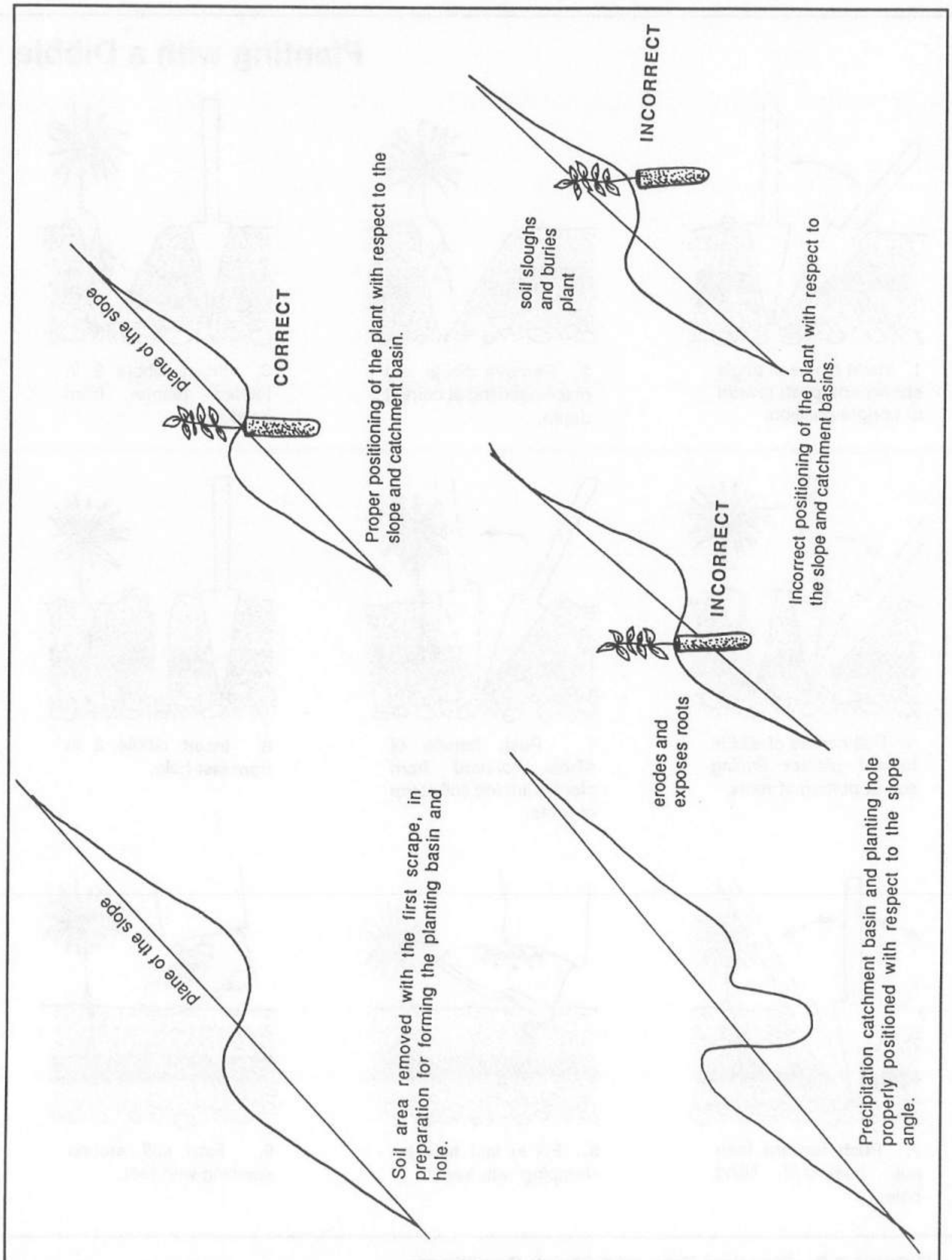
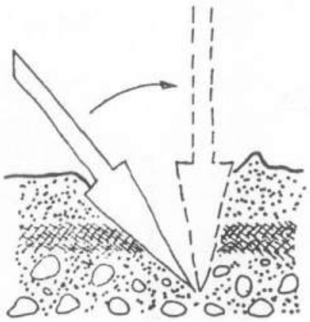
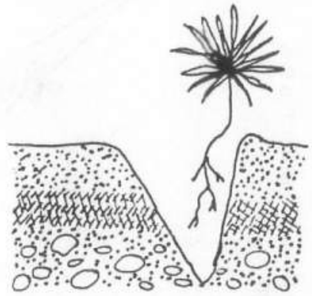


Exhibit 3-1. Correct and Incorrect Methods of Planting Stock On a Hillslope.

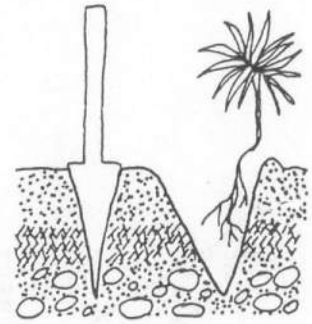
Planting with a Dibble



1. Insert dibble at angle shown and push toward to upright position.

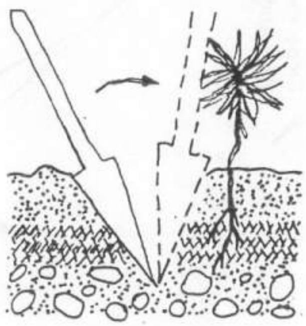


2. Remove dibble and place seedling at correct depth.

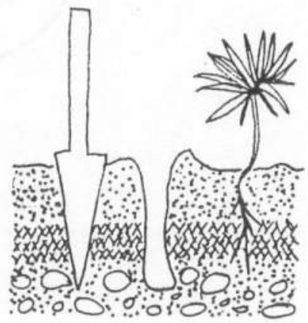


3. Insert dibble 2 in toward planter from seedling.

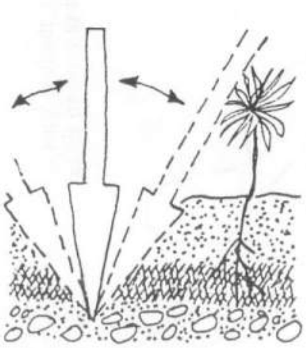
4. Pull handle of dibble toward planter firming soil at bottom of roots.



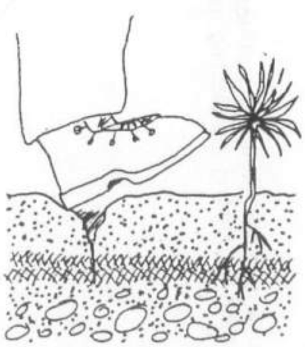
5. Push handle of dibble forward from planter firming soil at top of roots.



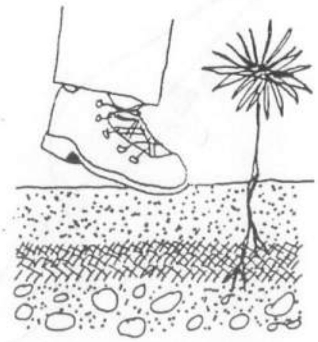
6. Insert dibble 2 in from last hole.



7. Push forward then pull backward filling hole.



8. Fill in last hole by stamping with heel.



9. Firm soil around seedling with feet.

Exhibit 3-2. Planting Tree and Shrub Seedlings.

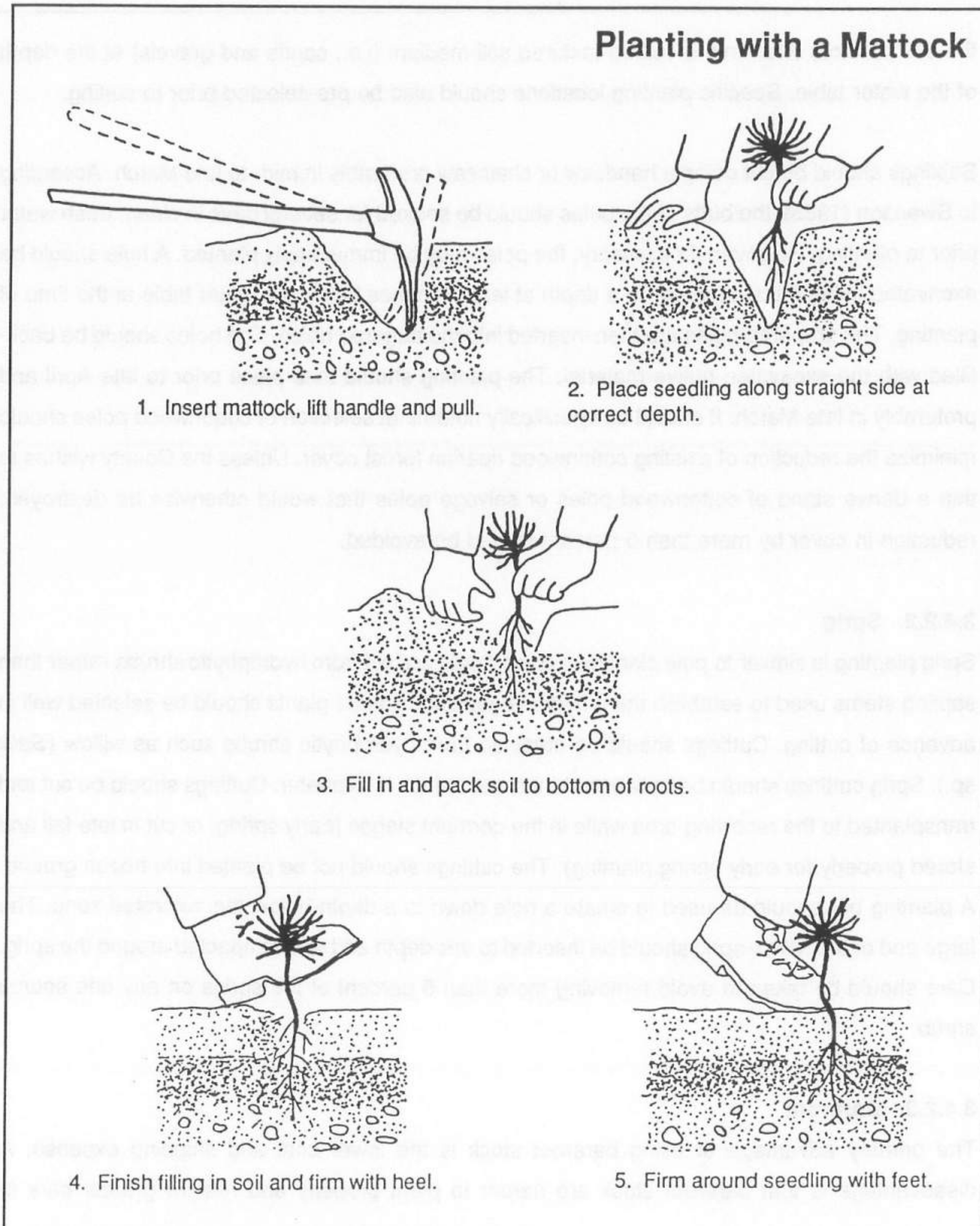


Exhibit 3-3. Planting Tree and Shrub Seedlings.

the soil surface) and have a coarse-textured soil medium (i.e., sands and gravels) at the depth of the water table. Specific planting locations should also be pre-selected prior to cutting.

Saplings should be cut using a handsaw or chainsaw preferably in mid- to late March. According to Swenson (1988), the butts of the poles should be soaked for several days in clean, fresh water prior to planting. However, if necessary, the poles may be immediately planted. A hole should be excavated using a power auger to a depth at least 6 inches below the water table at the time of planting. The prepared poles are then inserted into the augured holes. The holes should be back-filled with the excavated native material. The planting should take place prior to late April and preferably in late March. It should be specifically noted that selection of cottonwood poles should minimize the reduction of existing cottonwood riparian forest cover. Unless the County wishes to thin a dense stand of cottonwood poles or salvage poles that would otherwise be destroyed, reduction in cover by more than 5 percent should be avoided.

3.4.2.2 Sprig

Sprig planting is similar to pole planting except stems are cut from hydrophytic shrubs rather than sapling stems used to establish the desired vegetation. Source plants should be selected well in advance of cutting. Cuttings should be obtained from hydrophytic shrubs such as willow (*Salix* sp.). Sprig cuttings should be between ¼ inch and ½ inch in diameter. Cuttings should be cut and transplanted to the receiving area while in the dormant stages (early spring; or cut in late fall and stored properly for early spring planting). The cuttings should not be planted into frozen ground. A planting bar should be used to create a hole down to a depth below the saturated zone. The large end of the willow sprig should be inserted to this depth and soil compacted around the sprig. Care should be taken to avoid removing more than 5 percent of the sprigs on any one source shrub.

3.4.2.3 Bareroot

The primary advantage of using bareroot stock is the lower cost and shipping expense. A disadvantage is that bareroot stock are harder to plant properly and require greater care in shipping, storage, and planting than containerized plants. Although bareroot stock can be held in a dormant state in cold storage for short periods of time, there are limits as to when the bareroot stock can be lifted and planted. Following the instructions of a local nursery will usually provide the best planting results. Another limitation is that the use of bareroot plants often requires advanced planning to ensure availability. This is because one to two years are needed to produce the plants. Survival data comparing bareroot and container-grown plants vary. While bareroot plants are generally older, they lack the advantages of being planted in a growth-medium that has a higher water-holding capacity. On very harsh sites, establishment success from container plants exceeds bareroot plants (see Exhibit 3-4).

3.4.2.4 Containerized Transplants

Containerized transplants are quite expensive. On the other hand, they are more readily available and allow for greater scheduling flexibility than bareroot plants. Container-grown plants also seem to perform better on extremely harsh sites. Although not to the same lesser degree with mature transplants, containerized stock contain beneficial soil microorganisms such as mycorrhizae.

If set in the sun before being planted, containerized seedlings may be killed or injured by toxic gases that can form in the plastic bags. To prevent this, the boxes and plastic liners should be opened when ambient temperatures are above 55°F for more than 12 hours.

The seedling should not be removed from the container until it will be planted. Careful removal prevents injury and unthrifty plants. To remove the seedling, gently pull at the base of the stem. A light thump on the bottom of the pot may aid in the removal of the root wad. Do not break up the rooting media. Simply set the plant upright in the planting hole and cover the intact rooting media with 0.5 inches of soil. Firm the soil around the plant and root mass, but do not compress or compact the soil (See Exhibits 3-5, 3-6, and 3-7).

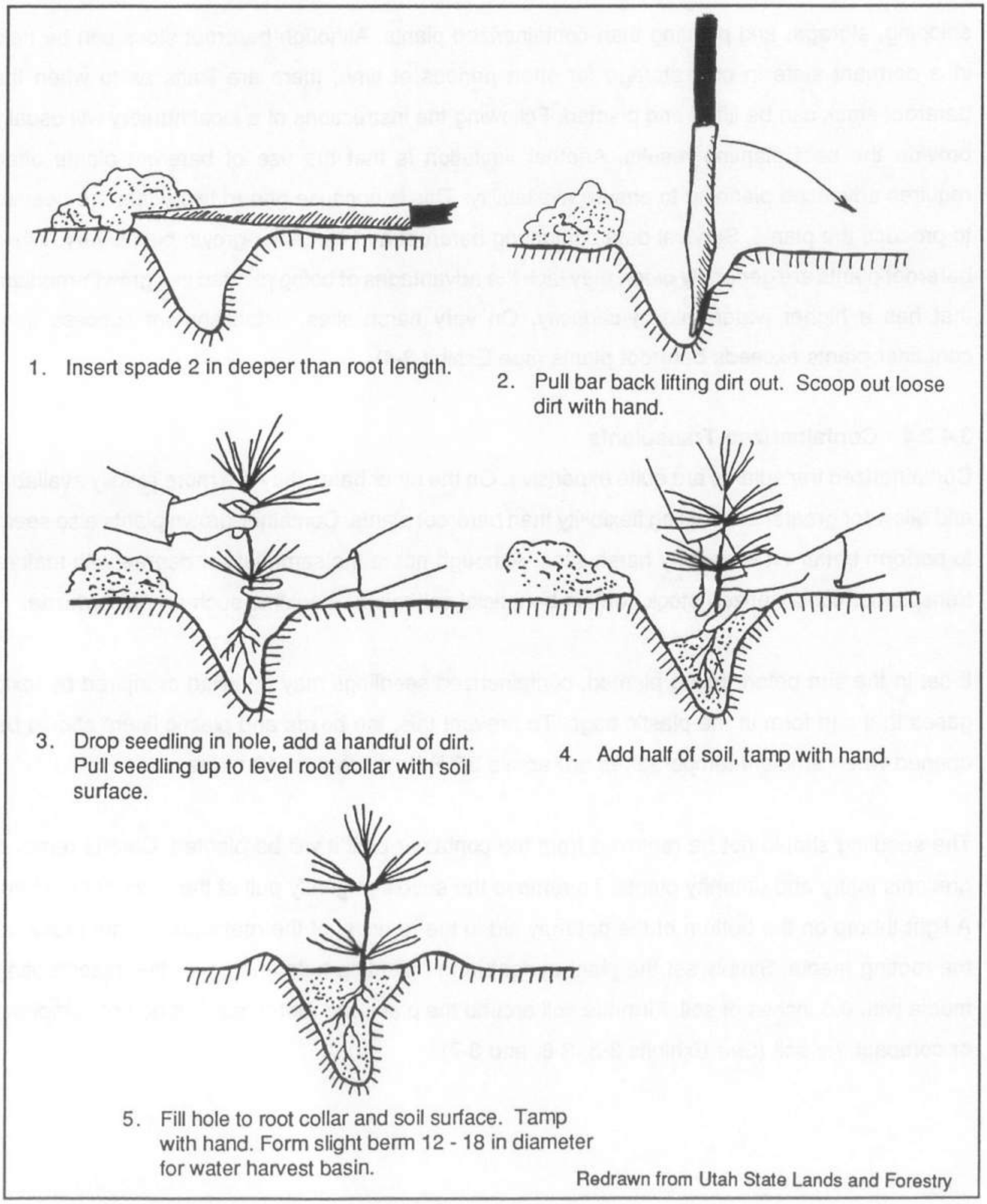


Exhibit 3-4. Planting a Bare Root or Tubing Stock.

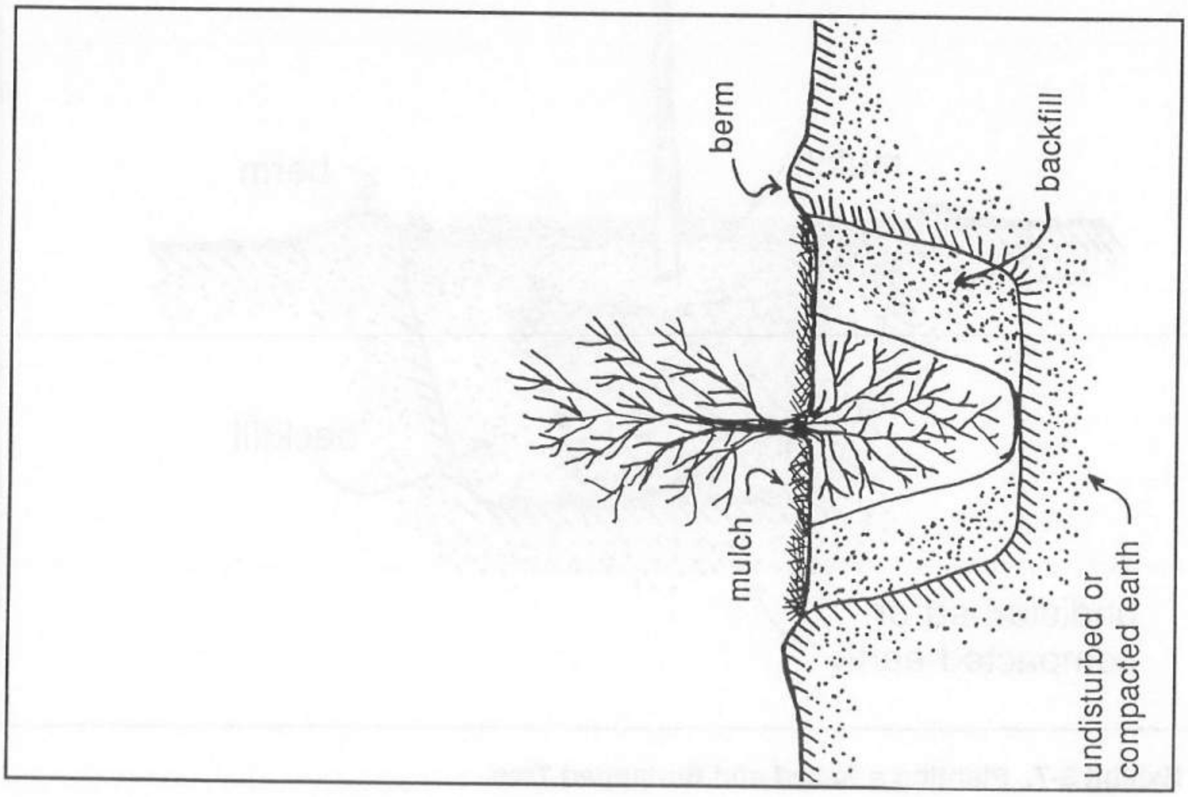


Exhibit 3-5. Planting a Container Shrub.

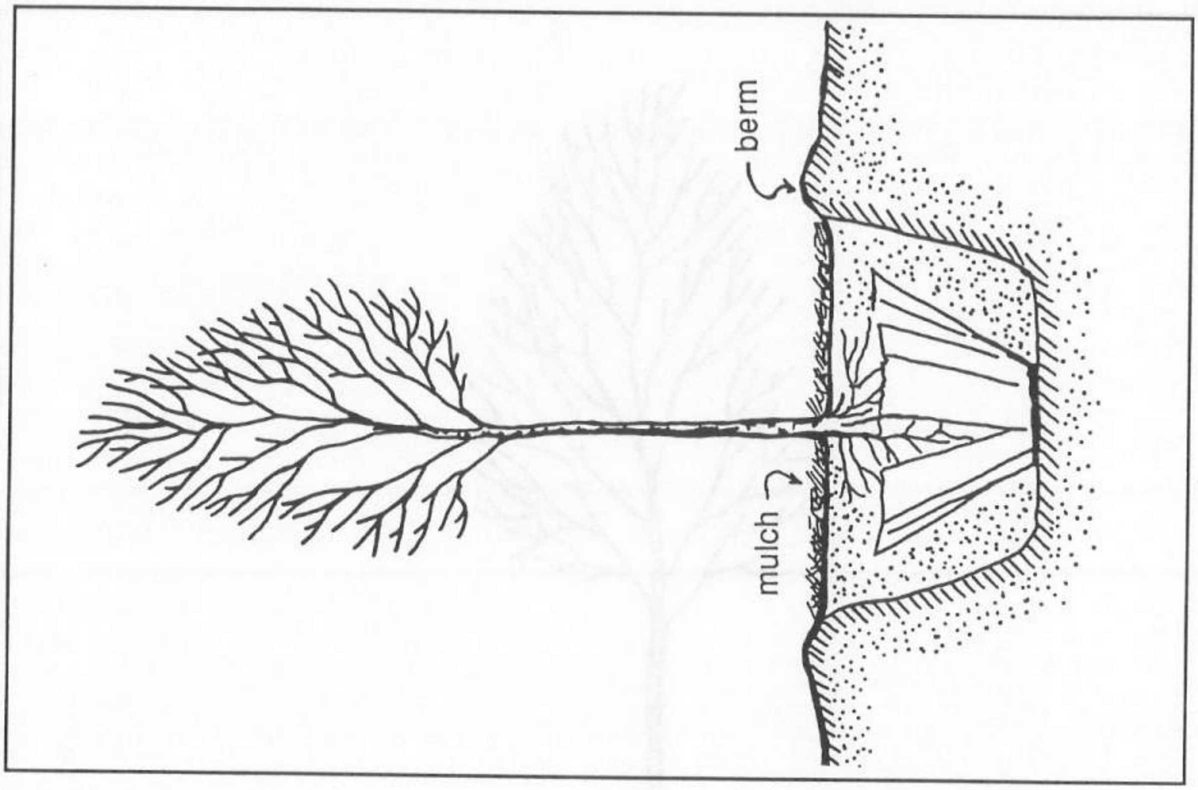


Exhibit 3-6. Planting a Container Tree.

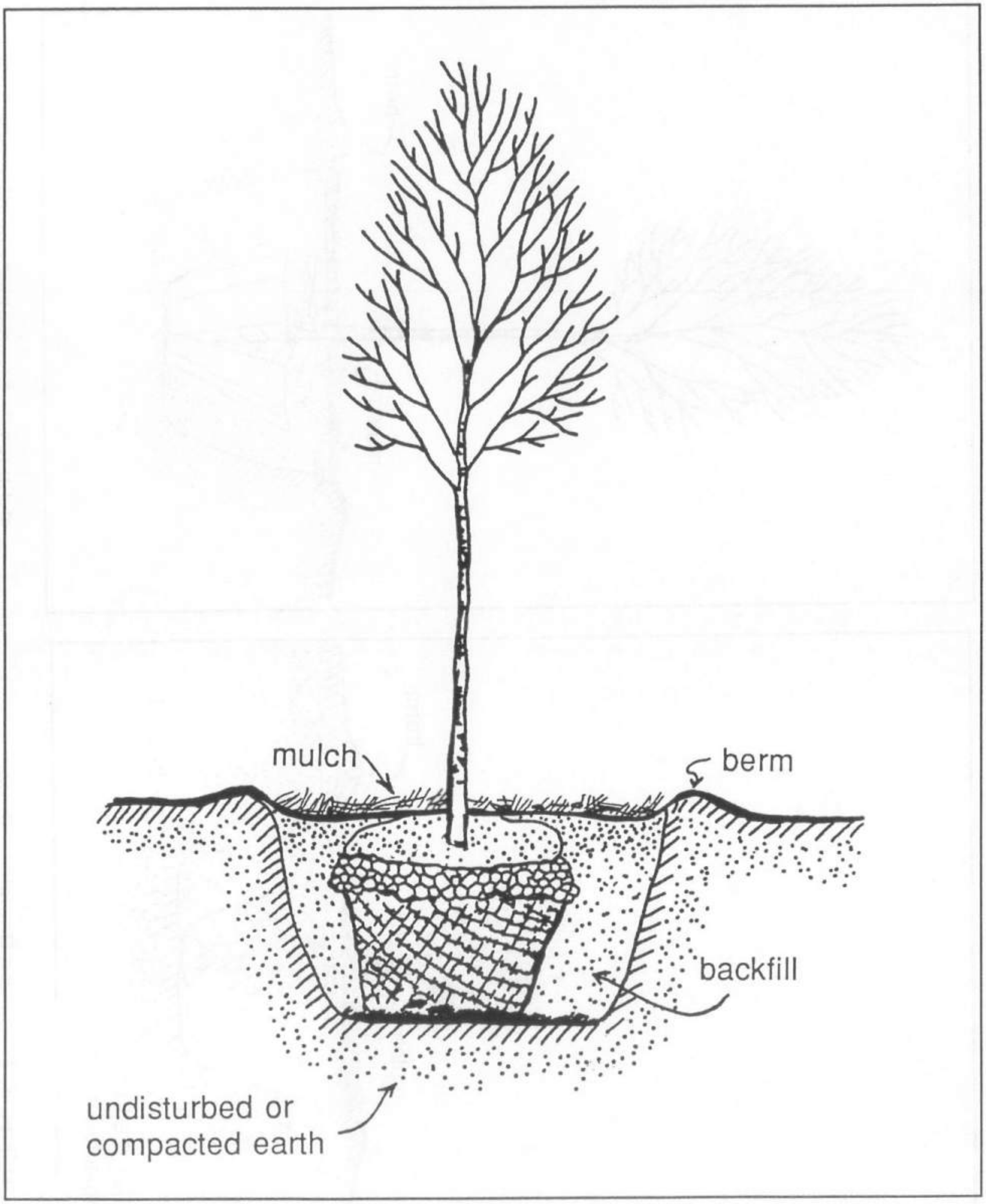


Exhibit 3-7. Planting a Balled and Burlapped Tree.

3.4.2.5 Mature Transplants

Deep, wide root systems of wild trees and shrubs often hinder their use as transplants because such root systems cannot be effectively excavated with the plant. This typically causes the mature transplant to die back or die completely.

Mature transplants of native trees and shrubs having shallow roots offer greater success. Such species--and their associated grasses and forbs--can be removed intact using a front-end loader. A tree spade is effective for removing larger materials. The entire soil mass can be transplanted into a disturbed area to form source islands of native seed and root material. The increased diversity from such a technique is difficult to obtain by seeding or use of containerized stock. In addition, relocation of the soil mass includes beneficial soil microorganisms. Species such as box elder, willow, red-osier dogwood, and alder that resprout from the stem have a higher potential for this method of transplanting than species lacking this capability.

3.4.2.6 Sod Pads/Plugs

Although grasses may be established using sod pads or plugs, they are generally established using seed as described in the previous section. The practice of establishing grass from sodding is done primarily for perennial rhizomatous and/or stoloniferous grasses. This method is poorly suited for perennial bunchgrasses. Because this method is expensive, it is typically used only for establishing grass in critical areas. An example would be the rapid stabilization of critical reconstructed drainages, localized steep slopes, marshes, and wet meadow wetlands. This method can also be used to reestablish grasses that propagate well vegetatively but produce little viable seed (e.g., inland saltgrass). Many grass-like species are established using plugs of native vegetation.

Materials may be obtained from commercial sources or from adjacent source areas. If source areas are used, care must be taken in the removal to avoid undue damage to the source area.

Placement of aquatic plants should be done by hand. Plants should be set in shallow ponds and grouped in clumps of 18 on 3-foot centers. Spacing and number of groups may vary slightly depending on the size of the pond. Water depth at planting locations shall be between 6 to 18 inches below the full pool depth. Water should be deep enough to entirely cover the roots and rhizomes. If used, rhizome sections should be buried 1-inch deep in the soil or mud. The entire rhizome section must be covered. Take care not to walk on or otherwise damage rhizome sections. If wetland sod or plugs are obtained from existing wetlands, the density of plant material removed from the source area should be less than 5 percent of the total cover of that source area. Such starts should be planted in early spring or late fall.

3.4.3 PLANTING METHODS

Allow sufficient time in advance of planting to obtain and properly harden plants. Eight months is recommended for tubeling-sized container plants. Additional lead time may be needed to grow larger container-sized plants if they are not readily available. Lead time of 1 to 2 years may be needed to ensure the availability of bareroot plants. The following general prescriptions apply to establishment of transplant material, particularly woody species.

3.4.3.1 Receipt and Handling

Proper care upon receiving a shipment is vital to maintain healthy plants. All plants should be watered as soon as possible after they arrive. This will ensure that each container receives adequate moisture. Plants can generally be left in the shipping container when watered to reduce handling and to avoid mechanical damage. Transplants should be planted as soon as possible. <u>Never</u> allow planting stock to sit in the sun before being planted.

3.4.3.2 Storage

Holding facilities should be constructed prior to receiving plants in case weather or logistics prevent them from being planted within a couple of days. Generally, if plants are adequately cold hardened (see below) a simple enclosure that discourages animal or human damage provides adequate protection for early spring planting. However, someone should be assigned to monitor plant and/or water conditions daily.

Plants should be stored for a limited period of time and should be checked once a week to determine if there is any fungal growth on the stems or if the plants are breaking dormancy. If either occur, they should be planted immediately. Under ideal storage conditions, some dormant bareroot seedlings can be stored for 90 days or more. However, many native shrubs cannot be stored longer than about one week. Aquatic plant tubers and rhizomes must not be stored more than 10 days before being planted, and they should be rinsed with water and drained every 3 days, beginning one day after arrival.

Storage temperatures for bareroot seedlings should be between 34°F and 39°F. The best method is field storage in an insulated shed or cellar that can be cooled by ice or snow. Never use "dry ice" (solidified carbon dioxide) as a coolant; it is toxic to seedlings and humans in high concentrations. In addition, the very low temperature it creates could damage seedlings.

As indicated, plants should not be stored for long periods. When the storage temperature warms to 39°F, seedlings should be stored no longer than a week. Containerized plants should be kept in a cooler or refrigerator with the temperature set between 30° and 35°F (Hansen et al. 1991). If no cooler is available, the plants may be stored for short periods in a snow bank or root cellar.

During storage, the plant's rooting media should feel moist. Plants should receive sufficient water to moisten the entire root column. Do not just water the surface layer.

Two other criteria for properly storing plants are shade and adequate ventilation. Shading plants does not mean preventing them from receiving light. The lack of adequate light for growth will adversely affect containerized plants. In other words, never leave plants enclosed in the shipping box or place them in a corner of an office or warehouse. Remove plants from the shipping boxes and place them in holding facilities. Nursery supply houses or greenhouses have a material known as "shade cloth" that allows different amounts of light to pass through it. This material can be used to reduce or prevent heat build-up and the resultant plant moisture stress. Shade cloth is commonly used by attaching the material to a simple frame structure and placing the plants inside the structure.

While ventilation is important, stored plants can be seriously harmed by excessive exposure to wind. Under hot and dry conditions, one should take adequate precautions to protect container-grown stock from water stress, which is generally the most critical factor to monitor during windy and/or hot periods. A wilted plant is susceptible to disease and indicates the urgent need for moisture. If not watered, plants may wilt beyond the point of recovery. This can result in the additional expense of having to purchase new plants. The use of shade cloth and construction of temporary windbreaks (e.g., placing sideboards on the frame structure as needed) can help prevent moisture stress.

3.4.3.3 Hardening

Containerized plants should be inspected for adequate hardening. Hardening is a developmental process in which containerized plants are removed from favorable growing environments to cool conditions and water and fertilizer are applied in minimal amounts. This induces physiological and morphological adaptations in plants that help them better adjust to stress conditions they will likely encounter at the planting site. Hence, hardening container-grown plants improves transplant success and survival. However, simply withholding water a few days before planting will not harden plants; it will only reduce the carbohydrate reserves needed for rapid root growth and survival, thereby weakening and stressing the plant.

Adequate hardening generally requires 2 to 3 months, but the amount of time depends on the season of the year. If planting site conditions are dramatically different from climatic conditions at the nursery, plants should be site-hardened for a few weeks or months. If hardened plants are exposed to a few days of warm temperatures, they may warm up sufficiently to alter the internal cell physiology. Out-planting such plants may expose them to freezing temperatures, which can result in frost damage.

3.4.3.4 Planting Patterns and Spacing

The spacing of and patterns generated by plantings provide vertical and horizontal structure to a set of vegetation. Variability in these features generally provide a higher degree of aesthetic appeal to humans and use by wildlife. Horizontal spacing and foliage density of plants can provide protective screening and an easy avenue of escape for wildlife. Vertical layers can provide feeding, roosting, nesting, and screening cover. Vegetation provides food, water, nest sites, and protection/cover simultaneously. Native vegetation with natural structure will provide these needs of native wildlife. Target wildlife species are listed for each cover type in Section 4.

Similarly to wildlife, diversity in vegetation in terms of color, line, form, texture, horizontal spacing, and vertical spacing provides for visually pleasing landscapes. Single-row patterns have one species planted per row and a different species planted in adjacent rows. This pattern appears highly artificial in a natural area. Random patterns have no design or selected placement and appear more natural, but are more labor intensive. Block or group patterns are recommended, wherein one to several species are planted in clumps scattered throughout the area being planted. Random placement of small blocks or groups of single species simulates the pattern of natural vegetation establishment. Boundaries or edges of plantings should not be uniform or exact. Ragged and irregular edges increase the aesthetic appeal of an area.

Spacing of plants depends on the purpose of planting, the species, and locality. Ideal spacing is wide enough to avoid crowding but close enough to ensure good form and development. Conifer species need to be planted slightly further apart than deciduous trees. Spacing at 6 to 7 feet is recommended for deciduous plantings. Spacing of 7 to 8 feet is better for large conifers. Plants should not be spaced uniformly over the area as this appears too artificial for a nature area. Exhibits 3-8 through 3-10 provide examples of recommended structures for various situations that may be encountered in the County.

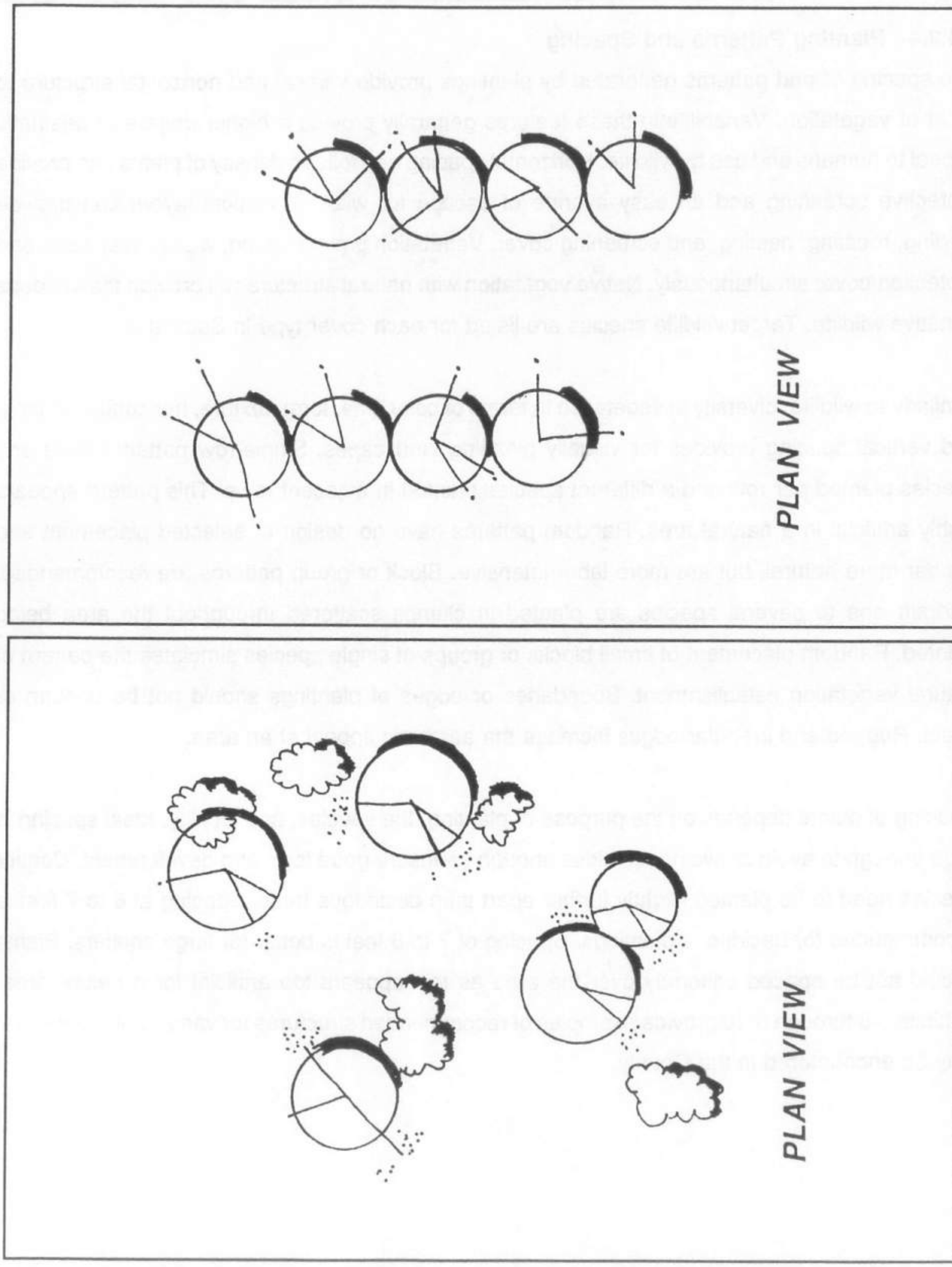


Exhibit 3-8a. Examples of Spatial Arrangements of Plantings.

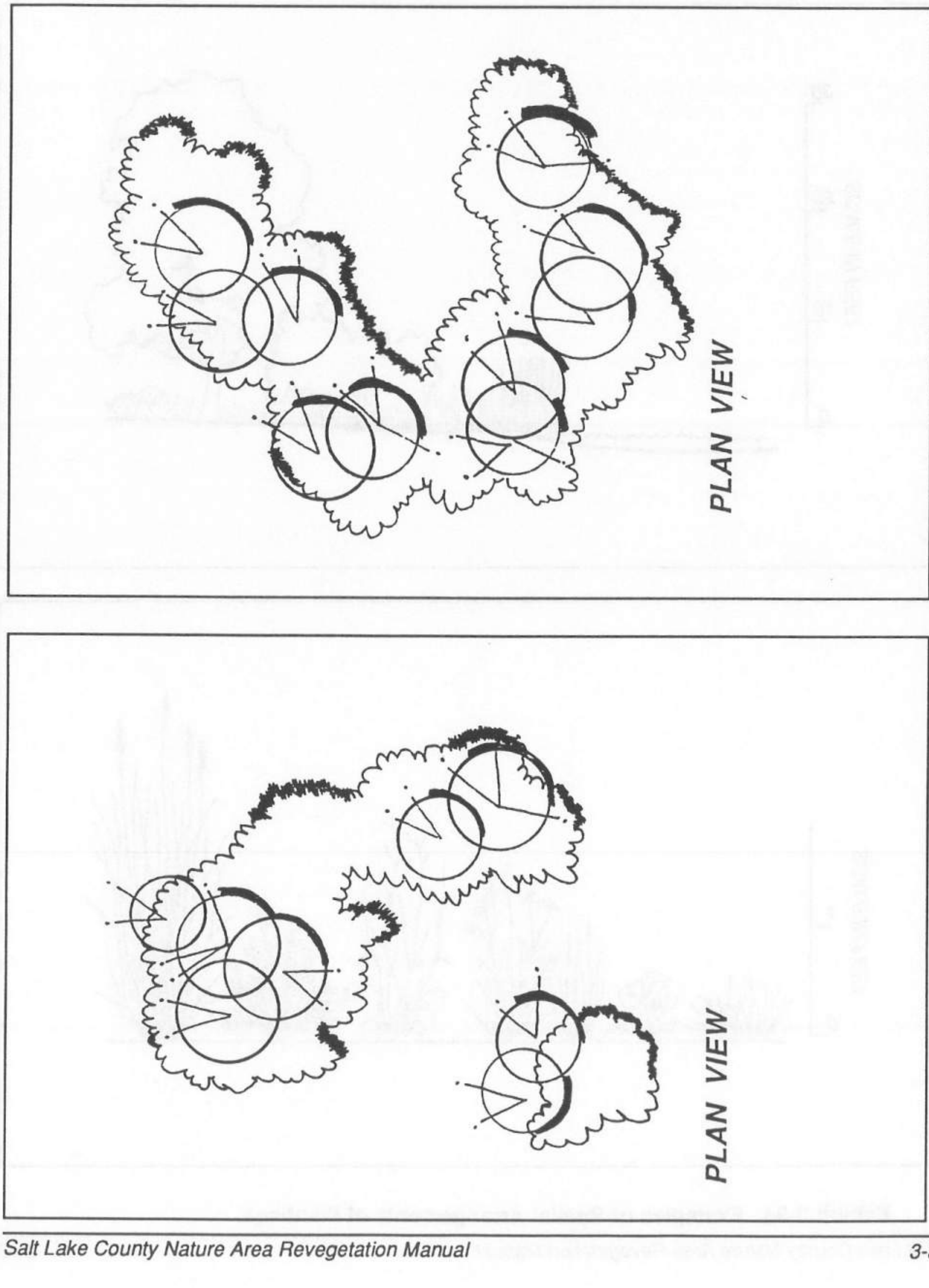
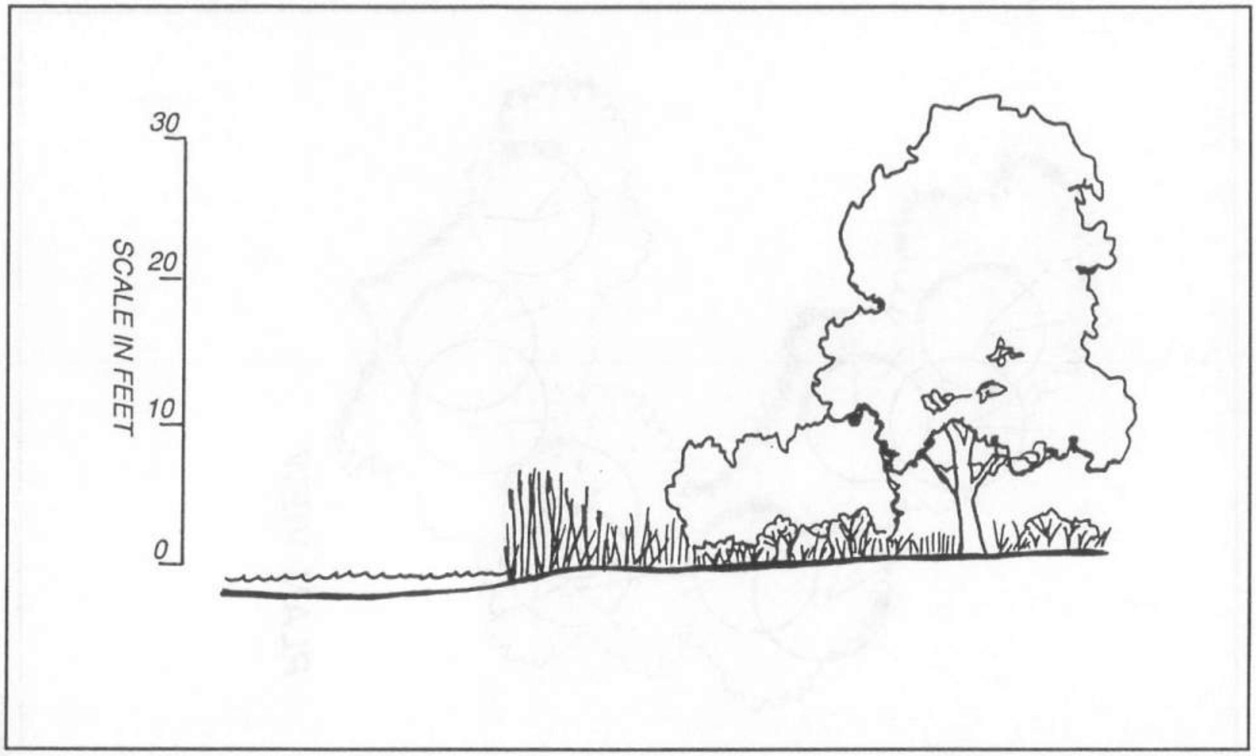


Exhibit 3-8b. Examples of Spatial Arrangements of Plantings.



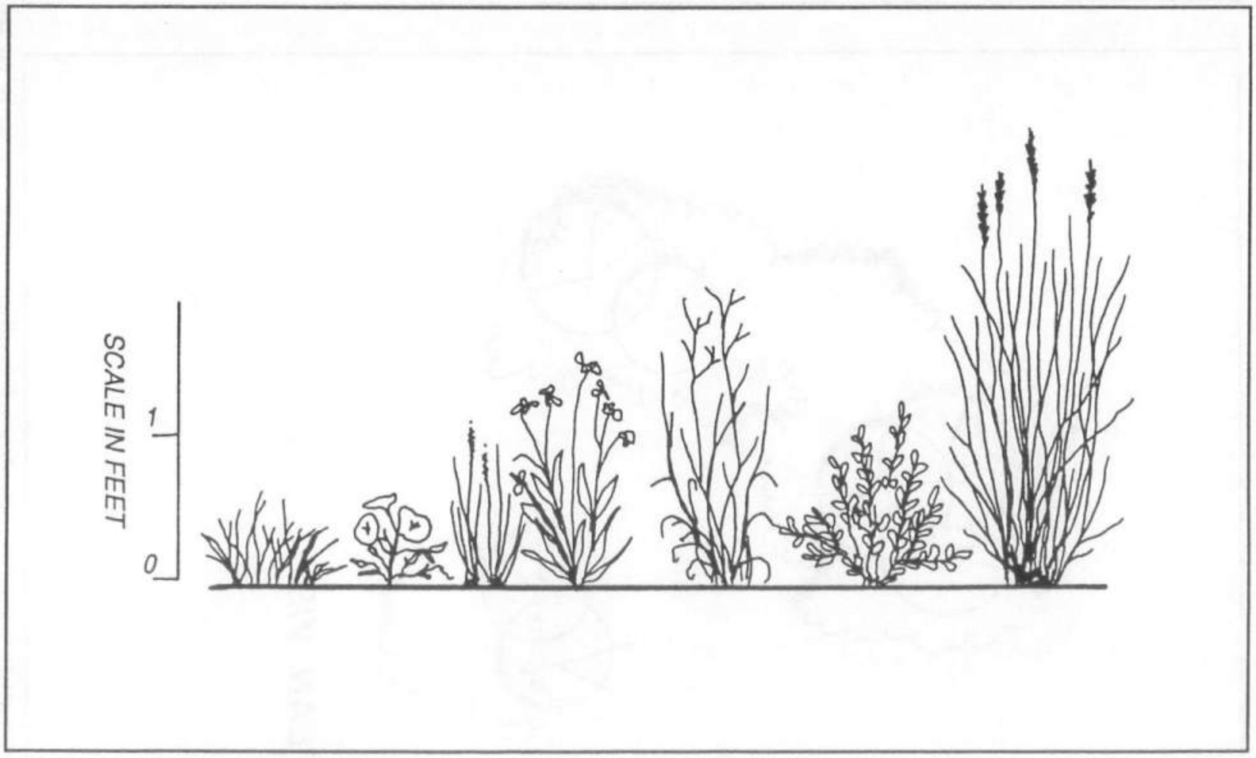
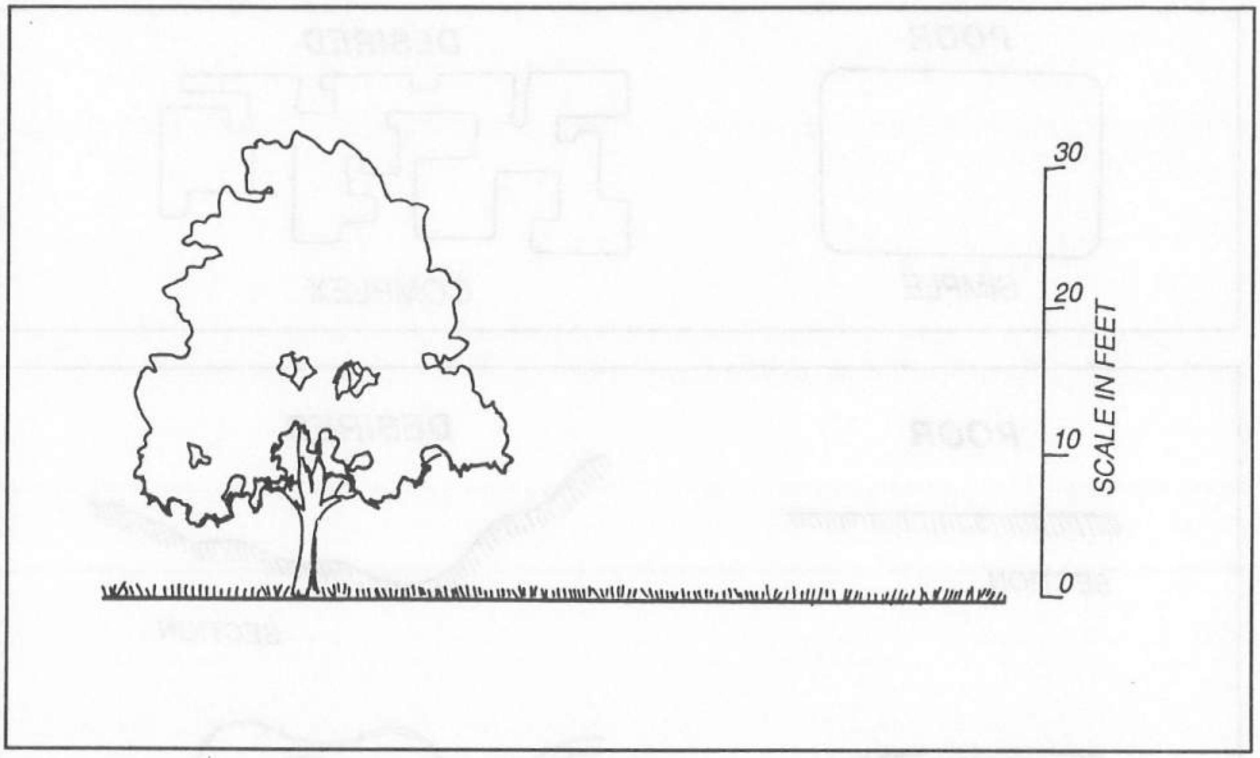


Exhibit 3-9a. Examples of Spatial Arrangements of Plantings.



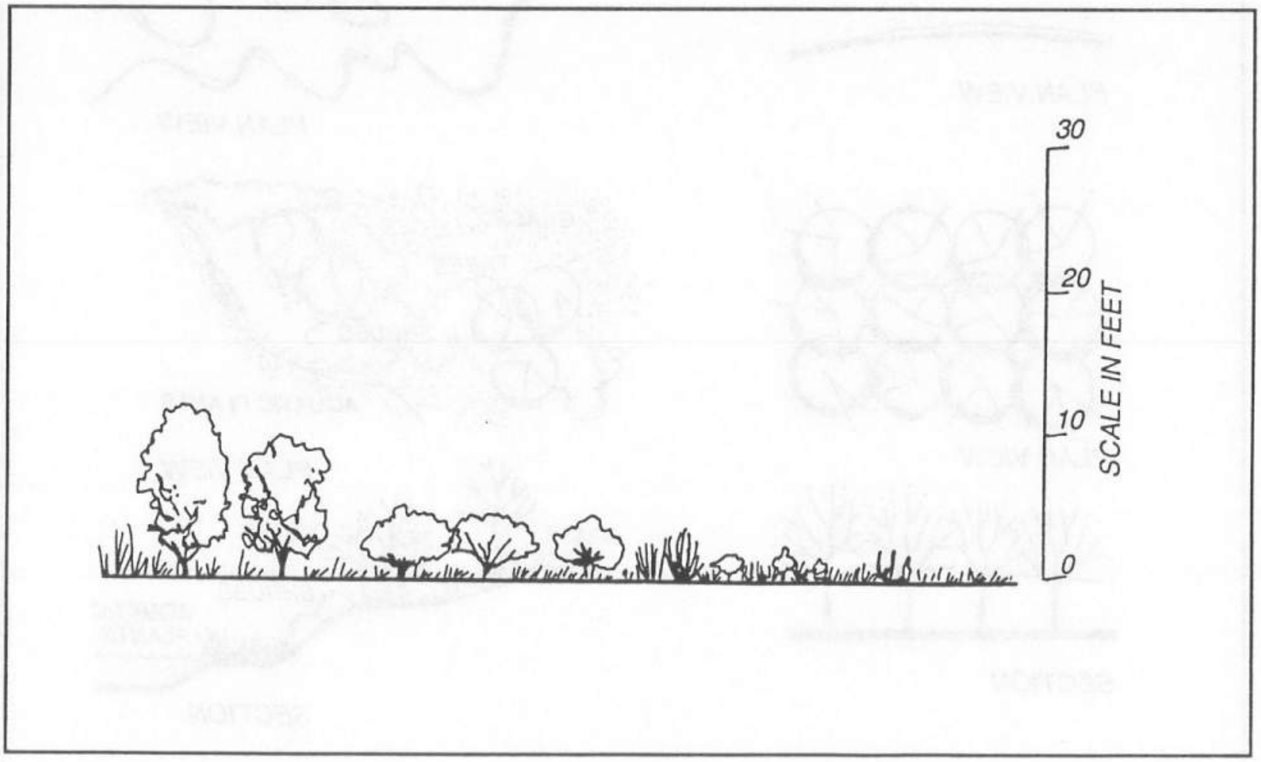


Exhibit 3-9b. Examples of Spatial Arrangements of Plantings.

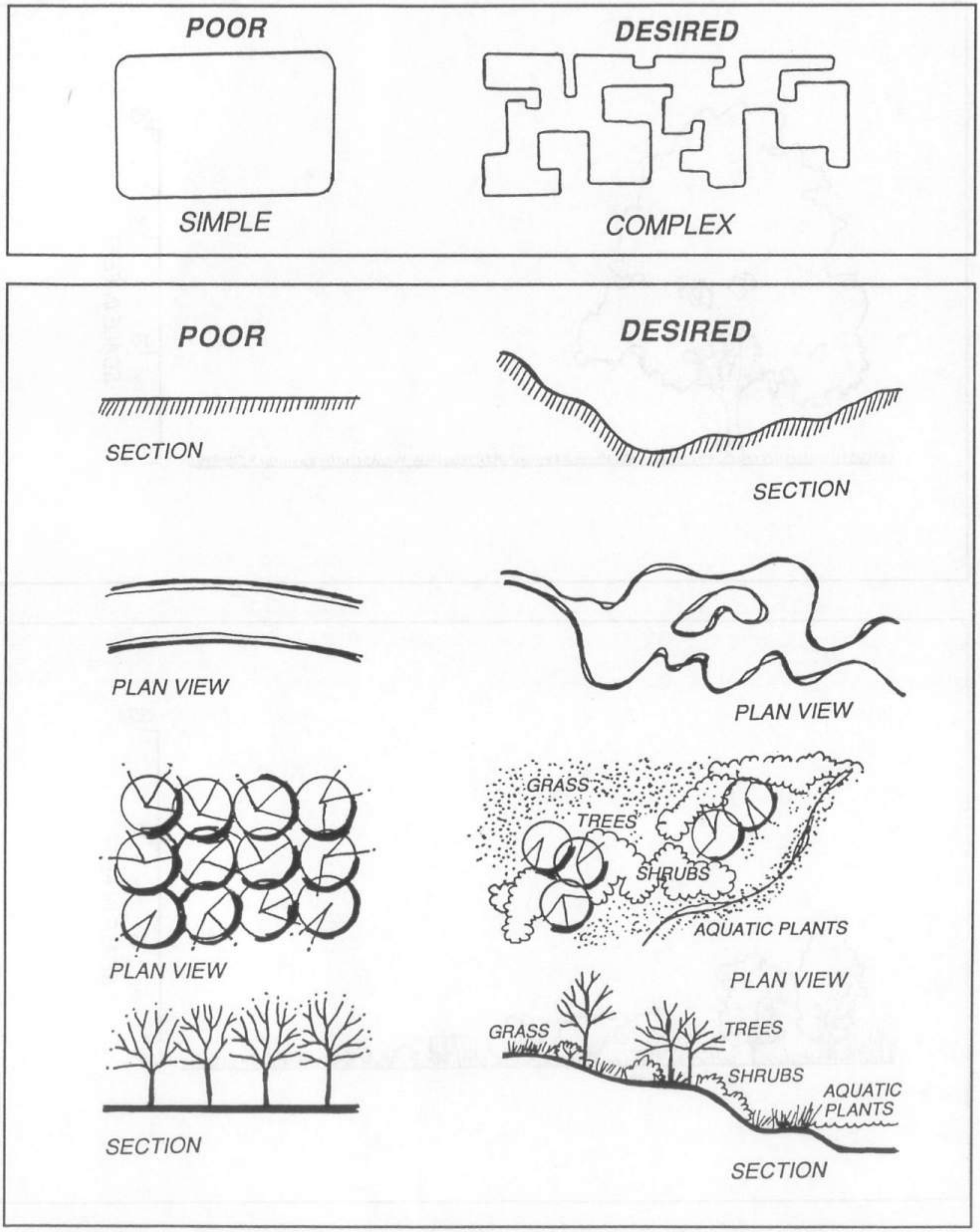


Exhibit 3-10. Examples of Poor and Desired Arrangements of Plantings.

3.4.3.5 Preparing the Planting Hole

To prepare an area, excavate a circular pit with vertical sides. The diameter of the pit should be sized large enough to accommodate all plant roots. The depth of pits should be 6 inches deeper than the bottom of the roots when the tree or shrub is set to finished grade.

The planting hole can be made with any implement that makes an adequate hole size. Holes for planting small transplant materials are effectively excavated with motor-driven augers. These augers are usually of the backpack or hand-held types. In some very rocky or heavy clay soils, augers are not always effective. In such cases, hoes, picks, planting bars, or planting shovels should be used instead. Holes for medium-sized transplants are readily excavated using a hoe or shovel. Take particular care, however, that the people digging the holes do not out-pace the planters. This would allow the extracted soil to dry out, and could reduce transplant success.

When excavating the hole, it is important to avoid compacting the wall. Such compaction prevents root growth into the surrounding soil. It is particularly important to avoid compaction if the soil has a high clay content.

Backfill the bottom 6 inches of the pit with soil and insert fertilizer pellets in the bottom 3 to 5 inches of the pit. Make sure the pellets are placed below the roots and that they **DO NOT** come into contact with the roots.

3.4.3.6 Setting the Plant

Once the hole is made and slow-release fertilizer pellets have been placed in the bottom of the hole and covered, the plant should be positioned vertically into the hole. Plants should not be left exposed to dry out. With bareroot stock, the roots should be spread into a normal position, and all broken or frayed roots cut off. Be sure that there is no bending or kinking of the roots.

Soil placed around the roots must be gently but firmly compacted. Take care to avoid injury to the roots, but be sure to fill all voids. Fill the hole such that the top of the root plug is ½ to 1 inch below the ground surface. This is important because it allows water to wick up through the rooting medium to the surface and prevents the root plug from drying. Form a ridge around the plant. The ridge should be 2 feet in diameter. Fill the saucer inside the ridge with water. When the water infiltrates and settles the soil, fill the remaining hole with the soil from the ridge. this should bring the soil surface to level grade. Be sure that no ring is left around the plant.

Crushing the root plug between rocks can stunt the root system and create a weak plant. This hazard is especially important to avoid when working in rocky soils. With a stunted root system, a plant is more susceptible to environmental stresses from lack of moisture, disease, or insects.

There are further challenges associated with successfully establishing plants on steep slopes. One key to success is to not have planters working directly above or below one another. This creates safety hazards to both the plants and planters as soil or rocks may be dislodged and may bury or injure the plants. Another key is to have planters start at the top of the slope, work their way across, and eventually down (i.e., working parallel to the contour of) the slope. A third factor is the way in which the plants are positioned on very steep slopes. One-foot diameter basins are formed around the plant. These can help stabilize the slope, detain moisture, and increase infiltration in the vicinity of the plant.

Exhibit 3-1 (page 3-25) depicts the proper way to set a plant. Using a hoe or shovel, scrape the excess soil from above the plant. On the down-slope side of the plant, form a catchment basin with a hole positioned near the outer edge of the basin's lip. Insert the plant (and in some cases, fertilizer) and cover the root stock. Be sure the plant is positioned near the outer lip of the catchment basin. This will prevent unintentional burial or exposure of the root system by erosion. Aligning the crown of the root plug with the plane of the undisturbed slope is very important. If this is not done correctly the root plug will be exposed as the soil positioned above the plane of the slope erodes away with time. In short, the plane of the slope should tend to reestablish itself with time. This may occur as early as the first event of precipitation or spring snow melt and runoff.

3.4.3.7 Repairs to the Plant

When finished planting, repair any injuries that may have occurred to the tree or shrub by pruning affected branches. Only prune dead or injured twigs or branches, and prune in such a manner that the natural shape of the plant is not affected. Make all cuts flush with the plant--do not leave stubs. Be sure to smooth and shape the wounds so they should not retain water.

3.4.4 SEASON OF ESTABLISHMENT

3.4.4.1 Optimal

Generally, the most favorable results from planting shrubs and trees in northern regions occur from spring planting. Adequately cold-hardened plants should be planted as soon as access is possible, thus taking advantage of soil moisture accumulation during the winter and potential late spring precipitation depending on snow cover. Aquatic plants should be planted in mid-spring between April and mid-May.

3.4.4.2 Alternative

Planting may also take place in mid- to late fall when evapotranspiration rates are low and/or the plants have lost their leaves. Survival rates are not as high with fall planting because there is relatively poor root to soil contact and a plant has a difficult time meeting evapotranspirational losses.

3.4.5 OTHER ASPECTS PERTINENT TO PLANTING ESTABLISHMENT

3.4.5.1 Watering

Provided the soil is not moist at the time of planting, plants should receive approximately 2 quarts of water for each tubeling or standard 1 gallon container plant. Larger-sized materials require more water. Watering provides an initial irrigation to the plant and soil surrounding the root. In addition, it helps settle the soil around the roots and remove air pockets that could damage roots. Water can be supplied by irrigation lines or by truck-mounted tanks. (See the discussion under Section 3.6, Irrigation). If possible, transplanted seedlings should be watered once again during mid-summer of the first growing season to ensure optimum success.

Sedges, bulrush, cattail, and other marsh species should be planted in water or saturated soils and should not require supplemental watering to aid in establishment as they should be supported by subirrigation and surface water ponding. Wet meadow plugs should be saturated with water after planting if the soil is not already saturated.

3.4.5.2 Weeds

Refer to Section 3.7 for Weed Management details.

3.4.5.3 Protection from Animals and Insects

The lushness and high palatability of young plants can attract animals to newly planted or seeded areas. Deer, elk, rabbits, rodents, and insects such as grasshoppers are the most likely to create problems. Serious damage may result to the vegetation. In addition, livestock trampling may promote soil erosion or compaction. If grazing or trampling inhibits the revegetation effort, animal control measures may be necessary. Measures to control animals are discussed under Maintenance/Management. For example, transplants at the Jordanelle Dam mitigation area were protected by using vexar tubing at the time of planting to discourage animal damage.

3.5 EROSION CONTROL AND SITE STABILIZATION

3.5.1 RANGE OF APPLICATION

Methods of erosion control and site stabilization include bank stabilization, water bars, mulching (non-competitive mulch stubble or nurse crop), straw bales, rough grading, contour grading, etc.

Slope steepness can be a limiting factor for establishing vegetation. Slope stability is a function of slope gradient, length, and shape; soil particle size; moisture relationships (i.e., high water table and/or seepage zones); and climate. Revegetation results are generally unsatisfactory and erosion rates critical on slopes of 2:1 or steeper as shown by Exhibit 3-11. A slope steepness of less than 2:1 represents the seedbed preparation limit. On slopes of 3:1, there is generally a moderate to high erosion hazard and revegetation success is fair. On slopes of 4:1, there is a

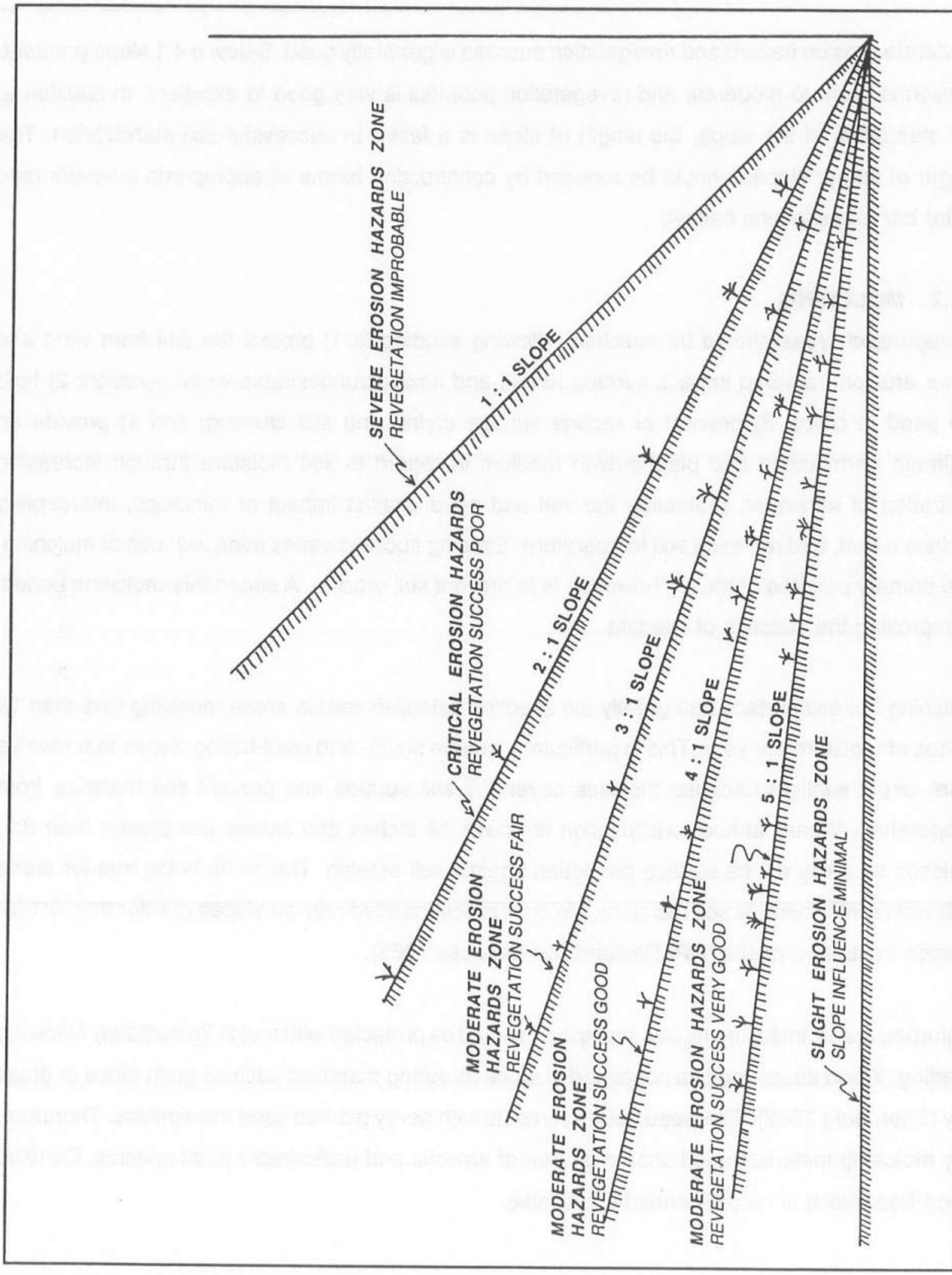


Exhibit 3-11. Influence of Percent Slope on Revegetation.

moderate erosion hazard and revegetation success is generally good. Below a 4:1 slope gradient, erosion is slight to moderate and revegetation potential is very good to excellent. In addition to the steepness of the slope, the length of slope is a factor in successful soil stabilization. The length of longer slopes should be reduced by constructing berms at appropriate intervals (see water bar prescriptions below).

3.5.2 MULCHING

Revegetated areas should be mulched following seeding to 1) protect the soil from wind and water erosion, raindrop impact, surface runoff, and noxious/undesirable weed invasion; 2) hold the seed in place; 3) prevent or reduce surface drying and soil crusting; and 4) provide an optimum germination and plant-growth medium in regard to soil moisture through increasing infiltration of rainwater, protecting the soil and seed against impact of raindrops, intercepting surface runoff, and reducing soil temperature. Seeding success varies even with use of mulching. The primary purpose of mulch, however, is to prevent soil erosion. A secondary mulching benefit is improving the success of seeding.

Mulching the soil surface can greatly aid seedling establishment in areas receiving less than 18 inches of moisture per year. This is particularly true on south- and west-facing slopes that receive more direct sunlight because mulches cover the soil surface and prevent soil moisture from evaporating. Where annual precipitation is above 19 inches and slopes are greater than 3:1, mulches primarily act as surface protection against soil erosion. The same holds true for areas with wet or intermediate soil moisture. Mulch is recommended only on slopes greater than 5:1 for erosion control purposes (NPI Reclamation Services 1985).

Disturbed areas, including topsoil stockpiles, should be protected with mulch immediately following seeding. Weed seeds may be contained in some mulching materials such as grain straw or grass hay (Thornburg 1982). The weed seeds compete with newly planted seed mix species. Therefore, any mulching materials used should be free of noxious and undesirable plant species. Certified weed-free mulch is recommended if available.

3.5.2.1 Types of Mulch

Types of mulching material include clean cereal grain straw, grass hay, long-fiber wood cellulose, hydromulch, biodegradable plastic netting and matting, rock mulch, or biodegradable erosion control blankets. The type of mulch should depend on slope gradients, wind erodibility of the soil, and the size of area under consideration. Manufactured erosion control blankets, although very effective, are very expensive and may not be cost feasible to use on large areas (i.e., greater than 0.5 acres). Whatever type of mulch is used, the mulch must be appropriately anchored to the soil to be effective.

3.5.2.1.1 ***Straw or Hay.*** Some of the best mulch materials are clean native grain straw or grass hay. Benefits of straw mulch over hay mulch are 1) the reduced palatability of straw to wildlife and livestock, 2) a reduced amount of undesirable species such as weed seeds, and 3) lower cost. A benefit of grass hay over straw is its reduced brittleness.

The straw or grass hay mulch should have no more than 20 percent moisture content or the mulch would be difficult to apply uniformly and the specified application rate would not be achieved due to the high water weight. Straw or hay mulch should be free of mold or other unspecified material. Weed-free certification by the county extension agent is strongly recommended. Loose material from broken bales are difficult to handle. Therefore, they should be rejected.

On slopes less than 30 percent, mulch should be applied by a mechanical mulch blower. The blower breaks apart the straw or hay bale without shattering the fiber and blows the fibers out over the seedbed. The ability of the blower to distribute mulch over distances of 50 feet or greater depends on the wind direction and speed. Mulch should be broadcast applied uniformly so that at least 50 percent of the soil surface is covered. Machine broadcast straw mulch should be applied at a rate of at least 2 tons/acre after seeding. If a mulch blower is used, the straw strands should not be shredded less than 8 inches in length to allow effective anchoring. Hay mulch should be applied only if prices are cost-competitive. If used, application at 1.5 to 2 tons/acre grass hay is recommended. A chemical binder should be considered in areas that are too small or other areas that are inaccessible to equipment.

If an area can be accessed by equipment, straw should be crimped about 2 inches deep into the soil. This will secure the fibers from being wind blown and will place some of the fibers on end so they project above the soil surface. Such placement creates ideal conditions for trapping snowfall, reducing wind velocity at the soil surface, reducing raindrop impact, and encouraging moisture penetration into the soil thus increasing available moisture on most sites (Hansen et al. 1991). For effective anchoring, straw fibers should be at least 8 inches long and the soil should not be compacted. Round disks are not recommended for crimping straw into the soil as they tend to cut fibers. Blunt-notched disks or specially designed rollers should be used.

On slopes greater than 30 percent and in areas with difficult access, straw and hay mulches can be spread by hand. This is a less efficient operation than using a mechanical mulch blower because breaking apart the bale is more difficult and because the flakes of straw tend to clump when spread. Therefore, hand spreading requires approximately 3,500 to 4,000 lbs per acre to be effective.

On steeper slopes, mulch can be anchored by placing photodegradable plastic mesh net over the broadcast mulch or through the use of chemical tackifiers or binders. When applying netting, a trench is made at the top of the slope and the ends buried to prevent water from running underneath the netting. The netting is stapled at three-foot intervals and one-and-a-half-foot intervals along the sides and bottom. A U-shaped staple is generally used ranging from 6 to 12 inches in length. Shorter staples are used on rocky or non-topsoiled slopes. On extremely rocky or compacted soil surfaces, rocks or other objects may need to be placed on top of the netting to hold it in place. Whenever possible, the manufacturer's specifications should be followed for stapling requirements.

Hydromulching is the most effective means of applying a chemical tackifier. Hansen et al. (1991) recommend a rate of 120 lbs of tackifier with 300 lbs of fiber mulch per acre. This is mixed in a water slurry and applied evenly over the straw or hay mulch. Recommended rates, however, may differ with various products. As such, the manufacturer's suggested rates should be followed. Binding straw mulch with 300 gal/ac of asphalt emulsion (Thornburg 1982) is also recommended.

3.5.2.1.2 *Mats, Blankets, and Netting*. For use on critical sites that are steep or subject to erosion, several products are available on rolls or in sheets. These include netting, blankets, and mats. As indicated previously, staked plastic netting should be used over all broadcast mulched areas that are subject to wind and surface water erosion due to exposure. Erosion control blankets include several grades of slope protection through variation in construction and the materials used. The lightest and simplest blankets include a 100 percent straw matrix sewn into a lightweight, photo-degradable plastic net. The heaviest and most complex blankets consist of a combination matrix of 70 percent straw and 30 percent coconut fiber; or 100 percent coconut fiber matrix sewn between two heavy weight UV-stabilized nets. These blankets are also available with seed incorporated to facilitate revegetation establishment. All these products should be installed following manufacturer's specifications.

3.5.2.1.3 *Hydromulch*. A common practice in the Eastern states is to hydromulch a revegetated area with aspen fibers. Hydromulching has been used and promoted extensively in the past for revegetation efforts but is seldom effective for retaining sufficient moisture for good seed establishment. While this is particularly true in the West, this method may be successful at higher elevations--provided the seedbed is rough and has been prepared immediately prior to seeding and hydromulching. The technique may also be successful at lower elevations in the West if precipitation is sufficient. Since its success in revegetation efforts is limited, the primary benefit derived from using hydromulch is to tackify straw mulch and provide a visual marker for hydroseeding. If used, hydromulch and tackifier should be applied at a rate of 1,500 lbs/acre and should be applied in the manner described previously for hydroseeding.

3.5.2.1.5 *Nurse Crops and Stubble.* Nurse (companion) crops are generally annual crops such as barley or wheat. They are often seeded with the desired perennial mix but may be planted prior to the permanent mix if final grading occurs outside the more favorable seeding windows. Under such a scenario, the seedbed must be prepared twice: once to plant the nurse crop and later to plant the desired perennial mix. Nurse crop species grow rapidly. If planted concurrently with the slower-growing perennial crop, it acts as a "live" mulch and can provide protection from wind and water erosion. On the negative side, nurse crops compete for soil moisture--particularly in drier areas--because they germinate and establish at the same time as the perennial revegetation mix species. For this reason, one should not use nurse crops in areas with dry moisture regimes.

The difference between a nurse crop and a stubble mulch is that stubble mulch is seeded far enough in advance of the desired perennial crop to mature and die. The perennial mix is drilled into the stubble mulch to provide seed contact with mineral soil. Under drought conditions, a stubble mulch crop may fail. If this occurs, another means of soil protection must be implemented. Unfortunately, this may allow weed species to establish, which may create future competition and maintenance problems. Stubble should be kept to 8 to 18 inches height. According to Thornburg (1982), winter grains seeded in spring or spring grains seeded in early summer provide protection. However, seeding of winter grains should be done late enough in spring/summer for mulch crop to be killed <u>before</u> it produces seeds. In addition, sterile plant seed should be used to prevent the mulch crop from reproducing and dominating the revegetated areas for longer than the first year.

3.5.2.2 Cost-Effectiveness of Mulch

For high priority areas, the most cost-effective means of reducing soil erosion that allows the reestablishment of vegetation is the excelsior blanket or straw with a plastic netting. Straw, held with a tackifier, is effective for low priority sites. While less expensive than plastic netting, tackifiers also have less effective holding ability under high wind conditions.

Results of mulch cost efficiency analyses indicate that on steep slopes, mulch is beneficial for increasing seedling density and cover while decreasing erosion. On less steep slopes, mulch may not have a significant effect on the vegetation but is still effective in reducing erosion. On steep slopes, the use of a tackifier to anchor the mulch is also beneficial compared to mulch with no tackifier; this increases seedling density, vegetative cover and reduces erosion.

3.5.2.3 Effectiveness of Mulch

The effectiveness of mulch for water retention is a function of thickness; thin layers are less effective than thick layers, although if the mulch layer becomes too thick, adverse conditions may occur. Adverse conditions may include too much weight or thickness of mulch to permit seedling emergence, encouragement of mildew and fungal disease associated with the decomposition of wet mulch, and the potential of movement of mulch by water or wind action to depths that are excessive.

3.5.3 BANK STABILIZATION

The County may need to stabilize and revegetate excessively steep upland slopes as well as stream/river banks. The following provides a general disclosure of the types of methods used for such bank stabilization.

3.5.3.1 Riprap

Riprap consists of relatively large stones and boulders of specified diameter placed in a layer over the bank or slope to be protected. The diameter of each particle and the depth of the layer of stones or boulders depends on several factors including slope gradient and the tractive force of moving water. Riprap should be designed and specified by a Professional Civil Engineer. Exhibit 3-12 shows an example of riprap placement.

3.5.3.2 Gabions

Gabions are similar to riprap but are comprised of stones placed into wire mesh cages as an elemental building block. In general, the wire mesh cages are pre-fabricated. Rock and stones

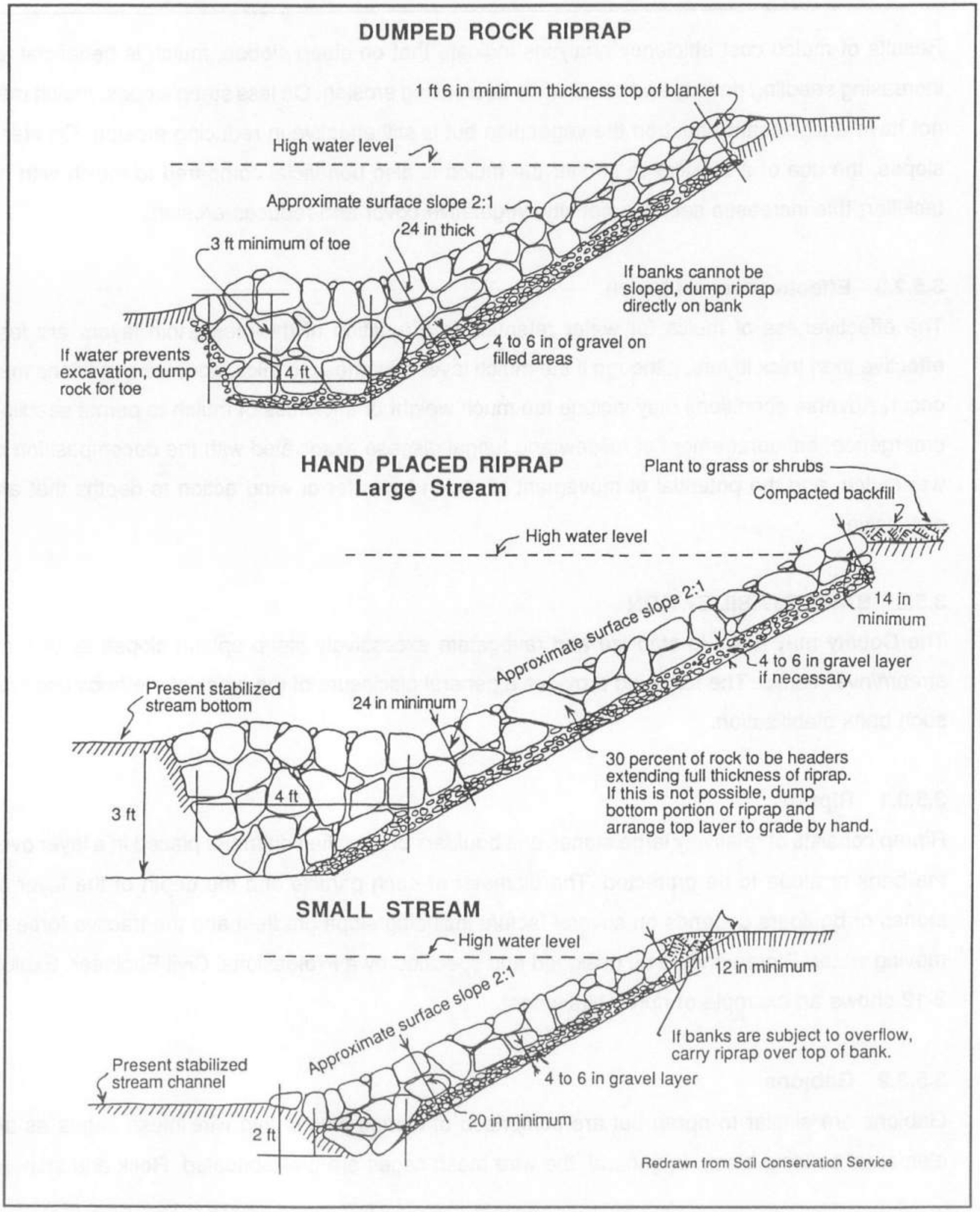


Exhibit 3-12. Design and Construction of Riprap Slope Protection.

of specified diameter are placed within the cages and wired shut at the site of bank stabilization. Walls or banks of these units are staked to provide both slope stability and resistivity to the tractive forces of moving water. The use and design of gabions should be directed by a Professional Civil Engineer. Exhibit 3-13 shows an example of gabion placement.

3.5.3.3 Biotechnical Stabilization

Biotechnical slope stabilization consists of using a combination of plants and engineered structures to stabilize slopes and banks. These include planting between riprap particles and in between gabions, wattles, and live stakes. The following information has been taken in part from Collins (1990) and Schiechtl (1980).

3.5.3.3.1 ***Wattles***. Wattles are bound bundles of live brush stems or sprigs approximately 10 inches in diameter and 6 to 10 feet long as shown in Exhibit 3-14. The bound bundles are placed in shallow trenches and staked to the soil surface perpendicular to the slope gradient. Native soil is spread back over the wattle bundles. For streambank stabilization, willows or other hydrophytic shrubs should be used. The bundles should be in contact with saturated soils. Planting should take place in early spring. The stems will send out roots and stems, becoming established shrubs that will ultimately provide more effective bank stabilization.

3.5.3.3.2 ***Live Stakes***. Live stakes are very similar in concept and application to pole and sprig planting as previously described. Sprigs, poles, and sections of stems and trunks are pounded or inserted into saturated soil on streambanks as shown in Exhibit 3-15.

3.5.3.3.3 ***Brush Layering***. Brush layering involves excavating cavities or indentations into banks along a terrace across the slope, placing a layer of hydrophytic shrub sprigs and stems, and backfilling the excavated area with saturated soil as shown in Exhibits 3-16 and 3-17. This technique is similar in concept and application to pole and sprig planting, wattles, and live stakes as previously described.

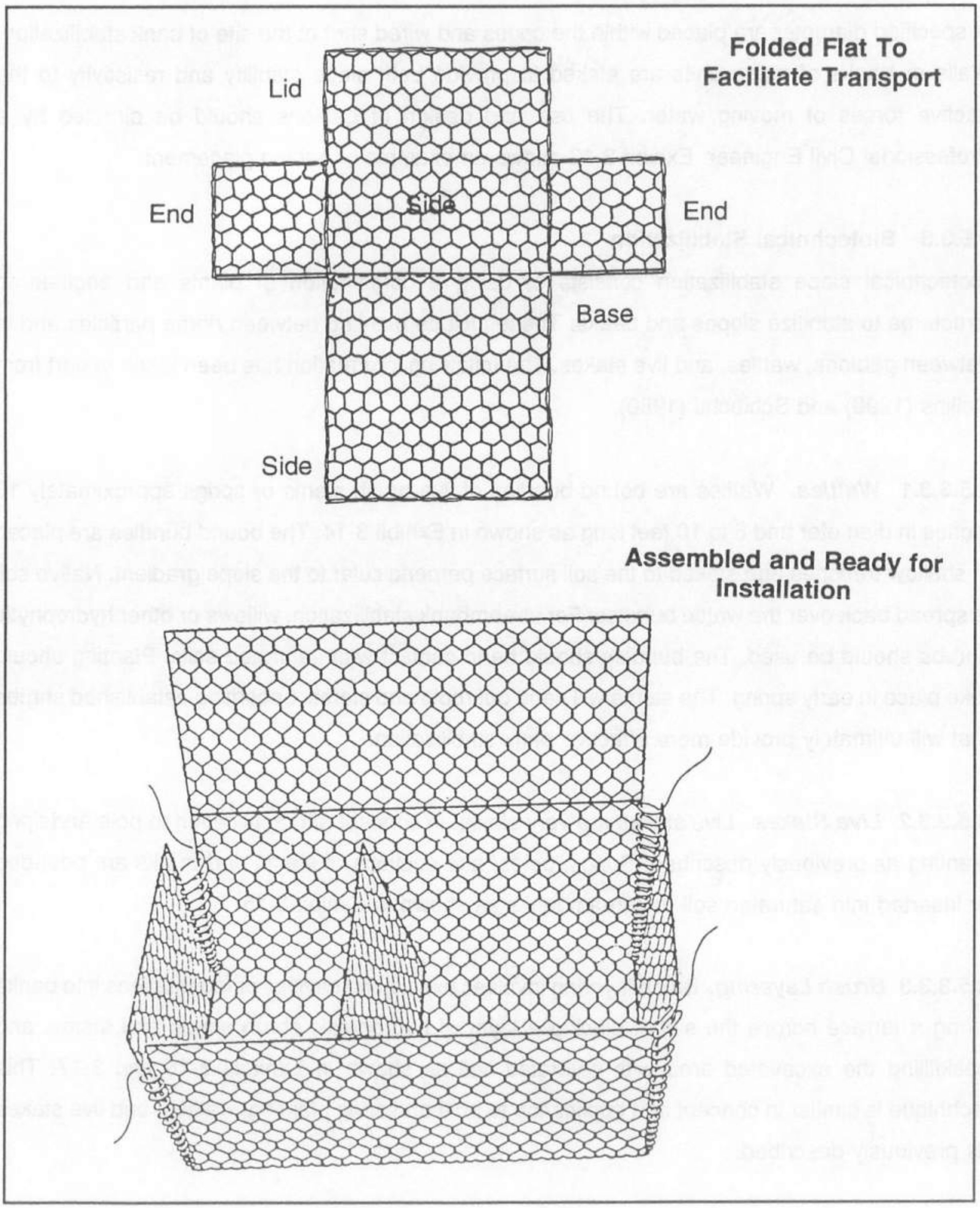
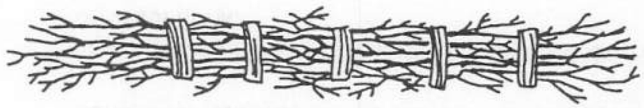
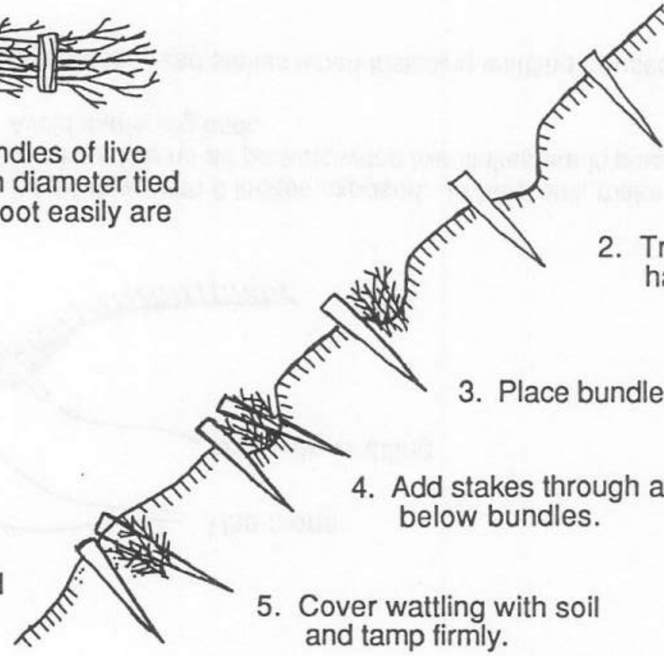


Exhibit 3-13. Design of Gabion.



Prepare wattling: cigar-shaped bundles of live brush with butts alternating, 8-10 in diameter tied 12-15 inches o.c. Species which root easily are preferred.

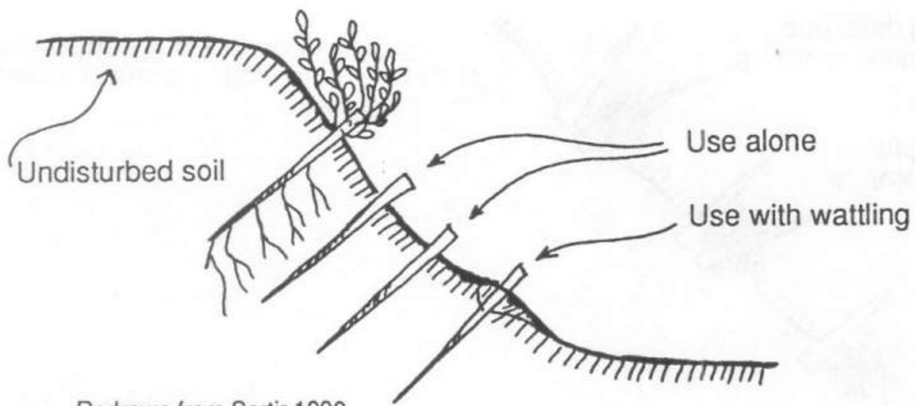


Note: work starts at bottom of cut or fill and proceeds from Step 1 through Step 5.

Redrawn from Gray and Leiser 1982

Sequence of operation is shown schematically in the diagram. Bundles are overlapped so overall thickness is uniform. Two stakes should be used at each bundle overlap. Additional stakes are driven through bundles at a maximum spacing of 18 inches o.c., usually near the ties.

Exhibit 3-14. Preparation of Wattling and Installation Procedure.



Redrawn from Sortir 1990

Use old stock, pounded in at least 2 feet deep with 6 inches exposed. In hard soil, make a hole with a small diameter pipe first. There should be no air pockets when live stakes are in place. Use dead-blow hammer on live stakes. Avoid damaging bark.

Live stakes may be alternately substituted for dead stakes when installing wattling or used alone on a cut bank.

Exhibit 3-15. Preparation of Live Stakes and Installation Procedure.

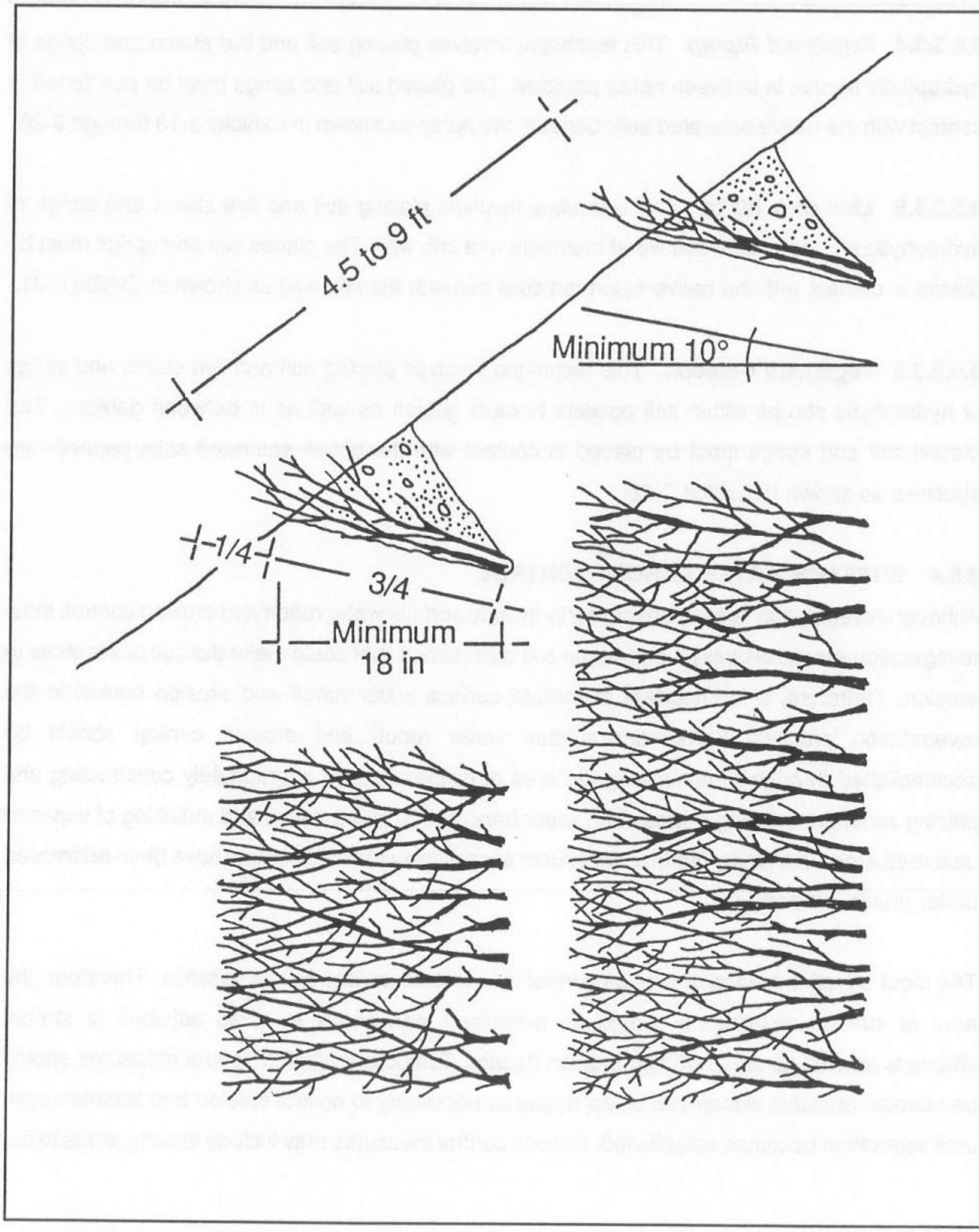


Exhibit 3-16. Design and Construction of Brush Layering for Slope Stabilization.

3.5.3.3.4 ***Vegetated Riprap.*** This technique involves placing soil and live stems and sprigs of hydrophytic shrubs in between riprap particles. The placed soil and sprigs must be positioned in contact with the native saturated soils beneath the riprap as shown in Exhibits 3-18 through 3-20.

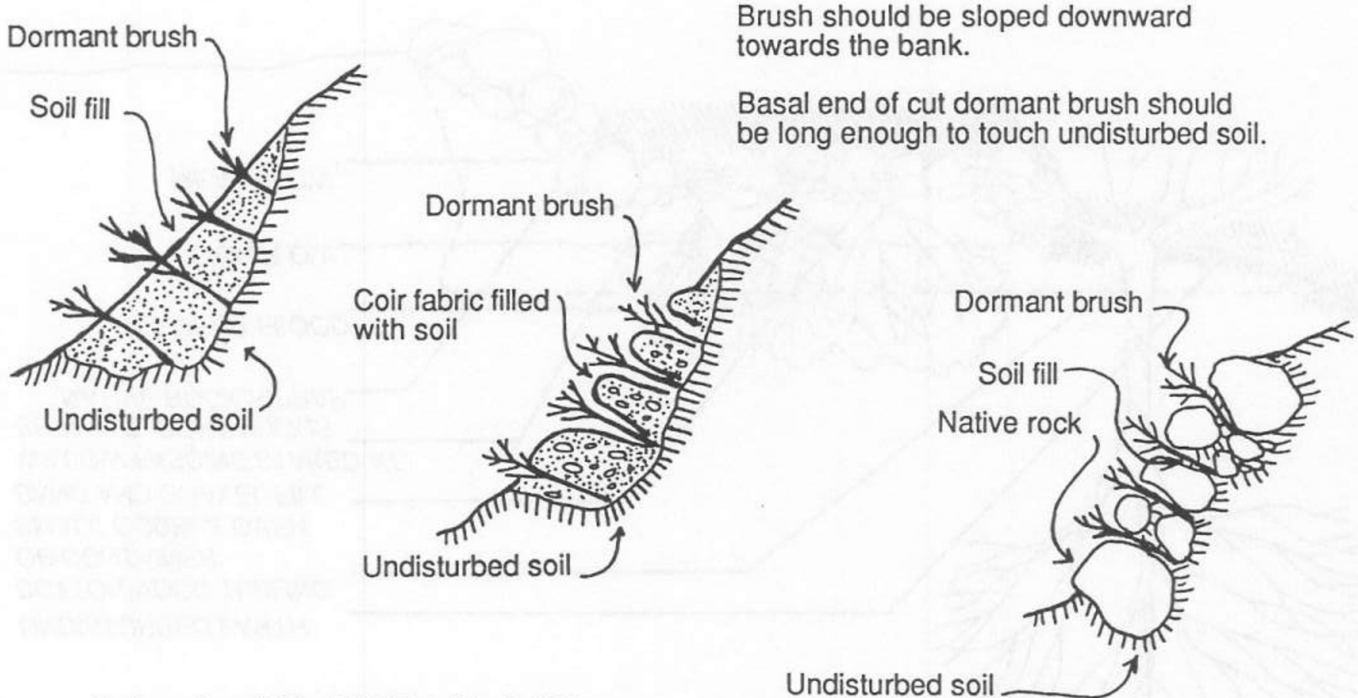
3.5.3.3.5 ***Live Crib Walls.*** This technique involves placing soil and live stems and sprigs of hydrophytic shrubs in between wood members of a crib wall. The placed soil and sprigs must be placed in contact with the native saturated soils beneath the crib wall as shown in Exhibit 3-21.

3.5.3.3.6 ***Vegetated Gabions.*** This technique involves placing soil and live stems and sprigs of hydrophytic shrubs within soil pockets in each gabion as well as in between gabions. The placed soil and sprigs must be placed in contact with the native saturated soils beneath the structure as shown in Exhibit 3-22.

3.5.4 SURFACE WATER RUNOFF CONTROL

Although revegetation does not necessarily include surface water runoff and erosion control, most revegetation processes will involve some soil disturbance that could make the soil susceptible to erosion. Therefore, it is important to include surface water runoff and erosion control in the revegetation process. Temporary surface water runoff and erosion control should be accomplished through 1) minimizing the area of disturbance, 2) appropriately constructing and placing sediment trapping devices and water bars, and 3) revegetating and mulching of exposed disturbed areas in a timely manner. Measures associated with the third item have been addressed under previous headings.

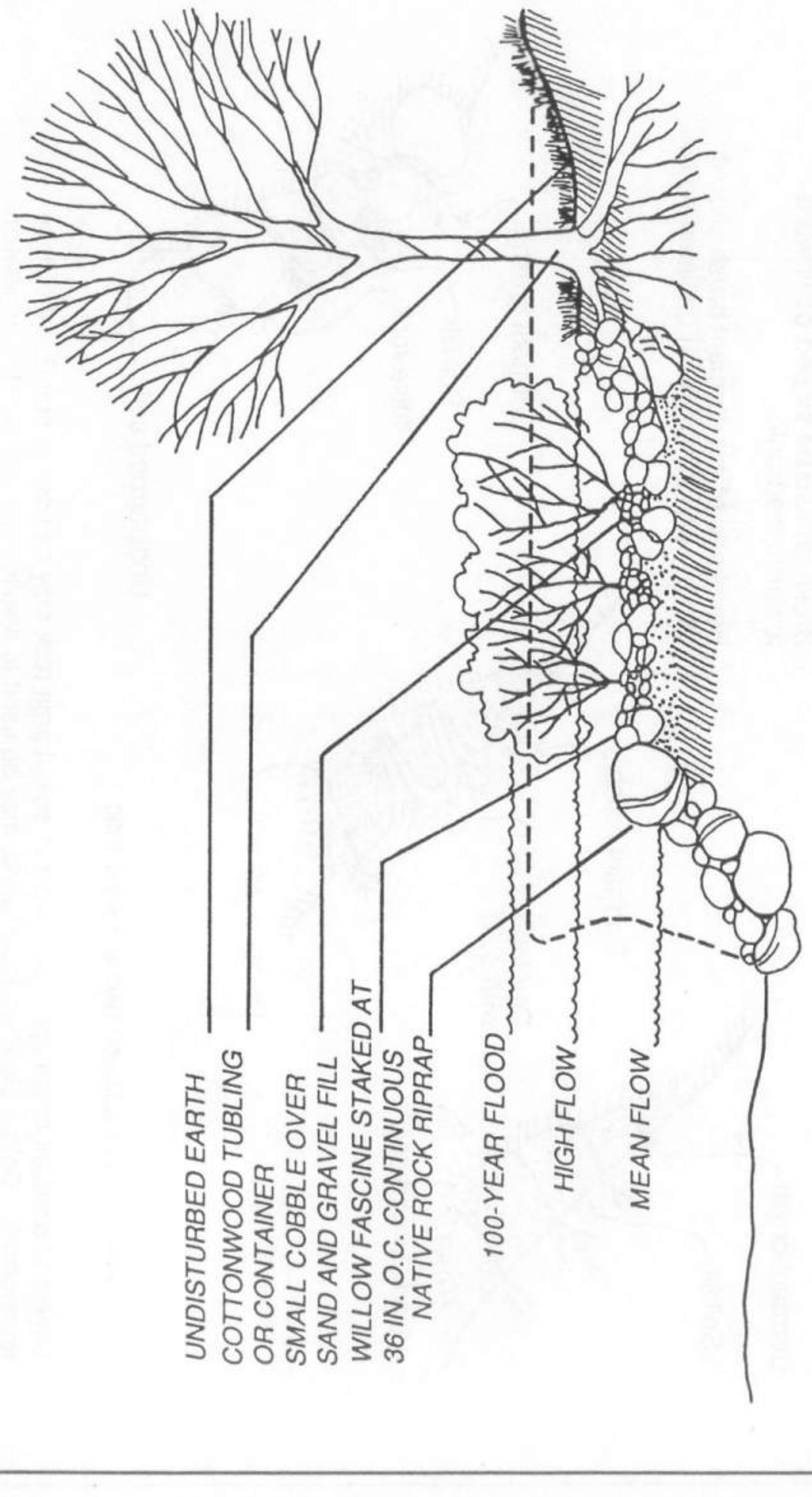
The most effective means of erosion control is to disturb as little soil as possible. Therefore, the area of surface disturbance should be minimized, particularly in areas adjacent to stream channels as well as areas of high erosion hazard. Temporary erosion control measures should be used on unstable slopes and steep slopes as necessary to control erosion and sedimentation until vegetation becomes established. Erosion control measures may include leaving areas to be



Redrawn from Schiechtl 1980 and Sortir 1990

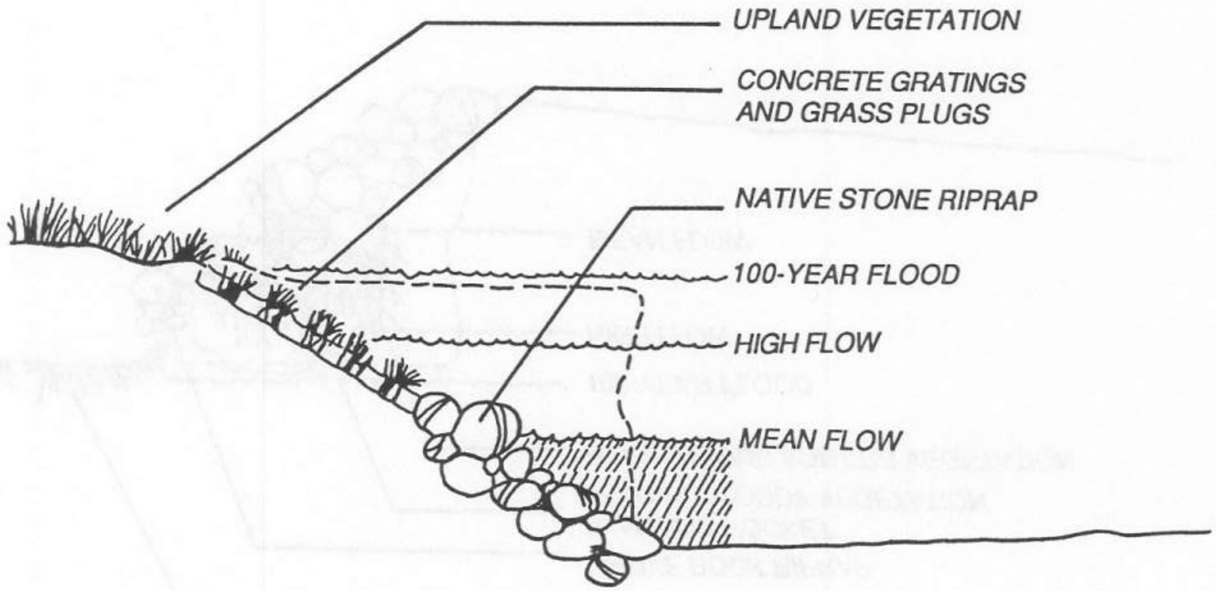
Layers of dormant brush are alternated with soil. Large rock may be used to stabilize the slope immediately. Coir, a biodegradable fabric, may be used to stabilize the soil until the vegetation grows.

Exhibit 3-17. Brushlayering and Installation Techniques.



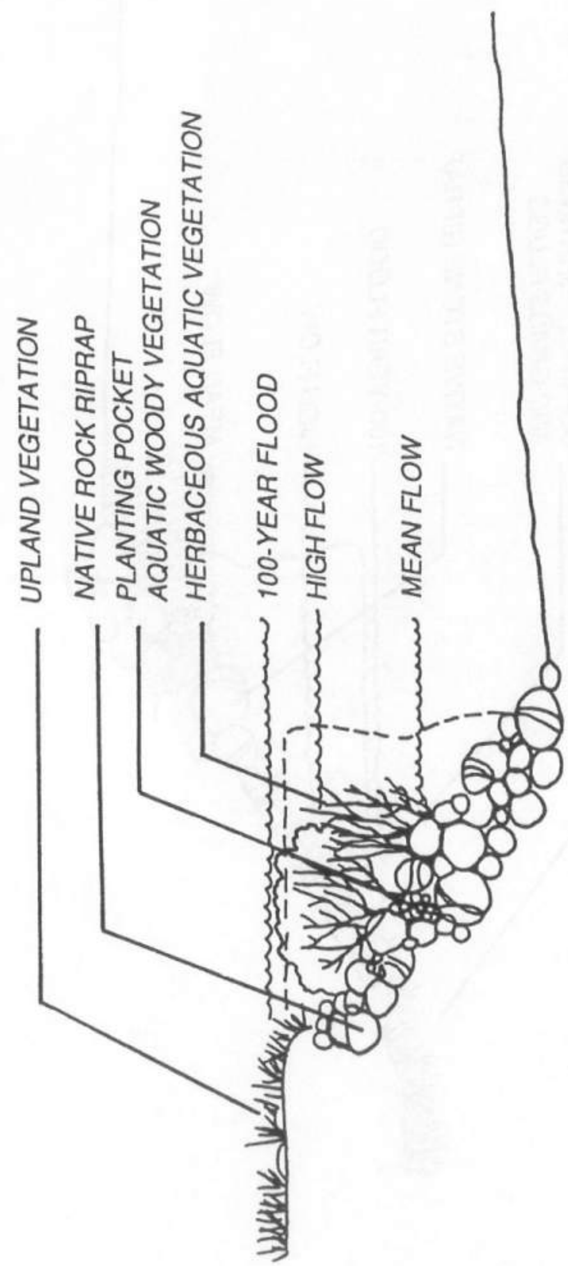
Terraces are stabilized with rock riprap and vegetation.

Exhibit 3-18. Riverbank Regraded and Stabilized at a 1:3 Slope.



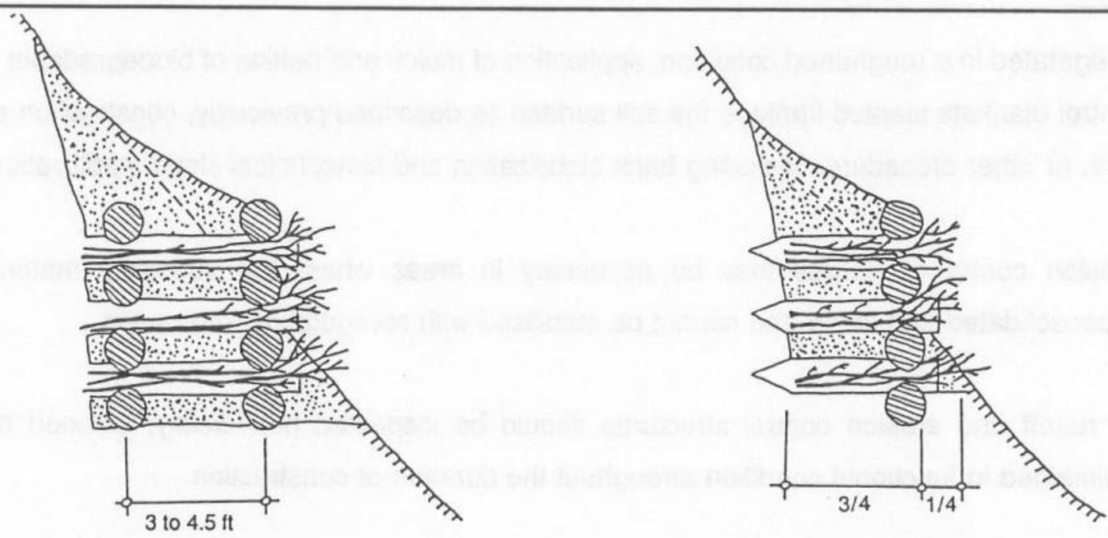
Rock riprap, concrete grating and vegetation are used to stabilize the riverbank. The concrete grating prevents bank erosion in access areas used by recreationists such as for fishing.

Exhibit 3-19. Riverbank Regraded and Stabilized at a 1:2 Slope.



Rock riprap and vegetation are used to stabilize the riverbank.

Exhibit 3-20. Riverbank Regraded and Stabilized at a 1:1 Slope.



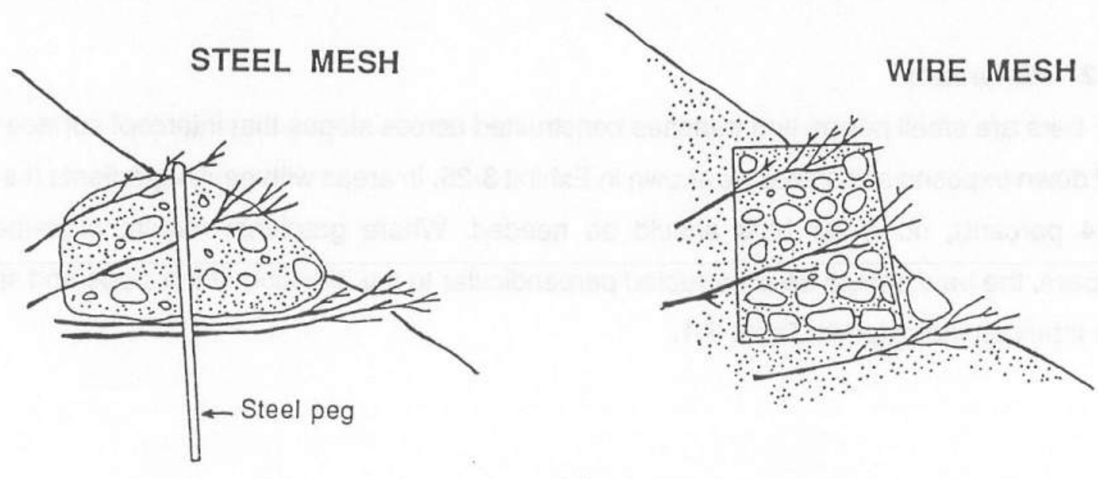
Double-walled live wooden crib wall

Single-walled live wooden crib wall

Redrawn from Schiechtl 1980

The joints between the timber parts should be approximately the same as the thickness of the timbers. Only 1/4 of the live branches should stick out. Avoid hollow spaces when filling. Fill should be fine grained enough to insure plant growth. Ideally, the basal cut end should reach into the soil behind the wall.

Exhibit 3-21. Live Wooden Crib Walls.



Redrawn from Schiechtl 1980

To protect the gabions from washouts (especially along water channel banks) it is best to place them on top of brush layers. Steel pegs can be driven into the ground with a compressor or sledge hammer. Gabions containing large rock can only be planted between the joints of the gabions.

Exhibit 3-22. Vegetated Gabions.

revegetated in a roughened condition, application of mulch and netting of biodegradable erosion control blankets stapled firmly to the soil surface as described previously, construction of water bars, or other procedures including bank stabilization and biotechnical slope stabilization.

Erosion control structures may be necessary in areas where the substrata materials are unconsolidated and loose and cannot be stabilized with revegetation and mulch.

All runoff and erosion control structures should be inspected periodically, cleaned out, and maintained in functional condition throughout the duration of construction.

3.5.4.1 Silt Fences

Silt fences are generally comprised of permeable geotextile fabric stapled onto a vertical structure or hay bales keyed into the soil and placed end to end and staked to the soil surface as shown by Exhibits 3-23 and 3-24. Silt fences should be placed at the base of all fill slopes and disturbed areas as appropriate. Construction of silt fences comprised of geotextile fabric should closely follow manufacturers' specifications.

3.5.4.2 Waterbars

Water bars are small berms and trenches constructed across slopes that intercept surface water runoff down exposed soil slopes as shown in Exhibit 3-25. In areas with gentle gradients (i.e., less than 4 percent), no water bars should be needed. Where gradients require placement of waterbars, the bars should be constructed perpendicular to the direction of the slope and spaced at the intervals indicated in Table 3-1.

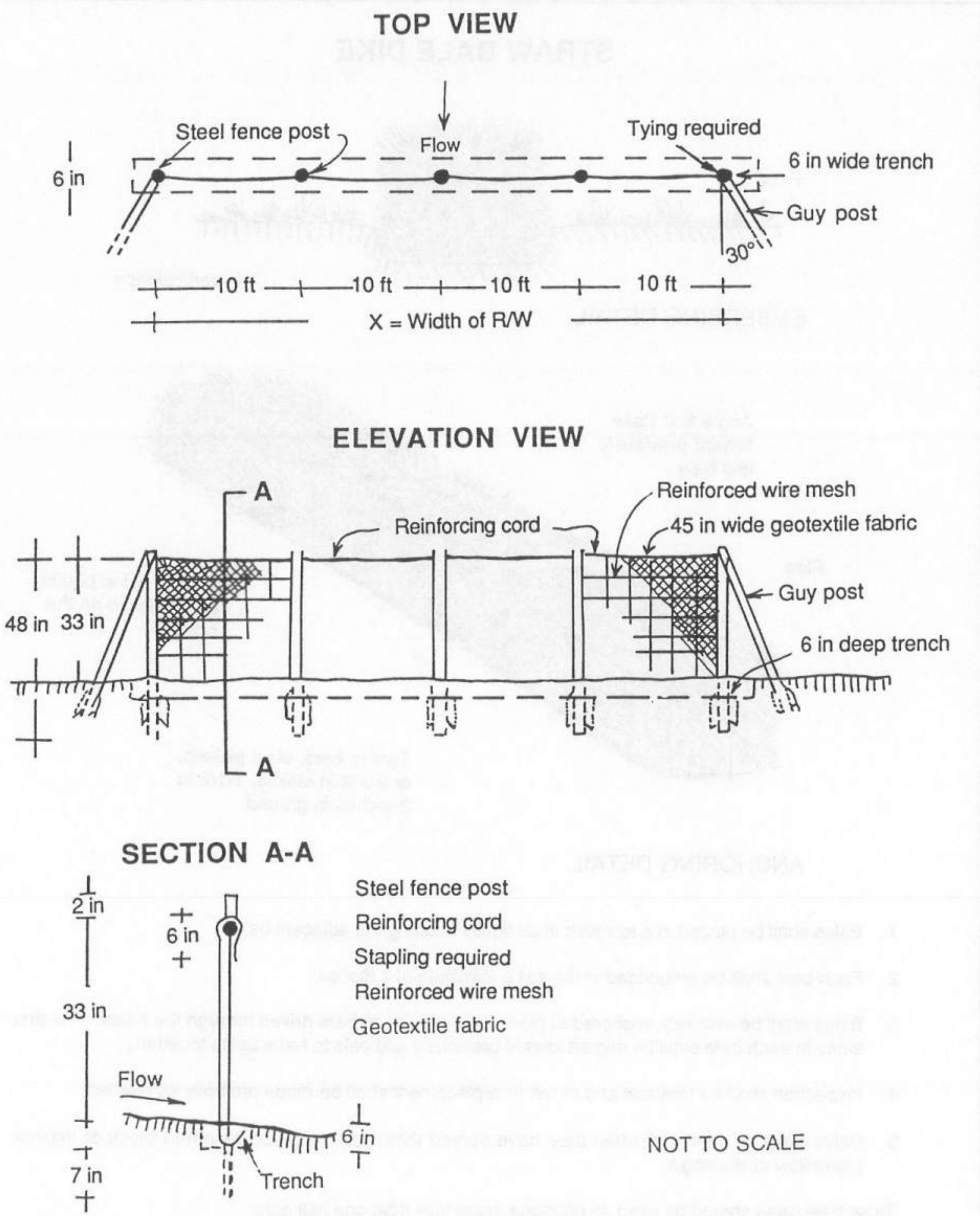
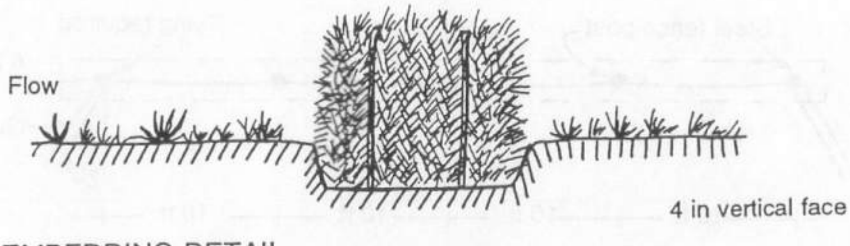
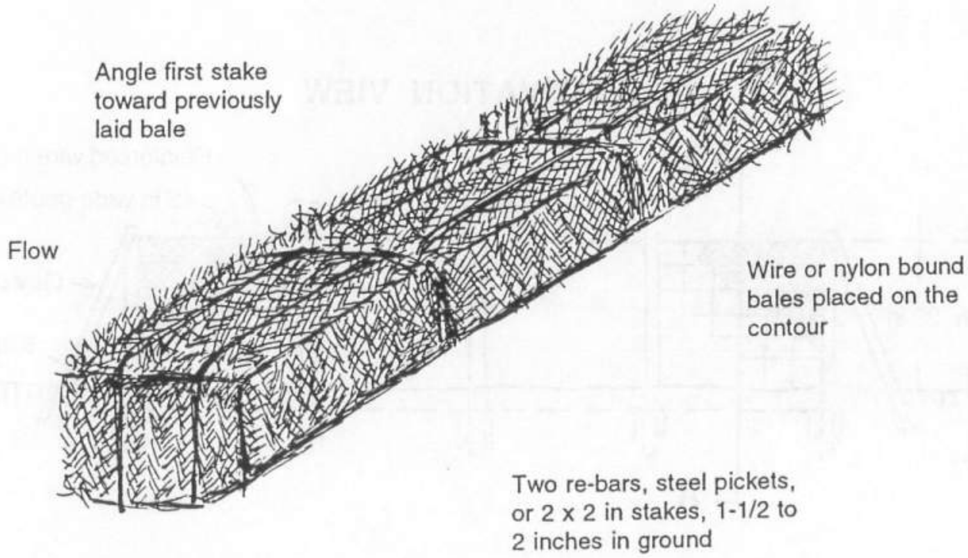


Exhibit 3-23. Example of Silt Fence Construction Using Geotextile Fabric.

STRAW BALE DIKE



EMBEDDING DETAIL



ANCHORING DETAIL

1. Bales shall be placed in a row with ends tightly abutting the adjacent bales.
2. Each bale shall be embedded in the soil a minimum of 4 inches.
3. Bales shall be securely anchored in place by stakes or re-bars driven through the bales. The first stake in each bale shall be angled toward previously laid bale to force bales together.
4. Inspection shall be frequent and repair or replacement shall be made promptly as needed.
5. Bales shall be removed when they have served their usefulness so as not to block or impede storm flow or drainage.

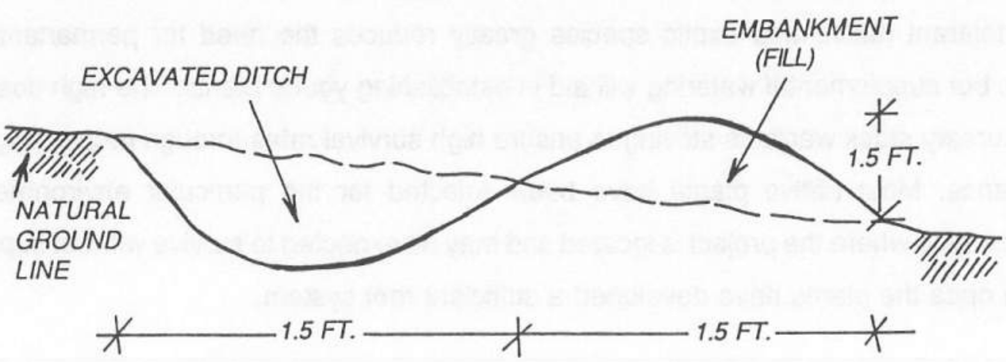
Straw bale dikes should be used on drainage areas less than one half acre.

Exhibit 3-24. Example of Silt Fence Construction Using Hay Bales.

Table 3-1. Water Bar Intervals According to Slope Gradient.

With Mulching		Without Mulching	
Slope Gradient (percent)	**Interval (feet)**	**Slope Gradient (percent)**	**Interval (feet)**
10	150	10	100
15	100	15	75
20	50	20	45
30	40	30	40
40	35	40	35
50	30	50	30
>50	30	>50	30

WATERBARS



CROSS-SECTION WATERBARS

NOTES:

All waterbars will be constructed between 1 and 2 percent gradient across slope.

Waterbars will initiate in and discharge into undisturbed vegetation on both sides of the disturbed area.

Exhibit 3-25. Example of Waterbar Construction.

Water bars should be constructed 12 to 18 inches deep by digging a small trench and side-casting the soil material to the downhill side in a row. Each water bar should initiate in undisturbed vegetation upslope, traverse the disturbed area across the slope at a gradient between 1 and 2 percent, and discharge water into undisturbed vegetation on the lower side.

3.6 IRRIGATION

The decision to apply supplemental irrigation will be based on information obtained from timely monitoring activities. Application of supplemental water may appear to be a high cost option but in the long run may be very cost effective if high-value transplants are prevented from dying by drought.

Application of supplemental irrigation water, particularly under arid land conditions, may be the difference between revegetation success and failure. This is particularly true if species of low drought tolerance have been planted, if plants have not developed an adequate root system, or if plants have insufficient growth to sustain them through a period of drought stress. The use of drought-tolerant native and exotic species greatly reduces the need for permanent irrigation systems, but supplemental watering will aid in establishing young plants. The high cost of larger caliper nursery stock warrants striving to ensure high survival rates through proper irrigation and maintenance. Most native plants have been selected for the particular environment of the vegetation type where the project is located and may be expected to survive without supplemental watering once the plants have developed a sufficient root system.

Three watering options are available depending on the species selected for a particular site during the project planning process. The first option is to install an irrigation system. This method is effective in sustaining relatively dense vegetation in critical areas having high visibility. The second option is to provide supplemental water to transplants to ensure their survival until an adequate root system has developed. Such supplemental irrigation will not be necessary in all years. Close monitoring of site conditions will determine the need for such irrigation. The third option may involve no irrigation. This choice may be selected due to the high cost of irrigation and the expectation that seeds and the resulting seedlings will be able to establish under natural rainfall amounts normal for the site.

3.6.1 WATER SOURCE

Viable sources of water suited for irrigation could come from the following locations:

- Culinary water sources at developed recreation sites
- In-place irrigation systems
- Pumping from the Jordan River, other perennial streams, or canals (with the appropriate authorization)
- Stormwater detention basins
- Temporary water tanks

3.6.2 IRRIGATION METHODS

Several general irrigation methods may be used for maintaining revegetated areas. These types include drip, flood, sprinkle, roller, hose, and subirrigation. The type used will depend on the characteristics and needs of the project sites.

3.6.2.1 Drip

Drip or trickle systems use low-volume, low-pressure irrigation lines that deliver water only to the target area of individual plants or clump plantings through small emitters. Water and energy conservation are major advantages of drip-irrigation systems. Other advantages include reduced weed growth (areas between plants are not watered), reduced puddling (avoiding high evaporation), and the ability to precisely control the amount of water being applied to the plants.

Drip irrigation materials are less expensive than underground sprinkler systems. However, labor costs for installation and upkeep are generally higher because of the increased amount of tubing and the maintenance-intensive nature of the system.

Drip irrigation may be applicable to some aspects of projects within County natural areas. For instance, drip systems could be installed on a temporary basis to help ensure the success of establishing costly, large-caliper container stock. They may also work well near trail edges where substantial visual impact from plant materials is desired.

3.6.2.2 Flood

Flood irrigation is a common practice in the West, particularly for growth and production of hay and alfalfa on otherwise dry uplands. However, this method is less effective than drip or sprinkle types of irrigation methods because it applies water in greater amounts than may be necessary, water is indiscriminantly applied to the entire area (which can promote growth of weed species), and flow through the soil occurs under saturated conditions rather than unsaturated conditions. Flow in saturated conditions temporarily creates a lack of soil oxygen to the plant roots.

Flood irrigation to County projects is not recommended because of lack of source water and inability to inundate areas other than low-lying wetlands which require no irrigation.

3.6.2.3 Sprinkle

Installation of permanent sprinkling systems is recommended for areas where plants requiring considerable amounts of water are located in prominent places where visual screening is essential. The permanent system may consist of fixed sprinkler lines with sprinkler heads and impact-type sprinklers. This system provides complete water coverage of the areas. Water conservation is generally not a high priority under such a system. Salt accumulations (e.g., hardwater lime deposits) may clog the sprinkler orifices. Proper maintenance and care of the sprinkler heads--particularly in areas with water high in calcium--must be exercised to maintain the sprinkler orifices free of accumulations.

For County projects that involve parking lots, trailheads, or other constructed permanent facilities, underground sprinkler systems would most likely be required. Sprinkler systems are appropriate for these highly visual, more formalized areas. Water can be conserved by spraying with reduced pressures and by accurately regulating application rates, frequency, and time of application.

To ensure effective establishment of seeded areas in high use, highly visual areas, sprinkling should be considered during the first year of establishment. In addition, such sprinkling could give the desirable plants a competitive edge over undesirable weedy species.

3.6.2.4 Roller

Roller-type irrigation systems function in the same manner as underground sprinkler systems but operate aboveground and are mobile. The most common use for roller systems is irrigating agricultural areas. Roller systems provide water to a specific area and then the system is moved to the next section. The system is generally simple to operate; however, it requires the use of pressurized underground irrigation lines. Only large open fallow agricultural areas would warrant the use of a roller irrigation system. Due to the high water pressures required to operate this system and the need for a relatively large area to make the system feasible, the County will have very few opportunities to use a roller system of irrigation.

3.6.2.5 Hose

Another irrigation system consists of supplemental irrigation by hoses from existing irrigation or culinary water systems, water-truck tanks, or by hand-carried containers. Water is directed to individual plants. Spot watering from a hose will likely be the most common form of water application, particularly for shrub and tree transplants.

Use of hoses from water tanks on County projects could be practical as many of the areas are accessible by vehicles. Although labor-intensive, supplemental irrigation is critical to the establishment of containerized stock and ensures a much higher success rate.

3.6.2.6 Subirrigation

Subirrigation occurs when the water table is sufficiently close to the soil surface to supply moisture to the overlying soil layers but does not create ponded water conditions. Subirrigation may occur throughout the growing season or only for a portion of the growing season such as during high water table levels associated with spring runoff.

Except for wetland creation projects, subirrigation is not recommended for County projects because of the tremendous cost involved in most areas to excavate the soils down to close proximity of the water table or to modify the water table by bringing it closer to the surface. However, existing areas within some projects may be sufficiently close to the seasonally high water table to provide subirrigation.

3.6.3 QUANTITY OF WATER

As a general rule transplants should be given sufficient water to penetrate 6 to 18 inches, depending on the size of the transplant. Deeper soil moisture encourages a deeper root system that is more likely to survive future droughts. It also makes available a larger area for the uptake of plant nutrients from the soil. Most areas will not involve long-term irrigation beyond initial establishment.

3.6.3.1 Timing

Generally irrigation of any kind is more effective if done during cooler hours. Watering after dark or in the early morning will ensure the highest water pressures. Sprinkling during the warmest part of the day should be avoided if possible to prevent damage to the plants and excessive evaporation of water. Irrigation, where used, will likely be required from mid-spring through the summer.

3.6.3.2 Frequency

Always consider climate, soil, and root depth data when establishing watering frequency for the various plant materials. The goal is to maintain optimum levels of subsurface moisture for the plant root zone. The plant water requirement includes the water lost by evaporation into the atmosphere from the soil and soil surface and by transpiration, which is the water actually used by the plant. The combination of these is called evapotranspiration. Care should be taken to prevent the creation of a "hard pan" around young plants. Plants should be watered thoroughly and then allowed to dry out before re-watering. This will encourage a deeper, more healthy root system. A rough guideline for irrigation frequency follows in Table 3-2.

Table 3-2. Irrigation Frequency Schedule.

Plant Type	Irrigation Frequency	
	Spring	Summer
Small shrubs, vines	2/month	2/month
Large shrubs, small trees	1/month	2/month
Medium to large trees	1/month	2/month

3.6.3.3 Duration

Duration of water application mainly involves the ability of the soil to take up water. If excessive drying, runoff or puddling occurs, adjust the watering time and interval to eliminate the problem and still meet the plant water requirements. Smaller amounts of water applied over a longer duration provides for more effective irrigation than larger amounts of water applied in a short period.

3.7 WEED MANAGEMENT

3.7.1 GENERAL INTRODUCTION

A "weed" is a plant that interferes with the welfare of humankind or the management objectives of a parcel of land at a given time (Whitson 1991). A plant considered a weed in one situation may be desirable in another. A "noxious weed" is any plant that the Commissioner of Agriculture determines to be especially injurious to public health, crops, livestock, land, or other property (Title 4, Ch. 17, Section 2, Utah Code Annotated 1953, as Amended).

Weeds are well adapted for colonizing open, disturbed habitats, as well as relatively undisturbed habitats, and can quickly take advantage of areas with disturbed soils. The following characteristics facilitate rapid colonization (Taylor 1990) and are typical of weeds: 1) seeds germinate in a variety of environments and have considerable longevity; 2) plants are capable of self-fertilization and cross-fertilization; 3) plants have effective seed dispersal mechanisms; 4) plants grow quickly and produce seed in a short period of time; and 5) plants are strong competitors (i.e., they grow more rapidly or exude substances that inhibit the growth of other species).

Information on noxious and other undesirable weedy species is available from many sources. These include agencies such as the County Weed Control Board, State Weed Specialist, County Public Works, County Extension Agent, and/or the Weed and Pest Supervisor as well as published literature (e.g., Whitson 1991, Whitson 1987, Lorenzi and Jeffery 1987, Whitson et al. 1993) and private businesses (e.g., BWC 1993).

The list of noxious weeds and new/invading weed species for Utah includes the species in Table 3-3.

3.7.2 GENERAL MANAGEMENT OF WEEDS

Weeds may be managed by prevention, control, and/or eradication.

3.7.2.1 Prevention

Prevention refers to avoiding contamination or infestation by a weedy species still absent from an area. Prevention can be accomplished by using caution when intentionally introducing non-native species into an area as well as by implementing methods that restrict the unintentional movement of weed seeds into non-infested areas or which inhibit weed germination and growth. Such methods might include covering exposed soil areas with mulch (particularly if certified weed-free straw or hay mulch is used), steam cleaning equipment that might transport weed seeds, or screening irrigation water where weed seeds contaminate surface water transported in canals and rivers, etc.

3.7.2.2 Control

Control refers to weed "manipulation and management for reduction" and may vary in degree (Vallentine 1971). This method is highly dependent on plant biology, particularly the plant life

Table 3-3. Noxious and New/Invading Potential Weeds for the State of Utah.

Common Name	Scientific Name
Officially Designated Noxious Weeds	
Bermudagrass*	*Cynodon dactylon*
Bindweed	*Convolvulus spp.*
Broad-leaved peppergrass	*Lepidium latifolium*
Canada thistle	*Cirsium arvense*
Diffuse knapweed	*Centaurea diffusa*
Dyers woad	*Isatis tinctoria*
Leafy spurge	*Euphorbia esula*
Medusahead	*Taeniatherum caput-medusae*
Musk thistle	*Carduus nutans*
Perennial sorghums	*Sorghum halpense, S. almum*
Quackgrass	*Agropyron repens*
Russian knapweed	*Centaurea repens*
Scotch thistle	*Onopordum acanthium*
Spotted knapweed	*Centaurea maculosa*
Squarrose knapweed	*Centaurea squarrosa*
Whitetop	*Cardaria spp.*
Yellow star-thistle	*Centaurea solstitialis*
New and Invading Weeds, Other Plants that May Require Control	
Black henbane	*Hyoscyamus niger*
Burdock	*Arctium minus*
Camel thorn	*Alhagi camelorum*
Cheatgrass	*Bromus tectorum*
Dalmatian toadflax	*Linaria dalmatica*
Goatsrue	*Galega officinalis*
Houndstongue	*Cynoglossum officinale*
Jointed goatgrass	*Aegilops cylindrica*

* This grass is not considered a noxious weed in Washington County, Utah.

Table 3-3. Noxious and New/Invading Potential Weeds for the State of Utah, Continued.

Common Name	Scientific Name
Poison hemlock	*Conium maculatum*
Purple loosestrife	*Lythrum salicaria*
Purple starthistle	*Centaurea calcitrapa*
Reed canarygrass	*Phalaris arundinacea*
Russian olive	*Elaeagnus angustifolia*
Silverleaf nightshade	*Solanum elaeagnifolium*
St. Johnswort	*Hypericum perforatum*
Teasel	*Dipsacus sylvestris*
Tamarisk	*Tamarix ramosissima*
Velvetleaf	*Abutilon theophrasti*
Water hemlock	*Cicuta douglasii*
Wild proso millet	*Panicum miliaceum*
Yellow nutsedge	*Cyperus esculentus*
Yellow toadflax	*Linaria vulgaris*

cycle (i.e., annual or perennial or biennial), growth stage, and whether or not the plant is affected by apical dominance (where hormones in the upper branches prevent sprouting from buds and nodes lower on the plant stem or roots). Methods of weed control include cultural control, mechanical control, biological control, and chemical control.

3.7.2.2.1 ***Cultural.*** Cultural control refers to the use of different land management strategies to manage weeds. For example, crop rotation can disrupt the life cycle of weed species, particularly if a competitive crop is planted prior to a non-competitive crop. Other examples include the use of alternative planting dates, including planting for maximum growth of the crop species or delaying planting; careful application and timing of fertilizers, especially nitrogen; use of plant density and planting arrangements to shade weeds; use of minimum or no-till systems; and water management alternatives such as drip irrigation or different timing of watering. Often there is overlap between cultural and mechanical control methods.

3.7.2.2.2 ***Mechanical.*** Mechanical control works well for certain species and when weed numbers are limited. This method provides control by weakening the target plant and making it draw more reserve energy from the roots. Mechanical control may be a regimented cutting program, where weedy areas are cut to lawnmower height several times during the growing season. For some species, rogueing (i.e., removing the taproot--often by hand) is an effective means of control; however, rogueing is most effective for areas where weed plants are scattered or in areas just being invaded. It must also be done several times a year to ensure 100 percent control in an area. Burning and tillage practices may provide other means of mechanical control. Clean cultivating has been implemented as a means of cutting up roots and burying the above-ground portion of the weed so that it cannot photosynthesize. Clean cultivating can be used over larger areas of land than either mowing or rogueing.

3.7.2.2.3 ***Biological.*** Biological control uses natural enemies to stress the weedy plant, reduce its competitiveness, and lower its abundance to levels where it is not an economic threat. The classical approach of biological control uses insects, although animals such as goats, sheep, and geese may be used, as may plant diseases. Various host-specific insects attack different portions of a plant. Some impede seed set, others affect the roots, stems, leaves, etc. Often, several different vectors are needed to achieve effective control of a weed species. Biological control with insects is slower than other weed control methods, requiring from 5 to 15 years to gain control of targeted weedy species. This method does not promise to eliminate weeds, but it can provide a long-term, host-specific, non-chemical way to manage weeds.

3.7.2.2.4 ***Chemical.*** Chemical control relates to an herbicides' ability to enter a plant and disrupt a vital function. To be effective, an herbicide must contact and penetrate the plant and then move to the appropriate location (e.g., roots, stems, leaves, etc). Herbicides may defoliate a plant, interfere with seed set, inhibit roots or shoots, inhibit chemical reactions (e.g., photosynthesis, growth regulation, systemic, synthetic hormone), or sterilize the soil. Herbicides can affect all plants (general, non-selective) or only specific target plants (selective). Selectivity relates to the chemical form used, the rate of application, and whether or not surfactants were incorporated. Environmental factors influencing effectiveness include soil moisture, texture, structure, and fertility; the amount of rainfall; temperature/ humidity; wind; and light (Vallentine 1971).

Properties important to safe and effective herbicide application and weed control include the solubility in water, runoff potential, leaching potential, degradation/half-life, toxicity and LD_{50}, and adsorption. Herbicides may be incorporated into the soil prior to planting or weed emergence. They may also be applied after weeds have emerged. Methods of application include spray, dust, and broadcast. Methods vary depending on the size of the area and the type of chemical, chemical combinations, and chemical carriers used. Special precaution must be taken with herbicides to account for spray drift, herbicide volatility, soil organic matter content, and weed resistance (See Weed Sheet 3). The EPA has classified some herbicides as having restricted use. **Only certified private or commercial applicators may apply or supervise the use of such chemicals.** The university extension agent for Salt Lake County should be consulted if a person needs to be certified.

3.7.2.3 Eradication

Eradication refers to the complete removal of weeds. This includes all parts that could reproduce. Eradication of weeds is primarily attempted for areas where weed species are limited and/or just beginning to invade a new area. Methods for eradication and control are similar, but to achieve eradication, the treatments are usually more intensive and occur over a longer period of time.

3.7.3 STEPS FOR WEED MANAGEMENT

The following are general steps and strategies for designing a program for weed management. Measures to control specific weed species are located in Section 3.7.5.

1. Identify the location and extent of weeds (by species) to be controlled. Prioritize the species that will receive management efforts. Priority should be given to any noxious weed species present. Small size (1 acre or less), scattered infestations and new infestations

of any weed species have the highest priority. The goal is to eradicate these infestations. For medium-size infestations (1.1 to 10 acres), with low to moderate weed cover, control and reduction of the weed population are the goals. Chemical treatment is the preferred method. For large infestations (over 10 acres), chemical treatment should be applied to the periphery to contain and prevent spread. The goal is containment. Biological control should be considered for the main body of the infestation if successful biological agents are available.

For the remaining weeds in Table 3-3, weeds that are highly competitive (e.g, teasel, purple loosestrife, reed canarygrass, and tamarisk) should be controlled when they start to out-compete more desirable species. Moderately competitive species (e.g, cheatgrass, burdock, purple starthistle, poison hemlock, water hemlock, and Russian olive) should be suppressed by weed management as needed. The remaining species are low-growing or less competitive and will likely not require management.

2. Consider environmental aspects such as erosion potential, surrounding high-value vegetation, or urban/recreational areas. No weed control or eradication activities should be performed in wetland areas or in proximity to water without prior approval by the EPA.

3. Consider logistics of weed management. This includes costs, management skills, and timing of application. Consult with the appropriate County authority and/or the extension service for current recommended method(s) of control for the selected species. Follow County weed control procedures and instructions on the labels for any herbicides used. Also, perform/apply weed control measures at the appropriate growth stage or season.

4. For each spray operation, record the time, date, location, and amount of each herbicide used as well as the weather data. Avoid drift of spray or dust with chemical weed control. Use separate equipment for applying hormone-type herbicides to prevent accidental injury to susceptible plants.

5. If a restricted-use herbicide is being used, have herbicides applied by someone with a pesticide applicator license.

6. Evaluate results of weed management. Was the target species controlled, suppressed, or eradicated as desired? Were non-target species affected. If so, to what degree? Are new weed infestations present? If so, do the infestations require management at this time?

3.7.4 HERBICIDE SAFETY

Herbicides are primary means of weed control and have inherent hazards beyond those of the other control methods identified in Section 3.7.3. Therefore, this sheet further discusses proper safety, handling procedures, and herbicide properties as abstracted from USDA-FS (1993) and Whitson (1991).

NOTE: The information presented is not intended to be a complete guide to herbicide use. The authors have assembled the most reliable information available to them at the time of publication. Due to constantly changing laws and regulations, the authors assume no liability for the recommendations.

3.7.4.1 Laws and Regulations

1. Clean Water Act
2. Safe Drinking Water Act
3. Resource Conservation and Recovery Act
4. Toxic Substances Control Act
5. Comprehensive Environmental Response Compensation and Liability Act
6. Federal Food, Drug, and Cosmetic Act
7. Federal Insecticide, Fungicide, and Rodenticide Act

Remember:

- A restricted-use herbicide may only be applied by a certified private or commercial applicator.
- It is not legal to disregard instructions on the label or use an herbicide in a manner contrary to the instructions on the printed label (MSDS).

3.7.4.2 Personal Safety Protocol

1. Avoid contact and inhalation of chemicals. Wear protective gear (water repellent coverings are preferable), including long-sleeved shirts and pants, safety goggles, gloves, and respirator.

2. Read the label. KNOW YOUR CHEMICALS. Note all warnings and cautions each time before opening a container.

3. If in doubt after reading the label, contact a person who is qualified to evaluate the hazard of the chemical (i.e., appropriate extension specialists and chemical company representatives).

4. Never disregard instructions on the label--this is a violation of the law!

5. Use proper hygiene. This includes laundering clothing and bathing daily when working with chemicals. Always wash hands before and after handling chemicals.

6. Do not smoke, eat, or chew tobacco when handling chemicals.

7. Know the proper first-aid/poisoning protocol, which should include the following steps:
   a. get the affected person to hospital or physician as soon as possible (if you know the chemical involved, take along the label/entire bottle for the doctor's information);
   b. remove clothing where chemical (especially in the concentrated form) has come in contact with the skin, and liberally bathe the area with soap and water;
   c. if chemical is in the eyes, flush with running or flowing water;
   d. apply general first aid for shock as appropriate;
   e. for chemical ingestion, induce vomiting unless the chemical label indicates other action.

3.7.4.3 Procedures for Mixing, Loading, and Disposing of Herbicides

1. Do not mix herbicides within 100 feet of surface waters or well heads.

2. Add dilution water to spray container after adding spray concentrate, not before.

3. Mix herbicides according to directions and apply at precisely the recommended rate.

4. Have all hoses used to add dilution water equipped with a device to prevent back-siphoning.

5. Mix only the quantity/quantities of herbicides that can be reasonably used in one day.

6. Wear proper protective gear when mixing and applying herbicides.

7. Triple rinse all empty containers. Do this near the application site at rates that do not exceed those on the spray site.

8. Store unused chemicals in a locked building and in a properly marked cabinet or storeroom separate from food, fertilizer, or feed. All chemicals should be labeled.

9. All empty and rinsed containers should be punctured and properly disposed of per DEQ regulations. Do not burn containers that held herbicides.

3.7.4.4 Procedures for Handling Spills

1. Have the following "spill kit" equipment available for cleanups:
   a. a broom and dustpan
   b. a shovel
   c. 10 lbs absorbent material (i.e. "cat litter," soil, sawdust)
   d. box of large plastic garbage bags
   e. protective clothing (including gloves, safety goggles, overalls, rubber boots)
   f. a bucket
   g. highway flares
   h. detergent

2. Minor spills:

   a. immediately wash chemical off anyone it might have spilled on, and don protective clothing if not already wearing it
   b. keep people away from spilled chemicals--rope off area and flag it to warn people
   c. confine the spill--dike with sand or soil, use absorbent material to soak up spill
   d. do not leave area unless there is someone there to confine spill
   e. shovel contaminated material into leak-proof container
   f. transport spilled chemicals and contaminated material to a DEQ-authorized disposal site
   f. **do not** hose down the area
   g. work carefully and do not hurry
   h. do not let anyone enter the area until spill is entirely cleaned up

3. Major spills:

   a. keep people away and give first aid if needed
   b. confine the spill
   c. call appropriate state, county, or federal agencies or Chemtrec for help (CHEMTREC, the Chemical Transportation Emergency Center, is a public service that provides immediate advice for those at the scene of chemical emergencies. They operate 24 hours a day, seven days a week and have a toll-free number for emergencies only: **(800) 424-9300)**.

3.7.4.5 Special Precautions when Applying Herbicides

1. To Prevent Spray Drift:

   a. Use large droplet size to prevent drift. Use low spray pressures (20 to 30 psi) and nozzles that deliver high gallons per acre increase in droplet size.

b. Apply herbicide when wind direction is away from susceptible crops; wind velocity should be below 10 mph.

c. Minimize distance between nozzle and target.

d. Use less volatile herbicide formulations when possible. In particular, herbicides such as 2,4-D esters, MCPA esters, and dicamba (*Banvel*™) have high potential to form damaging vapors and should not be used near susceptible plants.

e. Use a spray nozzle or spray system that produces droplets less subject to drift. Examples include Delavan Raindrop™ nozzle and Spraying Systems™ LP nozzle. Adding Nalco-Trol™ and other non-drift additives to spray mixtures produces larger droplets and reduces drift.

2. To Reduce Herbicide Volatility:

a. Some herbicides volatilize at lower temperatures than other herbicides. Therefore, apply at temperatures most conducive to preventing volatilization of the herbicide being used.

3. Amount of Organic matter

a. Some herbicides (e.g., atrazine, cycloate, EPTC, linuron and pyrazon) are adsorbed or inactivated by organic matter in the soil and require higher rates to be effective. Therefore, organic matter levels should be determined where organic-matter sensitive herbicides are to be used.

4. Some herbicides have been cleared for use in Utah only under EPA-SLN registration. For such herbicides, the user must have the labeling in possession at all times.

5. Restricted use herbicides (indicated on the herbicide label) may be applied only by certified private or commercial applicators.

3.7.5 WEED SPECIES ECOLOGY AND MANAGEMENT

This section only covers the weeds identified in Table 3-3 that have the potential to occur in Salt Lake County. Material on the four knapweed species is presented together. Ecological information was abstracted from Whitson (1991), USDA-ARS (1971), Holmgren and Andersen (1971), Shaw (1989), Evans and Chase (1981), Arnow et al. (1980), Hitchcock and Cronquist (1973), and Welsh et al. (1987). Use of technical terms is sometimes necessary. Terms are defined to the extent possible.

Management recommendations were obtained from USU-CES (n.d.), Vallentine (1971), Jensen (1980a, 1980b), USDA-FS (1986), Lorenzi and Jeffery (1987), Whitson (1991), Lamming (1993), and Whitson et al. (1993). The County Weed Board and/or Extension Agent should always be contacted to obtain the most up-to-date methods for weed control.

3.7.5.1 Bindweed

Ecology: Bindweeds are perennial plants with arrow-shaped leaves arranged alternately along the stem. Flowers are pink or white and funnel-shaped (similar to a morning glory). The stems lie along the ground and twine about objects, giving the plant its descriptive common name. Stems often form dense, tangled mats. Bindweeds reproduce by seeds and extensive, creeping rhizomes. The roots grow in all directions and can penetrate the soil to depths of 6 to 8 feet. Buds along the rhizome send up new shoots. The seeds can survive in the soil for over 60 years. In addition, this plant has a remarkable adaptability to different environmental conditions. The large, fleshy, deep-seated tap root, which can penetrate the soil to 10 feet, makes this plant difficult to eradicate.

Control: Complete eradication of this plant is possible but difficult and requires a persistent effort over a period of time. Perennial sod-forming grasses provide excellent competition. Top growth is easily controlled by cultivation.

2,4-D or dicamba (*Banvel*™) may be used where this weed is associated with grasses. A combination of these two herbicides is the most effective. Best control is achieved when applied to weeds that are actively growing in the post-bloom stage. The herbicide should be applied in late summer or fall but prior to a killing frost. Infestations should be sprayed twice a year.

Picloram (*Tordon*™), a restricted-use herbicide, may also be used to control bindweeds. However, it is registered only on rangeland, permanent pastures, and fallow agricultural land. Timing of application is not critical, but the most consistent results occur when treatment is made in early bud to full bloom stages. This herbicide should be applied as a coarse, low-pressure spray. Only ground applications should be used. Treatment should not extend 10 feet beyond the infestation.

Glyphosate (*Roundup*™) will control bindweed, grasses, and other vegetation in the treated area. This chemical should be selectively applied at full bloom to early seed stage. Application on fall regrowth may provide some control. Plants must be thoroughly wetted but spray runoff must be avoided. Repeat treatments may be required for complete control. Control is improved if the treated area is tilled 2 to 3 weeks after treatment.

3.7.5.2 Broad-leaved Peppergrass

Ecology: This plant is a vigorous perennial that grows over 3 feet tall and may reach heights of up to 6 feet. The stems are much branched, have lance-shaped leaves that are bright green to gray-green in color. Leaves are arranged on alternate sides of the stem. White flowers are densely clustered at the top of the stems. The plant reproduces by the rootstock and seeds. This plant has a deep-seated rootstock and a waxy layer covering the leaves and stems. These features make it difficult to control.

Control: Chemical control with 2,4-D amine should be applied at the bud stage of growth, with repeat treatments as needed. Good grass cover will help control this species. Chlorsulfuron may be applied during bud to early bloom stage. The spray solutions should be mixed with a non-ionic surfactant and used within 24 hours of mixing. Good sprayer agitation must also be used. Alternately, chlorsulfuron (*Telar*™) may be applied during bud to early bloom stage. It should be applied to non-cropland areas. Good sprayer agitation is necessary, and spray should be mixed with a non-ionic surfactant. Use mixture within 24 hours.

3.7.5.3 Canada Thistle

Ecology: This aggressive perennial thistle grows upright two to four feet high. The leaves are very crinkly, dark green, and alternate in placement from one side of the stem to the other. Numerous sharp spines occur on the outer edges of the leaves as well as on the branches and main stem.

Canada thistle flowers are small, light pink to rose purple in color, and brownish tan at maturity. They occur in flat-topped clusters at the top of the stems. The seeds are small and attached to a small tuft of hairs, which permits the wind to assist in scattering. The plant also develops via an extensive, coarse, and branching horizontal underground root system that gives rise to many new shoots--particularly if the above-ground portion of the plant is cut off.

Control: For species such as Canada thistle, chemical control is the most effective method since mechanical methods such as mowing or rogueing only encourage roots to spread. Clopyralid (*Curtail*™) is a non-aquatic chemical herbicide with 90-day residual that works effectively on Canada thistle. It is easy on the root zones and on grasses, but cannot be used where it can come into direct contact with the water table (i.e., on the inside banks of ditches or around ponds). This herbicide should be applied to target plant(s) using a handgun when the thistles reach a height of 4 to 6 inches. The herbicide should not be used as a general spray. Do not let this herbicide contaminate water. Application is necessary only once per year.

Aquatic herbicides that work effectively on Canada thistle include 2,4-D (aquatic label) and *Rodeo*™. The latter, however, will eliminate all grasses and forbs.

Herbicide treatment should occur when the plant is actively growing and approximately 12 inches tall in the spring of the year. Fall treatment can be achieved if mowed and allowed to regrow before applying herbicide.

Biological control with weevils and gall flies can aid in control of this plant. However, control by this method takes considerable time.

3.7.5.4 Dyers Woad

Ecology: This plant is a member of the mustard family and has a distinctive blue-green color on the leaves and stems. It has been described as a winter annual, a biennial, or a short-lived perennial plant. The plant grows up to 3 feet tall. The stems are woody. The leaves are oblong to lance-shaped, alternate, and have a white nerve on the upper surface of the blade. The plant germinates in the spring and forms a rosette of basal leaves. From one to several stems arise from the basal rosette. Flowers are a distinct yellow and are arranged in a flat-topped inflorescence. The seed pods are distinct; they are slightly pear-shaped, one-celled, and winged all around. The plant has a large, fleshy taproot from which it may reproduce asexually. The tap root may extend down to 5 feet. The plant will regenerate from roots if the leaves are removed.

Control: The most important aspect to remember is this: Do not let this plant go to seed! Dyers woad plant can be effectively controlled by rogueing or hand pulling if infestations are not too extensive; however, cutting plants off at the root will only encourage new sprouts. Rogueing needs to be done two to three times each year for two to three years.

Cultivation can effectively control this weed. There are two critical periods. The first is early spring before the plant goes to seed. The second is in late fall.

Use of herbicides in areas with trees and shrubs should be limited to foliar-applied herbicides to prevent damage to woody plants. Glyphosphate (*Roundup*™) or paraquat (*Gramozone Extra*™), may be used. 2,4-D amine or ester provides excellent control when applied to plants in the rosette stage. Treatments should occur after seedlings have started growth in the fall. Repeated treatments are required for control.

If used, the combination of 2,4-D and dicamba (*Banvel*™) should be applied in the bud or bloom stage or in the fall after seedlings have germinated. Plants must be actively growing at the time of treatment. With this chemical application combination, the chemical must not be allowed to contaminate water. It must also not be used in areas with a shallow water table.

3.7.5.5 Knapweed and Starthistle

Ecology: Knapweeds and starthistle are a member of the sunflower family. There are four species of concern: Russian knapweed, spotted knapweed, diffuse knapweed, and yellow starthistle.

Russian knapweed is a perennial plant that has extensive, slender rhizomes that may penetrate more than 8 feet into good soils. The stems are erect, openly branched, and reach up to 3 feet tall. The leaves are oblong-lanceolate. Leaves of newly emerging plants are toothed and covered with fine hairs. These give it the appearance of knap. This gives them a blue-green color. The flowers are pinkish-purplish. They are borne in solitary, thistle-like heads at the end of the stems.

Spotted knapweed, a biennial or short-lived perennial forb, thrives under a wide range of conditions. This plant reproduces by seeds, which germinate whenever the growing conditions are favorable. Spotted knapweed usually remains in a rosette of basal leaves the first year. Stems of the flowering stalk grow up to 3 feet high the second year. Flowers are pink to purple (rarely white) and held in black-tipped bracts. The leaves have an alternate arrangement on the stem and are covered with fine hairs. This plant is highly aggressive and can infest large areas quickly. The plant contains a chemical compound which, if released into the soil, can suppress the germination of other plants.

Diffuse knapweed is a bushy annual or biennial that grows up to 2 feet tall. A rosette forms the first year and the flowering stalk elongates the second year. Leaves are grayish-green and arranged alternately. The upper leaves are smaller than those closer to the ground. Leaves are covered with fine hairs. The stem is erect and hairy. There is a single main stem from the rootstalk. Flowers are usually white but may be pink, rose, or lavender. The seedhead bracts end as sharp, rigid spines. The taproot is elongated.

Yellow starthistle is an erect annual with rigid branching stems. The stems are covered with cottony fibers and grow up to 30 inches tall. Leaves at the base of the plant are deeply lobed. The upper leaves are not lobed but are small and sharply pointed. The flowers are yellow and occur at the end of stems. Bracts beneath the flowers are tipped with a straw-colored, 3/4-inch thorn. This plant has a taproot.

Control: Control of Russian knapweed with picloram (*Tordon*™) can occur at any time during the growing season from when the plants are in the early flower stage up to the first killing frost. Competition with grasses following treatments is important to maintaining long-term control. Spot application of this herbicide should be applied to the foliage. Picloram is a restricted-use herbicide and should not be used near water. Many broadleaf plants are sensitive to this chemical. A treatment of glyphosate (*Roundup*™), applied to the actively growing Russian knapweed at late bud to early flower stage, is usually effective at eliminating most plants. Respraying will be necessary the second year to control the plants not killed by the first spraying. Glyphosate is a non-selective herbicide and should be used with caution.

Both spotted knapweed and diffuse knapweed are susceptible to biological control methods. Both species may be treated with herbicide application of picloram, 2,4-D, or dicamba (*Banvel*™) and 2,4-D. With picloram, application should occur from rosette to mid-bolt stage. Treatment should be applied selectively, and if done at recommended rates, should not damage perennial grasses. In addition, most broadleaf crops are sensitive to this herbicide. Picloram is a restricted-use herbicide that should not be allowed to contaminate water. Fall application should occur only when adequate moisture is available. Using 2,4-D, application should occur at the early stage of flower stem elongation (late April to early May). However, this treatment will only control plants that emerged at the time of spraying. Drift must be avoided. Dicamba application to actively growing rosettes (but before the knapweed bolts) should occur in the spring. Selective treatment will not injure established grasses. Water must not be contaminated with this herbicide. Diffuse and spotted knapweed may also be affected using biological control with gall flies.

Squarrose knapweed, being a long-rooted perennial, is not effectively controlled by mowing, but it does not tolerate tillage. Chemical control of small seedlings can be accomplished by 2,4-D or clopyralid (*Curtail*™ or *Stinger*™). Nearly 100 percent control of mature plants was achieved for 3 years in Juab County using clopyralid (*Curtail*™) and picloram (*Tordon*™) (Dewey 1994).

Since yellow starthistle reproduces only by seed, biological control with weevils can provide an important impact on the species. Means of chemical control include control with metsulfuron (*Ally*™), clopyralid (*Curtail*™ or *Stinger*™), picloram (*Tordon*™) and 2,4-D, or 2,4-D. This plant does not tolerate tillage. Mowing, on the other hand, will delay but not prevent flowering and seed development. Pulling or digging can be an effective means of control.

3.7.5.6 Leafy Spurge

Ecology: This perennial plant has extensively spreading, branched rhizomes and can also reproduce by seed. The roots can penetrate the soil to considerable depth, sometimes as much as 15 feet. Numerous pink buds on the roots may produce new shoots or roots. The stems are erect and up to 3 feet tall, slender, and unbranched except for the inflorescence. The leaves are alternately arranged along the stem, and narrowly linear. There are a number of flowering stems borne at the tops of the stems as well as a single one in the axil of the upper leaves. The flowers are small and greenish-yellow. They are subtended by a pair of broad, heart-shaped yellow-green bracts. The seeds are contained in capsules, which explode when dry. This can throw seeds as far away as 20 feet. Seeds may remain viable in the soil for up to 8 years. This, and the extensive root system which contains large nutrient reserves, makes this plant difficult to control.

Control: Herbicide treatment should occur when the plant is actively growing and in the early bud stage. Fall or spring treatments are possible with picloram (*Tordon*™) and 2,4-D ester. Picloram, a restricted-use herbicide, may be applied at any time during the growing season up to the first frost. This product gives excellent control if follow-up treatments are used. The herbicide can persist for up to 2 years at higher application rates. Picloram must not be allowed to contaminate water. Many broad-leaf crops are sensitive to this chemical.

Lower rates of 2,4-D ester can prevent seed formation in the bud and early bloom stage. Higher rates should be used in early spring applications. This chemical may also be used when infestations are near surface water or over shallow water tables. When mowing is possible, this chemical should be sprayed on new regrowth 2 weeks after mowing.

Leafy spurge is also susceptible to biological control methods using the hawkmoth, flea beetle, mining long-horned beetle, and gall fly.

3.7.5.7 Musk Thistle and Scotch Thistle

Ecology: Musk thistle is a winter annual or more often a biennial plant with stems up to 6 feet in height. Stems are winged from leaf bases. The leaves are dark green with a light green midrib, deeply lobed, and spiny margined. In the basal rosette, the leaves have a wavy, white margin, a large light green midrib, and a smooth upper leaf surface. The large (up to 3 inches wide), nodding flower head occurs singly at the end of the stem. Flowers are deep rose, violet, or purple. Occasionally they may also be white. The bracts beneath the head are broad and have a spine-pointed tip. The aggressive nature of this plant allows it to spread rapidly and form very dense stands that crowd out other species. It reproduces only by seed but can produce in excess of 20,000 seeds per plant, of which 90 percent are generally viable. Ninety percent of the seeds may germinate in the first two years. However, seeds may remain viable in the soil for 10 years or more.

Scotch thistle is quite large (up to 9 feet) and is a coarse, branching biennial. As a biennial, it forms a basal rosette of leaves the first year and sends a stem up from the basal rosette the second year. The stems are broadly winged and spiny. The leaves are large, toothed or slightly lobed, and the herbage is gray to nearly white with soft, wooly hairs. The basal leaves may be up to 2 feet long and 1 foot wide. Flower heads are solitary, numerous, and 1 to 2 inches in diameter. The flower receptacle is flat and honey-combed, and flowers are violet to reddish in color. The involucral bracts are sharply spine-tipped. This plant reproduces only by seed and may form stands sufficiently dense to prevent penetration by livestock.

Control: Chemical control is effective for these thistle species. Application of picloram (*Tordon*™), a restricted-use herbicide, should occur in the spring before the thistles produce seed stalks. Follow-up applications will be needed to control new seedlings and escaped plants. Soil residuals may last over 1 year. Broadleaf species are sensitive to picloram, and the herbicide should not be used near water.

Alternately, a combination of clopyralid and 2,4-D amine (e.g, *Curtail*™) may be applied to these thistle species after seedlings and rosettes have emerged but before the flower stem has fully developed. Lower herbicide rates may be applied if plants are growing rapidly or growing in areas with good soil moisture. Enough total spray volume should be applied to ensure good coverage. This herbicide combination should not be applied when temperature inversions exist.

Also, the musk thistle weevil, which feeds on the seeds, can limit the spread of musk thistle plant through biological control. Another species of weevil attacks the rosettes and interrupts the apical dominance of the plant.

3.7.5.8 Perennial Sorghums

Ecology: Perennial sorghums are typically vigorous grasses arising from coarse, creeping rhizomes. For Johnsongrass, the erect stems reach from 3 to 8 feet high, have a sugary juice, and have prominent nodes. The leaves are flat and open nearly 1 inch wide. The mid-vein is conspicuous. The flowering portion is a panicle with spreading branches arising in whorls. The color tone of the inflorescence is reddish to purple. The spikelets occur in groups of two, with the lower one forming the grain and bearing a twisted and bent awn. The plant reproduces by seeds or rhizomes.

Control: Pulling is ineffective and mowing is almost useless for control of these plants. No biological agents are known. There are several methods of chemical treatment. If used, broadcast treatment of dalapon (*Dowpon*™) should be applied in the spring when sorghum is growing rapidly. A repeat application at 2-week intervals provides best control. Pre-plant treatments plowed before seeding will usually reduce weed competition with little crop injury if proper waiting intervals (up to 6 weeks) follow. Caution: prolonged skin contact may cause irritation. Alternately, glyphosate (*Roundup*™) applied as a spray or by a wiper method is effective on these weeds.

A third method is application of sethoxydim (*Poast*™). This herbicide can be used as a selective foliar spray on sites where broadleaf species are abundant.

3.7.5.9 Quackgrass

Ecology: This erect perennial grass will grow readily in most soils; it is salt tolerant but will not grow on heavily saline areas. The stems are unbranched and up to 3 feet high. The leaf blades are flat, thin, and up to ½-inch wide. The leaf sheaths and blades may be thinly covered with soft hairs. The flowering heads resemble wheat but are more slender. From 20 to 30 viable seeds are produced in each head. The roots are shallow but may penetrate as much as 8 inches in cultivated soil. Rhizomes are usually yellowish-white, extend away from a parent plant for several feet, and branch extensively to form a tough, interwoven mass. This plant may be allelopathic. Broken rhizome segments can grow and produce new plants.

Control: Broadcast treatment of dalapon (*Dowpon*™) should be applied in the spring when quackgrass is growing rapidly. A repeat application at 2-week intervals provides best control. Pre-plant treatments plowed before seeding will usually reduce weed competition with little crop injury if proper waiting intervals (up to 6 weeks) follow. Caution: prolonged skin contact may cause irritation.

Alternately, Amitrole (*Amitrol-T*™, *Amino Triazole*™, *Weedazol*™) may be applied when the grass is making rapid spring growth and is 6 to 9 inches tall. Foliage must be thoroughly wetted, and addition of a non-ionic surfactant provides the best results. Amitrole commercial uses were designated as restricted in 1985, and this herbicide is not registered for use on grazing lands.

Another method of chemical control is with glyphosate (*Roundup*™) using a broadcast treatment. The herbicide should be applied during fallow periods when quackgrass is in the late boot stage to early flowering stage. A thorough wetting of foliage is necessary, but runoff should be avoided as this is a non-selective herbicide. Follow-up treatments may be necessary for complete control.

3.7.5.10 Whitetop

Ecology: This perennial plant competes aggressively with other plants and often forms dense, pure stands. The four-petaled white flowers, which occur in a dense and flat-topped inflorescence, make this plant easy to recognize. This plant spreads via extensive, coarse rhizomes and seeds. Roots are deep. The stems are erect to spreading and up to 2 feet high. The overall color of the plant is somewhat grayish due to the dense hair covering. Leaves are oval or oblong in shape, with the upper stem leaves narrower and lacking petioles. Flowers are numerous, small, and white. They occur in a flat, broad inflorescence at the top of the stem. The fruit is a round- to heart-shaped pod. This species is common in alkaline, disturbed soils.

Control: This species can be effectively controlled with herbicides. 2,4-D low volatile ester or amine applied in the early growth stage provides control. Little control is provided after bud stage, however. When possible, the herbicide should be applied in the spring. Respray should occur in the fall if new growth appears. Alternately, amitrole (*Amitrol-T™*, *Amino Triazole™*, *Weedazol™*) may be applied before the first bloom appears. Thorough foliage wetting is necessary. Caution: all commercial uses of amitrole were designated as restricted in 1985.

3.7.5.11 Burdock

Ecology: This biennial reproduces only by seed. A rosette forms the first year. The flowering stem elongates during the second year. The stem is rough, hairy, and somewhat grooved. The leaves are hairy and alternate; they are dull green above and grayish beneath. The basal leaves are heart-shaped and look like rhubarb leaves. The upper leaves are more oval. Flowers are numerous and clustered. The seedheads are covered with hooked spines and form a bur at maturity. The taproot is fleshy and large. This plant does well in shade and most fertile soils.

Control: 2,4-D amine or ester may be used to control this plant. Treatments should be made before flower buds develop, and plants should be actively growing at the time of treatment.

3.7.5.12 Cheatgrass

Ecology: Also known as downy brome, cheatgrass is an annual grass species that grows 4 to 30 inches tall. This grass reproduces by seed, which germinate in late fall or early spring and mature about 2 months later, by early to mid-summer. Leaf sheaths and blades are covered with a dense, soft hair. The flowering inflorescence is dense, slender, and drooping. The spikelets nod. Awns are up to 5/8 inch long and usually purple with maturity. This plant competes for moisture because of its winter and early spring growth habit. After maturity it becomes a nuisance plant and a fire hazard.

Control: Chemical control may be achieved with atrazine (*Atrazine™*, *AAtrex™*). Application time is in October or November after perennial grasses have gone dormant for the winter. Moisture is required to activate the chemical after application. Atrazine will control cheatgrass before or after germination. Application should occur only once a year using a fan-type nozzle for uniform application. Screens should have no finer than 50-mesh. Agitation should be provided for suspension.

3.7.5.13 Goatsrue

Ecology: This perennial forb has pea-like blossoms that are white to bluish to purple. Flowers are borne in racemes. Flowering begins in June and continues until frost. Seed pods are elongated and pea-like. There are up to 9 seeds per pod, and there may be over 15,000 pods per plant. Seeds are bean-shaped, dull yellow, and may remain viable in the soil for up to 10 years. The plant propagates itself by seed. When mature, this plant will reach 3 feet tall, but can reach up to 6 feet. The plant may have 20 or more stems arising from a deep taproot. The stems are hollow. Young leaves are large, oval and dark green. Mature leaves are odd-pinnate, with 6 to 10 pairs of leaflets. Each leaflet has a small, hair-like projection at the tip.

Control: Mechanical control methods are ineffective as the plant will flower and produce seed even when very small. Use of selective herbicides is the most effective means of control. 2,4-D + dicamba (*Banvel™*), or dicamba used by itself, may be applied to control this species.

Applications should occur twice a year for two years. Plants should be sprayed once in the summer and once in the fall. This usually gives 100 percent control. If needed, herbicide may be applied for a third year.

3.7.5.14 Poison Hemlock

Ecology: Poison hemlock is a robust perennial herb with a taproot. The stems are upright, stout, branched, smooth, and up to 10 feet tall. Conspicuous on the stem are purple spots. Leaves are alternate and pinnately compound. They grow up to 18 inches long and are finely divided into leaflets up to ½-inch wide. Each leaflet is deeply toothed or lobed and smooth. Flowers are borne in umbels, with many umbels per plant. Each umbel is up to 3 inches wide and is subtended by small, lance-shaped bracts. The foliage of this plant has a strong, distinct parsnip odor. The plant tolerates poorly drained soils and frequents stream and ditch banks. All parts of the plant are poisonous. Humans have been poisoned by mistaking the plant for parsley.

Control: Mowing is only a temporary solution for controlling this plant, and there are no biological agents available. Digging or pulling can be highly effective because the weed is a taprooted biennial. Poison hemlock in pastures, rangeland, or non-crop sites can be controlled with 2,4-D or dicamba (*Banvel*™). Sufficient carrier should be used to ensure good coverage. Spray application to the foliage should occur during early growth to early flowering stage. Applications are most effective if made in the first year or before the plants bolt and form a seed head in the second year. Application of metsulfuron (*Escort*™ or *Ally*™) also gives excellent control.

3.7.5.15 Reed Canarygrass

Ecology: This stout perennial grass regenerates from a large rootstock. Stems reach up to 7 feet and are covered with a waxy coating that gives the plant a blue-green color. Leaves are flat and up to ¾-inch broad. The panicle is compact at first, then the branches spread. This is an aggressive species that occurs on wet ground, along streams, and in canals and irrigation ditches.

Control: Glyphosate (*Roundup*™, *Rodeo*™) should be applied from mid-September to after the first light frost. The label should be checked regarding use of a surfactant. This herbicide will control other vegetation in the treated area. *Roundup*™ may be used in non-aquatic areas. *Rodeo*™ should be used near water. Alternately, fluazifop (*Fusilade*™) may be applied to actively growing plants. A surfactant should be used. This chemical should not be applied to stressed grasses. If regrowth occurs, the application should be repeated. Do not apply this chemical if rainfall is expected within 1 hour.

3.7.5.16 Houndstongue

Ecology: This biennial spreads by seed. Leaves are velvety to the touch. Basal leaves are lance-shaped. Upper leaves are narrower, pointed, and clasp the stem. The stem is usually branched above and reaches 3 feet tall. Flowers are dark red and occur in terminal clusters. Fruits are four, flattened, bur-like nutlets that attach to the hair and fur of animals and are easily transported.

Control: Timing of chemical application of 2,4-D (low volatile ester) should occur in early spring before blooming. Herbicide should be applied to foliage. Early applications prevent the plant from forming seed. Since this plant is a biennial, a follow-up spraying the next spring may be needed. Mowing before seed set is also effective.

3.7.5.17 Russian Olive

Ecology: This fast-growing tree reaches moderate heights of 10 to 25 feet. Trunks and branches have 1- to 2-inch woody thorns. Leaves are narrow, 2 to 3 inches long, and covered with small scales that give them a distinctive silver appearance. Scales are more abundant on the underside of the leaves. Flowers are yellow and occur in clusters. Fruits are shaped like small olives. They are silvery when first formed but turn tan to brown at maturity. When allowed to invade low-lying pastures, meadows, or waterways, it can become a serious weed problem if left unmanaged.

Control: Control of Russian olive should occur when the leaves are fully developed. Two to three annual retreatments of 2,4-D low volatile ester may be necessary for complete control. In order to prevent volatilization, this herbicide should not be applied when temperatures are over 85°F. Chemicals should not be applied to desirable trees or in windy conditions. Dicamba (*Banvel*™) broadcast applications on the foliage also provide control. Repeat treatment the following year may be needed for complete control.

3.7.5.18 Tamarisk

Ecology: This shrub or small tree is extremely persistent and resprouts from the roots and stem base. This can make it a serious weed problem species. The plant thrives along water courses and tolerates high amounts of salt. The plant has slender branches. These are covered with scale-like leaves in young growth. Flowers are deep pink to nearly white. They occur in slender spikes terminating the branchlets. The flowers have four to five sepals and petals. Numerous seeds form and have a tuft of hair on one end to aid in dispersal. Dense thickets of this species have little wildlife value, are very aggressive and extremely difficult to remove once established. Tamarisk can root deeply and quickly send up new shoots when cut back.

Control: Experience with most herbicides on tamarisk has been disappointing (Dewey 1994). Tamarisk control is more effective on young plants than old plants. Mechanical removal followed by chemical treatment of regrowth is also more effective than herbicide alone. Small-scale experimenting is recommended to determine the most effective means of control.

Dicamba (*Banvel*™) and 2,4-D provide only temporary control for a season; plants treated with these chemicals will resprout from the base. Imazapyr (*Arsenal*™) and picloram (*Tordon*™) have successfully killed tamarisk. These herbicides may be applied by cutting tamarisk stems 6 to 8 inches from the ground and painting the herbicide on with a brush or small sprayer. Entirely soak the cambium layer but avoid dripping the herbicide on surrounding vegetation and soil. *Arsenal*™ will remain effective in the soil for up to 2 years and will non-selectively kill all plants. Alternately, these herbicides may be injected into the trunks of larger trees. Foliar applications also work; however, the impact to non-target species is much greater than when using the other methods. Reapplication of herbicide treatment may be necessary for effective control. **NOTE:** Tamarisk generally grows near water or in areas with a high water table. *Tordon*™ cannot be used in such areas. *Arsenal*™ is approved for some sites where *Tordon*™ is not. Always follow the label instructions to prevent harm to the water and other plants. An alternate herbicides includes triclopyr (*Garlon*™ or *Crossbow*™). A spray of this chemical should be broadcast applied to the foliage. Glyphosate (*Roundup*™) is ineffective on this species.

3.7.5.19 Teasel

Ecology: This biennial forb has spine-tipped heads and has become a common weed along ditch banks and pastures, especially in rich, damp soils. The stout, stiff stems have prickles arising from prominent angles. A rosette of conspicuously veined, spiny leaves forms during the first year.

The plant stem grows the second year and reaches heights of 6 feet. Stem leaves are opposite, with upper pairs fused at the base to form a cup. The flowers are pale lavender and borne in dense, spiny heads.

Control: No biological control agents are known. Digging can be effective if all rosettes are removed and if the operation is repeated at least once a year for several years. This will deplete the soil of all dormant seeds. Repeated mowing over several years can also reduce seed production in this plant because bolting in this plant is slow and difficult for many plants. Mowing should occur after flower heads appear. Two mowings per season are more helpful. This inhibits seed production and encourages the plant to use up root reserves.

The best herbicides for controlling teasel contain either metsulfuron (*Escort*™ or *Ally*™) or chlorsulfuron (*Telar*™). Addition of a non-ionic surfactant is necessary for these products to be effective. In addition, both are more effective when applied in combination with 2,4-D. Because teasel is a biennial, it should be treated during the first year before the basal rosettes bolt. If the plants have already bolted, mowing prior to herbicide application is recommended. Knocking down or burning last year's dead stalks improves spray coverage on rosettes and small seedlings.

Chemical application of dicamba (*Banvel*™) in early to mid-spring when the plant is actively growing is also an effective means of control.

3.7.5.20 Jointed Goatgrass

Ecology: This grass is a winter annual that spreads only by seed. The stems stand erect up to 30 inches tall. Leaves are arranged alternately. Leaves can be smooth or hairy. The seedhead spike is cylindrical and more than 10 times long as wide. Spikelets are awned. The uppermost spikelets have especially long awns. At maturity, the spikelets separate and look like wheat stems. Roots are shallow and fibrous.

Control: Glyphosate (*Roundup*™) may be used as a spot treatment in scattered infestations of jointed goatgrass to prevent seed formation. The herbicide should be applied when all plants have emerged and are fully tilled. Other chemicals such as atrazine or paraquat may also be used. Caution must be used with application of glyphosate as it is non-selective and will kill other plants.

3.7.5.21 Toadflax

Ecology: Toadflaxes are a member of the snapdragon family. Dalmatian toadflax is a perennial forb that spreads by creeping rootstocks as well as seed. The plants grow to 3 feet high, are pale green, and have bright yellow flowers. The flowers are tinged with orange. Leaves are heart-shaped and broad. They clasp the stem.

Also called butter-and-eggs, yellow toadflax is a 3-foot-high perennial with bright yellow flowers. The flowers have a deep orange center. The stem is smooth, erect, and sometimes branched. The leaves are long and narrow. Their color is pale green, and they attach directly to the stem. The roots are woody. This plant spreads by seeds and creeping root stalks.

Control: Herbicide treatment with picloram (*Tordon*™) should occur when toadflax plants are actively growing in the spring before full bloom. Application during the early bud or rosette stages produce good results. Picloram (*Banvel*™), however, is a restricted-use herbicide and must not be allowed to contaminate water. Selective treatment that targets toadflax is recommended as many other plants are sensitive to this chemical. Alternatively, 2,4-D is effective when applied in the early bloom stage.

3.8 VEGETATION MAINTENANCE/MANAGEMENT

Essential to a vegetation reestablishment program is the quality of maintenance, both immediately after the project is completed and for several years following the project. Any effort to enhance vegetation establishment and recovery requires close coordination between the construction project management and maintenance personnel. Areas need to be clearly marked. Personnel need to be fully informed about which maintenance activities should be done and how they are to be scheduled in those areas that are undergoing plant establishment and site stability. Maintenance activities will vary among areas being revegetated; thus, the impact of maintenance or no maintenance will also vary. A general rule is that continual disturbances of a site via mowing, herbicide applications, etc. will hinder recovery of the native vegetation unless coordinated with the specific needs and tolerances of the native plant species. Site-specific maintenance plans should be developed and modified according to the information gained in a monitoring activity.

Maintenance procedures to control vegetation generally consist of mowing, brush cutting and trimming, and application of herbicides or growth regulators. High impact management procedures such as these, if used, must be planned to enhance plant survival as well as ensure safety and the stability of sites following establishment. For the most part, however, revegetated areas should be designed to be relatively maintenance-free.

3.8.1 REQUIREMENTS AND GUIDELINES

3.8.1.1 New Plantings

Plantings may require 25 years to become fully established into a mature stand in arid/semiarid areas (Thornberg 1982). Because of this, an area may look like a revegetation failure at the end of the seeding year but can still develop into an excellent stand. As seeds may germinate 1 to

2 years after seeding (due to dormancy and moisture requirements), no reseeded areas should be destroyed until they are examined by someone who can identify seeds and seedlings. Shrubby species need longer period of protection and more time to establish than grasses.

When finished planting, repair any injuries that may have occurred to the tree or shrub by pruning affected branches. Only prune dead or injured twigs or branches, and prune in such a manner that the natural shape of the plant is not affected. Make all cuts flush with the plant--do not leave stubs. Be sure to smooth and shape the wounds so they will not retain water.

3.8.1.2 Long-term Mature Plantings

As a general rule, native woody vegetation should receive minimal maintenance. Because plants should have been chosen for the visual needs (including the natural height and diameter of the mature plant) for a particular site, pruning should occur only where plants surpass their normal size and create safety hazards by obstructing lines of sight.

Maintenance pruning should be performed sparingly and only when truly needed. Always exercise care in maintaining the natural shape of the plant. Never top or mash woody plants! Take particular care with the vital growing points. These occur at the tips of the lateral or central stems. Injudicious cutting at these locations can severely alter and/or destroy the natural shape (e.g., the tops of pine trees). If it becomes necessary to check the upward growth of a shrub or tree, cut the ends of the uppermost branches. This will encourage the plant to increase lateral growth and create a more bushy plant form.

Maintenance of forbs is essentially the same as for woody plants. Cutting the tops will also result in a bushier plant. However, if the plants are topped prior to flowering, seed production may be sacrificed. For annual forbs, the loss of seed for more than a year or two will result in the disappearance of the species. In many maintenance procedures, frequent mowing is a routine practice to reduce plant density and flammable plant litter as a fire prevention measure. Unless dictated by safety or true aesthetic objectives, reduction of mowing frequency, even eliminating it, may be a good means of reducing maintenance budgets.

Untimely and persistent mowing of native perennial plants can inhibit plant vigor, which can induce changes in species composition. This may encourage the invasion of weedy species of annuals. Carefully evaluate management practices such as mowing or burning to ensure that they will not be counterproductive.

3.8.1.3 Supplemental Watering

Although the primary emphasis of this manual is revegetation establishment through irrigation where needed, supplemental watering may be required for effective establishment and maintenance. See the Irrigation discussion (Section 3.6) on watering.

3.8.1.4 Follow-up Seeding

Areas that have poor revegetation success may require reseeding. However, as seeds often have a dormancy requirement, reseeding should not occur until two years after the initial seeding. Modifications of the original seed mix to obtain better results may be justified based on monitoring of the first two years.

3.8.2 NATURAL SUCCESSION

Vegetation composition and density changes over time. Open areas become overgrown; trees and shrubs will die out and leave "gaps" in the vegetation. Such change is normal and desirable and provides visual and wildlife habitat diversity. Maintenance procedures should not attempt to counteract this natural process.

However, overgrowth may require maintenance in areas near trails, etc. Maintenance practices may involve mowing, pruning, and/or controlled burning. The use of fire may be detrimental as it will destroy most desirable shrubby species (Thornberg 1982); therefore, prescribed burning as a maintenance and management procedure should only be used with expert assistance. Areas with poor vegetation establishment may require reseeding.

3.8.3 WEED MANAGEMENT

Refer to the previous discussion on Weed Management (Section 3.7).

3.8.4 WILDLIFE

Plantings need to be capable of providing cover, food, and escape for specific wildlife species (Thornberg 1982). Target wildlife species have been identified for each cover type described in Section 4 of this manual.

3.9 MONITORING/REMEDIATION

A monitoring program locates problems and develops recommendations for remediation of problem areas, if necessary, as well as maintenance. Monitoring is often overlooked but is a vital part of ensuring that reclamation activities are completed properly and revegetation is successful. Monitoring has the potential for considerable cost savings, particularly with regard to halting erosion problems before they become serious. In addition, monitoring of plant establishment provides valuable information on the success of past management practices. This information can guide future decisions and circumvent the expense of repeat seeding or planting in order to achieve successful revegetation.

A monitoring program has reduced value if a maintenance program is not part of the revegetation plan. Identifying problem areas is only the first step; the real benefits come from the correction of those problems in a timely manner. Very seldom will a vegetation establishment project result in a complete success in all of its aspects. Remedial actions may require something as simple as filling in small erosion rills and retacking excelsior matting or as major as regrading and filling a slope then reseeding it. Obviously, on-site information is needed to substantiate and guide the follow-up activities. The resulting recommendations should reflect the visual and numerical observations of the various specialists monitoring the project. Any recommendations should be formulated in relation to the original project criteria and specifications.

3.9.1 GOALS AND OBJECTIVES OF MONITORING

The goal of a monitoring program is to evaluate the success or failure of all revegetation activities and management practices. Monitoring also verifies compliance with contract specifications and ensures that adequate data will be available to guide remedial actions, if required. A clear understanding of the goals and objectives of the monitoring program will help all participants to support the effort. Several objectives may be appropriate in planning a monitoring program:

- Gather general observations about site conditions and slope stability and identify which erosion control and site stabilization methods were successful and why. Also identify methods that were unsuccessful and why.
- Gather data on the survival and vigor of existing plants in relation to the numbers specified in the construction contract. Determine species suitability for site-specific conditions.
- Evaluate plant establishment and survival in relation to site and weather conditions. Identify and evaluate areas with revegetation success and areas with failure and determine why.
- Summarize monitoring information and prepare recommendations for follow-up remedial activities.
- Establish cost-effective long-term maintenance procedures and evaluate alternative revegetation techniques for cost effectiveness.

3.9.2 COORDINATION

Because monitoring often may involve specialists with botanical and engineering technical skills, there is need for coordination among these people so that the goals of the monitoring program can be achieved. Further, any background information on a project's history should be shared prior to field monitoring visits. Communication of results following development of monitoring data is important to ensure that appropriate use of information will be made in preparing remedial and maintenance programs.

3.9.3 TIME FRAME OF MONITORING

The schedule of the monitoring and maintenance activities depends on the reclamation program implemented. Construction monitoring should occur during the implementation of the revegetation activities to ensure that work is carried out according to specifications. Performance monitoring should occur for 3 to 5 years following such implementation to ensure that revegetation has been successful. Correction of improper techniques or misinformation is far more effective and far less expensive if detected and corrected early in the construction activities.

It is recommended that a minimum of two monitoring visits per year occur during the first two years following the revegetation of high priority sites; at least one visit per year should be made for low priority sites. Visits should be timed so that the maximum benefits can be obtained such as following a rainfall event to evaluate water management techniques or at the peak of the growing season to determine the reseeding success. All sites should be revisited annually for at least three years and revisited once after an additional 2 to 3 years to assess the longer term stability and plant survival.

3.9.4 PERFORMANCE STANDARDS

Quality control of all project aspects requires information that compares the expected results with those that have been obtained at any given time after the project has been completed. Since revegetation success is based on the objectives specified above and in Section 1, the following monitoring performance standards have been tiered to them.

3.9.4.1 All Years

- Protective cover - all disturbed areas to be left bare, unprotected, or unvegetated for more than one month will have at least a 50 percent cover of protective material in the form of mulch, matting, or vegetative growth. This does not apply to work areas.

3.9.4.2 Second Year

- Seedling Density - the density and abundance of desirable species is at least three to four seedlings per linear foot of drill row (if drilled) or transect (if broadcast).

- Percent Cover - total vegetal cover will be at least 50 percent of predisturbance vegetal cover as measured along the reference transect for establishing baseline conditions.

3.9.4.3 By the Fifth Year

- Percent Cover - total vegetal cover will be at least 80 percent of predisturbance vegetal cover as measured along the reference transect for establishing baseline conditions.

- Dominant Species - 90 percent of the revegetation consists of desirable species included in the seed mix and/or that occurs in the surrounding natural vegetation as measured along the reference transect for establishing baseline conditions.

- Erosion Condition/Soil Surface Factor - erosion condition of the reclaimed areas is equal to or in better condition than that measured for the reference transect for establishing baseline conditions.

- Visual Aesthetics - horizontal and vertical structure, species composition, and color combinations conform to the objectives identified for each cover type in Section 4.

3.9.5 GENERAL OBSERVATIONS

Revegetation success should be monitored both in the short term (temporary revegetation) and long term (final revegetation). Monitoring of both temporary and long-term measures should include 1) visual observations of soil stability and overall aesthetics, 2) observations on the condition and effectiveness of mulching and runoff and erosion control measures, 3) photomonitoring, and 4) a quantitative and qualitative evaluation of revegetation success where appropriate.

The following items should be noted during onsite inspection(s):

- soil slumping
- channel siltation
- noxious or undesirable weed invasion

- degree of herbivory by wildlife (including insects, rodents, and lagomorphs) on seed, seedlings, or planted materials
- revegetation success
- degree of trampling on revegetated areas
- channel erosion
- sheet and rill erosion
- soundness and effectiveness of erosion control structures

3.9.6 PHOTOMONITORING

Photographic documentation of site conditions at timed intervals (e.g., monthly, or seasonally), can be helpful to guide future projects and to evaluate revegetation activities. Usually 2 to 4 rolls of film, (36 exposures/roll) are adequate for most documentation. Colored photographs, both closeup (1 foot) and site panoramic views, are especially helpful to document changing conditions. These photographs are also useful to landscape architects or private consultants whose services may be required to address specific problems that may develop beyond the expertise of the local office.

Permanent photomonitoring points should be established at appropriate vantage locations that provide adequate visual access of revegetated areas. Each photomonitoring point should be permanently marked with re-bar and identified on a topographic map of the area. The location of each point should be described in detail to assist in relocation. Photos should be taken at each photomonitoring point prior to initiation of reclamation activities. Photos, framing the same scene as previously taken, should be taken each year to document revegetation success and/or indicate necessary remedial measures.

Video camcorders are also an excellent tool to help record visual and audio notes. The use of videotape provides the opportunity to capture panoramic views together with notes and field decisions that may help document directives to contractors and future notes for follow-up. Use of camcorders is becoming more commonplace for monitoring vegetation.

3.9.7 EVALUATION

Project information may cover a number of specific items as well as those of a general and major nature. Two general monitoring techniques are available for determining project results:

1. Reconnaissance of the project area to observe and make notes of deficiencies in topographic objectives, stability or erosion of soil surface materials, anchoring of surface mulches, appearance of seedlings, evidence of any dead seedlings, condition of transplanted plants, and presence of unwanted weeds that could cause problems for survival of plants.

2. Quantitative methods consisting of counts of living plants, either seedings or transplants. Commonly used approaches include counting the number of plants in: a) specific areas such as samples from a length of row if seeded in rows by a mechanical seed drill or, b) the number of plants in representative sample plots in areas such as a circle or quadrant if the seeds were broadcast. Where transplants have been planted in a random fashion in a grouping, the total number of individuals, by species, should be determined in representative areas.

Monitoring need not involve extensive data gathering on species density or production. The alternative could be to make a rapid qualitative assessment of species establishment and growth, and identify problem areas. The assessment could provide much more information with considerably less cost. The value of such a monitoring program is very real and provides information for not only improving future reclamation by selecting those techniques or species that performed the best but also by providing cost savings through eliminating those aspects of the reclamation plan that were not effective.

In larger tracts of revegetated land or areas of higher concern, quantitative revegetation evaluation may be accomplished. If done, this evaluation should be done annually in August until performance standards have been met. Procedures should follow Forms I and II. Parameters to be measured include percent cover (plant, litter, rock, bare ground, total), dominant species and percent composition, seedling density and abundance, grazing utilization, and erosion condition.

Revegetation success should be determined through monitoring and evaluation of percent ground cover to include a measure of vegetal cover (by species), litter/mulch, rock/gravel, and bare ground. Groundcover should be documented at each 1-foot intervals along a 100-foot line transect. Seedling density and relative abundance should be determined by selection of plots at the 20-, 40-, 60-, and 80-foot marks on the transect. Grazing impacts should be assessed as an ocular estimate of the percent utilization along the transect.

The condition of the soil surface relative to erosion and erosion protection should be annually observed during the monitoring process along the monitoring and reference transects. Parameters listed on Form II, Part C, should be evaluated to arrive at a soil stability rating. Soil stability should be measured using an erosion condition class/soil surface factor rating method to numerically rate soil movement, surface litter, surface rock, pedestalling, flow patterns, and rill-gully formation. Information obtained through this rating system represents an expression of current erosion activity and can be used to reflect revegetation success as a function of soil stability.

3.9.8 REMEDIATION

Site conditions are always subject to change. Annual monitoring should assess effects of this change relative to site conditions and/or management practices on newly developing plant communities.

Preliminary observations at a site may sometimes lead one to conclude that there has been a complete failure of a management practice. However, long-term monitoring has shown that the conclusion of revegetation failure can be a hasty conclusion and that more time is often required before accurate conclusions can be made. For example, because many species of native seeds have a hard seed coat or have some kind of natural dormancy, not all seeds will germinate during the first favorable period. Thus, it is not reasonable to expect 100 percent germination. This is a natural protection for the species which ensures some viable seed carryover from season to season under natural conditions. If an extended dry period occurs after the seeding and a large portion of the seedlings die, the site should be monitored after a subsequent season to determine if any new seedlings have developed from dormant seeds. Even if a few plants become established, the subsequent production of seeds may be a means of increasing plant density through natural seed production and seedling establishment.

Keeping these aspects in mind, if an area does not exhibit successful revegetation (as determined through monitoring), that area should be reseeded such that an adequate cover of vegetation is established. See the discussion under Maintenance/Management.

If monitoring indicates that 1) trampling, 2) herbivory by insects, and/or 3) invasion of undesirable plant species are deterrents to revegetation success, a control plan should be designed and implemented. The plan may indicate the need for fencing of sensitive sites. If pesticide use is necessary, a Pesticide Use Plan should be prepared and approved by the County prior to implementation. At a minimum, this plan should indicate the pest(s) identified for control, the type and quantity of material to be used, the method of application, the storage location, and the method of container disposal. Pesticide application should be in compliance with all applicable state and federal laws.

3.9.9 REPORTING

The level of reporting should fit the project's needs. If the information should be used to direct a local maintenance program, the reports may be provided on the basis of memoranda containing summarized field data and a set of recommendations for immediate and necessary remediation and maintenance. Where a more formal report, such as a final analysis of project results is desired, a detailed and documented report, including tables of statistically analyzed data and photographs, should be prepared. Copies should be provided to all appropriate levels of management.

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SECTION 4:

SPECIFIC REVEGETATION PRESCRIPTIONS

SECTION 4: SPECIFIC REVEGETATION PRESCRIPTIONS

4.0 ORGANIZATION OF SECTION

This section focuses on revegetation prescriptions for cover types identified in Section 2.1. Where the previous section provided general information relevant to all cover types, this section focuses on specific cover-type recommendations and references general information as appropriate. For each cover type, information is provided on revegetation objectives, site clearing, seedbed preparation, seeding, planting, erosion control, irrigation, weed management, management/maintenance, and monitoring/remediation. Where appropriate, discussions are provided for implementing revegetation procedures for small and large areas. Tables A-1 and A-2, Appendix A, list substitute or alternate species that can be used in place of recommended seed and plantings due to excessive cost or lack of availability, etc. These tables also identified flowering period and flower color of all species where appropriate.

Each cover type prescription is prescribed in a following stand-alone section, which can be pulled out from an 8½ x 11 in. three ring binder. Photographic examples of each cover type are presented at the end of each section.

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4.1 MIXED CONIFER

4.1.1 OBJECTIVES

4.1.1.1 Visuals

To establish a conifer cover type similar in visual character to adjacent natural areas, where present.

Dominance of deciduous or coniferous tree species should match the adjacent undisturbed landscape. Where conditions permit, tree stands should be dense and uneven-aged. All plant spacing should be irregular, the planting configuration informal. Small tree groupings and single trees should be transitional from dense tree stands into shrub, grass, and forb areas. Shade tolerant shrubs and forbs should be growing beneath tree canopies. Grasses may dominate open areas with shrubs and forbs as subordinates in the plant community (Exhibit 4-1).

4.1.1.1.1 ***General Overall.*** The mixed conifer cover type will have multiple canopy layers, including a tree overstory, an intermediate shrub layer, and an herbaceous and woody understory.

4.1.1.1.2 ***Acceptable Variations.*** The tree overstory may be comprised of a dominance of conifers, a mixture of conifers and deciduous trees such as aspen, or a dominance of deciduous trees with younger conifers present in the understory. The understory may have an intermediate shrub layer over a ground herbaceous layer, or the intermediate shrub layer may be lacking. Differences in tree and shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.1.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

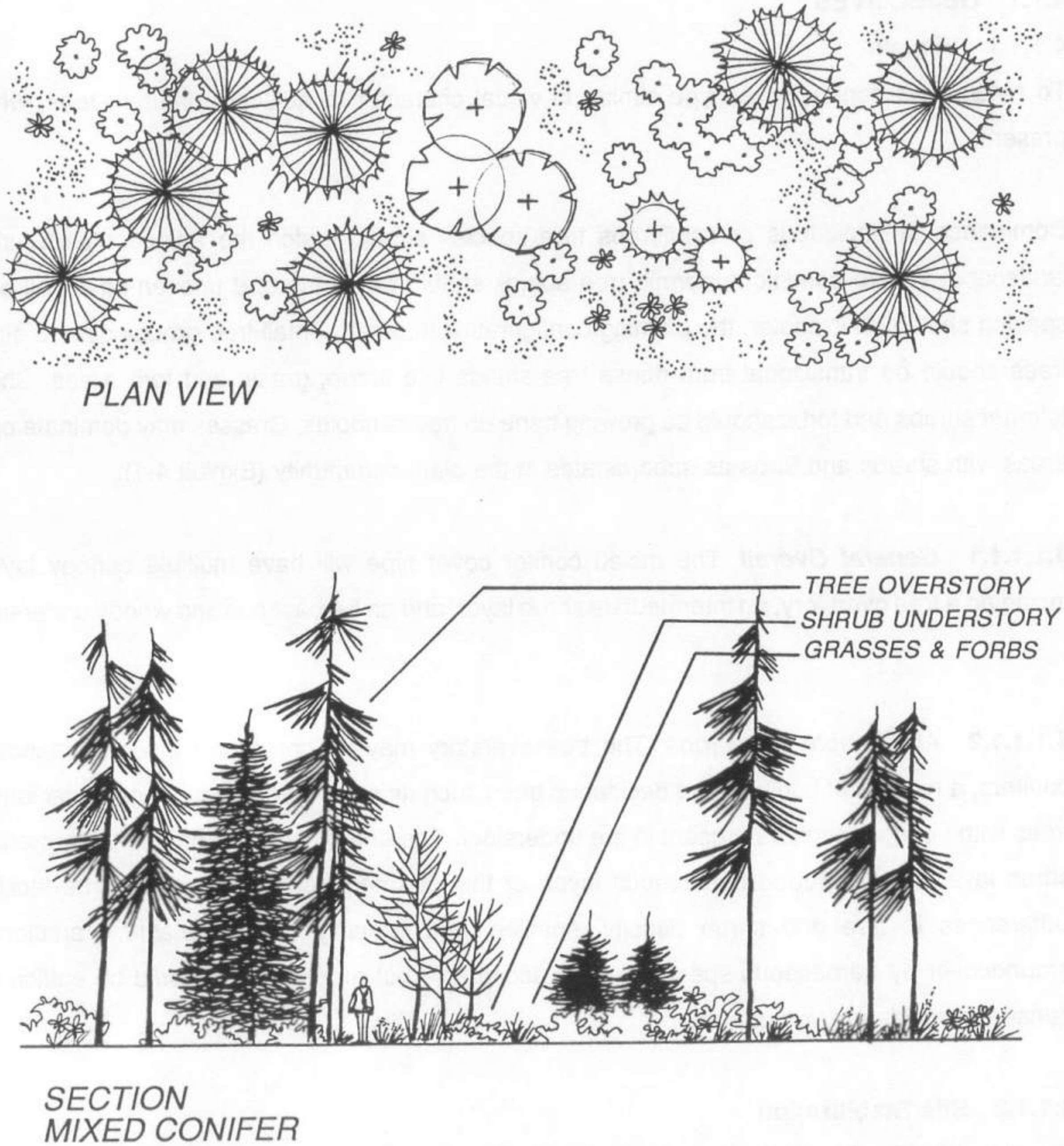


Exhibit 4-1. Mixed Conifer Cover Type.

4.1.1.3 Wildlife

Selected indicator wildlife species for the Mixed Conifer cover type include the following:

Birds

Spruce grouse
Stellar's jay
Hermit thrush
Ruby-crowned kinglet
Great horned owl
Blue grouse
Pine siskin
Western tanager
Mountain chickadee
Chestnut-backed chickadee
Red-breasted nuthatch
Brown creeper
Broad-tailed hummingbird
Western wood peewee
Dark-eyed junco
Hairy woodpecker

Mammals

Snowshoe hare
Red squirrel
Northern flying squirrel
Porcupine
Bushy-tailed woodrat
Golden-mantled ground squirrel
Dusky shrew
Coyote
Red fox
Elk
Mule deer

4.1.1.4 Management/Maintenance

To establish a self-sustaining mixed conifer cover type requiring minimal maintenance effort.

4.1.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Trees with a diameter of four inches or less located within the clearing area should be salvaged for revegetating at the site/nearby sites.

Large trees should be individually marked for removal, and only marked trees should be downed. The method of dropping trees will depend on the size of the area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging trees that will not be removed. Stumps of cut trees should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs and trees could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.1.3 SEEDBED PREPARATION

4.1.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.1.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.1.4 SEEDING

4.1.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-1 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

Table 4-1. Mixed Conifer Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Slender wheatgrass (*Agropyron trachycaulum*)	San Luis	1.5	0.5
Mountain brome (*Bromus marginatus*)	Bromar	2.0	0.5
Blue wildrye (*Elymus glaucus*)	-	1.0	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	1.5	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Canby bluegrass (*Poa canbyi*)	Cambar	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Yellow columbine (*Aquilegia flavescens*)	-	0.5	0.5
Engelmann aster (*Aster engelmannii*)	-	1.0	0.5
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	-	1.0	0.5
Harebell (*Campanula rotundifolia*)	-	0.5	0.25
Wild geranium (*Geranium viscossimum*)	-	1.5	0.5
Silky lupine (*Lupinus sericeus*)	-	2.0	0.5
Rocky Mountain penstemon (*Penstemon strictus*)	-	1.0	0.5
TOTAL		16.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.1.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-1 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix in areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.1.5 PLANTING

4.1.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged trees and shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-2. Planting patterns and spacing should follow recommendations in Section 3.4.3.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired which provide wildlife habitat.

4.1.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants of trees and shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-2.

Table 4-2. Planting Recommendations for Mixed Conifer Cover Type.

Scientific Name	Common Name	Size
Abies concolor	White fir	• tubepak
Clematis ligusticifolia	Western clematis	• 2.5 in. pot
Mahonia repens	Creeping Oregon grape	• tubepak
Pachystima myrsinites	Mountain lover	• 10 cu.in.
Picea engelmannii	Engelmann spruce	• 2 gal.
Pinus contorta	Lodgepole pine	• 10 cu.in.
Populus tremuloides	Quaking aspen	• 1 gal. or tubepak
Pseudotsuga menziesii	Douglas-fir	• 10 cu.in. or 1 gal.
Ribes cereum	Wax currant	• 10 cu.in.
Sorbus scopulina	Dwarf mountain-ash	• 10 cu.in.

4.1.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.1.7 IRRIGATION

Due to the higher elevation of this cover type, seeded areas will not need watering for effective establishment. However, transplanted and containerized trees and shrubs will need periodic watering during the establishment period.

4.1.8 WEED MANAGEMENT

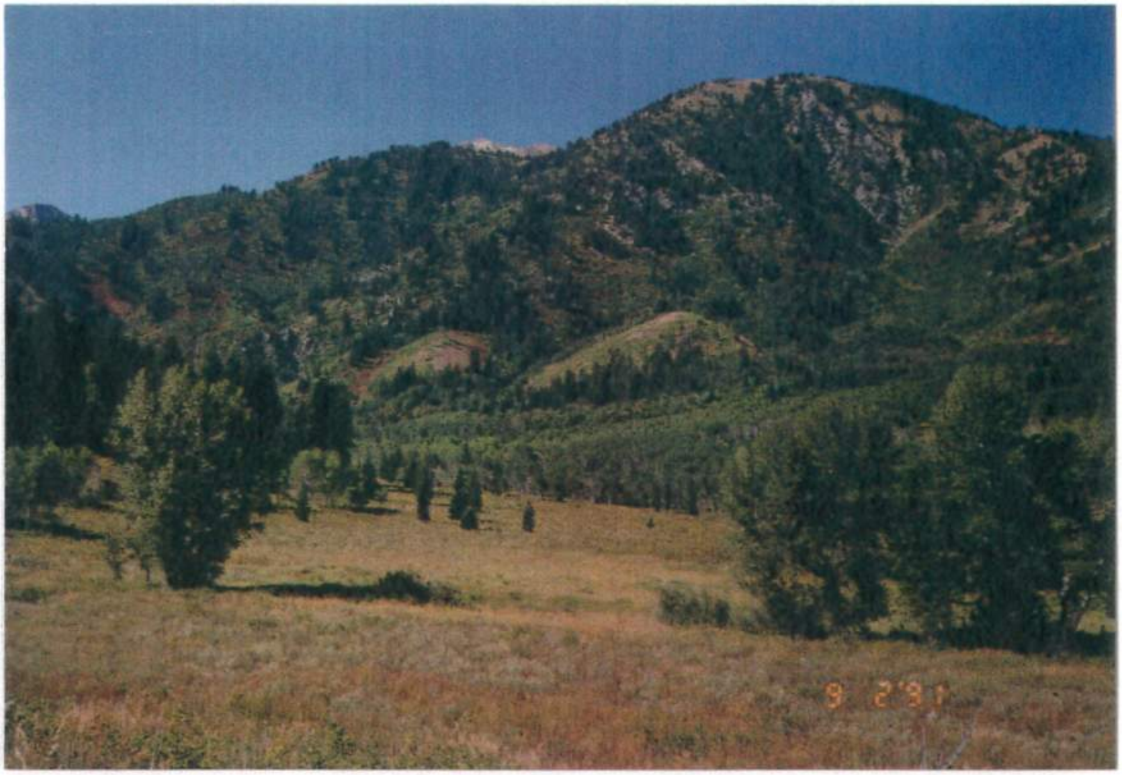
Weed prevention and management should occur as identified in Section 3.7.

4.1.9 MAINTENANCE/MANAGEMENT

Vegetation, particularly for forested cover types, changes over time. Pruning of overhanging branches and removal of dead limbs is generally required to maintain open trails. Dead standing trees should be left standing if they pose no hazard. Such trees provide habitat diversity and are highly important for certain wildlife species. Staking should only be used to support the trunk in an upright position, to anchor the root system, or to protect the tree from being injured (Johnson et al. 1990). Tree wrapping is not recommended. See further information in Section 3.8.

4.1.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the tree overstory.



Examples of Mixed Conifer Cover Type.

4.2 MOUNTAIN BRUSH - DRY

4.2.1 OBJECTIVES

4.2.1.1 Visuals

To establish a dry mountain brush cover type similar in visual character to adjacent natural areas, where present.

Stand density and patch size should match adjacent undisturbed areas. All plant spacing should be irregular and the planting configuration informal. Shade tolerant shrubs and forbs should be growing beneath tree canopies. Small tree groupings and single trees should be transitional from dense tree stands into shrub, grass and forb areas. Grasses and shrubs may co-dominate open areas with forbs as subordinates in the plant community (Exhibit 4-2).

4.2.1.1.1 ***General Overall.*** The dry mountain brush cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.2.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of deciduous shrubs with smaller shrubs present in the understory. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.2.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

4.2.1.3 Wildlife

Selected indicator species for the mountain brush cover type include the following:

Birds	Mammals
California quail	Mule deer
Green-tailed towhee	Elk
American robin	Cottontail rabbit
American goldfinch	Red fox
Black-billed magpie	Deer mouse
Broad-tailed hummingbird	Montane vole
Scrub jay	
Blue-gray gnatcatcher	
Sharp-tailed hawk	
Harris sparrow	

4.2.1.4 Management/Maintenance

To establish a self-sustaining dry mountain brush cover type requiring minimal maintenance effort.

4.2.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Shrubs with a diameter of four inches or less located within the clearing area should be salvaged for use in revegetation at the site or at nearby sites.

Large shrubs should be individually marked for removal, and only marked shrubs should be downed. The method of cutting the shrubs will depend on the size of the area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging other shrubs that will not be removed. Stumps of cut shrubs should be removed using crawler tractors.

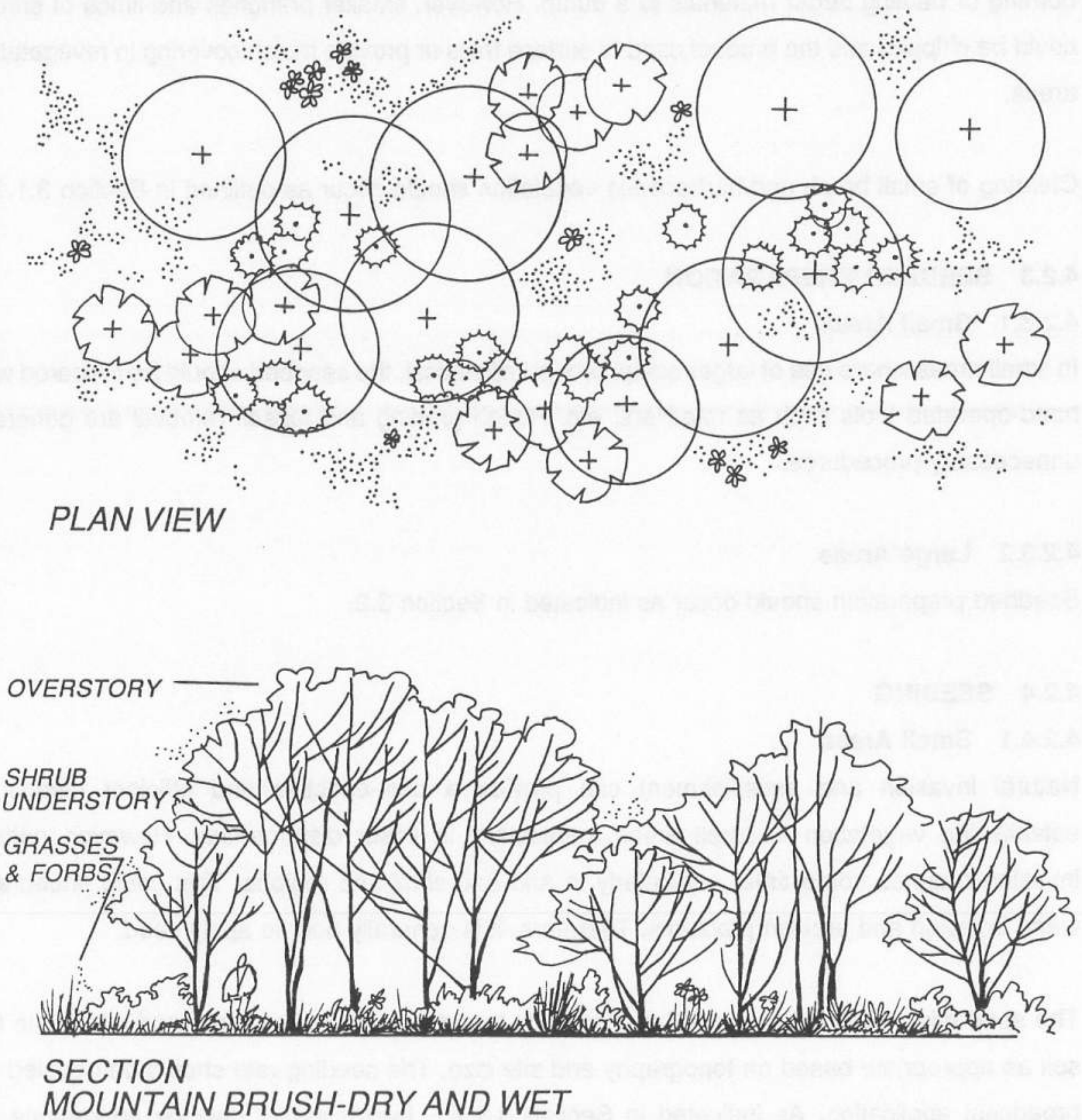


Exhibit 4-2. Dry Mountain Brush Cover Type.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.2.3 SEEDBED PREPARATION

4.2.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.2.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.2.4 SEEDING

4.2.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-3 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

Table 4-3. Dry Mountain Brush Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Western wheatgrass (*Agropyron smithii*)	Rosanna	1.5	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	1.5	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	1.0	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	1.5	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Sandberg bluegrass (*Poa secunda*)	-	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Pearly everlasting (*Anaphalis margaritacea*)	-	0.5	0.25
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	-	0.5	0.5
Early Indian paintbrush (*Castilleja chromosa*)	-	0.5	0.25
Plains coreopsis (*Coreopsis tinctoria*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Blue flax (*Linum lewisii*)	-	1.0	0.25
Wasatch penstemon (*Penstemon cyananthus*)	-	1.0	0.5
Prairie coneflower (*Ratibida columnaris*)	-	0.5	0.25
Munro globemallow (*Sphaeralcea munroana*)	-	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25

Table 4-3. Dry Mountain Brush Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
SHRUBS:			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	-	2.0	0.25
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	-	1.0	0.5
Antelope bitterbrush (*Purshia tridentata*)	Lassen	1.0	0.5
TOTAL		**18.5**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.2.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-3 seeding rates are provided for drilling. Alternately, broadcast application should be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix in areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.2.5 PLANTING

4.2.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-4. Planting patterns and spacing should follow recommendations in Section 3.4.3.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

4.2.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants and containerized stock of shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-4.

4.2.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.2.7 IRRIGATION

Due to the intermediate elevation of this cover type, seeded areas will likely not need watering for effective establishment if seeded in the fall or early spring. Areas seeded in the late spring or summer will likely require periodic sprinkling to ensure adequate establishment of the groundcover. Transplanted and containerized shrubs will need periodic watering during the establishment period.

4.2.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

Table 4-4. Planting Recommendations for Dry Mountain Brush Cover Type.

Scientific Name	Common Name	Size
Acer grandidentatum	Bigtooth maple	• 1-2 gal.
Amelanchier alnifolia	Serviceberry	• 1 gal.
Artemisia tridentata	Big sagebrush	• seed mix
Chrysothamnus nauseosus	Rubber rabbitbrush	• seed mix
Purshia tridentata	Antelope bitterbrush	• 10 cu. in. or 1 gal.
Quercus gambelii	Gambel oak	• 10 cu.in. or 1 gal.
Symphoricarpos oreophilus	Mountain snowberry	• 1 gal.

4.2.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.2.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

Examples of Dry Mountain Brush Cover Type.

4.3 MOUNTAIN BRUSH - WET

4.3.1 OBJECTIVES

4.3.1.1 Visuals

To establish a wet mountain brush cover type similar in visual character to adjacent natural areas, where present.

Dominance of shrubs or grasses should match adjacent undisturbed areas. All plant spacing should be irregular and the planting configuration informal. Shade tolerant shrubs and forbs should be growing beneath tree canopies. Small tree groupings and single trees should be planted as a transition from dense tree stands into shrub, grass, and forb areas. The size of the shrub, grass and forb area should match that of the adjacent undisturbed landscape. Grasses and shrubs may co-dominate in open areas with forbs as subordinates in the plant community (Exhibit 4-3).

4.3.1.1.1 ***General Overall.*** The wet mountain brush cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.3.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of deciduous shrubs with smaller shrubs present in the understory. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.3.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

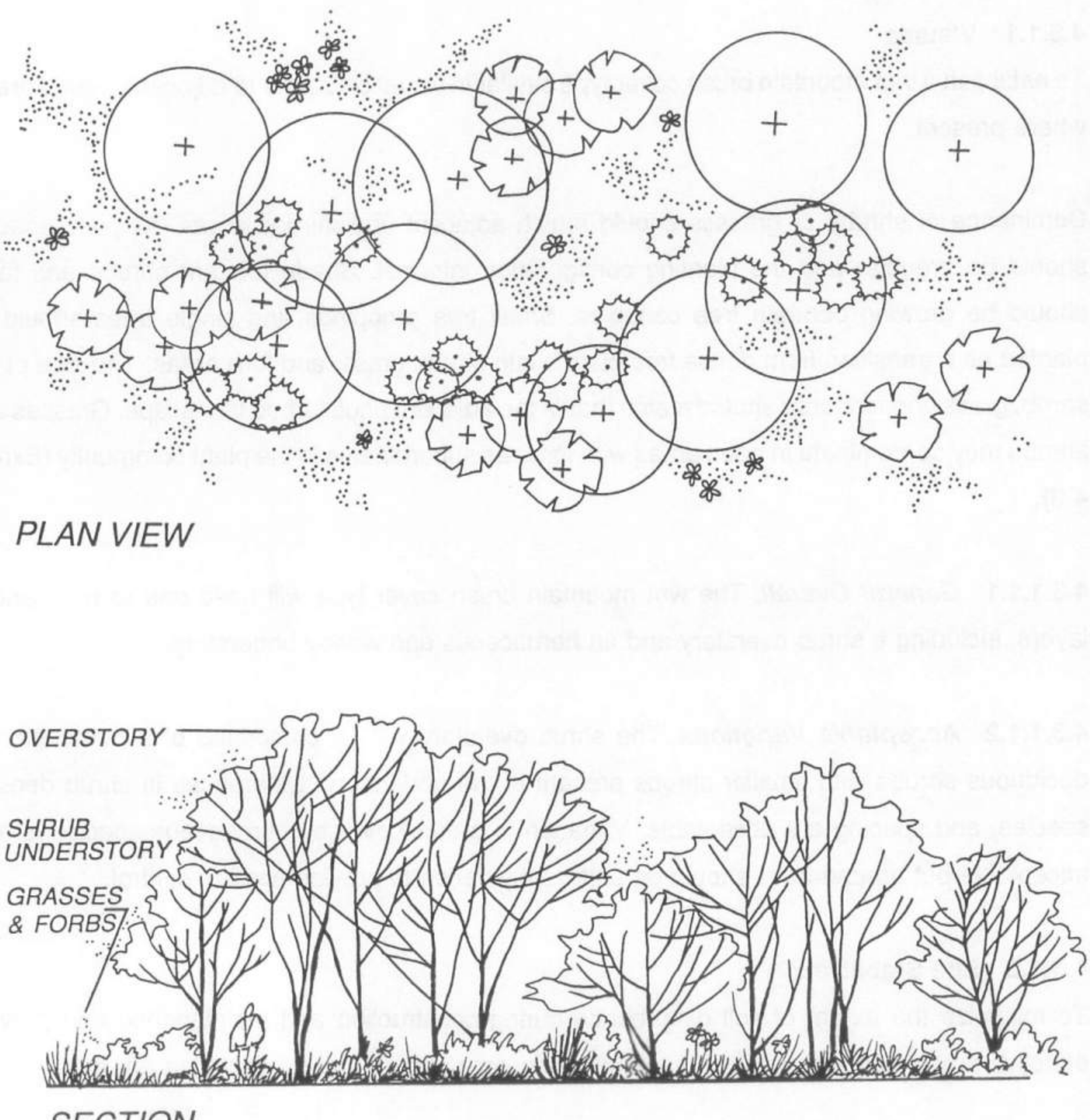


Exhibit 4-3. Wet Mountain Brush Cover Type.

4.3.1.3 Wildlife

Selected indicator species for the wet mountain brush cover type include the following:

Birds	Mammals
Winter wren	Deer mouse
Virginia warbler	Montane vole
Black-headed grosbeak	Coyote
Lazuli bunting	Least chipmunk
Rufous-sided towhee	Striped skunk
Swainson's thrush	Mule deer
Black-billed magpie	
Northern flicker	
White-crowned sparrow	
Yellow warbler	

4.3.1.4 Management/Maintenance

To establish a self-sustaining wet mountain brush cover type requiring minimal maintenance effort.

4.3.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Shrubs with a diameter of four inches or less located within the clearing area should be salvaged for use in revegetation at the site or at nearby sites.

Large shrubs should be individually marked for removal, and only marked shrubs should be downed. The method of cutting the shrubs will depend on the size of the area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging other shrubs that will not be removed. Stumps of cut shrubs should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.3.3 SEEDBED PREPARATION

4.3.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.3.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.3.4 SEEDING

4.3.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-5 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

4.3.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-5

Table 4-5. Wet Mountain Brush Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Western wheatgrass (*Agropyron smithii*)	Rosanna	1.5	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	1.5	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	1.0	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	1.5	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Sandberg bluegrass (*Poa secunda*)	-	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Pearly everlasting (*Anaphalis margaritacea*)	-	0.5	0.25
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	-	0.5	0.5
Early Indian paintbrush (*Castilleja chromosa*)	-	0.5	0.25
Plains coreopsis (*Coreopsis tinctoria*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Blue flax (*Linum lewisii*)	-	1.0	0.25
Wasatch penstemon (*Penstemon cyananthus*)	-	1.0	0.5
Prairie coneflower (*Ratibida columnaris*)	-	0.5	0.25
Munro globemallow (*Sphaeralcea munroana*)	-	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25

Table 4-5. Wet Mountain Brush Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
SHRUBS:			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	-	2.0	0.25
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	-	1.0	0.5
Antelope bitterbrush (*Purshia tridentata*)	Lassen	1.0	0.5
TOTAL		**18.5**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

seeding rates are provided for drilling. Alternately, broadcast application should be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix in areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.3.5 PLANTING

4.3.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged shrubs should be used.

Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-6. Planting patterns and spacing should follow recommendations in Section 3.4.3.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

4.3.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants and containerized stock of shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-6.

4.3.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by a specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.3.7 IRRIGATION

Due to the intermediate elevation of this cover type, seeded areas will likely not need supplemental watering for effective establishment if seeded in the fall or early spring. Transplanted and containerized shrubs will need periodic watering during the establishment period.

4.3.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.3.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

Table 4-6. Planting Recommendations for Wet Mountain Brush Cover Type.

Scientific Name	Common Name	Size
Acer glabrum	Rocky Mountain maple	• 1-2 gal.
Physocarpus malvaceus	Mallow ninebark	• 1 gal.
Prunus virginiana	Chokecherry	• 1-2 gal.
Rhus trilobata	Oakleaf sumac	• 1 gal.
Rubus parviflora	Thimbleberry	• 1 gal.
Sambucus cerulea	Blue elderberry	• 1 gal.
Symphoricarpos albus	Common snowberry	• 1 gal.

4.3.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

Examples of Wet Mountain Brush Cover Type.

4.4 SAGEBRUSH SCRUB

4.4.1 OBJECTIVES

4.4.1.1 Visuals

To establish a sagebrush cover type similar in visual character to adjacent natural areas, where present.

Dominance of shrubs or grasses should match adjacent undisturbed areas. All plant spacing should be irregular; the planting configuration should be informal. Shade tolerant shrubs and forbs should be growing beneath tree canopies. Small tree groupings and single trees should create a transition from dense tree stands into shrub, grass, and forb areas. The size of shrub, grass and forb area should match those of the adjacent undisturbed landscape. Grasses and shrubs may co-dominate open areas with forbs as a subordinate feature in the plant community (Exhibit 4-4).

4.4.1.1.1 ***General Overall.*** The sagebrush cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.4.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of sagebrush, rabbitbrush, and antelope bitterbrush. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.4.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

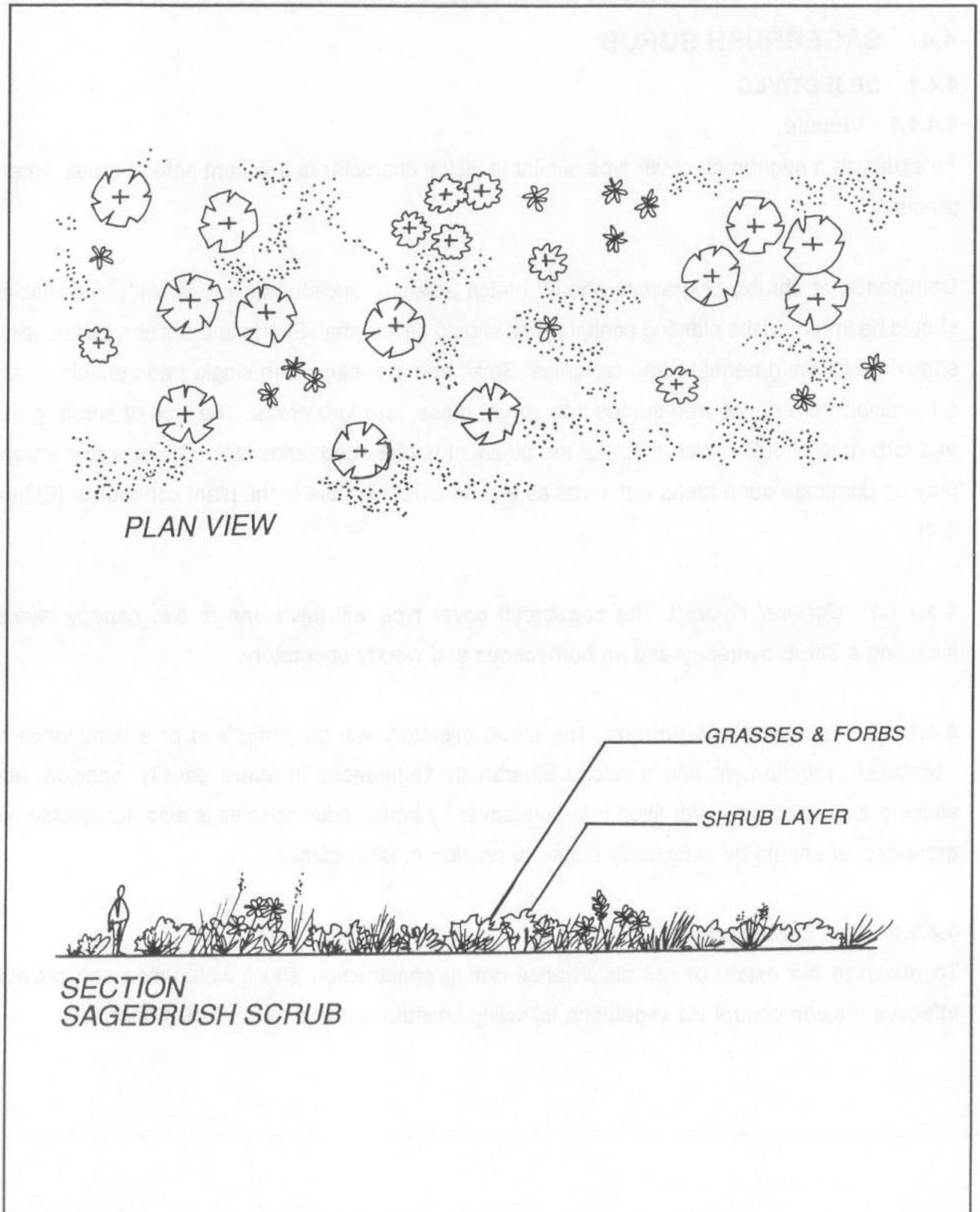


Exhibit 4-4. Sagebrush Scrub Cover Type.

4.4.1.3 Wildlife

Selected indicator species for the sagebrush cover type include the following:

Birds	Mammals
Red-tailed hawk	Coyote
Brewer's sparrow	Badger
Black-throated sparrow	Mule deer
Mountain bluebird	Sagebrush vole
Sage grouse	
Green-tailed towhee	
Lark sparrow	
Common raven	
Sage thrasher	

4.4.1.4 Management/Maintenance

To establish a self-sustaining sagebrush scrub cover type requiring minimal maintenance effort.

4.4.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials with topsoil stripping and salvage. Unless cover type conversion from a shrub- or tree-dominated area is envisioned, plants greater than 2 inches in stem diameter will likely not be encountered. The minimum area possible should be disturbed. Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.4.3 SEEDBED PREPARATION

4.4.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.4.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.4.4 SEEDING

4.4.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-7 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

4.4.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-7 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix in areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.4.5 PLANTING

4.4.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then containerized shrubs may be planted according to Table 4-8. Planting patterns and spacing should follow recommendations in Section 3.4.3.

Table 4-7. Sagebrush Scrub Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Western wheatgrass (*Agropyron smithii*)	Rosanna	1.5	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	1.5	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	0.5	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	1.0	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Indian ricegrass (*Oryzopsis hymenoides*)	Paloma	1.0	0.5
Sandberg bluegrass (*Poa secunda*)	-	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Pearly everlasting (*Anaphalis margaritacea*)	-	0.5	0.25
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	-	0.5	0.5
Early Indian paintbrush (*Castilleja chromosa*)	-	0.5	0.25
Plains coreopsis (*Coreopsis tinctoria*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Blue flax (*Linum lewisii*)	-	1.0	0.25
Wasatch penstemon (*Penstemon cyananthus*)	-	1.0	0.5
Prairie coneflower (*Ratibida columnaris*)	-	0.5	0.25
Munro globemallow (*Sphaeralcea munroana*)	-	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25

Table 4-7. Sagebrush Scrub Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
SHRUBS:			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	-	2.0	0.25
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	-	1.0	0.5
Green Mormon tea (*Ephedra viridis*)	-	1.0	0.5
Antelope bitterbrush (*Purshia tridentata*)	Lassen	1.0	0.5
TOTAL		**19.5**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

Table 4-8. Planting Recommendations for Sagebrush Scrub Cover Type.

Scientific Name	Common Name	Size
Artemisia tridentata	Big sagebrush	• 10 cu.in. or seed mix
Chrysothamnus nauseosus	Rubber rabbitbrush	• 10 cu.in. or seed mix
Purshia tridentata	Antelope bitterbrush	• 10 cu.in. or seed mix

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing shrub layer are desired.

4.4.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, planting of containerized stock of shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-8.

4.4.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.4.7 IRRIGATION

Areas to be reseeded should have seed applied in mid- to late fall or in early spring. In general, late spring and summer seeding will not be effective unless sprinkle irrigation is provided. Containerized shrubs will need periodic watering during the establishment period.

4.4.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.4.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.4.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

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Examples of Sagebrush Scrub Cover Type.

4.5 ALKALI SCRUB - UPLAND

4.5.1 OBJECTIVES

4.5.1.1 Visuals

To establish an upland alkali scrub cover type similar in visual character to adjacent natural areas, where present.

Dominance of shrubs or grasses should match the adjacent undisturbed landscape. Shrub masses should be most dense on sites with the best growing conditions. All plant spacing should be irregular and the planting configuration informal. Small shrub groupings and single shrubs should be planted to create a transition between dense shrub stands and grass and forb areas. Forbs should play a subordinate role in this plant community (Exhibit 4-5).

4.5.1.1.1 ***General Overall.*** The upland alkali scrub cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.5.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of black greasewood and Gardner saltbush. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.5.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

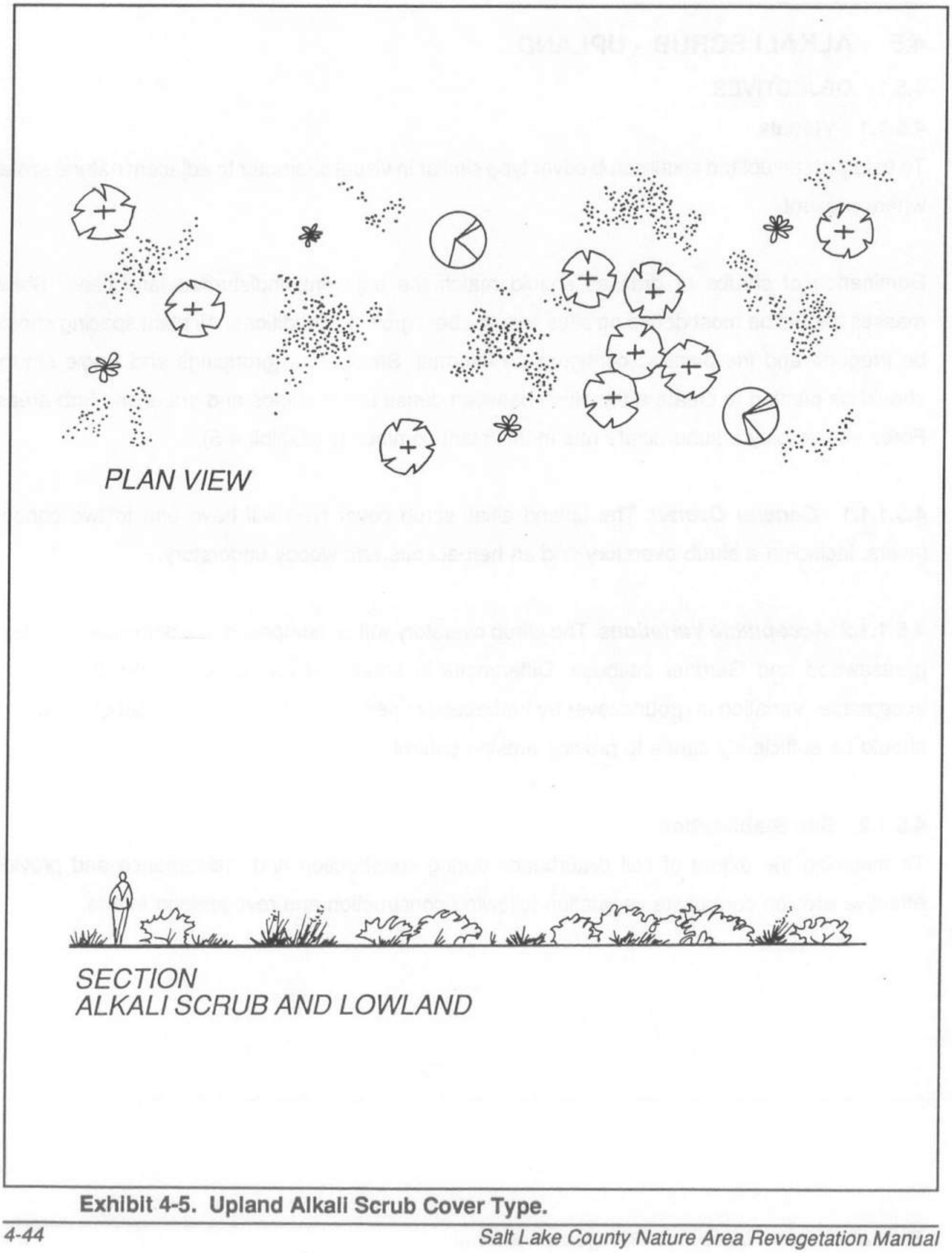

Exhibit 4-5. Upland Alkali Scrub Cover Type.

4.5.1.3 Wildlife

Selected indicator species for the upland alkali scrub cover type include the following:

Birds	Mammals
Brewer's sparrow	Coyote
Vesper sparrow	Mule deer
Green-tailed towhee	Striped skunk
Mourning dove	Deer mouse
Northern shrike	

4.5.1.4 Management/Maintenance

To establish a self-sustaining upland alkali scrub cover type requiring minimal maintenance effort.

4.5.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials with topsoil stripping and salvage. Plants greater than 2 inches in stem diameter will likely not be encountered. The minimum area possible should be disturbed. Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.5.3 SEEDBED PREPARATION

4.5.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.5.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.5.4 SEEDING

4.5.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-9 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes; however, steep slopes will likely not be encountered with this cover type.

4.5.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-9 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.5.5 PLANTING

4.5.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then containerized shrubs may be planted. Planting patterns and spacing should follow recommendations in Section 3.4.3.

Table 4-9. Upland Alkali Scrub Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Tall wheatgrass (*Agropyron elongatum*)	Alkar	1.5	0.5
Inland saltgrass (*Distichlis stricta*)	-	3.0	0.25
Alkaligrass (*Puccinellia distans*)	Fults	3.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	1.0	0.25
FORBS:			
Pacific aster (*Aster chilensis*)	-	1.0	0.25
Marsh Indian paintbrush (*Castilleja exilis*)	-	1.0	0.25
Strawberry clover (*Trifolium fragiferum*)	Salina	2.0	0.25
Alsike clover (*Trifolium hybridum*)	-	3.0	0.25
SHRUBS:			
Gardner saltbush (*Atriplex gardneri*)	-	2.0	0.25
Black greasewood (*Sarcobatus vermiculatus*)	-	1.0	0.5
TOTAL		18.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing shrub layer are desired.

4.5.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, planting of containerized stock of shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3.

4.5.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.5.7 IRRIGATION

Areas to be reseeded should have seed applied in mid- to late fall or in early spring. In general, late spring and summer seeding will not be effective unless sprinkle irrigation is provided. Containerized shrubs will need periodic watering during the establishment period.

4.5.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.5.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.5.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

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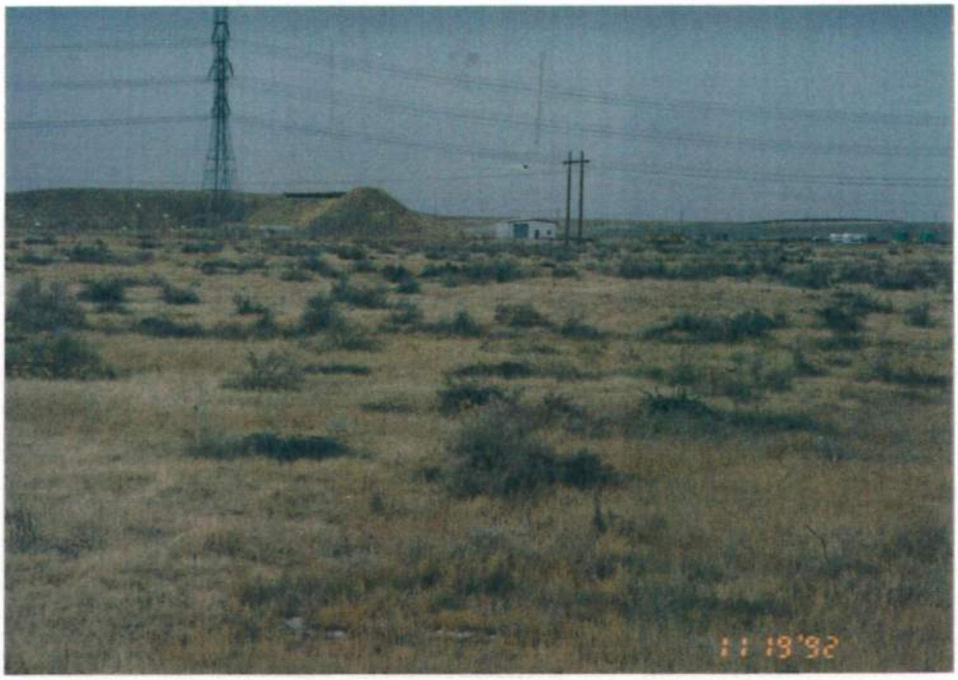

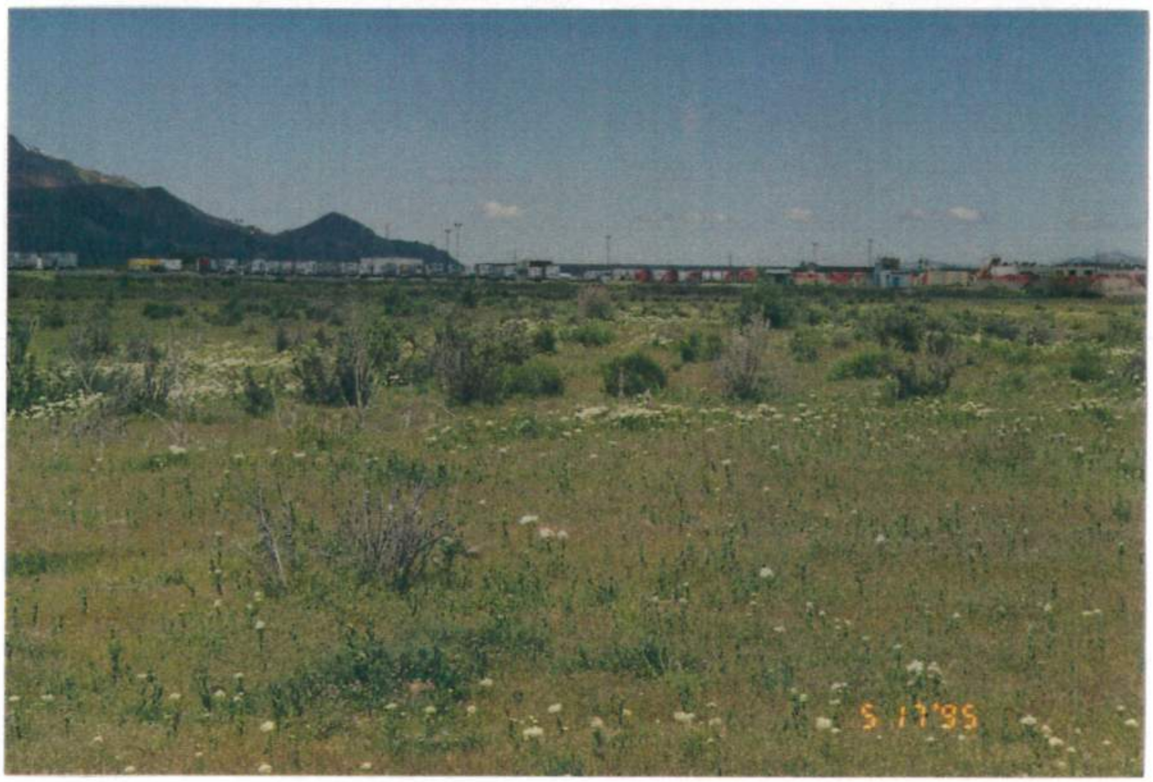

Examples of Upland Alkali Scrub Cover Type.

4.6 ALKALI SCRUB - LOWLAND

4.6.1 OBJECTIVES

4.6.1.1 Visuals

To establish a lowland alkali scrub cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Dominance of shrubs or grasses should match the adjacent undisturbed landscape. Shrub masses should be most dense on sites with the best growing conditions. All plant spacing should be irregular and the planting configuration informal. Small shrub groupings and single shrubs should create a transition from dense shrub stands into grass and forb areas. Forbs should play a subordinate role in this plant community (Exhibit 4-6).

4.6.1.1.1 ***General Overall.*** The lowland alkali scrub cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.6.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of black greasewood and Gardner saltbush. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.6.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

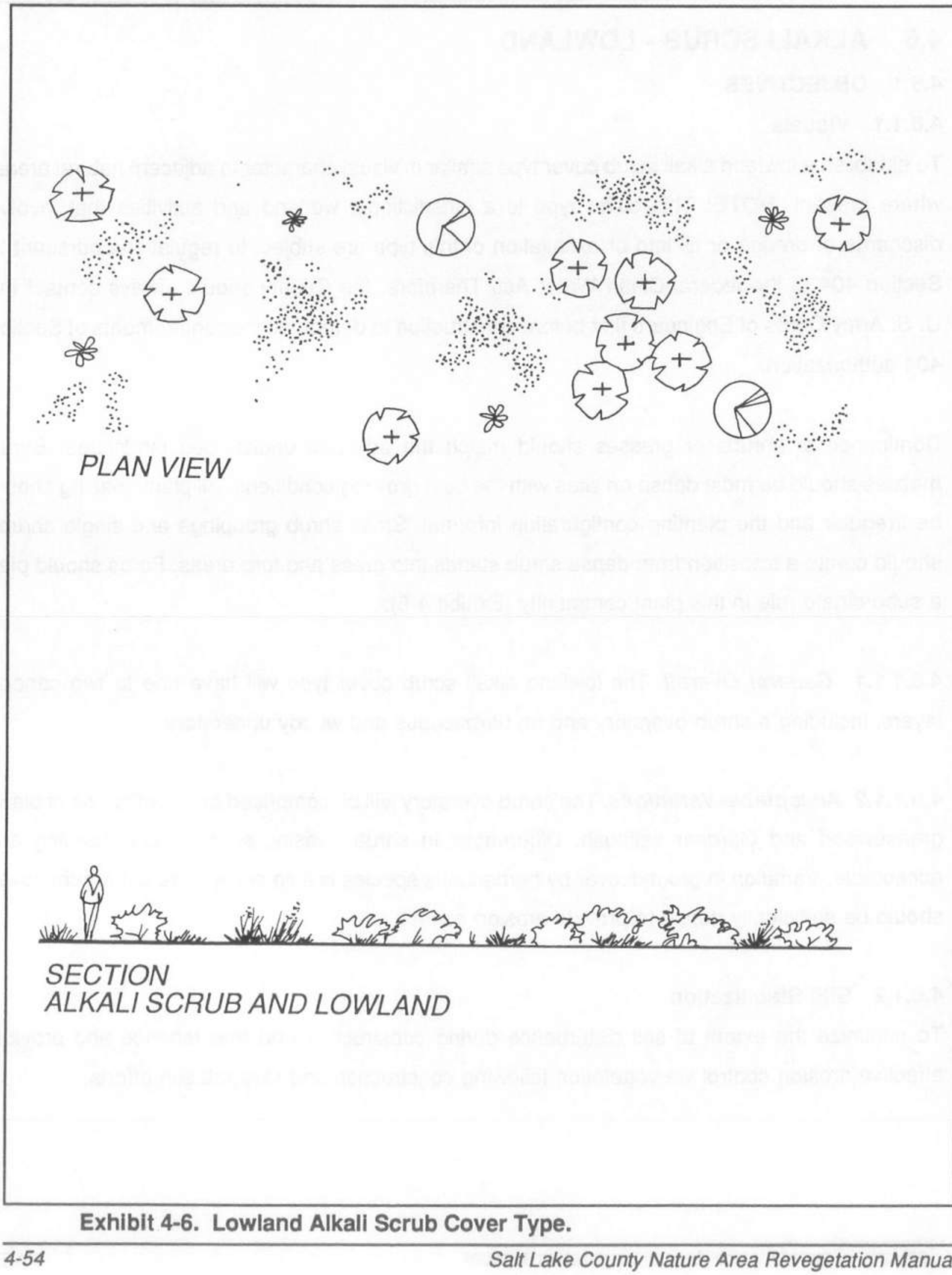

Exhibit 4-6. Lowland Alkali Scrub Cover Type.

4.6.1.3 Wildlife

Selected indicator species for the lowland alkali scrub cover type include the following:

Birds	Mammals
Brewer's sparrow	Coyote
Vesper sparrow	Mule deer
Green-tailed towhee	Striped skunk
Mourning dove	Deer mouse
Northern shrike	

4.6.1.4 Management/Maintenance

To establish a self-sustaining lowland alkali scrub cover type requiring minimal maintenance effort.

4.6.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials with topsoil stripping and salvage. Plants greater than 2 inches in stem diameter will likely not be encountered. The minimum area possible should be disturbed. Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1. Clearing should take place in late summer or fall when the area is dry and the water table has subsided.

4.6.3 SEEDBED PREPARATION

4.6.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.6.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Use of heavy equipment to prepare the seedbed will likely be hampered by wet soil conditions if attempted in the spring or early summer.

4.6.4 SEEDING

4.6.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-10 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes; however, steep slopes will likely not be encountered with this cover type.

4.6.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-10 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.6.5 PLANTING

4.6.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then containerized shrubs may be planted. Planting patterns and spacing should follow recommendations in Section 3.4.3.

Table 4-10. Lowland Alkali Scrub Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Tall wheatgrass (*Agropyron elongatum*)	Alkar	1.5	0.5
Inland saltgrass (*Distichlis stricta*)	-	3.0	0.25
Alkaligrass (*Puccinellia distans*)	Fults	3.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	1.0	0.25
FORBS:			
Pacific aster (*Aster chilensis*)	-	1.0	0.25
Marsh Indian paintbrush (*Castilleja exilis*)	-	1.0	0.25
Strawberry clover (*Trifolium fragiferum*)	Salina	2.0	0.25
Alsike clover (*Trifolium hybridum*)	-	3.0	0.25
SHRUBS:			
Gardner saltbush (*Atriplex gardneri*)	-	2.0	0.25
Black greasewood (*Sarcobatus vermiculatus*)	-	1.0	0.5
TOTAL		18.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing shrub layer are desired.

4.6.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, planting of containerized stock of shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3.

4.6.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.6.7 IRRIGATION

Areas to be reseeded should have seed applied in mid- to late fall or in early spring. Because of the wet soil conditions, irrigation will not be required in this cover type.

4.6.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.6.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.6.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

Examples of Lowland Alkali Scrub Cover Type.

4.7 UPLAND MEADOW

4.7.1 OBJECTIVES

4.7.1.1 Visuals

To establish an upland meadow cover type similar in visual character to adjacent natural areas, where present.

Grasses should dominate this plant community. Two or three grass species should comprise 75 percent of the cover. To the extent possible, grass patterns should be informal, a reflection of varied growing conditions. Patches of forbs may be most dense on sites with the best growing conditions. Small groups of forbs should create a transition from dense patches into predominantly grass areas, creating a graded effect (Exhibit 4-7).

4.7.1.1.1 ***General Overall.*** The upland meadow cover type will have a single herbaceous groundcover comprised of grass and forb species.

4.7.1.1.2 ***Acceptable Variations.*** It is acceptable for the County to include shrub species typical of the dry mountain brush or sagebrush scrub cover types described previously. Variation in groundcover by herbaceous species is acceptable but groundcover should be sufficiently dense to provide erosion control.

4.7.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

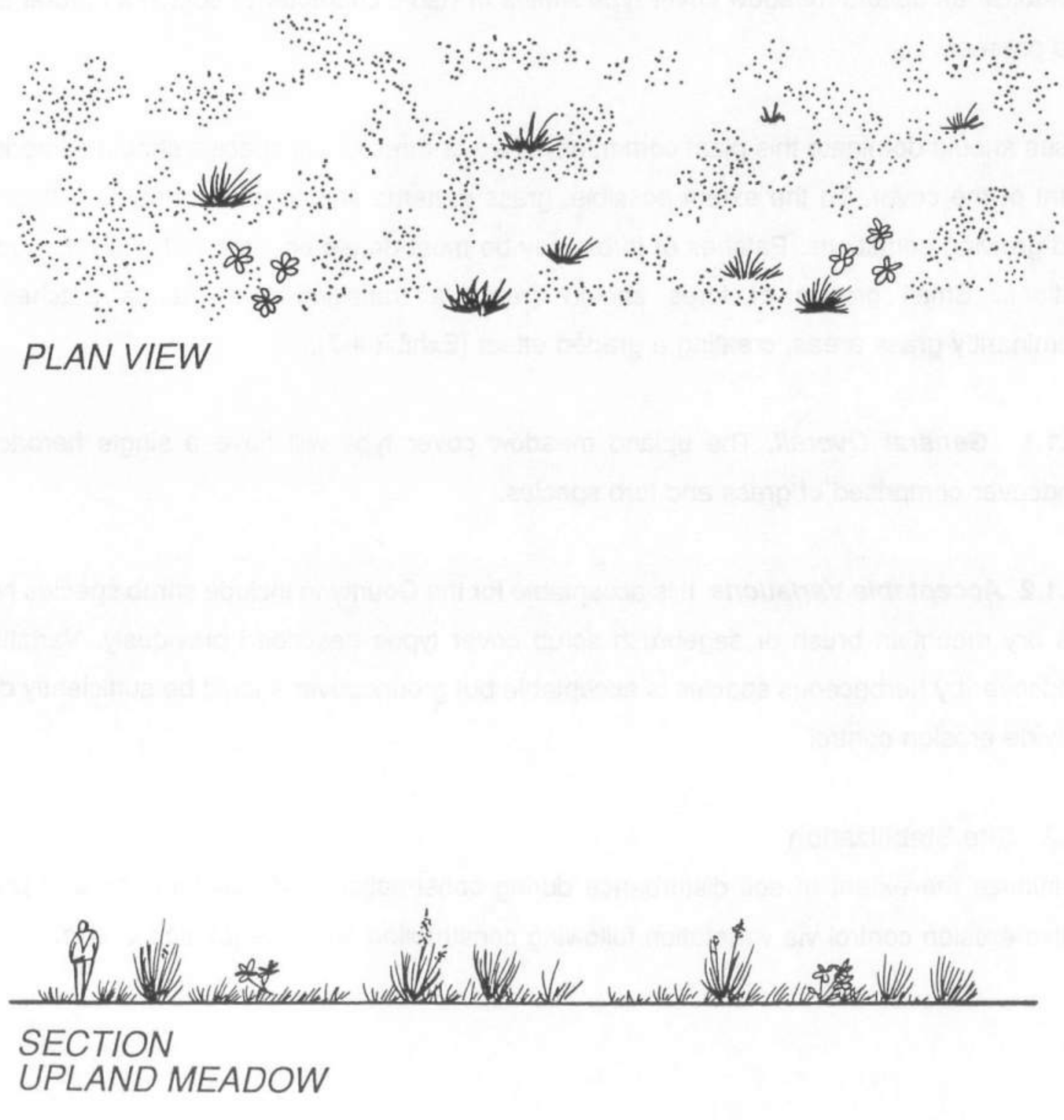

Exhibit 4-7. Upland Meadow Cover Type.

4.7.1.3 Wildlife

Selected indicator species for the upland meadow cover type include the following:

Birds

Western meadowlark
Savannah sparrow
Grasshopper sparrow
Common crow
Red-tailed hawk
Sandhill crane
Killdeer
Western kingbird
Horned lark
American goldfinch
Mountain bluebird
Common nighthawk

Mammals

Badger
Long-tailed weasel
Coyote
White-tailed jackrabbit
Northern pocket gopher
Uinta ground squirrel
Mule deer
Meadow vole
Striped skunk

4.7.1.4 Management/Maintenance

To establish a self-sustaining upland meadow cover type requiring minimal maintenance effort.

4.7.2 SITE CLEARING

Unless cover type conversion is planned, site clearing will involve removal of herbaceous (grasses and forbs) materials with topsoil stripping and salvage. If cover type conversion is planned, the site clearing procedure for the woody cover types would be appropriate. The minimum area possible should be disturbed.

4.7.3 SEEDBED PREPARATION

4.7.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.7.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.7.4 SEEDING

4.7.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-11 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

4.7.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-11 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.7.5 PLANTING

No planting of containerized stock is envisioned for establishment of this herbaceous cover type. However, the County may choose to plant shrub or tree species in the upland meadow to provide visual contrast with the otherwise strictly herbaceous groundcover.

Table 4-11. Upland Meadow Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Western wheatgrass (*Agropyron smithii*)	Rosanna	2.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	2.0	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	1.0	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	2.0	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Indian ricegrass (*Oryzopsis hymenoides*)	Paloma	1.0	0.5
Sandberg bluegrass (*Poa secunda*)	-	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Plains aster (*Aster bigelovii*)	-	0.5	0.25
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	-	0.5	0.5
Early Indian paintbrush (*Castilleja chromosa*)	-	0.5	0.25
Rocky Mountain beeplant (*Cleome serrulata*)	-	0.5	0.5
Plains coreopsis (*Coreopsis tinctoria*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Blue flax (*Linum lewisii*)	-	1.0	0.25
Wasatch penstemon (*Penstemon cyananthus*)	-	1.0	0.5
Drummond phlox (*Phlox drummondii*)	-	0.5	0.5

Table 4-11. Upland Meadow Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
FORBS, Continued:			
Prairie coneflower (*Ratibida columnaris*)	-	0.5	0.25
Munro globemallow (*Sphaeralcea munroana*)	-	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25
TOTAL		18.0	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, and current seed availability and cost.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.7.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.7.7 IRRIGATION

Areas to be reseeded should have seed applied in mid- to late fall or in early spring. In general, late spring and summer seeding will not be effective unless sprinkle irrigation is provided.

4.7.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.7.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.7.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory.

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Examples of Upland Meadow Cover Type.

4.8 DISTURBED, FALLOW AGRICULTURAL FIELD

4.8.1 OBJECTIVES

4.8.1.1 Visuals

To establish an upland meadow and/or sagebrush scrub cover type similar in visual character to adjacent natural areas, where present.

The plant community type prescription for fallowed areas will depend on design intent. Reference sagebrush scrub and upland meadow for guidelines (Exhibits 4-8 and 4-9).

4.8.1.1.1 ***General Overall.*** The upland meadow cover type will have a singular herbaceous groundcover comprised of grass and forb species. However, if the County chooses to revegetate the area to the sagebrush scrub cover type, a shrub canopy comprised of sagebrush, rabbitbrush, and antelope bitterbrush will be required.

4.8.1.1.2 ***Acceptable Variations.*** The fallow agricultural field can be revegetated to upland meadow, sagebrush scrub, or a mosaic of these two types. In addition, shrub species prescribed for the dry mountain brush cover type can also be included depending on wildlife and visual aesthetics objectives. The shrub overstory will be comprised of a dominance of sagebrush, rabbitbrush, and antelope bitterbrush. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.8.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

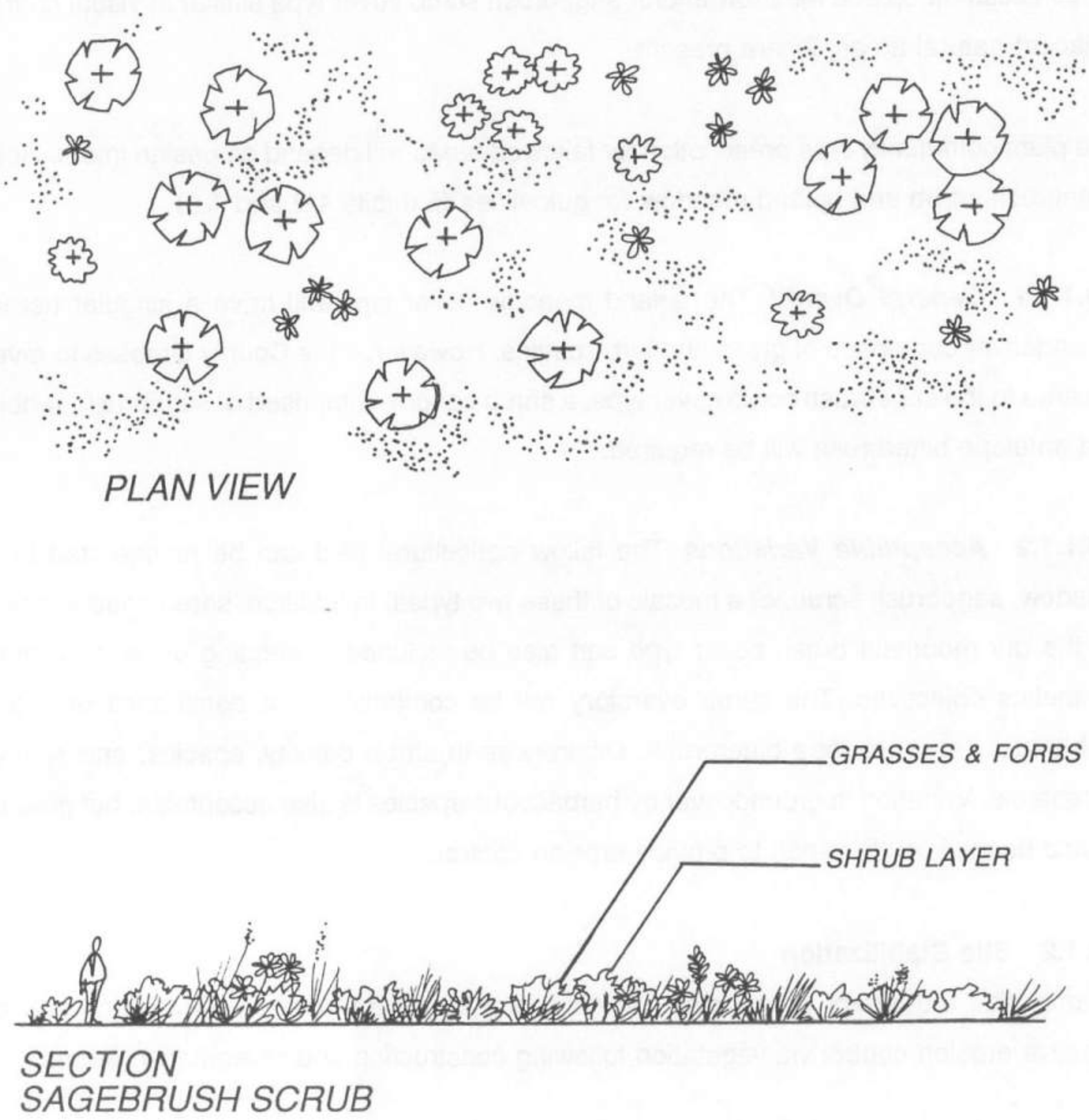

Exhibit 4-8. Disturbed, Fallow Agricultural Field (Sagebrush Scrub) Cover Type.

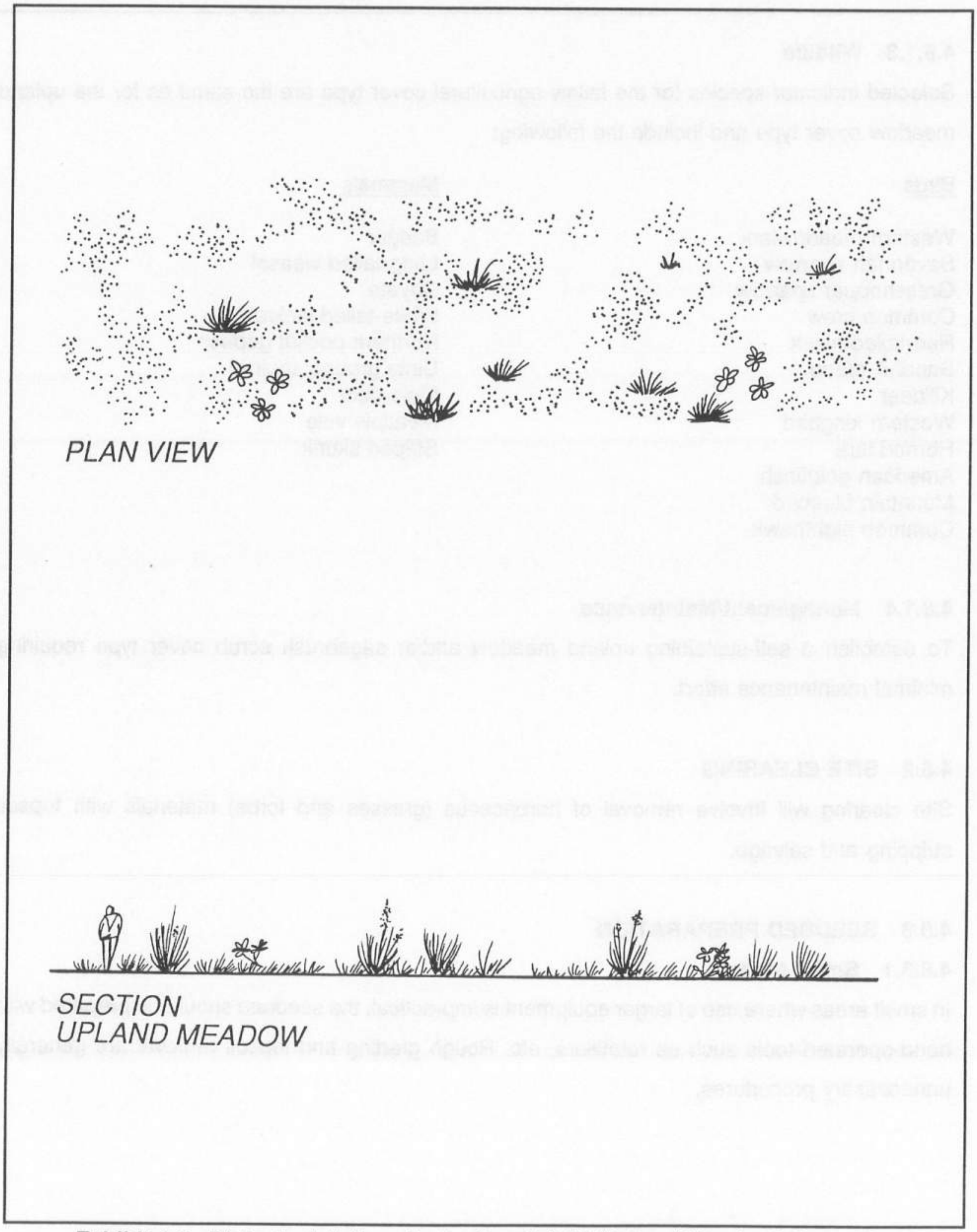

Exhibit 4-9. Disturbed, Fallow Agricultural Field (Upland Meadow) Cover Type.

4.8.1.3 Wildlife

Selected indicator species for the fallow agricultural cover type are the same as for the upland meadow cover type and include the following:

Birds

Western meadowlark
Savannah sparrow
Grasshopper sparrow
Common crow
Red-tailed hawk
Sandhill crane
Killdeer
Western kingbird
Horned lark
American goldfinch
Mountain bluebird
Common nighthawk

Mammals

Badger
Long-tailed weasel
Coyote
White-tailed jackrabbit
Northern pocket gopher
Uinta ground squirrel
Mule deer
Meadow vole
Striped skunk

4.8.1.4 Management/Maintenance

To establish a self-sustaining upland meadow and/or sagebrush scrub cover type requiring minimal maintenance effort.

4.8.2 SITE CLEARING

Site clearing will involve removal of herbaceous (grasses and forbs) materials with topsoil stripping and salvage.

4.8.3 SEEDBED PREPARATION

4.8.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.8.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.8.4 SEEDING

4.8.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-12 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes.

4.8.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-12 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.8.5 PLANTING

No planting of containerized stock is envisioned for establishment of the upland meadow cover type. However, for the sagebrush scrub type the County may choose to plant shrub or tree species in this cover type to provide visual contrast with the otherwise strictly herbaceous groundcover.

Table 4-12. Fallow Agricultural Land Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Western wheatgrass (*Agropyron smithii*)	Rosanna	3.0	0.5
Bluebunch wheatgrass (*Agropyron spicatum*)	Secar	3.0	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	2.0	0.5
Idaho fescue (*Festuca idahoensis*)	Joseph	2.0	0.5
Prairie junegrass (*Koeleria cristata*)	-	1.0	0.25
Indian ricegrass (*Oryzopsis hymenoides*)	Paloma	1.0	0.5
Sandberg bluegrass (*Poa secunda*)	-	1.0	0.5
FORBS:			
White yarrow (*Achillea millefolium*)	-	1.0	0.5
Rocky Mountain beeplant (*Cleome serrulata*)	-	0.5	0.5
Plains coreopsis (*Coreopsis tinctoria*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Blue flax (*Linum lewisii*)	-	1.0	0.25
Wasatch penstemon (*Penstemon cyananthus*)	-	1.0	0.5
Munro globemallow (*Sphaeralcea munroana*)	-	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25
TOTAL		18.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.8.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.8.7 IRRIGATION

Areas to be reseeded should have seed applied in mid- to late fall or in early spring. In general, late spring and summer seeding will not be effective unless sprinkle irrigation is provided.

4.8.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.8.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.8.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory, if present.

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Examples of Fallow Agricultural Land Cover Type.

4.9 RIPARIAN FOREST - DRY

4.9.1 OBJECTIVES

4.9.1.1 Visuals

To establish a dry riparian forest cover type similar in visual character to adjacent natural areas, where present.

Stand density and size should match adjacent undisturbed areas. Generally tree and shrub density should be highest near water sources and grade into more open stands on upland sites. One or two tree species should dominate the canopy layer. Shrubs, grasses, and forbs should be most dense on the outer edges of the tree canopy. However, shade tolerant shrubs, grasses and forbs should also be growing beneath tree canopies. All plant spacings should be irregular and the planting configuration informal (Exhibit 4-10).

4.9.1.1.1 ***General Overall.*** The dry riparian forest cover type will have multiple canopy layers, including a tree overstory and an herbaceous and woody understory.

4.9.1.1.2 ***Acceptable Variations.*** The tree overstory may be comprised of a dominance of cottonwood, or a mixture of cottonwood and other hydrophytic shrubs and trees. The understory may have an intermediate shrub layer over a ground herbaceous layer, or the intermediate shrub layer may be lacking. Differences in tree and shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable but groundcover should be sufficiently dense to provide erosion control.

4.9.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

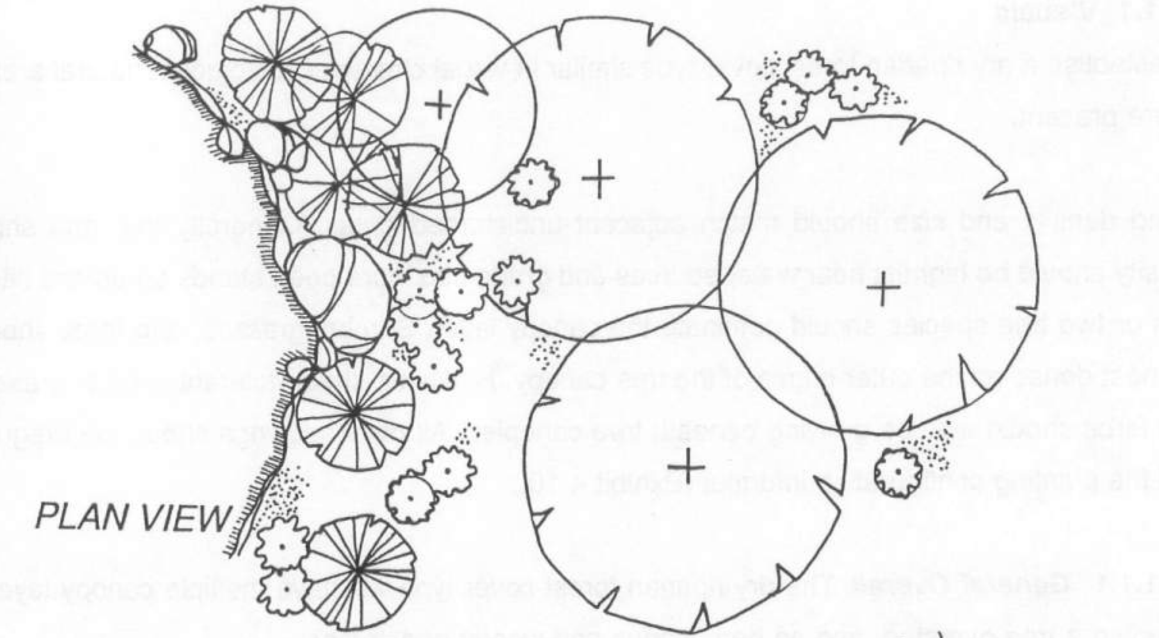


Exhibit 4-10. Dry Riparian Forest Cover Type.

4.9.1.3 Wildlife

Selected indicator species for the riparian forest cover type include the following:

Birds

MacGillivray's warbler
Yellow-breasted chat
Swainson's thrush
Black-headed grosbeak
Long-eared owl
Great horned owl
Belted kingfisher
Bald eagle
Norther oriole
Lazuli bunting
Great blue heron
Downy woodpecker
Common yellowthroat
Tree swallow
Yellow warbler
Red-tailed hawk

Mammals

Mule deer
Mink
Long-tailed weasel
Porcupine
Beaver
Moose
Red fox
Northern water shrew

4.9.1.4 Management/Maintenance

To establish a self-sustaining dry riparian forest cover type requiring minimal maintenance effort.

4.9.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Trees with a diameter of four inches or less located within the clearing area should be salvaged for use to revegetate the site or nearby sites. In particular, cottonwood saplings in areas to be cleared should be salvaged and used for pole plantings.

Large trees should be individually marked for removal, and only marked trees should be downed. The method of dropping trees will depend on the size of area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging trees that will not be removed. Stumps of cut trees should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs and trees could be chipped and the product used to surface trails or provide mulch covering in revegetation areas. Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.9.3 SEEDBED PREPARATION

4.9.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.9.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.9.4 SEEDING

4.9.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-13 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes, if present.

Table 4-13. Dry Riparian Forest Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Redtop (*Agrostis alba*)	-	2.0	0.25
Mountain brome (*Bromus marginatus*)	Bromar	3.0	0.25
Great Basin wildrye (*Elymus cinereus*)	Trailhead	2.0	0.5
Canby bluegrass (*Poa canbyi*)	Canbar	2.0	0.25
FORBS:			
Western yarrow (*Achillea millefolium*)	-	2.0	0.5
Eastern red columbine (*Aquilegia canadensis*)	-	0.5	0.5
Engelmann aster (*Aster engelmannii*)	-	1.0	0.5
Harebell (*Campanula rotundifolia*)	-	1.0	0.25
Lance-leaved coreopsis (*Coreopsis lanceolata*)	-	1.0	0.5
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Wild lupine (*Lupinus perennis*)	-	0.5	0.5
Five spot (*Nemophila maculata*)	-	0.5	0.5
Wasatch penstemon (*Penstemon cyananthus*)	-	0.5	0.5
Black-eyed Susan (*Rudbeckia hirta*)	-	1.0	0.25
Golden banner (*Thermopsis montana*)	-	0.5	0.25
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25

Table 4-13. Dry Riparian Forest Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
SHRUBS:			
Golden currant (*Ribes aureum*)	-	0.5	0.25
Nootka rose (*Rosa nutkana*)	-	0.5	0.25
TOTAL		**19.5**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.9.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-13 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.9.5 PLANTING

4.9.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged trees and shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-14. This cover type is particularly suited for the transplant of cottonwood poles and other bioengineering techniques. Planting patterns and spacing should follow recommendations in Section 3.4.3.

Table 4-14. Planting Recommendations for Dry Riparian Forest Cover Type.

Scientific Name	Common Name	Size
Acer glabrum	Rocky Mountain maple	• 1-2 gal.
Acer grandidentatum	Bigtooth maple	• 1-2 gal.
Physocarpus malvaceus	Mallow ninebark	• 1 gal.
Populus angustifolia	Narrowleaf cottonwood	• 1-2 gal. or poles
Prunus virginiana	Chokecherry	• 1-2 gal.
Rhus trilobata	Oakleaf sumac	1 gal.
Rubus parviflora	Thimbleberry	• 1 gal.
Sambucus cerulea	Blue elderberry	• 1 gal.
Symphoricarpos albus	Common snowberry	• 1 gal.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

4.9.5.1 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants of trees and shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-14.

4.9.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.9.7 IRRIGATION

Due to the more mesic condition of this cover type, seeded areas will not in general need watering for effective establishment. However, transplanted and containerized trees and shrubs will need periodic watering during the establishment period. Sprinkling may be helpful to obtain quick establishment of seeded areas including small areas along the margins of trails and at other popular, high visibility areas.

4.9.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.9.9 MAINTENANCE/MANAGEMENT

Vegetation, particularly for forested cover types, changes over time. Pruning of overhanging branches and removal of dead limbs is generally required to maintain open trails. Dead standing trees should be left standing if they pose no hazard. Such trees provide habitat diversity and are highly important for certain bird species. Staking should only be used to support the trunk in an upright position, to anchor the root system, or to protect the tree from being injured (Johnson et al. 1990). Tree wrapping is not recommended. See further information in Section 3.8.

4.9.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the tree overstory.

Examples of Dry Riparian Forest Cover Type.

4.10 RIPARIAN FOREST - WET

4.10.1 OBJECTIVES

4.10.1.1 Visuals

To establish a wet riparian forest cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland, and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Stand density and size should match adjacent undisturbed areas. Generally tree and shrub density should be highest near water sources and grade into more open stands on upland sites. One or two tree species should dominate the canopy layer. Shrubs, grasses, and forbs should be most dense on the outer edges of the tree canopy. However, shade tolerant shrubs, grasses and forbs should also be growing beneath tree canopies. All plant spacings should be irregular and the planting configuration informal (Exhibit 4-11).

4.10.1.1.1 ***General Overall.*** The wet riparian forest cover type will have multiple canopy layers, including a tree overstory and an herbaceous and woody understory.

4.10.1.1.2 ***Acceptable Variations.*** The tree overstory may be comprised of a dominance of cottonwood, or a mixture of cottonwood and other hydrophytic shrubs and trees. The understory may have an intermediate shrub layer over a ground herbaceous layer, or the intermediate shrub layer may be lacking. Differences in tree and shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable, but groundcover should be sufficiently dense to provide erosion control.

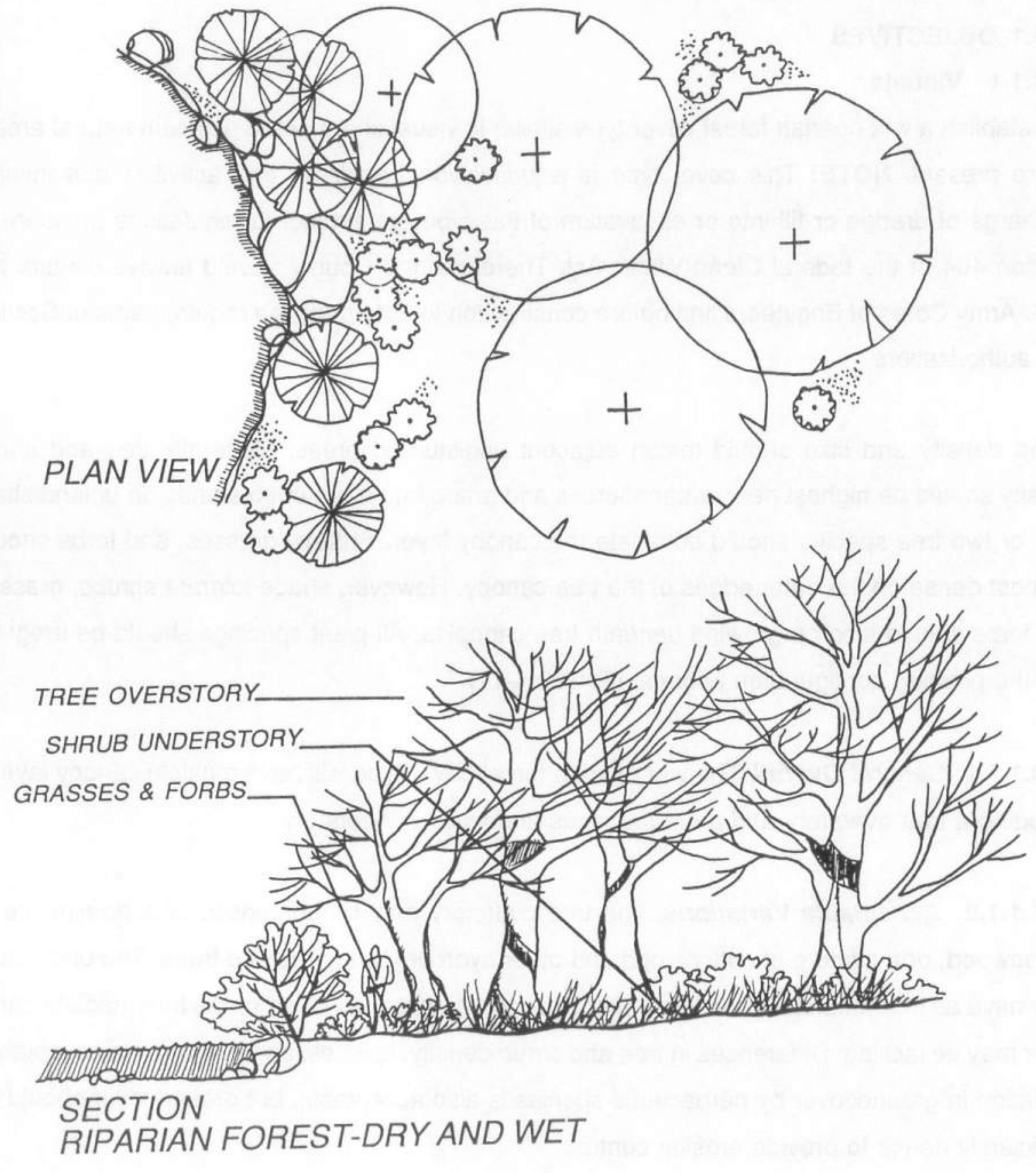


Exhibit 4-11. Wet Riparian Forest Cover Type.

4.10.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

4.10.1.3 Wildlife

Selected indicator species for the wet riparian forest cover type include the following:

Birds	Mammals
MacGillivray's warbler	Porcupine
Yellow-breasted chat	Beaver
Swainson's thrush	Moose
Black-headed grosbeak	Red fox
Long-eared owl	Northern water shrew
Great horned owl	Mule deer
Belted kingfisher	Mink
Bald eagle	Long-tailed weasel
Norther oriole	
Lazuli bunting	
Great blue heron	
Downy woodpecker	
Common yellowthroat	
Tree swallow	
Yellow warbler	
Red-tailed hawk	

4.10.1.4 Management/Maintenance

To establish a self-sustaining wet riparian forest cover type requiring minimal maintenance effort.

4.10.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Trees with a diameter of four inches or less located within the clearing area should be salvaged for use in revegetation at the site or at nearby sites. In particular, cottonwood saplings in areas to be cleared should be salvaged and used for pole plantings.

Large trees should be individually marked for removal, and only marked trees should be downed. The method of dropping trees will depend on the size of area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging trees that will not be removed. Stumps of cut trees should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs and trees could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.10.3 SEEDBED PREPARATION

4.10.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.10.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.10.4 SEEDING

4.10.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-15 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes, if present. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.10.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-15 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.10.5 PLANTING

4.10.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged trees and shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-16. This cover type is particularly suited for the transplant of cottonwood poles and other bioengineering techniques. Planting patterns and spacing should follow recommendations in Section 3.4.3.

Table 4-15. Wet Riparian Forest Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Streambank wheatgrass (*Agropyron riparium*)	Sodar	3.0	0.5
Redtop (*Agrostis alba*)	-	3.0	0.5
Bluejoint reedgrass (*Calamagrostis canadensis*)	Sourdough	1.0	0.25
Tufted hairgrass (*Deschampsia cespitosa*)	-	1.0	0.25
Blue wildrye (*Elymus glaucus*)	-	2.0	0.5
GRAMINOIDS:			
Nebraska sedge (*Carex nebrascensis*)	-	0.5	0.5
FORBS:			
Blue-leaf aster (*Aster glaucodes*)	-	1.0	0.5
Marsh Indian paintbrush (*Castilleja exilis*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Missouri iris (*Iris missouriensis*)	-	0.5	0.5
Lemon mint (*Monarda citriodora*)	-	0.25	0.25
Blue-eyed grass (*Sisyrinchium bellum*)	-	0.25	0.5
Golden banner (*Thermopsis montanus*)	-	1.0	0.5
Strawberry clover (*Trifolium fragiferum*)	Salina	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25
TOTAL		15.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

Table 4-16. Planting Recommendations for Wet Riparian Forest Cover Type.

Scientific Name	Common Name	Size
Alnus incana	Mountain alder	• 1-2 gal.
Betula occidentalis	Water birch	• 1 gal.
Populus angustifolia	Narrowleaf cottonwood	• 1-2 gal. or poles
Salix exigua	Sandbar willow	• tubepak or 1 gal.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

4.10.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants of trees and shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3.4.

4.10.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.10.7 IRRIGATION

Due to the saturated soil conditions of this cover type, seeded areas will not need watering for effective establishment.

4.10.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.10.9 MAINTENANCE/MANAGEMENT

Vegetation, particularly for forested cover types, changes over time. Pruning of overhanging branches and removal of dead limbs is generally required to maintain open trails. Dead standing trees should be left standing if they pose no hazard. Such trees provide habitat diversity and are highly important for certain bird species. Staking should only be used to support the trunk in an upright position, to anchor the root system, or to protect the tree from being injured (Johnson et al. 1990). Tree wrapping is not recommended. See further information in Section 3.8.

4.10.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the tree overstory.

Examples of Wet Riparian Forest Cover Type.

Examples of Pre-Riparian Forest Cover Type.

4.11 RIPARIAN SHRUB - DRY

4.11.1 OBJECTIVES

4.11.1.1 Visuals

To establish a dry riparian scrub cover type similar in visual character to adjacent natural areas, where present.

Shrub stand density and patch size should match adjacent undisturbed areas. All plant spacing should be irregular and the planting configuration informal. Generally, shrub density should be highest near water sources and grade into more open stands on adjacent upland sites. Two or three shrub species should dominate the plant community. Grass and forb density should be highest on the edges of shrub patches (Exhibit 4-12).

4.11.1.1.1 ***General Overall.*** The dry riparian scrub cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.11.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of deciduous shrubs with smaller shrubs present in the understory. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.11.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

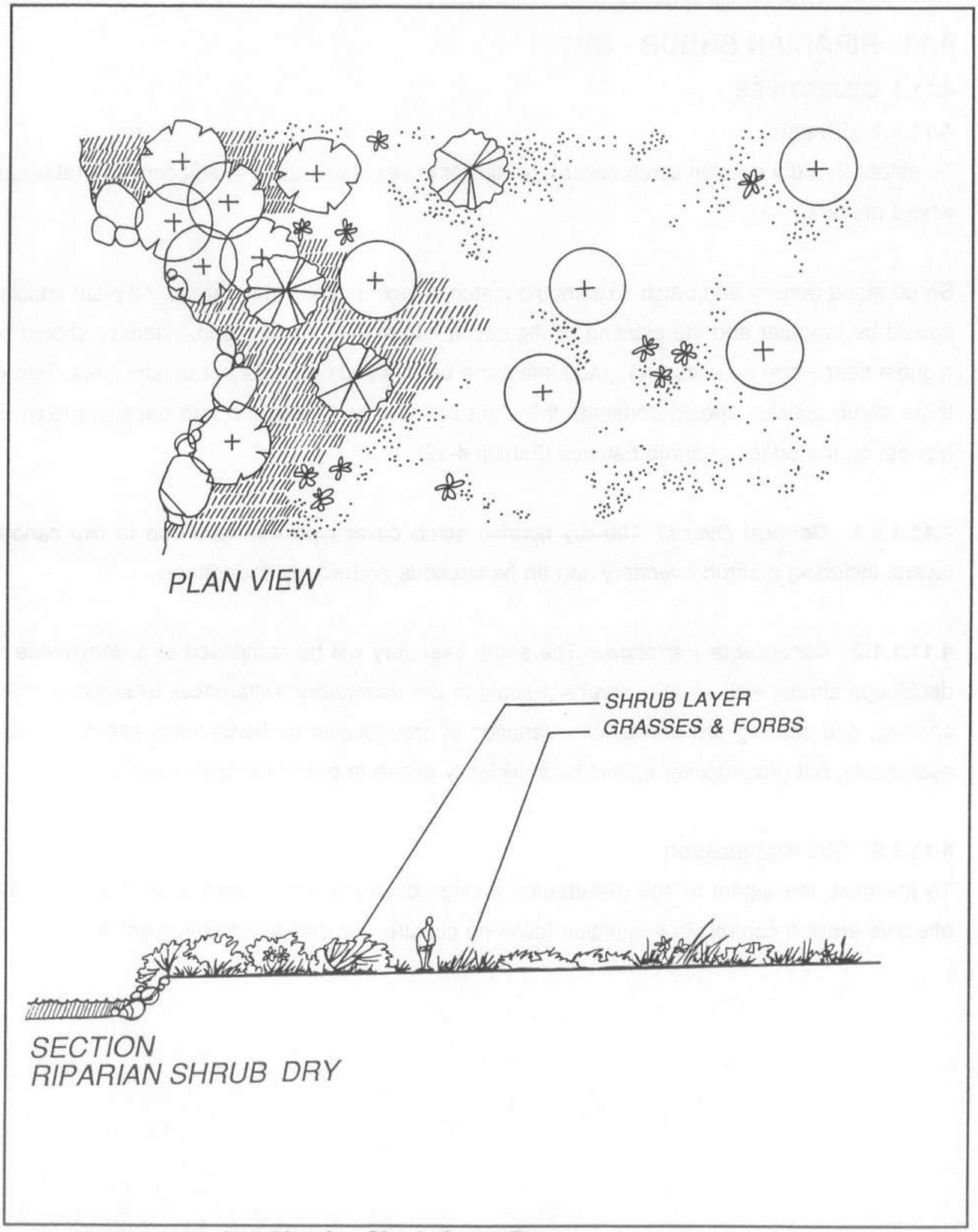


Exhibit 4-12. Dry Riparian Shrub Cover Type.

4.11.1.3 Wildlife

Selected indicator species for the dry riparian shrub cover type include the following:

Birds

MacGillivray's warbler
Yellow-breasted chat
Swainson's thrush
Black-headed grosbeak
Long-eared owl
Great horned owl
Belted kingfisher
Bald eagle
Northern oriole
Lazuli bunting
Great blue heron
Downy woodpecker
Common yellowthroat
Tree swallow
Yellow warbler

Mammals

Mule deer
Mink
Long-tailed weasel
Porcupine
Beaver
Moose
Red fox
Northern water shrew

4.11.1.4 Management/Maintenance

To establish a self-sustaining dry riparian scrub cover type requiring minimal maintenance effort.

4.11.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Shrubs with a diameter of four inches or less located within the clearing area should be salvaged for use in revegetation at the site or at nearby sites. Large shrubs should be individually marked for removal, and only marked shrubs should be downed. The method of cutting the shrubs will depend on the size of area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging other shrubs that will not be removed. Stumps of cut shrubs should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.11.3 SEEDBED PREPARATION

4.11.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures.

4.11.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2.

4.11.4 SEEDING

4.11.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-17 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes, if present.

Table 4-17. Dry Riparian Shrub Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Redtop (*Agrostis alba*)	-	2.0	0.25
Mountain brome (*Bromus marginatus*)	Bromar	3.0	0.5
Great Basin wildrye (*Elymus cinereus*)	Trailhead	2.0	0.5
Canby bluegrass (*Poa canbyi*)	Canbar	2.0	0.25
FORBS:			
Western yarrow (*Achillea millefolium*)	-	2.0	0.5
Eastern red columbine (*Aquilegia canadensis*)	-	0.5	0.5
Engelmann aster (*Aster engelmannii*)	-	1.0	0.5
Harebell (*Campanula rotundifolia*)	-	1.0	0.25
Lance-leaved coreopsis (*Coreopsis lanceolata*)	-	1.0	0.5
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Wild lupine (*Lupinus perennis*)	-	0.5	0.5
Five spot (*Nemophila maculata*)	-	0.5	0.5
Wasatch penstemon (*Penstemon cyananthus*)	-	0.5	0.5
Black-eyed Susan (*Rudbeckia hirta*)	-	1.0	0.25
Golden banner (*Thermopsis montana*)	-	0.5	0.25
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25

Table 4-17. Dry Riparian Shrub Seed Mix[1], Continued.

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
SHRUBS:			
Golden currant (*Ribes aureum*)	-	0.5	0.25
Nootka rose (*Rosa nutkana*)	-	0.5	0.5
TOTAL		**19.5**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.11.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-17 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good.

4.11.5 PLANTING

4.11.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged trees and shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-18.

This cover type is particularly suited for the transplant of cottonwood poles, sprig planting of willow and other hydrophytic shrubs, and other bioengineering techniques. Planting patterns and spacing should follow recommendations in Section 3.4.3.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

4.11.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants of trees and shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3 and Table 4-18.

4.11.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.11.7 IRRIGATION

Due to the more mesic condition of this cover type, seeded areas will not in general need watering for effective establishment. However, transplanted and containerized shrubs will need periodic watering during the establishment period. Sprinkling may be helpful to obtain quick establishment of seeded areas including small areas along the margins of trails and at other popular, high visibility areas.

4.11.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

Table 4-18. Planting Recommendations for Dry Riparian Shrub Cover Type.

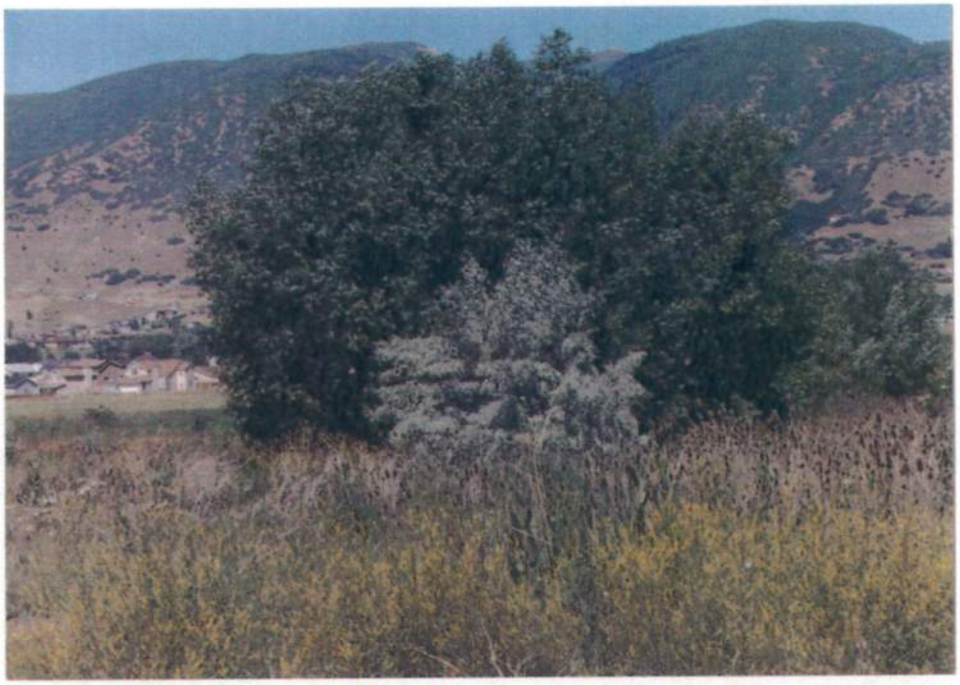
Scientific Name	Common Name	Size
Betula occidentalis	Water birch	• 1 gal.
Crataegus douglasii	Douglas hawthorn	• 1 gal.
Prunus virginiana	Chokecherry	• 1-2 gal.
Rhus trilobata	Oakleaf sumac	• 1 gal.
Rosa woodsii	Woods wildrose	• 1 gal.
Rubus parviflora	Thimbleberry	• 1 gal.

4.11.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.11.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the tree overstory.



Examples of Dry Riparian Shrub Cover Type.

4.12 RIPARIAN SHRUB - WET

4.12.1 OBJECTIVES

4.12.1.1 Visuals

To establish a wet riparian scrub cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Shrub stand density and patch size should match adjacent undisturbed areas. All plant spacing should be irregular and the planting configuration informal. Generally, shrub density should be highest near water sources and grade into more open stands on adjacent upland sites. Two or three shrub species should dominate the plant community. Grass and forb density should be highest for the edges of shrub patches (Exhibit 4-13).

4.12.1.1.1 ***General Overall.*** The wet riparian scrub cover type will have one to two canopy layers, including a shrub overstory and an herbaceous and woody understory.

4.12.1.1.2 ***Acceptable Variations.*** The shrub overstory will be comprised of a dominance of tall deciduous shrubs with smaller shrubs present in the understory. Differences in shrub density, species, and spacing are acceptable. Variation in groundcover by herbaceous species is also acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.12.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

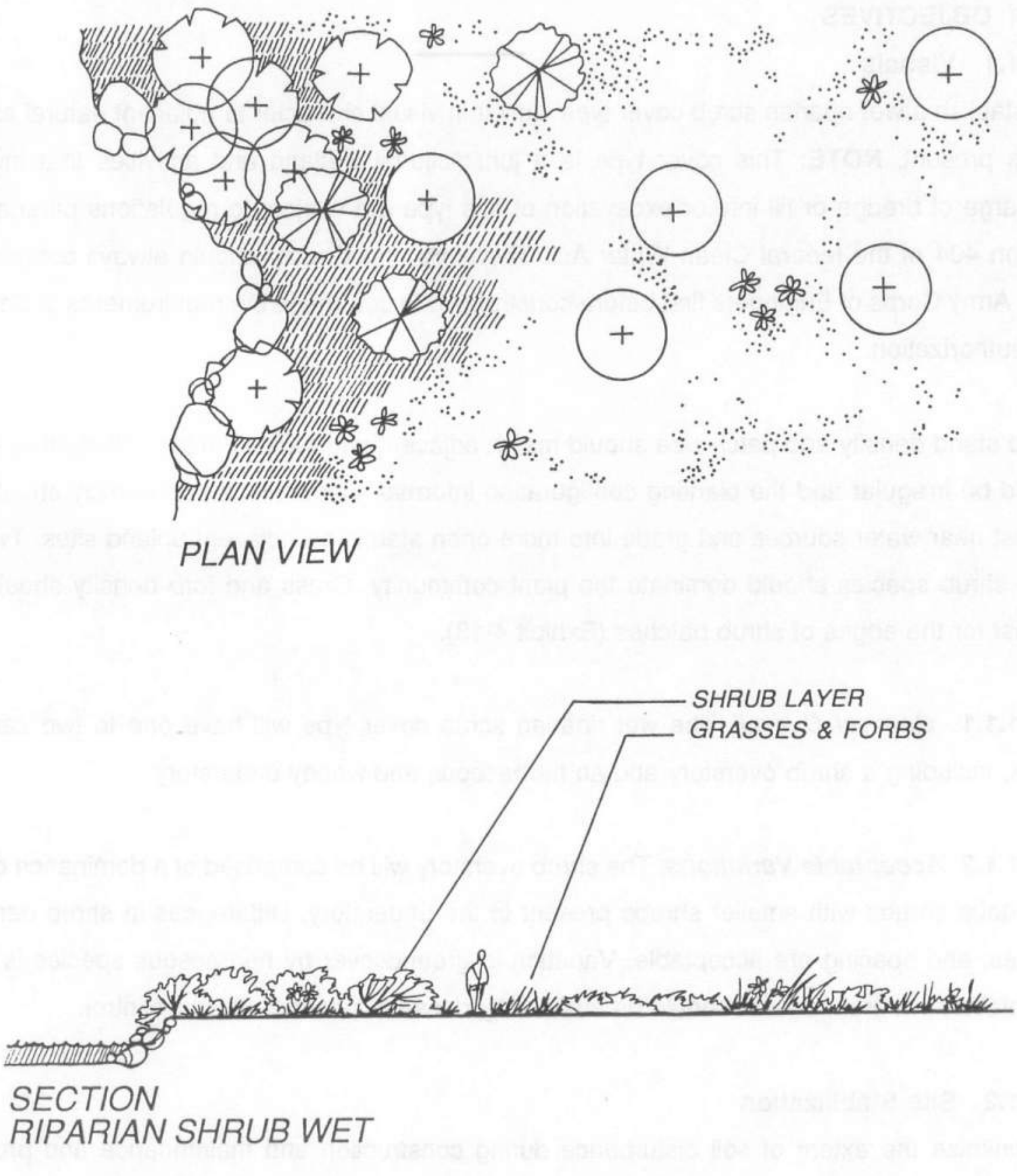


Exhibit 4-13. Wet Riparian Shrub Cover Type.

4.12.1.3 Wildlife

Selected indicator species for the wet riparian shrub cover type include the following:

Birds	Mammals
MacGillivray's warbler	Mule deer
Yellow-breasted chat	Mink
Swainson's thrush	Long-tailed weasel
Black-headed grosbeak	Porcupine
Long-eared owl	Beaver
Great horned owl	Moose
Belted kingfisher	Red fox
Bald eagle	
Northern oriole	
Lazuli bunting	
Great blue heron	
Downy woodpecker	
Common yellowthroat	
Tree swallow	
Yellow warbler	

4.12.1.4 Management/Maintenance

To establish a self-sustaining wet riparian scrub cover type requiring minimal maintenance effort.

4.12.2 SITE CLEARING

Site clearing could involve removal of woody and herbaceous (grasses and forbs) materials. The minimum area possible should be disturbed. Shrubs with a diameter of four inches or less located within the clearing area should be salvaged for use in revegetation at the site or at nearby sites.

Large shrubs should be individually marked for removal, and only marked shrubs should be downed. The method of cutting the shrubs will depend on the size of area; however, most projects that involve this cover type will likely be linear or less than 1.0 acre. Thus, removal by chainsaw is the preferred method. Care must be taken to avoid damaging other shrubs that will not be removed. Stumps of cut shrubs should be removed using crawler tractors.

Downed large material must be disposed of in an approved manner. This may include on-site burning or hauling larger materials to a dump. However, smaller branches and limbs of shrubs could be chipped and the product used to surface trails or provide mulch covering in revegetation areas.

Clearing of small brush and herbaceous vegetation should occur as outlined in Section 3.1.1.

4.12.3 SEEDBED PREPARATION

4.12.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.12.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.12.4 SEEDING

4.12.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-19 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on

Table 4-19. Wet Riparian Shrub Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Streambank wheatgrass (*Agropyron riparium*)	Sodar	3.0	0.5
Redtop (*Agrostis alba*)	-	3.0	0.5
Bluejoint reedgrass (*Calamagrostis canadensis*)	Sourdough	1.0	0.25
Tufted hairgrass (*Deschampsia cespitosa*)	-	1.0	0.25
Blue wildrye (*Elymus glaucus*)	-	2.0	0.5
GRAMINOIDS:			
Nebraska sedge (*Carex nebrascensis*)	-	0.5	0.5
FORBS:			
Blue-leaf aster (*Aster glaucodes*)	-	1.0	0.5
Marsh Indian paintbrush (*Castilleja exilis*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Missouri iris (*Iris missouriensis*)	-	0.5	0.5
Lemon mint (*Monarda citriodora*)	-	0.25	0.25
Blue-eyed grass (*Sisyrinchium bellum*)	-	0.25	0.5
Golden banner (*Thermopsis montanus*)	-	1.0	0.5
Strawberry clover (*Trifolium fragiferum*)	Salina	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25
TOTAL		15.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

particularly steep slopes, if present. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.12.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-19 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.12.5 PLANTING

4.12.5.1 Small Areas

Natural invasion can provide a cost-effective and efficient means of establishing trees and shrubs in small areas, particularly in linear disturbances. However, if an immediate response is desired, then transplants of salvaged trees and shrubs should be used. Alternatively, bareroot stock or containerized shrubs may be planted according to Table 4-20. This cover type is particularly suited for the transplant of cottonwood poles, sprig planting of willow and other hydrophytic shrubs, and other bioengineering techniques. Planting patterns and spacing should follow recommendations in Section 3.4.3.

The County may choose not to plant containerized and/or transplanted plants in small areas and rely on seeding alone. This would be particularly appropriate for small areas with desirable residual shrubs or where openings within the existing overstory are desired.

Table 4-20. Planting Recommendations for Wet Riparian Shrub Cover Type.

Scientific Name	Common Name	Size
Cornus stolonifera	Red-osier dogwood	• 1 gal.
Ribes aureum	Golden currant	• 1 gal.
Salix exigua	Sandbar willow	• tubepak or 1 gal.
Salix lutea	Yellow willow	• 10 cu.in. or 1 gal.

4.12.5.2 Large Areas

Natural invasion is an ineffective means of establishing woody vegetation, particularly in large areas. If an immediate response is desired, transplants of trees and shrubs should be used. Planting patterns and spacing should follow recommendations in Section 3.4.3.4.

4.12.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.12.7 IRRIGATION

Due to the saturated soil conditions of this cover type, seeded areas will not need watering for effective establishment.

4.12.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.12.9 MAINTENANCE/MANAGEMENT

Maintenance activities may include replacement of dead shrubs and supplemental plantings. See further information in Section 3.8.

4.12.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the tree overstory.

Examples of Wet Riparian Shrub Cover Type.

4.13 WET MEADOW - FRESHWATER

4.13.1 OBJECTIVES

4.13.1.1 Visuals

To establish a freshwater wet meadow cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Sedges should dominate the plant community. One or two species should comprise 75 percent of the cover. Forbs and grasses should persist as scattered clumps, being most dense on the edges of sedge patches. To the extent possible, vegetative patterns should be informal, a reflection of varied growing conditions (Exhibit 4-14).

4.13.1.1.1 ***General Overall.*** The freshwater wet meadow cover type will have a single herbaceous groundcover layer comprised of grass and forb species.

4.13.1.1.2 ***Acceptable Variations.*** It is acceptable for the County to include shrub species typical of the riparian scrub cover type described previously. Variation in groundcover by herbaceous species is acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.13.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

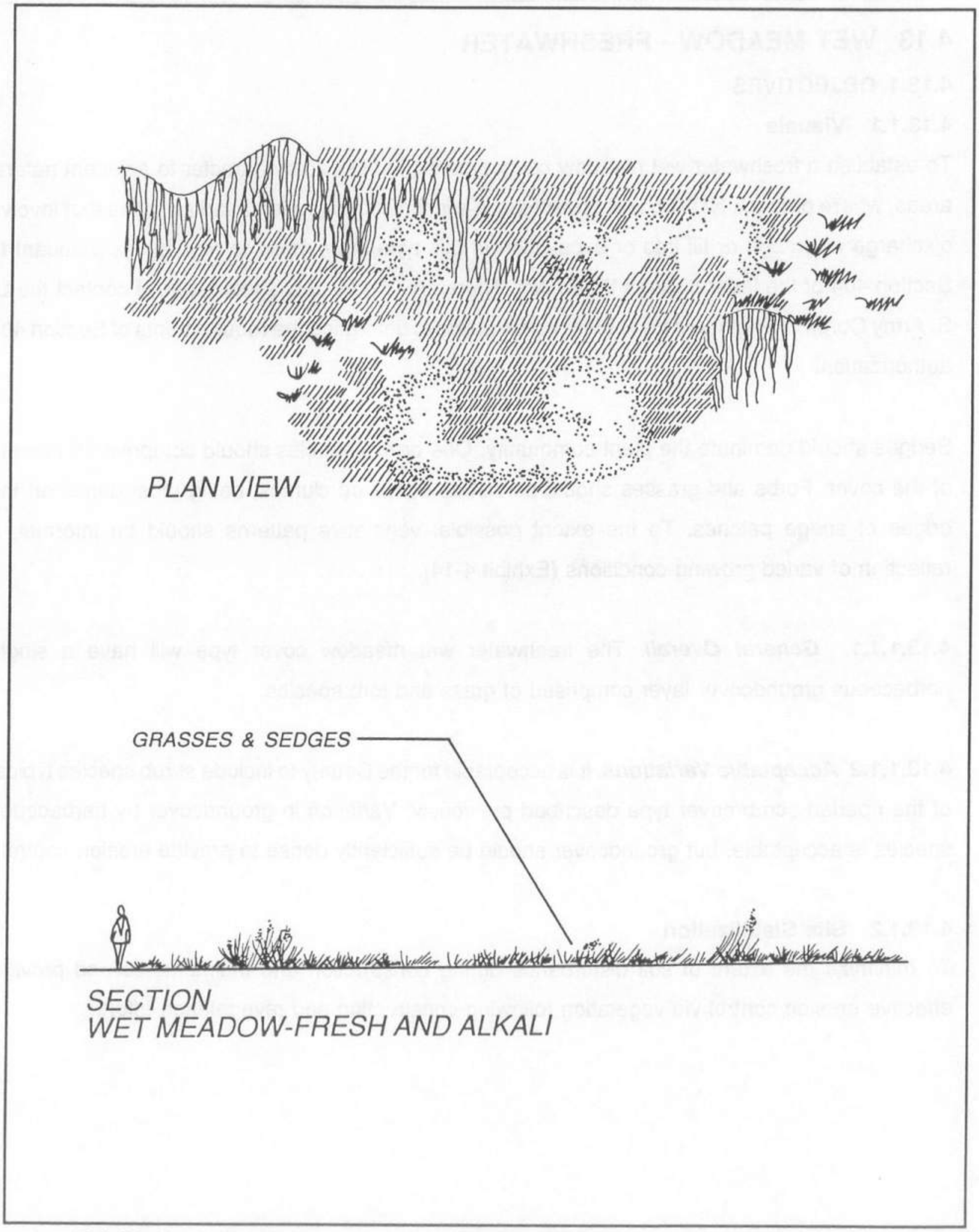


Exhibit 4-14. Freshwater Wet Meadow Cover Type.

4.13.1.3 Wildlife

Selected indicator species for the freshwater wet meadow cover type include the following:

Birds	Mammals
Common snipe	Deer mouse
Willet	Meadow vole
White-faced ibis	Red fox
Snowy egret	Long-tailed weasel
Cattle egret	Striped skunk
Canada goose	
Northern harrier	
American kestrel	
Sandhill crane	
Killdeer	

4.13.1.4 Management/Maintenance

To establish a self-sustaining freshwater wet meadow cover type requiring minimal maintenance effort.

4.13.2 SITE CLEARING

Unless cover type conversion is planned, site clearing will involve removal of herbaceous (grasses and forbs) material with topsoil stripping and salvage. If cover type conversion is planned, site clearing procedure for the woody cover types would be appropriate. The minimum area possible should be disturbed.

4.13.3 SEEDBED PREPARATION

4.13.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.13.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.13.4 SEEDING

4.13.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

The seed mix in Table 4-21 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.13.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-21 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

Table 4-21. Freshwater Wet Meadow Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Blue wildrye (*Elymus glaucus*)		2.0	0.5
Bluejoint reedgrass (*Calamagrostis canadensis*)	Sourdough	1.0	0.25
Redtop (*Agrostis alba*)	-	3.0	0.5
Streambank wheatgrass (*Agropyron riparium*)	Sodar	3.0	0.5
Tufted hairgrass (*Deschampsia cespitosa*)	-	1.0	0.25
GRAMINOIDS:			
Nebraska sedge (*Carex nebrascensis*)	-	0.5	0.5
FORBS:			
Blue-leaf aster (*Aster glaucodes*)	-	1.0	0.5
Marsh Indian paintbrush (*Castilleja exilis*)	-	0.5	0.25
Northern sweetvetch (*Hedysarum boreale*)	-	0.5	0.25
Missouri iris (*Iris missouriensis*)	-	0.5	0.5
Lemon mint (*Monarda citriodora*)	-	0.25	0.25
Blue-eyed grass (*Sisyrinchium bellum*)	-	0.25	0.5
Golden banner (*Thermopsis montanus*)	-	1.0	0.5
Strawberry clover (*Trifolium fragiferum*)	Salina	0.5	0.5
Alsike clover (*Trifolium hybridum*)	-	0.5	0.25
TOTAL		15.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.13.5 PLANTING

No planting of containerized stock is envisioned for establishment of this herbaceous cover type. However, the County may choose to plant shrub or tree species typical of riparian forest and riparian scrub in the wet meadow to provide visual contrast with the otherwise strictly herbaceous groundcover.

4.13.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on area size and degree of disturbance. See Section 3.5 erosion control information.

4.13.7 IRRIGATION

Due to the saturated soil conditions of this cover type, seeded areas will not need watering for effective establishment.

4.13.8 WEED MANAGEMENT

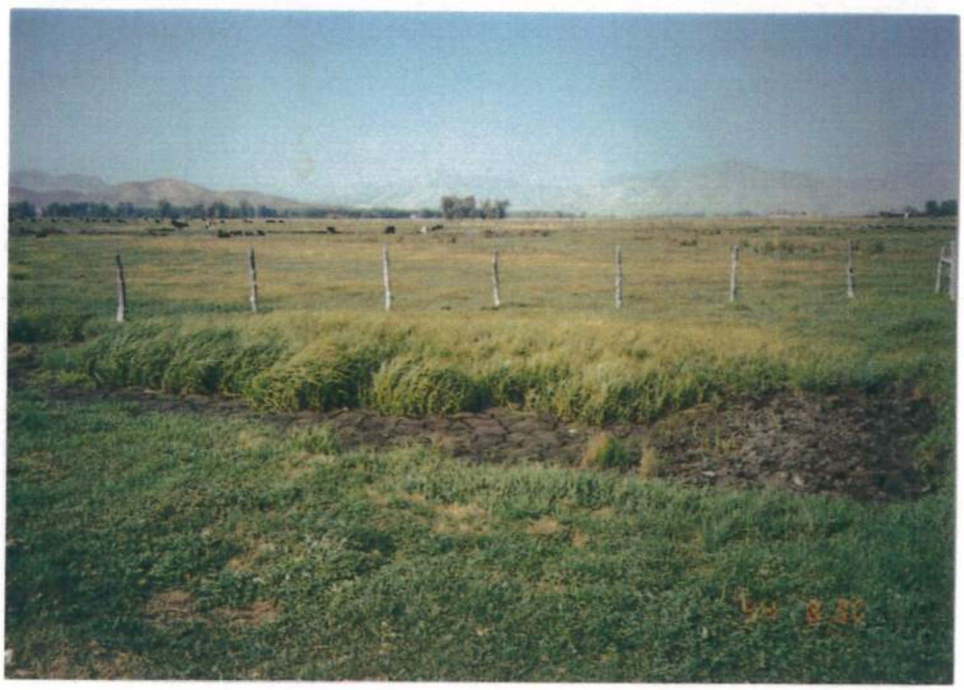
Weed prevention and management should occur as identified in Section 3.7.

4.13.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.13.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory, if present.



Examples of Freshwater Wet Meadow Cover Type.

4.14 WET MEADOW - ALKALI

4.14.1 OBJECTIVES

4.14.1.1 Visuals

To establish an alkali wet meadow cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Sedges should dominate the plant community. One or two species should comprise 75 percent of the cover. Forbs and grasses should persist as scattered clumps, being most dense on the edges of sedge patches. To the extent possible, vegetative patterns should be informal, a reflection of varied growing conditions (Exhibit 4-15).

4.14.1.1.1 ***General Overall.*** The alkali wet meadow cover type will have a single herbaceous groundcover layer comprised of grass and forb species.

4.14.1.1.2 ***Acceptable Variations.*** It is acceptable for the County to include shrub species typical of the riparian scrub cover type described previously. However, care should be taken to determine that alkali levels are not excessive for such species. Shrub species identified for the lowland alkali scrub cover type may be applicable to this cover type as well. Variation in groundcover by herbaceous species is acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.14.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

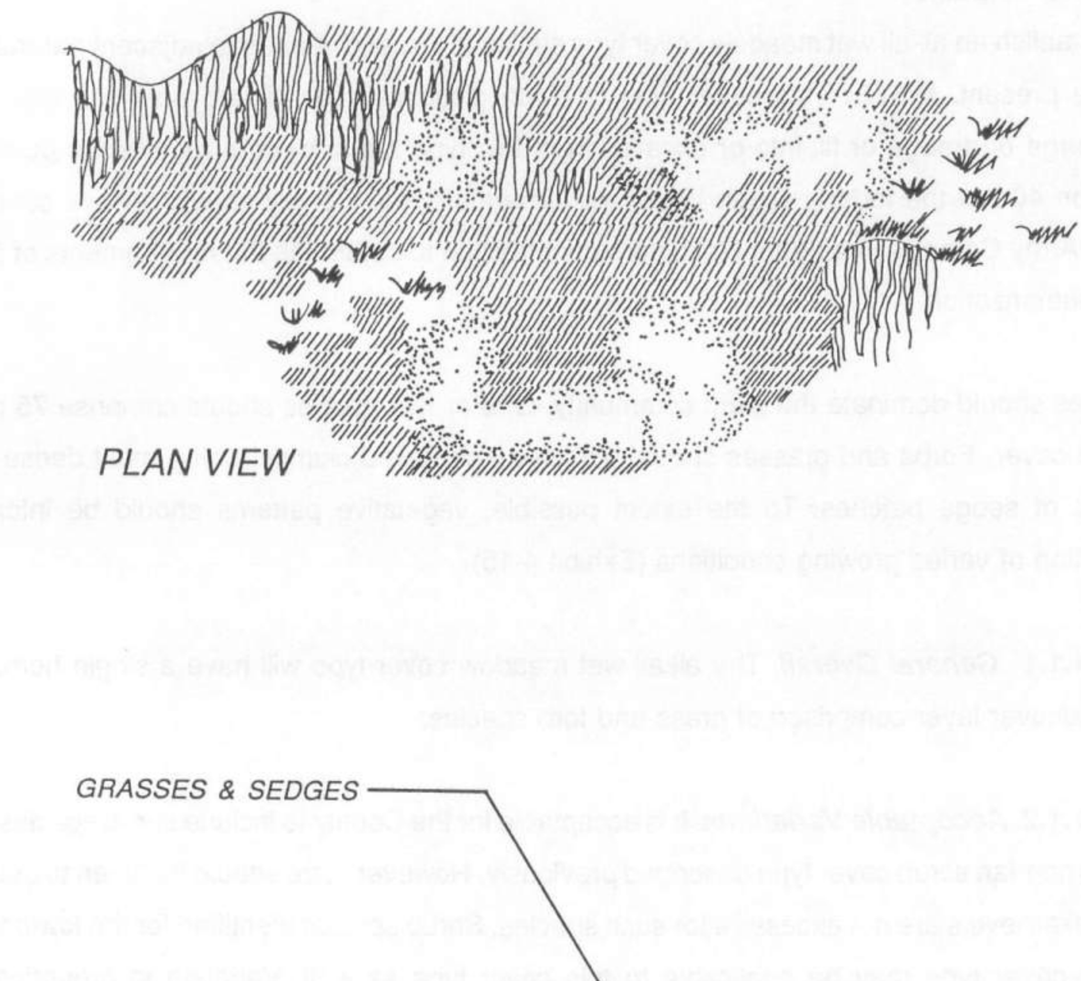


Exhibit 4-15. Alkali Wet Meadow Cover Type.

4.14.1.3 Wildlife

Selected indicator species for the alkali wet meadow cover type include the following:

Birds	Mammals
Lesser yellowlegs	Muskrat
Greater yellowlegs	Raccoon
Willet	Long-tailed weasel
Least sandpiper	Red fox
American avocet	
Black-necked stilt	
Wilson's phalarope	
Long-billed dowitcher	

4.14.1.4 Management/Maintenance

To establish a self-sustaining alkali wet meadow cover type requiring minimal maintenance effort.

4.14.2 SITE CLEARING

Unless cover type conversion is planned, site clearing will involve removal of herbaceous (grasses and forbs) materials with topsoil stripping and salvage. If cover type conversion is planned, the site clearing procedure for the woody cover types would be appropriate. The minimum area possible should be disturbed.

4.14.3 SEEDBED PREPARATION

4.14.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.14.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.14.4 SEEDING

4.14.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed.

The seed mix in Table 4-22 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.14.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-22 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

Table 4-22. Alkali Wet Meadow Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION DRILLED RATE (PLS[2] lbs/ac)[3]	PLANTING DEPTH (if drilled) (inches)
GRASSES:			
Tall wheatgrass (*Agropyron elongatum*)	Alkar	1.5	0.5
Inland saltgrass (*Distichlis stricta*)	-	3.0	0.25
Alkaligrass (*Puccinellia distans*)	Fults	3.0	0.5
Alkali sacaton (*Sporobolus airoides*)	Salado	1.0	0.25
FORBS:			
Pacific aster (*Aster chilensis*)	-	1.0	0.25
Marsh Indian paintbrush (*Castilleja exilis*)	-	1.0	0.25
Strawberry clover (*Trifolium fragiferum*)	Salina	1.0	0.25
Alsike clover (*Trifolium hybridum*)	-	3.0	0.25
TOTAL		14.5	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

3 - Where drill seeding is not possible, seed should be broadcast at twice the recommended drilling rate and raked into the soil surface.

4.14.5 PLANTING

No planting of containerized stock is envisioned for establishment of this herbaceous cover type. However, the County may choose to plant shrub or tree species typical of riparian forest and riparian scrub in the wet meadow to provide visual contrast with the otherwise strictly herbaceous groundcover. Care should be taken to determine that alkali levels are not excessive for such species. Shrub species identified for lowland alkali scrub may be applicable to this cover type as well.

4.14.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.14.7 IRRIGATION

Due to the saturated soil conditions of this cover type, seeded areas will not need watering for effective establishment.

4.14.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.14.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.14.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory, if present.

Examples of Alkali Wet Meadow Cover Type.

4.15 MARSH - FRESHWATER

4.15.1 OBJECTIVES

4.15.1.1 Visuals

To establish a marsh cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a jurisdictional wetland, and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Emergent vegetation should dominate this plant community. One or two species should comprise 75 percent of the vegetative cover. Stands should be very dense with no more than 50 percent of the wetland basin as open water. Vegetation patch patterns should be informal. A typical pattern is two or three concentric rings of vegetation. Each ring is dominated by a different species, a response to changes in water depth. Where changes in water depth are minimal, there will be considerable integration of species between rings (Exhibit 4-16).

4.15.1.1.1 ***General Overall.*** The marsh cover type will have a single herbaceous groundcover layer comprised of grass and forb species.

4.15.1.1.2 ***Acceptable Variations.*** No tree or shrub species are appropriate for this cover type unless they are provided on islands as habitat features. Under this scenario, tree and shrub species typical of riparian forest and riparian scrub would be suitable. Variation in groundcover by herbaceous species is acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.15.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

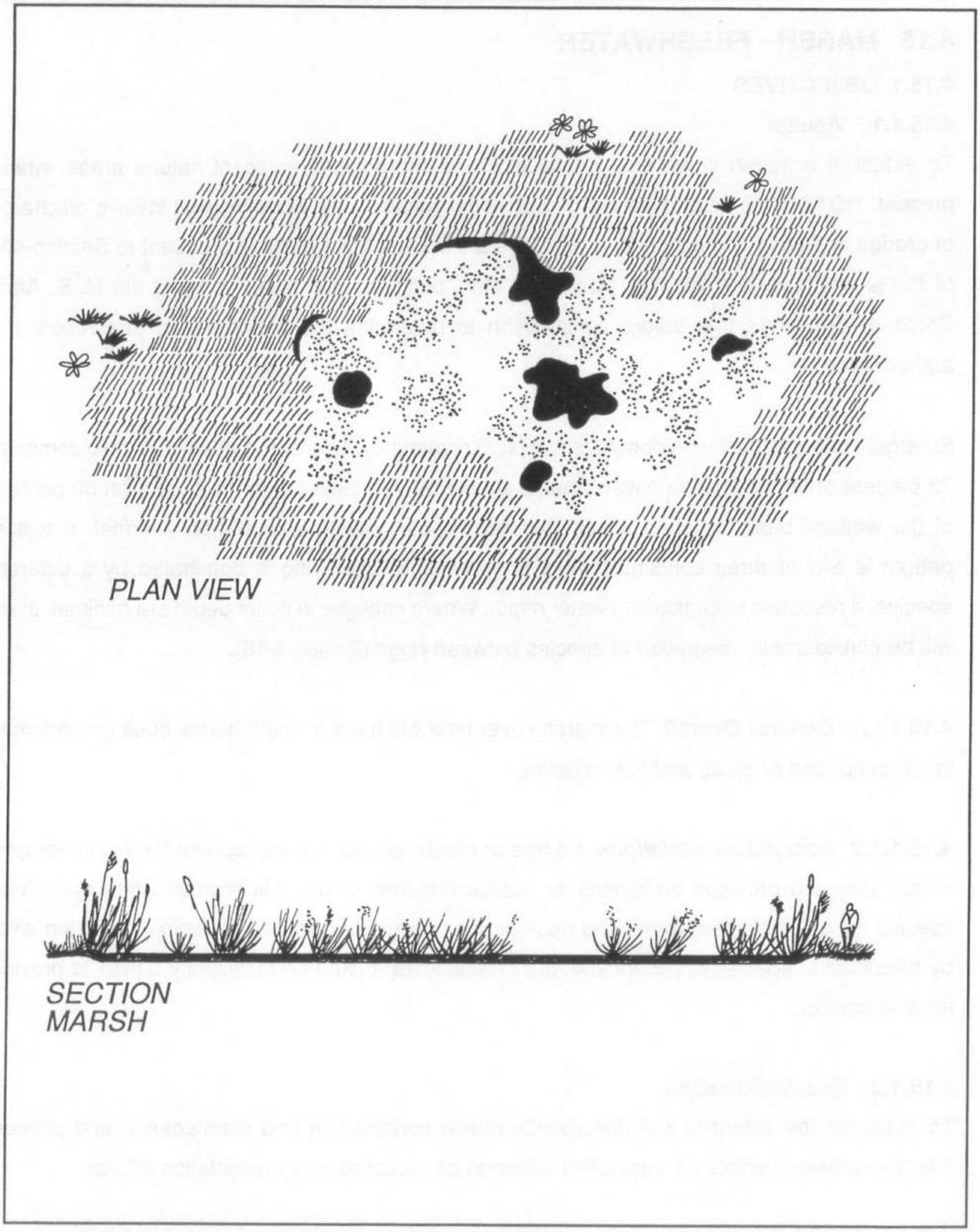


Exhibit 4-16. Freshwater Marsh Cover Type.

4.15.1.3 Wildlife

Selected indicator species for the marsh cover type include the following:

Birds	Mammals
White pelican	Muskrat
Great blue heron	Beaver
Black-crowned night heron	Long-tailed weasel
Canada goose	Mink
Snow goose	Raccoon
Tundra swan	
Mallard	
Green-winged teal	
Cinnamon teal	
Double-crested cormorant	
Yellow-headed blackbird	
Red-winged blackbird	
Common yellowthroat	
Long-billed marsh wren	
Northern harrier	
Yellow warbler	

4.15.1.4 Management/Maintenance

To establish a self-sustaining marsh cover type requiring minimal maintenance effort.

4.15.2 SITE CLEARING

Unless cover type conversion is planned, site clearing will involve removal of herbaceous (grasses and forbs) materials with topsoil stripping and salvage. If cover type conversion is planned, site clearing procedure for the woody cover types would be appropriate. The minimum area possible should be disturbed.

4.15.3 SEEDBED PREPARATION

4.15.3.1 Small Areas

In small areas where use of larger equipment is impractical, the seedbed should be prepared with hand-operated tools such as rototillers, etc. Rough grading and topsoil removal are generally unnecessary procedures. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.15.3.2 Large Areas

Seedbed preparation should occur as indicated in Section 3.2. Seedbed preparation activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.15.4 SEEDING

4.15.4.1 Small Areas

Natural invasion and establishment can provide a cost-effective and efficient means of establishing vegetation in small areas, particularly in linear disturbances. However, natural invasion requires some time, particularly in arid and semi-arid regions. This could encourage weed invasion and erosion problems. Therefore, it is generally best to apply seed. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

The seed mix in Table 4-23 should be applied by broadcast application and hand-raked into the soil as appropriate based on topography and site size. The seeding rate should be doubled for broadcast application. As indicated in Section 3.3.3.1, hydroseeding may be appropriate on particularly steep slopes. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

Table 4-23. Freshwater Marsh Seed Mix[1].

SPECIES	CULTIVAR OR VARIETY	SEED APPLICATION BROADCAST RATE (PLS[2] lbs/ac)	PLANTING DEPTH (inches)
GRASSES:			
American sloughgrass (*Beckmannia syzigachne*)	Egan	4.0	0.25
GRAMINOIDS:			
Beaked sedge (*Carex rostrata*)		2.0	0.5
Alkali bulrush (*Scirpus maritima*)	-	2.0	0.5
Cattail (*Typha latifolia*)	-	0.5	0.25
FORBS:			
Missouri iris (*Iris missouriensis*)	-	1.0	0.5
Blue-eyed grass (*Sisyrinchium bellum*)	-	0.5	0.5
TOTAL		**10.0**	

1 - Seed mix based on adaptation to the site conditions of the project, usefulness of species for rapid site stabilization, species success in revegetation efforts, current seed availability and cost, and specific project objectives.

2 - PLS = pure live seed.

4.15.4.2 Large Areas

Natural establishment is ineffective for revegetation of larger areas. Seeding in large areas should follow procedures identified in Section 3.3.3.2 where drill-type equipment may be used. Table 4-23 seeding rates are provided for drilling. Alternately, broadcast application could be used. If seed is broadcast applied, the seeding rate in the table must be doubled. Also, to keep costs down, several of the wildflower species could be eliminated from the seed mix for areas greater than 1.0 acre where visual access is poor except along trails, roads, or parking areas where visual access is good. Seeding activities should take place in the fall or early spring to avoid excessive soil moistures that may hamper activities.

4.15.5 PLANTING

No planting of containerized stock is envisioned for establishment of this herbaceous cover type. However, the County may choose to plant shrub or tree species typical of riparian forest and riparian scrub in islands in the marsh to provide visual contrast with the otherwise strictly herbaceous groundcover or to provide habitat features.

4.15.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.15.7 IRRIGATION

Due to the saturated soil conditions of this cover type, seeded areas will not need watering for effective establishment.

4.15.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.15.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.15.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including the shrub overstory, if present.

Examples of Freshwater Marsh Cover Type.

4.16 MUDFLAT/PLAYA

4.16.1 OBJECTIVES

4.16.1.1 Visuals

To establish a mudflat/playa cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a special aquatic site, and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Typically, mudflats would not be planted. However, plants may invade mudflat areas when conditions for germination and establishment are present (Exhibit 4-17).

4.16.1.1.1 ***General Overall.*** The mudflat/playa cover type will be devoid of plants and will consist of a flat or level flat and gently sloping area.

4.16.1.1.2 ***Acceptable Variations.*** In general, no vegetation is needed for this cover type. However, habitat features provided by other wetland cover types would be acceptable.

4.16.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

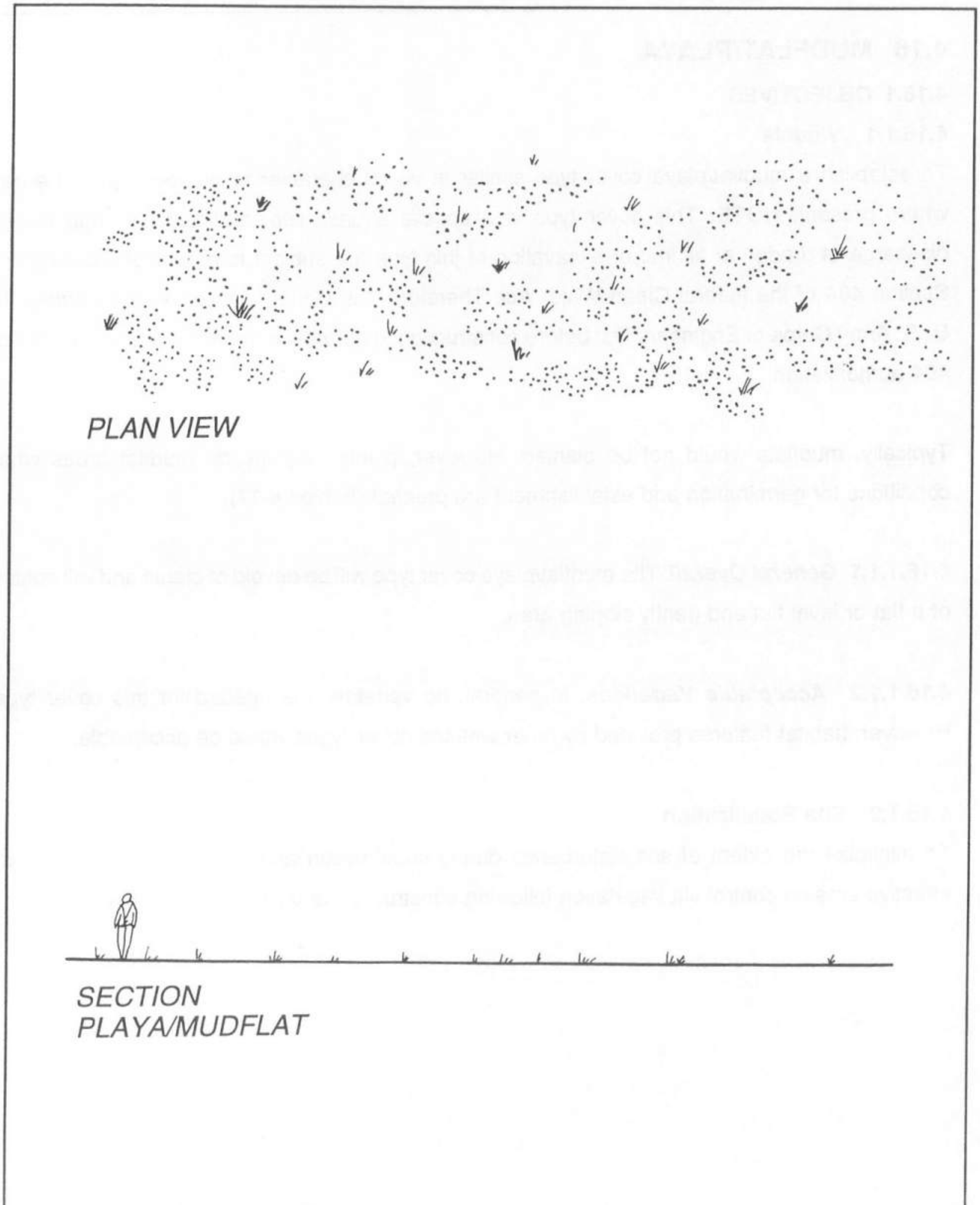


Exhibit 4-17. Mudflat/Playa Cover Type.

4.16.1.3 Wildlife

Selected indicator species for the mudflat/playa cover type include the following:

Birds

Lesser yellowlegs
Greater yellowlegs
Willet
Least sandpiper
American avocet
Black-necked stilt
Wilson's phalarope
Long-billed dowitcher

Mammals

Muskrat
Raccoon
Long-tailed weasel
Red fox

4.16.1.4 Management/Maintenance

To establish a self-sustaining mudflat/playa type requiring minimal maintenance effort.

4.16.2 SITE CLEARING

No site clearing activities are envisioned with this cover type.

4.16.3 SEEDBED PREPARATION

No seedbed preparation activities will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.16.4 SEEDING

No seeding activities will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.16.5 PLANTING

No planting will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.16.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.16.7 IRRIGATION

No watering will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.16.8 WEED MANAGEMENT

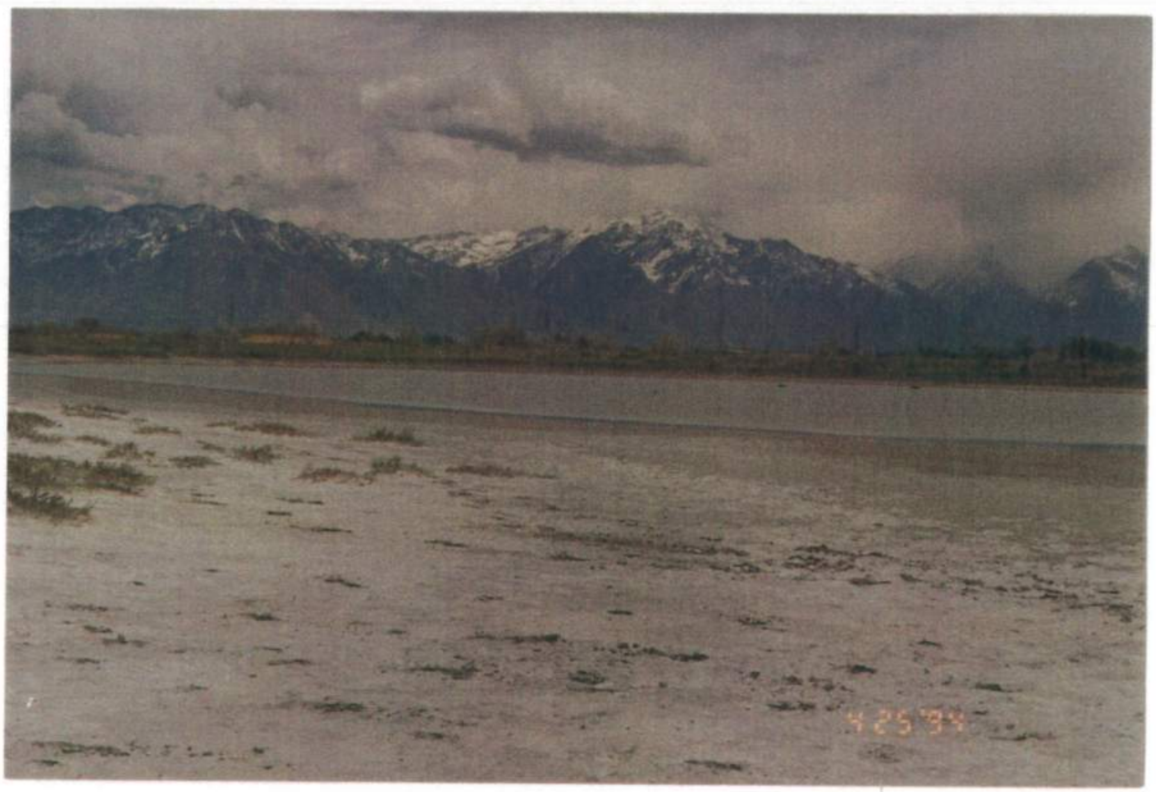
Weed prevention and management should occur as identified in Section 3.7.

4.16.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.16.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers), including an herbaceous groundcover and a shrub overstory, if present.



Examples of Mudflat/Playa Cover Type.

4.17 AQUATIC BED

4.17.1 OBJECTIVES

4.17.1.1 Visuals

To establish an aquatic bed cover type similar in visual character to adjacent natural areas, where present. **NOTE:** This cover type is a special aquatic site and activities that involve discharge of dredge or fill into or excavation of this type are subject to regulations pursuant to Section 404 of the federal Clean Water Act. Therefore, the County should always contact the U. S. Army Corps of Engineers first before construction to determine the requirements of Section 404 authorization.

Submerged aquatic vegetation should dominate the aquatic bed, with two or three species being most prevalent. At least 25 percent of the open water area should be filled with submerged aquatics. These standards should also be applied to open water aquatic beds within marsh areas (Exhibit 4-18).

4.17.1.1.1 ***General Overall.*** The aquatic bed cover type will have a single or multiple layer of herbaceous floating and submerged vegetation comprised of forb species.

4.17.1.1.2 ***Acceptable Variations.*** No tree or shrub species are appropriate for this cover type unless they are provided on islands as habitat features. Under this scenario, tree and shrub species typical of riparian forest and riparian scrub would be suitable. Variation in groundcover by herbaceous species is acceptable, but groundcover should be sufficiently dense to provide erosion control.

4.17.1.2 Site Stabilization

To minimize the extent of soil disturbance during construction and maintenance and provide effective erosion control via vegetation following construction and revegetation efforts.

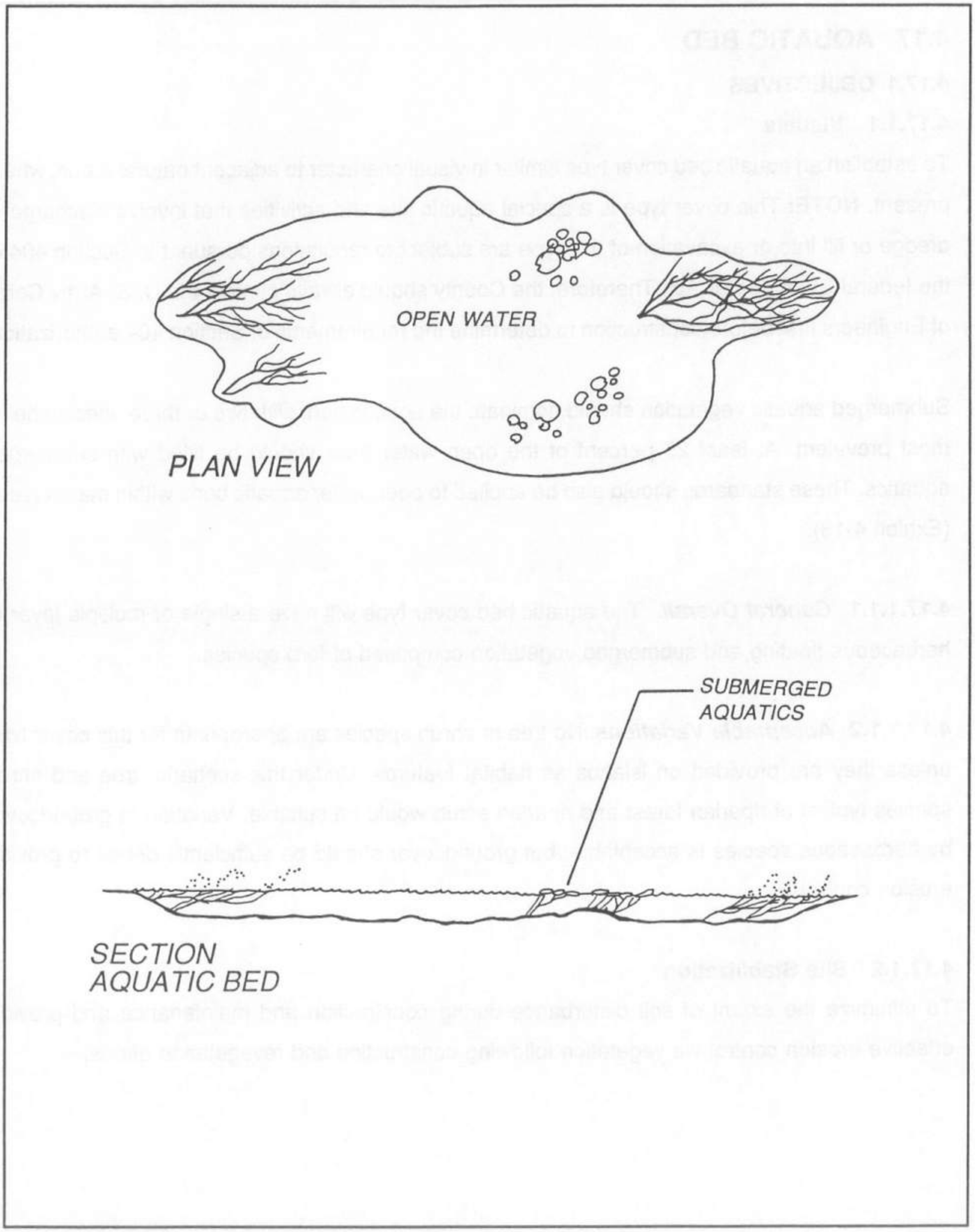


Exhibit 4-18. Aquatic Bed Cover Type.

4.17.1.3 Wildlife

Selected indicator species for the aquatic bed cover type include the following:

Birds	Mammals
American coot	Beaver
California gull	Muskrat
Franklin's gull	Mink
Forster's tern	Raccoon
Pintail	
Mallard	
Canada goose	
Tundra swan	
White pelican	
Common loon	
Cinnamon teal	
Barn swallow	
Western grebe	
Double-crested cormorant	
Snow goose	
Canvasback	
Common goldeneye	
Common merganser	
Belted kingfisher	
Rough-winged swallow	

4.17.1.4 Management/Maintenance

To establish a self-sustaining aquatic bed cover type requiring minimal maintenance effort.

4.17.2 SITE CLEARING

No site clearing activities are envisioned with this cover type.

4.17.3 SEEDBED PREPARATION

No seedbed preparation activities will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.17.4 SEEDING

No seeding activities will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.17.5 PLANTING

Planting will involve transferring water from existing aquatic bed habitats and the associated plant propagules to the site to be revegetated. Some aquatic bed starts are commercially available as identified in Table 4-24. If habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.17.6 EROSION CONTROL

Erosion control measures must be designed on a site-specific basis. Control will be most effective if designed by an erosion control specialist. The amount of erosion control applied is highly dependent on the size of the area and the degree of disturbance. See Section 3.5 for information on erosion control.

4.17.7 IRRIGATION

No watering will be necessary for this cover type. However, if habitat features comprised of other wetland cover types are desired, follow the recommendations for each type.

4.17.8 WEED MANAGEMENT

Weed prevention and management should occur as identified in Section 3.7.

4.17.9 MAINTENANCE/MANAGEMENT

See further information in Section 3.8.

4.17.10 MONITORING/REMEDIATION

Monitoring should evaluate development of all vegetation strata (vertical layers).

Table 4-24. Planting Recommendations for Aquatic Bed Cover Type.

Scientific Name	Common Name	Size
Alisma gramineum	Narrow-leaf water plantain	• transplants
Lemna spp.	Duckweed	• transplants
Potamogeton crispus	Curly pondweed	• transplants
Sagittaria cuneata	Northern arrowhead	• transplants

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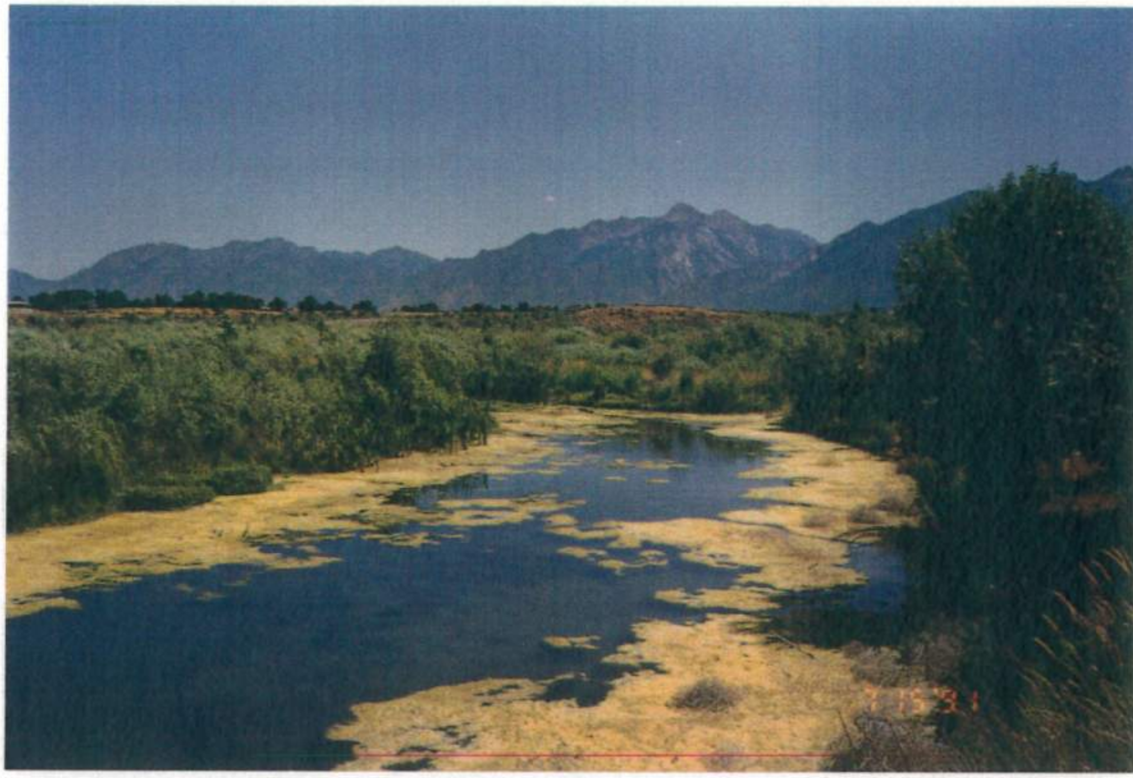


Examples of Aquatic Bed Cover Type.

4.18 OPEN WATER/RIVERINE

No revegetation recommendations are provided for the open water/riverine cover type as this cover type is comprised of water features contained within or associated with the wetland and special aquatic site cover types described previously (Exhibit 4-19).

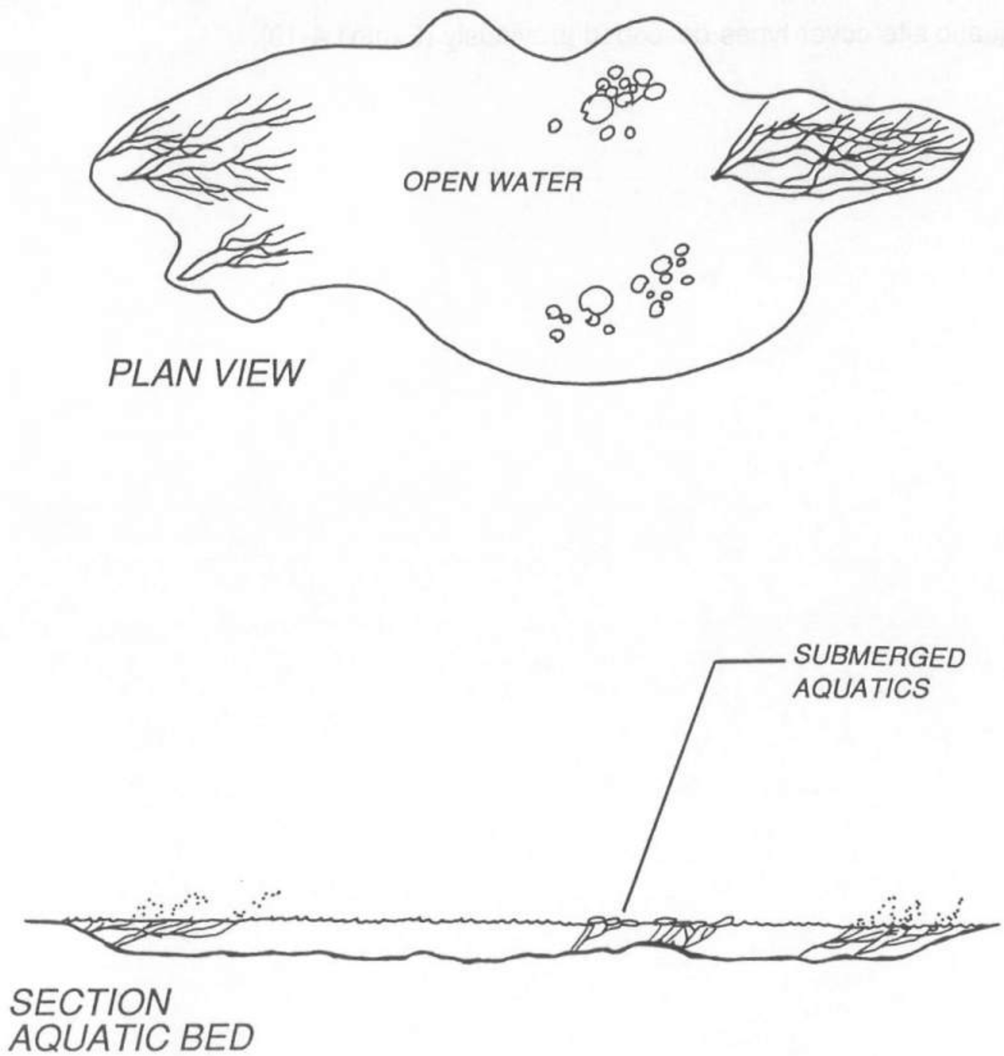
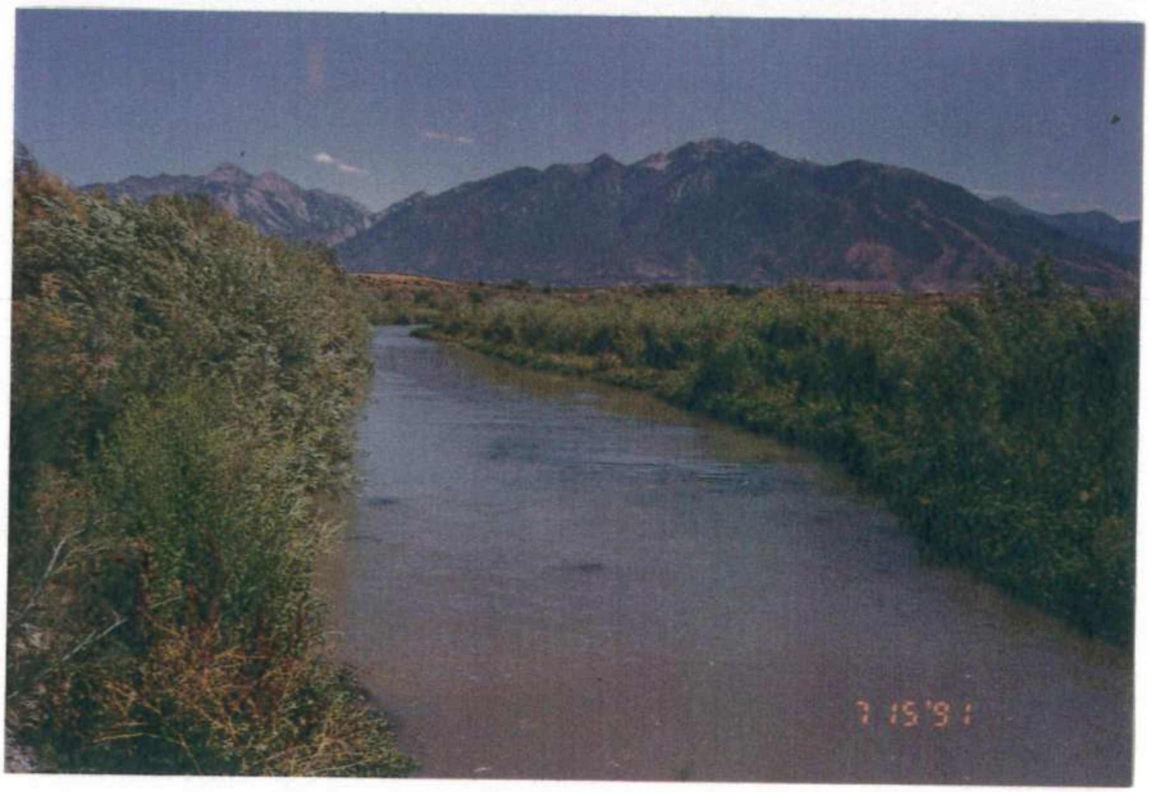


Exhibit 4-19. Open Water/Riverine Cover Type.



Examples of Open Water/Riverine Cover Type.

SECTION 5:

LIST OF PREPARERS

SECTION 5: LIST OF PREPARERS

List of Preparers	
Oliver John Grah	Project Manager, Principal Investigator, and Reclamation Scientist
Craig Johnson	Landscape Architect
Juli Crane	Weed Control Specialist and Technical Assistant
Karen Matsumoto	Editor, Graphic Artist, and Document Production

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SECTION 6:

REFERENCES

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APPENDICES:

APPENDIX A - Substitute Species Tables
APPENDIX B - Product Suppliers
APPENDIX C - American Standard for Nursery Stock

APPENDIX A

Substitute Species Tables

Table A-1. Proposed and Recommended Substitute Species for the Seed Mix.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
SEED MIX:								
White yarrow (*Achillea millefolium*)	F	--	white	May-August	Pearly everlasting (*Anaphilas margaritacea*)	—	white	June-July
Tall wheatgrass (*Agropyron elongatum*)	G	Alkar	N/A	N/A	Intermediate wheatgrass (*Agropyron intermedium*)	Greenar	N/A	N/A
Streambank wheatgrass (*Agropyron riparium*)	G	Sodar	N/A	N/A	Slender wheatgrass (*Agropyron trachycaulum*)	San Luis	N/A	N/A
Western wheatgrass (*Agropyron smithii*)	G	Rosanna	N/A	N/A	Slender wheatgrass (*Agropyron trachycaulum*)	San Luis	N/A	N/A
Bluebunch wheatgrass (*Agropyron spicatum*)	G	Secar	N/A	N/A	Beardless bluebunch wheatgrass (*Agropyron inerme*)	Whitmar	NA	N/A
Slender wheatgrass (*Agropyron trachycaulum*)	G	San Luis	N/A	N/A	Western wheatgrass (*Agropyron smithii*)	Rosanna	N/A	N/A
Redtop (*Agrostis alba*)	G	—	N/A	N/A	Colonial bentgrass (*Agrostis tenuis*)	—	N/A	N/A
Pearly everlasting (*Anaphalis margaritacea*)	F	—	white	June-July	Mountain phlox (*Linanthus grandiflorus*)	—	white	April-July
Eastern red columbine (*Aquilegia canadensis*)	F	—	red-yellow	April-July	Western red columbine (*Aquilegia formosa*)	—	red-yellow	May-August
Yellow columbine (*Aquilegia flavescens*)	F	—	yellow	June-August	Fragrant yellow columbine (*Aquilegia chrysantha*)	—	yellow	April-Sept.
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	S	—	light green-light brown	August-Sept.	Mountain big sagebrush (*Artemisia tridentata vaseyana*)	—	light green-light brown	August-Sept.
Plains aster (*Aster bigelovii*)	F	—	purple	Sept.-Oct.	Prairie aster (*Aster tanacetifolius*)	—	purple	June-Oct.

Table A-1. Proposed and Recommended Substitute Species for the Seed Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Pacific aster (*Aster chilensis*)	F	—	lavender-white	July-Oct.	Blueleaf aster (*Aster glaucodes*)	—	white-lavender	July-Sept.
Engelmann aster (*Aster engelmannii*)	F	—	white-pink	July-Sept.	New England aster (*Aster novae-angliae*)	—	lavender-purple	August-Oct.
Blue-leaf aster (*Aster glaucodes*)	F	—	white-lavender	July-Sept.	New England aster (*Aster novae-angliae*)	—	lavender-purple	August-Oct.
Gardner saltbush (*Atriplex gardneri*)	S	—	N/A	N/A	Castle Valley saltbush (*Atriplex cunenta*)	—	N/A	N/A
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	F	—	yellow	May-July	Clasping coneflower (*Rudbeckia amplexicaulus*)	—	yellow	June-August
American sloughgrass (*Beckmannia syzigachne*)	F	Egan	N/A	N/A	Hardstem bulrush (*Scirpus acutus*)	—	N/A	N/A
Mountain brome (*Bromus marginatus*)	G	Bromar	N/A	N/A	Meadow brome (*Bromus biebersteinii*)	Regar	N/A	N/A
Bluejoint reedgrass (*Calamagrostis canadensis*)	G	Sourdough	N/A	N/A	Creeping wildrye (*Elymus tricoides*)	Shoshone	N/A	N/A
Harebell (*Campanula rotundifolia*)	F	—	blue	June-Sept.	Canterbury bells (*Campanula Carpatica*)	—	Bluish-lavender	June-August
Nebraska sedge (*Carex nebrascensis*)	G	—	N/A	N/A	Water sedge (*Carex aquatilis*)	—	N/A	N/A
Beaked sedge (*Carex rostrata*)	G	—	N/A	N/A	Small winged sedge (*Carex microptera*)	—	N/A	N/A
Marsh Indian paintbrush (*Castilleja exilis*)	F	—	red	June-August	Split leaf Indian paintbrush (*Castilleja rhexifolia*)	—	pink-violet purple	June-August
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	S	—	yellow	August-Sept.	Antelope bitterbrush (*Purshia tridentata*)	—	yellow	July-August

Table A-1. Proposed and Recommended Substitute Species for the Seed Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Rocky Mountain beeplant (*Cleome serrulata*)	F	—	pink-purple	June-Sept.	Narrow-leaf Indian paintbrush (*Castilleja linariaefolia*)	—	red	June-August
Lance-leaved coreopsis (*Coreopsis lanceolata*)	F	—	yellow-burgundy	June-Sept.	Plains coreopsis (*Coreopsis tinctoria*)	—	yellow w/ maroon	June-Sept.
Plains coreopsis (*Coreopsis tinctoria*)	F	—	yellow w/ maroon	June-Sept.	Clasping coneflower (*Rudbeckia amplexicaulis*)	—	yellow	June-August
Tufted hairgrass (*Deschampsia cespitosa*)	G	—	—	—	Alkaligrass (*Puccinellia distans*)	Fults	—	—
Inland saltgrass (*Distichlis stricta*)	G	—	—	—	Nuttall saltgrass (*Puccinellia airoides*)	—	—	—
Great Basin wildrye (*Elymus cinereus*)	G	Trailhead	—	—	Great Basin wildrye (*Elymus cinereus*)	Magnar	—	—
Blue wildrye (*Elymus glaucus*)	G	—	—	—	Canada wildrye (*Elymus canadensis*)	—	—	—
Green Mormon tea (*Ephedra viridis*)	S	—	—	—	Nevada Mormon tea (*Ephedra navadensis*)	—	—	—
Idaho fescue (*Festuca idahoensis*)	G	Joseph	—	—	Sheep fescue (*Festuca ovina*)	Durar	—	—
Wild geranium (*Geranium viscossimum*)	F	—	lavender-pink	May-Sept.	Purple prairie clover (*Petalostemum purpureum*)	—	red-purple	May-July
Northern sweetvetch (*Hedysarum boreale*)	F	—	pink-purple	May-June	Cicer milkvetch (*Astragalus cicer*)	Monarch	yellow	May-July
Missouri iris (*Iris missouriensis*)	F	—	pale blue pale violet	March-May	New England aster (*Aster novae-angliue*)	—	lavender-purplish blue	August-Oct.
Prairie junegrass (*Koeleria cristata*)	G	—	—	—	Mountain brome (*Bromus marginatus*)	—	N/A	N/A

Table A-1. **Proposed and Recommended Substitute Species for the Seed Mix, Continued.**

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Blue flax (*Linum lewisii*)	F	—	blue	May-July	Scarlet flax (*Linum grandiflorum rubrum*)	—	Scarlet	May-August
Wild lupine (*Lupinus perennis*)	F	—	purplish-blue	May-August	Silky lupine (*Lupinus sericeus*)	—	blue-lavender	June-August
Silky lupine (*Lupinus sericeus*)	F	—	blue-lavender	May-August	Wild lupine (*Lupinus perennis*)	—	purplish-blue	May-August
Lemon mint (*Monarda citriodora*)	F	—	white-lavender	May-August	Fireweed (*Epilobium angustifolium*)	—	pink	May-August
Five spot (*Nemophila maculata*)	F	—	white w/ purple	April-July	Baby blue eyes (*Nemophila menzesii*)	—	blue	April-July
Indian ricegrass (*Oryzopsis hymenoides*)	G	Paloma	N/A	N/A	Needle and thread (*Stipa comata*)	—	N/A	N/A
Wasatch penstemon (*Penstemon cyananthus*)	F	—	deep blue	May-August	Scarlet bugler (*Penstemon barbatus*)	—	red	June-Sept.
Rocky Mountain penstemon (*Penstemon strictus*)	F	—	deep blue violet	May-June	Large-flowered penstemon (*Penstemon grandiflorus*)	—	white-pink	May-June
Drummond phlox (*Phlox drummondii*)	F	—	red-purple	May-Oct.	Mountain phlox (*Linanthus grandiflorus*)	—	white w/ blue	April-July
Canby bluegrass (*Poa canbyi*)	G	Canbar	N/A	N/A	Big bluegrass (*Poa ampla*)	Sherman	N/A	N/A
Sandberg bluegrass (*Poa secunda*)	G	—	N/A	N/A	Big bluegrass (*Poa ampla*)	Sherman	N/A	N/A
Alkaligrass (*Puccinellia distans*)	G	Fults	N/A	N/A	Nuttall saltgrass (*Puccinellia airoides*)	—	—	—
Antelope bitterbrush (*Purshia tridentata*)	S	Lassen	yellow	June-July	Desert bitterbrush (*Purshia glandulosa*)	—	N/A	N/A

Table A-1. **Proposed and Recommended Substitute Species for the Seed Mix, Continued.**

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Prairie coneflower (*Ratibida columnaris*)	F	—	yellow	June-August	Mexican hat (*Ratibida columnaris forma pulcherrima*)	—	red	July-Oct.
Oakbrush sumac (*Rhus trilobita*)	S	—	N/A	N/A	Fourwing saltbush (*Atriplex canescens*)	—	N/A	N/A
Golden currant (*Ribes aureum*)	S	—	N/A	N/A	Wax currant (*Ribes cereum*)	—	—	—
Nootka rose (*Rosa nutkana*)	S	—	rose-purple	June-August	Woods rose (*Rosa woodsii*)	—	rose-purple	June-August
Woods Rose (*Rosa woodsii*)	S	—	rose-purple	June-August	Nootka rose (*Rosa nutkana*)	—	rose-purple	June-August
Black-eyed Susan (*Rudbeckia hirta*)	F	—	yellow	June-Oct.	Clasping coneflower (*Rudbeckia amplexicaulis*)	—	yellow	June-Sept.
Black greasewood (*Sarcobatus vermiculatus*)	S	—	N/A	N/A	Trident saltbush (*Atriplex tridentata*)	—	N/A	N/A
Alkali bulrush (*Scirpus maritima*)	G	—	N/A	N/A	Alkali bulrush (*Scirpus maritima*)	—	N/A	N/A
Blue-eyed grass (*Sisyrinchium bellum*)	F	—	blue	May-July	Obidience (*Physostegia virginiana*)	—	pink-white	June-Sept.
Munro globemallow (*Sphaeralcea munroana*)	F	—	red-orange	May-August	Scarlet globemallow (*Sphaeralcea coccinea*)	—	reddish-orange	April-August
Alkali sacaton (*Sporobolus airoides*)	G	Salado	N/A	N/A	Nuttall alkaligrass (*Puccinellia airoides*)	—	N/A	N/A
Golden banner (*Thermopsis montana*)	F	—	yellow	May-August	Fireweed (*Epilobium angustifolium*)	—	pink	June-Sept.
Strawberry clover (*Trifolium fragiferum*)	F	Salina	white-pink	April-Sept.	White Dutch clover (*Trifolium repens*)	—	white	April-Sept.

Table A-1. Proposed and Recommended Substitute Species for the Seed Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Alsike clover (*Trifolium hybridum*)	F	—	white-pink	April-Sept.	White Dutch clover (*Trifolium repens*)	—	white	April-Sept.
Cattail (*Typha latifolia*)	F	—	N/A	N/A	Softstem bulrush (*Scirpus validus*)	—	N/A	N/A

[1] F=forb; G=grass; S=shrub
[2] __ indicates no cultivar is specified
[3] N/A - not applicable

Table A-2. Proposed and Recommended Substitute Species for the Stock Mix.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
STOCK:								
White fir (*Abies concolor*)	T	—	N/A	N/A	Subalpine fir (*Abies lasiocarpa*)	—	N/A	N/A
Rocky Mountain maple (*Acer glabrum*)	S-T	—	N/A	N/A	Bigtooth maple (*Acer grandidentatum*)	—	N/A	N/A
Bigtooth maple (*Acer grandidentatum*)	S-T	—	N/A	N/A	Serviceberry (*Amelanchier alnifolia*)	—	white	June-July
Narrow-leaf water plantain (*Alisma gramineum*)	F	—	N/A	N/A	N/A	—	N/A	N/A
Mountain alder (*Alnus incana*)	S-T	—	N/A	N/A	Sitka alder (*Alnus sinuata*)	—	N/A	N/A
Serviceberry (*Amelanchier alnifolia*)	S-T	—	white	June-July	Russet buffaloberry (*Shepherdia canadensis*)	—	N/A	N/A
Wyoming big sagebrush (*Artemisia tridentata*)	S	—	N/A	N/A	Mountain big sagebrush (*Artemisia tridentata vaseyana*)	—	N/A	N/A
Water birch (*Betula occidentalis*)	S-T	—	N/A	N/A	Bog birch (*Betula glandulosa*)	—	N/A	N/A
Curl-leaf mountain mahogany (*Cercocarpus ledifolius*)	S-T	—	N/A	N/A	True mountain-mahogany (*Cercocarpus montanus*)	—	N/A	N/A
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	S	—	yellow-gold	August-Sept.	Antelope bitterbrush (*Purshia tridentata*)	—	N/A	N/A
Western clematis (*Clematis ligusticifolia*)	F	—	purple	May-June	N/A	—	N/A	N/A

Table A-2. Proposed and Recommended Substitute Species for the Stock Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Red-osier dogwood (*Cornus stolonifera*)	S	—	white	May-June	Twinberry (*Lonicera involucrata*)	—	greenish-white	June-August
Douglas hawthorn (*Crataegus douglasii*)	S-T	—	white	May-July	Serviceberry (*Amelanchiar alnifolia*)	—	white	June-July
Duckweed (*Lemna spp.*)	F	—	N/A	N/A	N/A	—	N/A	N/A
Creeping Oregon grape (*Mahonia repens*)	S	—	yellow	June-July	Mountain lover (*Phachystima myrsinites*)	—	—	—
Mountain lover (*Pachystima myrsinites*)	S	—	—	—	Creeping Oregon grape (*Mahonia repens*)	—	yellow	June-July
Mallow ninebark (*Physocarpus malvaceus*)	S	—	cream	June	Mountain snowberry (*Symphoricarpus oreophilus*)	—	—	—
Engelmann spruce (*Picea engelmannii*)	T	—	—	—	Colorado blue spruce (*Picea pungens*)	—	—	—
Lodgepole pine (*Pinus contorta*)	T	—	—	—	Colorado blue spruce (*Picea pungens*)	—	—	—
Narrowleaf cottonwood (*Populus angustifolia*)	T	—	—	—	Fremont cottonwood (*Populus fremontii*)	—	—	—
Quaking aspen (*Populus tremuloides*)	T	—	—	—	Black cottonwood (*Populus trichocarpa*)	—	—	—
Curly pondweed (*Potamogeton crispus*)	F	—	—	—	N/A	—	—	—
Chokecherry (*Prunus virginiana*)	S-T	—	white	May-July	American plum (*Pinus americana*)	—	white-pink	May-July

Table A-2. Proposed and Recommended Substitute Species for the Stock Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Douglas-fir (*Pseudotsuga menziesii*)	T	—	—	—	Colorado blue spruce (*Picea pungens*)	—	—	—
Antelope bitterbrush (*Purshia tridentata*)	S	Lassen	—	—	Desert bitterbrush (*Purshia glandulosa*)	—	—	—
Gambel oak (*Quercus gambelii*)	S-T	—	N/A	N/A	Bur oak (*Quercus macrocarpa*)	—	N/A	N/A
Oakleaf sumac (*Rhus trilobata*)	S	—	N/A	N/A	Utah honeysuckle (*Lonicera utahensis*)	—	yellow	May-July
Golden currant (*Ribes aureum*)	S	—	yellow	May-July	Oakleaf sumac (*Rhus trilobata*)	—	N/A	N/A
Wax currant (*Ribes cereum*)	S	—	yellow	June-July	Shrubby cinquefoil (*Potentilla fruticosa*)	—	yellow	May-July
Woods wildrose (*Rosa woodsii*)	S	—	rose-purple	June-August	Nootka rose (*Rosa nutkana*)	—	rose-purple	June-August
Thimbleberry (*Rubus parviflora*)	S	—	purple	June-July	Utah honeysuckle (*Lonicera utahensis*)	—	yellow	May-July
Northern arrowhead (*Sagittaria cuneata*)	F	—	N/A	N/A	N/A	—	N/A	N/A
Sandbar willow (*Salix exigua*)	S-T	—	N/A	N/A	Bebb's willow (*Salix bebbiana*)	—	N/A	N/A
Yellow willow (*Salix lutea*)	S-T	—	N/A	N/A	Geyer's willow (*Salix geyeriana*)	—	N/A	N/A
Blue elderberry (*Sambucus cerulea*)	S-T	—	white	June-July	Black elderberry (*Sambucus racemosa*)	—	white	June-July

Table A-2. Proposed and Recommended Substitute Species for the Stock Mix, Continued.

Proposed Species					Substitute Species			
Species	Life Form[1]	Cultivar[2]	Color[3]	Flowering Period	Species	Cultivar	Color	Flowering Period
Dwarf mountain-ash (*Sorbus scopulina*)	S-T	—	N/A	N/A	Rocky Mountain maple (*Acer glabrum*)	—	N/A	N/A
Common snowberry (*Symphoricarpos albus*)	S	—	N/A	N/A	Mallow ninebark (*Physocarpus malvaceus*)	—	cream	June
Mountain snowberry (*Symphoricarpos oreophilus*)	S	—	N/A	N/A	Common snowberry (*Symphoricarpos albus*)	—	N/A	N/A

[1] F=forb; G=grass; S=shrub
[2] __ indicates no cultivar specified
[3] N/A - not applicable

APPENDIX B

Product Suppliers

VEGETATION SUPPLIERS

Company	Plants
ARIZONA	
Desert Enterprises P.O. Box 23 Morristown, AZ 85342 phone: 1-602-388-2448	
CALIFORNIA	
S&S Seeds P.O. Box 1275 Carpinteria, CA 93013 phone: 1-805-684-0436 fax: 1-805-684-2798	seeds, native and non-native wildflowers, shrubs, grasses, legumes, reclamation mixes, bulrushes, cattail
COLORADO	
Anderson Seed Company 1020 9th St. P.O. Box 2252 Greeley, CO 80632 phone: 1-800-456-0169	native grasses, forbs, and native shrub seeds
Applewood Seed Co. 5380 Vivian St. Arvada, CO 80002 phone: 1-303-431-6283 fax: 1-303-431-7981	wildflower carpet sod, bulk seed, fescues
Aquatic and Wetland Nurseries, Inc. Siena Square 2060 Broadway, Suite 260 Boulder, CO 80302-5232 phone: 1-303-442-5770 fax: 1-303-442-8133	wetland/riparian tree and shrub cuttings, bare root material, grass plugs, root-stock and tubers of emergent species, select wetland grass and forb seeds

Company	Plants
COLORADO, Continued	
Arkansas Valley Seed Co. 4625 Colorado Blvd. Denver, CO 80216 phone: 1-303-320-7500 fax: 1-303-320-7516	seed
Dean Swift Seed Co. P.O. Box B Jaroso, CO 81138 phone: 1-719-672-3739	source identified tree seeds: blue spruce, Douglas-fir, white fir; additional Rocky Mountain evergreen seeds
James Ranches Landscaping, Inc. 33800 Hwy. 550, N. Durango, CO 81301 phone: 1-303-259-0301 fax: 1-303-329-0307	hydroseeding, hydromulching, tree transplanting
Lake Valley Seed 5741 Arapahoe Boulder, CO 80302 phone: 1-303-449-4882 fax: 1-303-449-8752	
Sharp Brothers Seed Co. 101 East 4th St. Rd. Greeley, CO 80631 phone: 1-303-672-3739	native grasses
Western Native Seed 1424 Hickory Cannon City, CO 81212 phone: 1-710-275-6406	

Company	Plants
IDAHO	
Flowers of Tomorrow 29014 Highway 95 P.O. Box 818 Parma, ID 83660 phone: 1-208-722-7333	
High Altitude Gardens P.O. Box 4619 Ketchum, ID 83340 phone: 1-800-874-7333 fax: 1-208-726-1575	wildflowers, contract
Idaho Native Nursery 1906 Raintree Drive Boise, ID 83712 phone: 1-208-338-5400	native plants
MONTANA	
Bitterroot Native Growers P.O. Box 566 Hamilton, MT 59840 phone: 1-406-961-4991 fax: 1-406-961-4626	containerized native plants, trees, shrubs, flowers, wetland plants
Buffalo Bill Nursery Rt. 2, Box 66 Buffalo Bill Road Plains, MT 59859 phone: 1-406-826-3405	wholesale seedlings and transplants, natives and non-native trees and shrubs
Lawyer Nurseries 950 Highway 200 W. Plains, MT 59859	

Company	Plants
NEBRASKA	
Stock Seed Farms 28008 Mill Rd. Murdock, NE 68407-2350 phone: 1-800-759-1520 fax: 1-402-867-2442	seed for prairie grasses and wildflowers
NEVADA	
Comstock Seed Co. 8520 W. 4th St. Reno, NV 89523 phone: 1-702-746-3681 fax: 1-702-746-2795	Intermountain native shrub, grass, and flower seed and traditional grass cultivars
NEW MEXICO	
Plants of the Southwest 1812 Second St. Santa Fe, NM 87501 phone: 1-505-983-1548	native wildflower, grasses, and forbs
UTAH	
Foulger Seed Company 6999 S. 400 W. Midvale, UT 84047 phone: 1-801-255-1131 fax: 1-801-255-6352	wheatgrasses, native grasses, wildflowers
Gobel and Son Warehouse P.O. Box 203 Gunnison, UT 84634 phone: 1-801-528-7535 fax: 1-801-528-7309	wheatgrasses, native grasses, wildflowers, forbs, and native shrubs

Company	Plants
UTAH, Continued	
Granite Seed Company 1697 W. 2100 N. P.O. Box 177 Lehi, UT 84043 phone: 1-801-768-4422	native and introduced seed, grass, forb, legume, wild-flower, tree and shrub, hydro-mulches, tackifiers
Intermountain Seed P.O. Box 62 Ephraim, UT 84627 phone: 1-801-283-4383	native shrubs, trees, grasses, and forbs
Lone Peak Conservation Center State Forest Nurseries 14650 S. Prison R. Draper, UT 84020-9599	plants only
Maple Leaf Industries 450 S. 50 E. Ephraim, UT 84627 phone: 1-801-283-4701 fax: 1-801-283-6872	native grasses
Mountain Valley Seeds and Nursery 1798 N. 1200 E. Logan, UT 84321 phone: 1-801-752-0247	
Porter Lane Wholesale Nursery 262 W. 400 S. Centerville, UT 84014 phone: 1-800-533-8498 / 801-298-2613 fax: 801-298-5986	native and non-native shrubs, trees, and forbs
Progress Plants 9180 S. Wasatch Blvd. Sandy, UT 84902 phone: 1-801-942-7333	plants and seeds

Company	Plants
UTAH, Continued	
Steve Reagan Company 4215 S. 500 W. Murray, UT 84115 phone: 1-801-268-4500 fax: 1-801-268-4596	native grasses, wildflowers, turf grass
Stevenson Intermountain Seed P.O. Box 2 Ephraim, UT 84627 phone: 1-801-283-6639	native tree shrub, forb, and grass seed
WASHINGTON	
Davenport Seed Corporation 1404 Fourth St. P.O. Box 187 Davenport, WA 99122 phone: 1-800-828-8873 fax: 1-509-725-7015	native grass seed, legumes, wildflowers, wetland plants, wetland shrubs
Plants of the Wild P.O. Box 866 Tekoa, WA 99033 phone: 1-509-284-2848	
WYOMING	
Wind River Seed 3075 Lane 51½ Route 1 Box 97 Manderson, WY 82432 phone: 1-307-568-3325 fax: 1-307-568-3326	native and introduced upland and wetland grasses, legumes, shrubs and trees, wildflowers and forbs

Company	Product
CALIFORNIA	
Hilfiker Retaining Walls P.O. Box 2012 Eureka, CA 95502 phone: 1-800-762-8962 fax: 1-702-443-2891	gabions, retaining walls
MACCAFERRI Gabions, West Coast, Inc. 3650 Seaport Blvd. West Sacramento, CA 95691 phone: 1-916-371-5805 fax: 1-916-371-0764	gabions, mattresses, rockfall netting
Santa Fe Bag Co., Inc. 102 Varni Rd. Corralitos, CA 95076 phone: 1-408-728-9539 fax: 1-408-728-4672	jute netting, silt fence, burlap
Soil Stabilization Products P.O. Box 2779 Merced, CA 95344 phone: 1-209-383-3296 fax: 1-209-383-7849	resin modified emulsion
Phillips Fibers Corporation Engineered Products Marketing 1900 Point West Way, Suite 261 Sacramento, CA 95815 phone: 1-916-924-3151	erosion blankets/geotextiles
COLORADO	
CONTECH Construction Products, Inc. 4891 Independence St. Wheat Ridge, CO 80033 phone: 1-303-431-8999 fax: 1-303-431-0821 (Sales office in Salt Lake City)	erosion blankets, excelsior, revegetation mats, geotextiles, geogrids, geocomposits

Company	Product
COLORADO, Continued	
NILEX Corp. 12503 E. Euclid Dr. #10 Engelwood, CO 80111 phone: 1-303-790-7222 fax: 1-303-792-2610 (Sales office also in Salt Lake City)	complete line of erosion control blankets, gabions, geotextiles, geogrids
IDAHO	
Bon Terra America P.O. Box 9485 Moscow, ID 83843 phone: 1-208-882-9489 fax: 1-208-882-2512	erosion blankets, organic mats, biologs
Hamilton Manufacturing, Inc. P.O. Box 1426 Twin Falls, ID 83301 phone: 1-208-733-9689 fax: 1-208-733-9447	paper fiber mulch
NEVADA	
Terra Aqua Gabions P.O. Box 7546 Reno, NV 89510 phone: 1-702-828-1390 fax: 1-702-828-1394	gabions, rockfall netting, soil reinforcement
TEXAS	
American Excelsior Co. P.O. Box 5067 Arlington, TX 76005 phone: 1-817-640-1555 fax: 1-817-649-7816	erosion control mats, blankets, concrete blocks, fabrics

Company	Product
TEXAS, Continued	
Modular Gabion Systems, Inc. P.O. Box 230150 Houston, TX 77223-0150 phone: 1-800-324-8282 fax: 1-713-928-2324	gabions, gabion mattresses, rockfall protection netting
Reef Industries, Inc. P.O. Box 750218 Houston, TX 77275-0218 phone: 1-713-943-7213 fax: 1-713-947-2053	high density PE membranes
WASHINGTON	
ECOFIBRE Marketing International, Inc. 4311 N.E. Sunset Blvd. Renton, WA 98059 phone: 1-206-277-9966 fax: 1-206-277-9971	hydroseeding mulch
OTHER	
Charankattu Coir Mfg. Co. (P) Ltd. Post Box No. 7 Shertallay, Kerala, India phone: 91-4788-2631 fax: 91-4788-2807	organic fiber geotextiles
CONWED Fibers First Plaza Suite 350 1985 Tate Blvd. SE Hickory, NC 28601 phone: 1-800-366-1180 fax: 1-704-328-9826	grass revegetation mat

Company	Product

OTHER, Continued

Company	Product
Erosion Control Systems, Inc. 1800 McFarland Blvd. N. Suite 180 Tuscaloosa, AL 35406 phone: 1-800-942-1986 fax: 1-205-759-5154	temporary erosion control blankets, permanent mats, mulch, gabions, silt fences
National Stone Association 1415 Elliot Place N.W. Washington, D.C. 20007 phone: 1-202-342-1100 fax: 1-202-342-0702	crushed stone, rip rap, filter stone, landscaping stone
North American Green 14649 Highway 41 North Evansville, IN 47711 phone: 1-800-772-2040 fax: 1-812-867-0247	erosion control blankets

(Granite Seed Company in Lehi, UT, is the local authorized distributor. phone: 1-801-768-4422)

Company	Product
WEBTEC, Inc. P.O. Box 240302 Charlotte, NC 28224 phone: 1-800-438-0027 fax: 1-704-394-7946	geosynthetics, erosion control fabrics, silt fences, excelsior, blanket

APPENDIX C

American Standard for Nursery Stock

ANSI
Z60.1-1986
Revision of
Z60.1-1949 (R1980)

AMERICAN STANDARD FOR NURSERY STOCK

Sponsor:
American Association of Nurserymen, Inc.

Approved May 2, 1986
American National Standards Institute, Inc.

ABSTRACT

Nurserymen, landscape architects, landscape contractors and others trading in or specifying nursery plants have assisted in developing these standards for the various kinds of nursery plants to facilitate the commerce in nursery stock. Illustrations, examples, and written descriptions have been combined to clarify the standards.

1 SHADE & FLOWERING TREES

This section applies to plants generally sold to the retail and landscape trade. For liner grades see section 6.

1.1 GENERAL SPECIFICATIONS

1.1.1 CALIPER AND HEIGHT MEASUREMENT

In size grading B&B trees, caliper shall take precedence over height.

In size grading bare root trees, height shall take precedence to 6 feet for Tree Type 3 and 4 and to 8 feet for Trees Types 1 and 2; thereafter, caliper takes precedence.

Caliper of the trunk shall be taken 6 inches above the ground up to and including 4-inch caliper size, and 12 inches above the ground for larger sizes.

Seldom are tree trunks perfectly round. Caliper measurement may be taken with "slot" type caliper, "pincer" type caliper or diameter tape.

For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade and shall include plants from that size up to but not including the next larger grade size.

Example: *Acer rubrum*, 2 inch caliper. This could include *Acer rubrum* calipering 2 inches up to but not including 2½ inches in caliper, measured 6 inches above the ground line.

1.1.2 HEIGHT OF BRANCHING—STREET TREES

Bid specifications for trees for street plantings should specify the height to which the tree should be free of branching. Height of branching should bear a relationship to the size and kind of tree, also, so that the crown of the tree will be in good balance with the trunk as the tree grows.

Examples:

Acer platanoides, 2 in. cal., 12 to 14 ft., branches 6 to 7 ft.

Quercus rubra 3½ in. cal., 14 to 16 ft., branched 7 to 9 ft.

Trees with ascending branches (example—*Ulmus americana* and *Tilia tomentosa*) may be branched 1 foot or more below the standard height and still provide proper clearance, which is the purpose of this specification.

1.1.3 HEIGHT RELATIONSHIP TO CALIPER BY TYPES

It is recognized that climatic conditions in different sections of the country produce trees of different caliper-height proportions. Trees from one region of the country may have less caliper in proportion to height while trees from another section may have greater caliper in proportion to height than shown in the following table.

The table in Type 1 shows the average height range and the maximum heights permitted (See 1.1.3.1)

1.1.3.1 Type 1. Shade Trees

The height relationship to caliper, for most standard shade trees, will be as follows:

Caliper	Average Height Range	Maximum Heights
½ in.	5 to 6 ft.	8 ft.
¾ in.	6 to 8 ft.	10 ft.
1 in.	8 to 10 ft.	11 ft.
1¼ in.	8 to 10 ft.	12 ft.
1½ in.	10 to 12 ft.	14 ft.
1¾ in.	10 to 12 ft.	14 ft.
2 in.	12 to 14 ft.	16 ft.
2½ in.	12 to 14 ft.	16 ft.
3 in.	14 to 16 ft.	18 ft.
3½ in.	14 to 16 ft.	18 ft.
4 in.	16 to 18 ft.	22 ft.
5 in.	18 ft. and up	26 ft.

Sizes under one inch may be calipered if desired.

Examples:

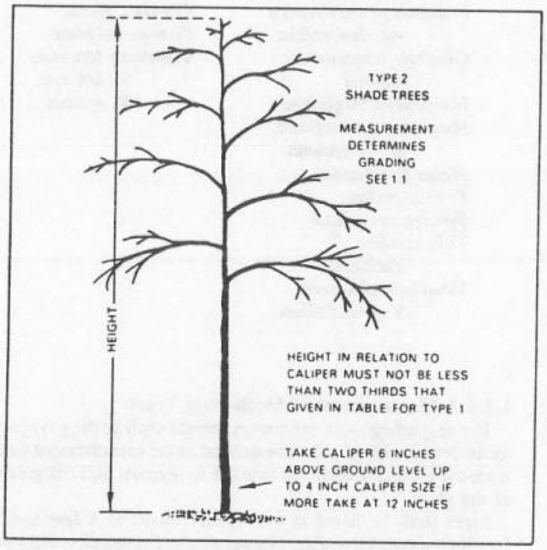
Acer rubrum, A. saccharinum
Betula
Cinnamomum camphora
Fraxinus americana, F. pennsylvanica, F. uhdei
Ginkgo
Gleditsia
Liriodendron
Platanus
Populus
Quercus macrocarpa, Q. palustris, Q. phellos, Q. virginiana
Salix
Tilia americana

1.1.3.2 Type 2. Shade Trees

Trees of slower growth which will not usually attain the height measurement in relation to caliper as in Type 1. The height, however, should not be less than two-thirds the height relationship given for Type 1. (See 1.1.3.1)

Examples:

Aesculus
Celtis
Cladrastis lutea
Fagus sylvatica
Koelreuteria
Laburnum
Liquidambar
Magnolia grandiflora
Nyssa
Olea europaea
Quercus alba
Sorbus
Tilia cordata, T. euchlora



1.1.3.3 Type 3. Small Upright Trees

This is a broad group including small, upright trees which may be grown as single-stem plants, as clumps, or as shrubs.

Up to 6 feet, height shall be the governing measurement. Sizing shall be in 1 foot intervals. At 6 feet and over, caliper takes precedence. A height relative to caliper may be specified but shall not be considered in determining minimum diameter ball sizes.

For single-stem plants, the minimum relationship for height caliper and branching will usually be as follows:

2 ft., 5/16" caliper, three or more branches
3 ft., 7/16" caliper, four or more branches
4 ft., 9/16" caliper, five or more branches
5 ft., 11/16" caliper, six or more branches
3/4" caliper, seven or more branches

Examples:

Acer campestre, A. circinatum
Cercis
Crataegus
Halesia
Malus (most crabapples)
Prunus cerasifera 'Thundercloud'
Prunus serrulata, P. subhirtella
Styrax
Syringa reticulata

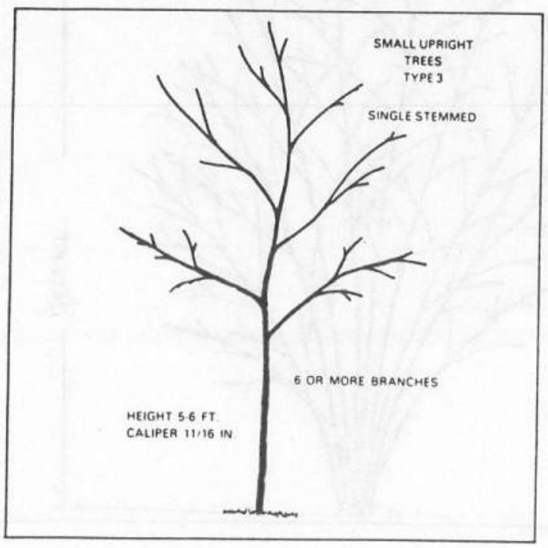
1.1.3.4 Type 4. Small Spreading Trees

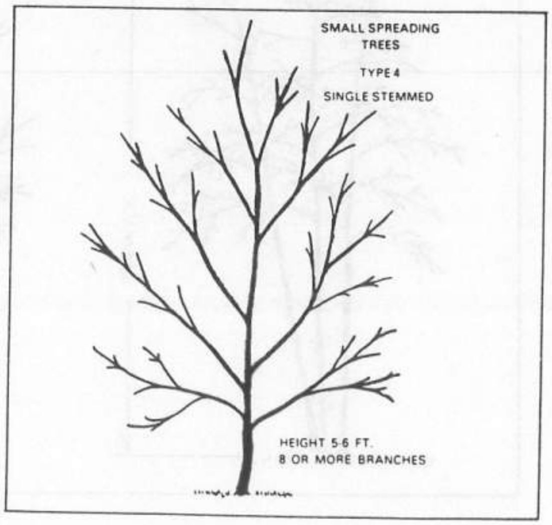
This is a broad group including small, spreading trees of dwarf growth habit and certain large shrubs grown in tree or multi-stem form.

Up to 6 feet, height shall be the governing measurement. Sizing shall be in 1 foot intervals. At 6 feet and over, caliper takes precedence. A height relative to caliper may be specified but shall not be considered in determining minimum diameter ball sizes.

For single-stem plants, the minimum branching will be as follows:

2 ft., four or more branches
3 ft., five or more branches
4 ft., seven or more branches
5 ft., eight or more branches
3/4 in. caliper, eight or more branches





Examples

Acer palmatum, A. griseum
Cornus
Lagerstroemia indica
Ligustrum japonicum (tree forms), *L. lucidum*
Magnolia soulangiana, M. stellata
Malus sargentii
Viburnum prunifolium

1.1.4 TREES FOR OTHER USES

Trees for special uses should be branched or pruned naturally according to type. Where a form of growth is desired which is not in accordance with a natural growth habit, this form should be so specified.

Examples:

Cut back or Sheared—trees that have been pruned back so as to multiply the branching structure and to develop a more formal effect.

Topiary—trees sheared or trimmed closely in a formal geometric pattern.

1.1.5 MULTI-STEM TREES

Multi-stem trees occur naturally in many genera, and other kinds may be grown multi-stem in the nursery. Multi-stem trees may be further defined as Clump form and Shrub form.

Clump form: Having two or more main stems arising from the root crown or from the main trunk not more than 6 inches from the ground level. The main stems shall have branching typical for the species or cultivar.

Shrub form: A tree with multiple stems arising from the root crown in the manner of a shrub.

Examples:

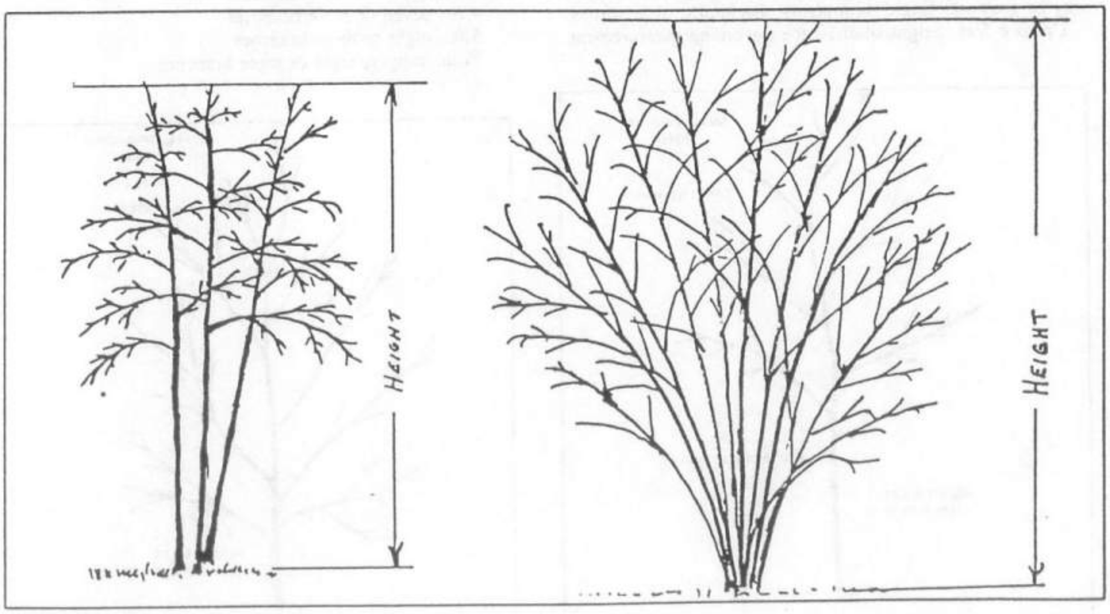
Clump form:
Acer ginnala, A. rubrum
Alnus glutinosa
Amelanchier laevis
Betula nigra
Carpinus caroliniana
Cercis canadensis
Cornus alternifolia, C. florida
Corylus avellana
Crataegus punctata
Fraxinus pennsylvanica var. *lanceolata*
Gleditsia triacanthos inermis
Hamamelis virginiana
Magnolia soulangiana, M. virginiana
Malus floribunda
Prunus padus
Syringa reticulata
Tilia cordata, T. euchlora
Viburnum plicatum, V. prunifolium

Shrub form:
Amelanchier arborea, A. grandiflora
Cornus kousa, C. mas
Corylus americana
Cotoneaster multiflorus
Crataegus cordata, C. crus-galli
Hamamelis vernalis
Lagerstroemia indica
Magnolia stellata
Malus sargentii
Prunus cistena
Syringa vulgaris
Viburnum lantana, V. lentago, V. opulus

1.1.5.1 Measurement of Multi-stem Trees

In size grading multi-stem trees, height shall be the governing measurement. Height shall be defined as the measurement taken from the ground level to the average uppermost point of growth of the plant.

Sizes shall be listed in 1-foot increments to 8 feet and 2-foot increments thereafter. For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade and shall include plants from that size up to, but not including, the next larger size.



Example: *Acer ginnala*, 6'. This would include *Acer ginnala* 6 feet high up to, but not including, 7 feet high from the ground level to the average uppermost point of growth of the plant.

Although height will be the determining factor, for landscape specifications other definitive measurements may be used to further "picture" the desired plant. Such added factors as a number of stems and plant width may be specified.

Multi-Stem Trees with Ascending Growth Habit

Average Height	Minimum Diameter Ball
4 feet	14 inches
5 feet	16 inches
6 feet	18 inches
7 feet	20 inches
8 feet	22 inches
10 feet	24 inches
12 feet	28 inches
14 feet	32 inches
16 feet	38 inches
18 feet	42 inches
20 feet	48 inches

Exception:

Specifications for balling and burlapping multi-stem trees with a spreading growth habit shall provide for balls one size larger than sizes specified above for multi-stem trees with ascending growth habit.

1.1.6 PALMS

In size grading palm trees, height shall take precedence. Either of two heights may be specified: overall height or trunk height.

Overall height is the perpendicular height from the ground to the top of the arc made by the uppermost arching frond with the tree standing in natural position.

Trunk height is measured from the ground line to the base of the heart leaf.

1.1.7 SPECIMEN TREES

This recommendation for specification writers applies to both deciduous and evergreen trees. When "specimen" trees are called for in landscape specifications, the desired specimen characteristics must be stated, including deviations from Standard minimums for caliper, height, fullness of branching, rootball, etc.

1.2 BARE ROOT SPECIFICATIONS

1.2.1 NURSERY GROWN—SPREAD OF ROOTS

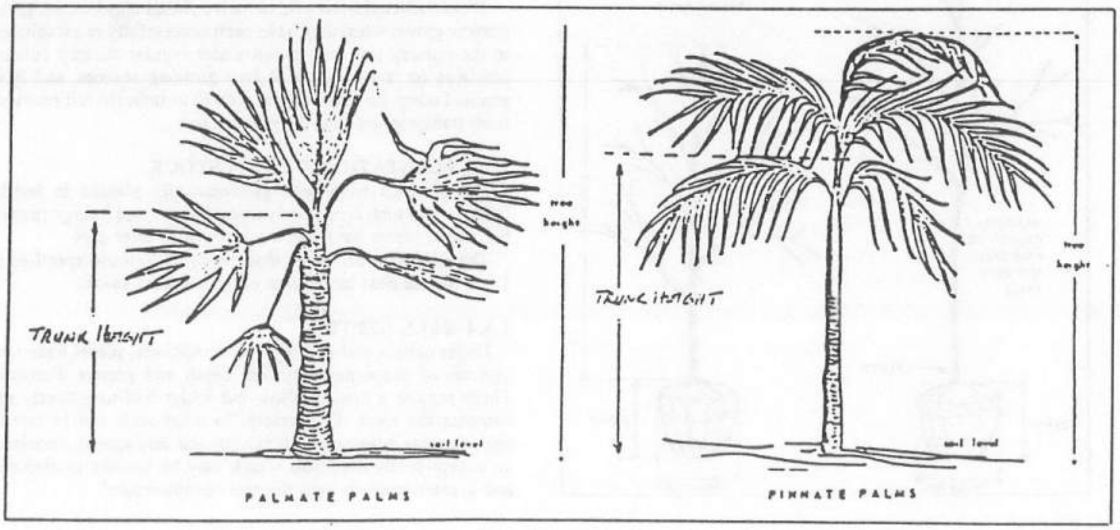
All bare root trees shall have a well branched root system characteristic of the species. The following table represents the approved minimum root spread for nursery grown shade trees.

Caliper	Average Height Range	Minimum Root Spread
½ in.	5 to 6 ft.	12 in.
¾ in.	6 to 8 ft.	16 in.
1 in.	8 to 10 ft.	18 in.
1¼ in.	8 to 10 ft.	20 in.
1½ in.	10 to 12 ft.	22 in.
1¾ in.	10 to 12 ft.	24 in.
2 in.	12 to 14 ft.	28 in.
2½ in.	12 to 14 ft.	32 in.
3 in.	14 to 16 ft.	38 in.

1.2.2 COLLECTED—SPREAD OF ROOTS

Trees collected from native stands or established plantings must be so designated. The spread of roots, bare root collected trees, shall be ⅓ greater than the spread of roots, bare root nursery grown, as tabulated above.

Trees collected from wild or native stands may be considered nursery grown when they have been successfully re-established in the nursery row and grown under regular nursery cultural practices for a minimum of two growing seasons and have attained adequate root and top growth to indicate full recovery from transplanting into the nursery row.



1.3 BALLING AND BURLAPPING SPECIFICATIONS

Ball sizes should always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

It is recognized that balling of nursery grown stock can be accomplished by hand digging or by mechanical devices especially designed for nursery conditions. The use of digging machines is an acceptable nursery practice.

1.3.1 NURSERY GROWN

The following table represents the recommended minimum sizes of balls for trees which are being grown in the nursery under favorable growing conditions and which have received the proper cultural treatment to develop a well branched root system.

These specifications are for plants either hand dug or machine dug with the ball of earth in which they are growing.

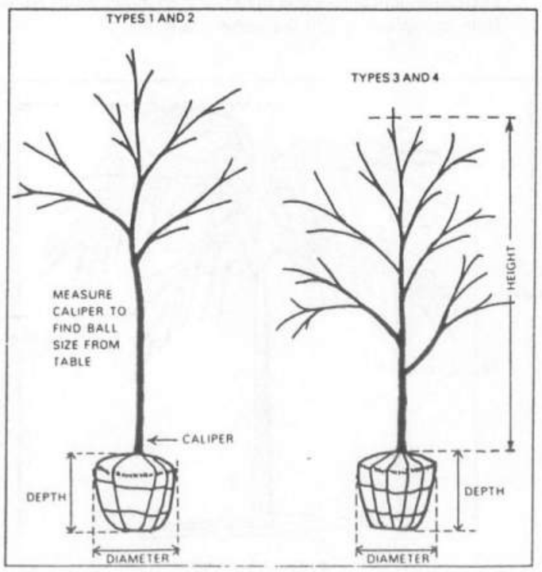
Plants dug to specifications in the foregoing table should have the trunk or stem of the plant in the center of the earth ball. A tolerance of 10% of the diameter is the maximum deviation allowable.

Example: For a tree with a 30-inch rootball, the center of the plant at ground level must be within a circle 13½ inches from the outer edge of the ball.

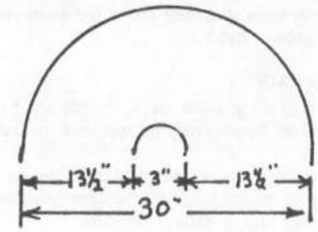
It is recognized that plants having a coarse or widespreading root system because of natural habit of growth, soil condition, infrequent transplanting practice, or plants which are moved out of season, would require a size of ball in excess of the recommended sizes.

1.3.2 COLLECTED

It is generally recognized that plants growing in their native state will sustain a much more severe shock when transplanted than the same kinds of plants when nursery grown. If collected material is moved, considerably larger ball than that recommended for transplanted nursery stock is required, because of the unrestricted root development and the varying conditions of soil in which such material is found.



Shade Trees Types 1 and 2		Trees Types 3 and 4	
Caliper	Minimum Diameter Ball	Up to 6 ft.- Height 6 ft. & over- Caliper	Minimum Diameter Ball
Inches	Inches	Feet/Inches	Inches
½	12	2 ft.	10
¾	14	3 ft.	12
1	16	4 ft.	14
1¼	18	5 ft.	16
1½	20	¾ in.	16
1¾	22	1 in.	18
2	24	1½ in	20
2½	28	1¾ in.	22
3	32	2 in.	24
3½	38	2½ in.	28
4	42	3 in.	32
4½	48	3½ in.	38
5	54	4 in.	42
5½	57	4½ in.	48
6	60	5 in.	54
7	70	5½ in.	57
8	80	6 in.	60
		7 in.	70
		8 in.	80



The minimum ball sizes shall be equal to those specified in 1.3.1 for the next larger size nursery grown stock.

Trees collected from wild or native stands may be considered nursery grown when they have been successfully re-established in the nursery row and grown under regular nursery cultural practices for a minimum of two growing seasons and have attained adequate root and top growth to indicate full recovery from transplanting into the nursery row.

1.3.3 PLANTATION GROWN STOCK

Plants which have been systematically planted in fertile, friable soil which is relatively free of stones and foreign matter, but where plants have had a minimum of after-care.

The minimum ball sizes shall be equal to those specified in 1.3.1 for the next larger size nursery grown stock.

1.3.4 BALL DEPTHS

Under certain soil and regional conditions, plants have root systems of proportionately less depth and greater diameter. These require a more shallow but wider ball to properly encompass the roots. Conversely, in other soils and in certain regions roots develop greater depth and less spread, requiring an exceptionally deep ball which may be smaller in diameter and greater in depth than the size recommended.

For the greater part of the country, ball depths will carry the following ratios:

Balls with diameters less than 20 inches—depth not less than 75% of diameter.

Balls with diameters of 20 inches to 30 inches inclusive—depth not less than 66⅔% of diameter.

Balls with diameters of 30 inches to 48 inches inclusive—depth not less than 60% of diameter.

Balls with diameters over 48 inches will have the depth scaled down proportionately.

1.3.5 BURLAPPING

Burlap or other suitable material shall completely cover the root ball. This wrapping shall be between the earth ball and the lacing or ball supporting device.

1.3.6 BALL SUPPORTING DEVICES

Ball supporting devices, such as wire baskets, shall hold the ball in a firm, rigid condition.

1.4 CONTAINER GROWN SPECIFICATIONS

All container grown trees shall be healthy, vigorous, well rooted and established in the container in which they are sold. They shall have tops of good quality and in a healthy growing condition.

An established container grown tree shall be a tree transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping.

Dwarf and light growing varieties may be 1 or 2 sizes smaller than standard for a given size container.

All shade and flowering trees in a container should be sold by both plant size and container size. The plant size shall agree with sizes specified in Section 1.1.1 of this chapter, and the container sizes shall agree with the plant container class table in the Foreword on page iii.

The following table gives tree sizes and acceptable container sizes:

Tree Height	Container Size
12 in.	#1
18 in.	
2 ft.	
3 ft.	
2 ft.	#2
3 ft.	
4 ft.	
4 ft.	#3
5 ft.	
6 ft.	

1.5 BALLED AND POTTED

Balled and potted plants are field-grown nursery plants, dug with a ball of earth still intact in which they are growing, and which, in lieu of burlapping, are placed in a container to retain the ball unbroken.

Ball sizes shall always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

The minimum ball size specification for "balled and potted" plants shall be the same as for "balled and burlapped" plants. (See 1.3.1)

1.6 PROCESSED BALLED

A processed balled shade or flowering tree is one dug bare root, while dormant, to which a growing medium is added around the roots to form a ball designed to sustain plant growth.

The following table represents the recommended minimum sizes of processed balls for trees processed by machine or hand. All trees shall have a root system which has been developed by proper cultural practices.

Single Stem Trees Types 1, 2 & 3		Small Spreading Trees Type 4	
Caliper	Minimum Diameter Ball	Height; Caliper	Minimum Diameter Ball
Inches	Inches	Feet/Inches	Inches
½	10	2 feet	10
¾	10	3 feet	10
1	12	4 feet	12
1¼	14	5 feet	12
1½	16	¾ inches	12
1¾	18	1 inch	14
2	20	1¼ inches	14
2½	20	1¼ inches	14
3	28	1¾ inches	18

3 CONIFEROUS EVERGREENS

This section applies to plants generally sold to the retail and landscape trade. For liner grades see section 6.

3.1 GENERAL SPECIFICATIONS

For purposes of simplicity, only one size per "grade" will be listed. That size will be the minimum size allowable for that grade, and as shown shall include plants from that size up to but not including the next larger grade size.

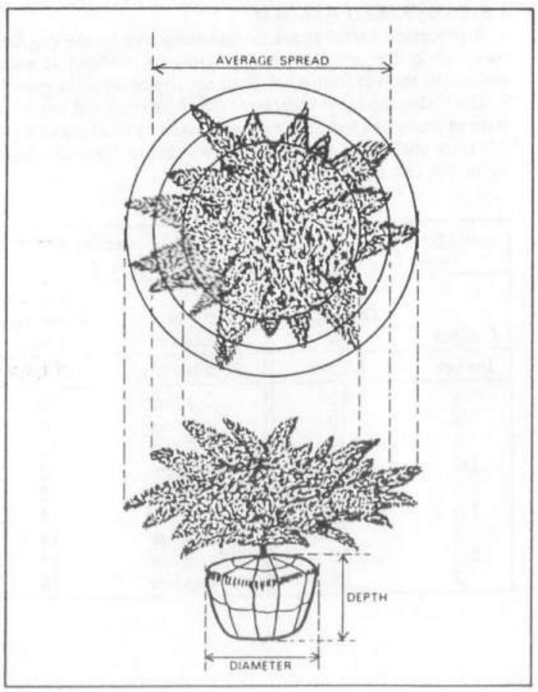
Example: *Taxus media* 'Brownii,' 15 inches. (This could include *Taxus media* 'Brownii' 15 inches in height up to but not including 18 inches and having a minimum spread of 12 inches.)

3.1.1 QUALITY DEFINITIONS

The quality of evergreens offered is assumed to be normal for the species or variety unless otherwise designated as:

Specimen (Spec.) This designation may be used to indicate exceptionally heavy, well shaped plants and is usually applied to the larger commercial sizes and plants which have been cut back or trimmed to form a perfectly symmetrical, tightly knit plant. The letters "X," "XX," or "XXX" may be used to designate the degree of heavy grades in place of using the word "specimen" (spec.).

Collected (Coll.) Natural seedling plants dug from native stands or forest plantings must be so designated. (Also see 3.2.2)



3.1.2 TYPES OF CONIFERS

3.1.2.1 Type 1. Creeping or Prostrate Type

Measurement designates spread (height not considered).
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up

Measurement should be average of plant and not the greatest diameter. Plants properly trimmed and transplanted should measure the same in any direction. If a plant is uneven, for example, 15 inches the widest way and nine the narrowest, it should be classified as 12" stock.

Examples:
Juniperus horizontalis cultivars
Juniperus chinensis var. *procumbens*
Pinus mugo var. *mughus*

3.1.2.2 Type 2. Semi-Spreading Type

Measurement designates spread.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up
Measurement should be average as in Type 1.

Height will be at least one half the spread. Above 3 feet the height will be less than the spread, varying somewhat according to natural growth of the particular species and method of handling.

Spread	Height
6 in. up to 3 ft.	Same as spread
3 ft.	2½ to 3½ ft.
4 ft.	3 to 4 ft.

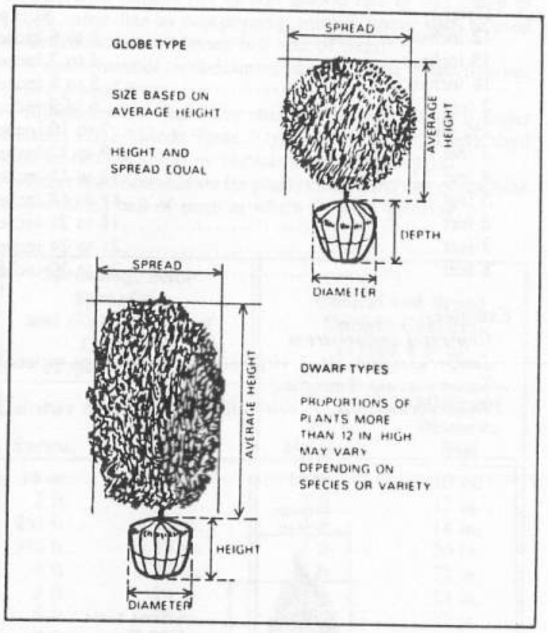
Examples:
Juniperus chinensis 'Pfitzerana', *J. sabina*
Taxus cuspidata, *T. cuspidata* 'Nana', *T. media* 'Densiformis'

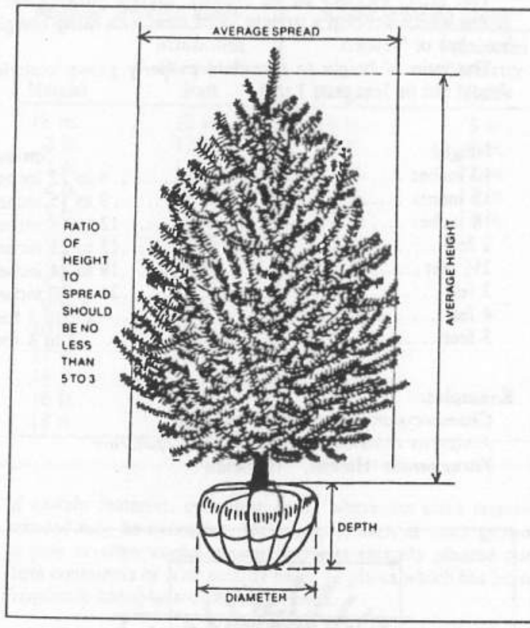
3.1.2.3 Type 3. Broad Spreading, Globe and Upright Types

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 4 feet
Use 1 foot intervals from 4 feet up

Spread will usually be equal to height in well grown material up to twelve inches. From there on there will be a variation of spread to height depending on the variety.

Height	Minimum Spread
6 in.	6 in.
9 in.	9 in.
12 in.	10 in.
15 in.	12 in.
18 in.	15 in.
2 ft.	18 in.
2½ ft.	21 in.
3 ft.	24 in.





Many broad spreading and globe types included in this classification will have the same or greater spread as height, even in the larger sizes.

Examples:

Chamaecyparis obtusa 'Nana'; *C. pisifera* 'Plumosa Nana,' 'Squarrosa Minima'
Juniperus virginiana 'Globora'
Picea abies 'Nidiformis'
Taxus media 'Brownii'
Thuja occidentalis 'Globosa,' 'Little Gem'
Upright growing dwarf types may approach the minimum dimensions above.

Examples:

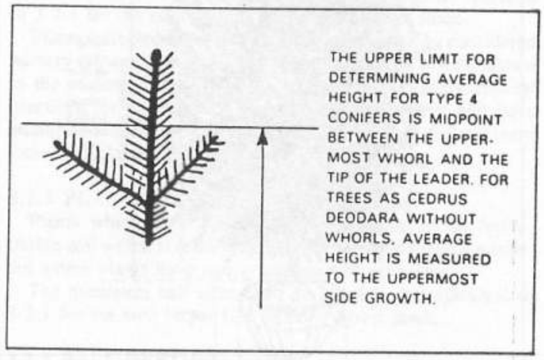
Chamaecyparis obtusa 'Gracilis'
Juniperus squamata 'Meyeri'
Thuja occidentalis 'Hoveyi,' 'Compocta,' 'Woodwardii'; *T. orientalis* 'Goldbush'

3.1.2.4 Type 4. Cone Type (Pyramidal)

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 3 feet
Use 1 foot intervals from 3 feet to 10 feet
Use 2 foot intervals from 10 feet up

The ratio of height to spread of properly grown material should not be less than 5 to 3.

Height	Spread
12 inch	8 to 12 inches
15 inch	9 to 15 inches
18 inch	12 to 18 inches
2 feet	15 to 21 inches
2½ feet	18 to 24 inches
3 feet	21 to 30 inches
4 feet	2½ to 3 feet
5 feet	3 to 4 feet

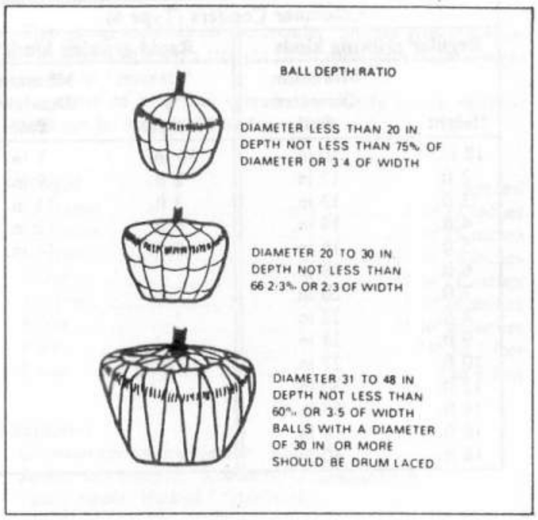


Examples:

Abies
Cedrus deodara
Chamaecyparis pisifera and varieties (except dwarf types)
Picea abies (conical types)
Pinus (except dwarf type)
Pseudotsuga menziesii
Taxus cuspidata 'Capitata'
Thuja occidentalis, T. orientalis (conical types)
Tsuga canadensis, T. caroliniana

3.1.2.5 Type 5. Broad Upright Type

Measurement designates height.
Use 3 inch intervals up to 18 inches
Use 6 inch intervals from 18 inches to 3 feet
Use 1 foot intervals from 3 feet to 10 feet
Use 2 foot intervals from 10 feet up



3.2.5 BURLAPPING

Burlap or other suitable material shall completely cover the root ball. This wrapping shall be between the earth ball and the lacing or ball supporting device.

3.2.6 BALL SUPPORTING DEVICES

Ball supporting devices, such as wire baskets, shall hold the ball in a firm, rigid condition.

3.3 CONTAINER GROWN SPECIFICATIONS

All container grown conifers shall be healthy, vigorous, well rooted and established in the container in which they are sold. They shall have tops of good quality and in a healthy growing condition.

An established container grown conifer shall be a conifer transplanted into a container and grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping.

Dwarf and light growing varieties may be 1 or 2 sizes smaller than standard for a given size container.

All coniferous evergreen plants sold in a container should be sold by both plant size and container size. The plant size shall agree with sizes specified in Section 3.1.2 of this chapter, and the container sizes shall agree with the plant container class table in the Foreword on page iii.

3.3.1 TYPES 1, 2 AND 3

Spread (Type 1, Spreading Conifers and Type 2, Semi-Spreading Conifers)
Height (Type 3, Globe or Dwarf Conifers)

	Container Size
6 in.	#1
9 in.	
12 in.	
12 in.	#2
15 in.	
18 in.	#3
2 ft.	
2½ ft.	

3.3.2 TYPES 4, 5 AND 6*

(Conicals, Broad Upright, and Columnar Conifers)

Height	Container Size
6 in.	#1
9 in.	
12 in.	
15 in.	
18 in.	
12 in.	#2
15 in.	
18 in.	
2 ft.	
18 in.	#3
2 ft.	
2½ ft.	
3 ft.	
3½ ft.	

*Except for extreme columnar types as *Cupressus sempervirens* (Italian cypress), which is acceptable 1 or 2 sizes taller than standard for a given container.

3.4 BALLED AND POTTED

Balled and potted plants are field-grown nursery plants, dug with a ball of earth still intact in which they are growing, and which, in lieu of burlapping, are placed in a container to retain the ball unbroken.

Ball sizes shall always be of a diameter and depth to encompass enough of the fibrous and feeding root system as necessary for the full recovery of the plant.

The minimum ball size specification for "balled and potted" plants shall be the same as for "balled and burlapped" plants. (See 3.2.1)