



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

Seeding Guidance for Cal-Trans District 4

Section A: Introduction

This manual provides a seed selection guide for erosion control and revegetation for Landscape Designers in District 4. In recent years native perennial plant material has become environmentally preferable for all but the shortest-term projects. Accordingly, the majority of the information in this report relates to California Native plant materials. The authors assume that Cal Trans will continue to provide immediate erosion control through appropriate physical erosion control treatments until the plant materials can significantly contribute to the long-term erosion control of the site. This illustrates the importance of defining the goals and objectives of the planting and then analyzing the plant material selections and anticipated plant establishment and maintenance needs in order to reach the planting goals. Finally, this manual contains plant material menus for MLRA's in District 4 comprised mainly of California native species

- 1.) **Physical Erosion Control Treatments** – The term “physical erosion control”, as used in this document, is defined as treatments applied to disturbed soils after earthwork has been completed that protect the soil surface during *germination and growth of specified vegetation*. Tables 1, 2, and 3 in Appendix A outline the physical erosion control treatments and soil amendment treatments typically used to provide suitable erosion control under most conditions in District 4. The plant materials selected and rates of seeding in this manual are predicated on the assumption that most seeded areas will continue to have equal or higher levels of treatment than those outlined in the tables.
- 2.) **Planting Goals** address four scenarios; a) *temporary* one season winterization, b) *short-term* revegetation, c) *permanent* revegetation and d) newly proposed phytomediaion grassy swales and extended basin plantings. (See Phytomediaion Cal-Trans, tdc Environmental 2001)
- 3.) **Environmental conditions:** This manual utilizes the NRCS system of MRLA's to assist in plant material selection. The authors have chosen to expand the details of the baseline MLRAs to reflect important variations in precipitation across District 4.



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

- 4.) **Plant material selection** criteria are discussed including plant stature, regional seed availability, certification programs, trade names and special collection.
- 5.) **Plant establishment, maintenance and management activities** are outlined and discussed for the various types of planting but do not presume to provide a complete guide. Establishment and maintenance of roadside planting are processes as opposed to events. While many establishment and maintenance needs can be anticipated, the most effective management programs employ site monitoring, prescription and implementation of best maintenance practices.
- 6.) **Plant material menus** are presented by MLRAs and include botanical and common name, a range of suggested seeding rates and guide for minimum germination percentage.

Section B: *Planting, Establishing & Maintaining Roadsides*

1. Physical Erosion Control Treatments

Cal-Trans District 4 employs a range of physical erosion control treatments that are installed in conjunction with seeding to secure the surface soil until more effective and permanent erosion control can be provided by vegetation. These physical treatments are necessary because a host of environmental factors determine the length of time between the onset of germinating rains and effective establishment of vegetated erosion protection. Ideally, seeding and physical erosion control treatments are most effective when applied by October 30th before the night temperatures fall below 5 degrees C (41 degrees F) in the early fall and before the occurrence of significant precipitation. In most parts of District 4, this timing allows for the greatest potential for significant seed growth during the first growing season. This planting period coincides well with most grading schedules and is in compliance with Storm Water Pollution Protection Plans for non-point pollution control. There are two periods of the year that are advisable to refrain from seeding: (1) from approximately November 20th to January 15th when the soils are typically so cold that seed tends to rot instead of germinate and (2) from February 20th to April 1st. In this time frame, District 4 can receive enough germinating rain to initiate plant growth but not have it continue for a long enough time to grow plants with sufficient integrity to survive summer drought. After April 1st, seed will likely remain dry and dormant until the first germinating rains of fall. *In most years, the two preferred planting windows are from August 15 through October 15 and January 15 through February 10.*



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

On the majority of Cal-Trans jobs, specification for preparation of seeding areas is absent or minimal. Although this manual is not intended to write new specifications for Section 20, the reader wants to be aware that much can be done ahead of seeding to ensure successful establishment. Several references to soil improvements and weed eradication appear in the following paragraphs. They deserve consideration as a new component of the seeding/mulching sequence.

Erosion Control Type D as outlined in Section 20 of the Standard Specifications is the basis of all erosion control planting treatments outlined in this section. The authors have chosen to use commercial fertilizer 16-20-0 for the temporary plantings and slower release organic fertilizer, compost and soil inoculants for short-term and permanent planting methods. With these exceptions in materials applications, the planting techniques are the same for all areas. (See Appendix A)

While the above treatment is a good first step in providing a quality germination environment, the vast majority of final grades are either cuts that expose subsoils or bedrock, or fills that consist of subsoils that have been compacted to 90% or more. These soils provide a poor medium for plant growth and would benefit from being disked or harrowed to break up the surface crust and allow better water and root penetration. Additionally, significant quantities of compost (40-50 Tonnes/HA 45 – 56,000 lbs/acre) and slow release organic fertilizers can be used to improve the growing conditions and raise the subsoil to a nutritional level that can support perennial plant communities. These materials would need to be incorporated into the top 12 inches of soil. (See Generation of Water-Stable Soil Aggregates for Improved Erosion Control and Revegetation Success, Cal-Trans 1998).

Several different seeding techniques are used to establish native perennials. The most common seeding technique used by Cal-Trans is often called a “three step process.” The application is to first apply seed, fertilizer, mulch and possibly other ingredients to the soil surface. Next, a layer of straw mulch is applied at 4.5 tonnes per Ha (2 Tons/Acre) and finally a tackifying agent and/or other materials are applied to hold the straw in place. This treatment places the seed and growth amendments in good contact with the surface soil. The straw is intended to provide favorable plant growth conditions (i.e. increase infiltration, retain soil moisture and insulate the ground) and to protect the surface soil from the impact of rainfall. The final tacking treatment is meant to hold the straw in place especially against wind, gravity and other forces.

While the three step physical erosion control treatment outlined above is the most widely used, drill seeding, broadcast and harrow seeding and imprint seeding are



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

all excellent techniques that might be employed on individual projects or sections of projects.

2. Goals and objectives of planting

The primary criteria for selecting plants is whether the planting is intended to have a *temporary*, *short term* or *permanent* life span. Along with each of these goals, highway plantings are also expected to achieve other objectives. Currently, Cal-Trans' stated primary goals are to provide surface soil erosion control and compliance with the SWPPP requirements. Other objectives usually included are such items as public safety, fire control and aesthetic considerations. Depending on the specific project, further objectives such as invasive weed control, special maintenance issues, environmental remediation, and endangered species are considered and addressed. All possible objectives are too numerous to consider in the scope of this publication.

- A) **Temporary** one-season winterization: When highway construction projects have yet to reach final grade, and weather conditions necessitate winter closure, temporary winterization treatments are applied. The goal of the planting is to quickly revegetate the site and retain the soil in place. The site will be re-graded before the construction is complete.
- B) **Short to mid-term revegetation:** Many sites are planted with short-lived perennials or annual reseeding plants to protect and revegetate the land until the permanent landscape is designed, funded and installed. These plantings rely on a broad mix of the short-lived perennials, which have the potential to persist until landscaping begins.
- C) **Permanent vegetation/restoration:** Areas within the highway rights of way are being revegetated to provide environmental enhancement or to integrate the vegetation into the surrounding natural environment. These plantings utilize a highly diverse mixture of native grasses, clovers, forbs and woody plants. In general, such plantings are slower to develop than the other treatments and thus probably do not provide significant contributions to erosion control during the first season of growth.
- D) **Phytoremediation Plantings:** Grassy swales and extended detention basins are a new feature of Cal-Trans construction projects. As discussed in "Phytoremediation of Highway Runoff", Cal-Trans June 2001, these plantings are useful for treating the initial flushes of storm water off the highway



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

surface and effectively removing many injurious metals such as Copper, Lead, Nickel, Zinc as well as suspended solids and petroleum hydrocarbons. Plants in swales and basins need to be able to survive through both periods of inundation and periods of drought. Best plants are resilient, finely divided (lots of surface area at ground surface for filtering), dense, and deep rooted. The most effective water quality treatment occurs when water depth in the swale does not exceed height of grass (at least during small storms); this leads to a recommended minimum height of at least 9 inches/. 23 meters.

3. Environmental Conditions

The system of Land Resource Regions and Major Land Resource Areas as developed in 1981 by the Soil Conservation Service (SCS) categorizes areas into similar environmental regions for plant selection purposes. The Major Land Resource Areas are *regional classifications and are* described briefly under the headings: Land Use, Elevation and Topography, Climate, Water, Soils, and Potential Natural Vegetation. The descriptions are based on information from many sources, mainly from the U.S. Department of Agriculture.

From a designer's point of view, the MLRA characterization can be viewed as a guide for site analysis and species selection. Regional and local microclimate variation as well as soil type and physical and social factors can influence plant selection. Until multidisciplinary maps are developed, designers *are encouraged to* utilize other site-specific data to aid in plant selection from the menus.

In this regard, some examples of site considerations for designers include urban setting vs. rural setting and soil type. In an urban setting one might select more traditional Mediterranean plants if the surrounding environment no longer contains "natural systems". In more rural areas, designers might choose to select a diverse collection of California native legumes, grasses, flowers and shrubs. These *plantings* might include trees from seed or from transplants. *Another example of using site-specific data is consideration of specific soil type.* the soil conditions be when the site is ready to be seeded? Is the soil serpentine, high or low in pH, or heavy with salt? Is the project site on-balance wetter, drier, more or less exposed, or at a greater or lesser elevation than the general description? Any or all of these variables can affect plant selection.

4. Plant Material Selection

For all the seeding treatments several principles were used to develop the new plant menus. All plants listed on these menus are either native to the MLRA or if



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

an annual cereal grain they are either sterile or likely to be short-lived on the site. If the site is better suited for Mediterranean plants, see Appendix B. The native grass, clover and flower species are generally available from commercial seed vendors. Native shrubs and forbs suggested are found commonly in the MLRA and should be available most of the time. Seed menus are designed to provide a varied architecture and texture and thus the menus are usually composed of taller and shorter, clumping and spreading, narrow leafed and broad-leafed plants. Seeding rates are based on current standard practices, are listed in Pure Live Seed units (PLS) and endeavor to take into consideration seed counts per unit area, plant aggressiveness, establishment success and survival rates. The native species presented in this manual have not been tested in replicated field trials. The Temporary Mix Menus are most aggressive and less diverse while the short-term and permanent menus are increasingly less aggressive and more diverse. Phytoremediation plants are lists by species with no seeding rates as they will be planted as plugs or sod.

Currently, academic researchers and most practicing restorationists believe that native plants from a given region or like regions are more likely to succeed in wildland plantings than plants from other sources. This belief has led to a desire to identify the original sources of the seeds to be used on replanting projects. The California Crop Improvement Association (CCIA), California native seed producers and others have developed a program for production of Site Identified Seed. It is anticipated that this program will come into regular use over the next decade.

At this time, many native grasses and other plants are sold under what are essentially trade names. *These names* are widely accepted in restoration contracting but have no official horticultural status. Cal-Trans should enforce compliance with trade nomenclature to ensure receipt of desired plant material. Seeds such as *Elymus glaucus*, Blue Wildrye - Anderson or Berkeley, are types of plants recognized in the native seed trade. Consequently, this manual will use some current trade names in its menus. Also, this manual employs asterisks (*) to indicate species that can be specified as “California Native Seed Sources” as there are other non-native seed sources available in the seed industry.

Site-specific seed collection is an option in certain specialized situations. In most cases, the project would need to be 8 hectares or greater in size, and have a 1 to 2 year seed collection time frame. A biologist should identify potential collection locations and assess the need for permits and or permission to collect seed. The contract should outline minimum seed quality standards, require seed testing, and provide a procedure to monitor field collection, seed cleaning and seed storage.



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

The California Crop Improvement Association has programs for field collection of site identified seed that might serve as appropriate models.

5. Establishment and Maintenance

Cal-Trans Landscape Construction Contracts typically are installed some years after initial highway contracts have been completed. These contracts include specification for both installation of plant material and also a maintenance and establishment period. When roadside seeding is part of these contracts, specific performance criteria and a minimum of 3 years establishment period should be included in these contracts. The balance of the discussion in this section will focus on establishment and maintenance of Highway Construction and Erosion Control plantings.

Oftentimes, the last item of work on a highway construction project is Erosion Control. Once complete, new highways, including seeded areas, are transitioned to Cal-Trans Maintenance personnel for establishment, maintenance, and long-term management. For newly constructed jobs, Cal-Trans Maintenance should establish a monitoring and prescription treatment program for plant establishment on these projects.

After selection of appropriate plant material is complete, the establishment of the target species is the next challenge. Establishment and maintenance efforts for temporary plantings are typically low, while establishment and maintenance efforts of short-term and permanent plantings are more complex. There are many aspects of seeded native roadside planting which have not been resolved. (This is particularly true regarding applications to Highway Construction.) Edmunson's recommendations are based on results of his field trial, but applied science and research regarding seeded natives is still in its early stages. Questions concerning the pros and cons of planting nurse crops, the appropriate levels of organic matter, seeding rates and the value of simpler vs. more diverse planting mixtures are all in need of exploration. When that work is done, a revised version of this manual can be written.

While awaiting the development of more specific techniques, we have summarized currently available practices which are adaptable and useful for establishing plants by direct seeding in District 4. Many of the techniques described follow basic agronomic principles used to establish other perennial plantings such as permanent cover crops, pastures or sod. The following is a



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

compilation of techniques found to be effective in current wildland restoration work and are the most fully developed to date.

A.) Weed Control, Weed Control, Weed Control

A basic understanding of the weeds on the site is essential to the development of a management prescription. The two major categories of weeds are: broadleaf and grass weeds and can be further subdivided based on their growing periods of fall/winter, winter/spring, and spring/summer. The timing and type of management treatments will thus vary according to the seeds on site and the weather patterns of the year. For instance, late spring rains can bring on a new flush of undesirable summer weeds.

Control of invasive annual weed plants is the main challenge to establishing and maintaining roadside plantings in California. These highly aggressive weedy plants grow rapidly during the winter and spring, and left uncontrolled, can smother the preferred roadside vegetation. The primary prescription of most management practices is to suppress the annual weeds and foster the growth of the target species. During the establishment phase, the techniques are primarily mowing, swathing, fire (rarely), and short-term selective herbicide application. There will be more discussion of weed control through the balance of this section.

B.) Establishment and Maintenance of Temporary Plantings

Temporary vegetation is usually easily established from seed and requires little attention. The plants are aggressive and thus emerge from the ground quickly, cover the soil densely and grow actively until they exhaust the soil moisture in early spring. Currently, maintenance of temporary plantings consists of mowing the plants for fire control at the end of the growing season. This is the preferred strategy if, in fact, the area will be re-graded before the final planting treatment. Another strategy is to chemically kill the plants after they have reached a suitable height (perhaps 12 inches), thus reducing the overall biomass accumulation on the project and limiting seed set while still providing plant cover to satisfy water quality goals.

C.) Establishment of short-term and permanent vegetation

The goal of permanent ground covering vegetation is to establish long lived native perennial grasses, legumes, wildflowers and other plants in a



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

self-sustaining planting. Even when shrubs and trees are going to be part of the planting design, appropriate understory plant systems will eventually provide weed control and aesthetic value.

Every site is going to be different and specific practices must be tailored to the individual circumstances. When temporary erosion control has preceded a permanent planting, seeds left by the first crop will magnify the weed control headaches in subsequent seedings. Weed seed banks augmented by previous plantings can take more than a year of kill-off before they are eradicated.

It is helpful to determine what the weed problems are likely to be before planting. If topsoil is replaced after construction, the origin of the topsoil may provide that information. Otherwise, monitor the planting site once seedlings begin to grow and develop an establishment plan based on what weeds emerge and the density of the weeds. If it is known that the site is going to be particularly weedy, pre-germination of weeds, followed by herbicide application is a practice that in many cases is almost essential.

Be sure to evaluate what weed species are in the seed to be planted. Legal seed can have up to 1.49% weeds as long as they are not officially noxious. Legal seed can also contain up to 4.99% other crop seed. Blando brome, annual ryegrass and other traditional reclamation grasses are in this category and if the site does not have these weeds, it is advisable to limit use of seed with these legal contaminants.

Basic post-planting establishment practices include mowing, swathing, prescribed fire (when possible), and selective herbicide application. Timing of these practices is important with the basic goals being to prevent weeds from *out-competing* the desired species during initial establishment and prevent weeds from reseeding. A good working knowledge of the growth characteristics (germination time, flowering, seed set, etc.) of planted species and weed species is essential in order to establish an effective integrated establishment program. **Most perennials are generally slow growing and competition from rapidly growing annuals will shade and starve them out and they will not survive. Even a heavy stand of native wildflowers can overwhelm perennial grass seedlings. Site monitoring during the first growing season is essential and prompt remedial action is equally important. During the first growing season, monitoring and prescriptive action must be performed every 4 to 6 weeks.**



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

Mechanical Weed Control Treatments

Mowing will probably be the most commonly used management tool during establishment and long term maintenance of grassland plantings. Mowing is used to remove the competitive shading by rapidly growing annual weedy species. In general, late winter or early spring is when the first mowing is required. Mowing is also used to remove forming seed heads and thus decrease the production of new weed seeds. Mowing height during the rapid growth period of cool season native perennials should be 3-6 inches during the establishment year and 6-8 inches for mature plants. A second mowing in late spring or early summer to 3-6 inches is usually helpful as long as summer active forbs such as *Grindelia* sp are not damaged.

Swathing grassland sites is an excellent mowing system that can be used where terrain allows. Swathing cuts all plant material and piles it into windrows. Tall weeds with seed heads and mature seed are thereby concentrated to one area or strip and the intervening areas are essentially cleared of the current crop of weed seed. The best situation is to bale the windrows and remove the weedy material. This technique is especially useful in first and second year plantings that are infested with tall grass weeds such as *wild* oats and ripgut brome. The technique might be easily implemented along median strips and linear right of ways.

Prescribed fire, or a combination of mowing and prescribed fire, is a highly effective management practice but in many areas prescribed fire options are severely limited. In areas where accidental fire is a frequent occurrence on roadsides and median strips, one prescribed burn could eliminate the nuisance, provide agronomic benefits and reduce total fire suppression costs. Established native perennials thrive after prescribed fire and annual wild flowers and legumes flourish. In areas where swathing has been performed, Cal-Trans might consider using propane field burning equipment to remove the remaining stubble under controlled conditions.

E.) Chemical Weed Control

Herbicides are important tools during the establishment period of a vegetation system. One of the goals of a vegetated system is to establish



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

plant materials that will competitively suppress invasive weeds with an ultimate reduction of reliance on herbicides. During the establishment period, weeds cannot be allowed to mature and make seed and all methods of weed control may need to be employed. A wide range of selective herbicides, both post emergent and pre-emergent, are now available to the restoration practitioner and a good working knowledge of their use is essential. Timing, rates of application, tolerance of desirable plant species, spectrum of activity against exotic species, environmental hazards, are a few of the characteristics that need to be considered. Selection of plant materials resistant to an herbicide is very useful. For example, *Nassella* species are very tolerant to low rates of glyphosate in early winter. This characteristic allows for effective control of early germinating weed species. Monitors may wish to consult *The Use of Native Grassland Plant Species for Roadside Revegetation (Training workshop designed for CalTrans and Roadside managers, Oct. 2001.*

A detailed description of all treatments is beyond the scope of this manual, but three examples will be used to illustrate the concepts. First, broadleaf weeds such as yellow star thistle, mustard, prickly lettuce, and a host of others are best treated with selective broadleaf herbicides when they are small, usually in late January or February. Second, if it is known that a heavy infestation of broadleaf weed seeds is on the site, it is advisable to not plant flowers and legumes the first year and concentrate on growing just perennial grasses. This allows for the use of a number of herbicides that can target serious broadleaf weed species. Finally, some broadleaf weeds, such as yellow star thistle and prickly lettuce, flower in late spring, after the seeded annual legumes and flowers have set seed. Treatment with an herbicide or mowing will thus not negatively impact seed production of the seeded flowers for the following year.

A very effective technique in late winter or early spring is wick herbicide application to the tall weeds leaving the shorter perennials untreated. This treatment can be followed by mowing which will allow more light to reach the slower growing perennial plants. A significant advantage of this technique is that no or only minimal weed seed is produced.

F.) Management of short-term and permanent plantings

The goal of management is to maintain and expand the bio-density of the vegetation system. All of the agronomic tools previously discussed are



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

useful in this task. Monitoring, prescription and implementation must be continued from establishment phase to the management phase. Monitoring is required at least twice yearly with some areas needing more attention. A certified Pest Control Advisor (PCA) is a valuable member of the integrated roadside vegetation management team.

Weed control continues to be the main challenge. It should be emphasized that the use of herbicides is only during the first 1-3 years of establishment and may not be necessary at all because a well established vegetation system will keep weeds out or at a tolerable minimum. Another management concern is biomass and thatch control. The long-term accumulation of biomass tends to smother the system and reduces its diversity. Thus, periodic biomass and thatch removal frees the system to express its full potential and redevelop maximum diversity.

Management treatments can be divided into physical treatments and chemical treatments. Physical treatments include mowing, swathing, fire, fertilizing, watering, reseeding or transplanting new plant material.

Mowing will remain the most widely used management practice. Mowing in late spring or early summer is practiced for thatch control and late maturing broadleaf weed control. Cool season perennial grasses can be mowed lower at this time since they are going into the dormant season. At the end of the growing season, the ground should retain 2 to 4 inches or 600 – 1,000 lbs./acre of residual dry material to help control summer weeds, especially star thistle. On established systems mowing every 2 – 4 years is advisable.

Fertilizing plantings in soils that do not naturally have enough nutrition to sustain established perennial vegetation is an important and effective treatment. Timely fertilization in the early spring will strengthen the seeded plant, and at the same time will not encourage as much weed competition as fertilization at other times of the year. Watering is a very useful tool, however it is rarely available on roadsides, and trucking water is usually cost prohibitive. Reseeding and transplanting container plants are effective treatments where roadside plantings have been severely damaged. If these areas are reseeded or replanted, they should receive *with* the establishment protocol outlined in Section B.5.

Chemical treatments include the use of herbicides, plant growth hormones and other treatments. The activities of herbicides can act as a pre-



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

emergent (which prevents seeds from germinating), a post-emergent (which acts on growing weeds), and some that have both properties or can be used in combination. While plant growth hormones and other treatments are not as yet widely used, they are prospects to be included in management programs.

Section C: Summary

The creation and management of effective native roadside vegetation is a process as opposed to an event. This manual presents a new set of menus for plant material selection for seeding in District 4. Also, it includes original species selection work by George Edmunson as much of his work is still applicable today. These menus are intended to guide designers in the selection and specification of plant material and are intended to be part of a more “holistic” approach to planting highways in District 4. Further this manual presents the different thinking and techniques used when designers consider winter soil cover as part of SWPPP construction activities. The construction process is very dynamic and an assortment of tools some vegetated and some not are usually used.

The selection of the plant material is one element in the planting process. Establishment and management of native vegetation for different MLRA’s within Cal-Trans District 4 are equally important. Every step carries equal importance, from soil preparation and physical erosion control treatments, to ongoing management programs.

As the interest and importance of these plantings continues to grow, Cal-Trans should consider implementing performance-based contracts for multiple years. These contracts are becoming more popular in private restoration projects and Cal-Trans might produce highly successful projects at lower cost with this approach.

Improved soil preparation, pre-plant weed control, longer establishment and maintenance periods and long-term integrated vegetation management practices are all identified as areas where significant strides can be made in the future. When seeding native perennials, reducing or eliminating the use of commonly used temporary erosion control species such as Blando Brome, Zorro Fescue, annual ryegrass and others would greatly enhance the performance, as these invasive exotics can overwhelm the seeded species during the first year or two of establishment.



SEED & SUPPLIES FOR NORTHERN CALIFORNIA

This manual presents lists of many California native plants that are *usually* available and being used in revegetation plantings. It recognizes that there are likely to be more items available, some as “Certified Source Identified” in the coming years. There is still much to be learned about effective seeding rates under different establishment techniques. It is anticipated that more effective establishment techniques will lead to lower seeding rates.

This guide emphasizes the need for monitoring, prescription and prompt remedial action to effectively maintain planted areas. While Cal-Trans recruits, develops and trains personnel, they could explore the prospects of retaining private contractors to monitor, prescribe and / or perform the prescribed tasks. This program is similar to those outlined in *Guide to Phytoremediation of Highway Runoff*, tdc Enviromental 2001.

A frequently asked question is how long newly planted, weedy sites require intensive management before they become self-sustaining. The answer will vary with the site, but a reasonable general estimate would be 3-6 years. Annual management will always be required and long-term integrated management practices are essential for their long-term effectiveness. While it can be said that intensive herbicide use will not be necessary for the entire life span of a given site, mowing, swathing, burning and/or other treatments will remain important tools of long-term management. Other a technique, or utilization of known techniques in specific combinations, is likely to emerge and become part of a growing arsenal of tools to meet the needs of District 4 and California’s Roadsides.

Erosion control is accomplished in many ways. It can be done with or without living plants. Physical erosion control with plants is applicable wherever and whenever control is needed in time spans too short for seed growth. Physical erosion control can be winter soil cover or it can be the start of permanent vegetation. Readers must develop their understanding of the available techniques and then choose those that serve all the project planting goals.