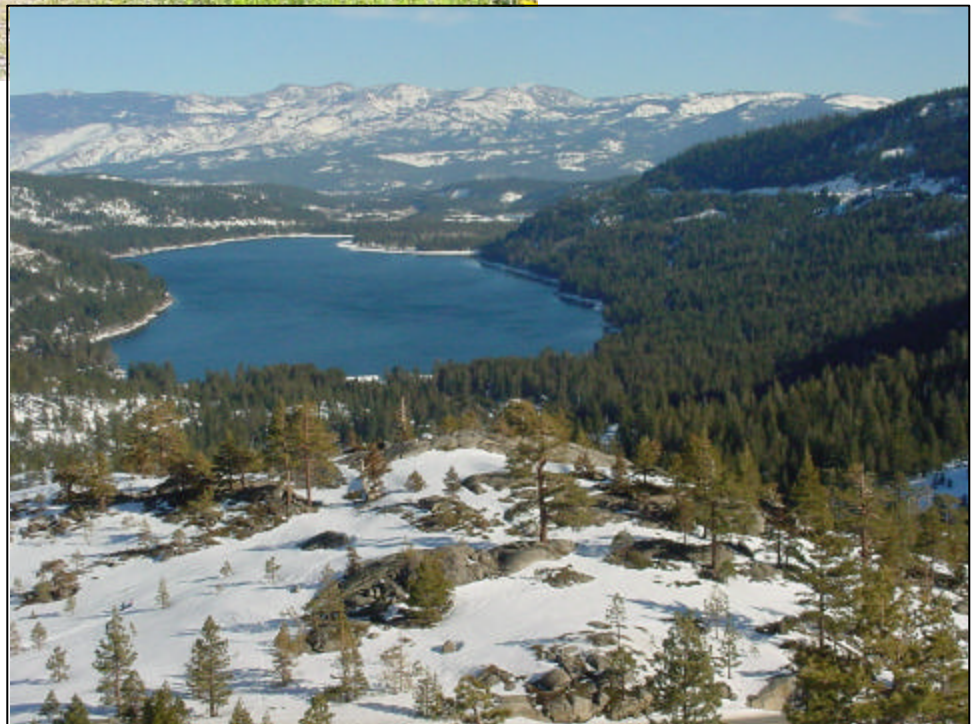


Vegetation Establishment Guidelines for the Sierra Nevada Foothills and Mountains



High Sierra
Resource
Conservation and
Development
Council

2005



VEGETATION ESTABLISHMENT GUIDELINES FOR THE SIERRA NEVADA FOOTHILLS AND MOUNTAINS

Introduction

These vegetative guidelines were prepared to address soil stabilization and accelerated erosion for construction activities in the Sierra foothills. Establishing vegetation is a very effective means of stabilizing soil and reducing accelerated erosion. Vegetative measures can be characterized as temporary or permanent. Temporary measures are designed to provide short-term protection until permanent measures can be installed. Permanent measures are installed once construction is completed. It is important to remember that vegetative measures need to be combined with runoff and sediment control measures in order to be effective.

Runoff and sediment control measures can be found in this handbook or in the California Stormwater Best Management Practice (BMP) Handbooks (available at www.casqa.org). Designers will need to consult with their local USDA Natural Resources Conservation Service Office for soils information and local departments of public works and/or transportation for specific hydrologic and hydraulic analysis procedures.

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VEGETATION ESTABLISHMENT GUIDELINES FOR THE SIERRA NEVADA FOOTHILLS AND MOUNTAINS

This document addresses vegetative erosion control practices. Vegetation by itself cannot control “concentrated flow” erosion. However, vegetation is the most cost effective means of controlling sheet and rill erosion on disturbed sites. Revegetation can take many forms, from establishing a natural ground cover to landscaping using ornamental plants. In all cases, the plantings must be compatible with soil conditions, climatic factors, and topography. The emphasis of these vegetation guidelines is to utilize grasses and legumes that are proven to be successful for short and/or long-term erosion control. Contact local nurseries and landscape architects for information on types of ornamentals to plant in disturbed areas. If native grasses/legumes are desired for erosion control, contact the California Native Grasslands Association (<http://www.cnga.org/index.php>), the California Native Plant Society (<http://www.cnps.org/>), or other groups specializing in their use.

Shrubs and trees can be planted from seed but are difficult to establish in a natural environment. The availability of shrub and tree seed can also vary widely from year to year. Planting of bare-root stock or potted plantings requires supplemental irrigation in the first year and a high degree of maintenance. They are also subject to damage by deer, rabbits, rodents, insects and disease.

Incorporating native vegetation and landscaping with introduced shrubs and trees will provide additional protection from erosion. Once established, shrubs and trees can provide a deep-rooting system and canopy that provide additional permanent protection to the area(s) seeded with grasses. However, shrubs and trees usually take longer to establish and are slow growing.

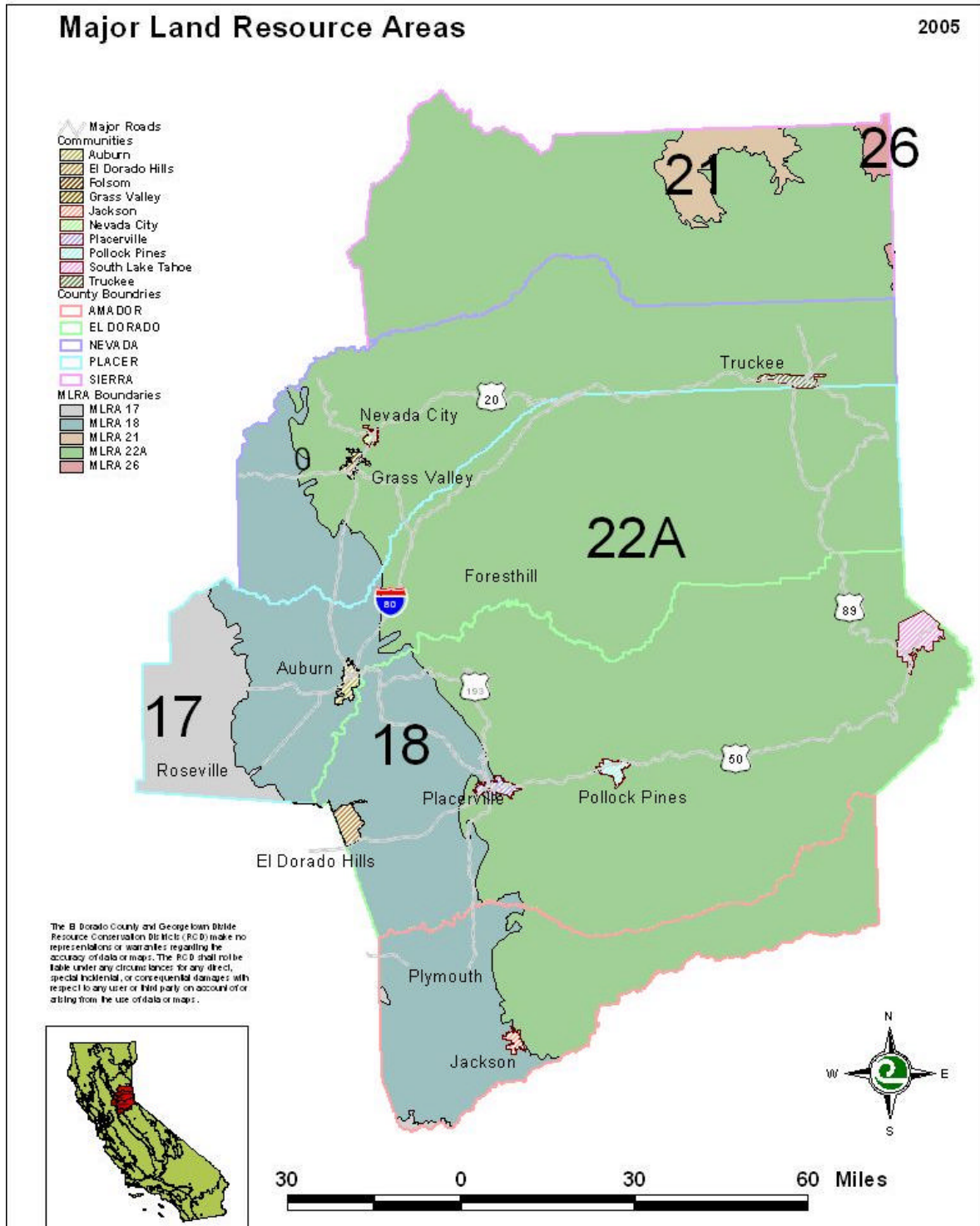
MAJOR LAND RESOURCE AREAS

The climate, topography, soils and vegetation are very diverse in the Sierra Nevada Foothill and Mountain counties. Plant needs vary from one species or variety to another in relation to soils and climatic conditions. Planting dates are critical and are related to soil type/conditions, exposure, temperature and precipitation patterns/amounts.

For these reasons, the Foothill and Mountain areas are divided into four areas called “Major Land Resources Areas” (MLRA.). This system has been refined since its initial use in California by the U.S. Department of Agriculture, Soil Conservation Service (now the Natural Resources Conservation Service or NRCS). It is important to know in which MLRA your project is located in the selection of seeding mixtures, seeding rates, dates of seeding, and fertilizer rates. The following narrative descriptions will be helpful in determining the area you are concerned with. These have been tailored to meet the conditions in the Sierra counties.

These guidelines do not guarantee the successful establishment of vegetation. As mentioned in the introduction, successful establishment of vegetation is dependent on successful runoff control. Furthermore, these guidelines do not guarantee the vegetation establishment will be suitable for all applications. The long-term success of vegetation establishment can be difficult. Vegetative establishment failures are often attributed to poor timing of seeding, poor soil conditions, improper seed mix and/or plant selection, or harsh climatic conditions.

Therefore, these vegetative establishment guidelines will include a statement of “limiting factors” for each MLRA. The limiting factors serve as a guide to the planning considerations that will improve the likelihood of success.



The local USDA *Natural Resources Conservation Service* offices have detailed maps showing these various MLRAs.

MLRA 17

This MLRA makes up about 18,650 square miles (48,330 square kilometers). Over four-fifths of the Sacramento and San Joaquin Valley area is in farms and ranches. The cropland in this MLRA represents about one-third of the cropland in California, and the irrigated cropland over four-fifths of the irrigated land in the state. Crops grown include cotton, fruits, nuts, grapes, hay, grain, pasture, rice, alfalfa, citrus, and tomatoes. Soils are mostly Alfisols, Aridisols, Entisols, Mollisols and Vertisols with a thermic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. Almost equal amounts of ground and surface water provides the water utilized within the area.

From north to south, some of the major towns and cities in this area include Redding, Red Bluff, Chico, Yuba City, Marysville, Woodland, Davis, Vacaville, Fairfield, Sacramento, Stockton, Modesto, Merced, Madera, Firebaugh, Fresno, Hanford, Visalia, and Bakersfield. Interstate Highway 5 traverses the entire length of this area as does California State Highway 99. Interstate Highway 80 crosses the midpoint of this area in Sacramento. Beale and Travis Air Force Bases are all in this area. The Sacramento Army Depot, Lemoore Naval Air Station, and Naval Petroleum Reserves #1 and #2 are also in this MLRA. There are numerous National Wildlife Refuges throughout this area. The Central Valley is part of the Pacific migratory waterfowl flyway.

Physiography

All of this area is in the Pacific Border province of the Pacific Mountain System physiographic division. Almost all this MLRA is in the California Trough section. Small areas along the western border are in the California Coast Ranges section. This area includes the valley basins adjacent to the Sacramento and San Joaquin Rivers, fans and flood plains of tributary streams, and terraces and foothills around the edge of the valley. Elevation ranges from sea level to 660 feet (200 meters) in the foothills surrounding the Central Valley. The valley floor is almost flat and relief is small even along the borders of this area.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Tulare-Buena Vista Lakes (1803), 42 percent; Sacramento (1802), 31 percent; and San Joaquin (1804), 27 percent. The two largest rivers in California, the Sacramento and San Joaquin, are in this MLRA. The major water supply reservoirs on the Sacramento River and its tributaries are just outside the north and east boundaries of this area. A stretch of the American River below Folsom Lake has been designated as a National Wild and Scenic River. Two major canals are in this area. The state-owned California Aqueduct and the federal Delta-Mendota Canal move water from northern California, from the California Delta, to Buena Vista Lake just southwest of Bakersfield.

Geology

California's Great Valley is underlain by up to 8 or 9 miles of sediments derived from the adjacent uplands and deposited in a variety of marine and non-marine environments. The Great Valley began to separate from the open ocean very roughly 150 million years ago, when subduction of Franciscan marine sediments and volcanics beneath the edge of the old ocean floor jacked it up and created a barrier to movement of sediments. The oldest sediments were derived in large part from the early Sierra Nevada's volcanoes and deposited in a deeper marine environment. The composition of the sediments shifted as the volcanic cover was stripped off,

exposing the granites of the Sierra Nevada Batholith to erosion. At the same time, the Valley started to fill and deposition was occurring in an increasingly shallow marine environment, particularly in the Sacramento Valley where, by roughly 50 million years ago, shallow marine environments started giving way to non-marine depositional processes. The interbedded layers of clays, sands, silts, and gravels strongly influence subsurface hydrology, and are a source of gas reserves in the Sacramento Valley and oil and gas reserves in the deeper San Joaquin Valley.

The uppermost sediments reflect a recent history of sedimentation in a variety of non-marine depositional environments. Finer-grained deposits are typically associated with floodplains, basins, and lakes. Coarser grained sands and gravels are deposited in stream channels and across alluvial fans. Erosional remnants of gravelly stream terraces and older sedimentary formations are also present, especially along the edges of the Valley Sutter Buttes in the northern Sacramento River valley, which are the eroded remnants of a volcano.

Climate

The average annual precipitation is from 5 to 12 inches (125 to 305 millimeters) in the San Joaquin Valley. The Tulare Basin at the southern end of this MLRA typically receives less than 6 inches (150 millimeters) of rainfall per year. The average annual precipitation is from 12 to 30 inches (305 to 760 millimeters) over most of the Sacramento Valley. Average annual rainfall of 40 inches (1,015 millimeters) occurs at the higher elevations at the edges of the valley at the north end. Summers are long, hot, and dry, and winters are cool and rainy. Most of the rainfall occurs as low to moderate intensity, Pacific frontal storms during the winter from October to May. Snow is very rare in this area but has occurred in the Sacramento Valley from Sacramento to points farther north. The average annual temperature is from 59 to 67 degrees F (15 to 20 degrees C), decreasing from south to north. The average frost-free period is 325 days (280 to 365 days), decreasing with elevation and from south to north.

Soils

The dominant soil orders in the MLRA are Alfisols, Aridisols, Entisols, Mollisols and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. They are generally very deep, well or moderately well drained, and loamy or clayey. Some soils are shallow to a duripan.

Durixeralfs (Redding and San Joaquin series) and Palexeralfs (Newville series) formed in alluvium on terraces. Haplocambids (Cerini and Panoche series) formed in alluvium on alluvial fans. Haplargids (Milham series) formed in alluvium on alluvial fans and terraces. Xeropsamments (Delhi series), Xerorthents (Hanford series) and Torriorthents (Hesperia and Kimberlina series) formed in alluvium on floodplains, fans and terraces. Haploxerolls (Grangeville and Nord series) formed in alluvium on alluvial fans and floodplains. Haploxererts (Capay series) formed in alluvium on alluvial fans and flats. Very poorly drained Endoaquerts (Willows series) formed in alluvium in basins.

Biological Resources

This area supports naturalized annuals and scattered trees. Wild barley, wild oats, soft chess, ripgut brome, red brome, foxtail fescue, burr clover, and filaree are dominant species. Scattered oaks on terraces and oak, willow, and cottonwood grow along the rivers and streams and in the

overflow areas. Saltgrass, along with such shrubs as iodinebush and Australian saltbush, grow on saline-sodic soils on terraces and in basins.

Some of the major wildlife species in this area are rabbits, coyote, fox, ground squirrel, pocket gopher and various song birds. The species of fish in the area include salmon, striped bass, steelhead, shad, sturgeon, largemouth bass, smallmouth bass, bluegill, and catfish. Portions of the area are extremely important for over wintering waterfowl and seasonally neo-tropical migrants.

MLRA 18

This MLRA makes up about 8,160 square miles (21,145 square kilometers). About four-fifths of the Sierra Nevada Foothills area is in farms and ranches with the production of livestock on range the principal enterprise. The vegetation consists primarily of soft chess, wild oats, filaree, burr clover and ripgut brome and an overstory of scattered individual to very dense stands of blue oak, scrub live oak and foothill pine. Soils are mainly Alfisols, Entisols, Inceptisols, and Mollisols with a thermic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. Almost equal amounts of ground and surface water provides the water utilized within the area. There are numerous reservoirs storing water for use outside this area.

The towns of Auburn, Folsom, Cameron Park, Oroville and Ione are in the north half of this area. The western edges of the Lassen, Plumas, Sierra, and Sequoia National Forests are in this MLRA. The Tule Indian Reservation is in the southern portion of this area. California State Highway 49 traverses the middle third of this MLRA and Interstate Highway 80 crosses its mid point.

Physiography

This area straddles the boundary between two physiographic provinces in the Pacific Mountain System division. Most of the western half is in the California Trough section of the Pacific Border province. Most of the eastern half is in the Sierra Nevada section of the Cascade-Sierra mountains province. The Sierra Nevada Mountains are a fault-block mountain range. The fault on the east side of the mountains created a steep face of alpine summits but the west side is a more gentle slope from east to west. This area is at the toe of that gentle east-west slope. It is an area of rolling to steep dissected hills and low mountains. The stream valleys are narrow and fairly steep. Elevation ranges from 660 to 1,650 feet (200 to 505 meters), but on some isolated mountain peaks it is 3,950 feet (1,205 meters).

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: San Joaquin (1804), 36 percent; Tulare-Buena Vista Lakes (1803), 35 percent; Sacramento (1802), 26 percent; and Northern Mojave-Mono Lake (1809), 3 percent. Many of the streams crossing this area were hydraulically mined for placer gold from 1849 to 1900. Some of the major streams in this area draining the Sierra Nevada Mountains from north to south include, Butte, Feather, Yuba, American, Cosumnes, Mokelumne, Tuolumne, San Joaquin, Kings, and Kern Rivers. Numerous federal and state water project reservoirs are in this area, including Lakes Oroville, Collins, Englebright, Camp Far West, Folsom, Comanche, Pardee, New Hogan, New Melones, Don Pedro, McClure, Millerton, Pine Flat, Kaweah, Success, and Isabella.

Geology

The northernmost end of this area is underlain predominantly by volcanic mudflow and pyroclastic rocks of the Tuscan Formation, which was derived from the eruption of Cascade volcanoes during the Pliocene, roughly 3-4 million years ago. South of about Oroville, the foothills are underlain by Mesozoic-age, metamorphosed marine sedimentary and volcanic rocks emplaced as terranes when the subduction trench was located in the vicinity of the present-day Sierra Nevada Mountains. Discrete granitic plutons are intruded through the older Mesozoic metamorphics in the northern portion, and a thin band of Tertiary-age sedimentary formations is exposed along the eastern edge from the Cosumnes River south. From around Merced southward, the foothills are underlain predominantly by Mesozoic-age granites of the Sierra Nevada Batholith, with local exposures of gabbro, metavolcanics, and other metamorphics. Tertiary-age sedimentary formations and Quaternary-age alluvial terrace deposits extend westward from the granitics in the vicinity of Bakersfield.

Climate

The average annual precipitation is from 18 to 45 inches (455 to 1,145 millimeters) in most of the area. Annual precipitation increases from south to north and with elevation. The average annual rainfall is as little as 8 inches (205 millimeters) in the extreme southern end of this area and as much as 68 inches (1,730 millimeters) in the extreme northern end. Summers are hot and dry, and winters are cool and moist. Most of the rainfall occurs as Pacific frontal storms during the winter from October to May. The average annual temperature is from 47 to 67 degrees F (8 to 20 degrees C). The average frost-free period is 275 days (180 to 365 days), decreasing from south to north and with elevation.

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, a xeric soil moisture regime, and mixed mineralogy. They are generally very shallow to deep, well drained or somewhat excessively drained, and loamy.

Haploxeralfs (Ahwahnee, Auberry, Blasingame, Coarsegold, and Sobrante series), Xerorthents (Cieneba and Dalton series), Haploxerepts (Auburn, Toomes, and Vista series), Argixerolls (Arujo and Supan series), and Haploxerolls (Pentz and Walong series) formed in residuum on mountains, foothills, and footslopes.

Biological Resources

This area supports naturalized annual grasses, shrubs, and trees. Soft chess, wild oats, filaree, burr clover, riggut brome, and foxtail fescue are dominant species on grassland. An overstory of scattered individual to very dense stands of blue oak and foothill pine, with scrub live oak as an important component, grow in some places. Chamise, manzanita, wedgeleaf ceanothus, yerba santa, and poison-oak are dominant on brushland. Scattered stands of ponderosa pine, mixed with manzanita and black oak, are at the upper elevations.

Some of the major wildlife species in this area are black-tailed deer, mountain lion, coyote, gray fox, raccoon, porcupine, skunk, jackrabbit, ground squirrel, pocket gopher, brown rat, field mouse, valley quail, band-tailed pigeon, red-headed woodpecker, mourning dove, mallard, cinnamon teal, wood duck, and rattlesnake. The species of fish in the area include black bass, bluegill, crappie, bluegill, trout, salmon, steelhead and catfish.

MLRA 21

This area is in California (65 percent) and Oregon (35 percent) (fig. 21-1). This MLRA makes up about 11,500 square miles (29,790 square kilometers). The Klamath and Shasta Valleys and Basins are mostly rangeland and forestland with a minor amount of cropland. The rangeland areas support a shrub-grassland plant community with big sagebrush being the dominant shrub. Bluebunch wheatgrass and Idaho fescue are the dominant grasses. Ponderosa pine, white fir, and Douglas-fir are the dominant tree species in the forested areas. The cropland is mostly irrigated and used for growing potatoes, grain, seed crops, hay, and pasture. The area is characterized by plateaus and valleys and basins surrounded by relatively short north-south tending mountain ranges. Most of the mountain ranges are fault blocks that have been tilted up but there are some isolated volcanic peaks. Another characteristic of this MLRA are the many shallow lakes scattered throughout the area. The soils are mostly Mollisols. The soil temperature regimes are mesic and frigid and the soil moisture regime is xeric. At the higher elevations the soils have a cryic or frigid soil temperature regime and an udic soil moisture regime. The primary resource concerns are water quantity and quality and soil erosion.

The towns of Alturas, Adin, Canby, Yreka, and Fall River Mills, California and Klamath Falls, Lakeview, Malin, and Merrill, Oregon occur in this MLRA. Numerous National Forests occur in this MLRA including the Klamath, Modoc, Fremont, Lassen, Plumas and Shasta.

Physiography

This area is in a transition zone between the Basin and Range province to the southeast, the Cascade and Klamath Mountains to the west and northwest, and the Sierra Nevada Mountains to the south. Most of this MLRA is located within the Modoc Plateau subprovince of the Basin and Range geomorphic province. The Shasta River Valley portion of this MLRA near Yreka is located along the western edge of the Cascade Range near the Klamath Mountains, while the Scott River Valley portion is located further west within the Klamath Mountains province. The Modoc portion of this MLRA is characterized by a vast volcanic upland interspersed with numerous reservoirs, lakes, and narrow stream valleys that comprise the Pit and Klamath River drainages; hydrologically separate, internally-drained basins with lakes or periodically dry lakebeds; and isolated volcanic peaks.

Elevation typically ranges from 2,600 to 4,600 feet (800 to 1,400 meters), but there are many mountain peaks that exceed 7,000 feet (2,130 meters) and a few peaks in Oregon exceed 8,000 feet (2,440 meters). Lava plateaus and many valleys and basins make up most of the area. Steep mountain spurs and rimrock escarpments surround the plateaus. The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Klamath-Northern California Coastal (1801), 47 percent; Sacramento (1802), 36 percent; North Lahontan (1808), 11 percent; and Oregon Closed Basins (1712), 6 percent. The Klamath River begins in this area.

Geology

The Modoc portion of this MLRA is underlain at depth by Cenozoic volcanic rocks, with surface exposures dominated by Miocene- to Pleistocene-age “flood basalts” and rhyolite ash. Andesites, volcanic mudflow deposits, and rhyolitic intrusives are also present. Volcanism and the extrusion of flood basalts occurred as a result of crustal thinning and extension associated with development of the Basin and Range. Valleys are typically underlain by recent alluvial, lacustrine, and dry lakebed (playa) deposits. Pliocene to Pleistocene-age non-marine sedimentary deposits (including fan and stream terraces and old lake deposits) underlie portions of many of the basins.

The geology of the Shasta River Valley portion of this MLRA is complex, reflecting its location between the Klamath and High Cascades Province. Uplands in the northern and western part of the area are underlain by pre-Cenozoic metamorphics and sedimentary formations, while the eastern portion is dominated by Tertiary and Quaternary volcanics.

The Scott River Valley portion of this MLRA is underlain by alluvium and alluvial terrace deposits derived from the nearby Klamath Mountains, which are locally composed of Pre-Cenozoic metamorphic, granitic, and ultramafic rocks.

Climate

The average annual precipitation is from 12 to 30 inches (306 to 760 millimeters) over most of this area. There are small, high elevation areas on the western and southwestern edges of this MLRA where the average annual precipitation is much higher, 30 to 58 inches (760 to 1,470 millimeters). These higher precipitation zones also occur in the scattered mountain ranges throughout the rest of this area. Most of the rainfall occurs as low to moderate intensity, Pacific frontal storms during the winter. At higher elevations, rain generally turns to snow. Snow may fall at lower elevations in winter but does not last. Summers are dry. The average annual temperature is from 39 to 52 degrees F (4 to 11 degrees C). The average frost-free period is 130 days (70 to 185 days), decreasing with elevation.

Soils

The dominant soil order in the MLRA is Mollisols. There are small areas of Inceptisols and Histosols in the basins. The soils in the area dominantly have a mesic or frigid soil temperature regime, a xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are well drained except in the basins where they may be poorly or very poorly drained. They generally have loamy, clayey, or sandy textures, and are shallow to very deep.

Argixerolls formed in residuum (Lorella and Orhood series) and in residuum mixed with loess and/or volcanic ash (Devada, Royst, and Woodcock series) on plateaus, hills and mountains. Haploxerolls (Fordney series) formed in sandy alluvium on terraces. Haploxerolls (Petescreek series) formed in residuum on hills and mountains. Palexerolls (Booth series) formed in colluvium on plateaus, hills and mountains. Durixerolls (Salisbury series) formed in old alluvium on terraces. Humaquepts (Tulana series) formed in lacustrine sediments on lacustrine bottoms. Haplohemists (Lather series) formed in organic material in marshes.

Biological Resources

This area supports a cover of shrubs interspersed with annual and perennial grasses. Nevada bluegrass, Sandberg bluegrass, Idaho fescue, and bluebunch wheatgrass are major species. Soils in basins and meadows have a cover of sedges, wiregrass, slender wheatgrass, creeping wild rye, and bluegrass. Sagebrush, rabbitbrush, bitterbrush, and mountain mahogany are the dominant shrubs. Western juniper is common, and scattered ponderosa pine grows in the lower elevation foothills. In the higher elevations there are forests of ponderosa pine, Douglas-fir, white fir, and California red fir, and bitterbrush and ceanothus are in the understory.

Some of the major wildlife species in this area are elk, mule deer, antelope, golden eagle, red-tailed hawk, prairie falcon, great horned owl, barn owl, sage grouse, and chukar.

MLRA 22A

This area is mainly in California (98 percent) with a portion in western Nevada (2 percent). This MLRA makes up about 18,850 square miles (48,800 square kilometers). The Sierra Nevada is almost entirely coniferous forest used for forest products, wildlife habitat, watershed and recreation. Dominant tree species include Ponderosa pine, Douglas-fir, incense-cedar, sugar pine, white fir, California red fir, Jeffrey pine, and lodgepole pine. It is a strongly asymmetric mountain range with a long gentle western slope and a steep eastern escarpment. Most of the soils are Alfisols, Entisols, Inceptisols, Mollisols and Ultisols. The soils in the area dominantly have a mesic, frigid or cryic soil temperature regime, depending largely on elevation, a xeric soil moisture regime, and mixed mineralogy. This area is a major source of water. Much of this water is stored in large reservoirs and is used in the Sacramento and San Joaquin Valleys and in southern California. The erosion hazard is severe on the soils if the vegetative cover is depleted or destroyed by overgrazing or fire. Preventing and controlling wildland fires is a major resource management objective in this area.

There are few large communities. Quincy, South Lake Tahoe and Truckee, California, occur in this MLRA. The majority are smaller communities such as Markleville, Colfax or Kernville. A major portion of this MLRA is comprised of National Forests including the Eldorado, Inyo, Plumas, Sierra, Sequoia, Stanislaus, and Tahoe. Yosemite and Sequoia-Kings Canyon National Parks occur in this area. Mount Whitney, the highest elevation in the continental U.S. occurs in this area. Numerous Indian Reservations occur in this MLRA including the Berry Creek Rancheria, Enterprise Rancheria, Greenville Rancheria, Jackson Rancheria, Sheep Ranch Rancheria, and Tuolumne Rancheria. Interstate 80 crosses the center of this area.

Physiography

This area lies entirely within the Sierra Nevada section of the Cascade-Sierra Mountain Province of the Pacific Mountain System. The MLRA consists of the higher elevations of the Sierra

Nevada mountain range. It is a strongly asymmetric mountain range with a long gentle western slope and a steep eastern escarpment. It is characterized by hilly to steep mountain relief with occasional mountain valleys. It is 50 to 80 miles wide and runs in an approximately north south direction through Eastern and Central California for more than 400 miles.

Elevation ranges from 1,500 to 9,000 feet (500 to 2,400 meters) in most of the area. The highest peaks can exceed 12,000 feet (3,700 meters). Mount Whitney, at 14,494 feet (4,418 meters), is the highest point in the lower 48 states. These strongly sloping to precipitous mountains have unstable slopes and sharp crests. Valleys are typically narrow and are filled with alluvium. Almost all the valleys contain streams with actively eroding banks.

The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: (1802), 31 percent; (1804), 31 percent; (1803), 20 percent; (1605), 10 percent; (1809), 7 percent; and (1808), 1 percent. The American, Carson, Kern, San Joaquin, Truckee, Walker and Yuba Rivers originate in this area.

Geology

The majority of the area is dominated by plutonic (dominantly quartz monzonite and granodiorite) rocks of Mesozoic age, otherwise known as the Sierra Nevada batholith. The north half of the range is flanked on the west by the western metamorphic belt, an area of strongly deformed and metamorphosed sedimentary and volcanic rocks of the Paleozoic and Mesozoic age. Farther south scattered remains of these metamorphic rocks are located within the batholith on the western edge or along the crest of the range. Of minor extent, volcanic activity has also produced lava flows of the Miocene age. The valleys are filled with relatively coarse alluvium since most of the sediments have not moved far from their source.

Gold occurs as lode deposits in Mesozoic metamorphic rocks of the western foothills, where heat generated from the intrusion of the Sierra Nevada batholith mobilized and concentrated the gold in quartz veins. The most productive districts are located in the “Mother Lode” belt in the northern and central Sierra Nevada. Placer deposits of gold, which accounted for more than 40 percent of California’s total gold output, are found in Tertiary stream gravels in the northwestern Sierra, and in recent stream channels where gold-bearing rocks eroded from areas near the Sierran crest are transported towards the Sacramento and San Joaquin River valleys. Hydraulic mining was the largest source of gold from 1853 until the practice was curtailed by court order in 1884. The practice resulted in the erosion and transport of large volumes of sediment to depositional sites as far as the San Francisco Bay, severely impacted stream form, function, and navigability.

Pleistocene to Recent glaciers have shaped the Sierra Nevada Range by scouring out cirques, U-shaped valleys, and other glacial erosional features, depositing poorly sorted till in glacial moraines, and influencing streamflow patterns by contributing variable amounts of runoff and periodically forming ice dams and lakes. The intermontaine valleys are filled with relatively glacial deposits and with coarse alluvium since most of the sediments have not moved far from their source.

Climate

The average annual precipitation is from 40 to 80 inches (1,020 to 2,040 millimeters) in much of the area but as low as 25 inches (625 mm) in the lower valleys and foothills and as much as 100

inches (2,540 mm) on the mountain peaks. Precipitation increases with elevation and from south to north. Summers are dry, but there are occasional thundershowers. Much of the winter precipitation is snow. The average annual temperature is from 28 to 57 degrees F (-2 to 14 degrees C), decreasing with elevation. The average frost-free period is 100 days (30 to 180 days) in most of the area, decreasing with elevation. The longest frost-free period occurs along the western edge at the lower elevations.

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, Inceptisols, Mollisols and Ultisols. The soils in the area dominantly have a mesic, frigid or cryic soil temperature regime, depending largely on elevation, a xeric soil moisture regime, and mixed mineralogy. They are generally very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils in the MLRA formed in residuum and colluvium on hills and mountains. Soils at an elevation below 1,200 to 1,500 meters include deep or very deep Haplohumults (Sites and Aiken series), Haploxeralfs (Secca, Holland, and Cohasset series), Haploxerults (Josephine series), moderately deep Haploxerults (Mariposa series), all formed in material weathered from metavolcanic and metasedimentary rocks. Deep and very deep Dystroxerepts (Chaix and Shaver series) formed in granodiorite.

Soils at higher elevations formed in residuum and colluvium include deep and very deep Haploxeralfs (Holland and Musick series), Xeropsamments (Cagwin, Corbett and Toiyabe series), Dystroxerepts (Meeks series) formed in granodiorite. Dystroxerepts (Umpa series), Haploxerands (Meiss series), Vitrixerands (Waca and Windy series) formed in andesite. Large areas of rock outcrop are scattered throughout the area and on broad expanses on ridge crests and peaks above timberline 7,875 to 8,850 feet (2,400 to 2,700 meters). Soils in mountain valleys formed in mixed alluvium are Dystroxerepts (Gefo and Jabu series), Argicryolls (Macareeno series), and Haploxeralfs (Inville series).

Biological Resources

This area supports montane coniferous forest vegetation. Ponderosa pine, Douglas-fir, incense-cedar, sugar pine, white fir, California red fir, Jeffrey pine, lodgepole pine, mountain hemlock, California black oak, Oregon white oak, canyon live oak, and tanoak are major tree species. Bristlecone pine grows in protected draws at elevations above 8,850 feet (2,700 meters). Bluegrass, hairgrass, sedges, wiregrass, clovers, and wild iris grow in montane meadows. Manzanita, sagebrush, blue wild rye, fescues, bluegrasses, and mountain brome are common understory species occurring in open stands of timber.

Some of the major wildlife species in this area are black-tailed deer, mountain lion, bighorn sheep, coyote, bobcat, gray fox, raccoon, skunk, jackrabbit, gray squirrel, ground squirrel, rattlesnake, California condor, turkey vulture, roadrunner, crow, quail, band-tailed pigeon, blackbird, and mourning dove.

The species of fish in the area include rainbow, brown, brook cutthroat and golden trout, and anadromous salmonids, and northern pike minnow.

MLRA 26

This area is in Nevada (75 percent) and California (25 percent) (fig. 26-1). This long, narrow MLRA makes up about 6,520 square miles (16,890 square kilometers). Much of the area is used as rangeland and wildlife habitat. Rapidly expanding urban and suburban areas are common along the valleys and foothills of the eastern Sierra Nevada. The valleys have irrigated farmland, primarily producing alfalfa hay and improved pasture. Large portions of the area are under federal jurisdiction and are used primarily as rangeland, and wildlife habitat. Soils are mostly Aridisols and Mollisols with mesic soil temperature regimes. Ground water and surface water from major streams and rivers provide water for agriculture, industry, and urban development.

The cities of Carson City, Reno, and Sparks, Nevada occur in this MLRA. The Plumas, Toiyabe, and Inyo National Forests occur in this area. The Washoe and Reno-Sparks and the western part of the Walker River Indian Reservations also occur in this area. The lower east slope of the Sierra Nevada and northern part of the Excelsior Mountains occur in this MLRA.

Physiography

Almost all of this area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus physiographic division. Isolated, north-south-trending mountain ranges are separated by aggraded desert plains. The mountains are uplifted fault blocks with steep side slopes. Most of the valleys are drained by three major rivers flowing east across this MLRA. A narrow strip along the western border of this area is in the Sierra Nevada section of the Cascade-Sierra Mountains province within the Pacific Mountain System major division. The Sierra Nevada Mountains are primarily a large fault block that has been uplifted with a dominant tilt to the west. This structure leaves an impressive wall of mountains just west of this area. Parts of this eastern face, but mostly just foothills, mark the western boundary of this area.

Elevation ranges from 3,900 to 6,550 feet (1,200 to 2,000 meters) in valleys, but mountain crests are as high as 13,100 feet (4,000 meters). The extent of the major Hydrologic Unit Areas (identified by four-digit numbers) that make up this MLRA is as follows: Central Lahontan (1605), 72 percent; Northern Mojave-Mono Lake (1809), 16 percent; North Lahontan (1808), 7 percent; and Central Nevada Desert Basins (1606), 5 percent. The Truckee River originates at Lake Tahoe and runs through Reno, Nevada on its way east to its terminus just outside this area in Pyramid Lake. The headwaters of the Carson River run through Carson City which flows to its terminus just outside this area in the Carson Sink below the Lahontan Reservoir. The East and West Walker Rivers join to form the Walker River in the southern tip of this area. The Walker river flows into Weber Reservoir and then on to its terminus, Walker Lake, just outside this area.

Geology

Mesozoic and Tertiary intrusives are common in this area. These rocks are granitic near the Sierra Nevada Mountains on the west side but are typically andesite and basalt in the rest of the area. There are some young tuffaceous sediments in this MLRA and a complex of Mesozoic sediments and volcanic rocks also occur on the edges of uplifted fault blocks. Alluvium fills the valleys between the mountains. The major rivers in this area have reworked the alluvium forming prominent terraces and floodplains. There is a level line seen on the higher slopes marking the former extent of glacial Lake Lahontan.

Climate

The average annual precipitation is from 5 to 36 inches (130 to 910 millimeters), increasing with elevation. Most of the rainfall occurs as high intensity, convective storms in spring and in autumn. Precipitation is mostly snow in winter. Summers are dry. The average annual temperature is from 37 to 54 degrees F (3 to 12 degrees C). The average frost-free period is 115 days (40 to 195 days), decreasing with elevation.

Soils

The dominant soil orders in the MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an aridic or xeric soil moisture regime, and mixed or smectitic mineralogy. They generally are well drained, clayey or loamy and often skeletal, and very shallow to moderately deep.

Argixerolls (Duco and Ister series) formed in residuum and colluvium on hills and mountain slopes. Argidurids (Fulstone, Reno and Smedley series) and very deep Haplocambids (Haybourne series) formed in alluvium on alluvial fans, terraces, and piedmonts. Haplargids (Old Camp and Xman series) and Argidurids (Lapon series) formed in residuum and colluvium on hills, plateaus, and mountain slopes. Very deep Torriorthents (Yerington series) formed in alluvium and eolian sand on plains and alluvial fan remnants.

Biological Resources

This area supports shrub-grass vegetation characterized by big sagebrush, with low sagebrush and Lahontan sagebrush on some soils. Antelope bitterbrush, squirreltail, desert needlegrass, Thurber needlegrass, and Indian ricegrass are important associated plants. Green ephedra, Sandberg bluegrass, Anderson peachbrush, and several forb species also are common. Juniper-pinyon woodland is typical on mountain slopes. Jeffery pine, lodgepole pine, white fir, and manzanita grow on the highest mountain slopes. Shadscale is the typical plant in the drier parts of the area. Sedges, rushes, and moisture-loving grasses grow on the wettest parts of the wet flood plains and terraces. Basin wild rye, alkali sacaton, saltgrass, buffaloberry, black greasewood, and rubber rabbitbrush grow on drier sites that have a high salt concentration.

Some of the major wildlife species in this area are mule deer, coyote, beaver, muskrat, jackrabbit, cottontail, raptors, pheasant, chukar, blue grouse, mountain quail, and mourning dove. The species of fish in the area include trout and catfish.

SEEDING OF GRASSES AND/OR LEGUMES

The revegetation of disturbed or cleared sites due to construction activities, as developed in this handbook, is restricted to grasses or grasses and legumes. All methods and procedures are listed in order of priority to be considered and completed.

Definition: Planting vegetation on critical areas.

Purpose: To stabilize soils and reduce or prevent erosion; to reduce damage from sediment and run-off to downstream areas and; to enhance natural beauty.

Applicability: Graded or cleared areas subject to erosion. Top of building pads need not be re-vegetated if the following criteria are met:

1. Pad area is level (maximum slope of less than 0.2%);
2. Mulch, fertilizer and seed are applied from the toe of the slope, up the pad slope, over the hinge point and 20 feet onto the pad; and
3. Accumulated water on the pad is controlled *by physical means*, such as diversion dikes/berms, and discharged through a slope drain (or equal) to a stable area.

PLANNING CRITERIA

Planning Criteria: Revegetation of critical areas require the following criteria for success:

- 1) **Criteria #1:** Site Determination: Identify the MLRA in which the project is located.
- 2) **Criteria #2:** Choose the vegetation type, seeding rate(s), and seeding date(s).
- 3) **Criteria #3:** Preparation of the seedbed.
- 4) **Criteria #4:** Determine rate and type of fertilizer.
- 5) **Criteria #5:** Determine the method of seeding.
- 6) **Criteria #6:** Determine mulching methods needed to protect the site until revegetation is established.
- 7) **Criteria #7:** Operation and Maintenance.

Planning Criteria #1: Site Determination:

Determine the elevation, climatic conditions, average annual precipitation, soils and soil condition(s), and the MLRA in which the project is located. Your local USDA-*Natural Resources Conservation Service* office can provide much of this information and assist in identifying the correct MLRA. Once the MLRA has been determined, grasses and legumes can be selected that are appropriate for the climate and soil conditions of the site to be re-vegetated. Site determination will also help specify fertilizer rates and appropriate application dates.

Planning Criteria #2: Selection of Seed Mixtures and Rates

Selecting the correct seed mixture and rate is based upon the site's MLRA location and the purpose of the seeding. All seed delivered to the site should be in conformance with the California State Seed Law of the California Department of Food and Agriculture. Each seed bag should be delivered to the site sealed and clearly marked as to species, purity, percent germination, dealer's guarantee, and the dates of test. The container should be labeled to clearly reflect the amount of Pure Live Seed (PLS) contained. The planting recommendations below assume 90% PLS and 90% germination. Actual field seeding rates may be higher based on the quality of the purchased seed. Calculate the PLS content of each bag of seed (or seed lot) using the formula:

$$\text{Percent PLS} = \text{Percent Germination} \times \text{Percent Purity}$$

These items are found on all seed tags. Calculate the Field Seeding Rate for each bag of seed as follows:

$$\text{Field Seeding Rate (lbs/acre)} = \text{Recommended Seeding Rate (lbs/acre PLS)} \times 100/\text{PLS}$$

Example:

Seed Tag

- 80% germination
- 90% purity
- Recommended Seeding Rate (PLS) = 15 lbs/acre

$$\text{PLS} = 80\% \times 90\% = 72\%$$

$$\text{Field Seeding Rate} = 15 \text{ lbs/acre} \times 100/72 = 20.83 \text{ lbs/acre}$$

All legume seed should be pellet inoculated with proper bacteria before planting. Inoculant sources should be species specific and should be applied at a rate of 2 lb of inoculant per 100 lb seed.

Temporary Seedings are used on those sites where the construction activities should not be completed by the start of the rainy season, October 1. Temporary seedings are of short duration, providing groundcover for one rainy season. Temporary seedings are ideal for areas that will be landscaped the following spring or summer.

Permanent Seedings are recommended on those sites where construction and grading activities have been completed or unfinished construction projects that require vegetative protection for more than one rainy season. Permanent seedings provide groundcover for one or more seasons. Grasses used for permanent seedings are perennials and/or self-reseeding annuals that provide long term cover.

Planning Criteria #3: Seedbed Preparation:

The area to be seeded should have a firm seedbed that has previously been roughened by scarifying, disking, harrowing, chiseling, or otherwise worked to a depth of 2 to 4 inches. Any

debris that would interfere with seeding operation, growth, or maintenance of the vegetative cover should be removed. Scarifying operations should be cross slope when possible. No implement should be used that will create an excessive amount of downward movement of soil or clods. The seedbed may be prepared at time of completion of earth moving work, or immediately before seeding.

When soil conditions are adverse for plant growth establishment (such as serpentine soils, droughty soil materials, shallow soil, etc), 2 to 4 inches of topsoil (or other fairly good soil material) should be spread evenly over the surface to provide a medium for plant germination.

Stockpiling of topsoil should be the first phase of cut and fill operations when suitable topsoil is present. It should be free of gravels, cobbles, stones, roots, trash and other extraneous materials larger than 1 ½ inches in diameter.

Topsoil should be applied after the sub-grade is scarified to a depth of 2 inches. It should be uniformly distributed to prevent any irregularities that would cause formation of depressions and should not be placed in a muddy condition or when the subsoil is excessively wet. Topsoil should have a minimum depth of 2 inches after compaction. Packing can be done by passing a bulldozer vertically over the area or by use of other suitable equipment. Care should be taken to avoid excessive downward movement of soil or clods. Bonding should be cross slope except when using a bulldozer for bonding and compacting.

SEEDING MIXTURE AND FERTILIZER RATES WITH ANNUALS FOR *TEMPORARY* COVER

MLRA 17, 18, 22A				
MIXTURE	LBS / ACRE **	LBS of P.L.S./1000 SQ. FT	Fertilizer rates of ammonium phosphate (16-20-0)*	
Briggs Barley	180	4.13	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Annual Rye Grass	24	0.55	300 lbs/ Acre	12 lbs/ 1000 sq.ft.

MLRA 21, 22A, 26				
MIXTURE	LBS / ACRE **	LBS of P.L.S./1000 SQ. FT	Fertilizer rates of ammonium phosphate (16-20-0)*	
Cereal Rye	60	1.37	400 lbs/ Acre	9 lbs/ 1000 sq.ft.
Annual Rye Grass	8	0.2	400 lbs/ Acre	9 lbs/ 1000 sq.ft.

* Those projects in areas in and around the Tahoe Basin should contact the appropriate agency(s) prior to using fertilizer.

** Rates based on broadcast seeding application

Standard seeding rates listed are based on the minimum acceptable pure live seed (PLS) standards (80%) for certified seed. When PLS is below 80%, seeding rates should be increased accordingly.

Permanent Seedings

Permanent seedings are used when the construction activities are completed and there are no more major soil moving activities. Permanent seed mixes are used to re-vegetate when the project has reached final grade. Annual grasses and annual legumes are prolific re-seeders. If allowed to mature in the spring, annual plants deposit seed for the next season and provide a substantial amount of plant residue. The residue provides soil protection into the next rainy season and an excellent germinating environment for next year's seed.

SEEDING MIXTURE AND FERTILIZER RATES WITH ANNUALS FOR *PERMANENT COVER*

MLRA 17, 18, 22A

MIXTURE	LBS / ACRE **	LBS of PLS/1000 SQ. FT	Fertilizer rates of ammonium phosphate (16-20-0)*	
Zorro Annual Fescue	6	.2	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Rose Clover (shallow soils with south or west exposure)	9	.2		
Blando Brome	12	.3	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Rose Clover (deeper soils or north exposure)	9	.2		
Blando Brome	12	.3	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Lana vetch	15	.4		

California Poppy and /or Lupine can be seeded in with any of these mixtures at a rate of 2 lbs/ Acre.

** Rates based on broadcast seeding application

Standard seeding rates listed are based on the minimum acceptable pure live seed (PLS) standards (80%) for certified seed. When PLS is below 80%, seeding rates should be increased accordingly.

SEEDING MIXTURE AND FERTILIZER RATES WITH PERENNIALS FOR *PERMANENT* COVER

MLRA 22A

MIXTURE	LBS / ACRE **	LBS of PLS/1000 SQ. FT	Fertilizer rates of ammonium phosphate (16-20-0)*	
Luna pubescent wheatgrass	24	.6	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Potomac orchard grass	8	.2		
Sherman big bluegrass	6	.15		
Duara hard fescue	6	.15		
Lutana cicer milkvetch	23	.53		
Luna pubescent wheatgrass	12	.3	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Tegmar intermediate wheatgrass	12	.3		
Potomac orchard grass	8	.2		
Sherman big bluegrass	6	.15		
Duara hard fescue	6	.15		
Lutana cicer milkvetch	23	.53		

MLRA 21, 26

MIXTURE	LBS / ACRE **	LBS of PLS/1000 SQ. FT	Fertilizer rates of ammonium phosphate (16-20-0)*	
Luna pubescent wheatgrass	18	.4	300 lbs/ Acre	12 lbs/ 1000 sq.ft.
Norden desert wheatgrass	12	.3		
Sherman big bluegrass	8	.2		

* Those projects in areas in and around the Tahoe Basin should contact the appropriate agency(s) prior to using fertilizer.

** Rates based on broadcast seeding application

Standard seeding rates listed are based on the minimum acceptable pure live seed (PLS) standards (80%) for certified seed. When PLS is below 80%, seeding rates should be increased accordingly.

For optimal germination, dates of seeding for permanent cover are critical. Seeding prior to recommended dates will cause seed to lose viability due to exposure and will be lost to insects and birds. If seeding is done after recommended dates it may not germinate because the weather is too cold and because it is subject to being washed away from concentrated rainfall.

Recommended seeding dates for successful germination are:

- 1) MLRA 17, 18, 22A – September 15 to October 15
- 2) MLRA 21, 26 – May 1 to June 30 (preferred) or after September 30 until such time as snow remains on the ground.

Planning Criteria #4: Determine Rate and Type of Fertilizer

Seeded areas need to be fertilized for two reasons. First, during construction activities the fertile top-soils are often mixed with infertile sub-soils. The resultant soil is rather infertile. An application of fertilizer will help insure re-growth. Secondly, construction sites typically have the potential for high erosion rates. Fertilizer will perpetuate rapid re-growth of vegetation. Fertilization rates (for ammonium phosphate 16-20-0) are included in the preceding tables.

Planning Criteria #5: Determine the seeding/fertilizer application method

Seed and fertilizer should be applied in a uniform manner to disturbed areas. Seed and fertilizer are typically applied at the same time, using the same method of application. There are basically two methods of seed and fertilizer application:

Method #1: Broadcast Seeding – The “broadcast” method uniformly distributes the seed/fertilizer over the soil surface by “broadcasting” the seed. Truck or tractor mounted automatic seeders are used on large sites. Breast seeders or “belly grinder” seeders are used for small areas, or on areas where trucks and tractors are impractical.

Grass, legumes and fertilizer may be mixed together in the specified proportions prior to broadcasting. However, all seed and fertilizer grains must be approximately the same size. Therefore, if different size seeds are selected, several passes will be necessary, one for each size seed.

Broadcasted seed should be in firm contact with soil and covered with mulch (see Planning Criteria #6). The best germination occurs when seeds are incorporated in ¼ to ½ inches of soil. This protects the seed and helps it take root. Raking should be done immediately following seeding. This can be done with agricultural rakes or spring toothed harrows set to run very lightly.

Method #2: Hydroseeding - Hydroseeding is the application of seed, fertilizer, tacking agent, and water as slurry. The slurry is then sprayed onto the site. Mulch is required following Hydroseeding (see mulching section).

Hydroseeding is an acceptable method of seeding, especially on steeper areas where broadcasting of seed is not practical. A properly prepared seedbed is recommended so the seed and fertilizer has good contact with the soil. Hydroseeding is suitable for large areas, steep slopes and/or sites that have excessive cobbles and stones.

The hydroseeder should be equipped with gear-driven pump and a paddle agitator. Agitation by re-circulation from the pump is not recommended. Agitation should be sufficient to produce homogeneous slurry of seed, fertilizer, and tacking agent in the designated proportions. Water should be applied at a rate of 3,000 gallons per acre. Wood fiber that has been dyed with a non-toxic substance should be added as an aid for uniform application at a rate of 500 pounds per acre.

No seed should be added to the slurry until immediately prior to beginning of the seeding operation. The time allowed between placement of seed in the hydroseeder and emptying of the hydroseeder tank should not exceed 30 minutes. Legume seed should be pellet inoculated

with the appropriate bacteria. Inoculation rates should be four times that required for dry seeding. Legume seed should be placed in the mixing tank after all other ingredients have been included, as pellet inoculated legumes may have the coating washed off in the mixing tank.

Tacking agent should be applied at 200 gallons of wet ingredients per acre. Apply 80 pounds of dry ingredients per acre to tackify straw mulch. Fertilizer of the specified formulation should be included at the specified rate. Both the hydroseeder manufacturer and the fertilizer manufacturer should be consulted regarding the appropriateness of the fertilizer for hydroseeder applications. If the fertilizer cannot be applied using the hydroseeder, broadcast using the methods presented above:

If Hydroseeding *is* selected, a “3-step” process is strongly recommended:

- **Step #1:** Hydraulically apply seed, fertilizer and slurry
- **Step #2:** Apply Straw Mulch
- **Step #3:** Hydraulically apply a tackifying agent or mechanically “punch-in” the straw mulch to secure the mulch to the slope. NOTE: If hydraulically applied mulch, such as wood fiber is used in step #2, a tackifying agent is not required, as most hydraulic mulches include it in the mulch slurry.

Method #3: “One-Step” Hydroseeding – “One-Step” Hydroseeding is identical to the method #2, Hydroseeding, with the addition of mulch and a tackifier. It is a process where the seed, fertilizer, **mulch and tackifier** are applied all at once, in one application. One-Step Hydroseeding should be completed between September 15 and October 15. If a one-step Hydroseeding is completed too early the nitrogen component of the fertilizer can escape as a gas, making the fertilizer less effective. If the mulch gets moist from an early rainfall, then becomes dry with no follow-up rain event, the seed can be weakened. Mulching is discussed in greater detail in Planning Criteria #6.

“One-Step” Hydroseeding after October 15 can be ineffective. Weather is often too cold and the days too short for effective germination and mulch often cannot withstand greater storm intensity. This scenario would result in inefficient slope protection before the heavy winter rains occur.

When hydraulic mulch is combined with seed, fertilizer and tackifier in one application, a portion of the seed is suspended in the mulch blanket. Therefore, a one-step application requires the seed rates to be increased by 25% to insure adequate seed-to-ground contact ratio.

As mentioned in the Hydroseeding section (method #1), the time allowed between placement of seed in the hydro seeder and emptying of the hydro seeder tank should not exceed 30 minutes. No seed should be added to the slurry until immediately prior to beginning the seeding operation. Legume seed should be pellet inoculated with the appropriate bacteria. Inoculation rates should be four times that required for dry seeding. Legume seed should be placed in the mixing tank after all other ingredients have been included, as pellet inoculated legumes may have the coating washed off in the mixing tank.

Planning Criteria #6: Selecting the appropriate mulch

The use of mulch in this handbook means the application of a non-erosive material over bare soil that will: 1) protect the soil from direct effects of rainfall (raindrops); 2) will slow surface flows 3) reduce the erosion potential and 4) provide a favorable environment for germination. The most effective mulch is good, clean, certified “weed-free”¹, grain straw. This would include: wheat, rice, barley, oats, etc. This section will also address the use of hydro mulch, erosion control blankets, Matrices, Bonded Fiber Matrix, etc.

Method #1: Straw Mulch – “Certified weed-free” straw mulch is used on slopes that have been seeded and are subject to erosion. It requires anchoring by crimping or punching, spraying with a tackifier, or covering with netting.

All blown straw should be tackified and/or anchored. On small slopes straw mulch should be applied by hand, broadcasting to a uniform depth of 2-3 inches. On larger slopes straw can be blown onto the slope to achieve a uniform cover of 1-2 inches. The straw mulch application rate is 2 tons per acre (or 80 to 100% coverage, two-inches deep). On soils subject to frost heaving 4 inches should be applied to reduce seeding mortality. Straw mulch should be anchored by one of the following methods:

1. **Hand Punching** – used on small sites, or sites without much rock and stone on the surface. A spade or shovel should be used to punch the straw into the slope until all areas have straw standing perpendicularly to the slope, and embedded at least 4 inches into the slope. The “bunches” of straw should resemble the tufts of a toothbrush. Generally, the spade or shovel should be punched into the soil between once every 18 square-inches to once every 2 square-feet.
2. **Roller Punching** – used on large or gently sloping sites without significant outcroppings of rock and stone. A roller equipped with straight studs not less than 6 inches long, from 4 to 6 inches wide, and approximately 7/8 inch thick, will best accomplish the desired effect. Studs should stand approximately 8 inches apart and should be staggered. All corners should be rounded to prevent withdrawing the straw from the soil and to leave a uniform surface.
3. **Crimper Punching** – specially designed straw crimping rollers are available for use wherever roller punching can be used. These crimpers consist of serrated disk blades set 4 to 8 inches apart, which force straw mulch into the soil. Crimping should be done in two directions with the final pass conducted across the slope rather than up and down it.
4. **Tacking Agent** – can be sprayed on straw mulch to bind the straw together so it will not blow or wash away. It can be used on any type of site. There are a number of tackifying materials on the market. The instructions from the tackifier manufacturer should be followed to insure success.
5. **Netting** – to be used on steep areas where straw mulch cannot be punched (usually slopes greater than 3 to 1). Netting is applied over unpunched straw and

¹ Contact your local agricultural commissioner’s office for sources of certified “weed-free” straw.

anchored using staples or anchor pins. The square mesh opening should be no larger than 1 inch X 1 inch. Anchor pins should be of rigid 0.12-inch diameter or heavier galvanized wire with a minimum length of 10 inches. Staples should be “U” shaped, made of wire 0.09 inches in diameter or greater, have legs at least 6 inches in length and have a 1-inch crown. Placement and spacing of staples or anchor pins should follow the recommendations of the netting manufacturer.

Method #2: Hydro mulching (or Hydraulic Mulches) – Hydro mulching is the application of wood fiber mulch and a tacking agent in slurry with water. Hydro mulching can be combined with seed and fertilizer in one application or can be applied as the second step after the initial Hydroseeding application.

The hydro mulching machine should be equipped with a gear-driven pump and a paddle agitator. Agitation by re-circulation from the pump is not recommended. Agitation should be sufficient to produce homogeneous slurry of tacking agent, mulch, and seed and fertilizer. Tacking agent should be applied at a rate of 200 gallons of wet ingredients per acre of 80 pounds of dry ingredients per acre. Wood fiber mulch should be applied at a rate of 2,000 to 4,000 pounds per acre. No seed should be added to the slurry until immediately prior to beginning the seeding operation. Legume seeds should be pellet inoculated with the appropriate bacteria. Inoculation rates should be four times that required for dry seeding. The time allowed between placement of seed in the hydro-mulcher and the emptying of the hydro-mulcher tank should not exceed 30 minutes.

Wood fiber may be dyed to aid in uniform placement. Dyes should not stain concrete or painted surfaces nor injure plant or animal life when applied at the manufacturer’s recommended rate. Application of the slurry should proceed until a uniform cover is achieved. The applicator should not be directed at one location for a period of time so as to cause applied water to create erosion.

Method #3: Hydraulic Matrices - Hydraulic Matrices include a mixture of wood fiber and acrylic polymer or other tackifier as binder. Apply as a liquid slurry using a hydraulic application machine (i.e., hydro seeder) at the following minimum rates, or as specified by the manufacturer to achieve complete coverage of the target area: 2,000 to 4,000 lb/acre wood fiber mulch, and 5 to 10% (by weight) of tackifier (acrylic copolymer, guar, psyllium, etc.

Method #4: Bonded Fiber Matrix - Bonded fiber matrix (BFM) is a hydraulically applied system of fibers and adhesives that upon drying forms an erosion resistant blanket that promotes vegetation, and prevents soil erosion. BFM’s are typically applied at rates from 3,000 lb/acre to 4,000lb/acre based on the manufacturer’s recommendations. A biodegradable BFM is composed of materials that are 100% biodegradable. The binder in the BFM should also be biodegradable and should not dissolve or disperse upon re-wetting. Typically, biodegradable BFM’s should not be applied immediately before, during or immediately after rainfall if the soil is saturated. Depending on the product, BFM’s typically require 12 to 24 hours to dry and become effective.

Method #5: Erosion Control Blankets – Erosion Control Blankets are sheets of fibrous and biodegradable material which cover the seeded and fertilized area in place of using mulch. The newer blankets contain straw mulch bound together by netting and sewn into blankets. Erosion

control blankets are most effective on steep slopes or critical sites (near water courses or sensitive areas).

Erosion control blankets come in rolls and are stapled to slopes to provide a uniform covering. The treated area must be reasonably smooth. Gullies and rills must be filled and compacted. Rocks and other obstructions that rise above the level of the soil must be removed.

Erosion control blankets come in various lengths, widths, and thickness. These blankets also are made of a variety of materials: straw, coconut fibers, wood fibers, jute and plastics (nylon). These materials are usually held together by netting and stitched with thread. The manufacturer's specifications will indicate which quality of blanket is to be used with various situation; i.e. percent slopes, length slope, etc. The manufacturer's instructions also dictate stapling patterns.

Planning Criteria #7: Operation and Maintenance

Maintenance is needed to insure germination and growth of grasses and legumes.

- 1) The site should be checked after first rains for areas of vegetative failure due to unfavorable weather conditions, localized site problems, or unforeseen damaging events. If vegetation failure is noted, and there is a high probability of favorable weather conditions for the next 30 days, the area should be reseeded to the original specifications to prevent them from becoming progressively larger. If unfavorable weather conditions are forecast, then the damaged area should be repaired by other methods, such as the application of an appropriate mulch or erosion control blanket.
- 2) These areas should be reseeded to the original specifications to prevent them from becoming progressively larger.
- 3) Livestock and traffic (bikers, foot traffic, etc.) controls are required where needed.
- 4) The control of herbaceous weeds may be required. This can be accomplished by a number of methods including mowing or the application of herbicides. Any herbicide applications should comply with the label and the County Ag Commissioner's requirements.
- 5) Applying fertilizer the second year before winter rains may be desirable for perennial grasses.
- 6) Where cover is sparse reseeding and fertilizing at the proper time could be necessary to increase the density of vegetative cover.

EXHIBIT I: GRASS AND LEGUME PLANT CHARACTERISTICS – ANNUALS

Common Name	Botanical Name	Droughty or Dry Sites	Reseeding	Plant Characteristics	Maintenance	
					Mower ²	Fertilizer ³
Annual Ryegrass	<i>Lolium multiflorum</i>	Fair	Poor	Slender	Not needed	--
Blando Brome	<i>Bromus mollis</i>	Good	Good	Leafy	4-6" after seed set	20 lbs. N
Briggs Barley	<i>Hordeum vulgare</i>	Fair	Poor	Leafy	Not needed	--
California Poppy	<i>Eschscholzia californica</i>	Good	Poor	Spindly	Not needed	--
Cereal Rye	<i>Secale cereale</i>	Fair	Fair	Leafy	Mow before head sets. Seed if used for temporary cover.	--
Lana Vetch	<i>Vicia dasycarpa</i>	Fair	Good ⁴	Robust & leafy	Mow before seed set	20-30 lbs. P ₂ O ₅
Lupine	<i>Lupinus spp.</i>	Good	Fair	Leafy	Not needed	--
Red Brome	<i>Bromus rubens</i>	Good	Fair	Slender	Not needed	20 lbs. N
Rose Clover	<i>Trifolium hirtum</i>	Good	Good	Spindly	After seed set	20-30 lbs. P ₂ O ₅
Zorro Fescue	<i>Vulpia yuros</i>	Excellent	Excellent	Short & slender	Not needed	20 lbs. N

² Mowing of annuals may be desirable for aesthetic value.

³ Fertilizer should be applied when soil is dry as specified in fertilization criteria.

⁴ Lana Vetch is a good seed producer, but many of the seeds are "hard." These will remain in the ground for a number of years before germination.

EXHIBIT II: PERENNIAL GRASSES AND LEGUMES

Common Name	Botanical Name	Dry Site but not Droughty	Low Velocity Channels	Sod Forming Ability	Growing Season	Mowing ⁵	Fertilization ⁶
Creeping wildrye	<i>Elymus triticoides</i>	Poor	Good	Good	Summer	4-6'	20-30 lbs. N
Durar Hard Fescue	<i>Festuca ovina var. duriscula</i>	Good	Poor	Poor	Spring –Fall	As needed	20 lbs. N
Fairway Crested Wheatgrass	<i>Agropyron cristatum</i>	Fair	Poor	Poor	Spring – Fall	As needed	20 lbs. N
Harding grass	<i>Phalaris tuberosa var. stenoptera</i>	Poor	Poor	Poor	Spring – Fall	4-6'	20 lbs. N
Largo Tall Wheatgrass	<i>Agropyron elongatum</i>	Poor	Poor	Poor	Spring	4-6'	20 lbs. N
Luna Pubescent Wheatgrass	<i>Agropyron trichophorum</i>	Good	Good	Good	Fall	4-6'	20 lbs. N
Lutana Cicer Milkvech	<i>Astragalus cicer</i>	Poor	Poor	Poor	Early Summer	4-6'	20-40 lbs. P ₂ O ₅
Norden Desert Wheatgrass	<i>Agropyron desertorus</i>	Good	Poor	Poor	Spring – Summer	4-6'	20 lbs. N
Owyhee Intermediate Wheatgrass	<i>Agropyron intermedium</i>	Fair	Poor	Poor	Spring & Fall	4-6'	20 lbs. N
Palestine Orchardgrass	<i>Dactylis glomerata</i>	Fair	Poor	Poor	Spring & Fall	4-6'	20 lbs. N
Perla Kokeagrass	<i>Phalaris tuberosa var. hirtiglumis</i>	Fair	Poor	Poor	Spring & Fall	4-6'	20 lbs. N
Potomac Orchardgrass	<i>Dactylis glomerata</i>	Fair	Poor	Poor	Spring & Summer	4-6'	20 lbs. N
Reeds Canarygrass (Cana)	<i>Phalaris arundinaces</i>	Poor	Good	Good	Year round	4-6'	30-40 lbs. N
Sherman Big Bluegrass	<i>Poa ampla</i>	Poor	Good	Poor	Spring & Fall	4-6'	20 lbs. N
Topar Pubescent Wheatgrass	<i>Agropyron trichophorum</i>	Fair	Good	Good	Spring & Fall	4-6'	20 lbs. N
Yellow Sweet Clover	<i>Melilotus officinalis</i>	Fair	Poor	Poor	Spring – Midsummer	--	20-40 lbs. P ₂ O ₅

⁵ Mowing for weed control should not occur until plants are established. Mowing should occur before the flower stage of seeded grasses.

⁶ Fertilizer should be applied when soil is dry as specified in fertilization criteria.

EXHIBIT III: SITE CONDITIONS AND ESTIMATED EFFECTIVENESS OF MULCHES FOR PRE-EMERGENT EROSION CONTROL

Mulch (pre-emergence erosion control)	Site Conditions for Use	Pre-Emergence Erosion Control Effectiveness⁷	Approximate Longevity
1. Straw Mulch a. Hand Punching b. Roller Punching c. Crimper Punching d. Tacking Agent e. Netting	<p>Small areas or areas with rock or stones that prevent the use of equipment. Use on slopes of 2.5:1 or less.</p> <p>Large areas without significant rock outcrops. Use on slopes of 2.5:1 or less. Can be used with wattling if space between wattling is available.</p> <p>Large areas without significant rock outcrops on slopes of 2.5:1 or less.</p> <p>Best suited to very rocky soils. Use on slopes up to 2:1.</p> <p>Area must be relative free of rock outcrops and less than 35% (by volume) of coarse fragments. Use on slopes of 2.5:1 or less.</p>	<p align="center">5-7</p> <p align="center">6-8</p> <p align="center">6-8</p> <p align="center">5-7</p> <p align="center">8-10</p>	<p align="center">1-2 rainy seasons</p> <p align="center">1-2 rainy seasons</p>

⁷ Estimated rating of effectiveness of mulch or pre-emergence erosion control (1 = minimal, 10 = excellent)

Mulch (pre-emergence erosion control)	Site Conditions for Use	Pre-Emergence Erosion Control Effectiveness⁷	Approximate Longevity
2. Hydromulching	Can be used in all areas within 200 feet of road or otherwise accessible by truck. Use on slopes of 2:1 or less.	2-5 (note: seeding success is much greater if seed is incorporated into soil before hydromulch is applied).	Short Term: 1-3 months (or until germination)
3. Hydraulic Matrices	Can be used in all areas within 200 feet of road or otherwise accessible by truck. Use on slopes of 5:1 or less.	4-7 (Note: seeding success is much greater if seed is incorporated into soil before hydraulic matrix is applied).	Short Term: 1-3 months (or until germination)
4. Bonded Fiber Matrix (BFM)	Can be used in all areas within 200 feet of road or otherwise accessible by truck. Use on slopes of 5:1 or less.	4-7 (Note: seeding success is much greater if seed is incorporated into soil before hydraulic matrix is applied).	Short Term: 1-3 months (or until germination)
5. Erosion Control Blankets a. 100% Straw b. 70% Straw/30% Coconut c. 100% Coconut Fiber d. 100% Manufactured Fibers	Areas must be relatively free of rock outcrops and have less than 35% (by volume) coarse fragments.	7-10	Long Term: 2-3 years

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Kay, B.L. 1976. "Hydroseedings, straw and chemicals for Erosion Control". Agronomy Progress Report No.77. Agronomy and Range Science Department, U.C.D. pp 14 June.

NRCS, "Field Office Technical Guide", USDA, District Field Office, (unpublished)

NRCS, "Major Land Resource Handbooks", Sacramento, NRCS, USDA (unpublished)

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GLOSSARY

COMPOST - A mixture of vegetable refuse, manure or other organic matter which has gone through a decaying process.

CONTOUR - 1: An imaginary line on the surface of the earth connecting points of the same elevation. 2: A line drawn on a map connecting points of the same elevation.

CRITICAL AREA OR SITE - Sediment producing, highly erodible or severely eroded areas.

CRITICAL SLOPE (HYDRAULICS) - That slope which will sustain a given discharge at uniform critical depth in a given channel.

CUT - Portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

CUT-AND-FILL - Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

CYCLONE (SEEDER) - A hand turned or tractor drawn seeder that broadcasts seed into the seedbed by a rotary motion that slings the seed outward from the seeder.

DEBRIS - Broken remains of plants, objects and rocks that form trash or remains.

DECIDUOUS - Plants that shed their leaves annually as opposed to evergreen.

DISTURBED AREA - An Area in which the natural vegetative soil cover has been removed or altered, and therefore is susceptible to erosion.

DRAINAGE - 1: The removal of excess surface water or groundwater from land by means of surface or subsurface drains. 2: Soil characteristics that affect natural drainage.

DRAINAGE AREA (WATERSHED)- All land and water area from which run-off may run to a common (design) point.

DROUGHTY (SOIL OR SLOPE) - Lacking medium to high moisture during part of the poor growing season during a typical year.

EROSION - 1: The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. 2: Detachment and movement of soil or rock fragments by water, wind, ice or gravity. The following terms are used to describe different types of water erosion:

Accelerated erosion - Erosion happening much more rapidly than is natural or geologic, primarily as a result of the influence of the activities of man or, in some cases, other animals or natural events (e.g., fire) that expose base surfaces.

Gully erosion - The erosion process whereby water accumulates in narrow channels and, over short periods, removes the soil from this narrow area to considerable depths, ranging from 1 or 2 feet to as much as 75 to 100 feet. See GULLY

Rill erosion - An erosion process in which numerous small channels only several inches deep are formed. See RILL.

Sheet erosion - The removal of a fairly uniform layer of soil from the land surface by run-off water.

Splash erosion - The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface run-off.

EXPOSURE (SLOPE)-

North - Slopes facing in any compass direction clockwise between N45W and S45E.

South - Slopes facing in any compass direction clockwise between S45E and N45W.

FINES (SOIL) - generally refers to the silt and clay particles in soil.

GRADE - 1: The slope of a road, channel or natural ground. 2: The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared for the support of construction, like paving or laying a conduit. 3: To finish a surface of a canal bed, roadbed, top of embankment or bottom of excavation.

GRADE STABILIZATION - A structure for the purpose of stabilizing the grade of a gully or other lowering of the channel grade.

GULLY - 1: Aggregate consisting of mixed sizes of ¼ inch to 3 inch particles which normally occur in or near old streambeds and have been worn smooth by the action of water. 2: A soil having particle sizes, according to the Unified Soil Classification System, ranging from the No. 4 sieve size (approximately ¼ inch) to 3 inches. Particles may be natural gravel or angular in shape as produced by mechanical crushing.

HERBACEOUS PERENNIAL (PLANTS) - A plant whose stems die back to the ground each year.

HERBICIDE - chemical formulations used to control weeds or brush.

HULLED (SEED) - Hull-less seed, such as sericea lespedeza. Seeds are usually processed after threshing to take off outer hull to facilitate scarification and quicken germination.

HYDROSEEDER - A machine designed to apply seed, fertilizer, lime or short fiber wood or paper mulch to the soil surface.

HYDROSEEDING - Seeding with a hydroseeder.

MAJOR LAND RESOURCE AREAS (M.L.R.A) - Consists of geographically associated land resource units (see below).

MAJOR LAND RESOURCE UNITS - Geographic areas of land, usually several thousand acres in extent, that are characterized by particular patterns of soil (including slope and erosion), climate, water resources, land use and type of farming.

MULCH - Covering on surface of soil to protect and enhance certain characteristics, such as water retention qualities.

NATIVE (GRASSES) - Naturally occurring; not introduced from other countries.

NATURAL GROUND - Ground surface which has not been disturbed by man.

NETTING (MULCH) - Plastic, paper or cotton material used to hold mulch material on the soil surface.

PARENT MATERIAL - The unconsolidated rock material from which soil profile develops.

PERMANENT SEEDING - Results in establishing vegetation which may remain on the area for more than one season.

RESIDUES (PLANT) - Dead parts of plants which may be left on the soil surface following harvest, grazing or cutting.

RILL - A small channel cut by concentrated run-off but through which water commonly flows only during and immediately after rains or during the melting of snow. A rill is usually only a few inches deep (but no more than a foot) and, hence, no obstacle to tillage operations.

SEDIMENT - Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface either above or below sea level.

SEDIMENTATION - Deposition of detached soil particles.

SEDIMENT DISCHARGE (SEDIMENT LOAD) - The quantity of sediment, measured in dry weight or by volume, transported through a stream cross section in a given time. Sediment discharges consists of both suspended load and bedload.

SHEET FLOW - Water, usually storm run-off, flowing in a thin layer over the ground surface.

STABILIZATION - Providing adequate measures, vegetative and/or structural that will prevent erosion from occurring.

STABILIZED AREA - An area sufficiently covered by erosion resistant material such as a good cover of grass, or paving by asphalt, concrete or stone, in order that erosion of the underlying soil does not occur.

STABILIZED GRADE - The slope of a channel at which neither erosion nor deposition occurs.

TEMPORARY SEEDING – Short duration plantings that provide groundcover for one rainy season.

TERRACE - An embankment or combination of an embankment and channel constructed across a slope at a suitable spacing to control erosion by diverting or storing surface run-off instead of permitting it to flow uninterrupted down the slope. Normally used only on cropland.

THATCH - A tightly intermingled layer of living and dead stems, leaves, and roots of grasses.

TOP SOIL - Presumably fertile or desirable soil material used to top-dress roadbanks, subsoils, parent material, etc.

WOOD FIBER - A short fiber mulch material, usually applied with a hydroseeder in an aqueous mixture.

NATURAL RESOURCE CONSERVATION SERVICE OFFICES

Auburn

251 Auburn Ravine Rd. Ste. 107
Auburn, CA 95603
(530) 823-5687 ext. 3

Placerville

100 Forni Rd., Ste. A
Placerville, CA 95667
(530) 295-5630

South Lake Tahoe

870 Emerald Bay Rd., Ste. 108
South Lake Tahoe, CA 96150
(530) 543-1501

Grass Valley

113 Presley Way Ste. 1
Grass Valley, CA 95945
(530) 272-3417

Yuba City

1511 Butte House Rd., Ste. B
Yuba City, CA 95993
(530) 674-1461

Greenville

PO Box 677
Greenville, CA 95947
(530) 284-1300

High Sierra Resource Conservation and Development Council

The High Sierra Resource Conservation and Development Council is a nonprofit organization that is supported by the USDA-Natural Resources Conservation Service. The council works with landowners, communities, organizations and agencies in El Dorado, Nevada, Placer, Sierra and Yuba Counties to enhance local economies and conserve natural resources.

CONTACT THE HIGH SIERRA RESOURCE CONSERVATION AND DEVELOPMENT COUNCIL

251 Auburn Ravine #105

Auburn, CA 95603

(530) 823-5687, ext. 115

Fax: (530) 823-5504

www.highsierra-rcandd.org

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