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MAPPING ECOSYSTEMS ALONG NEVADA HIGHWAYS AND THE DEVELOPMENT OF SPECIFICATIONS FOR VEGETATION REMEDIATION

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INTRODUCTION

This project was designed to inventory the major plant communities and general soil classification units along the various highways across the state, and to recommend the best procedures and management practices for vegetation remediation based on the appropriate ecosystems and soil types.

SALT DESERT SHRUB – Shadscale and Bailey’s Greasewood Sites

Site Analysis

These sites are adjacent to many miles of highways in northern and central Nevada. This vegetation primarily follows the valley bottoms and usually accompanies many miles of relatively straight highways. The soils vary but can be neutral to somewhat strongly saline. They are generally saline to strongly saline over much of this vegetation type. Many of the soils are fairly sodic. The surface soils are often restrictive to good water penetration. Some of the soils are quite sandy, especially on sites supporting Bailey’s greasewood. Many of the soils may have restrictive layers in the form of silica or calcium carbonate duripans.



The floristics of this vegetation is quite simple. Only a few shrubby species are found associated with the shadscale and Bailey’s greasewood. Some other common shrubs that might be present include green rabbitbrush, bud sage, whitesage (in some valleys), and spiny hopsage. Forbs are particularly wanting. They often consist of weeds such as mustards and halogeton, and annual grasses, such as cheatgrass. One important native forb is globe mallow. Perennial grasses include saltgrass, indian ricegrass and squirreltail.

Species Selection

Shrubs	lbs. seed/acre
1. Shadscale – <i>Atriplex confertifolia</i>	2.0
2. Fourwing saltbush – <i>Atriplex canescens</i>	2.0
3. Spiny hopsage – <i>Grayia spinosa</i>	1.0
4. Gardner saltbush – <i>Atriplex gardneri</i>	0.5
5. Prostrate summer cypress – <i>Kochia prostrata</i>	2.0
Grasses	
1. Saltgrass – <i>Distichlis spicatum</i>	2.0
2. Squirreltail – <i>Elymus elymoides</i>	0.5
3. Creeping wildrye – <i>Elymus tricoides</i>	1.0
4. Galleta grass – <i>Hilaria jamesii</i>	0.5

- 5. Indian ricegrass – *achnatherum hymenoides* 2.0
- 6. Siberian wheatgrass – *Agropyron sibiricum* 1.0
- 7. Alkali sacaton – *Sporobolus airoides* 1.0

Forbs

- 1. Globe mallow – *Spheralcea coccine* 1.0
- 2. Yellow sweet clover – *Melilotis officinalis* 2.0
- 3. Evening primrose* – *Oenothera spp.* 0.5

Total 20.0 lbs./acre

In developing appropriate seed mixes, the cost of some of the less common seed may be prohibitive. This must, of course, be taken into consideration as the seed mixture is formulated and the total costs for the seed mixture is determined. In our mixtures we have, in some cases, used lower seeding rates because some of these less available seeds would be much more costly. However, their potential importance on these landscapes suggests that they be included in the mixtures.

Site/Soil Preparation

Because these sites are often very droughty, we would recommend the use of some kind of mulch. For establishment supplemental irrigation would be very helpful, but water often is not available. In some cases, where you wish to obtain new vegetation with a high success rate, it might then be feasible to provide water for one or more supplemental irrigations by hauling water to the site. Often when seeding in shadscale/Bailey’s greasewood sites, the remediation specialist must be prepared to seed the entire area perhaps two years in a row particularly if no supplemental irrigation is used.

These sites often would be relatively low in many nutrients, particularly nitrogen, and would require a fertilizer of some sort, possibly applied with the supplemental irrigation. Since the seed sources might be devoid of mychorrizal fungi then an inoculum can be prescribed.

Revegetation Procedures

These sites may vary from rocky to loamy soils. If the site has few rocks, it might lend itself to seeding with a drill. Also, unless the berms are quite steep the terrain in this type of vegetation is generally flat and could be drilled with a rangeland drill or some other drill used for tough seeding.

SALT DESERT SHRUB - BLACK GREASEWOOD SITES



Site Analysis

These sites are found in valley bottoms and usually have alkaline and saline soils with heavy clay horizons. Sometimes they are impounded with water. The total number of species is generally low, and for many months the sites are very droughty. The dominant species is black greasewood (*Sarcobatus vermiculatus*) with only a few other species. Occasionally you will find mustard weeds (*Descurania sp.*), salt grass (*Distichlis spicata*), squirreltail grass (*Elymus elymoides*), and globe mallow. These soils hold onto soil moisture tenaciously because of the heavy clay horizons. The salinity or alkalinity may impact the kinds of species that can be seeded there.

Species Selection

Even though there are few native adapted species, attempts will be made to select common species found on such sites or species that have similar characteristics and requirements. Woody species (shrubs), grasses and forbs will be included in the specified mixtures. The species listed below are recommended for mixtures to be used on these sites.

Shrubs	lbs.seed/acre
1. Quail bush – <i>Atriplex lentiformi</i>	1.0
2. Rubber rabbitbrush – <i>Chrysothammus naseousus</i>	2.0
3. Greasewood – <i>Sarcobatus vermiculatus</i>	2.0
4. Kochia – <i>Kochia prostrata</i>	2.0
5. Fourwing saltbush – <i>Atriplex canescens</i>	2.0
Grasses	
1. Alkali sacaton – <i>Sporobolus airoides</i>	1.0
2. Tall wheatgrass – <i>Agropyron elongatum</i>	2.0
3. Great Basin wildrye – <i>Leymus cenerus</i>	2.0
4. Salt grass – <i>Distichlis spicata</i>	1.0
5. Squirreltail – <i>Elymus elymoides</i>	0.5

Forbs

1. Desert globe mallow – <i>Spaeralcea ambigua</i>	1.0
2. Yellow sweet clover – <i>Melilotus officinalis</i>	1.0
3. White evening primrose – <i>Oenothera pallida</i>	1.0
	Total 18.5 lbs./acre

Site and Soil Preparation

Importing topsoil may be necessary for initial establishment of these species. Screened soil from nearby material pits or the soil used for the road platform, 1/8 inch or less, would be suitable for topsoil. It is also suggested to apply 250 pounds/acre of horticulture sulfur to reduce the soil pH, making the site more conducive to establishment of the seed mixture. It might be possible to break up these heavy clays with a large chisel or other implement behind a tractor. It might be feasible to provide supplemental irrigation by sprinkling to assist in establishment. This, however, would be somewhat costly unless a water source was near by. It might be possible to bring water in by tanker-truck on a one-time basis. Also a nitrogen fertilizer, such as ammonium sulfate can be applied.

Revegetation Procedures

These areas tend to be relatively flat, and thus a drill might be used to place the mixture into the soil. However, the roadside berms might be too steep for this. In addition to the mixture of seeds, it might be very helpful to acquire some container-grown material of four wing saltbush and rubber rabbitbrush. Container-grown plants would require hand labor to place them in the relatively small areas to be revegetated. In order to reduce competition among the seeded species, it would be appropriate to place the container-grown plants apart from the seeded areas. In some cases different mixtures might be used to develop a pattern with grasses and forbs apart from areas seeded heavily with shrubs.

SAGEBRUSH SITES – LOWEST ELEVATION SITES WITH BIG SAGEBRUSH
 Wyoming big sagebrush (*Artemisia tridentata* var. *wyomingensis*), basin big sagebrush (*Artemisia tridentata tridentata*) and black sagebrush (*Artemisia nova*).



Site Analysis

The site is dominated by big sagebrush with a number of perennial grasses. Big sagebrush soils are often deep and relatively dark although they usually have little organic matter. The precipitation at the site is approximately 12 inches annually in the form of snow in winter and early spring. The goal of revegetation on disturbed sites will be to compete with noxious weeds, control erosion, and be fire resistance and aesthetically pleasing. In addition, it should not unduly attract wildlife. We have listed a preliminary set of procedures or specifications that could be used on such a site.

Species Selection

Shrubs	lbs.seed/acre
1. Big sagebrush – <i>Artemisia tridentata</i>	1.0
2. Antelope bitterbrush – <i>Purshia tridentata</i>	1.0
3. Desert peach – <i>Prunus andersonii</i>	1.0
4. Green ephedra – <i>Ephedra viridis</i>	1.0
5. Green rabbitbrush – <i>Chrysothamnus viscidiflorus</i>	1.0
6. Four-wing saltbush – <i>Atriplex canescens</i>	1.0
7. Skunkbush sumac – <i>Rhus trilobata</i>	1.0
8. Winterfat – <i>Krascheninnikovia lanata</i>	1.0
Grasses	
1. Blue bunch wheat grass – <i>Pseudoroegneria spicata</i>	1.0
2. Basin wildrye – <i>Leymus cinereus</i>	1.0
3. Sandberg bluegrass – <i>Poa secunda</i>	0.5
4. Big bluegrass – <i>Poa ampla</i>	1.0
5. Indian ricegrass – <i>Achnatherum hymenoides</i>	1.0
6. Desert needlegrass – <i>Achnatherum speciosum</i>	1.0
7. Creeping wildrye – <i>Leymus triticoides</i>	1.0
8. Great Basin wildrye – <i>Leymus cinereus</i>	1.0

Forbs

1. Yellow sweet clover – <i>Melilotus officinalis</i>	0.5
2. Small burnet – <i>Sanguisorba minor</i>	0.5
3. Prairie flax – <i>Linum lewisii</i>	0.5
4. Palmer’s penstemon – <i>Penstemon palmeri</i>	0.5
5. Evening primrose – <i>Oenothera tanacetifolia</i>	0.5
6. Scarlet gilia – <i>Ipomopsis aggregat</i>	0.5
7. Goldenrod – <i>Solidago spectabilis</i>	0.5
8. Globe mallow – <i>Sphaeralcea coccinea</i>	0.5
9. Firemaker penstemon – <i>Penstemon eatonii</i>	0.5
10. Lupine – <i>Lupinus spp.</i>	0.5
11. Vetch – <i>Vicia sp.</i>	0.5
12. Alfalfa – <i>Medicago sativa</i>	0.5
Total 21.5 lbs. seed/acre	

Site/Soil Preparation

Site preparation may require contour development and/or terracing on steep slopes. The appropriate amounts of soil amendments such as fertilizer and mycorrhizal inoculums may be added to the soil. The combination of fertilizer with a drip irrigation system could be used to assure plant establishment. Additional soil preparation such as disking may be required.

Revegetation Procedures

On steeper sites, the slopes should be shaped to no steeper than 3-to-1. Possibly replace topsoil. The container-grown shrubs should be placed on terraced slopes. Drill at 0.57 pounds/1000 square feet. Broadcast a mixture of forb/grass/shrub seed. Placement and arrangement of seed and container-grown shrubs should be decided with the landscape architect. Apply a portable, one-acre to two-acre drip system to assure establishment of container-grown shrubs. Determine the appropriate number of emitters to irrigate a specific density of shrubs. If the site dictates, possibly add an appropriate fertilizer and mycorrhizal inoculums. A mulch applied to support seeding success should be stabilized with netting or tackifier. Mulch with 68.9 pounds/1000 square feet of straw material that is tacked to the ground with jute netting.

UPPER ELEVATION BIG SAGEBRUSH SITES (Primarily *Artemisia tridentata* var. *vaseyana*) and Low sagebrush (*Artemisia arbuscula* and *A. longiloba*)



Site Analysis

These sites have higher rainfall and often deeper soils, higher in organic matter. However, the growing season is often short. The soils will be variable. Precipitation amounts can vary from 10 inches to 20 inches, and the winters can be cold and long. Snow cover is variable but can be deep during some winters. As a general rule-of-thumb the transition between the low-elevation sagebrush sites and the mountain big sagebrush sites is at about 5800 feet. The vegetation is dominated with mountain big sagebrush (*Artemisia tridentata vaseyana*) except as one crosses over the ridges or passes. Here if a sagebrush taxa is dominant, it usually will be a low sagebrush such as *Artemisia arbuscula* and will have very shallow soils with heavy clay subsoil at about 8 inches to 10 inches. The big sagebrush sites will have a wider variety of perennial grasses and annual and perennial forbs than found in the lower elevation sagebrush sites.

Species Selection

An ideal mix of species should include a combination of a couple species of grass, shrubs, and forbs. It should be emphasized that all of these species do not need to be included in the species selection for vegetation remediation. The number of seeds per pound should be considered in the density of application since, their numbers vary widely. For instance, tall fescue has approximately 225,000 seeds per pounds, while bentgrass has a density of 6 million seeds per pound.

Grasses	lbs. seed/acre
1. Bluebunch wheatgrass or beardless bluebunch wheatgrass – <i>Agropyron spicatum</i>	1.0
2. Idaho fescue – <i>Festuca idahoensis</i>	1.0
3. Big/Sherman bluegrass – <i>Poa ampla</i>	0.5
4. Smooth or mountain brome – <i>Bromus inermis/ Bromus marginatus</i>	1.0
5. Pubescen wheatgrass – <i>Agropyron trichophorum</i>	1.0
6. Creeping or Russian wildrye – <i>Leymus triticooides/ Leymus junceus</i>	1.0
7. Thurber’s Needlegrass – <i>Achnathermum thurberianum</i>	1.0

Forbs

- 1. Palmer’s penstemon/Firecracker penstemon – *Penstemon palmerii*/*Penstemon eatonii* 2.0
- 2. Woolypod vetch – *Vicia dasycarpa* 0.5
- 3. Indian paintbrush – *Castilleja spp.* 0.5
- 4. Lupine -*Lupinus spp.* 1.0
- 5. Blue flax -*Linium lewisii* 1.0
- 6. Prickly poppy -*Argemone munita* 0.5
- 7. Sunflower -*Helianthus annuus* 0.5

Shrubs

- 1. Mormon tea, (green) – *Ephedra viridis* 1.0
 - 2. Douglas rabbit brush – *Chrysothamnus viscidiflorus* 1.0
 - 3. Mountain big sagebrush – *Artemisia tridentate* 1.0
 - 4. Bitterbrush – *Purshia tridentate* 1.0
 - 5. Purple sage – *Salvia dorii* 1.0
- Total 17.5 lbs./acre

Site and Soil Preparation

These sites may lend themselves well to the storage and replacement of topsoil. These soils, when not too rocky, can lend themselves to machine drilling, possibly preceded by disking, to create a more favorable seedbed for initial establishment. Normally, they would not require fertilization, but this should be determined by soil tests taken at the site. The addition of organic matter would be beneficial for plant establishment. Often it may be necessary to assure establishment with the addition of nitrogen fertilizers, as determined by the soil samples.

Revegetation Procedures

Where feasible, the best procedure would be disking and drilling. In some cases, container-grown species spaced approximately 3-feet apart may be used in conjunction with drilling. Different shrub container species should be alternated at 3-foot spacing for purposes of landscape and aesthetic variety. Planting should occur in either the spring or fall. Planting from containers in the summer would require supplemental irrigation for the first season. Forbs and grasses should be drilled at a density of 20 pounds/acre. Mulches are important on these sites to assure establishment of drilled seed. Straw and other light-colored mulches will reduce the soil temperature during the summer months. An application rate of 2000-3000 pounds/acre of mulch is recommended to reduce erosion and cover seed (R-4 reclamation guide, p. 25). Mulches can be applied by hand on 3-to-1 or greater slopes. Steeper slopes will require a mechanical application of mulch.

PINYON/JUNIPER WOODLAND SITES



Site Analysis

Identify the naturally occurring vegetation as a possible means for assisting with species selection. Examine the vegetation maps and the soil polygons to further determine the natural vegetation. Examine the soils data to determine the natural physical and chemical conditions. This will lead to an analysis of the potential need for certain soil amendments, supplemental irrigation, and mulching to assure success. Examine the physical characteristics of the site such as precipitation, temperature, slope, aspect, and elevation. In some cases it may be necessary to examine the chemical and physical characteristics of the material to be revegetated.

Species Selection

Species selection for pinyon/juniper woodland sites will include species commonly found in the woodland. We will include primarily native species and a mixture of shrubs, grasses, and forbs. Among the forbs, we will include at least one leguminous species for possible nitrogen fixation. The species listed below are recommended for the mixture.

Shrubs	lbs. seeds/acre
1. Black sagebrush – <i>Artemisia nova</i>	1.0
2. Mountain big sagebrush – <i>Artemisia tridentata varvaseyana</i>	2.0
3. Green rabbitbrush - <i>Chrysothamnus nauseosa</i>	2.0
4. Mormon tea - <i>Ephedra viridis</i>	1.0
5. Summercypress - <i>Kochia prostrata</i>	2.0
6. Skunkbush sumac – <i>Rhus trilobata</i>	1.0
Grasses	
1. Bluebunch wheatgrass – <i>Pseudoroegneria spicata</i>	1.0
2. Sandberg’s bluegrass – <i>Poa sandbergii</i>	0.5
3. Smooth brome – <i>Bromus inermis</i>	1.0
4. Crested wheatgrass – <i>Agropyron cristatum</i>	2.0
5. Siberian wheatgrass – <i>Agropyron fragile</i>	2.0
6. Giant wild rye – <i>Leymus glaucus</i>	1.0

Forbs

1. Palmer's penstemon – <i>Penstemon palmeri</i>	1.0
2. Prarie flax – <i>Linium lewisii</i>	1.0
3. Small burnet – <i>Sanguisorba minor</i>	1.0
4. Lupine – <i>Lupinus spp.</i>	1.0
5. Indian paintbrush – <i>Castilleja spp.</i>	1.0
6. Sticky purple geranium – <i>Geranium viscosissimum</i>	1.0
Total	21.5 lbs./acre

Site and Soil Preparation

For most pinyon/juniper sites we would not recommend supplemental irrigation. However, we would recommend that a fertilizer be applied. If the topsoil has been removed, the site analysis would likely lead to the appropriate recommendation for a fertilizer. Since many of these soils have sufficient phosphorous and potassium, we would recommend a formulation of 16-20-0 ammonium phosphate applied at 40 pound/acre. If the material is a homogenous mixture of various materials, a higher nitrogen fertilizer might be recommended. Also in this case a mycorrhizal inoculum would be recommended. Slopes over 3-to-1 would require terracing to help retain soil moisture and provide safe sites for seed. In some cases this would require hand labor.

Revegetation Procedures

For small areas, less than an acre, it would be feasible to hand-seed using a cyclone spreader. This would be followed by the application of mulch. We would recommend the spreading of straw by hand on the terraces and tacking the straw by spreading soil by hand or placing a jute netting over the mulched areas. In some cases we would recommend that a number of container-grown specimens be planted on the site to improve establishment and provide instantaneous landscaping and aesthetics. The container-grown material can be planted in concert with other species of shrubs and the suggested grasses and forbs. To reduce competition between the woody and herbaceous species, we would recommend planting shrubs separate from areas where grasses and forbs are seeded.

MOUNTAIN BRUSH SITES

Site Analysis

These sites are at higher elevations, mostly above 6,000 feet, as the highways cross mountain passes. The typical mountain brush vegetation supports some of the following dominant species: bitterbrush, mountain mahogany, snowberry, serviceberry, mountain big sagebrush,



currant, gooseberry, elderberry and chokecherry. Soils are often higher in organic matter and may or may not be rocky. The soil chemistry normally would be neutral to slightly acid but not alkaline. Litter accumulation could be high. Often the road cuts are deep and steep. There may be a cut on one side and a fill on the other side. The cuts and fills can remove topsoil and/or cover it up. The organic matter would often be higher than most of the desert sites and similar to forested areas. The higher organic matter generally provides a greater abundance of nutrients.

Species Selection

Availability and costs will dictate what seed combination to use. We recommend 19 pounds/acre to 20 pounds/acre of a combination of seed from the species list below. Not all of these species should be used, but a combination of these is suggested.

Shrubs	lbs. seeds /acre
1. Serviceberry – <i>Amelanchier alnifolia</i>	1.0
2. Mountain big sagebrush – <i>Artemisia tridentata</i>	0.5
3. Chokecherry – <i>Prunus virginiana</i>	1.0
4. Cliffrose – <i>Cowania stransburiana</i> (southern passes)	1.0
5. Gambel's oak – <i>Quercus gambellii</i> (Eastern & S.eastern NV)	2.0
6. Common snowberry – <i>Symphoricarpus albus</i>	1.0
7. Three leaf sumac – <i>Rhus trilobata</i>	1.0
8. Rubber rabbitbrush – <i>Chrysothamnus nauseosus</i>	0.5

Grasses

1. Bluebunch wheatgrass – <i>Pseudoroegneria spicata</i>	1.0
2. Big bluegrass – <i>Poa ampla</i>	1.5
3. Smooth brome – <i>Bromus inermis</i>	1.0
4. Mountain brome – <i>Bromus marginatus</i>	1.5
5. Idaho fescue – <i>Poa festuca</i>	0.5
6. Perennial rye grass – <i>Lolium perenne</i>	1.0
7. Tall wheatgrass – <i>Agropyron longatum</i>	1.0
8. Great Basin wildrye – <i>Leymus cinereus</i>	1.0

Forbs

1. Palmer’s penstemon – <i>Penstemon palmeri</i>	1.0
2. Scarlet gilia – <i>Ipomopsis aggregata</i>	1.0
3. Indian paint brush – <i>Castilleja spp.</i>	1.0
4. Lupine – <i>Lupinus spp.</i>	1.0
5. Wild geranium - <i>Geranium viscosissimum</i>	1.0
Total 21.5bs.seed/acre	

Site and Soil Preparation

If slopes are steeper than 3-to-1, we recommend some terracing – either by hand or with a backhoe. Supplemental irrigation may not be necessary for these sites due to higher elevations correlated with more rainfall. Suggested fertilizer would require a formulation of 16-20-0 (16% nitrogen,20% phosphorous, and 0% potassium) applied at 40 pounds/acre. If seeding is done in the early fall or spring, we would not recommend supplemental irrigation. If the material is a homogenous mixture of various soils, possibly a higher nitrogen fertilizer would be recommended. However, this could be determined by site-specific soil tests. Mycorrhizal inoculums would most likely not be needed at these sites due to the high organic matter in these soils.

Revegetation procedures

On many of these sites, we would recommend container-grown shrubs of two or three species placed randomly across the disturbed landscapes to provide plant cover in a reasonable amount of time. Furthermore, container-grown species are conducive to successful establishment as many of these species require some sort of seed stratification for germination and are limited by short growing seasons. Seeding of grasses, forbs, and shrubs (not container-grown) along with mulch and tackifier, should precede the placement of the container-grown shrub species. We recommend the spreading of straw on terraces using a tackifier. Container grown shrub species should be planted in the spring to access more soil moisture.

FORESTED SITES: Forested areas are found primarily in western Nevada, in and around Lake Tahoe, and on a few sites in the spring range in southern Nevada.



Site Analysis

Forest sites and their soils are quite variable. They generally have a neutral to slightly acid reaction and may vary in depth. These sites are usually above 5,500 feet in elevation and are found on every aspect. In the Tahoe area many of the soils are granitic and have poor moisture holding capacity. Often the soils are quite stony, which would preclude revegetation practices involving machinery. Roadside areas can be quite steep requiring contouring or other practices. In the Tahoe Basin winter salting has negatively impacted many of the trees and other vegetation. Some roadside vegetation at higher elevations has been impacted by snow blowing equipment used to clear the highways. The widening, cutting, and filling involved in resurfacing the highways has also had a significant impact on roadside vegetation. The growing seasons are short and snowpack will influence remediation.

Species Selection

Trees and Shrubs. Normally we would not recommend trees close to the highway because of the problems mentioned above and safety concerns they pose by reducing visibility under some circumstances. Therefore our species lists include primarily native shrubs, grasses and forbs.

Shrubs	lbs. seed/acre
1. Snowbush – <i>Ceanothus velutinus</i>	1.0
2. Huckleberry oak – <i>Quercus vaccinifolia</i>	1.0
3. Serviceberry – <i>Amelanchier alnifolia</i>	1.0
4. Chokecherry – <i>Prunus melanocarpa</i>	1.0
5. Whitethorn – <i>Ceanothus integerrimus</i>	1.0
6. Mountain mahoghany – <i>Cercocarpus ledifolius</i>	1.0
7. Manzanita – <i>Arctostaphylos patula</i>	1.0
8. Squaw carpet – <i>Ceanothus prostrates</i>	1.0
9. Mountain big sagebrush – <i>Artemisia tridentata vaseyana*</i>	1.0
10. Bitterbrush – <i>Purshia tridentata*</i>	1.0

*Sagebrush and bitterbrush might be used at slightly lower, drier sites. Bitterbrush has been shown to be well adapted to very dry sites with low nutrients along road cuts. It should be noted, that many of these species do not establish well from seed, and it may be necessary on many sites to purchase and plant container-grown material.

Cost will readily dictate the quantity of species to be used in roadside revegetation procedures. Generally, we recommend planting one shrub species per square yard to allow shrub species to grow without competing against one another. The landscape architect could also suggest spacing for aesthetics and safety purposes.

Grasses

1. California brome – <i>Bromus marginatus</i>	1.0
2. Smooth brome – <i>Bromus inermis</i>	1.0
3. Tall fescue – <i>Festuca arundinacea</i>	2.0
4. Western wheatgrass – <i>Agropyron smithii</i>	1.0
5. Pubescent wheatgrass – <i>Agropyron trichorophum</i>	2.0
6. Sherman big bluegrass – <i>Poa ampla</i>	2.0

Forbs

1. Mules ear – <i>Wyethia mollis</i>	0.5
2. Palmers penstemon – <i>Penstemon palmeri</i>	0.5
3. Mountain lupine – <i>Lupinus alpestris</i>	0.5
4. Columbine – <i>Aquilegia formosa</i>	0.5
5. California bluebess – <i>Phacelia campanularia</i>	0.5
Total 17.5 lbs.seed/acre	

Several seed companies provide flower seed mixture for different kinds of habitats. For example, Flagstaff Native Plant and Seed (see appendix 2) has a mixture of flowers adapted to Pinus ponderosa sites that includes eight or ten species and is sold by the ounce. Such mixtures may be appropriate for broadcasting and covering with mulch on many of our forested and mountain sites. On these sites container-grown shrubs would be quite appropriate and so the amount of seed versus seedlings would vary. Approximately 10 pounds to 11 pounds/acre is suggested for broadcast seeding of grasses and forbs. This will be supplemented with grasses planted as ramets.

Site/Soil Preparation

Steep slopes will require contouring or furrowing. A mulch would be recommended, and straw would probably be the best mulch. It might be possible to obtain some local materials, such as mulch made from pine needles or pine cones. In addition wood chips and ground-up Christmas trees might be available to use as mulch material. The mulches would have to be tackified with jute netting or some other product. We would not recommend hydroseeding because of mixed reviews of success. A slow release nitrogen fertilizer might be appropriate at about ½ pound/thousand square feet. This might not be appropriate along stream environment zones because of potential lake and stream pollution.

Revegetation Procedures

Container-grown material would have to be hand planted. Container-grown grasses, such as ramets, could be used in conjunction with the broadcasted grass and wildflower seed for initial establishment. A mixture of wildflowers and grasses could be broadcasted in the interspaces between the container-grown shrub species at some spacing determined by the landscape architect. Mulch should be used to initially establish the container-grown species. Mulch may be applied after the broadcast seeding to protect the seed from wildlife and dehydration.

STREAM CROSSING SITES WITH GALLERY FORESTS OF POPLARS WITH WILLOW AND OTHER STREAMSIDE WOODY AND HERBACEOUS VEGETATION

Site Analysis

Unlike uplands areas, natural and human induced stream meander and channel downcutting result in continuous changes for these vegetation types. This vegetation is often associated with hydric soils. Riparian soils are often the result of streams, seeps, and springs and may not be dependent upon local precipitation. Soils tend to be more organic due to the long history of dense vegetation in these areas. These areas are not elevation dependent but rather dependent upon the presence of streams or riparian areas. Examples include the Humboldt, Truckee, Carson, Walker, Salmon, and the Muddy River drainages. Erosion and periodic flooding are some of the main challenges for the revegetation of these areas. Noxious weeds such as tall white top shown in the lower portion of the photo above often become a problem in these riparian areas.



Species Selection

Trees and Shrubs	lbs. seed/acre
1. Fremont cottonwood – <i>Populus fremontii</i>	0.0*
2. Mountain alder – <i>Alnus tenuifolia</i>	2.0
3. White alder – <i>Alnus incana</i>	2.0
4. Dogwood – <i>Cornus stolonifera</i>	1.0
5. Spirea – <i>Spirea densiflora</i>	1.0
6. Blue elderberry – <i>Sambucus coerulea</i>	1.0
7. Willow – <i>Salix boothii</i> (5700' – 9000')	0.0

- 8. Pacific willow – *Salix lasiandra* (5000'-7800') 0.0
- 9. Water willow or Seep willow – *Baccharis glutinosa* (Mohave stream areas) 1.0
- 10. Virgin's bower – *Clematis ligusticifolia* 1.0

Grasses

- 1. Streambank wheatgrass – *Agropyron riparium* 1.0
- 2. Fowl bluegrass – *Poa palustris* 1.0
- 3. Nebraska sedge – *Carex nebraskensis* 1.0
- 4. Baltic rush – *Juncus Baltic* 1.0
- 5. Meadow barley – *Hordeum brachyantherum* 1.0

Forbs

- 1. Nettleleaf giant hyssop – *Agastache urticifolia* 1.0
- 2. California false hellebore – *Veratrum californicum* 0.5
- 3. Small bluebells – *Mertensia longiflora* 0.5
- 4. Sticky purple geranium - *Geranium viscosissimum* 1.0
- 5. Columbian monkshood – *Aconitum columbianum* 1.0
- 6. Mule's ear – *Wyethia mollis* 1.0

Total 19.0 lbs.seed/acre

*Often these species are grown only from cuttings or container-grown plants. Usually seed is not available for poplars and willows.

Site and Soil Preparation

Generally these areas tend to be in moist sites, so adding organic matter to the existing soils may not be required. However, if fill soil is being used, the addition of organic matter is necessary. Irrigation for initial establishment may not be necessary for these soil types due to the prevalence of a high water table. The addition of nutrients will encourage faster establishment of plants. Topsoil should be stockpiled and reapplied after grading of these sites. Special care should be taken to minimize disturbing the existing plants in riparian zones. Soil samples should be taken at the site and compared to the undisturbed adjacent sites before amendments are applied.

Re-vegetation Procedures

In some cases, placement of topsoil on disturbed sites prior to seeding would be beneficial for seed germination. The application of amendments and fertilizers should be based on the results of the soil testing. Many of the shrubby plants, such as willow, for

example can be planted as unrooted cuttings to a depth of 6 inches. This is more practical and cost-effective than using container-grown stock. Seeds should be broadcast at the recommended rate for each species, raked lightly and mulched with a light application of composted bark. Evaluating the success of riparian revegetation efforts may be coordinated with other agencies such as the Bureau of Land Management and the Forest Service, who are actively monitoring these areas. Proper functioning condition (PFC) is one quick and qualitative method to assess stream health and vegetation.

Special attention should be given to areas where roads intersect with streams. Bridges and culverts have traditionally been inadequate at handling 150-year flood events. This results in massive sediment transport downstream, incising channels, and flooding of road surfaces. Planning for large culverts and bridge crossings that will not impede the flow of water during these events is essential in maintaining riparian health and road safety. The structural engineer should consult with a hydrologist on this issue.

SAMPLE SPECIFICATIONS

In this section we have taken one specific site and described specifications that might be followed in order to improve the aesthetics, dust control, and other problems on this site.



Example #1. A sagebrush/grass site in Elko County

REVEGETATION OF A SAGEBRUSH/ GRASS SITE NEAR WELLS, NEVADA

Site Analysis

- The predominate vegetation on this site is big sagebrush and a variety of perennial grasses.
- The soils are fairly high in organic matter and the topsoil can be shallow with heavy clay subsoil.
- The precipitation varies from 10 inches to 20 inches, and much of it comes in the form of snow.
- Revegetation is usually successful, even though the growing season is short. Slopes of more than 3-to-1 are common.

Suggested Reclamation Steps

- Step 1: Site Preparation
 - Shape site to slopes no steeper than 3-to-1.

Additional soil preparation such as disking may be required.

Step 2: Application of Soil amendments

Determine and apply appropriate additives

Step 3: Seed Application

Use a drill and seed apply at a rate of 0.57 lbs/1000 sq. ft.

Step 4: Mulching

Apply mulch at a rate of 68.9 lbs/1000 sq. ft of straw material that is tacked to the ground with jute netting.

The Proposed Species Mixture

- Blue bunch wheatgrass – *Pseudoroegneria spicata*
- Basin wildrye – *Leymus cinereus*
- Sandberg bluegrass – *Poa secunda*
- Yellow sweet clover – *Melilotus officinalis*
- Small burnet – *Sanguisorba minor*
- Prairie flax – *Linum lewisii*
- Big sagebrush – *Artemisia tridentata*
- Rubber rabbitbrush – *Chrysothamnus nauseosus*



Example #2 Robb Drive Interchange

REVEGETATION PROTOCOL FOR ROBB DRIVE INTERCHANGE ON INTERSTATE 80

Site Analysis

- There are very steep slopes.
- The soils have several layers of chalk or diatomaceous earth.
- Portions of topsoil have been removed.
- Deficient soil development will require tests for additions of mycorrhizal inoculums and fertilizers.
- The site is subject to frequent, high winds.
- It is a relatively droughty site.
- The site has considerable weedy volunteer vegetation.
- There is considerable litter along fences.
- There is a narrow steep soil/earth divider between the on and off ramps.
- The cost of placing aesthetic vegetation on this site is likely to be expensive.



Suggested Reclamation Steps

Step 1: Site Preparation

Contour development and/or terracing on steep slopes.

Step 2: Application of Soil Amendments

Determine and apply appropriate amounts of fertilizer and mycorrhizal inoculums.

Combine fertilizers with drip irrigation systems to ensure plant establishment.

Step 3: Supplemental Irrigation

Apply a portable, 1-to-2 acre drip system to ensure development of container-grown shrubs.

Determine the appropriate number of emitters needed to irrigate a specific density of shrubs.

Step 4: Seeding/Planting of Native Plants

Cold-desert native shrubs will out-compete the existing undesirable weedy vegetation.

Place container-grown shrubs on terraced slopes.

Broadcast a mixture of forb/grass/shrub seed.

Step 5: Mulching

Stabilize mulch applied to support seeding success with netting, soil or another tackifier.

Step 6: Species Selection

Place mixture of native species listed below on the terraces.

Placement and arrangement of seed and container grown shrubs should be decided upon with the landscape architect.

Native Shrub Species

- Antelope bitterbrush – *Purshia tridentata*
- Desert peach – *Prunus andersonii*
- Green ephedra – *Ephedra viridis*
- Green rabbitbrush – *Chrysothamnus viscidiflorus*
- Big sagebrush – *Artemisia tridentata*
- Four-wing saltbush – *Atriplex canescens*
- Skunkbush sumac – *Rhus trilobata*

Native Grass Species

- Big bluegrass – *Poa ampla*
- Sandberg's bluegrass – *Poa secunda*
- Indian ricegrass – *Achnatherum hymenoides*
- Desert needlegrass – *Achnatherum speciosum*
- Creeping wildrye – *Leymus triticoides*
- Great Basin wildrye – *Leymus cinereus*

Native Forb Species

- Palmer's penstemon – *Penstemon palmeri*
- Evening primrose – *Oenothera tanacetifolia*
- Scarlet gilia – *Ipomopsis aggregata*
- Goldenrod – *Solidago spectabilis*
- Globemallow – *Sphaeralcea coccinea*
- Firemaker penstemon – *Penstemon eatonii*
- Lupine – *Lupinus spp.*
- Vetch – *Vicia spp.*
- Yellow sweet clover – *Melilotus officinalis*
- Alfalfa – *Medicago sativa*

ADDENDUM**DUST CONTROL**

Soil productivity is affected by wind erosion in various ways. Areas of erosion and deposition on disturbed sites require more costly and less efficient soil management practices. Wind removes the smaller clay particles and organic matter from the soil while coarser materials are left behind. The continued loss of fine particles reduces soil quality. In shallow soils and soils with a hardpan layer, wind erosion also results in decreased root zone depth and water-holding capacity. Such changes may occur slowly and go unnoticed for many years. Bare soil can lead to dust that may be detrimental to safe driving and so must be considered. Many of the procedures discussed above will lead to good dust control. An number of emergency control methods are available to reduce damage from wind-induced soil erosion that already has started or is anticipated:

- tillage to produce ridges and clods;
- addition of a mulch;
- irrigation to increase soil moisture;
- temporary, artificial wind barriers;
- soil additives or spray-on adhesives.

Choice of method, or combination of methods, depends on severity of erosion and the relationship to planned remediation procedures that have been prescribed for a site.

MONITORING

Since remediation efforts are somewhat costly, we would recommend that monitoring be done to assess the success and failure of these efforts. This can be done either on an ad hoc basis or by using a more objective methodology to appraise success and/or failure over time. We would strongly recommend that an objective and scientifically based monitoring protocol be adopted to examine revegetated sites for several years after the treatment to assess the success and/or failure of the efforts. A number of excellent monitoring procedures are available. As a minimum we would suggest a series of belt transects where the seeded and volunteer species are counted one, two and five years after the treatment. Each belt should be about 15 meters or 50 feet in length and 1 meter or 3 feet wide. The number of transects would depend upon the size of the disturbed/seeded area. Small areas may require only two or three transects while larger areas may require several more to provide a good statistically valid sample.

Within each belt, a plant density count should be accomplished, counting the number of individual plants per unit area. Density should be determined for both seeded

and volunteer species. The purpose for looking at the density of the volunteer native species is to have some idea of the level of competition with the seeded species. For some superabundant species, i.e., cheatgrass, it would be necessary to use a subsample to obtain a reliable but feasible density count. Plant vigor should also be measured. Vigor can be determined in several ways, e.g. measuring the height of grass culms, leader length in seeded shrubs, and the height and number of leaves of both grasses and forbs. For grasses, a simple count of the number of seed heads signifying reproductive culms would be appropriate. These determinations should be done for all species but especially for seeded species. This can be accomplished in several ways such as by counting the number of seed heads, measuring the height of the plant, and counting the number of new tillers for the perennial grasses. In many cases, a mixture will be used to revegetate and it would be valuable to know which of these species established best and exhibited the greatest vigor on a particular site.

NOXIOUS AND INVASIVE WEEDS

Table 4 is a list of noxious weeds that have been designated by the Nevada State Department of Agriculture. There are a few other species that can be classified as invasive weeds. These might include cheatgrass (*Bromus tectorum*) and halogeton (*Halogeton glomeratus*) in the north and red brome (*Bromus rubens*) and Mediterranean Grass (*Schismus barbatus*) in the south. In some areas species of mustard (*Descurainia spp.* and *Sysimbrium spp.*) are invasive and can contribute to fire hazard. Our assessment of these weeds along Nevada highways is summarized in Table 5 where we have listed those species that we encountered and the location of populations found along Nevada highways. It would be important for those involved in remediation to have a working knowledge of these plant species and be able to identify them in the field. We have examined the records of the State Department of Agriculture. They have documented the location of a number of weeds at specific points along the highways. We have these records and they are available in the offices of the State of Nevada Department of Agriculture, Division of Plant Industry.



Table 4 Nevada’s noxious weeds listed by common name and scientific name as of 4/02

(alphabetical by common name)

Common Name	Scientific Name
African Rue	<i>Peganum harmala</i>
Austrian fieldcress	<i>Rorippa austriaca</i>
Austrian peaweed	<i>Sphaerophysa salsula / Swainsona salsula</i>
Black henbane	<i>Hyoscyamus niger</i>
Camelthorn	<i>Alhagi camelorum</i>
Common crupina	<i>Crupina vulgaris</i>
Dyer’s woad	<i>Isatis tinctoria</i>
Eurasian water-milfoil	<i>Myriophyllum spicatum</i>
Goats rue	<i>Galega officinalis</i>
Hemlock: (a) Poison (b) Water	<i>Conium maculatum</i> <i>Cicuta maculata</i>
Horse-nettle: (a) Carolina (b) White	<i>Solanum carolinense</i> <i>Solanum elaeagnifolium</i>
Houndstongue	<i>Cynoglossum officinale</i>
Hydrilla	<i>Hydrilla verticillata</i>
Klamath weed	<i>Hypericum perforatum</i>
Knapweed: (a) Diffuse (b) Russian (c) Spotted (d) Squarrose	<i>Centaurea diffusa</i> <i>Acroptilon repens</i> <i>Centaurea maculosa</i> <i>Centaurea virgata Lam. Var. squarrose</i>
Leafy spurge	<i>Euphorbia esula</i>
Mayweed chamomile	<i>Anthemis cotula</i>
Mediterranean sage	<i>Salvia aethiopsis</i>
Medusahead	<i>Taeniatherum caput-medusae</i>
Perennial pepperweed	<i>Lepidium latifolium</i>
Puncturevine	<i>Tribulus terrestris</i>
Purple loosestrife	<i>Lythrum salicaria, L. virgatum & cultivars</i>
Rush skeletonweed	<i>Chondrilla juncea</i>
Saltcedar (tamarisk)	<i>Tamarix ramosissima</i>
Sorghum species, perennial, Including, but not limited to: (a) Johnson grass; (b) Sorghum alum; and (c) Perennial sweet sudan	
Sulfur cinquefoil	<i>Potentilla recta</i>
Thistle: (a) Canada (b) Musk (c) Scotch (d) Sow (e) Iberian star (f) Purple star (g) Yellow star	<i>Cirsium arvense</i> <i>Carduus nutans</i> <i>Onopordum acanthium</i> <i>Sonchus arvensis</i> <i>Centaurea iberica</i> <i>Centaurea calcitrapa</i> <i>Centaurea solstitialis</i>

Toadflax, Dalmatian	<i>Linaria dalmatia</i>
Toadflax, yellow	<i>Linaria vulgaris</i>
Whitetop or hoary cress	<i>Cardaria draba</i>

(alphabetical by scientific name)

Scientific Name	Common Name
<i>Acrotilon repens</i>	Knapweed: (b) Russian
<i>Alhagi camelorum</i>	Camelthorn
<i>Anthemis cotula</i>	Mayweed chamomile
<i>Cardaria draba</i>	Whitetop or hoary cress
<i>Carduus nutans</i>	Thistle: (b) Musk
<i>Centaurea calcitrapa</i>	Thistle: (f) Purple star
<i>Centaurea diffusa</i>	Knapweed: (a) Diffuse
<i>Centaurea iberica</i>	Thistle: (e) Iberian star
<i>Centaurea maculosa</i>	Knapweed: (c) Spotted
<i>Centaurea solstitialis</i>	Thistle: (g) Yellow star
<i>Centaurea virgata Lam. Var. squarrose</i>	Knapweed: (d) Squarrose
<i>Chondrilla juncea</i>	Rush skeletonweed
<i>Cicuta maculata</i>	Hemlock: (b) Water
<i>Cirsium arvense</i>	Thistle: (a) Canada
<i>Conium maculatum</i>	Hemlock: (a) Poison
<i>Crupina vulgaris</i>	Common crupina
<i>Cynoglossum officinale</i>	Houndstongue
<i>Euphorbia esula</i>	Leafy spurge
<i>Galega officinalis</i>	Goats rue
<i>Hydrilla verticillata</i>	Hydrilla
<i>Hyoscyamus niger</i>	Black henbane
<i>Hypericum perforatum</i>	Klamath weed
<i>Isatis tinctoria</i>	Dyer's woad
<i>Lepidium latifolium</i>	Perennial pepperweed
<i>Linaria dalmatia</i>	Toadflax, Dalmatian
<i>Linaria vulgaris</i>	Toadflax, yellow
<i>Lythrum salicaria, L. virgatum & cultivars</i>	Purple loosestrife
<i>Myriophyllum spicatum</i>	Eurasian water-milfoil
<i>Onopordum acanthium</i>	Thistle: (c) Scotch
<i>Peganum harmala</i>	African Rue
<i>Potentilla recta</i>	Sulfur cinquefoil
<i>Rorippa austriaca</i>	Austrian fieldcress
<i>Salvia aethiopsis</i>	Mediterranean sage
<i>Solanum carolinense</i>	Horse-nettle: (a) Carolina
<i>Solanum elaeagnifolium</i>	Horse-nettle: (b) White
<i>Sonchus arvensis</i>	Thistle: (d) Sow
Sorghum species, perennial, Including, but not limited to: (a) Johnson grass (b) Sorghum alum (c) Perennial sweet sudan	

<i>Sphaerophysa salsula / Swainsona salsula</i>	Austrian peaweed
<i>Taeniatherum caput-medusae</i>	Medusahead
<i>Tamarix ramosissima</i>	Saltcedar (tamarisk)
<i>Tribulus terrestris</i>	Puncturevine

Attempts were made to record noxious and invasive weeds at mile markers visited along Nevada Highways as a part of this project. They are summarized as to location by Highway number and mile-marker and further summarized by numbers of occurrences along each highway (Table 5). This data is by no means complete and requires further inventory and monitoring. We also are aware of a number of other species as listed in this report that were not seen at the mile-markers that we visited.

WILDFIRE HAZARD

Wildfire is of considerable concern to all Nevadans. Unfortunately many sites along Nevada highways possess vegetation characteristics that have a high potential for wildfire ignition. In this report we are attempting to promote plants that do not constitute high fire hazard. Reference here must be made to the USDA Fire Effects Information System, which has useful information about most of the plants we have listed as possible revegetation species in this report. The FEIS can be accessed at the following Web site (<http://www.fs.fed.us/database/feis/>). Areas of high fire hazard have been identified on the vegetation maps. Those areas with the highest fire hazard are sites with pure stands of cheatgrass (*Bromus tectorum*), various sagebrush species with understories of cheatgrass, sites with other weeds such as mustards, and other areas where weeds have become commonplace along the rights-of-way. Cheatgrass is the most common fire species found along Nevada highways. These sites can generally be identified by examining the various vegetation polygons on the vegetation maps. Of course, under very dry conditions a wildfire can start anywhere. On especially high fire hazard sites, it may be wise to attempt to establish fire-resistant species along the highways. However, the cost of such endeavors might be prohibitive. It then becomes a situation where the users of the highway system must be informed about fire hazard. While the U. S. Forest Service and Bureau of Land Management are handling this, perhaps the NDOT could somehow add to the message, or work with them to help get the message out.

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Appendices

Appendix #1 Species selection

The species listed in the general ecosystem specifications are those that we selected from advertised seed sources. These species are thought to be adapted to the ecosystems in question. Species selection is of paramount importance and requires several steps. The first step is to evaluate the environment where the revegetation effort is to take place. This would require examining the soil and climatic conditions, topography and microtopography, and competing vegetation which may or may not be native species. Then someone familiar with the natural vegetation would begin the selection process. This would require going to various seed companies and determining just what seed is available and what might best fit into a mixture, considering cost and the desirability to include a species in the mixture. Some western seed companies are listed in Appendix #2. Others are available. For each site there would be a number of species that would be appropriate and desirable. For the major ecosystems along Nevada highways we have listed some of the appropriate species. After the selection process is complete, purchase and delivery can be requested. The species finally selected will be a function of availability and cost. In some cases the cost will preclude the inclusion of a species in the mixture even though it may be desirable. Also the cost and availability of container-grown plants must be carefully considered.

Seeding rates will vary from site to site depending upon the soil, the species used, the price and availability of the selected seed. A reasonable rule of thumb would be to seed at a rate of 19 pounds to 20 pounds/acre of pure live seed. In one of the appendices we have included information on how to convert the acre seeding rates to the weight of seed per square foot or per square meter. In addition, it is important to calculate, based on seed germination percentages, the pounds of bulk seed required to yield one pound of pure live seed. This information is also included in Appendix #3.

Appendix #2 Sources of native seeds

We have listed here only a few of numerous seed companies with emphasis on those who provide seed adapted to Nevada conditions. There certainly may be others that could be used.

Applewood Seed Co., 5310 Vivian Street, Dept. D., Arvada, CO 80002, Phone (303) 431 7333, Fax (303) 467 7886, e-mail applewoodseed@worldnet.att.net.

Comstock Seed, 917 Highway 88, Gardnerville, NV, 89410, Phone: (775) 746-3681, Fax: (775) 746-1701, e-mail ed@comstockseed.com. Web site www.gardenwatchdog.com.

Granite Seed, 1697 West 2100 North, Lehi, UT 84043. Phone: (801) 768-4422 Fax: (801)-768-3967, e-mail info@graniteseed.com. Web site www.graniteseed.com.

Lawyer Nursery, Inc., 950 Highway 200 West, Phone (800) 551 9875, Fax (406) 826 5700, e-mail trees@lawvernursery.com. Web site www.lawvernursery.com.

Pacific Coast Seed, 6144-A Industrial Way, Livermore, CA 94550. Phone (925) 373 4417 Fax (925) 373 6855, e-mail pcseed@worldnet.net.

Plants of the Southwest On-Line, Aqua Fria Rt. 6, Box 11-A, Santa Fe, NM 87507. (800)-788-SEED (7333), Web-site www.plantsofthesouthwest.com.

Appendix #3 Bulk pure live seed requirements for seed with specified germination rates.

Percent Germination

% Purity	100	95	90	85	80	75	70	65	60	55	50	45	40
100	1.0	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0	2.3	2.5
95	1.1	1.2	1.2	1.3	1.4	1.5	1.6	1.7	1.8	2.0	2.2	2.4	2.7
90	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.8	1.9	2.1	2.3	2.5	2.8
85	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.9	2.0	2.2	2.4	2.7	3.0
80	1.3	1.4	1.4	1.5	1.6	1.7	1.8	2.0	2.1	2.3	2.5	2.8	3.2
75	1.4	1.5	1.5	1.6	1.7	1.8	2.0	2.1	2.3	2.5	2.7	3.0	3.4
70	1.5	1.6	1.6	1.7	1.8	2.0	2.1	2.2	2.4	2.6	2.9	3.2	3.6
65	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.1	3.5	3.9
60	1.7	1.8	1.9	2.0	2.1	2.2	2.4	2.6	2.8	3.1	3.4	3.8	4.2
55	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.8	3.1	3.4	3.7	4.1	4.6
50	2.0	2.2	2.3	2.4	2.5	2.7	2.9	3.1	3.4	3.7	4.0	4.5	5.0
45	2.3	2.4	2.5	2.7	2.8	3.0	3.2	3.5	3.8	4.1	4.5	5.0	5.6
40	2.5	2.7	2.8	3.0	3.2	3.4	3.6	3.9	4.2	4.6	5.0	5.6	6.3
35	2.9	3.1	3.2	3.4	3.6	3.9	4.1	4.4	4.8	5.2	5.8	6.4	7.2
30	3.4	3.6	3.8	4.0	4.2	4.5	4.8	5.2	5.6	6.1	6.7	7.5	8.4
25	4.0	4.3	4.5	4.8	5.0	5.4	5.8	6.2	6.7	7.3	8.0	8.9	10.0
20	5.0	5.3	5.6	5.9	6.3	6.7	7.2	7.7	8.4	9.1	10.0	11.2	12.5
15	6.7	7.1	7.5	7.9	8.4	8.9	9.6	10.3	11.2	12.2	13.4	14.9	16.7
10	10.0	10.6	11.2	11.8	12.5	13.4	14.3	15.4	16.7	18.2	20.0	22.3	25.0

Prepared by Graig Plummer, Soil Conservation Service

Appendix #4 Soil Samples

The following soil sampling suggestions were included from the "Objectives and Guidelines for Revegetation Success Under the Tahoe Bond Act" by Michael Hogan. These methods are necessary to assess the soil properties vital to the success of the establishment and vigor of plant species used in remediation efforts.