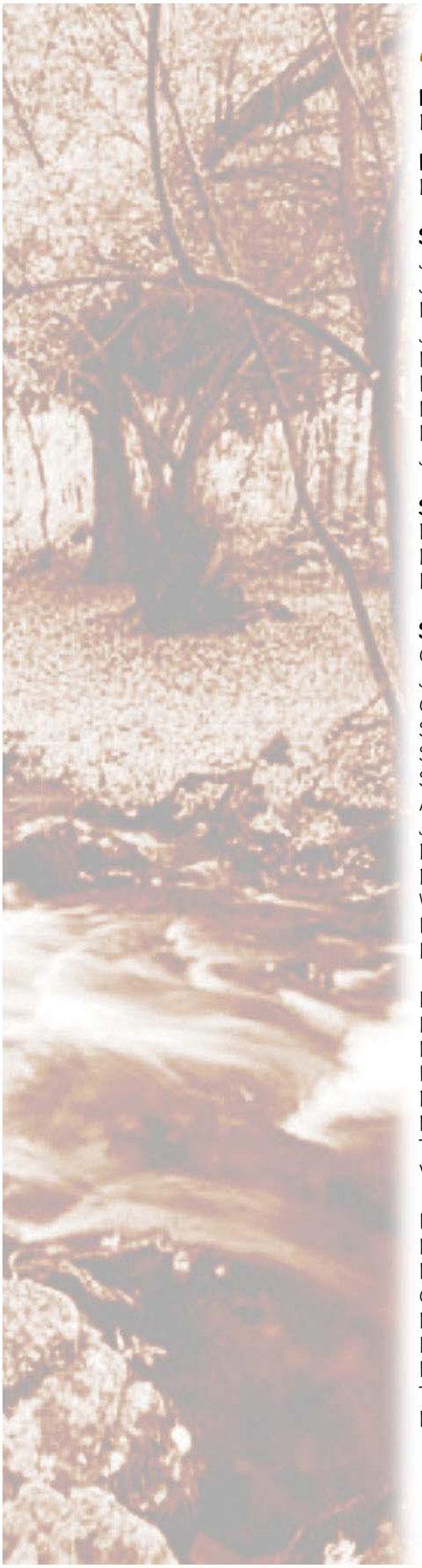
SALT LAKE COUNTY

Natural Areas Land Management Plan Standards and Operations Manual

DECEMBER 2007



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1. OVERVIEW

Salt Lake County (the County) owns and manages a diverse array of developed parks and undeveloped, "open space" lands, some of which are considered natural areas. The County's mission is to preserve, restore, and enhance these natural areas for their multiple community benefits ranging from aesthetics to wildlife habitat to low-impact recreation opportunities. To effectively manage lands that are set aside as natural areas, the County has developed this Natural Areas Land Management Plan: Standards and Operations Manual (the manual) to care for natural areas under its stewardship.

Residents, communities, and land-management agencies throughout the County have become increasingly concerned about the preservation of open-space and park lands, which are quickly disappearing as development continues at a rapid rate in Salt Lake Valley. The purpose of this manual is to guide County Parks and Recreation staff in identifying, monitoring, and maintaining natural areas under their jurisdiction. Also included in the manual is guidance and procedural direction for reclamation and restoration of natural areas. This manual does not focus on specific parcels of land but rather is generic in nature for application to all natural areas throughout the Salt Lake Valley, including those managed by private organizations, municipalities, and land-management agencies.

This manual establishes standards and guidelines for (1) defining and classifying natural areas by landscape type, (2) maintaining natural areas, and (3) rehabilitating degraded natural areas. Figure 1.1 illustrates the structure of the manual and how best to implement its contents.

In addition to the County's existing natural areas, more properties are anticipated to be purchased through the Open Space Trust Fund, which was established by the Salt Lake County Council in 2005.

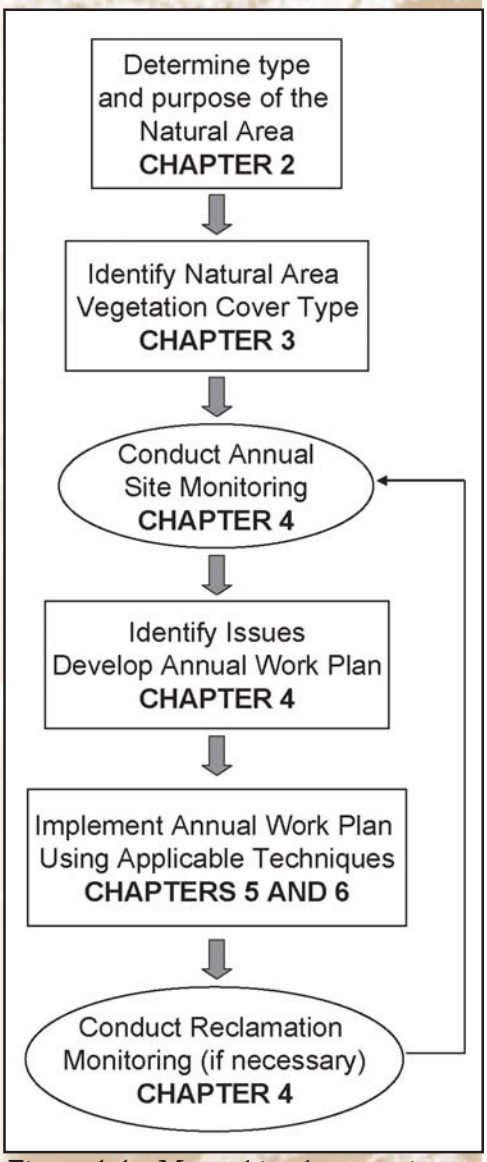


Figure 1.1. Manual implementation flow chart.

2. NATURAL AREAS DEFINED

Natural areas are remnants of Salt Lake Valley's presettlement landscapes that are scattered throughout the County. They contain rich, diverse plant and animal communities that differ dramatically from one another and range in size from a few acres to hundreds of acres. Natural areas are minimally developed and do not contain manicured lawns, ornamental flower beds, or formal landscape plantings. Natural areas are only slightly disturbed or undisturbed and may be used for passive, low-impact recreational activities. Many of the trails in natural areas are used by both residents and visitors for passive recreation activities.

Natural areas provide several quality of life values for residents and communities throughout Salt Lake Valley, as listed below.

OPEN SPACE: Within Salt Lake County, portions of the landscape that are undeveloped and that have natural vegetation provide open space to residents and communities, and allow for human connections to nature. All natural areas provide open space to County residents.

VIEWSHED: A viewshed is the visible landscape scenery as seen from a specific viewpoint along a travel corridor or at a fixed location. Natural areas help protect important scenic viewsheds of the undeveloped and natural landscape within Salt Lake Valley.

WILDLIFE AND NATIVE PLANT HABITAT: Undisturbed native vegetation in natural areas provides important habitat for a variety of wildlife species including deer, small mammals, and birds. In some cases rare or endangered plant and wildlife species, as defined by State or Federal agencies, may exist in specific natural areas.

WATERSHEDS, RIPARIAN-WETLANDS, AND WATERWAYS: Natural areas help protect water resources by providing for aquifer recharge, erosion control, flood attenuation, water-cleansing functions, and unique vegetation and wildlife habitat in those areas associated with natural watersheds, riparian-wetlands, and waterways.

GEOLOGIC FEATURES: Natural areas help protect important geologic features that may include unique rock formations, aquifer recharge zones, and the prehistoric Lake Bonneville Shoreline.

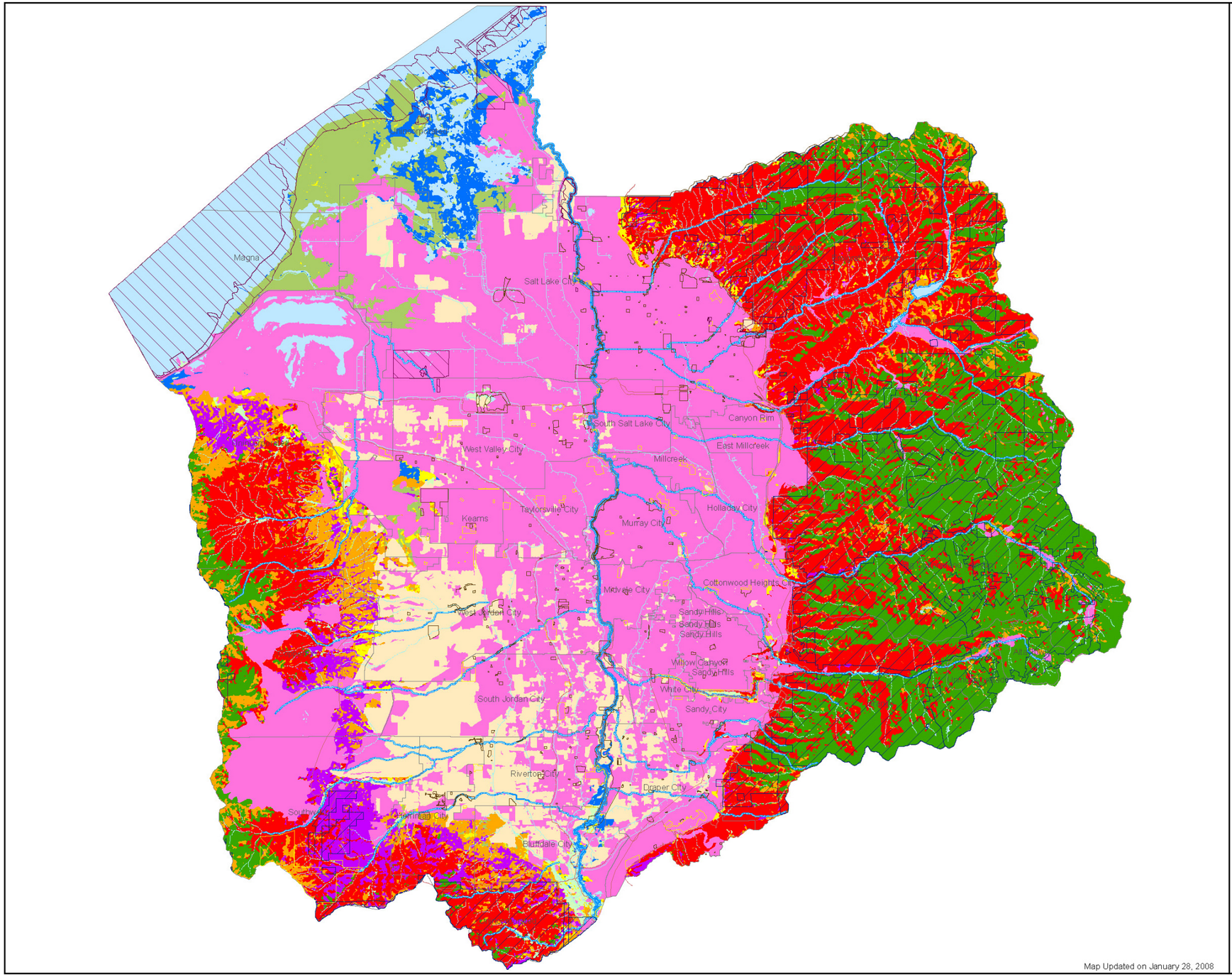
RECREATION: Passive recreation activities that commonly occur in natural areas include hiking, walking, equestrian trails, biking, picnicking, fishing, wildlife viewing, and education and interpretation. Natural areas provide a critical recreation resource to the residents and visitors of Salt Lake Valley.

Natural areas can be found throughout the County under the jurisdiction of numerous private and governmental organizations including municipalities, Salt Lake County, the State of Utah, and the U.S. Federal Government. Table 2.1 lists the current (2007) amount of natural areas by ownership within the County while Figure 2.1 shows the location of these natural areas and their associated ownership. Of the approximately 515,000 acres in Salt Lake County, approximately 280,000 acres or 55 percent are considered natural areas.

Table 2.1. Amount of natural areas by ownership in Salt Lake County.

OWNERSHIP	NATURAL AREA ACREAGE (2007) [a]
Private	141,890
Municipal	10,667
Salt Lake County	3,940
State of Utah	26,033
U.S. Federal Government	97,543

[a] Does not include disturbed, developed, or agricultural lands.



Salt Lake County Natural Areas

LEGEND

Landcover Type

- Agriculture
- Alpine or Subalpine
- Bigtooth Maple-Gambel Oak Wooland
- Disturbed
- Emergent Marsh
- Invasive
- Open Water
- Pinyon-Juniper Woodland
- Playa or Greasewood Flat
- Riparian Woodland and Shrubland
- Sagebrush Shrubland or Grassland

Land Ownership

- Federal Lands
- State Lands
- Municipal Parks
- Salt Lake County Parks

N W E S

4 2 0 4 Miles

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Figure 2.1. Salt Lake County natural areas and vegetetation cover types (2007).

3. NATURAL AREAS VEGETATION COVER TYPES

Introduction

Natural area landscape types in Salt Lake County have been classified into a series of vegetation cover types. Vegetation cover types vary through different elevation ranges, from the lower valley bottoms near the Great Salt Lake to the upper mountain elevations in the Wasatch Range. Salt Lake County's different elevation range classifications and the associated vegetation types are described below. Vegetation cover types are determined through identification and classification of plant species found in an area. The plant species vary depending upon soil type, slope, soil moisture, aspect, and elevation.

The vegetation cover types for this manual are shown on Figure 2.1 and based on information and data contained in the Southwest Regional GAP analysis Project (USGS 2004). This project included landcover mapping for the southwestern United States that mapped Utah and Salt Lake County. Some of the classifications in the GAP project were lumped together to simplify the vegetation cover types described in this manual. The vegetation cover types for Salt Lake County that are described in detail in the following sections include:

- Sagebrush Shrublands and Sagebrush Grasslands
- Playas and Greasewood Flats
- Alpine and Subalpine
- Bigtooth Maple and Gambel Oak Woodlands
- Pinyon-Juniper Woodlands
- Emergent Marshes
- Riparian Woodlands and Riparian Shrublands
- Invasive Species

The following sections provide detailed descriptions and photographs of each major vegetation cover type within Salt Lake County. The vegetation cover type descriptions include a general description and lists of typical shrubs, grasses, and forbs found within the cover type. Each cover type also includes a list of wildlife species often found in that area (Wildlife Indicator Species).

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3.1 Sagebrush Shrublands and Sagebrush Grasslands

General Description

Sagebrush shrublands and grasslands are found throughout the intermountain west and occupy broad basins between surrounding foothills and montane elevations. These vegetation cover types occur at low- to mid-elevation foothills on dry, well-drained slopes and are dominated by sagebrush, mixed bunchgrass, and various forb species. The soils are typically deep, well drained, and non-saline. The vegetation cover ranges from moderate to moderately dense (50 to 75 percent). In the County this cover type is found at nearly all elevations, but it is very prominent along the western valley benches and foothills (see Figure 2.1).

Common Plant Species

Shrubs

Wyoming sagebrush (*Artemisia tridentata wyomingensis*)
Mountain big sagebrush (*Artemisia tridentata tridentata*)
Rubber rabbitbrush (*Chrysothamnus nauseous*)
Antelope bitterbrush (*Pursia tridentata*)
Mountain snowberry (*Symphoricarpos oreophilus*)
Twisted leaf rabbit brush (*Chrysothamnus viscidiflorus*)

Grasses

Indian ricegrass (*Achnatherum hymenoides*)
Bottlebrush squirreltail (*Elymus elymoides*)
Prairie Junegrass (*Koeleria pyramidata*)
Great Basin wildrye (*Leymus cinerus*)
Western wheatgrass (*Pascopyrum smithii*)
Sandberg bluegrass (*Poa secunda*)
Bluebunch wheatgrass (*Pseudoroegneria spicata*)

Forbs

Arrowleaf balsamroot (*Balsamorhiza sagittata*)
Wild geranium (*Geranium viscosissimum*)
Sulfur-flower buckwheat (*Eriogonum umbellatum*)
Wasatch penstemon (*Penstemon cyananthus*)

Wildlife Indicator Species

Mammals
Coyote
Badger
Mule deer
Sagebrush vole
Pocket gopher

Birds
Red-tailed hawk
Brewer's sparrow
Black-throated sparrow
Mountain bluebird
Sage grouse
Green-tailed towhee
Lark sparrow
Common raven
Sage thrasher


sage thrasher

Credit: Larry Barnes@PRBO Conservation Science Shrubsteppe Monitoring Program


sagebrush shrubland

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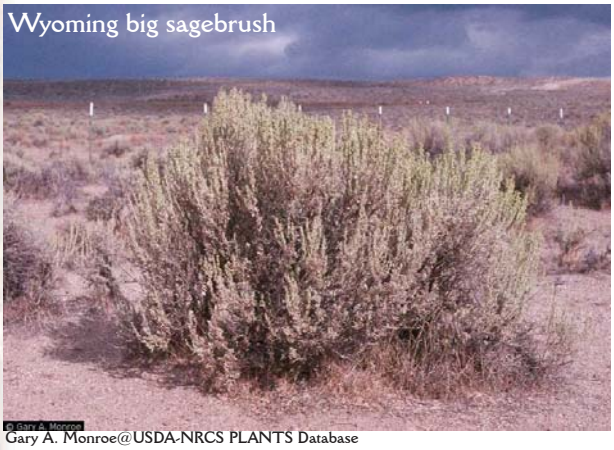
Sagebrush Shrublands and Sagebrush Grasslands Photos



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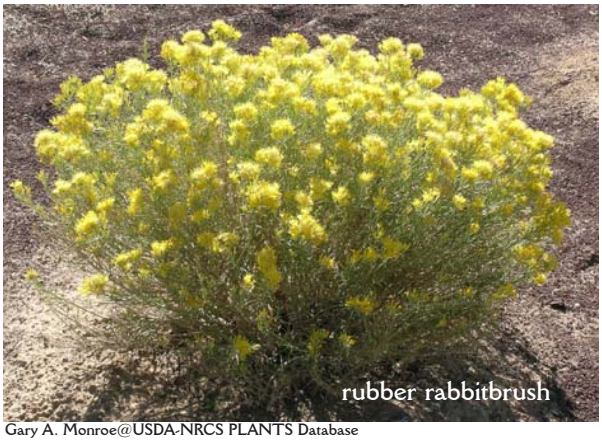

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3.2 Playas and Greasewood Flats

General Description

Playas are composed of barren and sparsely vegetated areas with typically less than 10 percent plant cover. Intermittent flooding occurs in these topographic lowlands of clay soil, and the subsequent evaporation creates saline soils. Salt crusts are common, with small saltgrass beds in depressions and sparse shrubs on the margins. Playas are a critical habitat for migrating shorebirds in Utah and are found primarily on the fringes of the Great Salt Lake in Salt Lake County (see Figure 2.1).

Greasewood flats occur near drainages on stream terraces and flats or may form rings around more sparsely vegetated playas. Sites have a shallow water table and saline soils, flood intermittently, and support vegetation. In Salt Lake County they are primarily found adjacent to playas on the fringes of the Great Salt Lake.

Common Plant Species

Shrubs

Greasewood (*Sarcobatus vermiculatus*)
Iodinebush (*Allenrolfea occidentalis*)
Shadescale (*Atriplex confertifolia*)
Gardner's saltbush (*Atriplex gardneri*)
Fourwing saltbush (*Atriplex canescens*)
Spiny hopsage (*Grayia spinosa*)

Grasses

Great Basin wildrye (*Leymus cinerus*)
Inland saltgrass (*Distichlis spicata*)
Alkaligrass (*Puccinellia distans*)
Alkali sacaton (*Sporobolus airoides*)


American avocet

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Wildlife Indicator Species

Mammals

Playa	Greasewood Flat
Muskrat	Coyote
Raccoon	Mule deer
Long-tailed weasel	Striped skunk
Red fox	Deer mouse

Birds

Playa	Greasewood Flat
Snowy plover	Brewer's sparrow
Lesser yellowlegs	Vesper sparrow
Greater yellowlegs	Green-tailed towhee
Willet	Mourning dove
Least sandpiper	Northern shrike
American avocet	
Black-necked stilt	
Wilson's phalarope	
Long-billed dowitcher	


playa

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snowy plover

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Playas and Greasewood Flats Photos

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3.3 Alpine and Subalpine

General Description

Alpine or subalpine vegetation cover types occur at upper elevations areas. These forested areas typically have 30 percent forest cover, of which 70 percent or more is made up of conifers. The plant species vary depending upon aspect and soil moisture. The moderately dense vegetative cover ranges from 60 to 90 percent. The primary alpine or subalpine areas in the County are found in the foothills and upper elevations of the Wasatch Range (see Figure 2.1).

Common Plant Species

Trees

Douglas fir (*Pseudotsuga menziesii*)
White fir (*Abies concolor*)
Subalpine fir (*Abies lasiocarp*a)
Englemann spruce (*Picea engelmannii*)
Aspen (*Populus tremuloides*)

Shrubs

Mountain snowberry (*Symphoricarpos oreophilus*)
Big sagebrush (*Artemesia tridentata*)
Serviceberry (*Amelanchier utahensis*)
Oregon grape (*Mahonia repens*)
Woods rose (*Rosa woodsii*)

Grasses

Timber oatgrass (*Danthonia intermedia*)
Bottlebrush squirreltail (*Elymus elymoides*)
Sheep fescue (*Festuca ovina*)
Mutton bluegrass (*Poa fendleriana*)
Sandberg bluegrass (*Poa secunda*)

Forbs

Yellow columbine (*Aquilegia flavescens*)
Arrowleaf balsamroot (*Balsamorhiza sagittata*)
Sundancer daisy (*Hymenoxys acaulis*)
Mountain beebalm (*Monardella odorotissima)*
Whipple's penstemon (*Penstemon whippleanus*)
Wasatch penstemon (*Penstemon cyananthus*)
Carpet Phlox (*Phox hoodii*)
Showy cinquefoil (*Potentilla gracillis*)

Wildlife Indicator Species

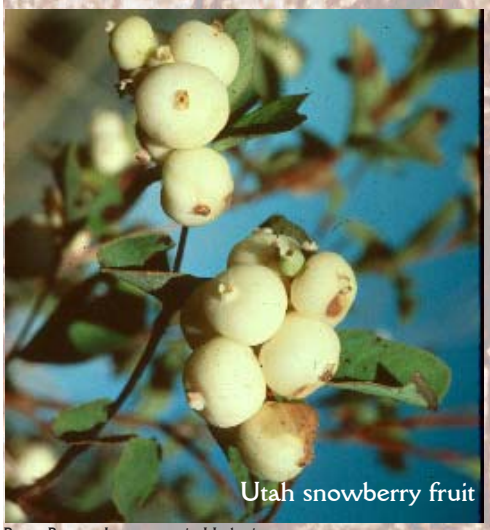
Mammals
Snowshoe hare
Red squirrel
Northern flying squirrel
Porcupine
Bushy-tailed woodrat
Golden-mantled ground squirrel
Dusky shrew
Coyote
Red fox
Elk
Mule deer

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-tailed hummingbird
Western wood peewee
Dark-eyed junco
Hairy woodpecker


Golden-mantled ground squirrel

Utah Department of Wildlife Resources

Alpine and Subalpine Photos



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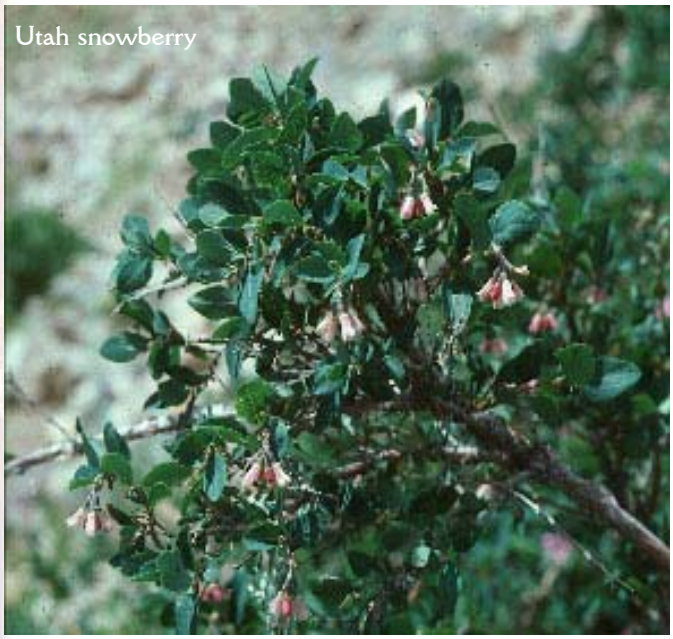

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3.4 Bigtooth Maple-Gambel Oak Woodlands

General Description

Bigtooth maple-Gambel oak woodland vegetation cover types occur in the upper foothills and lower montane areas in the mountains surrounding the Salt Lake Valley. The bigtooth maple areas occur in areas with higher soil moisture, typically on north-facing slopes. Gambel oak woodlands are found on drier west- and south-facing slopes. The vegetative cover ranges from moderate to dense. Bigtooth maple areas, which are the densest, range from 65 to 90 percent vegetation cover. These vegetation cover types are found in the foothills and montane areas throughout the County (see Figure 2.1).

Common Plant Species

Trees

Gambel oak (*Quercus gambelii*)
Bigtooth maple (*Acer grandidentatum*)

Shrubs

Mountain snowberry (*Symphoricarpos oreophilus*)
Big sagebrush (*Artemesia tridentata*)
Curl-leaf mountain mahogany (*Cercocarpis ledifolius*)
Chokecherry (*Prunus virginiana*)
Serviceberry (*Amelanchier utahensis*)
Oregon grape (*Mahonia repens*)
Woods rose (*Rosa woodsii*)
Snowbrush ceanothus (*Ceanothus velutinus*)

Grasses

Wheeler bluegrass (*Poa nervosa*)
Mountain brome (*Bromus marginatus*)
Slender wheatgrass (*Elymus trachycaulus*)
Indian ricegrass (*Achnatherum hymenoides*)
Bottlebrush squirreltail (*Elymus elymoides*)
Blue wildrye (*Elymus glaucus*)

Forbs

Mountain bluebells (*Mertensia ciliata*)
Wild geranium (*Geranium viscosissimum*)
Mule's ear (*Wyethia amplexicaule*)
Entire-leaf groundsel (*Senecio integerrimus*)
Arrowleaf balsamroot (*Balsamorhiza sagittata*)

Wildlife Indicator Species

Mammals
Deer mouse
Montane vole
Least chipmunk
Cottontail rabbit
Striped skunk
Coyote
Red fox
Elk
Mule deer

Birds
California quail
Green-tailed towhee
American robin
American goldfinch
Black-billed magpie
Broad-tailed hummingbird
Scrub jay
Blue-gray gnatcatcher
Sharp-tailed hawk
Harris sparrow
Winter wren
Virginia warbler
Black-headed grosbeak
Lazuli bunting
Rufous-sided towhee
Swainson's thrush
Northern flicker
White crowned sparrow
Yellow warbler


Swainson's thrush

Utah Department of Wildlife Resources

Bigtooth Maple-Gambel Oak Woodlands Photos

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3.5 Pinyon-Juniper Woodlands

General Description

Pinyon-juniper woodlands in the County occur primarily in the lower elevations of the Oquirrh Mountains in the south and west portions (see Figure 2.1). These woodlands occur on warm, dry sites on mountain slopes and ridges in a narrow band between the sagebrush grasslands and shrublands, and bigtooth maple-Gambel oak woodlands.

Common Plant Species

Trees

Singleleaf pinyon (*Pinus monophylla*)
Utah juniper (*Juniperus osteosperma*)

Shrubs

Big sagebrush (*Artemesia tridentata*)
Curl-leaf mountain mahogany (*Cercocarpis ledifolius*)
Rubber rabbitbrush (*Chrysothamnus nauseous*)
Bitterbrush (*Purshia tridentata*)

Grasses

Indian ricegrass (*Achnatherum hymenoides*)
Purple threeawn (*Aristada purpurea*)
Sand dropseed (Sporobolus cryptandrus)
Sandberg bluegrass (*Poa secunda*)
Needle and thread grass (*Hesperostipa comata*)
Bluebunch wheatgrass (*Pseudoroegneria spicata*)
Great Basin wildrye (*Leymus cinereus*)

Forbs

Carpet phlox (*Phlox hoodii*)
Silkly lupine (*Lupinus sericeus*)
Fire chalice (*Zauschneria latifolia*)
Scarlet globemallow (*Sphaeralcea coccinea*)
Broadleaf penstemon (*Penstemon platyphyllus*)
White-tufted evening-primrose (*Oenothera caespitosa*)

Wildlife Indicator Species

Mammals
Mule deer
Elk
Red fox
Coyote

Birds
Scott's oriole
Western scrub jay
Virginia's warbler
Pinyon jay
Townsend's solitaire
Juniper titmouse
Gray vireo
Clark's nutcracker
Sage grouse


coyote
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Virginia's warbler
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Pinyon-Juniper Woodlands Photos

Roger Banner, Intermountain Herbarium

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Utah State University Extension Office

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Roger Banner, Intermountain

3.6 Emergent Marshes

General Description

Emergent marshes occur in depressions in the landscape, around ponds and lakes, and along slow-flowing streams. These marshes are inundated with water for a majority of the growing season but allow for wetland vegetation growth. The water levels fluctuate throughout the growing season. Marshes provide critical wildlife habitat for migrating birds. In Salt Lake County, emergent marshes primarily occur adjacent to streams and rivers and on the fringe of the Great Salt Lake (see Figure 2.1).

Common Plant Species

Cattails (*Typha* spp.)
Common threesquare (*Scirpus pungens*)
Hardstem bulrush (*Scripus acutus*)
Alkali bulrush (*Scirpus maritumus*)
Common reed (*Phragmites australis*)
Spikerush (*Eleocharis* sp.)
Baltic rush (*Juncus balticus*)
Saltgrass (*Distichlis spicata*)
Reed canarygrass (*Phalaris arundinacea*)
Nebraska sedge (*Carex nebrascensis*)
Water sedge (*Carex aquatilis*)
Showy milkweed (*Asclepias speciosa*)
Foxtail barley (*Hordeum jubatum*)
Water groundsel (*Senecio hydrophyllus*)
Onley's threesquare bulrush (*Scirpus americanus*)


killdeer

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Wildlife Indicator Species

Mammals
Deer mouse
Meadow vole
Red fox
Long-tailed weasel
Striped skunk
Muskrat
Beaver
Long-tailed weasel
Mink
Raccoon

Birds
Common snipe
Willet
White-faced ibis
Snowy egret
Cattle egret
Mallard
Green-winged teal
Cinnamon teal
Tundra swan
Canada goose
Snow goose
American white pelican
Great blue heron
Black-crowned night heron
Double-crested cormorant
Yellow-headed blackbird
Red-winged blackbird
Common yellowthroat
Long-billed marsh wren
Northern harrier
Yellow warbler
American kestrel
Sandhill crane
Killdeer


striped skunk

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Emergent Marshes Photos

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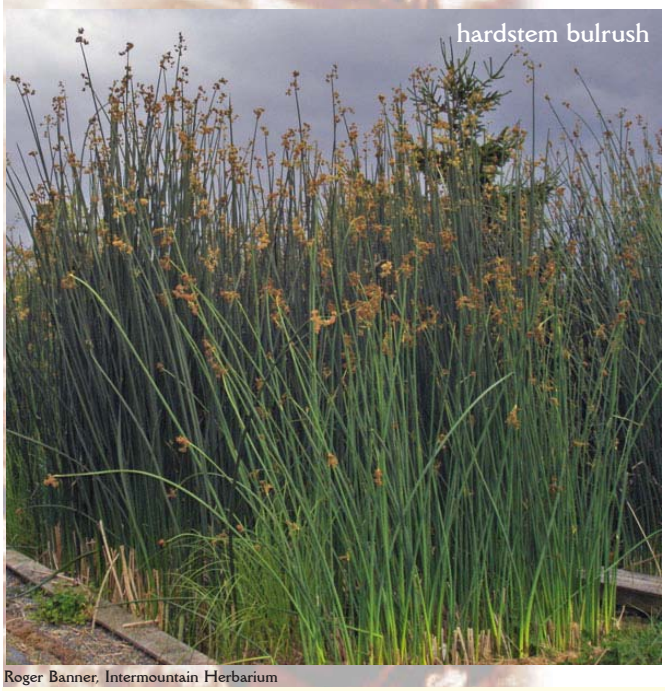

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3.7 Riparian Woodland and Riparian Shrubland

General Description

Riparian woodlands occur along rivers and streams in the Salt Lake Valley. The woodlands are dominated by trees and have a diverse shrub understory. Riparian areas provide important wildlife habitat throughout Salt Lake County to both mammal and bird species.

Common Plant Species

Trees

Narrowleaf cottonwood (*Populus angustifolia*)
Fremont cottonwood (*Populus fremontii*)
Boxelder (*Acer negundo*)
Douglas hawthorn (*Cratageus douglasii*)
Blue spruce (*Picea pungens*)
Russian olive (*Eleagnus angustifolia*) **Invasive**

Shrubs

Gray alder (*Alnus incana*)
Black hawthorn (*Crataegus doughlasii*)
Water birch (*Betula occidentalis*)
Red-twig dogwood (*Cornus sericea*)
Chokecherry (*Prunus virginiana*)
Skunkbush sumac (*Rhus trilobata*)
Drummond's willow (*Salix drummondiana*)
Narrowleaf willow (*Salix exigua*)
Booth's willow (*Salix boothii*)
Bebb's willow (*Salix bebbiana*)
Peachleaf willow (*Salix amygdaloides*)
Fragile willow (*Salix fragilis*)
Tamarisk (*Tamarix* spp.) **Invasive**

Grasses

Desert saltgrass (*Distichlis stricta*)
Great Basin wildrye (*Leymus cinereus)*
Alkali sacaton (*Sporobolus airoides*)

Forbs

Mountain hollyhock (*Iliama vivularis*)
Leafy Jacob's ladder (*Polemonium foliosissimum*)
Showy goldeneye (*Viguiera multiflora*)
Fire chalice (*Zauschneria latifolia*)

Wildlife Indicator Species

Mammals
Red fox
Long-tailed weasel
Beaver
Mink
Porcupine
Mule deer
Moose

Birds
MacGillevray'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
Red-tailed hawk


bald eagle

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Riparian Woodlands and Riparian Shrublands Photos

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Jeff Salt

Susan McDougall @ USDA-NRCS PLANTS Database

Dave Powell, USDA Forest Service, Bugwood.org

Joe F. Duft @ USDA-NRCS PLANTS Database

3.8 Invasive Species

General Description

The invasive plant community is dominated by plants that are either noxious or invasive weeds. The naturally occurring plant community has been replaced by invasive plants that out-compete native vegetation. Invasive plant communities are undesirable because they displace wildlife, change the natural ecosystem, and often burn more frequently.

Common Invasive Plant Species

Trees

Russian olive (*Eleagnus angustifolia*)
Siberian elm (*Ulmus pumila*)
Tree-of-heaven (*Ailanthus altissima*)
Fragile willow (*Salix fragilis*)

Shrubs

Tamarisk (*Tamarix ramosissima*)

Grasses

Annual rye (*Secale cereale*)
Cheatgrass (*Bromus tectorum*)
Smooth brome (*Bromus inermis*)
Crested wheatgrass (*Agropyron cristatum*)
Bulbous bluegrass (*Poa bulbosa*)
Kentucky bluegrass (*Poa pratensis*)

Forbs

Canada thistle (*Cirsium arvense*)
Yellow starthistle (*Centaurea solstitialis*)
Dalmation toadflax (*Linaria dalmatica*)
Myrtleleaf spurge (*Euphorbia myrsinites*)
Musk thistle (*Carduus nutans*)
Purple loosestrife (*Lythrum salicaria*)
Puncture vine (*Tribulus terrestris*)
Poison hemlock (*Conium maculatum*)
Knapweed (*Centaurea* spp.)
Leafy spurge (*Euphorbia esula*)
Dyer's woad (*Isatis tinctoria*)
Pepperweed (*Lepidium* spp.)
Yellow sweetclover (*Melilotus officinalis*)
Bull thistle (*Cirsium vulgare*)
Scotch thistle (*Onopordum acanthium*)

Invasive Species Photos

BIO-WEST, Inc.

BIO-WEST, Inc.

Steve Dewey, Utah State University, Bugwood.org

BIO-WEST, Inc.

BIO-WEST, Inc.

4. NATURAL AREAS MONITORING TECHNIQUES

Monitoring is an essential component in the proactive management of natural area lands. The information that is gained through site monitoring allows for focused management activities on the areas of greatest need, as well as evaluating the success of restoration projects. The effectiveness of management practices should be assessed through the monitoring program outlined in this chapter. Personnel and equipment necessary for conducting monitoring are shown in Table 4.1.

Table 4.1. Monitoring program staffing and equipment needs.

TASK	TIMING	PERSONNEL NEEDS	EQUIPMENT NEEDS
Program Supervision	Year-round	1 employee, 15 days per year for all natural areas combined	None
Annual Site Monitoring	Once per year per natural area site	1 employee, 1 day (8 hours) per natural area site (average)	Field vehicle, blank annual monitoring forms, camera, aerial photograph, Mylar overlay, tape, pens, and pencils
Annual Work Plan Development	Once per year per natural area site	1 employee, 0.25 day per natural area site work plan (average)	Annual work plan form and computer
Post-Restoration Project Monitoring	2 times per year	1 employee, 0.5 day per natural area site (average)	Field vehicle, blank post-restoration monitoring forms, camera, pens, pencils, aerial photograph, and Mylar overlay (if necessary)

The natural areas monitoring program consists of the following actions.

4.1 Annual Assessment Monitoring

Natural areas should be monitored annually using the Annual Monitoring Form provided in Appendix A. Information is gathered by taking notes on aerial photographs, listing and

describing problems and issues, and documenting the area with photographs. The following steps comprise the annual monitoring process.

Step 1. Familiarize yourself with the annual monitoring form (Appendix A).

Step 2. Gather necessary equipment:

- annual monitoring forms
- camera
- aerial photograph of monitoring site
- Mylar overlay
- tape
- pencils
- pens

Step 3. Visit the monitoring site and fill out the monitoring form, answering as many questions as possible.

Step 4. Make notes about issues and mark specific problem areas on the mylar/aerial photograph.

Step 5. Photograph site issues and problem areas.

Step 6. Return the monitoring form to personnel responsible for work plan development.

4.2 Work Plan Development

Upon completion of the annual monitoring visit, develop an annual work plan using the form provided in Appendix A. The annual work plan form will be used to direct the specific efforts required to address any problems or issues discovered during annual site monitoring efforts. The work plan will include the specific locations, actions, time of year, and labor needs for each natural area.

4.3 Monitoring Schedule

A monitoring schedule should be developed for individual natural areas based upon specific monitoring needs. Annual monitoring will generally occur in early spring (March or April). Early monitoring allows for timely work plan develop-

ment, project implementation, and completion. Natural areas with specific invasive weed outbreaks will require additional follow-up monitoring to facilitate appropriate control (see section 5.1.3). The timing of these efforts will be based on specific area issues and conditions.

4.4 Post-Restoration Project Monitoring

All restoration projects require a monitoring component to increase the opportunities for success. By regularly monitoring revegetation projects, issues can be identified and addressed in a timely manner. This will increase the potential for project success and aid in designing future projects by identifying successful and effective restoration strategies. The post-restoration monitoring form is provided in Appendix A.

Post-restoration project monitoring should occur at specific times outlined in the restoration project plan.

5. NATURAL AREAS MAINTENANCE TECHNIQUES

Maintaining natural areas in Salt Lake County is a challenging endeavor, but this can be accomplished by developing and implementing a comprehensive maintenance program. The natural area maintenance program should focus on maintaining healthy native vegetation, stabilizing soils, minimizing disturbance, and controlling recreation activities in an effort to reduce weeds and erosion problems. Weed infestations and soil erosion are less likely to occur in healthy plant communities. This section of the manual will guide managers in reducing new weed outbreaks and controlling existing weed outbreaks. It will also guide managers in employing appropriate erosion control methods in disturbed sites.

The following issues will be addressed in this section:

WEED MANAGEMENT: Weed management is an important maintenance component in all aspects of natural area management. The weed management information includes details on weed prevention and specific noxious weed control measures and identification photos.

EROSION CONTROL: Erosion controls for use in both site construction and site rehabilitation are described in detail. The erosion control practices can be applied in various natural area management projects to protect soils and water quality.

REVEGETATION: The revegetation information includes details on prioritizing revegetation efforts and revegetation construction techniques.

VEGETATION COVER TYPE SEED MIXES: A specific seed mix is listed for each vegetation cover type that includes seeding species, seeding rates, and containerized plant species.

MAINTENANCE RESOURCE REQUIREMENTS: Approximate requirements for small- and large-scale revegetation and weed control projects are included in Table 5.1. This includes information on labor (personnel), equipment, resources (e.g., seed, herbicide), and cost.

Table 5.1. Staffing and equipment needs for Natural Areas maintenance activities.

TASK	LABOR	EQUIPMENT	RESOURCES	APPROXIMATE COST
SMALL-SCALE REVEGETATION (LESS THAN 2-ACRES)				
Planning and Design	24-40 hours (includes site assessment, soil testing, seed mix ordering, construction coordination, etc.)	Vehicle, computer, and digital camera	NA	NA
Construction	3 person crew 1 week	Broadcast seeder, hand tools, chainsaw, vehicle, and mini-track hoe or skid-steer	Seed, plants, mulch, and erosion controls.	$5,000 per acre
Monitoring	Construction monitoring : 8 hours Long-term monitoring :1 person, 2 hours per month Maintenance: expected maintenance costs depend on project specific issues	Digital camera, monitoring sheets, vehicle	Replacements for seed, plants, mulch, and erosion controls, as needed.	
LARGE-SCALE REVEGETATION (MORE THAN 2-ACRES)				
Planning and Design	40-80 hours (includes site assessment, soil testing, seed mix ordering, construction coordination, etc.)	Vehicle, computer, and digital camera	NA	NA
Construction	3-person crew, 2 to 3 weeks	Broadcast seeder, hand tools, chainsaw, vehicle, mini-track hoe or skid-steer, and larger construction equipment	Seed, plants, mulch, erosion controls	$4,000 per acre
Monitoring	Construction monitoring: 8 hours Long-term monitoring: 1 person, 2 hours per month Maintenance: expected maintenance costs depend on project specific issues	Digital camera, monitoring sheets, and vehicle	Replacements for seed, plants, mulch, and erosion controls, as needed	
SMALL-SCALE WEED ERADICATION (LESS THAN 2-ACRES)				
Planning and Design	12 hours (includes site assessment, research, herbicide ordering, implementation coordination, etc.)	Vehicle, computer, and digital camera	NA	NA
Implementation	2-person crew, 2 days	Vehicle, herbicide application equipment, mowing equipment, hand tools, and chainsaw	Herbicide, flagging, stakes	
Monitoring	1 person monitoring at 4-8 week intervals during the growing season for up to several years (interval depends upon project)	Digital camera, monitoring forms, vehicle, and herbicide application equipment	Herbicide (if necessary for spot spraying), flagging, stakes	
LARGE-SCALE WEED ERADICATION (MORE THAN 2-ACRES)				
Planning and Design	24 hours (includes site assessment, research, herbicide ordering, implementation coordination, etc.)	Vehicle, computer, and digital camera	NA	NA
Implementation	5-person crew, 1 week (will vary depending on the project)	Vehicle, herbicide application equipment, mowing equipment, hand tools, and chainsaw	Herbicide, flagging, stakes	
Monitoring	1 person monitoring at 4-8 week intervals during the growing season for up to several years (interval depends upon project)	Digital camera, monitoring form, vehicle, herbicide application equipment, and mini-track hoe or skid-steer	Herbicide (if necessary for spot spraying), flagging, stakes	

5.1 Weed Management

Staffing and equipment needs for natural area maintenance activities are shown in Table 5.1. For more information on weed management, contact the Salt Lake County Weed Program at 801.468.2861 or www.weeds.slco.org.

5.1.1 Noxious Weeds and Invasive Plants

Noxious weed and invasive plant infestations are a problem in many of Salt Lake County's natural areas. The State of Utah and Salt Lake County Noxious Weed List are shown below in Table 5.2. For the purposes of prioritizing weed control, Salt Lake County noxious weeds are classified into four categories. Class A weeds are of the highest priority because of their limited distribution, limited abundance, and their high level of impact. Class B weeds have greater distribution and abundance than Class A weeds, and eradication is therefore unlikely, but control of Class B weeds is still considered feasible. Class C weeds are commonly found throughout the county and state, and generally not considered controlable given the resources available at the time of evaluation.

5.1.2 Prevention: The Number One Priority

5.1.2.1 Limit Disturbance

Invasive weeds easily spread into areas with disturbed soil; hence the best way to prevent weeds is to minimize disturbance. Methods for minimizing soil disturbance include (1) designing projects to have the smallest possible disturbance footprint on the landscape, (2) limiting construction disturbance by using "disturbance limits" fencing on all construction projects, and (3) avoiding driving motorized vehicles off hard surfaces into the natural areas. Figure 5.1 illustrates the concept of limiting disturbance through project design and disturbance limits fencing.

5.1.2.2 Clean Equipment

Avoid spreading weed seed by cleaning all equipment after mowing a known weed-infested area. Before working in natural areas that are relatively weed-free, take special care to thoroughly clean equipment by spraying it off or washing it.

5.1.2.3 Mulch and Revegetate Promptly

Mulching and revegetating a disturbed area (see Section 5.3) promptly after disturbance will inhibit weed germination and growth.

Table 5.2. State of Utah and Salt Lake County Noxious Weeds List.

COMMON NAME	SCIENTIFIC NAME	WEED CATEGORY
STATE OF UTAH NOXIOUS WEEDS		
Bermuda grass	*Cynodon dactylon*	C
Bindweed	*Convolvulus arvensis*	C
Canada thistle	*Cirsium arvense*	B
Diffuse knapweed	*Centaurea diffusa*	A
Dyer's woad	*Isatis tinctoria*	B
Hoary cress	*Cardaria draba*	C
Johnson grass	*Sorghum halepense*	C
Leafy spurge	*Euphorbia esula*	A
Medusahead	*Taeniatherum caput-medusae*	-
Musk thistle	*Carduus nutans*	C
Perennial pepperweed	*Lepidium latifolium*	A
Purple loosestrife	*Lythrum salicaria*	A
Quackgrass	*Elytrigia repens*	C
Russian knapweed	*Centaurea repens*	C
Scotch thistle	*Onopordum acanthium*	C
Spotted knapweed	*Centaurea maculosa*	A
Squarrose knapweed	*Centaurea virgata*	-
Yellow starthistle	*Centaurea solstitialis*	A
SALT LAKE COUNTY NOXIOUS WEEDS		
Dalmation toadflax	*Linaria genistifolia*	B
Garlic mustard	*Alliaria petiolata*	A
Myrtle spurge	*Euphorbia myrsinites*	B

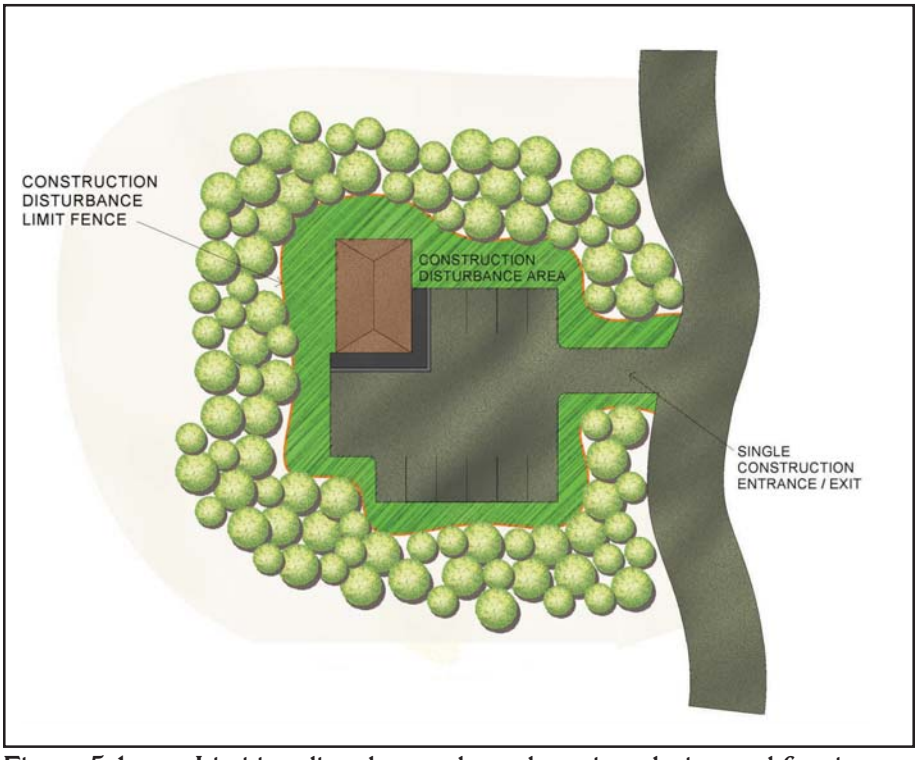


Figure 5.1. Limiting disturbance through project design and fencing.

5.1.3 Weed Identification and Control

5.1.3.1 General Steps for Weed Management

The weed outbreak scale is important for determining priorities and goals for the natural areas weed control program. A small (less than 1 acre), isolated outbreak that can be contained and eradicated before it quickly spreads is the highest weed control priority. Medium and large (1-10 acres and 10 or more acres) outbreaks must be prioritized based on specific infestation details regarding species and location. Medium outbreaks can be controlled using a long-term control plan with a goal of eventual eradication. The largest outbreaks need to be contained by controlling the weeds around the perimeter of the outbreak to prevent spreading as much as possible. See the following sections for species-specific weed control information.

Weed management consists of physical, cultural, biological, and chemical control techniques. Integrated weed management uses a combination of these techniques to create a sustainable weed management program. The different controls and their associated techniques are described below.

PHYSICAL: Physical controls consist of various ways to mechanically remove all or portions of a plant. Hand pulling is useful on weeds with small root systems and on annual weeds. Cultivation, the disking of and area to break the roots under the ground, is another mechanical control. Mowing weeds can be done with standard lawn mowing equipment, large tractor mounted mowers, and hand held weed whackers. Typically, mowing is used to control annual weeds when flowers begin to form (before seeds form). Perennial weeds do not usually respond to mowing controls.

CULTURAL: The primary method of cultural control is the establishment of desirable and competitive vegetation. In natural areas, establishment of a diversity of native vegetation is the goal. Healthy native plant communities out-compete weedy species.

BIOLOGICAL: Biological weed control through insect/plant interactions and pathogen/plant interactions is an option in the integrated weed management approach. Federal agencies study the implications and make approvals of releasing bio-controls for controlling a weed species. Bio-controls are employed in cases where eradication is impractical because of large weed infestations. Eradication of a weed species cannot be attained using bio-control.

CHEMICAL: Herbicides are applied to weed infestations either through broadcast spraying or spot spraying. Spot spraying is the most desirable technique because it allows the avoidance of desirable native plants. Broadcast spray only in large infestations (>1 acre) that contain few desirable native plants. If water is present in weed infestations use only herbicides that are approved for use near water.

The following sections include detailed information sheets for weeds with the highest priority for eradication, control, and containment. Each sheet includes detailed physical, cultural, biological, and chemical control information, as well as identification photos. These sheets are designed to be stand-alone resources that can be removed and used apart from this document. The following high-priority weed information sheets are included:

- Leafy spurge
- Canada thistle
- Dyer's woad
- Knapweed and starthistle
- Bindweed
- Musk thistle and Scotch thistle
- Whitetop (hoary cress)
- Cheatgrass
- Russian olive
- Tamarisk
- Dalmation toadflax
- Garlic mustard
- Johnson grass
- Myrtle spurge
- Perennial pepperweed
- Purple loosestrife
- Squarrose knapweed

Table 5.3. The weed control process.

STEP 1	Identify species and scale of the weed outbreak		
	Less than 1 acre	1-10 acres	10 or more acres
	Highest Priority	Medium Priority	Medium Priority
	Goal : Eradication	Goal: Control	Goal: Control and Contain
STEP 2	Look up species-specific control and eradication information		
STEP 3	Design and implement a specific treatment protocol		
STEP 4	Evaluate the effectiveness of the weed treatment protocol		

5.1.3.2 Leafy Spurge

Description

Leafy spurge is a deep-rooted, long-lived perennial plant that grows in a variety of habitats including dry and moist sites extending from flood-plains to mountain slopes. This erect plant grows up to 3 feet tall and has narrow leaves 1-4 inches long. With an extensive root system that can extend more than 15 feet vertically and horizontally, this noxious weed is very difficult to control.

Leafy spurge spreads very rapidly and, once established, is difficult to eradicate. **It is of utmost importance that small infestations are controlled immediately to prevent the spread to a larger area**.

Control Recommendations

Physical:

- Mowing and burning alone are not effective for reducing leafy spurge infestations because the plants simply re-sprout.
- Hand pulling is not effective because of the plant's extensive root system.
- Mowing or burning at least 5 weeks prior to herbicide treatment allows for uniform plant regrowth and easier spraying.

Cultural:

- Maintaining healthy native plant communities reduces noxious weed infestations. Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of leafy spurge.

Biological:

- A number of insect bio-control agents for leafy spurge have been approved for use in the United States.
- Two flea beetles, black dot spurge flea beetle (*Aphthoma nigriscurtis*) and brown legged spurge flea beetle (*Aphthoma lacertosa*), have been used successfully in Utah to reduce leafy spurge infestations.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Tordon 22K (picloram) is the most effective herbicide for managing leafy spurge.
- For small infestation areas tank mix Tordon 22K at 1 quart/acre combined with 2,4-D at 1 quart/acre. This is expensive but very effective for small areas.
- Apply herbicide annually during flowering (late spring or fall).
- For larger infestations tank mix Tordon 22K at 1 pint per acre combined with 2,4-D at 1 quart/acre. This is more cost effective, but it is only effective if sprayed when the plant is flowering.
- **For infestations near water**, use Rodeo at 1.5 pints per acre from July through September. Spot spray because any over-spray will kill contacted plants.
- Monitor and respray all leafy spurge sites at least once annually for up to 8 years.
- Reseed aggressive grasses (listed above) as infestations are reduced.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Leafy Spurge Identification Photos

Photo source: Utah State University Extension "The Weed Web." extension.usu.edu/weedweb/

5.1.3.3 Canada Thistle

Description

Canada thistle is an aggressive creeping perennial that reproduces from vegetative buds in its root system and seed. The plant grows to 2-4 feet tall. The leaves and stems have sharp spines, and the light pink to purple flowers occur at the top of the stems.

Reproduction from the extensive root system makes it a difficult weed to control because the entire root system needs to be killed to successfully eradicate the plant. Infestations usually start in areas of soil disturbance and quickly spread into surrounding areas via the root system or seed dispersal. Horizontal roots may extend 15 feet and vertical roots more than 6 feet. Flowering begins in late spring to early summer. The primary control strategy for Canada thistle is to stress the plant and force it to use the stored root nutrients. This may require several years to be successful.

Control Recommendations

Physical:
- Hand pulling is not effective because of the extensive root system.
- Mowing can be effective if conducted monthly over several growing seasons.
- Mowing combined with herbicide treatments is most successful if timed properly: mow in spring and spot treat new growth.

Cultural:
- Maintaining healthy native plant communities reduces weed infestations.
- Western wheatgrass (*Pascopyrum smithii*) has been shown to compete well with Canada thistle and can be seeded in infested areas to reduce spread.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of Canada thistle.
- Cultural controls alone are rarely effective at controlling Canada thistle.

Biological:
- A stem-mining weevil (*Ceutorhynchus litura*) has been used as a biological control on Canada thistle with mixed results. The weevil appears to weaken the plant, but alone it does not control infestations.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:
- Chemical control is most effective when combined with cultural or mechanical controls.
- Apply 2,4-D at 2 quarts per acre in the spring when Canada thistle is 10 to 15 inches tall.
- Retreat in the fall with Banvel at 2 quarts per acre applied to regrowth.
- Another option is to mow regularly and spot treat new, active growth with Tordon (picloram) at 1 quart per acre. Tordon applied in the fall is also very effective.
- In riparian areas and areas near water use Rodeo (glyposate) at 2 pints per acre. This is a non-specific herbicide and will kill all contacted plants. Apply with a wick rather than broadcast spray to avoid contacting and killing native vegetation.
- Treatment may be required for many growing seasons to completely eradicate Canada thistle infestations.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Canada Thistle Identification Photos

Norman E. Rees, USDA Agricultural Research Service. Bugwood.org

Mary Ellen (Mel) Harte. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

Beliston, Noxious Weed Field Guide for Utah.

5.1.3.4 Dyer's Woad

Description

Dyer's woad is a member of the mustard family and has a distinctive blue-green color on the leaves and stems. It is classified as a biennial and its seeds germinate in the spring or fall. The bright yellow flower clusters that form in the spring make it easy to identify. Flowering can occur as early as April with the seeds maturing in June to July. The plants establish on dry, rocky hillsides and roadsides, and appear to be very well adapted to conditions in the Intermountain region. It is a prolific seed spreader and has the ability to out-compete native vegetation.

Control Recommendations

Physical:

- **Do not let Dyer's woad go to seed**.
- Hand pulling Dyer's woad is a very effective way to control small infestations.
- Pull out the root or the plant can resprout.
- Pull plants at the beginning of May and again 2 to 3 weeks later to get any remaining plants.
- Remove all flowering plants from the area to prevent any seed dispersal.
- Monitor the site for up to 3 years to remove any additional plants and ensure eradication.

Cultural:

- Cultivation can effectively control Dyer's woad if conducted in the early spring and/or late fall.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of Dyer's woad.

Biological:

- A fungal rust (*Puccinia thlaspeos*) has been used successfully to slow the spread of Dyer's woad. Rust provides limited control, but it does reduce seed production.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Herbicide application is most effective in the rosette stage (see photo on next page) using 2-4,D in a 1 percent solution and spot spraying.
- Dense infestations require a higher concentration of 2-4,D (contact Salt Lake County Weeds Department for concentrations).
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Dyer's Woad Identification Photos

Dyer's Woad in rosette stage.

Photo source: Steve Dewey, Utah State University. Bugwood.org

5.1.3.5 Knapweed and Starthistle

Description

Knapweed and starthistle are members of the sunflower family. There are four species of concern: Russian knapweed (perennial), spotted knapweed (biennial), diffuse knapweed (annual), and yellow starthistle (annual).

Russian knapweed: Perennial with black, spreading roots that form new shoots; rounded bracts with transparent tips and pink to lavender flowers.
Spotted knapweed: Short-lived perennial or biennial with tap root, black-tipped bracts, pink flowers (rarely cream colored).
Diffuse knapweed: Short-lived perennial or biennial with tap root, spiny or "crab-like" bracts, white to rose-colored flowers or sometimes purple flowers.
Yellow starthistle: Annual with tap root, straw color-tipped bracts, and yellow flowers.

Control Recommendations

Physical:
- Hand pulling yellow starthistle can be effective because it is an annual that only spreads by seed. Pull plants and roots before plant goes to seed and remove plants from the area to prevent seed dispersal.
- Hand pulling the Russian, spotted, and diffuse varieties of knapweed is not effective because they are deep-rooted perennials; if the root is not completely removed the plant will resprout.

Cultural:
- Revegetate controlled areas immediately with aggressive grasses to prevent weed re-establishment.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of knapweed and starthistle.

Biological:
- Knapweed weevils have been introduced into diffuse and spotted knapweed infestations in Cache Valley with favorable results on diffuse knapweed and mixed results on spotted knapweed areas.
- A Yellow starthistle weevil has recently been introduced near Richmond, Utah, but the results of effectiveness are not yet known.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:
- Russian knapweed: apply Tordon (picloram) at 3 to 4 pints per acre any time during the growing season, but late fall application is most effective (spot spray and do not use near water). Rodeo can be used in areas near water. It is a nonselective herbicide and will kill all contacted plants.
- Spotted and diffuse knapweed: apply Tordon (picloram) at 1 to 2 pints per acre. This will provide residual control for 2-3 years. Another options is to apply 2-4,D when plants are in the rosette to early bolt growth stage at 1 to 2 quarts per acre. Several years of treatment may be required.
- Yellow starthistle: apply 2-4,D when plants are in the rosette to early bolt growth stage (when the plant first emerges in spring and shoots up a flower stalk) at 1 quart per acre. Other options include using metsulfuron, clopyralid, or picloram with 2-4,D.

Knapweed and Starthistle Identification Photos

Photo source: Utah State University Extension "The Weed Web." extension.usu.edu/weedweb/

5.1.3.6 Bindweed

Description

Bindweeed is a perennial plant with arrow-shaped leaves and pink or white funnel-shaped flowers. It produces by seed and from creeping rhizome roots. The roots grow in all directions and can penetrate the soil to depths of 6 to 8 feet. The seeds can survive in the soil for over 60 years. The plant, with a large tap root (up to 10 feet deep), is very difficult to eradicate.

Control Recommendations

Physical:

- Hand pulling bindweed is not effective because of the plant extensive root system.
- A thick layer of mulch can reduce bindweed growth.
- Regular mowing can prevent seed development, but it will not control existing weed populations.

Cultural:

- **The best control for bindweed is competition from healthy, vigorous, native grasses.**
- Seed weed-control areas immediately with aggressive grasses to compete with bindweed.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of bindweed.

Biological:

- Currently, there is little evidence of a biological control agent that significantly damages or reduces populations of bindweed. Two insects being studied are a gall mite (*Aceria mahlerbae*) and a moth (*Tyta luctuosa*).
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Apply glyphosate (Rodeo) in areas with water during the growing season when plants are at full bloom at a rate of 2 to 5 quarts per acre. This is less effective in the fall.
- Apply Tordon (picloram) at a rate of 2 to 4 pints per acre in the fall.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Bindweed Identification Photos

Steve Dewey, Utah State University. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

Mary Ellen (Mel) Harte. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

5.1.3.7 Musk Thistle and Scotch Thistle

Description

Musk and Scotch thistles are biennial and/or annual plants that reproduce via seed. Musk thistle grows upright to 6 feet tall with violet flowers at the end of the stems. The plant is aggressive and can quickly invade an area because of its prolific seed production (up to 20,000 seeds per plant). Scotch thistle grows upright up to 9 feet tall and has reddish flowers at the end of the stems.

Control Recommendations

Physical:

- Hand pulling musk and Scotch thistles should be done before flowering. This will control small infestations because the plants only reproduce by seed. Cut the plant below the ground or as close to the ground as possible with a sharp shovel to prevent regrowth.
- Three to four years of repeated hand removal may effectively remove the plant from the target area. This is the preferable method for small infestations because it allows all surrounding native vegetation to remain healthy and unaffected by herbicides.
- Mowing will also aid in controlling the plants. It is most effective when done between the rosette and flowering stages, because plants are less likely to regrow.

Cultural:

- Re-establishing native grasses provides weed competition. Seed controlled areas as soon as possible with aggressive grasses to compete with thistles.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of musk and Scotch thistles.

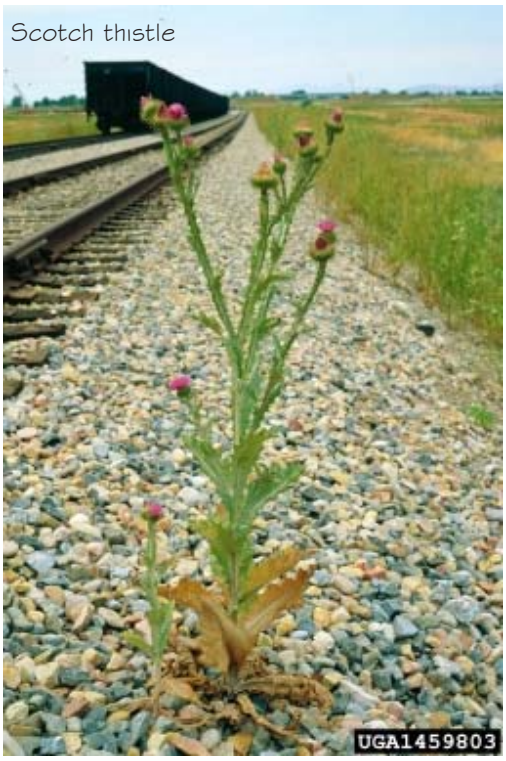
Biological:

- The musk thistle weevil (*Rhinocyllus conicus*) has been used to successfully reduce infestations of musk thistle, but it does not affect Scotch thistle. There are no biological controls currently in use for Scotch thistle.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Apply 2,4-D in the spring to the rosettes before the plant bolts.
- Apply Tordon (picloram) in the fall.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Musk Thistle and Scotch Thistle Identification Photos



5.1.3.8 Whitetop (Hoary Cress)

Description

Whitetop is a 2-foot-high perennial plant with a four-petal flower that grows in clusters at the tips of the stems, forming a flat, white top. It typically grows in dense stands and spreads via an extensive root system and by seed. Whitetop flowers in late May and early June, and it forms fruit in July and August. The plant's root system grows extensively both laterally and horizontally, making it a very difficult weed to eradicate.

Control Recommendations

Physical:

- Small infestations can be contained and controlled by hand-pulling or grubbing all plants throughout the growing season consistently for several years.
- Mowing during the growing season will reduce seed dispersal but will not provide any long-term control.

Cultural:

- Re-establishing native grasses provides weed competition. Seed control areas as soon as possible with aggressive grasses to compete with whitetop.
- Over-seeding sparsely vegetated areas with aggressive grasses (**bluebunch wheatgrass** [*Pseudoroegneria spicata*] and/or **bottlebrush squirreltail** [*Elymus elymoides*]) can reduce the spread of whitetop.

Biological:

- There are no biological controls currently in use for whitetop.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Chemical control of whitetop is difficult, and the proper timing of herbicide treatment is critical. It is difficult to control after the bud stage.
- Apply metsulfuron at rates of 0.5 to 1.0 ounce per acre to rosettes in early spring, to regrowth before bud stage, and to fall regrowth before the first frost. Follow the application instructions accompanying the herbicide.
- Apply 2-4,D in spring to rosettes. This may be less effective and require more years of treatment, but it is more cost effective.
- All chemical control methods must be repeated for several years to successfully eradicate whitetop.
- Tordon (picloram) is ineffective at controlling whitetop.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Whitetop (Hoary Cress) Identification Photos

Chris Evans, River to River CWMA. Bugwood.org

Chris Evans, River to River CWMA. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

5.1.3.9 Cheatgrass

Description

Cheatgrass is an erect winter or spring annual grass. The seedlings are bright green with hairy leaves and grow from 4-30 inches tall. As the foliage and seedheads mature, they often turn purple, dry out, and then turn tan in color. The grass seeds germinate in winter or early spring and grow quickly in spring, often maturing before most other species. Cheatgrass invades many areas in the western United States, particularly sagebrush/grassland plant communities. It often alters the fire regime of these plant communities and replaces native perennial grasses with a monotypic stand of annual cheatgrass. Native shrubs and grasses cannot tolerate and recover from the fire frequency of cheatgrass.

A combination of physical, cultural, and chemical controls are necessary to stress the plants and thus reduce their ability to spread.

Control Recommendations

Physical:

- Controlled burning provides some cheatgrass control. Conduct burns in early summer (June) after plants have dried out but before seeds have dropped. Contact the Salt Lake County Unified Fire Authority for assistance in conducting a controlled burn. Follow up with a fall seeding of native grasses.
- Mowing cheatgrass every 3-4 weeks to prevent seed development will provide further control, but is labor intensive and may not be practical.

Cultural:

- Re-establishing perennial native grasses in infested areas is necessary to out-compete the cheatgrass. Cheatgrass is relatively shallow rooted; thus deep-rooted perennials can persist without cheatgrass competition.
- A mix of native grasses such as western wheatgrass, bluebunch wheatgrass, and bottlebrush squirrel tail on heavier soils, or a mixture of needle-and-thread grass, Sandberg bluegrass, purple threeawn, sand dropseed, and Indian ricegrass is known to out-compete cheatgrass.

Biological:

- There are no biological controls currently used for cheatgrass, but a smut pathogen that infects the seed is being studied with promising initial results.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- Spot apply Roundup (glyphosate) to cheatgrass areas in spring. Spray when native perennials and forbs are dormant to lessen nontarget damage. Roundup treatment can follow up controlled burns in heavily infested areas. Roundup is a nonselective herbicide and will damage any plant it contacts.
- Plateau (imazameth) is a relatively new herbicide that is labeled for use in re-establishment of native prairie. It kills cheatgrass while allowing cool- and warm-season native grasses to survive. See specific use instructions for further information.
- Other spring application herbicides are available, but their impacts on native plants are unknown.
- Aatrex (atrazine) is a pre-emergent herbicide that is sometimes used in rangelands. Apply in the late fall after native perennials have gone dormant. Do not use near water.
- All chemical control methods will need to be repeated for several years to successfully eradicate cheatgrass.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Cheatgrass Identification Photos

Chris Evans, River to River CWMA. Bugwood.org

Toiyabe

Steve Dewey, Utah State University. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

5.1.3.10 Russian Olive

Description

Russian olive, native to southeastern Europe and central Asia, is a fast-growing tree usually found in riparian areas and other moist habitats, but it can also be found in upland areas. It has been used extensively for landscaping and as a wind break plant since the early 1900s. Russian olive is now considered an invasive plant but it is established on many rivers, streams, floodplains, and wetland areas throughout Utah. It is a perennial tree or large, multi-stemmed shrub that grows from 12-20 feet tall. The tree has silver, oblong leaves, fragrant flowers, and olive-shaped fruits. It reproduces by seeds that establish on disturbed sites in full sun, shade, and in intact ground cover. Non-specific establishment criteria and shade tolerance gives Russian olive advantages over native competitors (such as willows and cottonwoods), which require full sun. Russian olive also reproduces vegetatively with root suckers growing from the root crown after damage to the tree (fire, cutting, or girdling). It grows in dense, monotypic stands that out compete native vegetation. It is often found growing with tamarisk, another invasive riparian shrub.

Large, mature Russian olive stands are nearly impossible to eradicate. Early detection and rapid control of newly established Russian olive trees is very important. Successful control requires a combination of methods and several years of continued monitoring and control applications.

Control Recommendations

Physical:

- Seedlings and small saplings can be hand-pulled, but remove the entire root or the plant will resprout.
- Saplings with trunks less than 3.5 inches in diameter can be removed with a weed wrench.
- Apply herbicide (see chemical control recommendations) to stumps immediately after cutting.
- Large trees can be uprooted with heavy equipment; however, it is almost impossible to remove all of the root of a large tee, and the cut stump method described below is more effective.

Cultural:

- Following Russian olive removal, re-establishment of native plant species such and willows and cotton woods will allow native plant communities to compete with undesirable species.

Biological:

- There are currently no biological controls for use on Russian olive.
- Contact the Salt Lake County Weeds Department for more information on biological controls.

Chemical:

- The “cut-stump method” is most effective. Cut the stem or trunk as close to the ground as possible. Immediately apply herbicide onto the cambium layer of the cut-stump. Roundup (glyphosate) and Garlon 4 (triclopyr ester) have been used successfully on Russian olive stumps. Garlon 4 has been used successfully as a 50 percent solution and applied within 5 minutes of cutting. This may not be effective on trees more than 8 inches in diameter.
- Follow up stump treatment with foliar treatment of root sprouts for 2 years and continue to monitor for several years.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Russian Olive Identification Photos

Steve Dewey, Utah State University. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

Paul Wray, Iowa State University. Bugwood.org

5.1.3.11 Tamarisk

Description

Tamarisk are large shrubs or shrub-like trees that grow from 13 to 26 feet tall. They have feathery, deciduous leaves. At the end of its branches are pink flowers that bloom in June. Tamarisk has a deep and extensive root system that can extend to the water table. The plants reproduce vegetatively and by seed. The roots sprout after the shrub is cut or damaged. Cut stems can also form roots if left in warm, moist areas. Tamarisk tolerates a wide range of environmental conditions and has considerable competitive advantages over native plants (i.e., cottonwoods and willows) during all stages in the plants' growth cycles.

Originally used as a landscape plant, tamarisk has invaded most rivers in the southwestern United States during the past 100 years. It is found in large numbers in combination with the invasive Russian olive in Salt Lake County along the Jordan River, other streams, and in wetland areas. It is very difficult to eradicate and control takes major investments of time and effort.

Control Recommendations

Physical:

- Seedlings and small saplings can be hand pulled if the entire root is removed.
- Any roots left behind can resprout.
- An integrated approach of cutting, combined with herbicide application (see chemical control recommendations) to cut stumps, has proven a successful approach to tamarisk removal.

Cultural:

- Re-establishment of native plant species, such and willows and cottonwoods, following Tamarisk removal, will allow native plant communities to compete with undesirable weed species.

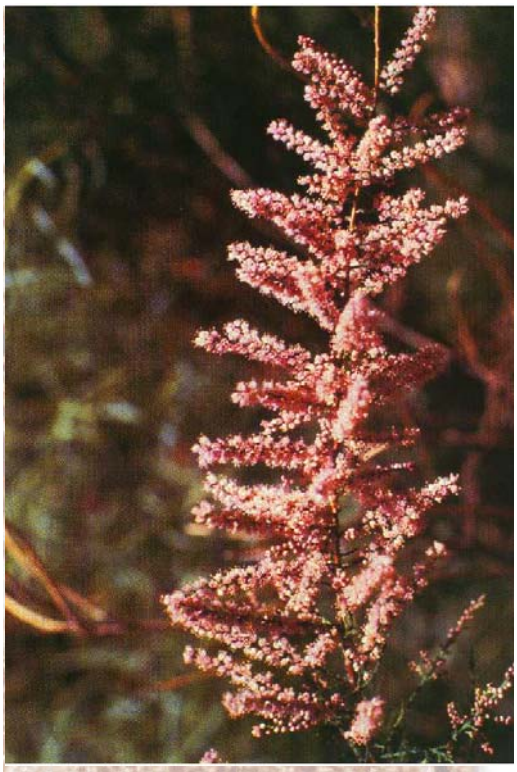
Biological:

- A leaf beetle (*Diorhabda elongatadeserticola*) has been released in Utah as a biological control for tamarisk.

Chemical:

- The "cut stump method" is most effective. Cut the stem or trunk as close to the ground as possible and immediately apply herbicide to the stump. Garlon 4 (tryclopyr ester) have been used successfully on the stump at a ratio of 1 part herbicide to 2 or 3 parts water. Roundup (glyphosate) is not effective for controlling tamarisk.
- Cutting and treating stumps has been most successful in fall, when the plants are entering dormancy. This allows for more herbicide to be taken up by the root system.
- Follow stump treatment with foliar treatment of root sprouts for 2 years and continue to monitor the site for several years.
- Contact the Salt Lake County Weeds Department for assistance in spraying noxious weeds.

Tamarisk Identification Photos



Mr. & Mrs. Robert G. Young. USDA NRCS. 1992. Western wetland flora: Field office guide to plant species. West Region, Sacramento. Courtesy of USDA NRCS Wetland Science Institute.

Photo source: Steve Dewey, Utah State University. Bugwood.org

5.1.3.12 Dalmation Toadflax

Description

Dalmatian toadflax is a short-lived (3 years), creeping perennial that reproduces from buds in its root system and seed. Roots grow 4 to 10 feet deep and can extend up to 10 feet from a single plant. Typical plant height is 3 feet and each plant produces up to 25 stems in the first year of growth. Flowers are yellow and resemble snapdragons. The plant is poisonous to cattle if consumed in large quantities.

A single plant can produce 500,000 seeds annually and the seeds can remain viable in soil for 10 years. Seeds also have a high germination rate. Seed dispersal and success along with vegetative spread of the plant make this weed very difficult to control.

Control Recommendations

Physical:

- Hand pulling plants in small infestations can be effective. Pulling should continue for at least a 5-year period and monitoring for up to 10 years to check for dormant seed germination.
- Mowing and burning are ineffective; roots and seeds are not affected.
- Cultivation can be effective but it is very labor intensive. It should begin in late spring and recur every 7 to 10 days for 2 years.

Cultural:

- Planting competitive grasses in infested areas can aid in controlling Dalmatian Toadflax. The most successful controls have been programs that combine seeding and chemical controls.
- Preliminary studies have shown sheep grazing to be an effective control. Sheep appear to not be affected by the poisonous compound.

Biological:

- Toadflax stem-mining weevil (*Mecinus janthinus*) was approved for release in the United States in 1995 and has been released in Utah. There is little information on the success of this control agent.
- Other biological control insects have been used in Utah against Toadflax, but the results are mixed.

Chemical:

- Apply Tordon (picloram) at 1-2 quarts per acre in fall. Combine with grass seeding for best results. Re-treatment for several years is required.
- Round-up (glyphosate) can be applied in the spring in early bloom stages. This will suppress the weed for 1 year, but regrowth will occur the following year. This non-specific herbicide and will kill any treated plants.
- Follow stump treatment with foliar treatment of root sprouts for 2 years and continue to monitor the site for several years.
- Contact the Salt Lake County Weeds Department for assistance in spraying noxious weeds.

Dalmation Toadflax Identification Photos

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

Susan Turner, British Columbia Ministry of Forests, Bugwood.org

5.1.3.13 Garlic Mustard

Description

Garlic mustard is a herbaceous biennial forb. Native to Europe, it is found in wooded areas and aggressively invades disturbed areas. The plant is highly shade tolerant and forms dense infestations. During its first year, the plant forms basal rosettes 1-6 inches tall with green, heart-shaped leaves. Plants flower in the second year and produce a flowering stalk 1-4 feet tall with small, white flowers. The leaves have a garlic odor when crushed.

Garlic mustard reproduces by seeds, which germinate in 1 to 2 years and remain viable in soil for 5 years. Individual plant seed production varies from a few hundred to several thousand seeds per plant. Seeds are produced in slender pods called siliques on the stem just below the flowers.

Control Recommendations

Physical:

- **Small infestations** are best controlled by hand pulling. Remove the upper portion of the root to prevent the root crown from sending up stalks (then remove **all** plants and seeds from the area).
- **Moderate infestations** can be controlled by mowing or cutting stems when the plant is in flower (then remove **all** plants and seeds from the area).
- Controlled burning of garlic mustard has been conducted with varying success. Burning must be conducted during two consecutive years. This will reduce but not completely eliminate the infestation.
- **These methods will be successful only** if all seeding plants and seed sources are removed from the infested area. A minimum of 5 years of plant and seed removal will be required to exhaust seed sources, and infested sites must be monitored for bolting plants several times each spring.

Cultural:

- Identifying potential infestation areas and removing plants quickly will reduce infestation of garlic mustard.
- Light to moderate infestations often do not require seeding of native plants if sufficient native plants inhabit the area.

Biological:

- There are currently no biological control agents in use to control garlic mustard. Studies of a variety of control agents are being conducted.

Chemical:

- Large, dense infestations can be controlled with a combination of hand pulling/cutting and herbicide application.

Garlic Mustard Identification Photos

Photo source: Steve Dewey, Utah State University. Bugwood.org

David Cappaert, Michigan State University, Bugwood.org

Chris Evans, River to River CWMA, Bugwood.org

Chris Evans, River to River CWMA, Bugwood.org

5.1.3.14 Johnson Grass

Description

Johnson grass is a tall, rhizomatous perennial grass in the grows in dense clumps or nearly solid stands that reach 8 feet in height. Leaves are smooth, lanceolate with a white mid vein, alternately arranged and 2 feet long. Stems are pink to rusty red near the base. Flowers are large, loosely branched, purplish, hairy panicles. It reproduces both vegetatively and by prolific seed production. It is found in crop fields, pastures, abandoned fields, rights-of-way, forest edges, ditches and wetlands. It thrives in open, disturbed, rich, bottom ground, particularly in cultivated fields. It is considered to be one of the ten worst weeds in the world.

Control Recommendations

Physical:

- Hand pulling in small infestation in June can be effective. Pull plants after a rainstorm when the ground is soft.
- All plant parts should be removed from the area. Broken stems and roots left in the ground should be dug up if only a small area is involved.
- Cutting by mowing or tilling combined with an herbicide treatment can be effective for large infestations.

Cultural:

- Healthy native plant communities reduce the infestation of Johnson grass.
- Revegetate areas with native grasses after plant removal.

Biological:

- There are currently no biological controls available for use with Johnson grass.

Chemical:

- Roundup (glyphosate) has been effective in controlling Johnson grass in natural areas.
- Spot spray actively growing plants with glyphosate.

Infestation must be monitored and treated for several years to effectively control the weeds.

- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Johnson Grass Identification Photos

Chris Evans, River to River CWMA, Bugwood.org

Bonnie Harper-Lore, Federal Highway Administration, Bugwood.org

Jil M. Swearingen, USDI National Park Service, Bugwood.org

Chris Evans, River to River CWMA, Bugwood.org

5.1.3.15 Myrtle Spurge

Description

Myrtle spurge is a perennial forb with stems that spread low to the ground. In early spring, new stems emerge from a central taproot. Mature plants are 4-6 inches tall spreading up to 18 inches laterally are blue-green in color. The flowers appear in early spring and are inconspicuous, surrounded by a showy yellow green bract. When broken, leaves, stems, and roots all exude a milky sap that irritates skin. The plant spreads by seed, but broken stems and roots can re-sprout. It has been used as a popular rock garden ornamental plant and can be found in many gardens in Salt Lake County.

Control Recommendations

Physical:

- Hand pulling and digging small patches can successfully eradicate the plant.
- Pull out the entire root to prevent re-sprouting.
- It is very important to wear very thick, impermeable gloves and protective clothing to prevent skin contact with the plant's highly toxic milky latex.

Cultural:

- Healthy native plant stands reduce the risk of weed invasions by myrtle spurge.
- Do not let plants go to seed.
- Discourage ornamental use and educate the public in the problems with myrtle spurge.

Biological:

- There are currently no biological controls available for use with myrtle spurge.

Chemical:

- Myrtle spurge is extremely difficult to control with herbicides because of the thick cuticle, although some results have been shown with Roundup.
- Because of the waxy cuticle, an appropriate surfactant must be used with the chosen herbicide
- The herbicides 2-4,D, dicamba, and glyphosate have been shown to be effective when applied during active growing.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Myrtle Spurge Identification Photos

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

5.1.3.16 Perennial Pepperweed

Description

Perennial pepperweed grows 1 to 3 feet tall, but may reach 6 feet. The many stems of the plant contain white flowers that grow in rounded clusters at branch tips from June through August. The plant has abundant seed production (thousands per year) and high seed germination rates. Seeds fall from the plant at irregular intervals throughout the winter. Plants also spread by vegetative reproduction through extensive, creeping root systems. Perennial pepperweed is invasive primarily in riparian areas and wetlands and may invade adjacent areas once established. It has proved to be a very difficult weed to control.

Control Recommendations

Physical:

- Physical and mechanical control methods such as mowing and disking alone are unlikely to control perennial pepperweed because new plants quickly regenerate from both undisturbed and fragmented roots in the soil.
- Controlled small infestations by repeated removal of plant material above and below the ground. Remove as much of the root as possible because small pieces can sprout. Repeat for several years.

Cultural:

- Removal of this plant requires establishment of native plants that are capable of competing successfully with perennial pepperweed.
- Saltgrass may compete with perennial pepperweed in a wetland area.

Biological:

- There are currently no biological controls available for use with perennial pepperweed.

Chemical:

- Small infestation of perennial pepperweed can be controlled by 2,4-D with application for several years. Spray plants during the flower bud stage in late June or early July.
- 2,4-D provides only short-term control in large infestations. It has been relatively successful with two applications of 2,4-D per year, for 3 to 6 years.
- Consistent success with the sulfuronal herbicides Telar and Escort has been shown. These herbicides are new and costly, so application quantities must be carefully considered. Do not use these near water.
- Roundup and Rodeo (glophosate) can be used successfully in small infestations. Take care not to spray non-targeted plant species. Large infestations should be mowed and the resprouts treated with glyphosate for several years.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Perennial Pepperweed Identification Photos

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

Photo source: Steve Dewey, Utah State University. Bugwood.org

5.1.3.17 Purple Loosestrife

Description

Purple loosestrife is a perennial forb that can grow 10 feet tall. It has spikes of purple flowers that occur at the tops of the plants. Purple loosestrife invades many wetland types, including wet meadows, river and stream banks, lake shores, tidal and non-tidal marshes, and ditches. It quickly forms dense stands that displace native vegetation. The plant can spread rapidly through prolific seed production; one plant can produce 2-3 million seeds per year. Seeds are easily dispersed by water, mud, and by adhering to aquatic wildlife, livestock, and people.

Control Recommendations

Physical:

- Hand pulling is most effective on 1- to 2-year-old plants (hand pulling older plants is not feasible).
- Pull as flowers appear in mid July to August. Roots extend about 1 foot into the soil.
- Remove and bag all plant parts to prevent vegetative sprouting.

Cultural:

- Purple loosestrife control can be enhanced by a combination of planting competitive grasses and selective herbicide.
- Seed competitive grasses after plant removal.
- Purple loosestrife seedlings will appear for several years and can be targeted with a broadleaf herbicide that does not affect grasses.
- Once purple loosestrife seedlings are controlled, other broadleaf plants and shrubs can be planted.

Biological:

- Two biological control agents for purple loosestrife are used in Utah.
- *Galerucella pusilla* is an 8 mm-long beetle that successfully defoliates purple loosestrife, which destroys the plant's ability to photosynthesize and produce seed. An area in Cache County has shown very successful results. This agent prefers stands of purple loosestrife that are not permanently flooded.
- *Hylobius transversovittatus* is an 8-12 mm-long root-boring weevil. Female weevils lay eggs on the soil or on the stem at soil level, and larvae develop in and destroy the roots while adult weevils feed on the foliage. This weevil tolerates a wide range of environmental conditions, but cannot thrive in areas with prolonged flooding.

Chemical:

- Glyphosate is most commonly used to control L. salicaria. In areas near water (where most purple loosestrife is located) use the glyphosate Rodeo that has been approved for use near or over water.

Purple Loosestrife Identification Photos

Photo source: Steve Dewey, Utah State University. Bugwood.org

Norman E. Rees, USDA Agricultural Research Service, Bugwood.org

Utah State University Archive, Utah State University, Bugwood.org

Utah State University Archive, Utah State University, Bugwood.org

John D. Byrd, Mississippi State University, Bugwood.org

5.1.3.18 Squarrose Knapweed

Description

Squarrose knapweed is a long-lived perennial with deep tap roots that reproduces only by seed. The stems are upright. Small plants have one stem and flower head; large plants have a stem with many branches and can have more than 100 flower heads. Plants range in height from 6 to 24 inches. Flowering occurs from July to September. Pink or purple flower heads are located at the tips of branches. Each flower contains approximately 4 seeds and seeds are dispersed as they fall from the flower heads. Squarrose knapweed flower heads are smaller than other knapweeds.

Control Recommendations

Physical:

- Hand pulling squarrose knapweed is ineffective because roots re-sprout when broken off.
- Digging the roots of individual plants or small infestations with a shovel may be effective if most of the taproot is removed. Cut roots at least 8 inches below the soil surface to prevent growth of new shoots.
- Bag and dispose of pulled plants.

Cultural:

- Healthy native plant communities reduce infestation of squarrose knapweed.
- Revegetate areas with native grasses after plant removal.

Biological:

- Squarrose, spotted, and diffuse (but not Russian) knapweed are subject to attack by two species of fruit fly (*Urophora affinis* and *U. quadrimaculatus*), which are now available in Utah.

Chemical:

- Glyphosate kills knapweed plants, but will also destroy competitive grasses. When using glyphosate, spot sprag actively growing plants in the bud stage. Seed a locally adapted perennial grass in the fall and at least 10 days after the application.
- Applying Tordon (picloram) at a rate of 0.25 to 0.5 lb per acre to knapweed plants in late spring before or during flower stem elongation will provide some control and will not damage perennial grasses. Treatment of plants in the bud stage may not prevent seed production in the year of application, but seed germination will be noticeably reduced.
- Monitoring and treatment must occur for several years to control the infestation.
- Contact the Salt Lake County Weeds Department for assistance with spraying noxious weeds.

Sqarrose Knapweed Identification Photos

Steve Dewey, Utah State University. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

Steve Dewey, Utah State University. Bugwood.org

USDA ARS Archive, USDA Agricultural Research Service, Bugwood.org

5.2 Erosion Control

5.2.1 General Erosion Control

Erosion control practices are an important maintenance component of natural area management. Many of the County's natural areas occupy sites with steep, erosion-prone slopes. Erosion is typically caused by construction practices (old and new) and recreational use practices. All natural area construction activities should implement erosion controls. Recreation-related erosion problems occur with public use and trampling from "user-created" trails. Wind and rain also affect these trampled areas, leading to soil erosion problems. Natural disturbances, such as flooding and wildfire, may also lead to soil erosion problems.

5.2.2 Identifying Erosion Problem Areas

Erosion problems should be identified during annual site inspections. Examples of soil erosion problems include bare soil, rills, and gullies (as shown in photos at right).

Photos: utah.sierraclub.org

5.2.3 Erosion Control Practices

A variety of erosion control practices are used to reduce erosion problems. These practices include the following:

- site grading and vegetative stabilization
- mulch and erosion control blanket
- bank stabilization
- silt fences
- dikes, berms, and swales
- water bars
- sediment traps

Each of these erosion control practices is described in detail on the following pages.

5.2.3.1 Site Grading and Vegetative Stabilization

Site grading, conducted during project construction, is the movement of the landscape and soil to form natural slope contours. Vegetative stabilization is the process of establishing vegetation on a site to prevent soil erosion. One of the most effective means of erosion control is appropriate site grading that reduces soil erosion and enhances vegetation establishment.

The limiting criteria for erosion control in site design is slope steepness. Steeper slopes allow for greater soil erosion and reduced vegetative stabilization (Figure 5.2).

- Slopes 2:1 and greater are very difficult to revegetate and present critical soil erosion problems. Disturbance of these steep slopes should be avoided, and project designs should not include 2:1 slopes.
- Slopes 3:1 present a moderate-to-high erosion hazard and generally allow fairly successful revegetation, although these slopes should also be avoided. If it is necessary to build on these slopes, additional erosion-control measures need to be included in design and construction to reduce soil erosion problems (e.g., berms, swales, water bars, mulch, silt fence).
- Slopes 4:1 present a moderate erosion hazard but allow successful revegetation.
- Slopes less steep than 4:1 present a moderate-to-low erosion hazard and allow successful revegetation.

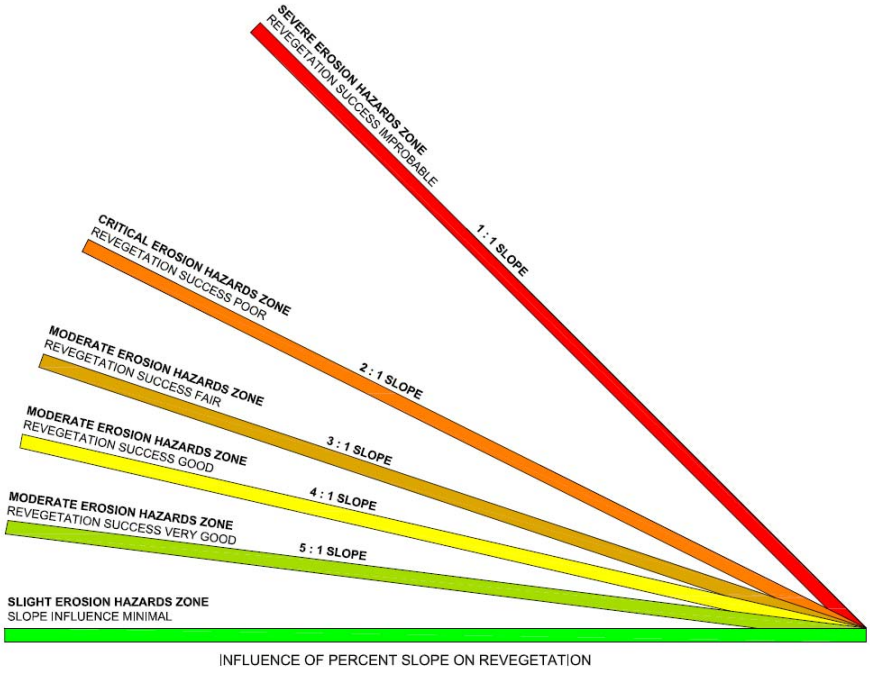


Figure 5.2. Influence of slope on revegetation success.

5.2.3.2 Mulch and Erosion Control Blankets

All construction and revegetation areas should be mulched immediately after construction or seeding. This reduces soil erosion and provides favorable seed germination conditions. Many types of mulch are available and should be chosen based upon different project criteria (e.g., project size, slope steepness, project budget). Use of mulch will help with the following:

- conserve soil moisture,
- moderate soil temperature,
- prevent erosion,
- improve water infiltration,
- prevent soil compaction,
- rebuild organics in soil, and
- improve nutrient retention.

The following summarizes the use for various mulches. For most details, see the 1995 *Salt Lake County Nature Area Revegetation Manual* (NARM), portions of which are included in Appendix B of this document.

- All mulches must be certified weed free to prevent the spread of weeds into construction and revegetation areas.
- Disturbed areas should be protected and/or seeded immediately following construction.
- During revegetation and seeding delays, cover construction areas with weed-free straw mulch to protect soil and prevent weed establishment until seeding begins.

Straw Mulch - Straw mulch is useful for erosion control and revegetation because of its effectiveness, availability, and low cost. It should be applied at a rate of approximately 2 tons/acre after seeding. It can be applied either by hand or with a mechanical mulch blower. Apply uniformly, covering at least 50 percent of the soil surface. Accessible slopes should be crimped 2 inches deep into the soil to secure the mulch fibers. This can be accomplished by rolling the placed straw with a sheepfoot roller or other roller). Slopes greater than 30 percent should be anchored in place using a degradable plastic mesh or tackifier.

Erosion Control Blanket - Erosion control blankets come in rolls and are used in critical erosion areas and/or smaller sites

because of their high costs. There area several types of blankets available that come with installation directions from the manufacturer (Figure 5.3).

Hydromulch - Hydromulch is typically a mulch medium (e.g., straw, wood fiber) combined with a tackifier and seed that is mechanically applied to revegetation areas. The effectiveness of hydromulch is questionable, especially on steep slopes (>2:1). Hydromulch is difficult to apply correctly. If it is applied too thickly, it inhibits seed germination. If it is applied to thinly, it will allow increased soil erosion. Areas that are difficult to access or areas in which conditions are persistently windy are most appropriate for hydromulching. Straw mulch and erosion control blankets are more effective for erosion control and vegetation establishment.

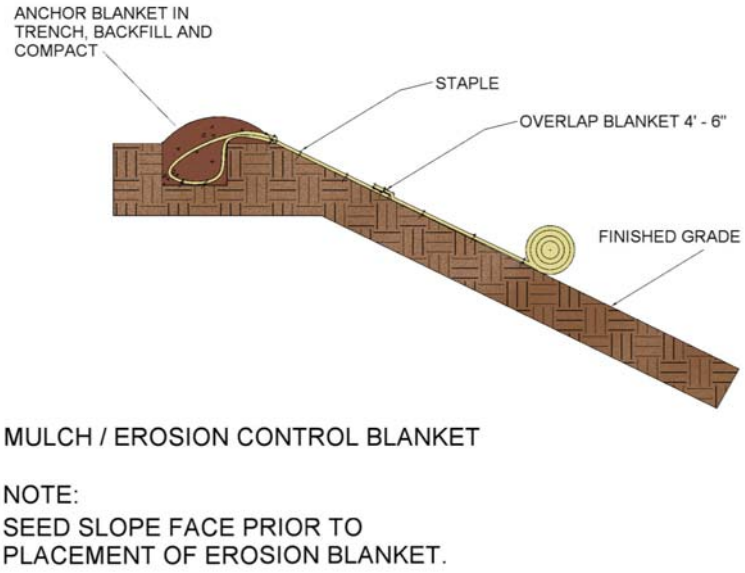


Figure 5.3. Guide for erosion control blanket installation.

5.2.3.3 Bank Stabilization

Bank stabilization may be necessary to control erosion and stabilize slopes on steep hillsides, streambanks, and lakeshores. Traditional methods include riprap, gabion structures, and retaining walls. An alternative approach is bioengineering, for which live plants are combined with either organic or inorganic materials to create erosion controls. Bioengineering advantages include long-term cost effectiveness, greater aesthetic appeal, and increased wildlife habitat. Some disadvantages include high initial labor costs and training, unfamiliarity with design practices and techniques, and limitations of available vegetative material and seasonal installation. See Appendix B for more details. A brief explanation of various bank stabilization practices follows.

Riprap - Riprap is a layer of large stones and boulders placed over an eroding bank to protect the bank from the force of moving water (Appendix B, Exhibit 3-12). Riprap structures need to be designed by a professional civil engineer.

Gabions - Gabions are wire mesh cages filled with stones and placed as building blocks at eroding banks (Appendix B, Exhibit 3-14). They protect the bank from the force of moving water. Gabion structures need to be designed by a professional civil engineer.

Wattles - Wattles are used to control surface erosion by breaking long slopes into shorter slopes. They are made of bound bundles (10 inches diameter and 6 to 10 feet long) of brush stems. The bundles are placed in shallow trenches, staked to the soil surface perpendicular to the slope, and backfilled until only the top of the bundle is exposed (Appendix B, Exhibit 3-14). This technique can be used for hillslope restoration, road embankments, wide gullies, and slump areas.

Live Stakes - Poles and sprigs collected from riparian willows and cottonwoods (see page 5-43 and Appendix C for more details on pole planting) are planted in saturated streambank soils (Appendix B, Exhibit 3-15). This method provides streambank erosion control.

Brush Layering - This method is used to restore slopes and streambanks by constructing a fill slope with live branches and soils, thereby creating a series of reinforced benches (Appendix B, Exhibit 3-16, 3-17). Large quantities of dormant willow branches are used, and the area is backfilled with saturated soil.

Prevegetated Mats - Commercially grown mats of wetland plants are available for streambank revegetation. They typically come in 4-foot by 8-foot sections. They are placed upon saturated soils, typically at the end of spring runoff. The mats quickly root into the soil and provide effective erosion control. The cost for this product is high.

Vegetated Riprap - Soil and live stems of willows and cottonwoods are placed in pockets in the riprap structures. The plants must be placed deep enough to penetrate soil underneath the riprap bank (Appendix B, Exhibit 3-18, 3-19, 3-20).

Vegetated Gabions - Willow and cottonwoods are placed into and between gabions to provide streambank erosion control that combines structures and vegetation (Appendix B, Exhibit 3-22). The vegetation must penetrate soil underneath the gabion structure.

5.2.3.4 Silt Fence

Silt fencing is a temporary erosion control device that traps sediment during and after project construction. It is constructed of a geotextile fabric and vertical structure posts. Placed at the base of fill slopes and at down-slope edges of construction sites, silt fences trap eroding soil, keeping it on site and thus protecting water resources. It is designed to be used in areas of sheet flow and very shallow flow, not in large drainage ways.

- Install silt fencing properly to successfully control erosion (Figures 5.4 and 5.5).
- Place silt fencing in the appropriate area to effectively trap sediment.
- Place silt fencing to stand up to large amounts of pressure from flowing water and sediment buildup.
- Purchase the fabric in a continuous roll to minimize gaps.
- Place silt fence at the bottom of drainage area, perpendicular to the slope.
- Place silt fencing fabric into an 8-inch trench and backfill the trench.
- Place vertical posts a maximum of 10 feet apart. Place posts closer together in expected areas of high stress and sediment accumulation.

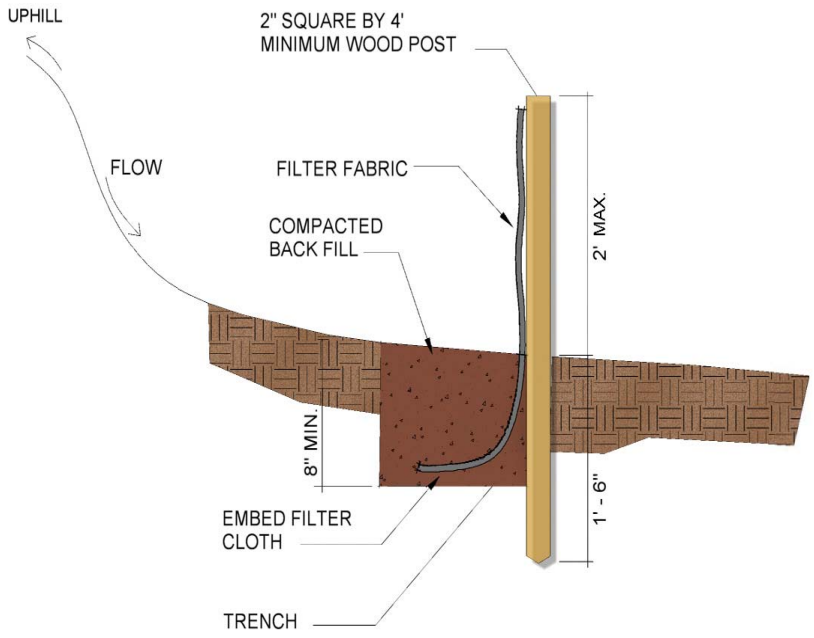


Figure 5.4. Correct silt fence installation and details.

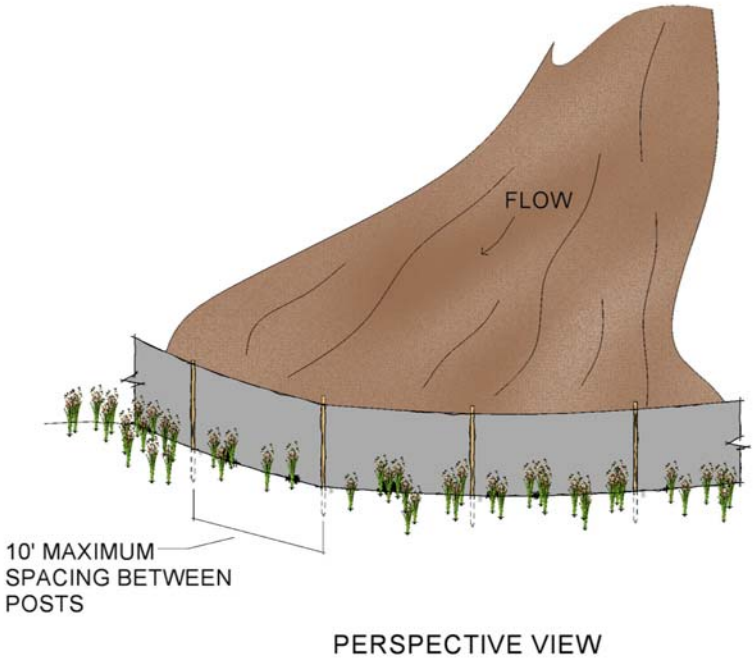


Figure 5.5. Correct silt fence installation and details.

5.2.3.5 Dikes, Berms, and Swales

Dikes and berms are ridges of soil or other material used to direct or contain flows on construction sites. Swales are often used in combination with dikes to divert water off of slopes and into sediment traps or away from highly erodible soils. These components can be either temporary or long-term erosion control devices. See Appendix B for more details.

- A strawbale dike (Appendix B, Exhibit 3-24) is a temporary erosion control that can be removed when an area has been successfully revegetated.
- Berms are typically a long-term erosion control that are designed into a site grading plan (Figure 5.6).
- Swales (Figure 5.7) can be lined with rock or vegetation to slow water flow and reduce erosion. Swales are typically a long-term erosion controls designed into a site plan. Swale sizes vary depending upon the size of the drainage area and expected runoff rates.

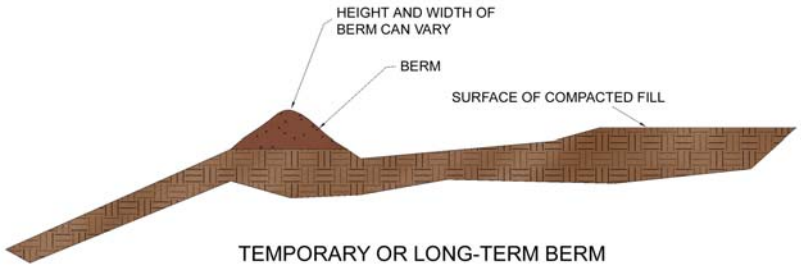


Figure 5.6. Berm example.

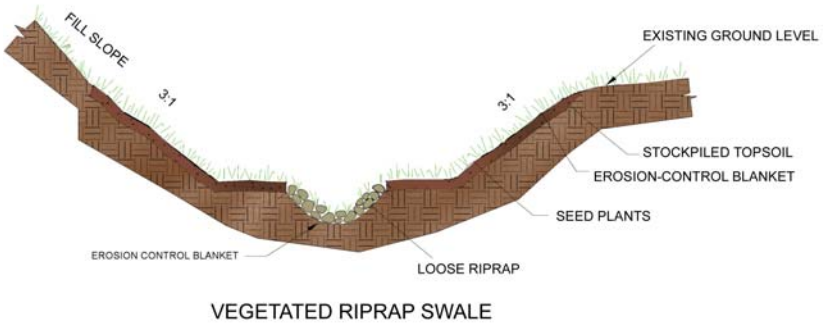
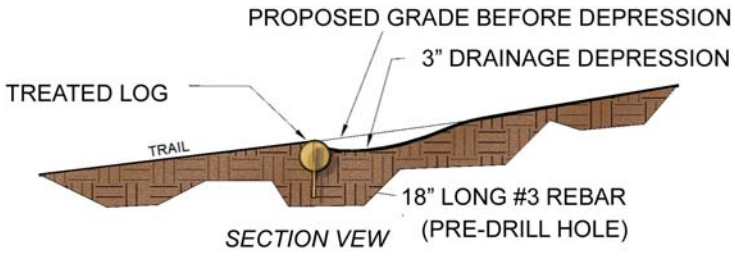


Figure 5.7. Swale example.

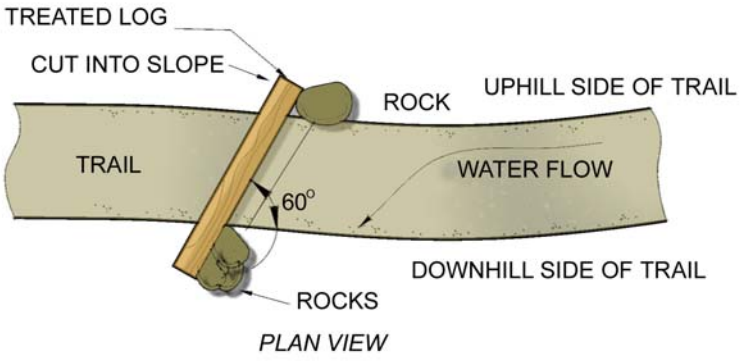
5.2.3.6 Water Bars

Water bars divert water from trails at designated intervals and in areas where erosion is actively occurring (Figure 5.8). They can be incorporated into trail design and construction efforts or installed later during trail maintenance activities. If done properly, water bars can reduce trail erosion. Poorly constructed water bars can increase erosion problems and be a trail hazard.

- Use either a 4-inch by 6-inch redwood timber or native log.
- Set the water bar at a 60 degree angle across the trail and secure in place with 18-inch-long Rebar pins.
- Extend the water bar so that water is carried completely off the trail to the side slope.
- Provide rocks at the down-slope end of the water bar to dissipate the energy of the flowing water.
- Level the top of the water bar nearly flush with the trail tread to minimize tripping hazards.



WATER BAR DETAIL



WATER BAR DETAIL

Figure 5.8. Water bar example.

5.2.3.7 Sediment Trap

Sediment traps (Figure 5.9) are typically used as temporary erosion controls at the outlets of other erosion controls such as swales, dikes, and berms that discharge water containing sediment and debris. Small sediment traps effectively prevent sediment from entering local waterways during project construction.

- Remove accumulated sediment from the trap when it reaches approximately 50 percent capacity.
- Inspect traps after heavy rains to determine whether the trap is draining properly.

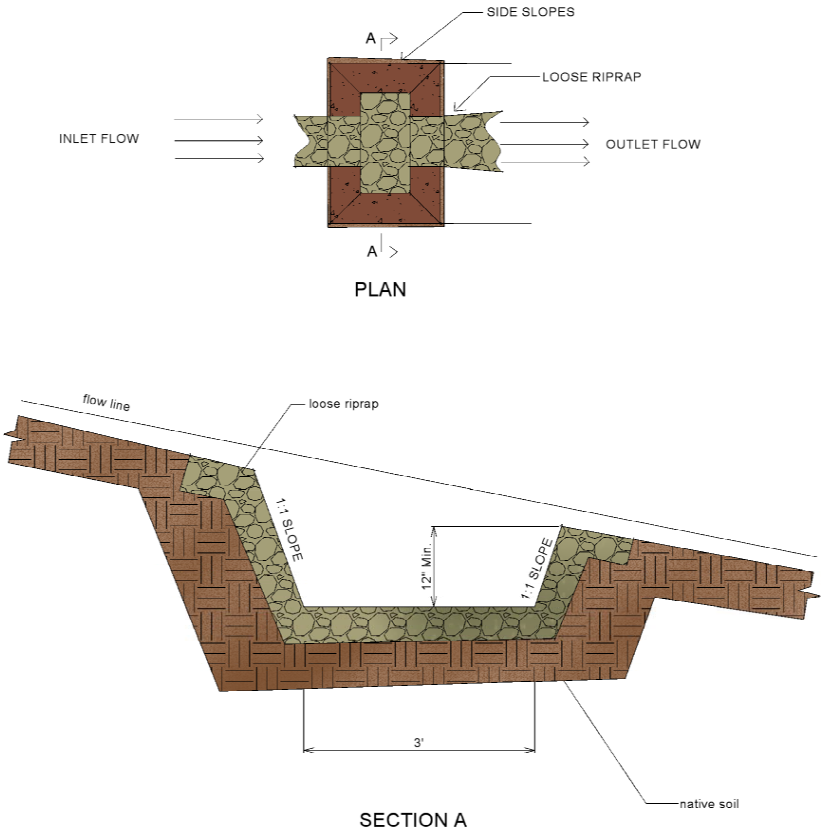


Figure 5.9. Sediment trap example.

5.3 Revegetation

Maintaining native vegetation cover within the County's natural areas requires many different types and scales of site revegetation. Weed outbreaks, construction, fires, and floods may disturb the soil, introduce invasive species, strip existing vegetation. By prioritizing revegetation efforts the County can focus and expend resources efficiently. To prioritize revegetation efforts, the following questions should be asked.

1. What are the project goals?
The goals of the project may include weed eradication, erosion control, and/or wildlife habitat establishment, etc. Determine the project purpose and set specific goals accordingly.

2. What is the project size and location?
It is easier and less expensive to accomplish successful revegetation on smaller sites, since larger sites require more resources. Project location will determine accessibility and constraints.

3. What are the project issues?
While planning the project, determine the issues likely to be encountered. For example, is the project associated with high-priority items such as construction, noxious weed eradication, significant erosion, and/or wildfire?

4. What is the time frame for the project?
Determine the best time to implement the revegetation project. Consider that it is often best to seed and plant in the fall.

Figure 5.10 lists types of highest-priority revegetation sites.

The phases necessary to complete a successful revegetation project are described in detail in the following subsections.

Construction/Planned Disturbance Areas

All planned construction and other ground disturbance must be accompanied by a revegetation plan to reduce erosion and invasive weed problems. Without immediate revegetation effort, weeds and erosion become more difficult to combat.

Noxious Weed/Invasive Species Eradication Areas

Revegetating noxious weed eradication sites with competitive grasses is essential for success.

High-Erosion Areas

Disturbed areas that are highly eroded require rehabilitation and revegetation. Revegetation plans should be included in all erosion -control projects.

Wildfire Areas

Rehabilitation and revegetation are necessary after wildfire. The scale and scope of revegetation depend upon the severity of the wildfire.

Figure 5.10. Highest-priority revegetation area types.

5.3.1 Revegetation Process

The revegetation process includes three components: (1) planning and design, (2) construction, and (3) monitoring. These components are described below and in subsequent sections of this document.

Planning and Design

After selection of a prioritized revegetation area, planning and design begins. During this phase the project is planned by conducting the following:

- site evaluation for existing conditions
- soil testing
- base map preparation (identify disturbance limits)
- planting plan development
- erosion control plan development
- construction plan development

Construction

The next component of the revegetation process includes step-by-step revegetation construction practices that apply to all natural areas. These steps are described in detail in this section.

Step 1. Site Preparation
Step 2. Seedbed Preparation
Step 3. Seeding
Step 4. Planting
Step 5. Short- and Long-Term Monitoring and Maintenance

Monitoring and Maintenance

During and following completion of a revegetation project, the project area must be continually monitored to ensure project success. Monitoring and maintenance include construction monitoring and post-construction monitoring, which are discussed in detail in Section 5.3.1.5 (Step 5 in the construction process).

5.3.1.1 Construction Step 1: Site Preparation

Site preparation consists of (1) minimizing disturbance, (2) removing competing vegetation, (3) stockpiling topsoil, and (4) rough grading.

Soil Testing

Soil tests identify the soil type and condition (saline, acidic, alkaline, high nitrogen content, etc.). Soil tests should be conducted during initial project planning and to identify necessary soil amendments that can adjust for nutrient deficiency and other problems. More information on soil amendments is located in Section 5.3.2.

Soil tests should include data on soil texture, organic matter, pH, and salinity. Additional information on nitrogen, phosphorous, and potassium is helpful, but are typically not limiting factors in revegetation.

To conduct a soil test, complete the following steps:

1. Provide one soil sample per 10-acre area or less. Provide different samples for different areas (wet, dry, slope, etc.).

2. With a shovel, make a deep hole in the soil and put the fill aside.

3. Cut a 1-inch slice of soil from the side of the hole that is even in width.

4. Place the slice in a bucket.

5. Repeat at six different locations (representing the same type of area) to get a representative sample.

6. Thoroughly mix the 6 sub-samples.

7. Send 1 pint of soil to lab for testing.

Minimizing Disturbance

It is critical that minimal disturbance occurs during site preparation for revegetation projects in natural areas. Minimizing disturbance will reduce soil loss and the overall area requiring revegetation. Maintaining as much native vegetation as possible in a revegetation area will aid in natural recovery.

- All revegetation project plans should include a “disturbance limits” boundary that is fenced. This prevents equipment from damaging soils beyond the project site boundaries.

Clearing and Grubbing

Vegetation that competes with native plants should be removed at the beginning of a revegetation project. Different vegetation and project sizes have different site-clearing requirements.

- **All noxious weeds and invasive plants should be completely removed from the site prior to revegetation.**
- Boulders, brush, and other on-site resources should be salvaged during site clearing and stockpiled for future use during site grading and shaping. This allows for use of on-site materials in construction of erosion controls and also adds natural aesthetic appeal.
- Large revegetation areas may require brush removal.
- Prior to planned construction or disturbance, some large, woody vegetation (>2 inch diameter) of desirable species can be salvaged for replanting. Replanting is less successful for species that have large root systems, but it is worth investigating the possibility prior to site clearing.
- Undesirable, large woody vegetation should be removed mechanically with a small bulldozer equipped with a brush rake. This reduces topsoil loss during woody vegetation removal.
- Smaller woody vegetation (<2 inch diameter) should be mulched and incorporated into the topsoil.
- Grasses and forbs can also be incorporated into the topsoil. This creates a seed source in the soil that will enhance revegetation efforts.

Applying Topsoil

Adequate topsoil is necessary for a successful revegetation project. Topsoil contains plant growth components, such as nutrients and organic matter, in addition to a potential native plant seed source.

- Evaluate topsoil at a revegetation site for quality and quantity during project planning.
- Collect and stockpile topsoil whenever possible during planned construction and/or disturbance.
- Import topsoil if necessary. This is costly, therefore it is always best to use existing topsoil resources when possible.
- Mulch and protect stockpiles from erosion if left for more that 1 month. Use the stockpiled topsoil as soon as possible to obtain the maximum benefits.
- Do not use existing topsoil in weedy areas.

5.3.1.2 Construction Step 2: Seedbed Preparation

Seedbed preparation consists of grading the site to the final desired form and creating a topsoil surface that provides an effective seedbed, allowing for seed germination and seedling establishment. Proper seedbed preparation, as explained below, improves soil aeration, water infiltration, and seed-to-soil contact while reducing soil erosion.

Site Grading and Contouring

Revegetation areas should be graded to mimic natural existing landforms. Contouring and shaping slopes to minimize sharp angles and transition into the adjacent natural landscape will reduce soil erosion and create a more natural appearance. Whenever possible, do not grade slopes steeper than 3:1, as those slopes are very difficult to revegetate. Use any salvaged boulders, brush, or other on-site objects to naturalize the site and provide erosion controls and planting pockets.

Topsoil Placement

The topsoil should be cleared or placed and the seedbed should exhibit the following characteristics:

- firm but not compacted below the seeding depth
- well-pulverized, friable soil on top
- free of clods and puddles
- free of existing plants
- free of weed and competitive vegetation species seeds

Soil Amendments

Soil amendments are chemical treatments that promote plant growth. Soil tests conducted during the planning and design phase of the revegetation project will provide information on any necessary soil amendments. According to Mangrove et al. (2005), acceptable ranges of primary soil problems that can inhibit revegetation success include the following:

- salinity - <8 electrical conductivity (millimeters hos/centimeters).
- organic matter - >2 percent
- pH - 5.5 to 8.5
- soil adsorption ratio - <10

If the revegetation area soils are outside the above parameters, consult a soils professional on the use of soil amendments.

Erosion Control

Long- and short-term erosion controls included in the revegetation plan should be constructed during initial seedbed preparation. This allows for efficient use of resources and reduces soil erosion off site. Whenever possible, silt fencing should be installed before site disturbance occurs. If prior installation is impossible, install fencing immediately after soil disturbance.

5.3.1.3 Construction Step 3: Seeding Guidelines

The seeding process, which consists of several steps, is perhaps the single most important component of each revegetation project. The variety of seed sizes used in revegetation makes dispersing seeds and achieving proper planting depths with mechanical equipment a challenge. In general, broadcast seeding, followed by raking, is the best seeding method because seeds are randomly sowed but purposefully planted.

Seeding Rates

Seeding rates are based upon an average seed density of 100 seeds per square foot. Percentages for all seeds within the seed mix are based upon desired seeds per square foot and individual seed weight.

- Individual seed mixes and rates for each vegetation cover type are included in section 5.4 and should be used in natural area revegetation projects.

Seeding Timing

Seeding of revegetation areas should be conducted when temperatures are cool (but above freezing) and precipitation is high. In the County these conditions occur more consistently during the fall months (mid September to mid November). Fall seeding allows utilization of soil moisture during the winter and spring, and provides for greater success than seeding during the spring months.

- Schedule revegetation projects and construction so that seeding can occur quickly after the seedbed preparation is completed and during the optimal fall seeding season.

Seeding Methods

Broadcast seeding should be used to more effectively distribute the small, irregularly shaped native seeds throughout the disturbed areas in a random pattern.

- Broadcast seed with a seed container placed over a spinner plate or propeller device. As this device spins, it throws seeds in all directions. Broadcast seed spreaders are available for carrying or hand spreading and as larger devices that attach to ATVs and other vehicles.
- Calibrate the spreader to distribute the correct number of seeds per square foot or pounds of seed per acre. Spread the seed evenly over the entire revegetation area.
- Do not broadcast seeds during windy weather.
- Lightly rake the seeds into the soil following broadcasting. Raking the seeds ensures proper seed-to-soil contact that enhances germination and reduces predation by birds.

5.3.1.4 Construction Step 4: Planting Guidelines

The use of containerized plantings can enhance a revegetation area and accelerate the overall revegetation process. However, using containerized plantings can substantially increase the cost of revegetation, which limits their use to smaller sites. Containerized plants and tubelings should be planted before seeding revegetation areas. Placing small clusters of shrubs and trees in a natural, random pattern on revegetation sites provides a more natural appearance and greater opportunities for wildlife.

Containerized Planting

Containerized plants are expensive, but they are more easily established on harsh sites than bareroot plants.

- Do not remove the plant from the container until it is to be planted.
- Place the plant in the hole and firm the soil around the plant and root mass, but do not compact the soil.

Details illustrating proper planting techniques are included in Figure 5.10 (see Appendix C for detailed information from the NARM).

Pole and Sprig Planting

Pole and sprig plantings are used in streambank stabilization and in other wet revegetation areas. If there is an on-site source of poles and sprigs, this is a very effective way to revegetate woody material in wet areas.

- Cut cottonwood saplings during dormancy (fall, winter, or early spring prior to mid April) for pole plants.
- Trim all stems off of the pole and place it in water to soak for several days.
- Place poles into augured holes on site at least 6 inches below the water table. Backfill the holes with native material.
- Cut willows, dogwoods, and other hydrophytic shrubs for sprig planting using the process outlined for poles.

Planting Patterns and Spacing

Plant placement should mimic natural conditions to enhance aesthetic appeal and wildlife habitat. Place plants in random patterns based on observations of the corresponding vegetation cover type(s) (see Appendix C for NARM details) .

- Plant groups or clumps of one or more species together.
- Randomly place these groups of plants throughout the site.

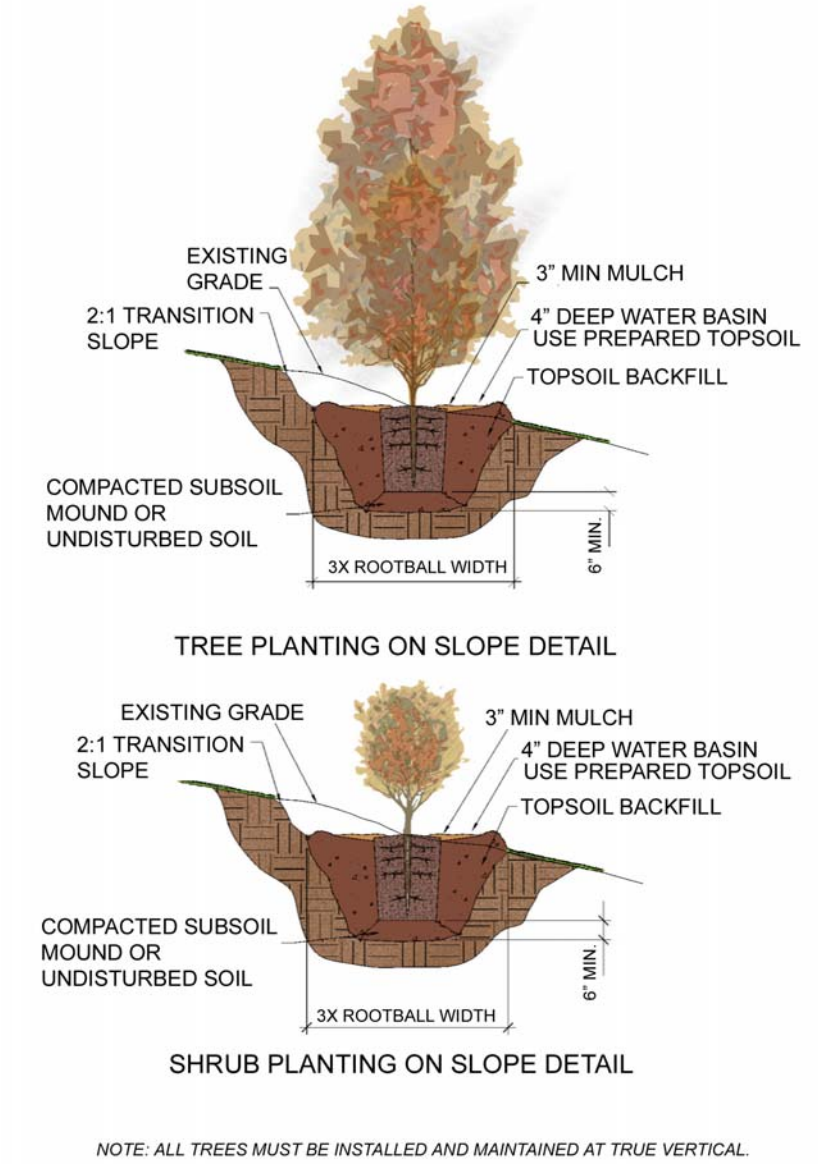


Figure 5.11. Tree and shrub planting guidelines.

Supplemental Irrigation

Supplemental watering for transplants and containerized planting stock may be required during the first growing season in order to ensure plant survival. This can be accomplished by using a truck-mounted watering tank or backpack sprayers during particularly hot, dry periods during the growing season.

- Give each plant approximately 2 gallons of water if soil is not moist at the time of initial planting.
- Give plants supplemental water during the first growing season and up to 3 years following planting, depending on conditions.

5.3.1.5 Construction Step 5: Short- and Long-Term Monitoring and Maintenance

The purpose of a revegetation monitoring and maintenance program is to identify problems during and after construction and develop recommendations for improving revegetation success. Monitoring revegetation projects will provide valuable information on successes and failures that is applicable to future projects.

Construction Monitoring

A revegetation specialist should be appointed to monitor revegetation construction projects. This person will monitor construction activities to ensure that contract documents and/or revegetation plans are followed.

- Conduct an predisturbance site visit to flag on-site salvage materials and important vegetation resources that are to be left in place.
- Verify that disturbance limit fencing is in place.
- Document the site from designated photo points to illustrate the revegetation process and progress.
- Monitor on-going construction activities on a regular basis (daily or weekly) and as necessary.

Post-Construction Monitoring

Post construction monitoring during the "establishment period" should occur for 3 years on a seasonal basis in spring, summer, and fall.

- Inspect revegetation areas for seeding success, vegetation stress, and vegetation mortality during the first year.
- Identify areas of soil erosion (cut and fill slopes, gulllying, rilling) and implement any necessary erosion controls.

- Use the following objectives to determine revegetation success:
  - √ **Year 1**: 50 percent total coverage (includes vegetation, organic debris, and rock)
  - √ **Year 2**: 75 percent total coverage
  - √ **Year 3**: 90 percent total coverage

- Use the post-construction monitoring form included in Appendix A to conduct monitoring.

Maintenance

Area-specific maintenance activities should be performed during the post-construction monitoring period as determined through revegetation monitoring. Possible maintenance activities include:

- watering plants
- implementing erosion controls
- reseeding bare areas
- controlling noxious and invasive weeds
- replanting containerized plants

5.4 Specific Vegetation Cover Type Seeding Guidelines and Seed Mixes

Each vegetation cover type has different requirements for revegetation planting and seeding. Each of the following vegetative cover types seed mixes and guidelines are described in detail:

- sagebrush shrublands and sagebrush grasslands
- playas and greasewood flats
- alpine and subalpine
- pinyon-juniper woodlands
- bigtooth maple-Gamble oak woodlands
- emergent marshes
- riparian woodlands and riparian shrublands

5.4.1 Sagebrush Shrublands and Grasslands

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Seed or plant in the fall, preferably after mid-September.
- Use broadcast seeding, hand raking, compaction, and mulching to establish seeds successfully.
- Irrigate in early summer, if necessary, to aid seed establishment (this may also establish non-native species).
- Monitor revegetation success and weed control.

Sagebrush Shrubland or Grassland Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Bottlebrush squirreltail (*Elymus elymoides*)	2	0.5	3
Western wheatgrass (*Pascopyrum smithii*)	6	0.5	9
Bluebunch wheatgrass (*Pseudoroegneria spicata*)	2	0.5	3
Forbs			
Northern sweetvetch (*Hedysarum boreale*)	1.75	0.25	2.5
Blue flax (*Linum lewisii*)	1.75	0.25	2.5
Wasatch penstemon (*Penstemon cyananthus*)	2	0.25	3
Scarlet globemallow (*Sphaeralcea coccinea*)	1.75	0.5	2.5
Shrubs			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	2.5	0.25	3.75
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	2.5	0.5	3.75
Total lbs/acre	22.25		33
Containerized/Bareroot Plantings			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*) Rubber rabbitbrush (*Chrysothamnus nauseosus*)	*See Nature Area Revegetation Manual* for plant placement guidelines.		

5.4.2 Playa or Greasewood Flat

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Seed or plant in the fall or early spring to ensure adequate moisture availability.
- Monitor revegetation success and weed control.

Playa or Greasewood Flat Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Saltgrass (*Distichlis spicata*)	3.5	0.25	5.25
Alkaligrass (*Puccinellia distans*)	1.5	0.5	2.25
Alkali sacaton (*Sporabolus airoides*)	1	0.25	1.5
Forbs			
Pacific aster (*Aster chilensis*)	0.5	0.25	0.75
Marsh Indian paintbrush (*Castilleja exilis*)	0.5	0.25	0.75
Strawberry clover (*Trifolium fragiferum*)	3.5	0.25	5.25
Shrubs			
Gardner saltbush (*Atriplex gardneri*)	2	0.25	3
Black greasewood (*Sarcobatus vermiculatus*)	1	0.5	1.5
Total lbs/acre	**13.5**		**20.25**
Containerized/Bareroot Plantings			
Gardner saltbush (*Atriplex gardneri*) Black greasewood (*Sarcobatus vermiculatus*)	*See Nature Area Revegetation Manual* for plant placement guidelines.		

5.4.3 Alpine or Subalpine

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Plant or seed in the early fall for best establishment.
- Revegetate small areas by broadcast seeding and hand raking. Use hydroseeding on steeper slopes.
- Use drill-type equipment for larger revegetation areas.
- Periodically water containerized trees and shrubs during the establishment period if they were planted in higher elevations.
- Monitor revegetation success and weed control.

Alpine or Subalpine Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Mountain brome (*Bromus marginatus*)	4	0.5	6
Blue wildrye (*Elymus glaucus*)	4	0.5	6
Sandberg bluegrass (*Poa secunda*)	1.5	0.5	2.25
Forbs			
Yellow columbine (*Aquilegia flavescens*)	1.5	0.5	2.25
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	3.5	0.5	5.25
Silky lupine (*Lupinus sericeus*)	8	0.5	12
Total lbs/acre	22.5		33.75
Containerized/Bareroot Plantings			
White fir (*Abies concolor*) Douglas-fir (*Pseudotsuga menziesii*)	*See Nature Area Revegetation Manual* for plant placement guidelines.		

5.4.4 Pinyon-Juniper Woodlands

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Plant or seed in the fall, preferably after mid September, for most successful establishment.
- Use broadcast seeding, hand raking, compaction, and mulching to promote seed establishment.
- Irrigate in early summer, if needed, to aide in seedling establishment (this may also encourage the growth of non-native species).
- Monitor revegetation success and weed control.

Pinyon-Juniper Woodland Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Indian ricegrass (*Achnatherum hymenoides*)	2.5	0.5	3.75
Squirrel tail (*Sitanion hystrix*)	4	0.5	6
Needle and thread grass (*Hesperostipa comata*)	3.5	0.5	5.25
James Galleta grass (*Hilaria jamesii*)	1	0.5	2
Forbs			
Gooseberry-leaf globemallow (*Sphaeralcea grossulariifolia*)	1	0.5	1.5
Wasatch penstemon (*Penstemon cyananthus*)	1	0.25	2
Silverleaf lupine (*Lupinus argenteus*)	10.5	0.5	15.75
Shrubs			
Big sagebrush (*Artemesia tridentata*)	2.5	0.25	3.75
Rubber rabbitbrush (*Chysothamnus nauseosus*)	2.5	0.5	3.75
Total lbs/acre	**28.5**		**43.75**
Containerized/Bareroot Plantings			
Big sagebrush (*Artemesia tridentata*) Rubber rabbitbrush (*Chysothamnus nauseosus*)	*See Nature Area Revegetation Manual* for plant placement guidelines.		

5.4.5 Big Tooth Maple-Gambel Oak Woodlands

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Seed or plant in the fall, preferably after mid September, for most successful establishment.
- Use broadcast seeding, hand raking, compaction, and mulching to establish seeds successfully.
- Irrigate in early summer, if necessary, to aide seed establishment (this may also establish non-native species).
- Monitor revegetation success and weed control.

Big Tooth Maple – Gambel Oak Woodland Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Bluebunch wheatgrass (*Pseudoroegneria spicata*)	3.5	0.5	5.25
Great Basin wildrye (*Leymus cinereus*)	2.5	0.5	3.75
Sheep fescue (*Festuca ovina*)	1.5	0.5	2
Forbs			
Arrowleaf balsamroot (*Balsamorhiza sagittata*)	3.5	0.5	5.25
Northern sweetvetch (*Hedysarum boreale*)	5	0.5	7.5
Blue flax (*Linum lewisii*)	1.5	1.0	2.25
Shrubs			
Wyoming big sagebrush (*Artemisia tridentata wyomingensis*)	3	0.25	4.5
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	2	0.5	3
Twistedleaf rabbitbrush (*Chryothamnus viscidiflorus*)	1	0.5	1.5
Utah serviceberry (*Amelanchier utahensis*)	1	0.5	1.5
Total lbs/acre	**24.5**		**36.5**
Containerized/Bareroot Plantings			
Gambel oak (*Quercus gambelii*)	See Nature Area Revegetation Manual for plant placement guidelines.		
Bigtooth maple (*Acer grandidentatum*)			

5.4.6 Emergent Marshes

Revegetation Guidance

- Follow general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Plant or seed in the fall, preferably after mid September, for most successful establishment.
- Use broadcast seeding, hand raking, compaction, and mulching to promote seed establishment.
- Do not irrigate this vegetation community type.
- Monitor revegetation success and weed control.

Emergent Marsh Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
American sloughgrass (*Beckmannia syzigachne*)	1.5	0.25	2.25
Redtop (*Agrostis gigantea*)	0.5	0.25	0.75
Graminoids			
Beaked sedge (*Carex rostrata*)	2.0	0.5	3.0
Alkali bulrush (*Scirpus maritime*)	2.0	0.5	3.0
Cattail (*Typha latifolia*)	0.5	0.25	0.75
Common threesquare bulrush (*Schoenoplectus pungens*)	1	0.25	1.5
Onley's threesquare bulrush (*Schoenoplectus americana*)	1	0.25	1.5
Forbs			
Missouri iris (*Iris missouriensis*)	1.0	0.5	1.5
Blue-eyed grass (*Sisyrinchium bellum*)	0.5	0.5	0.75
Total lbs/acre	**10.0**		**15.0**

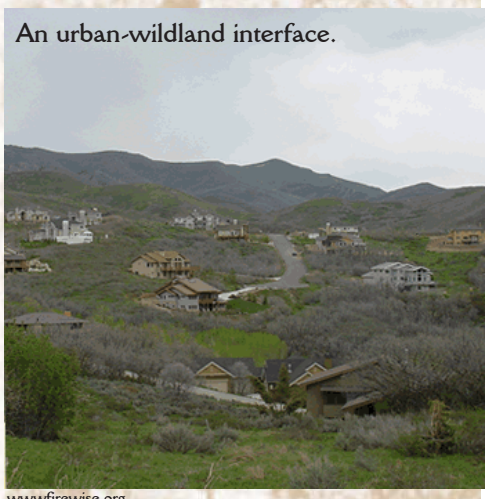
5.4.7 Riparian Woodlands and Shrublands

Revegetation Guidance

- Follow the general revegetation guidance in Section 5.3 that includes information on site preparation and seedbed preparation.
- Select appropriate seed mix and seeding rates (see table).
- Plant or seed in the fall, preferably after mid September, for most successful establishment.
- Use broadcast seeding, hand raking, compaction, and mulching to promote seed establishment.
- Periodically water transplanted and containerized plants.
- Monitor revegetation success and weed control.

Riparian Woodland and Shrubland Seed Mix			
Species	Drill Rate (PLS lbs/ac)	Drill Planting Depth	Broadcast Rate (PLS lbs/ac)
Grasses			
Canada wildrye (*Elymus canadensis*)	2	0.25	3.25
Mountain brome (*Bromus marginatus*)	4	0.5	6
Great Basin wildrye (*Elymus cinereus*)	2.5	0.25	3.75
Western wheatgrass (*Pascopyrum smithii*)	2	0.5	2.5
Forbs			
Western yarrow (*Achillea millefolium*)	0.5	0.5	0.75
Engelman aster (*Aster engelmannii*)	2.5	0.5	3.75
Golden banner (*Thermopsis montana*)	8.5	0.5	12.75
Shrubs			
Golden currant (*Ribes aureum*)	0.5	0.25	0.75
Nootka rose (*Rosa nutkana*)	0.5	0.5	0.75
Total lbs/acre	**21.0**		**31.75**
Containerized/Bareroot/Pole Plantings			
Golden currant (*Ribes aureum*)	*See Nature Area Revegetation Manual* for plant placement guidelines.		
Nootka rose (*Rosa nutkana*)			

6. NATURAL AREAS FIRE MANAGEMENT


An urban-wildland interface.

wwwfirewise.org

Wildfire management is an important component of managing and maintaining County natural areas. The natural areas are woven into the community fabric and are a part of what is called the "urban-wildland interface." The urban-wildland interface is where urban residential and commercial infrastructure is adjacent to and/or intermixed with wildlands or undeveloped areas. An example of this interface is residential homes bordering a County natural area. Wildfire is a natural process that is often necessary to maintain healthy ecosystems, but it also presents a significant hazard to residents in the urban-wildland interface. Natural area management strategies that include management and maintenance of vegetation in addition to public education and involvement will mitigate some of the area's wildfire hazards.

To begin the process of wildfire management it is necessary for the County to conduct a wildfire hazard assessment for each natural area. This will assess each natural area for wildfire potential along with adjacent residential risks. The Salt Lake County Natural Areas Fire Hazard Assessment Form (Appendix D) will guide the County through the fire hazard assessment process. The following items are necessary for conducting the assessment and are included in the Fire Hazard Assessment Form.

The natural area wildfire hazard assessment should include the following information:

1. **Coordinate with the Salt Lake County Unified Fire Authority, the U.S. Bureau of Land Management, and the U.S. Forest Service.**

   This wildfire hazard assessment should be coordinated with personnel in the Salt Lake County Unified Fire Authority, the U.S. Bureau of Land Management, and the Salt Lake Ranger District of the U.S. Forest Service. This will provide the natural area planners with professional assistance and guidance from wildfire professionals. Coordination will also foster communication of the wildfire risks and mitigation plans between all agencies involved.

2. **Identify fire-prone vegetation.**

   Three basic elements required for a fire to occur include (1) a heat source, (2) oxygen, and (3) fuel. Vegetation in

County natural areas (both live and dead) provides fuel for a wildfire and the hot, dry climate conditions create a fuel that is ready to burn. Historic fire suppression has allowed fuels to build up in specific vegetation cover types and has created an increased fuel load.

Fire prone vegetation factors included on the Fire Hazard Assessment Form include:

Forest Vegetation Density – Moderate to heavy density forest vegetation poses a greater wildfire risk. A high hazard crown fire is more likely to occur in a dense forest.

Surface Vegetation – Surface vegetation includes grasses, shrubs, and dead and down woody material. An abundance of shrubs and dead and down woody material on the landscape surface adds to wildfire risks.

Ladder Fuels – Ladder fuels are shrubs, immature trees, and branches that extend near the ground surface that give surface fires a pathway to the upper canopies of the trees.

Slope – Slope has a direct effect on fire behavior. The steeper the slope the faster the fire will spread uphill.

Position on Slope – The position of fire prone vegetation on a slope is an important factor in fire behavior. Long slopes of fire prone vegetation with properties at the top represent the highest risk. Some vegetation cover types are more susceptible to burning and becoming large wildfires. Typically, a fire traveling up a slope will move faster and have longer flames than a fire traveling on flat terrain.

Some vegetation cover types are more susceptible to burning and becoming large wildfires. The Bigtooth Maple and Gambel Oak Woodland vegetation cover type contains aging brushy and small vegetation and may contain a heavy fuel load. This load is from dead shrubs and trees which continue to accumulate in the absence of fire. Fire suppression is difficult in woodland areas and fire may burn intensely and severely (Uinta and Wasatch Cache National Forests Fire Management Plan 2001).

Cheatgrass, the invasive annual grass described in Section 5.1.3.9, contributes to wildfire hazards by decreasing the fire frequency in areas that are infested. It grows in early spring and is completely dried out and ready to burn early in the season. Cheatgrass may burn year after year and eventually out-compete all native vegetation in an area.

3. Identify fuel breaks.

Fuel breaks are natural or constructed landscape features that may help to contain a wildfire when it does occur. These include roads, trails, rivers, streams, rock outcrops, and fuel breaks constructed by removing vegetation.

4. Locate adjacent residential/commercial structures and private property.

All housing and commercial development within 600 feet of a natural area border will be identified as within the urban-wildland interface and therefore at risk of wildfire. Housing directly adjacent to areas with fire prone vegetation should be identified as "high wildfire risk" properties. These property owners will be notified of the potential for wildfire and landscape mitigation strategies.

5. Identify emergency access locations.

In the event of a wildfire occurring in a natural area, emergency access and egress to the wildfire area and adjacent residential properties is critical. Identify all natural area access points. Survey the adjacent residential areas for additional access/egress areas. A natural area with high risk for wildfire and adjacent residential properties must have access to the area for fighting any wildfires.

6. Identify water sources.

Wildfires are combated using water to douse flames and wet dry areas and structures to contain the fire. A water source for fire fighting should be accessible within or adjacent to all natural areas. The source may be a stream, pond, fire hydrant, or water tank.

7. Determine mitigation strategies.

Mitigation of wildfire hazards may include fuels reduction, fire suppression guidelines, and homeowner education.

6.1 Mitigation Strategies

Upon completion of the wildfire hazard assessment, the County can work to implement mitigation measures. Mitigation measures are programs and/or practices put into place to reduce wildfire hazards and risks to adjacent properties. There are many mitigation strategies, some of which include fuels reduction, fire suppression guidelines, and homeowner education, that area described below.

6.1.1 Fuels Modification

Specific areas within the County natural areas may exhibit extremely high wildfire potential with the potential to severely impact adjacent residences. It may be decided to plan and conduct a fuels modification project in these areas. This could consist of thinning trees and shrubs, removing dead fuels, and/or prescribed burning. A professional fire specialist should be contacted to help in planning and conducting any fuels modification project within County natural areas.

6.1.2 Fire Response and Evacuation Guidelines

Fire suppression activities and residential response will be most effective if a response and evacuation plan for each natural area is developed. Communicating and coordinating this information to the appropriate agencies will assist fire fighters in their efforts. Adjacent residents should also be educated in evacuation routes and what to do if a wildfire does occur.

6.1.3 Homeowner Education

The County can partner with adjacent home owners to coordinate an education plan. Home owners should be educated in the concept of “defensible space” which is the modification of vegetation around a home to reduce the chance that a wildfire will encroach onto private property and potentially destroy the home (see Figure 6.1). Defensible space distances depend upon the type of adjacent vegetation and slope steepness. It can vary from 30’ on relatively flat grass areas to 200’ in tree areas on steep slopes (utahfireinfo.gov). The details on homeowner

education and how to create a defensible space are contained in the web site www.utahfireinfo.gov.

A useful brochure, published by firewise.org, that educates home owners on "defensible space" is included in Appendix D. In addition, Appendix E contains *Firewise Plants for Utah Landscapes*. This brochure can be used by home owners interested in reducing their wildfire risk.

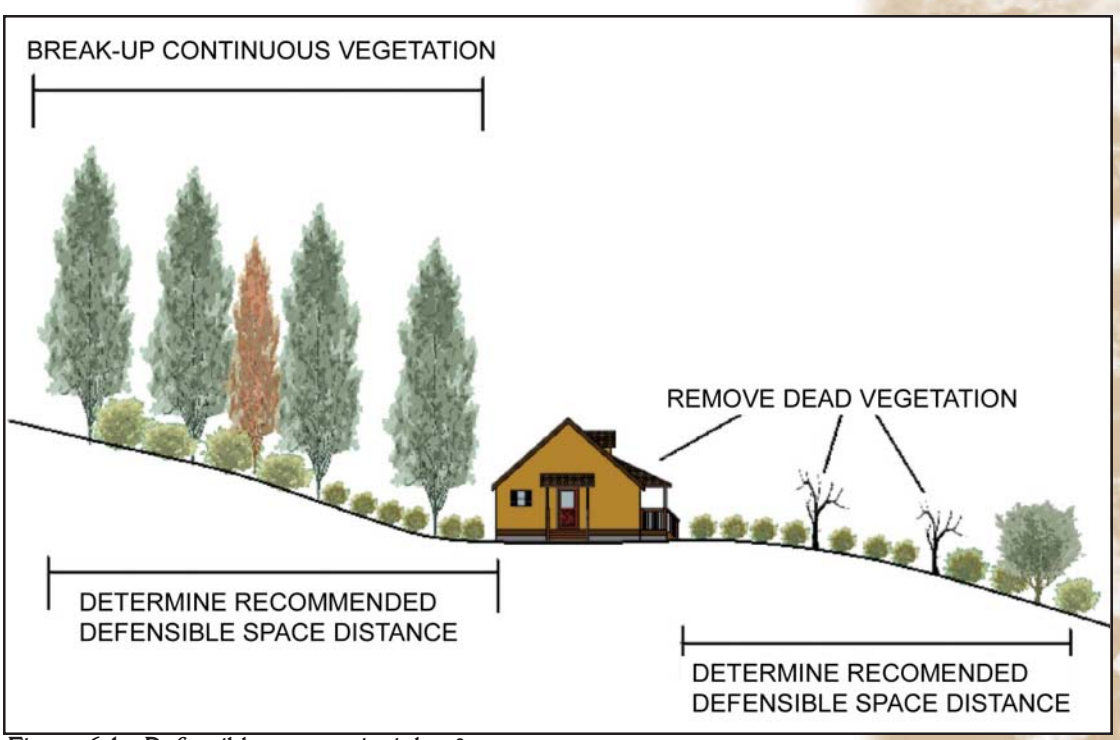


Figure 6.1. Defensible space principles. [a]

[a] See utahfireinfo.gov for defensible space recommendations.

APPENDIX A: FORMS

Salt Lake County Natural Areas Annual Monitoring Form

Site Name		
Site Location		
Site Purpose		
Inspector Name		**Date:**
Aerial Photo Used	yes / no	

ISSUES	**Description (location, scale, severity)**	**Action Taken / Recommendation**
User Created Trails		
BMX Tracks		
ATV Trespass		
Vehicular Access		
Fire Rings		
Homeless Use		
Fire Hazards		
Garbage		

Weeds

Location
Species
Scale / Size (<1, 1-10, 10+ acres)
Photograph Numbers
Recommendations

Erosion

Location
Type/Description
Scale / Size
Photograph Numbers
Recommendations

Salt Lake County Natural Areas --- Annual Work Plan Form

Site Name:
General Site Objectives:
Developed by:
Date:

Location	Actions	Season	Estimated # of work days/year	Work performed by	Date completed

Salt Lake County Natural Areas Post-Restoration Monitoring Form

Site Name		
Site Location		
Inspector Name		**Date:**

Vegetation Vigor

Overall Observation		
% Cover Plant Material		
Species List with % Cover	Species	% Cover
Photograph Numbers		

Weeds (if applicable)

Location
Species
Scale/Size
Photograph Numbers

Erosion (if applicable)

Location
Type / Description
Scale
Photograph Numbers

Recommendations

Salt Lake County Natural Areas Fire Hazard Assessment

Site Name				
Site Location				
Site Purpose				
Inspector Name			**Date:**	
Aerial Photo Used	yes / no			
Coordination with Salt Lake County Unified Fire Authority and Salt Lake Ranger District (list contacts and efforts)				
Hazard Factor	**Characteristics and Point Ratings**			**Score**
Forest Vegetation Density	Non-Forested	Light Density	Moderate/Heavy Density	
SCORE	0	15	25	
Surface Vegetation	Lawn or non combustible material	Native and introduced grasses or shrubs	Dead and down woody material	
SCORE	0	5	Scattered = 5 Abundant = 15	
Ladder Fuels	Absent	Scattered	Continuous	
SCORE	0	5	10	
Slope	0 - 10%	10 - 25%	>25%	
SCORE	0	5	10	
Position on Slope	Valley bottom or lower slope	Mid-slope	Upper-slope	
SCORE	0	3	5	
			Total Score	
			Area Hazard Level	
Hazard Level Low <21 points Moderate 21-29 points High 30-35 points Extreme >35 points				
Fuel Break Locations (roads, rivers, rock outcrops, unvegetated areas, mark on aerial photo)				
Adjacent Properties at Risk (list addresses and mark on aerial photo)				
Identify Emergency Access Locations (list and mark on aerial photo)				
Outline potential mitigation strategies and other comments (fuels modification, homeowner education, emergency guidelines)				

APPENDIX B: NARM EROSION CONTROL INFORMATION

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 before 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

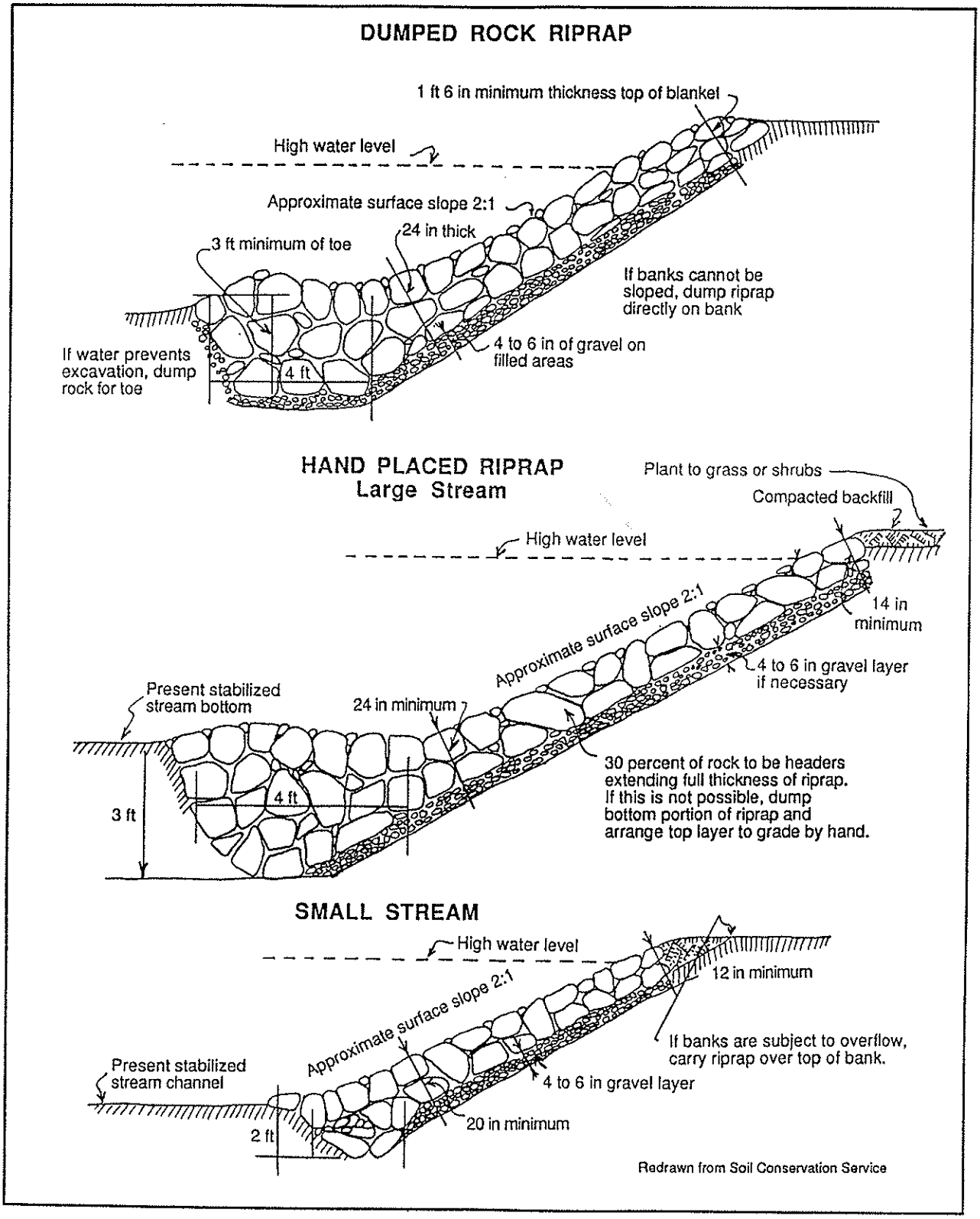


Exhibit 3-12. Design and Construction of Riprap Slope Protection.

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.

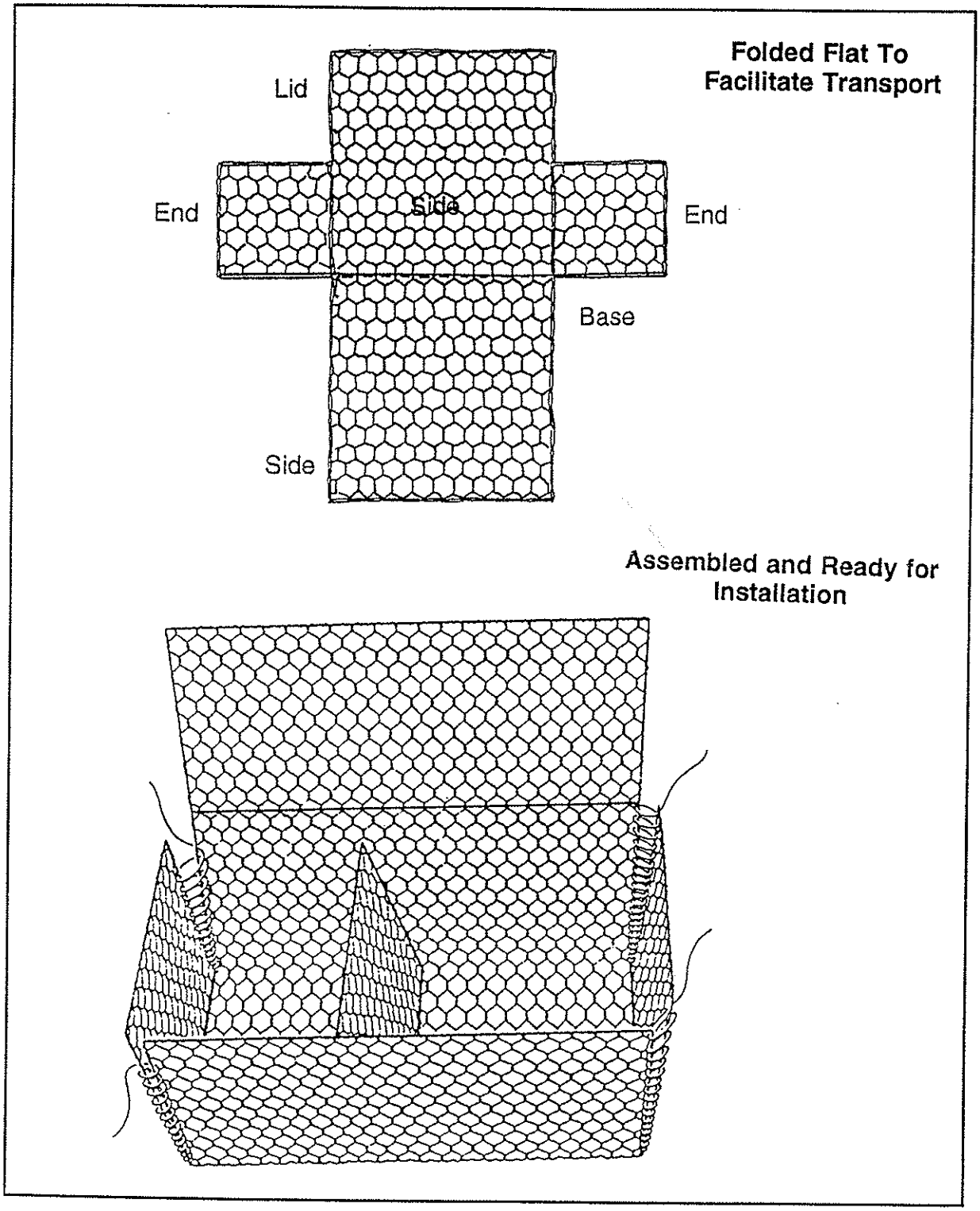
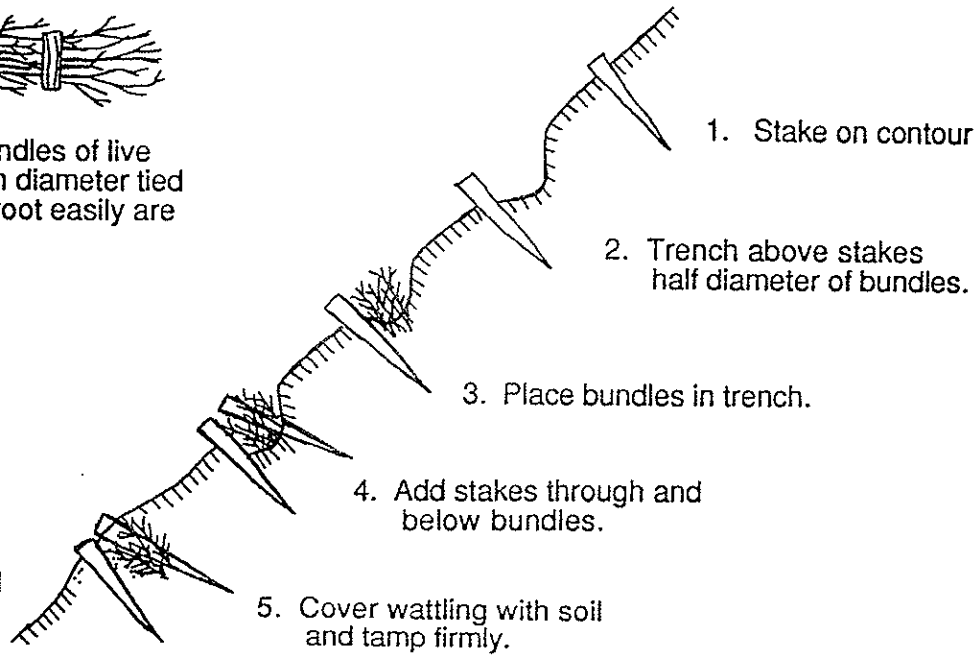


Exhibit 3-13. Design of Gabion.

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.

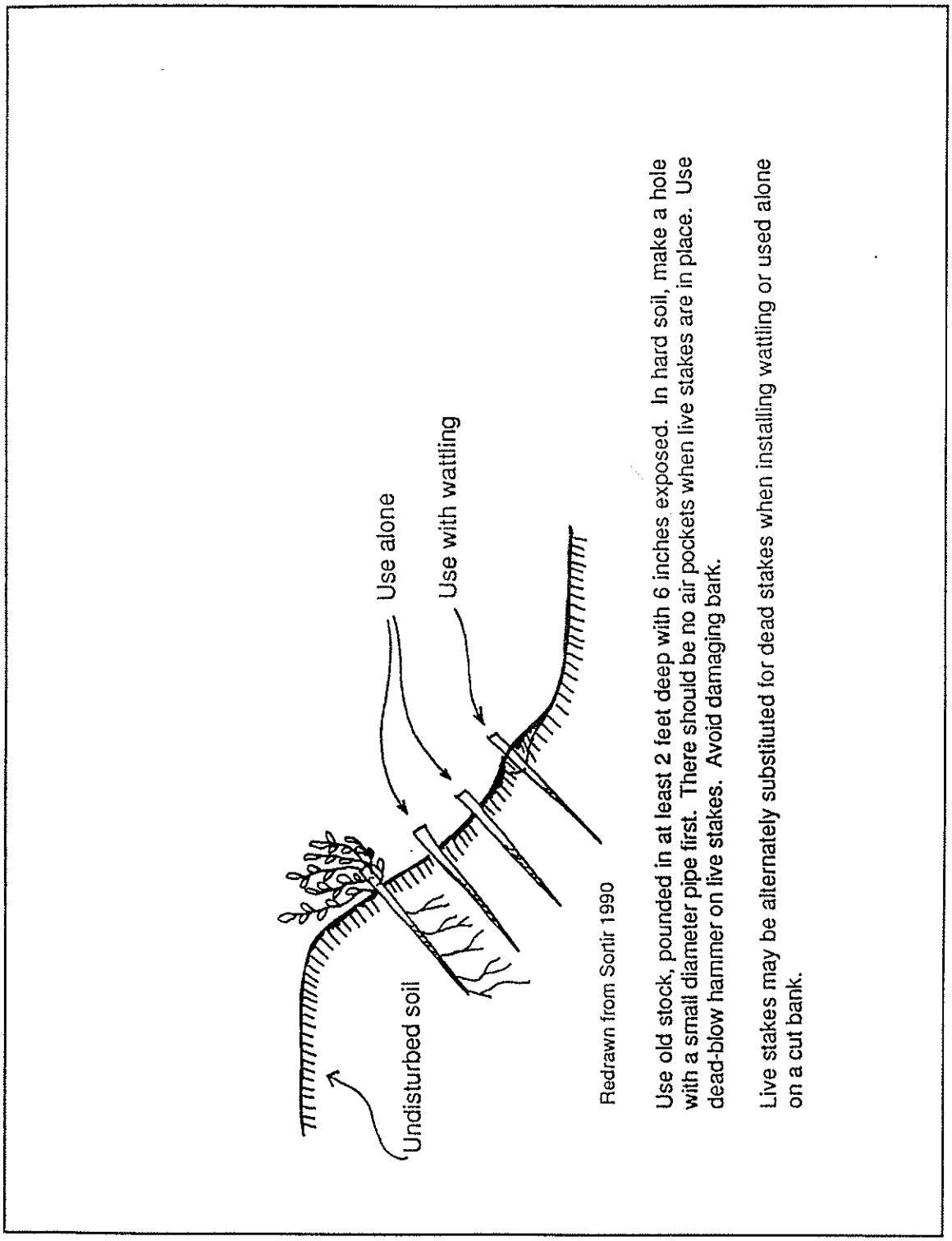


Note: work starts at bottom of cut or fill and proceeds from Step 1 through Step 5.

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.



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.

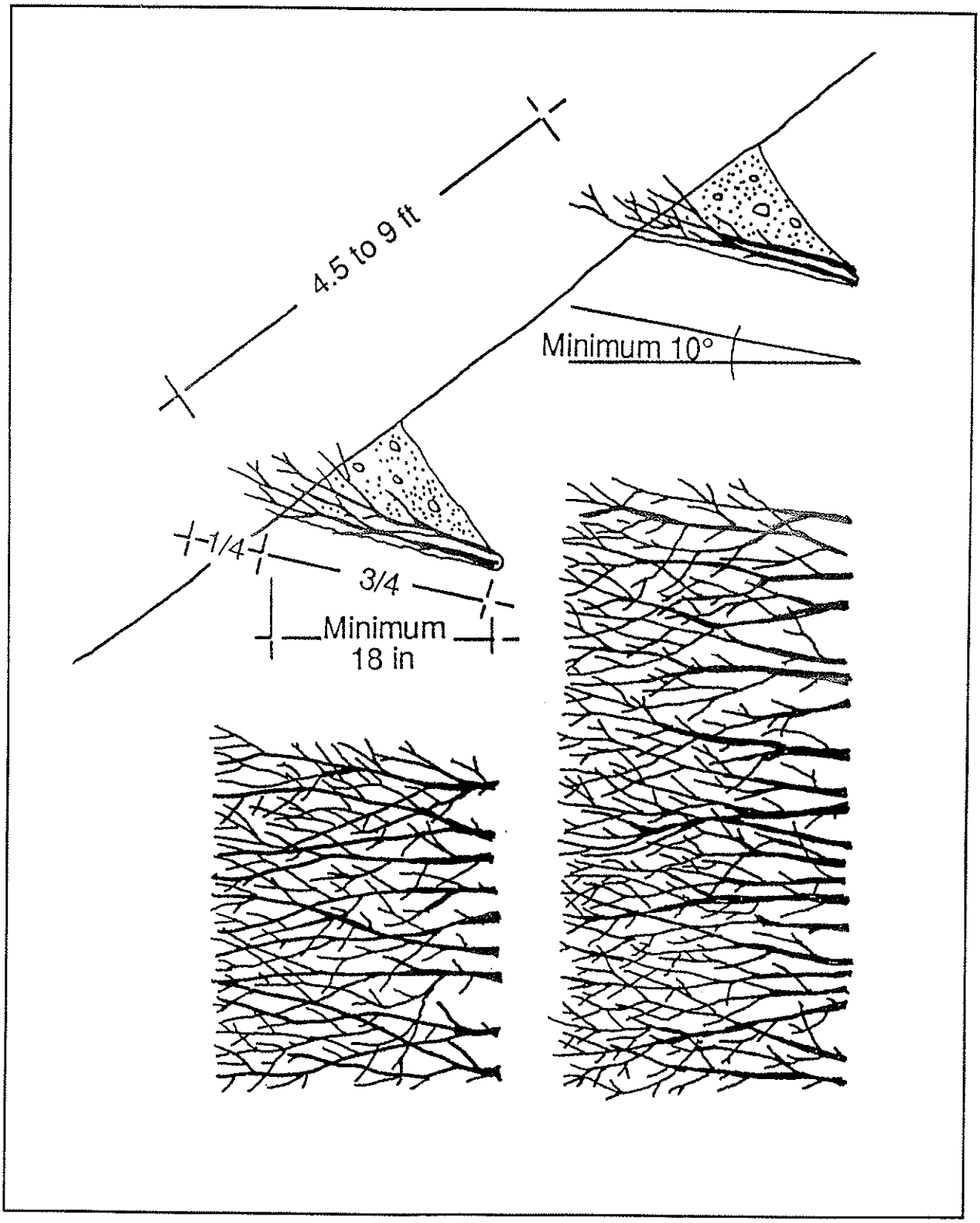


Exhibit 3-16. Design and Construction of Brush Layering for Slope Stabilization.

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

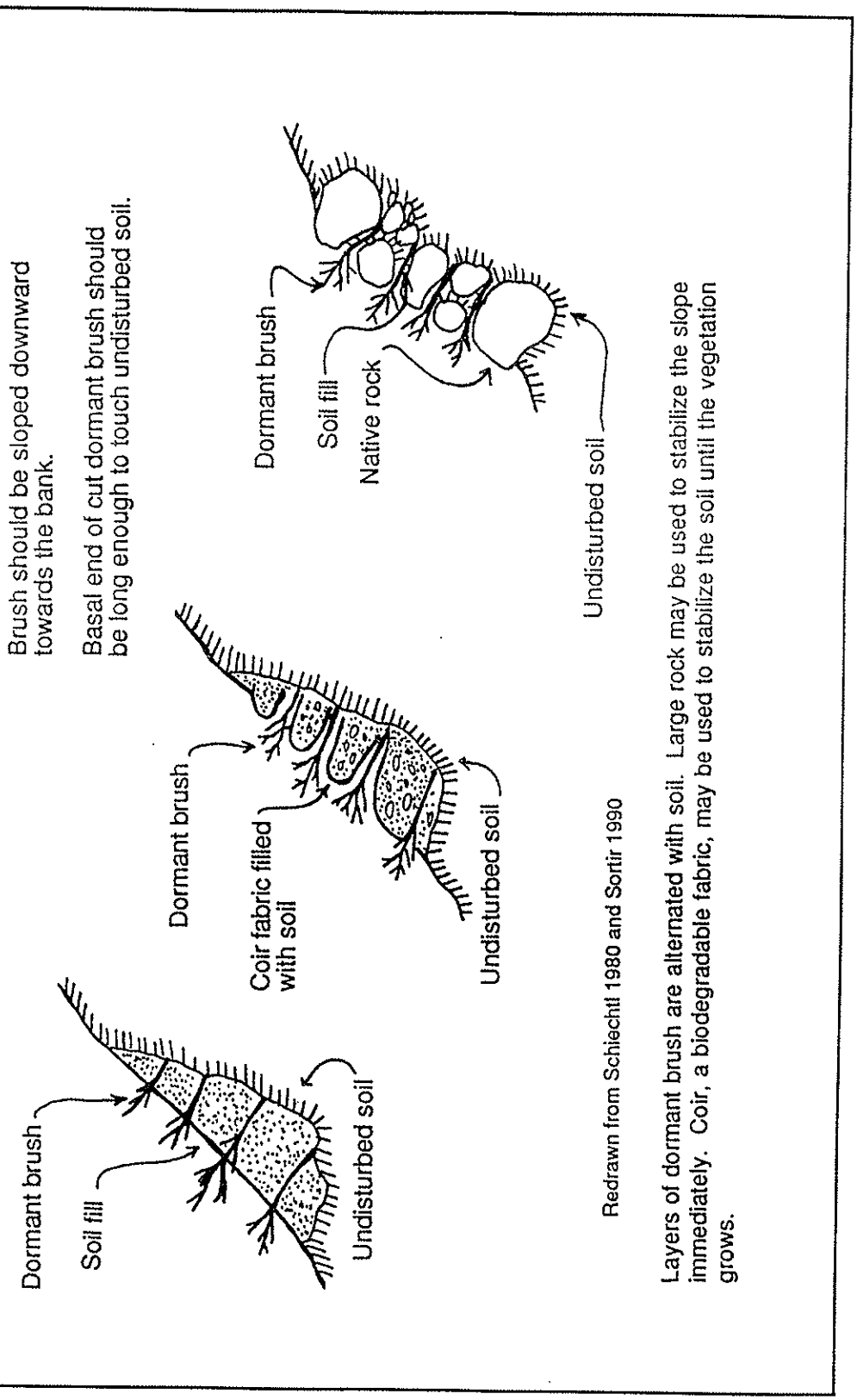


Exhibit 3-17. Brushlayering and Installation Techniques.

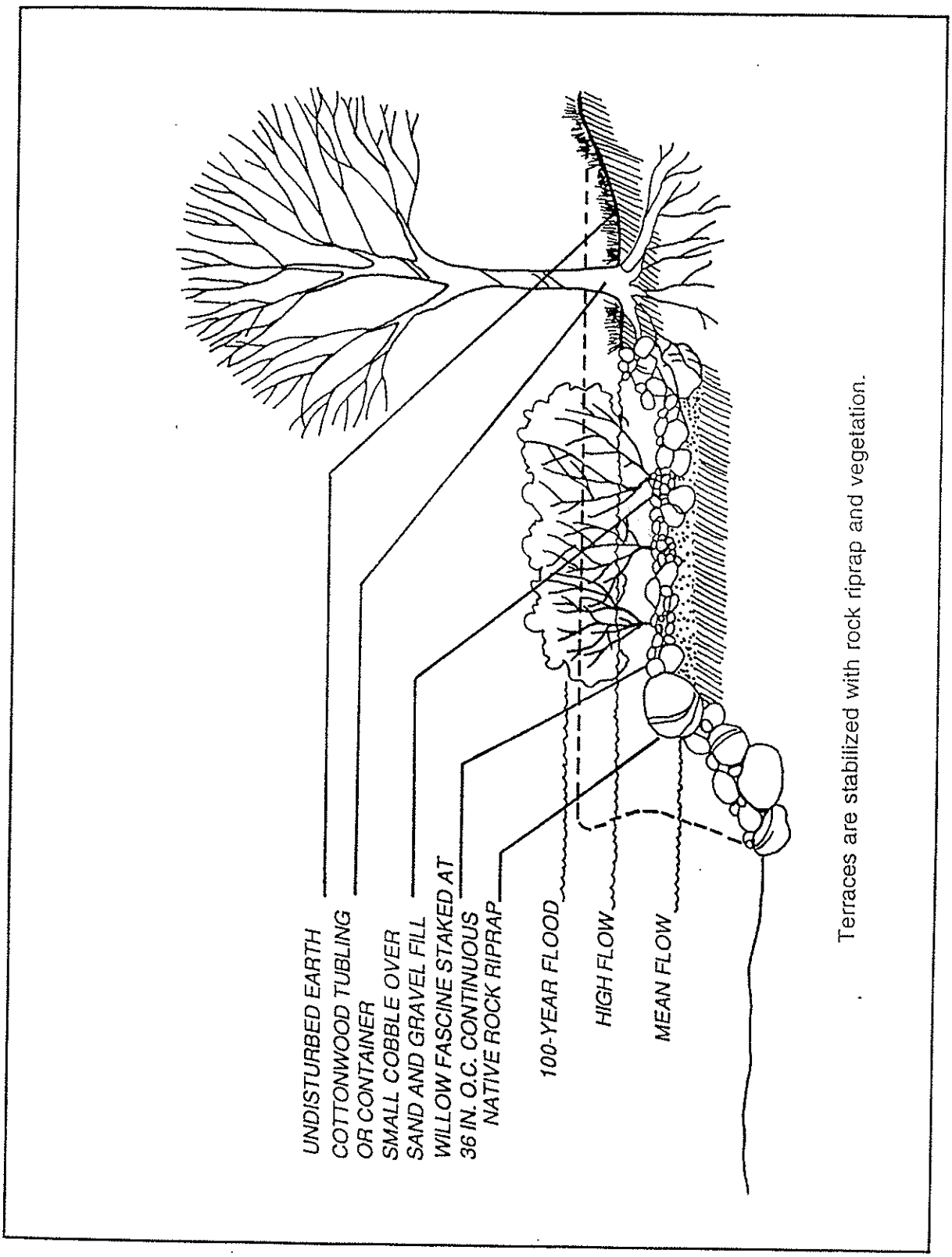
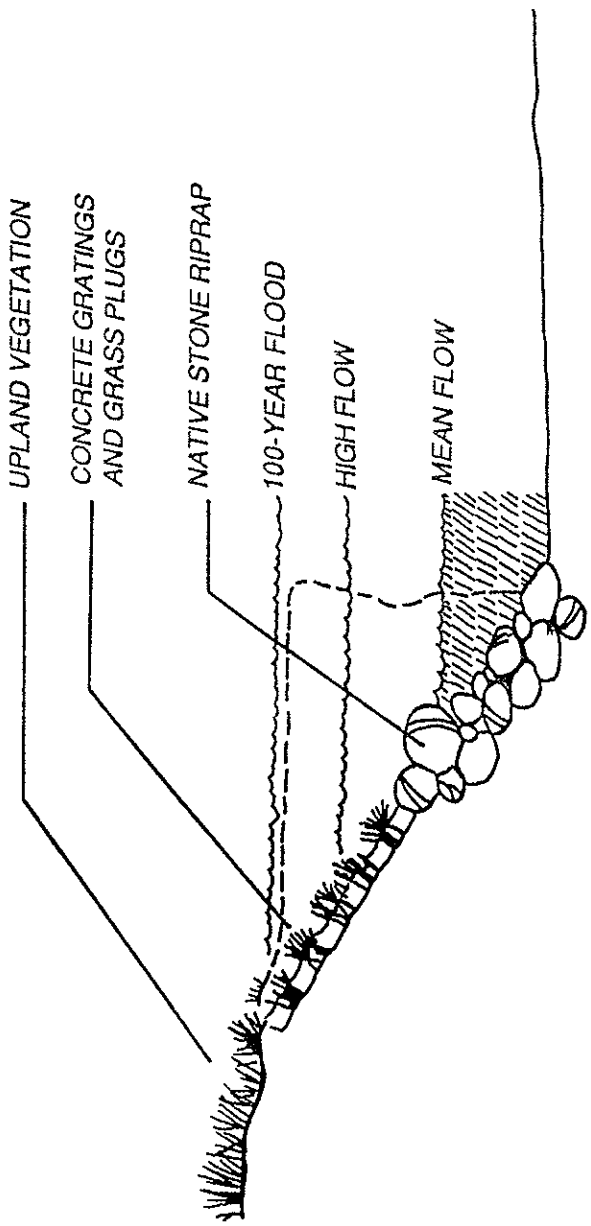


Exhibit 3-18. Riverbank Regraded and Stabllized at a 1:3 Slope.



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.

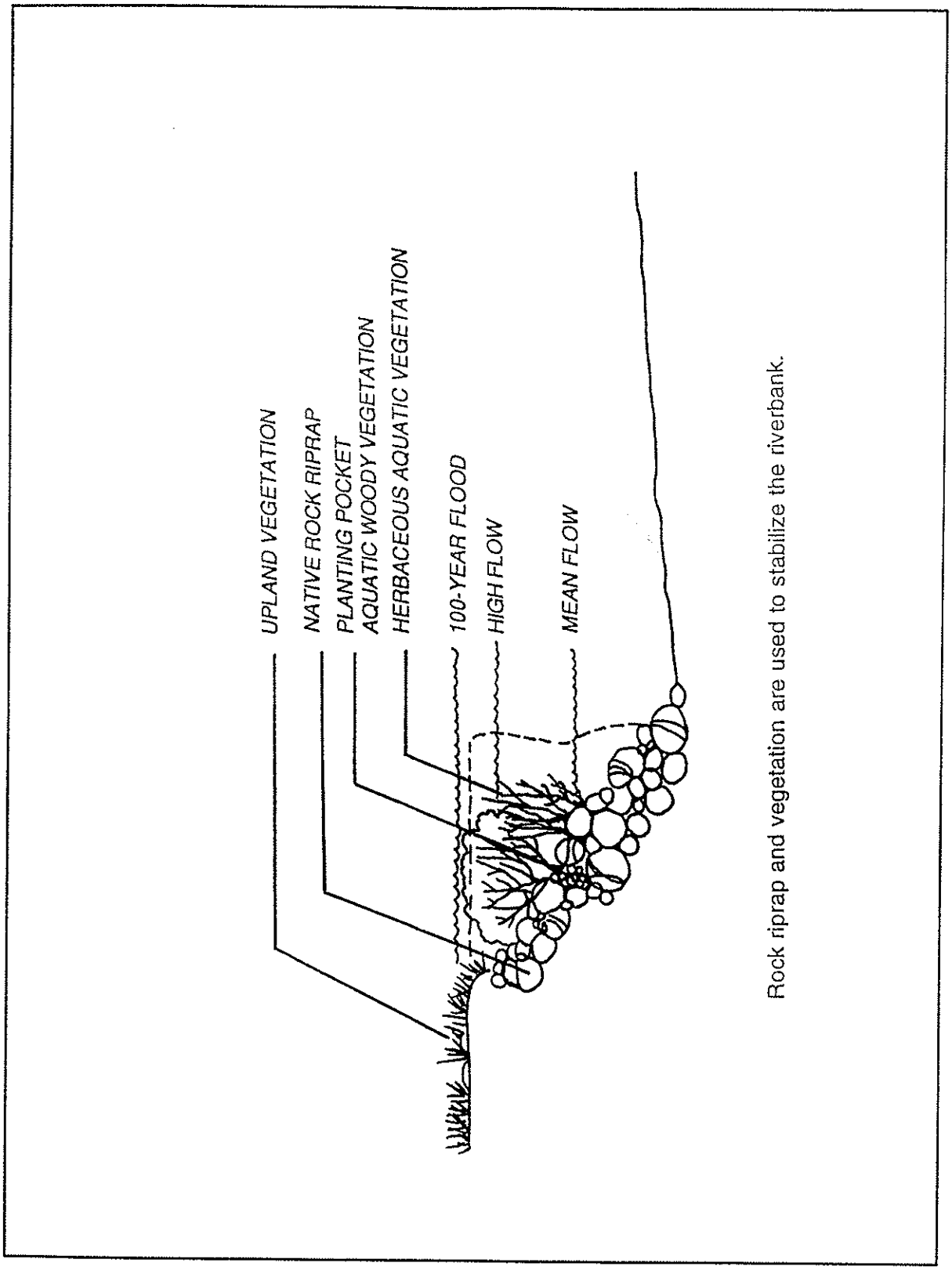
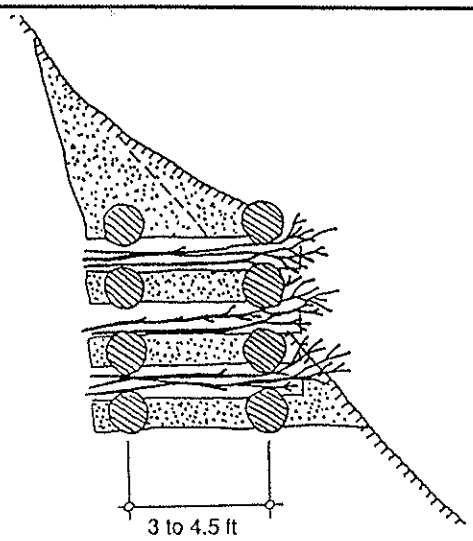
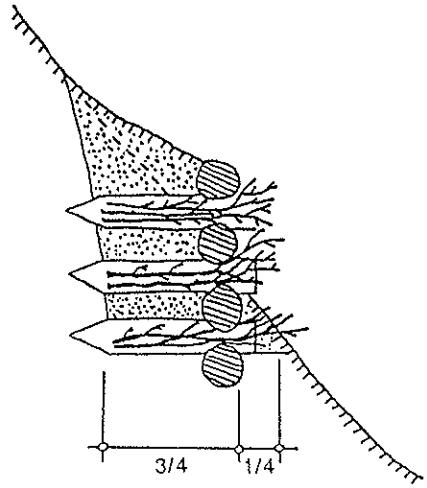


Exhibit 3-20. Riverbank Regraded and Stabilized at a 1:1 Slope.



Double-walled live wooden crib wall

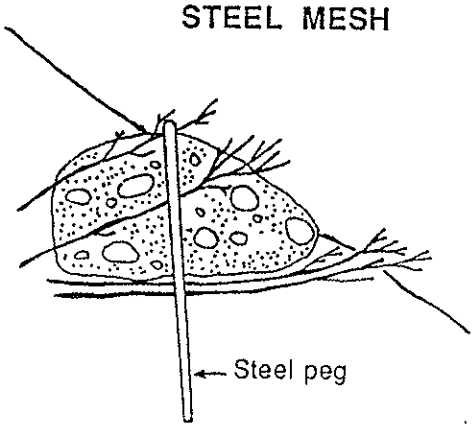


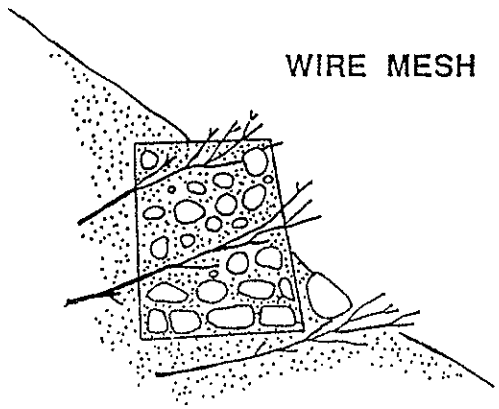
Single-walled live wooden crib wall

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.

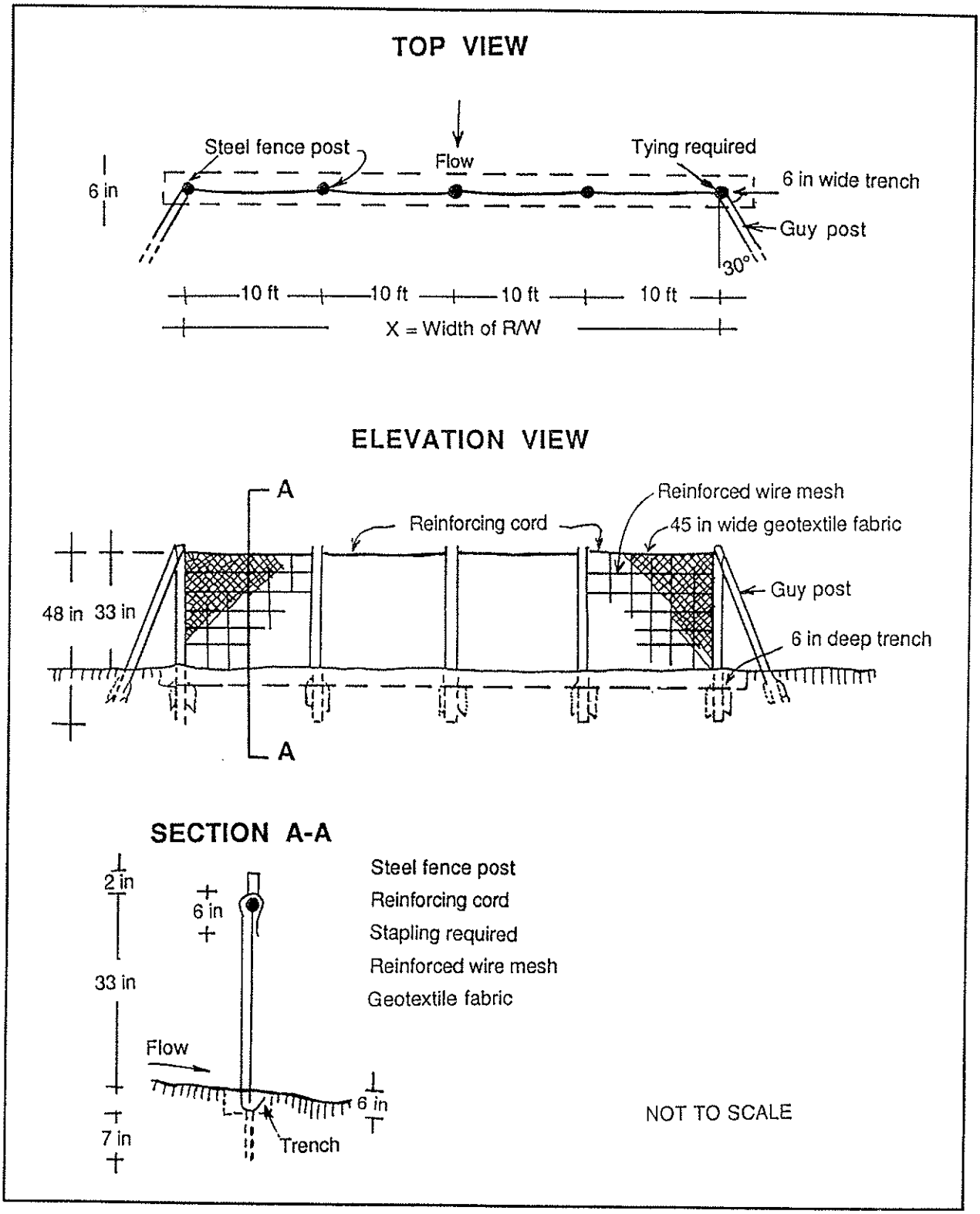
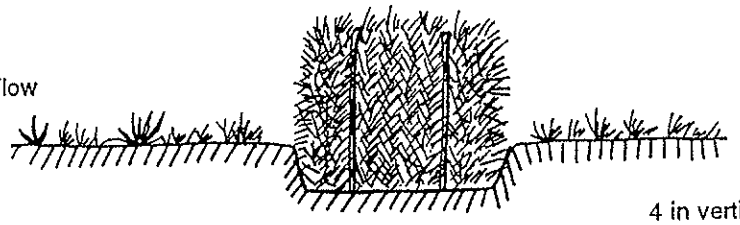
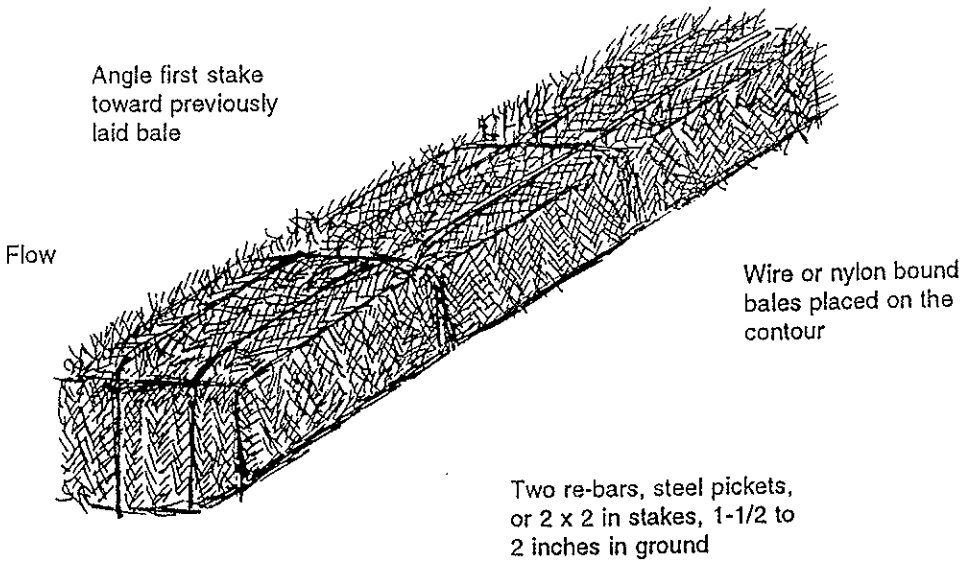


Exhibit 3-23. Example of Silt Fence Construction Using Geotextile Fabric.

STRAW BALE DIKE



EMBEDDING DETAIL



ANCHORING DETAIL

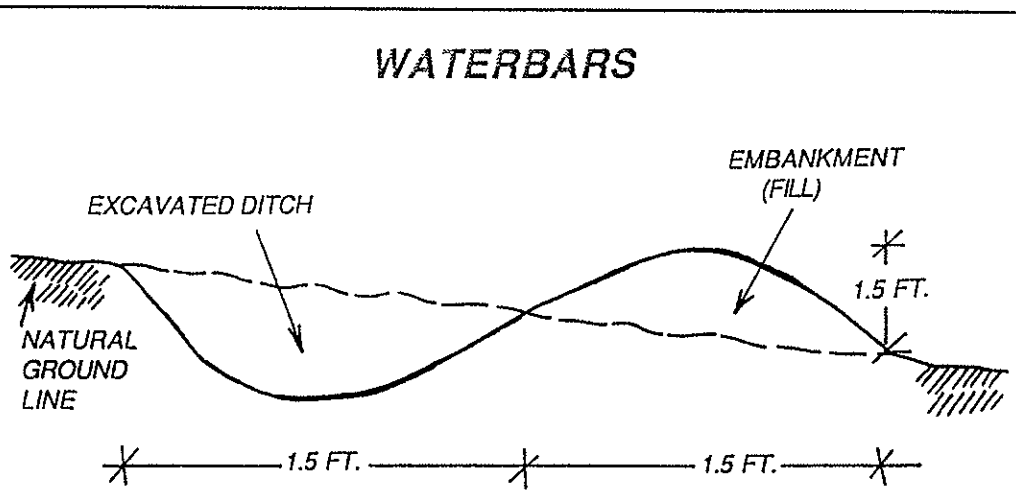
1. Bales shall be placed in a row with ends tightly abutting the adjacent bales.
2. Each bale shall be embedded in the soil a minimum of 4 inches.
3. Bales shall be securely anchored in place by stakes or re-bars driven through the bales. The first stake in each bale shall be angled toward previously 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



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.

APPENDIX C: NARM BANK STABILIZATION EXHIBITS

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

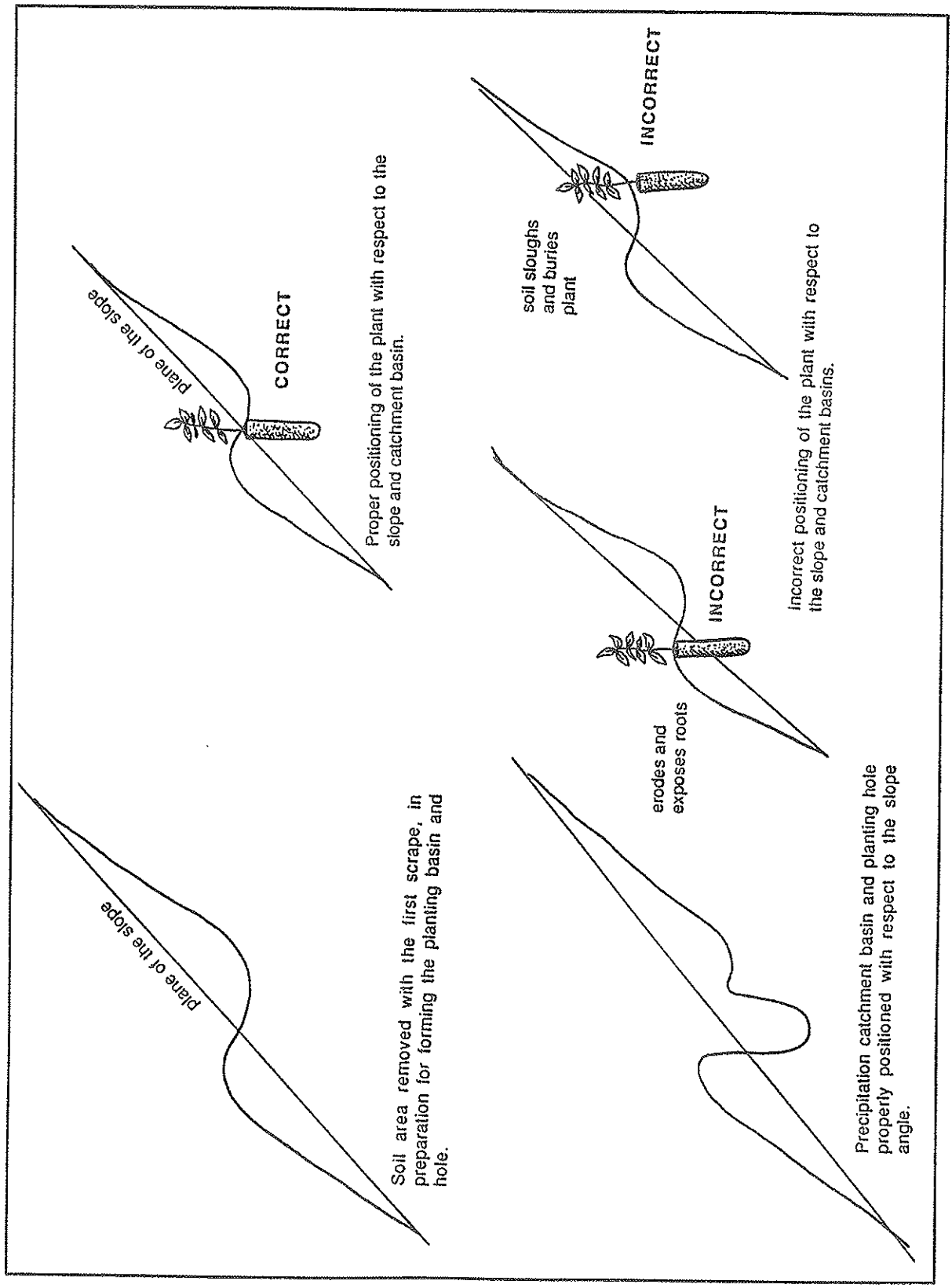
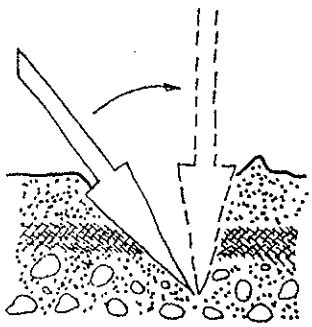
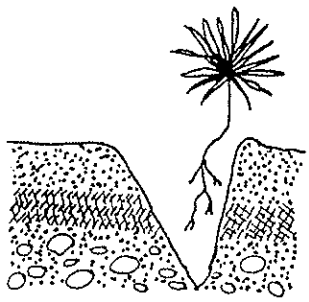


Exhibit 3-1. Correct and Incorrect Methods of Planting Stock On a Hillslope.

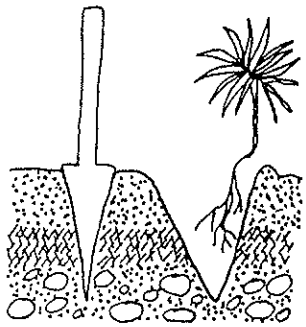
Planting with a Dibble



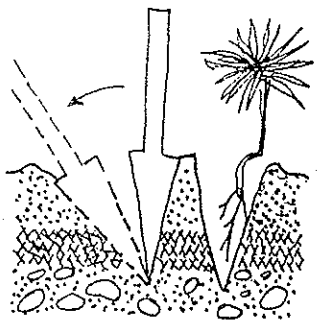
1. Insert dibble at angle shown and push toward to upright position.



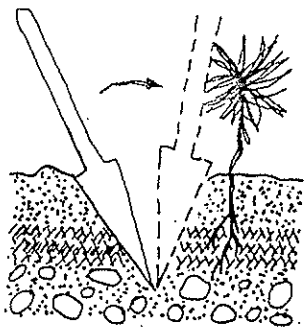
2. Remove dibble and place seedling at correct depth.



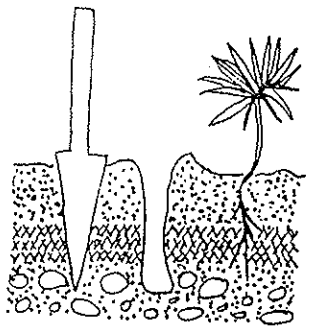
3. Insert dibble 2 in toward planter from seedling.



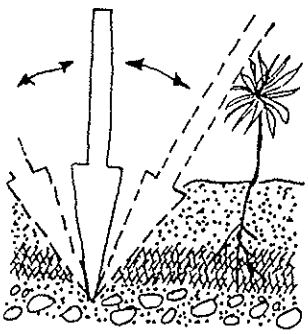
4. Pull handle of dibble toward planter firming soil at bottom of roots.



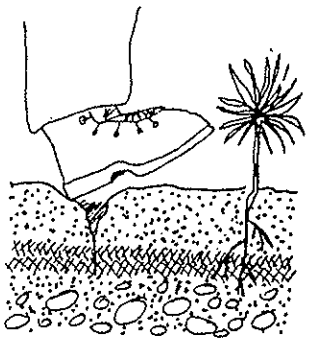
5. Push handle of dibble forward from planter firming soil at top of roots.



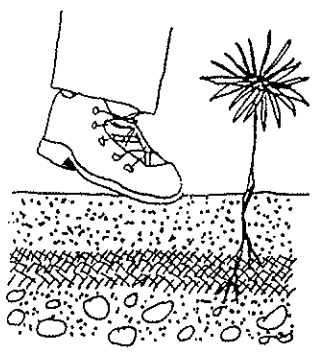
6. Insert dibble 2 in from last hole.



7. Push forward then pull backward filling hole.



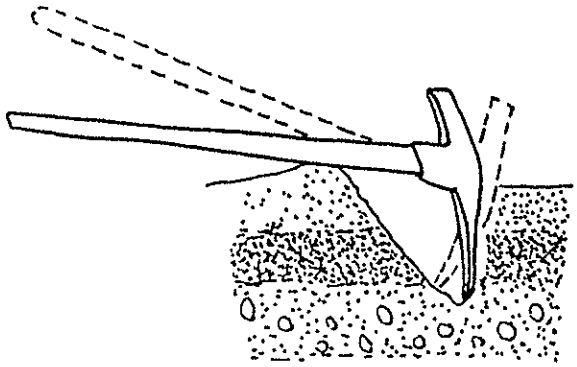
8. Fill in last hole by stamping with heel.



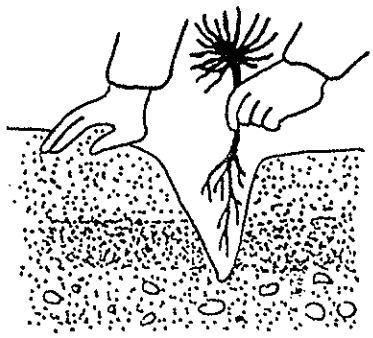
9. Firm soil around seedling with feet.

Exhibit 3-2. Planting Tree and Shrub Seedlings.

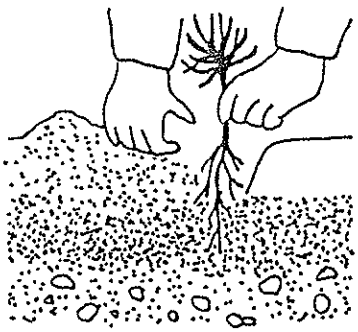
Planting with a Mattock



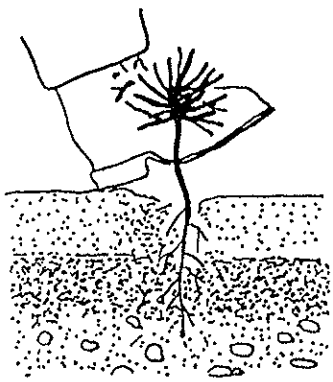
1. Insert mattock, lift handle and pull.



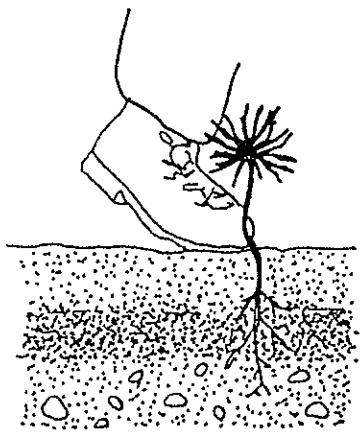
2. Place seedling along straight side at correct depth.



3. Fill in and pack soil to bottom of roots.



4. Finish filling in soil and firm with heel.



5. Firm around seedling with feet.

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

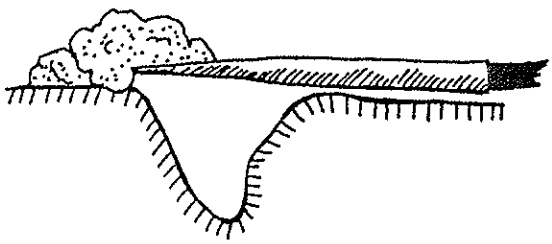
shipping, storage, and planting than containerized plants. Although bareroot stock can be held in a dormant state in cold storage for short periods of time, there are limits as to when the bareroot stock can be lifted and planted. Following the instructions of a local nursery will usually provide the 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

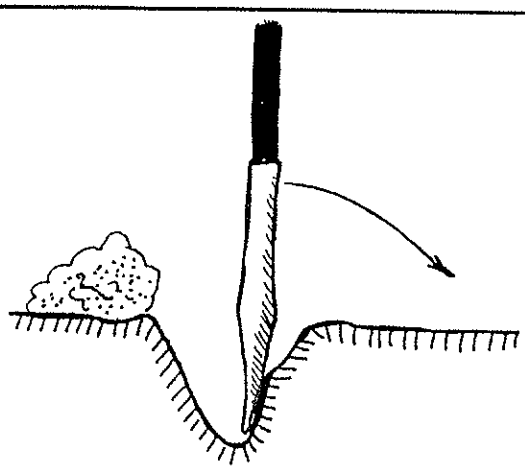
Containerized transplants are quite expensive. On the other hand, they are more readily available and allow for greater scheduling flexibility than bareroot plants. Container-grown plants also seem to perform better on extremely harsh sites. Although not to the same lesser degree with mature transplants,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

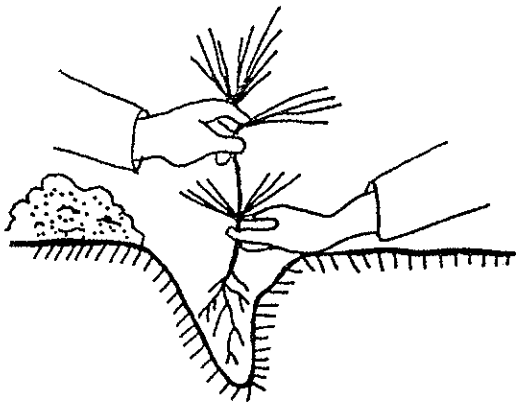
The seedling should not be removed from the container until it will be planted. Careful removal prevents injury and unthrifty plants. To remove the seedling, gently pull at the base of the stem. A light thump on the bottom of the pot may aid in the removal of the root wad. Do not break up the rooting 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).



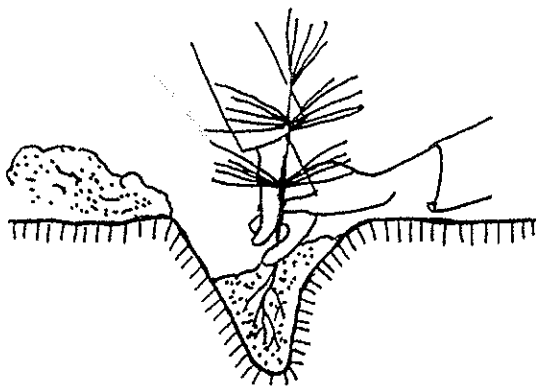
1. Insert spade 2 in deeper than root length.



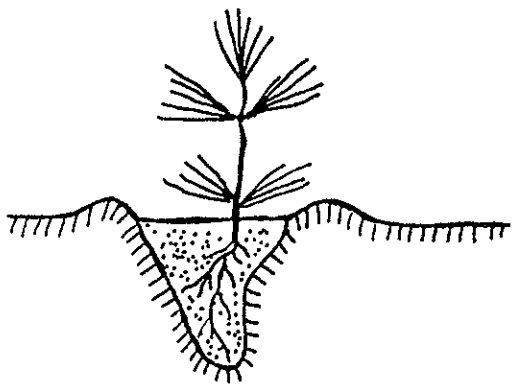
2. Pull bar back lifting dirt out. Scoop out loose dirt with hand.



3. Drop seedling in hole, add a handful of dirt. Pull seedling up to level root collar with soil surface.



4. Add half of soil, tamp with hand.



5. Fill hole to root collar and soil surface. Tamp with hand. Form slight berm 12 - 18 in diameter for water harvest basin.

Redrawn from Utah State Lands and Forestry

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

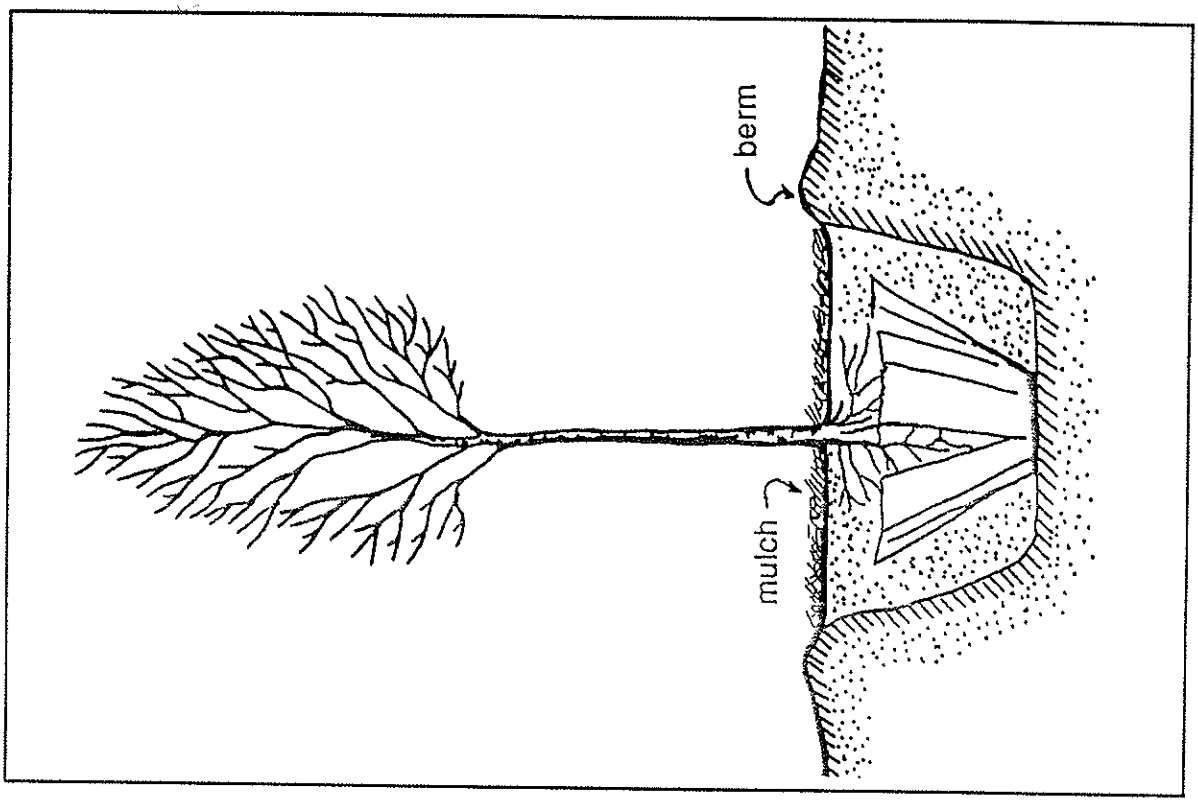


Exhibit 3-6. Planting a Container Tree.

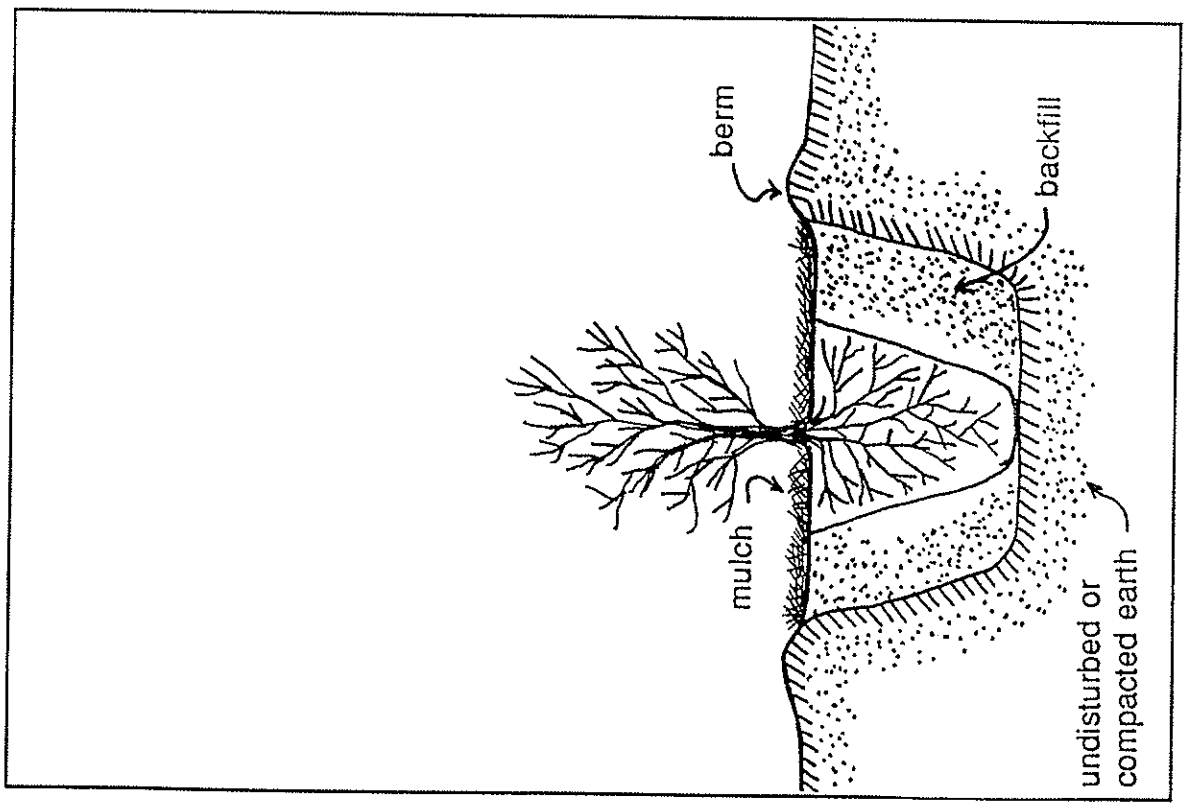


Exhibit 3-5. Planting a Container Shrub.

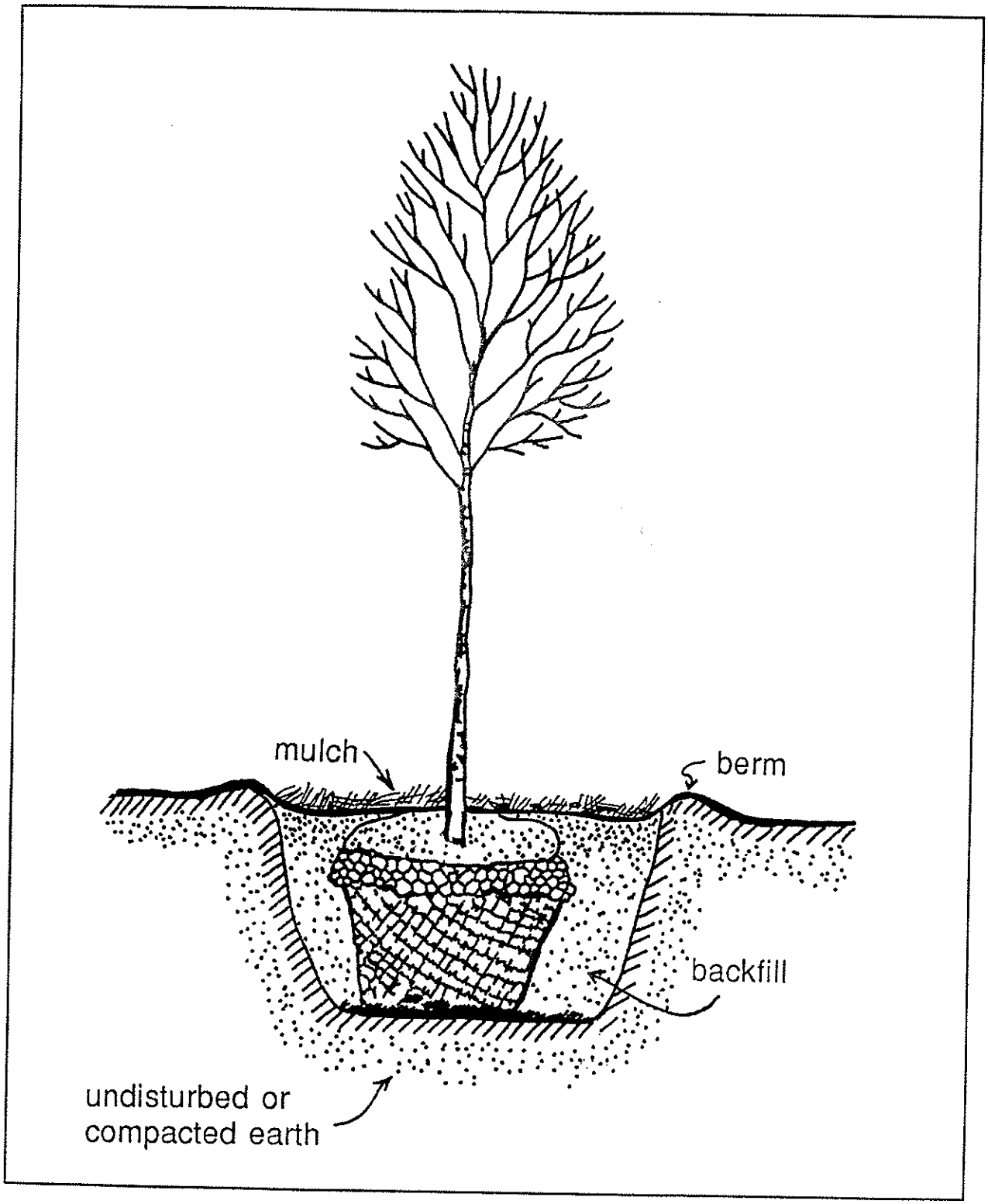


Exhibit 3-7. Planting a Balled and Burlapped Tree.

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. **Never** 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.

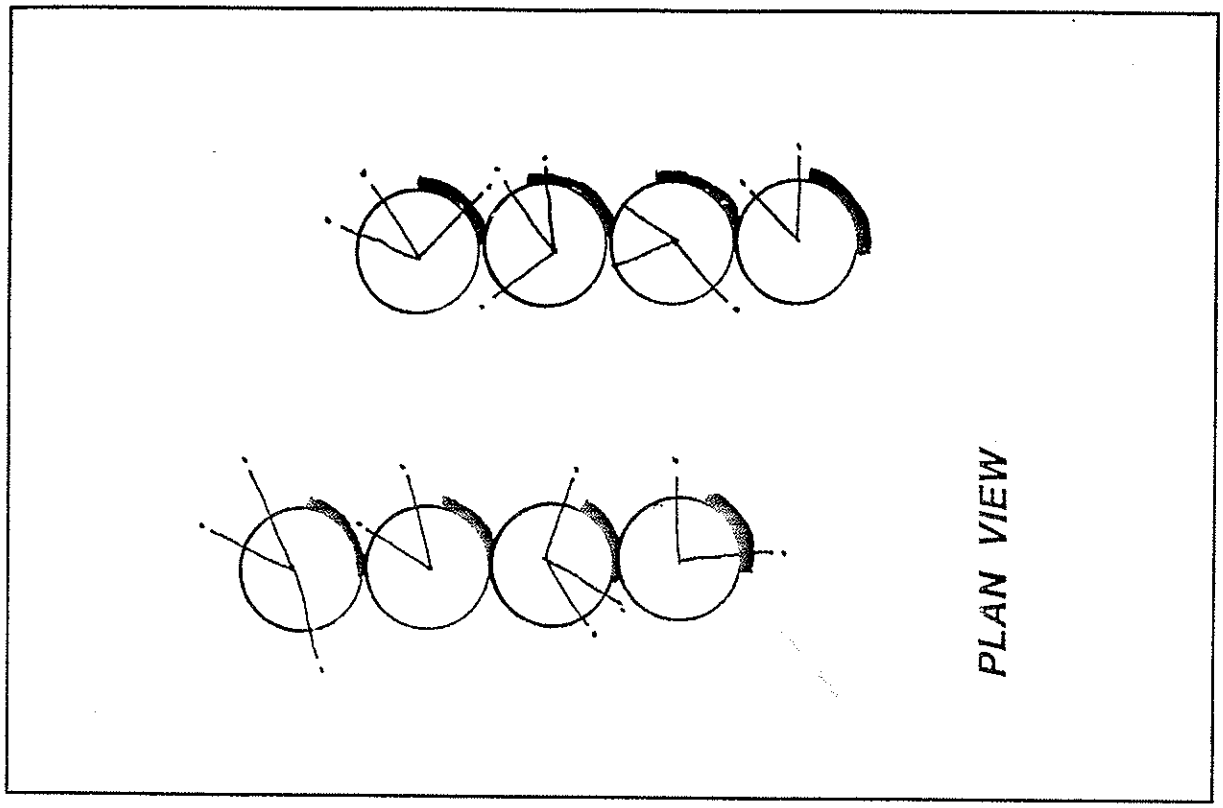
Adequate hardening generally requires 2 to 3 months, but the amount of time depends on the season of the year. If planting site conditions are dramatically different from climatic conditions at the nursery, plants should be site-hardened for a few weeks or months. If hardened plants are exposed to a 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.



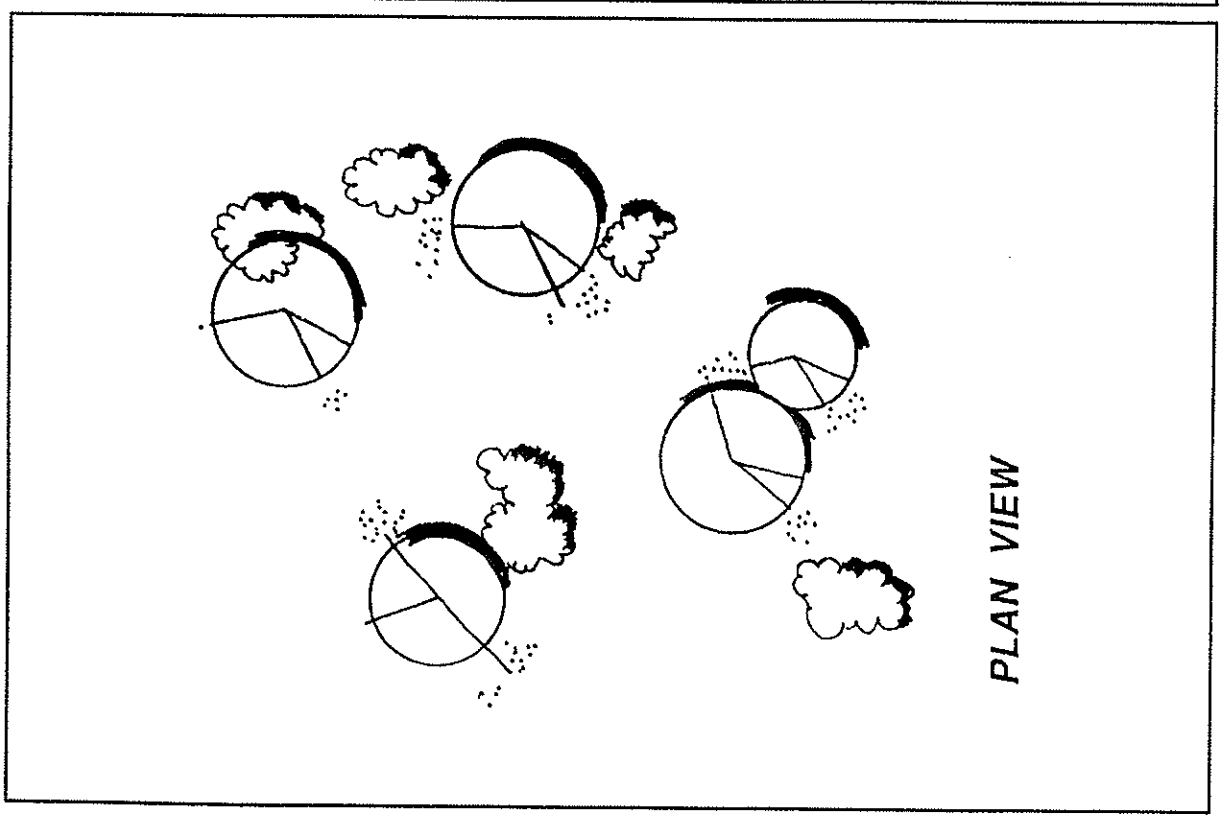
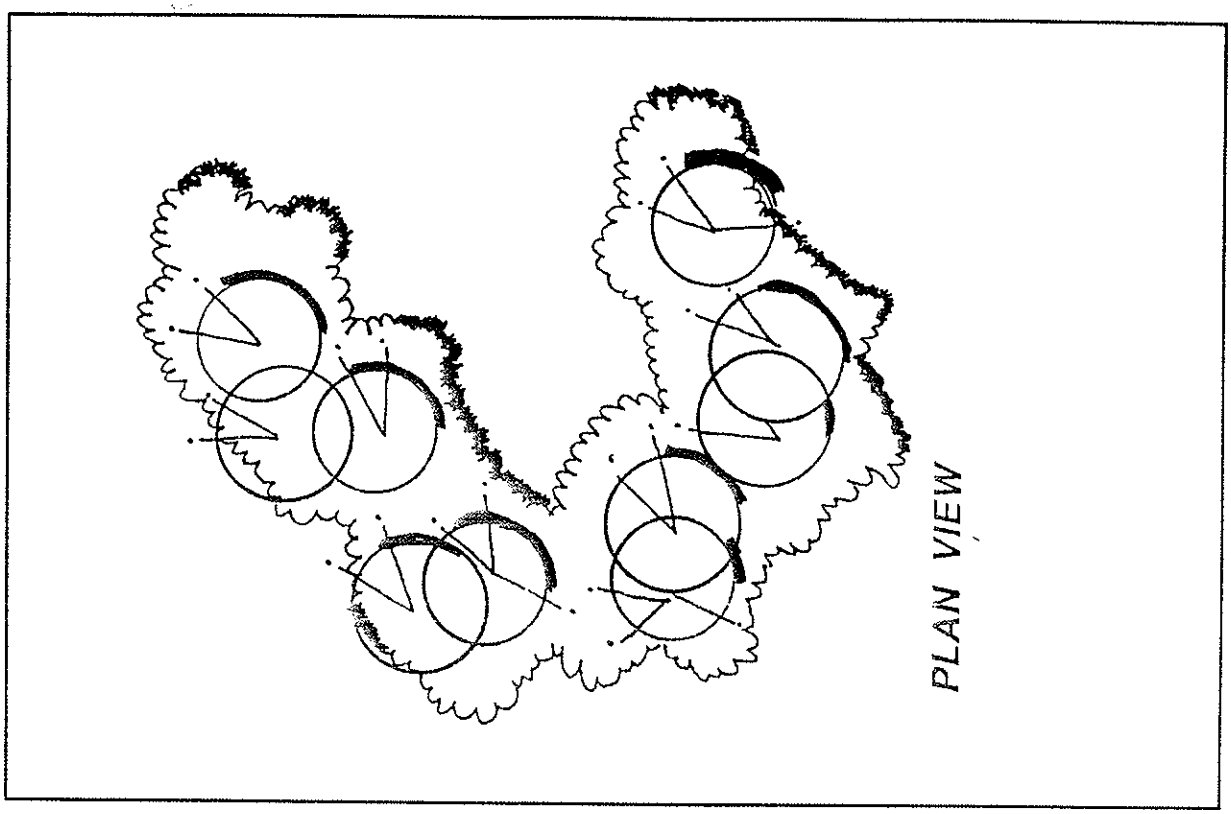


Exhibit 3-8a. Examples of Spatial Arrangements of Plantings.



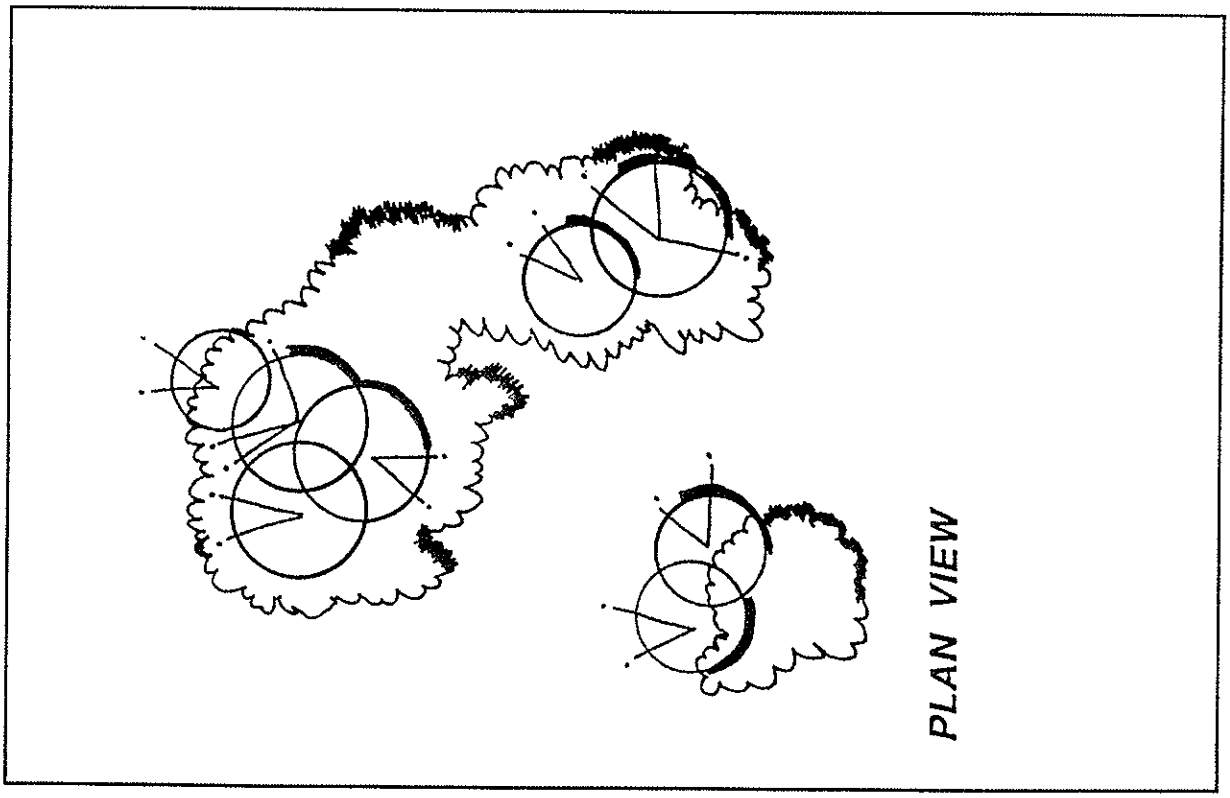
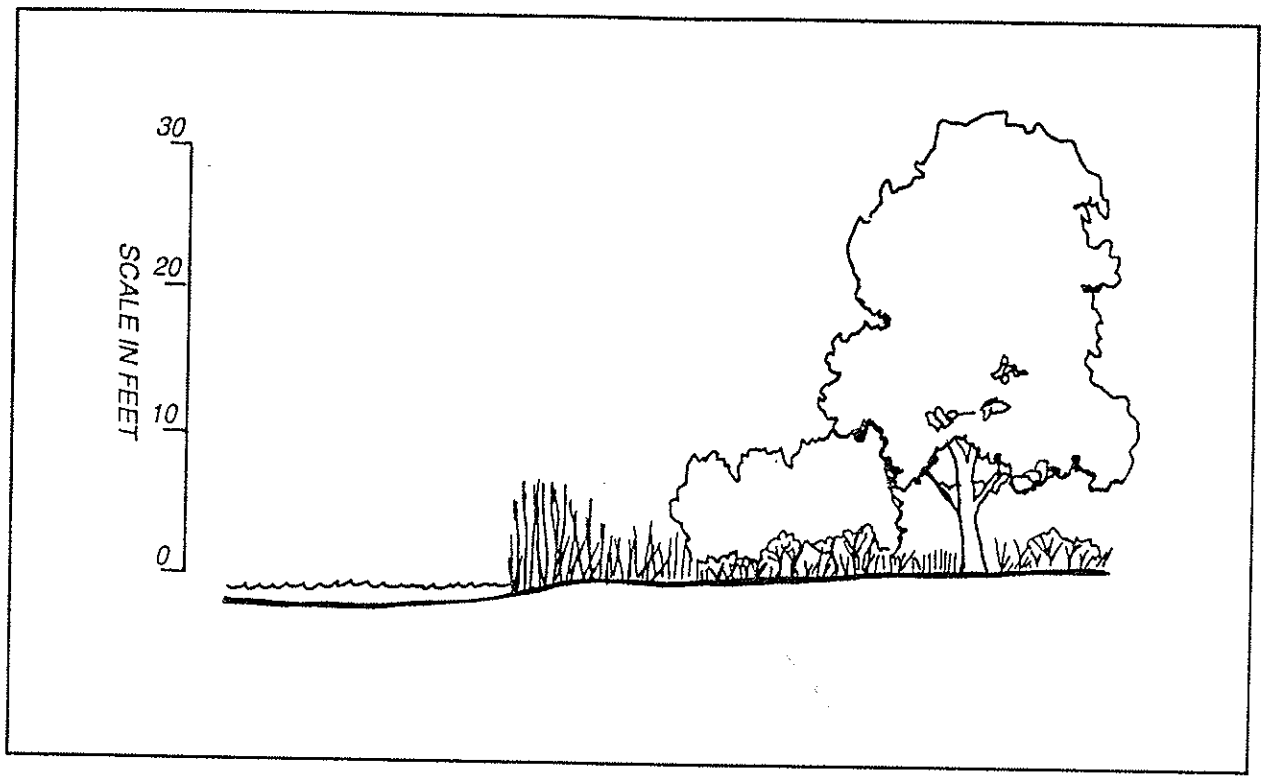


Exhibit 3-8b. Examples of Spatial Arrangements of Plantings.



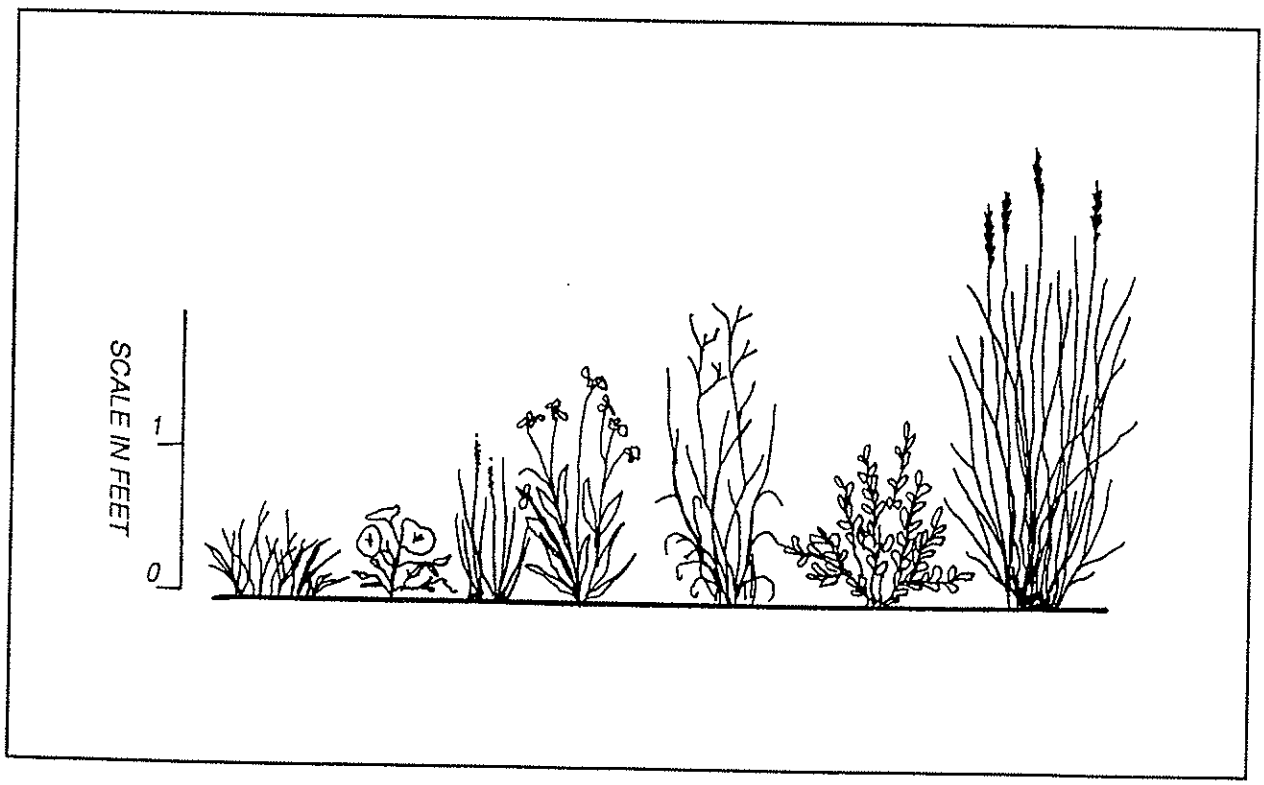
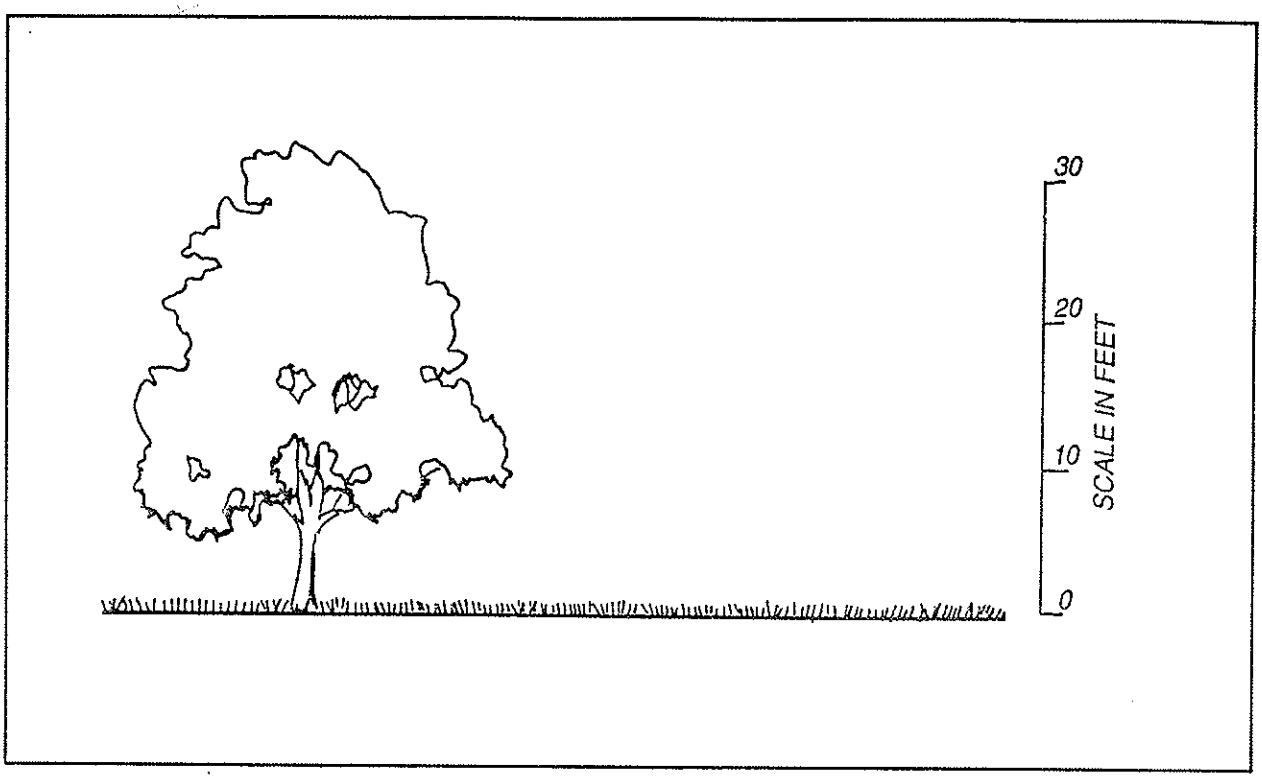


Exhibit 3-9a. Examples of Spatial Arrangements of Plantings.



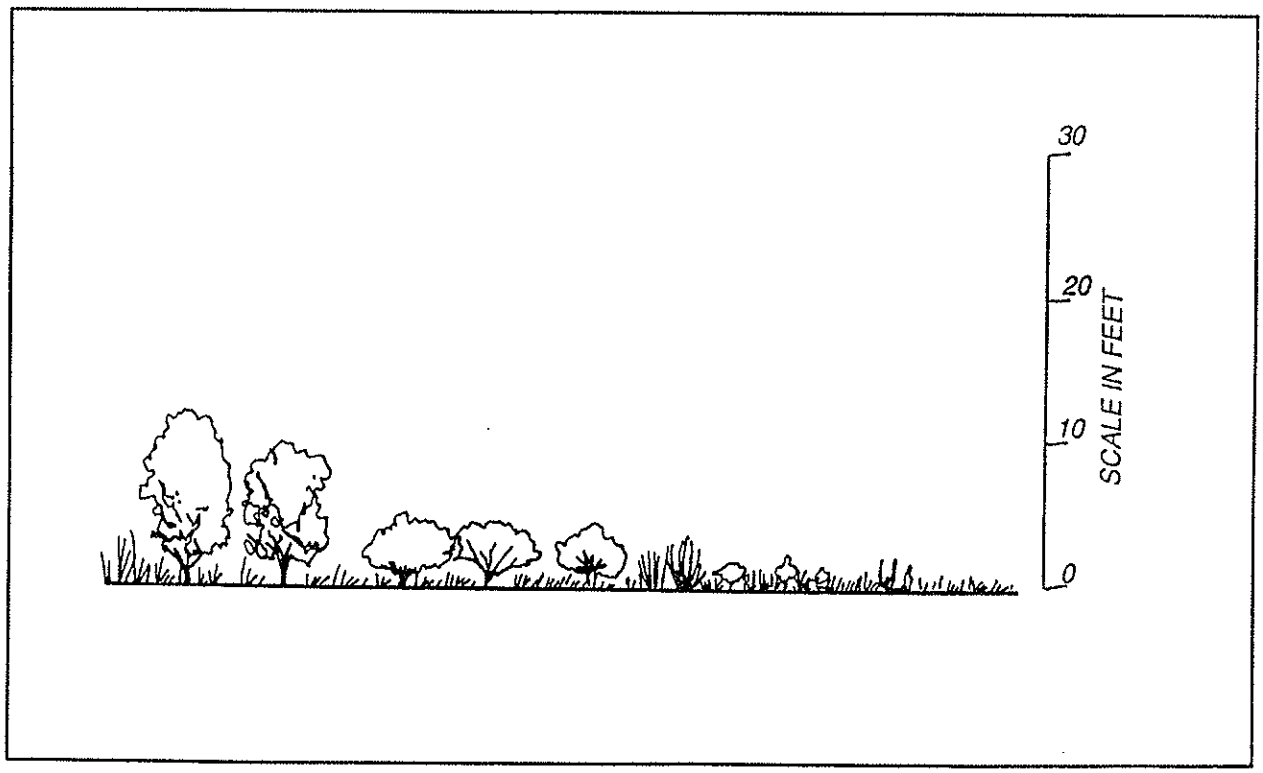
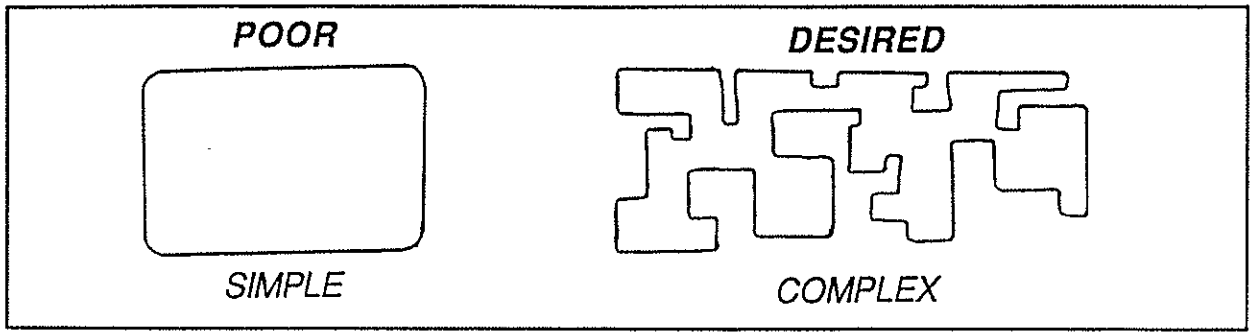


Exhibit 3-9b. Examples of Spatial Arrangements of Plantings.



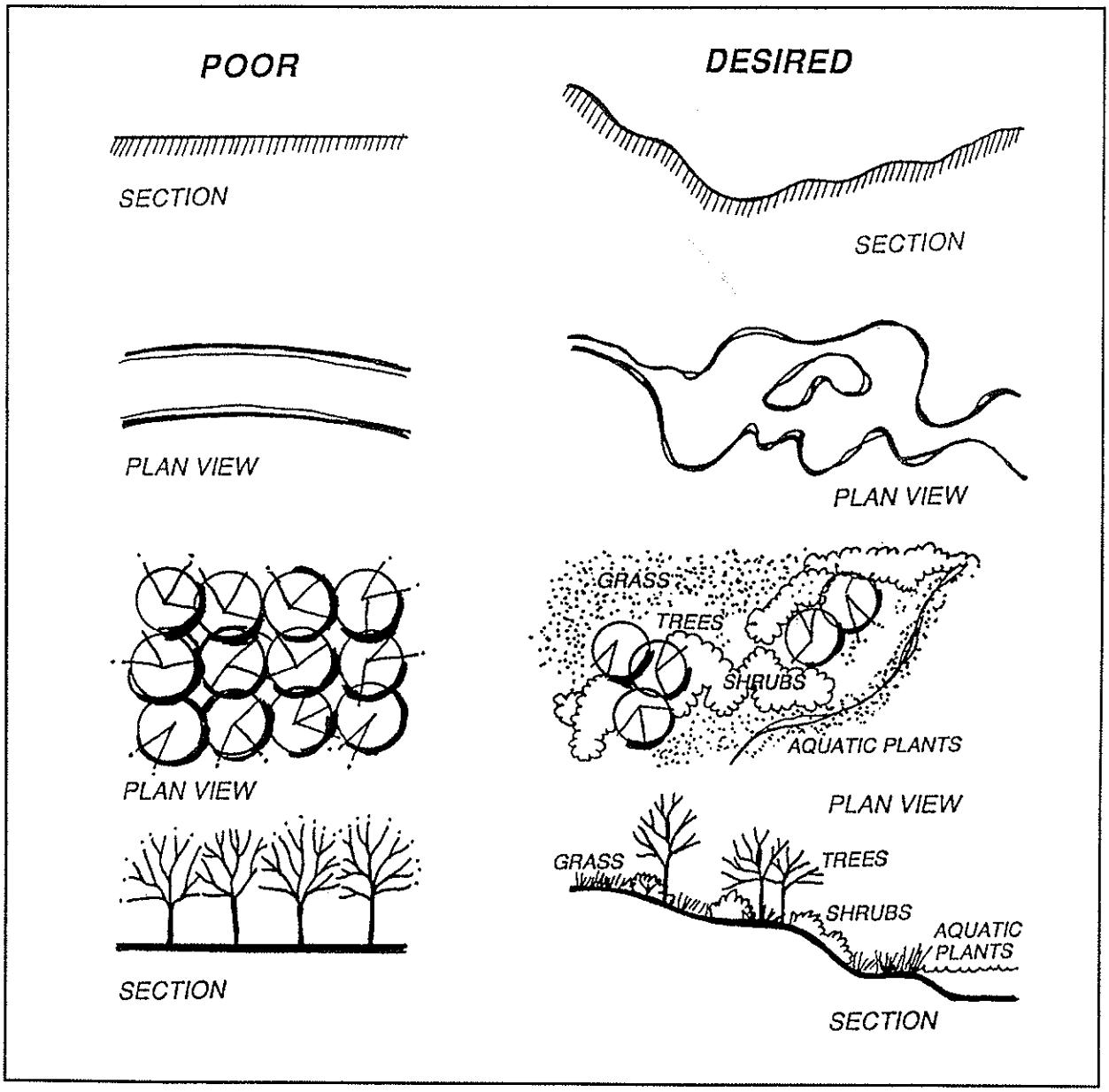


Exhibit 3-10. Examples of Poor and Desired Arrangements of Plantings.

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.

APPENDIX D: FIRE BROCHURE

FIREWISE CONSTRUCTION

To create your FIREWISE structure, remember that the primary goals are fuel and exposure reduction.

Use construction materials that are fire-resistant or non-combustible whenever possible.

Consider using materials such as Class-A asphalt shingles, slate or clay tile, metal, or cement and concrete products for roof construction.

Construct a fire-resistant sub-roof for added protection.

Use fire resistant materials such as stucco or masonry for exterior walls. These products are much better than vinyl which can soften and melt.

Consider both size and materials for windows; smaller panes hold up better in their frames than larger ones; double pane glass and tempered glass are more effective than single pane glass; plastic skylights can melt.

Prevent sparks from entering your home through vents, by covering exterior attic and underfloor vents with wire mesh no larger than 1/8 of an inch.

Keep your gutters, eaves and roof clear of leaves and other debris.

Clear dead wood and dense vegetation within at least 30 feet from your house, and move firewood away from your house or attachments like fences or decks.

Any structure attached to the house, such as decks, porches, fences and sheds should be considered part of the house. These structures can act as fuses or fuel bridges, particularly if constructed from flammable materials. Therefore, consider the following:

If you wish to attach an all-wood fence to your home, use masonry or metal as a protective barrier between the fence and house.

Use non-flammable metal when constructing a trellis and cover with high-moisture, fire-resistant vegetation.

Prevent combustible materials and debris from accumulating beneath patio deck or elevated porches; screen underneath or box in areas below the deck or porch with wire mesh no larger than 1/8 of an inch.

WWW.FIREWISE.ORG

BEWARE & PREPARE

Firefighters need your help. Use these tips to PREPARE your home and PROTECT your family and pets. BEWARE of accidentally starting a wildfire!

FIREWISE COMMUNITIES™

www.firewise.org

FOR MORE INFORMATION, VISIT THESE HELPFUL WEBSITES:

USDA FOREST SERVICE
www.fs.fed.us

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
BUREAU OF INDIAN AFFAIRS
FISH & WILDLIFE SERVICE
NATIOAL PARK SERVICE
www.doi.gov/bureaus.html

NATIONAL ASSOCIATION OF STATE FORESTERS
www.stateforesters.org

NATIONAL FIRE PROTECTION ASSOCIATION
www.nfpa.org

U.S. FIRE ADMINISTRATION
www.usfa.fema.gov

FEDERAL EMERGENCY MANAGEMENT AGENCY
www.fema.gov

FOR MORE INFORMATION CONTACT:

FIREWISE COMMUNITIES

1 BATTERYMARCH PARK - QUINCY, MA 02269

FIREWISE COMMUNITIES™

www.firewise.org

www.firewise.org

FIREWISE LANDSCAPING

To create a landscape that will make your home less vulnerable to wildfire, the primary goal is fuel reduction. Think of the area around your home in zones. Zone 1 is closest to the structure, Zone 4 is the farthest away.

Zone 1 This well-irrigated area encircles the structure for at least 30 feet on all sides, providing space for fire suppression equipment in the event of an emergency. Plants should be limited to carefully spaced fire resistant tree and shrub species.

Zone 2 Fire resistant plant materials should be used here. Plants should be low-growing, and the irrigation system should extend into this section.

Zone 3 Place low-growing plants and well-spaced trees in this area, remembering to keep the volume of vegetation (fuel) low.

Zone 4 This furthest zone from the structure is a natural area. Thin selectively here and remove highly flammable vegetation.

Also remember to:

Carefully space the trees you plant.

Take out the “ladder fuels” – vegetation that serves as a link between grass and tree tops. These fuels can carry fire from vegetation to a structure or from a structure to vegetation.

When maintaining a landscape:

Keep trees and shrubs pruned. Prune all trees six to 10 feet from the ground.

Water and maintain your lawn regularly.

Mow dry grass and weeds..

Dispose of cuttings and debris promptly.

Landscape with less-flammable plants: Contact your local state foerster, county extension office ot landscape specialist for plant information.

WWW.FIREWISE.ORG

A FIREWISE HOME HAS...

DEFENSIBLE SPACE

Do you have at least 30 ft of space surrounding your home that is **Lean**, **Clean** and **Green**?

The objective of Defensible Space is to reduce the wildfire threat to your home by changing the characteristics of the surrounding vegetation.

Lean – Prune shrubs and cut back tree branches, especially within 15 feet of your chimney.

Clean – Remove all dead plant material from around your home; this includes dead leaves, dry grass and even stacked firewood

Green – Plant fire-resistant vegetation that is healthy and green throughout the year.

Did You Know? **Defensible space allows firefighters room to put out fires.**

FIRE-RESISTANT ATTACHMENTS

Attachments include any structure connected to your home, such as decks, porches or fences. If an attachment to a home is *not* fire-resistant, then the home as a whole is *not* firewise.

A DISASTER PLAN

The time to plan for a fire emergency is now. Take a few minutes to discuss with your family what actions you will need to take.

- Post your local firefighting agency's telephone number in a visible place.
- Decide where you will go and how you will get there. With fire, you may only have a moments notice. Two escape routes out of your home and out of your neighborhood are preferable.
- Have tools available: shovel, rake, axe, handsaw or chainsaw, and a 2 gallon bucket
- Maintain an adequate water source
- Have a plan for your pets
- Practice family fire drills

Did You Know? **Evacuations for a wildfire can occur without notice; When wildfire conditions exist, BE ALERT.**

LEAN, CLEAN AND GREEN LANDSCAPING

With firewise landscaping, you can create defensible space around your home that reduces your wildfire threat. Large, leafy, hardwood trees should be pruned so that the lowest branches are at least 6 to 10 ft high to prevent a fire on the ground from spreading up to the tree tops. Within the defensible space, remove flammable plants that contain resins, oils and waxes that burn readily: Ornamental junipers, yaupon holly, red cedar, and young pine. A list of *less*-flammable plants can be found within this brochure.

Did You Know? **Although mulch helps retain soil moisture, when dry, it can become flammable. Mulch as well as all landscaping should be kept well watered to prevent them from becoming fire fuel.**

FIRE-RESISTANT ROOF CONSTRUCTION

Firewise construction materials include Class-A asphalt shingles, metal, cement and concrete products. Additionally, the inclusion of a fire-resistant sub-roof adds protection.

Did You Know? **Something as simple as making sure that your gutters, eaves and roof are clear of debris can reduce your fire threat.**

FIRE-RESISTANT EXTERIOR CONSTRUCTION

Wall materials that resist heat and flames include brick, cement, plaster, stucco and concrete masonry. Double pane glass windows can make a home more resistant to wildfire heat and flames.

Did You Know? **Although some vinyl will not burn, firefighters have found that some vinyl soffits can melt, allowing embers into the attic space.**

EMERGENCY ACCESS

Identify your home and neighborhood with legible and clearly marked street names and numbers so emergency vehicles can rapidly find the location of the emergency. Include a driveway that is at least 12 feet wide with a vertical clearance of 15 feet – to provide access to emergency apparatus.

BE FIREWISE™ AROUND YOUR HOME

Use these tips to prepare your home and protect your family and pets.

A homeowner's guide for protecting your property from wildfire.

The National Firewise Communities Program provides wildland/urban interface resources for firefighter safety, community planning, landscaping, construction, and maintenance to help protect people, property, and natural resources from wildfire. More information is available from the Firewise website at **www.firewise.org**

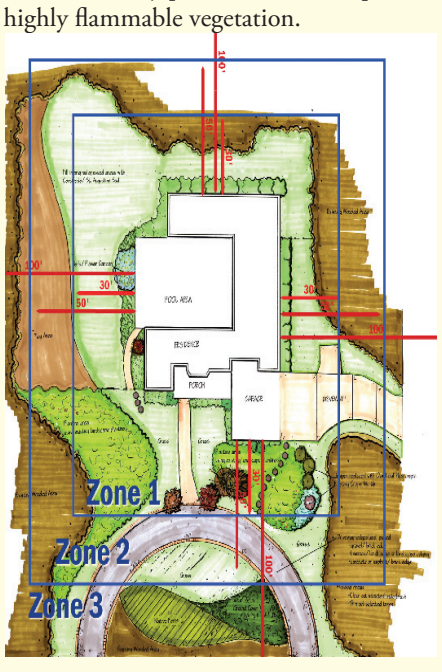
Review these helpful checklists for Firewise Landscaping and Firewise Construction.

INSIDE:
Seven features of Firewise homes...

REMINDERS FOR FIREWISE™ LANDSCAPING

When designing and installing a Firewise landscape, consider the following:
Local area fire history • Site location and overall terrain • Prevailing winds and seasonal weather • Property contours and boundaries • Native vegetation • Plant characteristics and placement (duffage, water and salt retention ability, aromatic oils, fuel load per area, and size) • Irrigation requirements • Give yourself added protection with "fuel breaks" like driveways, gravel walkways, and lawns •

To create a Firewise landscape, the primary goal is fuel reduction. To this end, initiate the zone concept. Zone 1 is closest to the structure; Zones 2-4 move progressively further away.
Zone 1: This well-irrigated area encircles the structure for at least 30 feet on all sides, providing space for fire suppression equipment in the event of an emergency. Plantings should be limited to carefully spaced low flammability species.
Zone 2: Low flammability plant materials should be used here. Plants should be low-growing and the irrigation system should extend into this section.
Zone 3: Place low-growing plants and well-spaced trees in this area, remembering to keep the volume of vegetation (fuel) low.
Zone 4: This furthest zone from the structure is a natural area. Selectively prune and thin all plants and remove highly flammable vegetation.



When maintaining a landscape:
- Mow the lawn regularly, and dispose of cuttings and debris promptly, according to local regulations.
- Be sure the irrigation system is well maintained.
- Use care when refueling garden equipment; maintain equipment regularly; store flammable liquids properly.
- Become familiar with local regulations regarding vegetation clearances, disposal of debris, and fire safety requirements for equipment.

REMINDERS FOR FIREWISE™ CONSTRUCTION

When constructing, renovating, or adding to a Firewise home, consider the following:
- Choose a Firewise location.
- Design and build a Firewise structure with fire resistant materials.
- Employ Firewise landscaping and maintenance.

To select a Firewise location, observe the following:
- Slope of terrain; be sure to build on the most level portion of the land, since fire spreads more rapidly on even minor slopes.
- Set your one-story structure at least 30 feet back from any ridge or cliff; increase distance if your home will be higher than one story.

In designing and building your Firewise structure, the primary goals are fuel and exposure reduction. Therefore:
- Use construction materials that are fire-resistant or non-combustible whenever possible.
- For roof construction, consider using materials such as Class-A asphalt shingles, slate or clay tile, metal, cement and concrete products, or terra-cotta tiles. A fire-resistant sub-roof can also add protection.
- On exterior wall facing, fire-resistive stucco or masonry may be much better choices than vinyl, which can soften and melt.
- Window materials and size are important. Smaller panes hold up better in their frames than larger ones. Double pane glass and tempered glass are more reliable and effective heat barriers than single pane glass. Plastic skylights can melt.
- Install non-flammable shutters on windows and skylights.
- To prevent sparks from entering your home through vents, cover exterior attic and under-floor vents with wire screening no larger than 1/8-inch mesh.
- Provide at least two ground-level doors for easy and safe exit, and at least two means of escape (i.e., doors or windows) in each room so that everyone has a way out.

Any structures attached to the house, such as decks, porches, fences, and outbuildings should be considered part of the house. These structures can act as fuel bridges, particularly if constructed from flammable materials. Therefore, consider the following:
- If you wish to attach an all-wood fence to your house, use masonry or metal as protective barriers between the fence and house.
- Use metal when constructing a trellis and cover it with high-moisture, low flammability vegetation.
- Prevent combustible materials and debris from accumulating beneath patio decks or elevated porches. Screen or box-in areas below patios and decks with wire screening no larger than 1/8-inch mesh.
- Make sure an elevated wooden deck is not located at the top of a hill where it will be in direct line of a fire moving up-slope. Consider a terrace instead.

Firewise website visitors can view streaming video and also download checklists, school educational materials, and other information. Visitors can browse an extensive list of helpful links and use a searchable library of national, state, and local documents on a wide range of wildland safety issues. Visitors can also find their state Firewise Communities liaison to contact for assistance in hazard mitigation and planning.

FIREWISE COMMUNITIES®

For more information contact:
FIREWISE COMMUNITIES
1 Batterymarch Park
Quincy, MA 02169

www.firewise.org

FWC-100-06

1 HOME IGNITION ZONE

The Home Ignition Zone begins with at least 30 feet of space immediately around the home and extending out as far as 100 to 200 feet depending on the characteristics of the surrounding forests or grasslands. Creating and maintaining the Home Ignition Zone reduces or eliminates ignition hazards presented by vegetation (by thinning or spacing, removing dead leaves and needles and pruning shrubs and tree branches) and combustible construction (wooden porches, decks, storage sheds, outbuildings, swing sets and fences).

WHY? **Reducing ignition hazards improves the chances that the structure will survive a wildfire...**

2 LEAN, CLEAN, AND GREEN LANDSCAPING

With Firewise landscaping, you can create survivable space around your home that reduces your wildfire threat. Prune large trees so that the lowest branches are at least 6 to 10 feet high to prevent a fire on the ground from spreading to the tree tops. Within the Home Ignition Zone, remove flammable plants that contain resins, oils, and waxes that burn readily: ornamental junipers, paupon, holly, red cedar, and young pine. A list of less-flammable plants can be obtained from your local state forester, forestry office, county extension office, or landscape specialist.

WHY? **Although mulch does help retain soil moisture, mulch and other landscape materials can become flammable when too dry...**

3 FIRE-RESISTANT ROOF CONSTRUCTION

Firewise roof construction materials include Class-A asphalt shingles, metal, slate or clay tile, and concrete products. The inclusion of a fire-resistant subroof adds protection. Make a periodic inspection looking for deterioration such as breaks and spaces between roof tiles. Keep the roof, gutters, and eaves clear of leaves and other debris. Make sure under-eave and soffit vents are as close as possible to the roof line. Box in eaves, but be sure to provide adequate ventilation to prevent condensation and mildew.

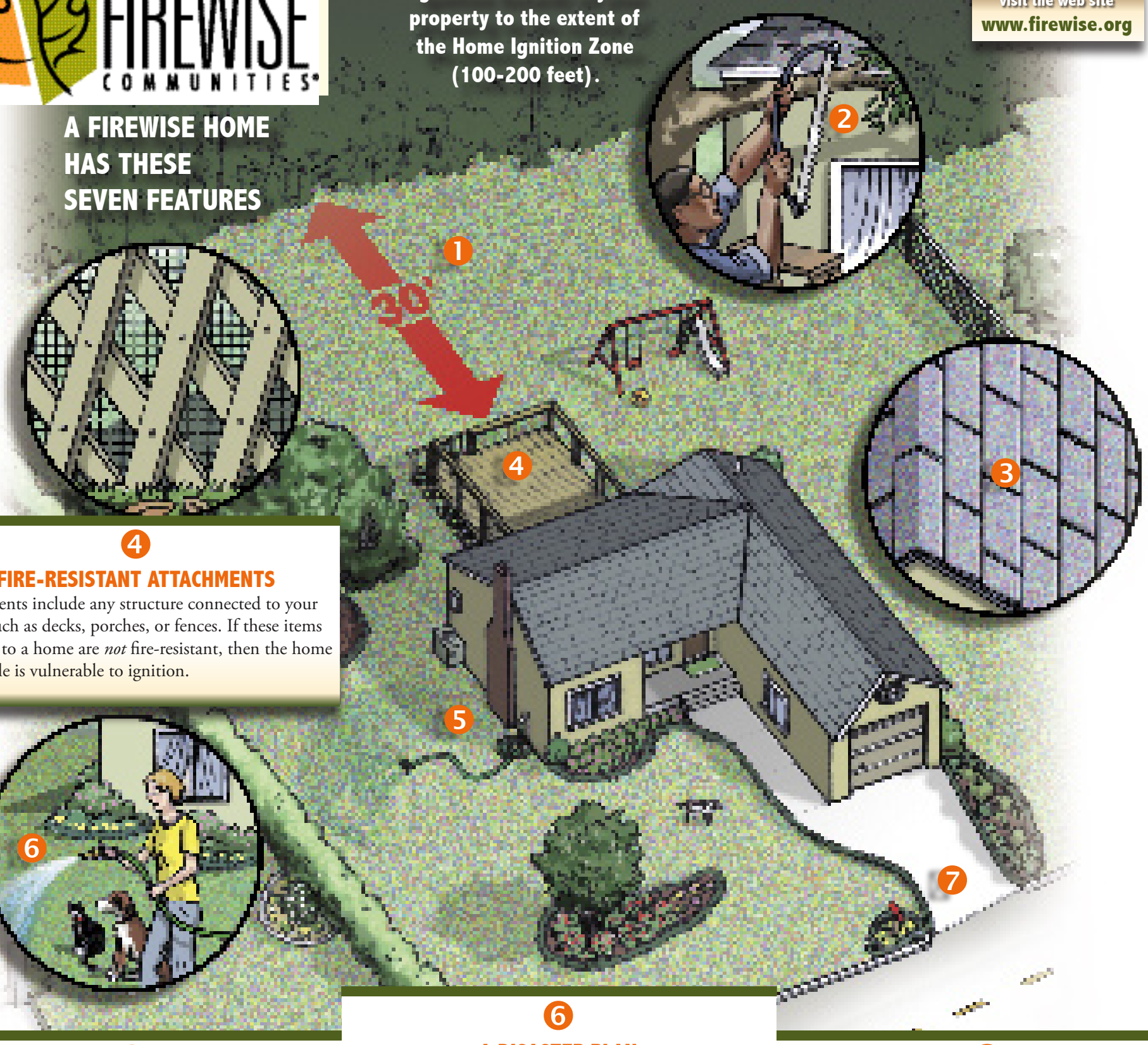
WHY? **Something as simple as making sure that your gutters, eaves, and roof are clear of debris will reduce your fire threat...**

FIREWISE COMMUNITIES®

A FIREWISE HOME HAS THESE SEVEN FEATURES

Be sure to reduce the ignition hazards on your property to the extent of the Home Ignition Zone (100-200 feet).

For more information, visit the web site www.firewise.org



4 FIRE-RESISTANT ATTACHMENTS

Attachments include any structure connected to your home, such as decks, porches, or fences. If these items attached to a home are *not* fire-resistant, then the home as a whole is vulnerable to ignition.

5 FIRE-RESISTANT CONSTRUCTION

Wall materials that resist heat and flames include brick, cement, plaster, stucco, and concrete masonry. Tempered and double-pane glass windows can make a home more resistant to wildfire heat and flames. For more information, see the Firewise Construction Checklist on the other side.

WHY? **Firebrands (embers) collect in small nooks and crannies and ignite combustible materials...**

6 A DISASTER PLAN

The time to plan for any emergency is prior to the event. Take time to discuss with your family what actions you will take. Post emergency telephone numbers in a visible place. Leave before it is too late. Decide where you will go and how you will get there. Have tools available (shovel, rake, axe, handsaw, or chain saw). Maintain an emergency water source. Have a plan for your pets. Practice family fire drills.

WHY? **The need to evacuate can occur without notice. When wildfire conditions exist, be ready to take action...**

7 EMERGENCY ACCESS

Identify your home and neighborhood with legible and clearly marked street names and numbers. Include a driveway that is at least 12 feet wide with a vertical clearance of 15 feet and a slope of less than 5 percent to provide access to emergency vehicles.

WHY? **So emergency personnel can rapidly find the location of the emergency...**

BE FIREWISE™ AROUND YOUR HOME

APPENDIX E: FIRE-WISE LANDSCAPE PLANTS

Utah Forest Facts

EXTENSION
UtahState UNIVERSITY

Wildland-Urban Interface NR/FF/002

Firewise Plants for Utah Landscapes

Mike Kuhns, State Extension Forester

This fact sheet describes characteristics of firewise plants and firewise landscapes, and lists examples of firewise plants that can be used in Utah landscapes.

Wildland/Urban Interface Fire Hazards

Fire is an important part of many of Utah's natural landscapes, including landscapes in fringe or interface areas near rapidly growing cities, towns, and recreational developments. But when people build homes in these areas, a minor fire that might have burned a few trees and shrubs in a natural area instead can become a major disaster. Throughout Utah wildland/urban interface fires are becoming more of a problem as people choose to live in previously undeveloped areas on the edges of cities, areas with trees, shrubs, and grasses that often are very flammable.

Firewise Landscaping

Firewise landscaping is the practice of designing, installing, and maintaining a landscape to minimize fire hazard to structures, residents, and neighbors, while maintaining components of the native ecosystems that attracted people to live in such areas in the first place. Such landscaping uses appropriate plants, then places and maintains them so that fuel loads decrease in zones between an area to be protected (like your home) and the surrounding wildland.

Use of firewise plants alone does not guarantee fire safety for you or your home. But, firewise plants coupled with good design and maintenance help establish a defensible space around your home or neighborhood that assists firefighters in their protection efforts. Native vegetation around homes and neighborhoods also can be managed in a firewise manner through pruning, thinning, and occasional clearing.

This fact sheet mainly covers selection of firewise plants for use in Utah landscapes. Other elements of firewise landscape design, installation, and maintenance will be covered in other fact sheets. Go to http://extension.usu.edu/forestry/HomeTown/HO_Firewise.htm for an electronic version of this fact sheet and a slide presentation showing most of these plants.

House in dense Gambel oak stand

Firewise Plant Characteristics

Firewise plants have a number of characteristics in common, but also can vary considerably. Following are some important points about these plants and their management.

✓*No plant is fireproof. All will burn in a very intense fire.*

✓Firewise plants all have one or more of these firewise characteristics:

- ✖Tissues contain more moisture, especially during the fire season.
- ✖Tissues contain low amounts of volatile oils and other readily flammable chemicals.
- ✖Plants provide less fuel, either by producing less litter or by staying small.
- ✖Plants are compact or low to the ground, allowing them to be used in the landscape to interrupt fire pathways.

✓All trees provide large amounts of fuel to a fire, so they should be carefully placed and maintained. Broadleaved trees generally are less flammable than conifers (pines, firs, spruces, junipers).

✓Most of the firewise plants listed in this publication do well in open, sunny areas typical of most fire-prone sites.

✓Some firewise plants need minimal or no irrigation to remain green and healthy; over-irrigation may harm such plants or may cause them to grow too fast and become hazardous. Other plants will need supplemental water to survive. Know your plants' needs and habits so you can use and manage them appropriately.

✓When choosing a particular plant species or cultivar for a firewise planting, favor those that are low to the ground, compact, and that stay green and healthy with low maintenance and minimal water.

✓All firewise plants should receive periodic maintenance, including removal of dead leaf and stem material within the crown and on the ground, pruning to keep crowns thinner and to keep tree crowns high, and removal of individual plants to break up fuel continuity.

✓Make sure that the plants you are considering are cold-hardy (check the USDA hardiness zone for the plant and compare it to the zone for your area) and otherwise well-suited for your locale and the specific planting site.

✓Some plants are weedy and may even be illegal to plant or cultivate.

Firewise Plants for Utah Landscapes

The following table lists plants and groups of plants that can be firewise if used properly in the landscape and properly maintained. Plants or groups of plants marked with an * can become weedy in certain circumstances, and may even be noxious weeds with legal restrictions against their planting and cultivation. Check with your local Extension office or State Department of Agriculture office for information on noxious weeds in your area.

Most of these plants are fairly commonly available in the nursery trade, and cultivars and hybrids usually are available. All of these plants should be cold-hardy in most of Utah (USDA hardiness zones 4 or 5). Some need considerable supplemental irrigation, while others need very little water. Be sure to learn about the plants you use and know their requirements.

Where no particular species or cultivar is listed, or when considering plants not listed here, pick one that has firewise characteristics as described above. Don't assume that a plant is firewise just because it is closely related to one in the list or because it has a similar name.

Botanical Name	Common Name
Grasses	
Agropyron cristatum	Crested Wheatgrass
◆resists fire spread due to growth form	
Buchloe dactyloides	Buffalograss
◆low growing without mowing; moist through summer with minimal irrigation	
Dactylis glomerata	Orchardgrass
◆must be mowed or grazed	
Festuca cinerea and other species	Blue Fescue
◆most low growing; may need to mow; stays moist with irrigation	
Lolium species	Rye Grass
◆stays green with less irrigation than some; need to mow or graze	
Pascopyrum smithii	Western Wheatgrass
◆low fuel loads; regrows quickly after fire	
Poa pratensis	Kentucky Bluegrass
◆low growing; may need to mow; stays moist with irrigation	
Poa secunda	Sandberg Bluegrass
◆low growing without mowing; low fuel loads	
Herbaceous Perennials	
Achillea clavennae	Silvery Yarrow
◆small plants for dry sites	

Botanical Name	Common Name
Achillea filipendulina	Fernleaf Yarrow
◆large; likes dry sites; moist in summer	
Achillea—other species & hybrids	Yarrow*
◆some are volatile; good for dry sites	
Aquilegia species & hybrids	Columbine
◆likes moisture and some shade	
Armeria maritima	Sea Pink, Sea Thrift
◆low growing; dry, infertile sites only; salt tolerant	
Artemisia stelleriana	Beach Wormwood, Dusty Miller
◆needs very well-drained soil; moist in summer	
Artemisia—other species & hybrids	Various names*
◆some are volatile; all like dry soils	
Bergenia species & hybrids	Bergenia
◆moisture loving; medium-sized; semi-evergreen	
Centranthus ruber	Red Valerian, Jupiter's Beard
◆gets fairly large; moist in summer	
Cerastium tomentosum	Snow-in-summer
◆low growing; moist in summer	
Coreopsis auriculata var. *Nana*	Dwarf Mouse Ear Coreopsis
◆needs moisture; fairly low growing	
Coreopsis—other perennial species	Coreopsis
◆more drought tolerant; larger plants	
Delosperma nubigenum	Hardy Ice Plant
◆also other ice plants; very drought tolerant; low growing	
Dianthus plumarius & others	Pinks
◆use perennials; needs moisture; moist in summer	
Erigeron hybrids	Fleabane*
◆moist through summer	
Gaillardia x *grandiflora*	Blanketflower
◆drought, heat tolerant; moist in summer; large	
Geranium cinereum	Hardy Geranium
◆low growing; cool sites	
Geranium sanguineum	Bloody Cranesbill, Bloodred Geranium
◆low/medium growing; partial shade or sun	
Geranium species	Geranium
◆use perennials; most low growing; need shade where hot	
Hemerocallis species	Daylily
◆green and moist through summer	
Heuchera sanguinea	Coral Bells, Alum Root
◆also other species, hybrids; low growing foliage	
Iberis sempervirens	Evergreen Candytuft
◆fairly low growing; evergreen	
Iris species & hybrids	Iris
◆green and moist through summer	
Kniphofia species & hybrids	Red-hot Poker
◆large plants; moist in summer	
Lavandula species	Lavender
◆moist in summer; compact; cut to ground regularly	
Leucanthemum x *superbum*	Shasta Daisy
◆green and moist through summer	

Botanical Name	Common Name
Limonium latifolium	Sea-lavender, Statice
◆low growing leaves; salt resistant; dry soils	
Linum species	Flax
◆good for tough sites & soils	
Liriope spicatum	Lily-turf
◆fairly low growing; moist or dry sites; evergreen	
Lupinus species & hybrids	Lupine*
◆some are annuals; poisonous to livestock; good for poor soils	
Medicago sativa	Alfalfa
◆green & moist through summer; low growing	
Oenothera species	Primrose
◆fairly low growing; best on poor soils	
Papaver species	Poppy
◆easy to grow; cut back regularly	
Penstemon species & hybrids	Penstemon
◆use on well-drained soils	
Perovskia atriplicifolia	Russian Sage, Azure Sage
◆moist through summer; cut back yearly	
Potentilla nepalensis	Nepal Cinquefoil
◆prostrate form	
Potentilla neumanniana 'Nana' *(P. verna)*	Spring Cinquefoil, Creeping Potentilla
◆very low growing	
Potentilla—other non-shrubby species & hybrids	Cinquefoil, Potentilla*
◆sulfur cinquefoil is weedy; full sun; moist through summer	
Salvia species & hybrids	Salvia, Sage*
◆some are annuals; Mediterranean sage is weedy; only use low growing, small plants	
Sedum species	Stonecrop, Sedum
◆very low growing; fleshy, moist leaves; drought tolerant	
Sempervivum tectorum	Hen and Chicks
◆very low growing; succulent; good on droughty, poor soils	
Sibbaldiopsis (Potentilla) tridentata	Wineleaf Cinquefoil
◆prostrate, spreading form	
Stachys byzantina	Lamb's Ear
◆moist through summer; good on poor soils	
Yucca filamentosa	Yucca
◆evergreen; very drought tolerant	

Shrubs and Woody Vines

Arctostaphylos uva-ursi	Bearberry, Kinnikinnick, Manzanita
◆very low and spreading; evergreen; use on poor soils; needs little pruning; salt tolerant	
Atriplex species	Saltbush
◆very drought tolerant; low maintenance	
Ceanothus americanus	New Jersey Tea
◆low, dense form; evergreen; fairly trouble free; drought tolerant	

Botanical Name	Common Name
Ceanothus ovatus (C. herbaceous) & others	Ceanothus
◆fairly low growing; evergreen; low maintenance	
Cistus species	Rock-rose
◆not all are cold hardy; evergreen; dry sites; size varies	
Cotoneaster dammeri	Bearberry Cotoneaster
◆low growing; evergreen; minimal maintenance; dry sites	
Cotoneaster horizontalis	Rockspray or Rock Cotoneaster
◆very low and spreading; evergreen	
Cotoneaster—other compact species	Cotoneaster
◆low growth form; low maintenance; tough	
Hedera helix	English Ivy
◆evergreen vine; low growing, spreading, climbing; prune to control spread; sun or shade	
Kochia prostrata	Immigrant Forage Kochia
◆stays green; no volatiles; clumps break up fuel continuity; don't use weedy annual kochia	
Lonicera species & hybrids	Honeysuckle
◆shrubs or vines; use low growing species, cultivars	
Mahonia repens	Creeping Oregon Grape
◆very low growing, spreading shrub; evergreen; needs some shade	
Parthenocissus quinquefolia	Virginia Creeper
◆vine; tough and vary adaptable; prune to control spread	
Prunus besseyi (P. pumila var. *besseyi)*	Western Sandcherry
◆small, spreading shrub for dry, tough sites	
Purshia tridentata	Bitterbrush, Antelope Bitterbrush
◆low maintenance; good for tough, dry sites	
Pyracantha species	Firethorn, Pyracantha
◆evergreen shrub; use low growing selections; prune regularly	
Rhamnus species	Buckthorn
◆tough shrub; low maintenance	
Rhus trilobata	Skunkbush Sumac
◆easy to grow shrub; fairly small; low maintenance	
Rhus—other species	Sumac
◆fairly tough and drought tolerant; some get large; thin or prune periodically	
Ribes species	Currant, Gooseberry
◆use low growing dwarf forms; fairly tough, adaptable	
Rosa rugosa & other hedge roses	Rugosa Rose
◆medium shrub; tough, fairly drought and salt tolerant	
Shepherdia canadensis	Russet Buffaloberry
◆does well on very poor soils; drought tolerant; fixes nitrogen; salt tolerant	
Syringa vulgaris	Lilac
◆small to large shrubs; stays green through summer with irrigation; thin and prune regularly	
Vinca major	Large Periwinkle
◆low growing, prostrate groundcover; sun or shade	
Vinca minor	Dwarf Periwinkle, Common Periwinkle
◆similar to large periwinkle, but very low to the ground	
Trees	
Acer species	Maple
◆needs supplemental moisture	
Betula species	Birch
◆needs supplemental moisture; use borer resistant selections	
Cercis occidentalis (C. orbiculata)	California Redbud
◆small tree or shrub; drought and heat resistant	
Populus tremuloides	Quaking Aspen
◆needs supplemental moisture; good if maintained in young clumps, otherwise not suitable for valleys	
Populus—other species	Poplar, Cottonwood
◆needs supplemental moisture; most need plenty of space	
Salix species	Willow
◆needs supplemental moisture; disease prone; some good shrubs	

For More Information

Kuhns, Michael 1998. Trees of Utah and the Intermountain West. USU Press, Logan, UT 84322-7800. 341pp.

Still, Steven M. 1994. Manual of Herbaceous Ornamental Plants. Stipes Publ., 10-12 Chester St., Champaign, IL 61820. 814 pp.

Visit the Forestry Extension Web site at http://extension.usu.edu/forestry/HomeTown/HO_Firewise.htm for fire safety information. Also, go to www.firewise.org and www.utahfireinfo.gov for more fire-related information.

Acknowledgements

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REFERENCES

Nature Area Revegetation Manual for Salt Lake County, Utah. 1995. Ecotone Environmental Consulting, Inc. Logan, Utah.

[USGS] U.S. Geological Survey. National Gap Analysis Program. 2004. Provisional Digital Land Cover Map for the Southwestern United States. Version 1.0. RS/GIS Laboratory, College of Natural Resources, Utah State University. Logan, Utah.