

Section 20 Erosion Control and Highway Planting

4-2001 General

Erosion control and highway planting is covered under Section 20, “Erosion Control and Highway Planting,” of the *Standard Specifications*. Erosion control materials are applied to roadside and median areas where erosion control is necessary and where planting may, or may not, be done in the future. Highway planting (landscaping) involves preparing areas for planting, furnishing and planting plants, and performing plant establishment work. Such landscaping is sometimes combined with erosion control. Irrigation systems are installed to apply water to highway planting.

For questions about the acceptability of materials and work for erosion control and highway planting, resident engineers may consult with landscape architects and landscape specialists in the district.

Note that many new products, materials, and methods used in erosion control and highway planting may not be included in Caltrans contracts. When new products, methods, or materials that meet contract requirements are used, report them to the district landscape architect and to the Landscape Architecture Program, using Form LA-16, “Product, Material, or Method Report,” (For Highway Planting or Erosion Control). The form is available in the Caltrans Electronic Forms System (CEFS) and the appendix of this manual.

4-2002 Erosion Control

Properly applied erosion control is a key element in preventing water pollution. The success of erosion control work often depends on the time of year that it is applied. Consult with the project landscape architect and landscape specialists if an apparent need exists for changing the order of work or the dates specified for erosion control.

4-2002A Materials

The following information discusses some of the materials used in erosion control:

4-2002A (1) Topsoil

Topsoil is the balance of organic matter, sand, clay, and nutrients necessary to support healthy plant life. For the specifications for topsoil, see Section 20-2.01, “Topsoil,” and Section 19-2.07, “Selected Material,” of the *Standard Specifications*. Topsoil that contains large percentages of sand and clay or silt-clay or is deficient in organic matter may be a poor medium for growing plants. High sand content tends to promote dry conditions. High clay content limits aeration and drainage. For good plant growth, the soluble salt content of topsoil generally should not exceed 500 ppm. If the topsoil’s composition is questionable, laboratory tests can determine the salt content.

Reject any proposed sources for topsoil if the topsoil has too much clay or sand or the topsoil lacks sufficient organic matter. Evidence of poor weed growth is a good indicator that the proposed topsoil source will not support healthy plant growth. If the proposed topsoil source is questionable, consider obtaining a basic soil test.

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4-2002 Erosion Control

4-2002A (2) *Commercial Fertilizer*

The *Standard Specifications* or the special provisions cover the requirements for commercial fertilizer, which is expressed as percentages of nitrogen, phosphoric acid, soluble potash, and sulfur. Commercial fertilizer may be spread with seed and other erosion control materials using hydroseeding equipment. Commercial fertilizer may also be specified for highway planting.

4-2002A (3) *Straw*

Straw is the mulch most commonly used to protect slopes and has proven to be an effective method of controlling slope erosion.

Straw provides the following benefits:

- Protects seeded soil from wind, rain, and sun.
- Conserves surface moisture and serves to maintain uniform soil surface temperatures, thereby promoting seed germination and early growth.
- Dissipates the impact of rainfall.
- Slows the velocity of runoff.

4-2002A (4) *Fiber*

Fiber, as used in erosion control, consists of fine, hair-like tissues processed into small clumps. Natural fiber is derived from wood or other vegetable products.

When properly used, fiber provides the following benefits:

- Protects seed within hydroseeding equipment from the action of centrifugal pumps and the action of discharge through the nozzle.
- Enables more uniform seed distribution.
- Enhances a visual inspection of seed coverage.
- Forms mulch, covering and anchoring seed to the slope.
- When applied with stabilizing emulsion, bonds straw to the slope.
- Enables seed and commercial fertilizer to be applied by hydroseeding in one application.
- Can be applied by means of a hose to slopes not accessible by other mulching equipment.

The most common method of applying fiber is with hydroseeding equipment. Seed, commercial fertilizers, and emulsion, when specified, usually are applied with the fiber and water in one or more applications. Fiber is used primarily as a carrier. It holds seed on slopes where it is not feasible to incorporate or anchor straw.

4-2002A (5) *Seed*

Minimum seed purity and germination are usually specified for seed. The purity of seed is defined as the percentage of a specified seed in relation to the total quantity, which includes inert matter, weed seed, and other seed. Seed germination is the percent of pure seed that will grow when tested under laboratory conditions. The percentage of pure live seed (PLS) is the product of percent seed purity and percent germination. (percent PLS = percent purity times percent germination).

Specifications require legume seed to be inoculated. Such inoculation involves combining the seed with viable bacteria appropriate for the species used.

4-2002A (6) Stabilizing Emulsion

Stabilizing emulsion may be applied with fiber and fertilizer. The emulsion increases the amount of fiber, seed, and fertilizer that a slope will retain and, therefore, improves the ultimate production of the desired vegetation.

Manufacturers of stabilizing emulsion normally specify the amount of water that must be added to the emulsion. The amount is usually specified as “liters of water to kilograms of solids of emulsion.”

4-2002B Before Work Begins

Before work begins, the resident engineer must do the following:

- Review the plans and specifications to determine the specified type of erosion control material and the time of application.
- Verify the receipt and proper distribution of Form CEM-3101, “Notice of Materials to Be Used,” which covers erosion control materials.
- When native topsoil is specified, examine the topsoil to determine that sufficient quantity is available and that it is suitable for the planned use. For possible solutions if the native topsoil appears inadequate, consult with the project landscape architect or landscape specialists. Ensure that sufficient area exists at the top of slopes to stockpile topsoil.
- The contractor must provide the seed vendor’s lab test results. Ensure they are complete and received in a timely manner.
- Erosion control materials are applied at a specified rate of so many kilograms or tonnes per hectare. Be prepared to measure and compute areas to which erosion control is to be applied so that spread rates may be checked during application.
- Examine equipment to be used in erosion control work to determine if it meets specified requirements.

4-2002C During the Course of Work

As materials for erosion control arrive on the project, and prior to application, do the following:

- Through examination, ensure imported topsoil meets the specified requirements.
- To determine if commercial fertilizer meets specifications, check the chemical analysis on the label of the fertilizer bag. This label generally suffices to determine whether the fertilizer meets the requirements.
- In addition to furnishing certified daily summary weigh sheets, require the contractor to furnish weight tickets with each load of straw delivered to the project. Keep records for the mass of straw delivered to stockpiles. Based on specifications, check for County Agricultural Certification if out-of-county straw is used.
- Ensure the receipt of a Certificate of Compliance for fiber. Check the labeling on the package for moisture content. If necessary, sample the fiber and perform California Test 226, “Determination of Moisture Content by Oven Drying.”

- Verify the species of seed listed on the seed label for consistency with the species listed in the special provisions.
- Compare the percent total viability stated on the vendor seed label with the percent total viability in the special provisions for the seed species.
- Ensure that the percent of total weed identified on the seed label is less than the percent stated in the special provisions.
- Determine whether California prohibited noxious weeds are identified on the vendor seed label.
- Check the seed lot test date. For purity and germination, the seed must be tested every twelve months.
- Check seed package labels and other required documentation. Calculate the weight of pure live seed (PLS) in each sack by referring to Section 4-2002A (5), “Seed,” of this manual.
- Collect seed samples according to Section 4-2002D, “Seed Sampling,” of this manual.
- Send the complete package to the Caltrans’s contracted seed clearinghouse in accordance with Section 4-2002D (4), “Sample Preparation, Preservation and Packaging.” Get the name and address of the clearinghouse at:
<http://onramp.dot.ca.gov/hq/design/landscape/seed.php>
- When approving the use of seed with a germination rate lower than the minimum rate specified, application rates must be such that the specified amount of pure live seed is used. Before approving a lower germination rate, consult with the project landscape architect.
- Ensure that legume seeds are inoculated as required in the specifications and that the required time limits are met.
- Ensure the receipt of a Certificate of Compliance for stabilizing emulsion. When stabilizing emulsion comes in powdered form, the actual mass of the powdered stabilizing emulsion will be the mass of the solids to be paid for. When the emulsion comes in liquid form, determine the percent of solids in the stabilizing emulsion by testing it as required by the *Standard Specifications*.

During the application of erosion control materials, do the following:

- Ensure the contractor prepares areas to receive erosion control as required in the specifications.
- Ensure topsoil, duff or compost is spread uniformly at the specified rate or depth. Ensure the contractor loosens any compacted topsoil.
- Ensure the contractor applies erosion control materials in the specified sequence and application rate.
- When straw is required, determine the spread rate by counting bales and using average bale weights. If the contractor applies the straw pneumatically, suspend the operation if wind conditions cause the straw or visible dust to be blown onto public roadways or across the property line onto private property.

- Observe the amounts and proportions of materials spread or entered into the hydroseeder. You may use sack counts and weights to determine the weights of seed, stabilizing emulsion, fiber and commercial fertilizer
- Compute and record the spread rates of the various materials applied. For each day of operation, compute and record the spread rates at least once.

4-2002D Seed Sampling

Use the following guidelines for obtaining samples for testing.

4-2002D (1) Scope

The purpose of seed testing is to get quality assurance data regarding the purity and viability (germination) of seed. For accurate laboratory test results, seed must be collected and handled to get representative samples. Samples submitted to the laboratory that are not representative can result in inaccurate or erroneous test results.

4-2002D (2) Size of Sample

For each seed lot greater than 1kg, take a seed sample of approximately 30 grams.

4-2002D (3) Procedure for Sampling

Before handling the seed sample, observe the following requirements:

- Do not touch or sample fungicide dyed seed, such as, dyed red or green, or mercury treated seed or seed labeled, "Treated Seed."
- Use protective gloves when sampling seed.
- Use clean gloves to avoid affecting the purity of the seed samples.
- Avoid inhaling any dust.

When taking the seed sample:

- Take a seed sample from a newly opened seed bag.
- Do not mix samples from different seed species or seed lots.
- Sample the seed by thrusting your gloved hand into the bag and withdrawing representative portions.
- Take at least seven equal portions of seed from various parts of the bag.
- Place each portion in a clean container and visually examine the seed for uniformity.
- When the portions appear to be uniform, combine them in a glassine lined bag provided by the contractor

4-2002D (4) Sample Preparation, Preservation and Packaging

Sample preservation maintains the integrity of the sample from the time of collection until the tests is performed.

- Keep the samples in a suitable and shaded location. Avoid placing samples in a hot or a damp location.

- Identify the contents of each sample by placing the vendor's original seed label in each bag. Place a custody seal over the bag opening.
- Protect the seed from damage. Package samples in a cardboard box with bubble wrap or insulating peanuts. No additional preservation is necessary.
- Include the following documentation:
 1. Completed Form TL-0101, "Identification Card."
 2. Copy of the seed requirements from the project special provisions.
 3. Seed vendor's seed lot test results.
 4. Copy of the vendor's original seed label.

Send (within 24 hours) the sample and documentation via express mail to the Caltrans contracted seed clearinghouse. The clearinghouse information can be located at:

<http://onramp.dot.ca.gov/hq/design/landscape/seed.php>

4-2002E Quality Assurance Seed Testing Results

Consider the following areas when making determinations about seed.

4-2002E (1) Results

Quality assurance testing results will be provided through Caltrans contracted seed clearinghouse.

The clearing house will contact the resident engineer by letter with the results of the quality assurance testing in conformance with the specifications. Some potential issues are:

- Species of seed on the seed label does not match the species in the special provisions.
- The percent total viability of the seed is lower than what is specified in the special provisions.
- The percent total weed identified on the vendor seed label is greater than what is specified in the special provisions.
- The presence of California prohibited noxious weeds is identified on the vendor seed label or test results.

4-2002E (2) Nonconformance Procedures

If the contractor fails to comply with the contract specifications for seed, enforce the appropriate contract provisions to ensure compliance based on the nature and severity of the situation. Refer to Section 6-1.04, "Defective Materials," in the *Standard Specifications*.

4-2002F Measurement and Payment

From the weight shown on the certified scale sheets, deduct any leftover straw not used in the work. If a "weigh back" certified weight is not available, you may use bale counts and average bale weights for this purpose.

To determine pay quantities, you may use sack counts and sack weights. Make accurate counts, and record them in the project records.

Determine the pay quantity of live seed using the germination and purity rates of the bulk seed.

4-2003 Highway Planting

For the specifications related to highway planting, see Section 20-4, “Highway Planting,” of the *Standard Specifications*. Highway planting consists of preparing areas for planting, applying pesticides, and furnishing, planting, and maintaining plants.

4-2003A Materials

The following provides some general information on various materials used for highway planting:

4-2003A (1) Soil Amendment

For the requirements for soil amendment, refer to the *Standard Specifications*. The special provisions may specify the type of material to be used. For the quantities, see the plans in the Plant List and Planting Specifications chart or the special provisions.

4-2003A (2) Iron Sulfate

Iron sulfate consists of iron and sulfur. Some soils lack iron, one of the micronutrients needed for the proper formation of chlorophyll. Iron sulfate is used both to correct soils deficient in iron and to lower the pH of the soil. It makes the existing iron more readily available for plants.

4-2003A (3) Lumber

Lumber, as described in the specifications, is used for header boards to define landscaped areas.

4-2003A (4) Plants

The contract plans will specify the types and sizes of the plants to be used on a given project. If a particular plant type is unavailable from any of the contractor’s nursery sources and a change is proposed, seek a recommendation of approval from the project landscape architect, who will need to review the proposal.

4-2003A (5) Foliage Protectors

Foliage protectors protect newly installed plants from animals or rodents interested in foraging the various above-ground parts of the plants. Eventually, as the plants grow larger, the need for foliage protectors decreases. On some projects with lengthy plant establishment periods, the specifications may require the protectors be removed before contract acceptance.

4-2003A (6) Root Protectors

Wire mesh root protectors serve a similar purpose as the foliage protectors, providing below-ground protection from burrowing rodents. The specifications require removing galvanizing from the wire mesh. Such removal facilitates the decomposition of the wire mesh in the soil and allows plant roots to grow through the wire mesh without being girdled or restricted. By the time wire mesh decomposes, the plant is usually large enough to withstand some root damage by rodents.

4-2003A (7) Mulch and Compost

Mulch is used in many situations on various construction projects. Applications may vary from simple installations within plant basins to larger areas as a ground

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cover within mass planting areas until the plants fill in and cover the ground. On some projects, mulch may be used as part of an approved water pollution control plan. Mulch has the following benefits:

- Retains soil moisture to assist in healthy plant development
- Acts as a weed barrier
- Aids in the prevention of surface erosion

Section 20-2.08, “Mulch,” of the *Standard Specifications*, specifies the materials and size requirements for mulch. Ensure the receipt of a Certificate of Compliance for mulch.

4-2003B Before Work Begins

Before work begins, the resident engineer must do the following:

- To determine the requirements for highway planting, review the plans and specifications.
- Verify the receipt and proper distribution of Form CEM-3101, “Notice of Materials to Be Used,” which covers highway planting materials.
- Check for planting areas where little or no weeds are growing because the lack of weeds may indicate sterile ground. Ask the maintenance landscape specialist if any planned planting areas were sterilized. If certain areas were sterilized, find out when the sterilization occurred, what chemicals were used, and what the rates of application were. For corrective measures, request assistance from the project landscape architect or the maintenance landscape specialist.
- Take photographs of existing site conditions, especially where you find evidence of sterile soil and damaged facilities.
- Invite the district landscape architect or project landscape architect and the maintenance landscape specialist to visit the site. Review the areas to be planted, and verify the limits and work involved in roadside clearing. Discuss any unusual features or potential problem areas.
- Ensure the contractor is aware of any special requirements, particularly any facilities or plants that must be preserved and protected.

4-2003B (1) Pesticides

Before any work using pesticides begins, the resident engineer must do the following:

- Review the specifications covering pesticide use.
- Review the guidelines for pesticide use contained in Chapter C2, “Vegetation Control,” of the Caltrans *Maintenance Manual*. These guidelines can also be applied in a general way to contract work.
- Obtain and review a copy of the contractor’s recommendations for pesticide use, as submitted to the contractor by a licensed pest control adviser. For assistance, you may call the maintenance landscape specialist, who is an expert in this area. Ensure the recommended pesticides are limited to those specified in the special provisions. Any change in the specified pesticides must be made by a contract change order.

- Some counties have environmentally sensitive areas where special requirements or prohibitions may apply. Consider any restrictions imposed by county agricultural commissioners.
- Ensure the proposed application rates or other features will not cause damage to abutting properties or to existing plants that must remain. Do not approve harmful pesticides that can be carried to other locations by runoff during the rainy season.
- Upon completion of the necessary reviews, advise the contractor in writing that the pest control adviser's recommendations have been approved subject to the provisions of Section 7-1.01H, "Use of Pesticides," of the *Standard Specifications*.

4-2003B (2) *Plants*

Before any work with plants begins, the resident engineer must do the following:

- Discuss the requirements for plants with the contractor and ask if the contractor wants the inspection of plants to occur before shipping. Ensure the contractor understands that the plants will still be subject to inspection at the job site.
- When requested by the contractor, you may arrange to inspect the plants at the plant supplier's nursery. For inspection of the plants at a nursery in another district, request assistance from a qualified person in the district where the nursery is located. Send all necessary contract information to the plant inspector.
- The inspection should be done after the contractor submits the required 10-day notice of the plant shipping date. The plant inspector must document the results of the inspection, including rejection of any plants and the reasons for rejection. The inspector must send the report to the resident engineer. However, plants that have been examined at the nursery are still subject to inspection at the job site. Inspect plants for compliance with Section 20-2.13, "Plants," of the *Standard Specifications*, and with any special provisions. The following are guidelines for plant inspection.
 1. Examine the plants and their nametags to confirm the plants are of the variety and size specified.
 2. Observe the methods of transporting and storing the plants. Pay particular attention to the requirements for keeping plants wet. Reject plants that are dry, wilted, or otherwise unsuitable when delivered to the planting area. Note such rejection in the daily report.
 3. Check to see if plants are obviously deformed, diseased, or insect infested. Obtain inspection certificates that indicate all plants comply with federal and state laws requiring inspection for diseases and infestations. Before accepting plants from another county, require the contractor to produce evidence of clearance from the county agricultural commissioner.
 4. For the specified number of plants, remove earth from the roots of container-grown plants to determine the condition of the roots. Ensure enough roots have grown so that the dirt and root ball will hold together when planting.
 5. Do not accept root bound plants. See Figure 4-20.1 "Roots," for an example

of acceptable and non-acceptable roots. After a root bound plant is planted, water cannot penetrate the tight mass of roots, or at maturity, the plant may strangle itself. Root bound plants occur when seedlings are grown too long in small containers. The roots grow to the bottom of the container and then turn and grow around the ball of the plant. It is difficult to overcome a root bound condition merely by planting into a larger container or into the ground.

Figure 4-20.1 Roots



Good Roots
Acceptable



Pot Bound Roots
Not Acceptable

6. Check for root girdling in plants that have a main taproot. Girdling occurs when a plant has been left in a container for too long. The taproot circles and chokes the root system until the plant eventually dies.
7. Ensure plants in larger containers have not recently been transplanted from a smaller container. Plants should be well rooted in proportion to the container from which they are taken.

8. Make random measurements of carpobrotus cuttings to ensure the cuttings equal the specified length.

4-2003C During the Course of Work

Use the following guidelines to ensure highway planting complies with the plans and specifications:

4-2003C (1) Roadside Clearing

Roadside clearing includes removing trash and debris, killing, removing, or mowing weeds and other vegetation, and controlling rodents. During roadside clearing, the resident engineer must do the following:

- Give due consideration to the requirements for water pollution control. It may be desirable to leave some vegetation on the slopes to reduce the potential for storm water pollution during the rainy season.
- Ensure the contractor removes stumps and large roots to the depth specified. Check areas to be planted to ensure they are free of living weeds at the time of planting.
- Gophers are among the rodents requiring control. Evidence of gophers includes surface mounds left from their nighttime tunneling when the gophers eat plant roots and chew on irrigation wires. Their burrows can damage plant basins. Baiting and trapping are the methods used to control gophers. Some counties have rodent abatement programs and will give expert advice upon request. For information, contact the maintenance landscape specialist.

4-2003C (2) Pesticides

During pesticide use, the resident engineer must do the following:

- Observe the mixing and applying of pesticides to ensure these processes comply with the approved recommendations and specifications. Ensure that workers applying pesticides wear protective clothing, including eye protection. A person with a pesticide applicator's license must be at the site. However, the person spraying the chemicals does not need a license. Include notes about the pesticide application in the daily report
- Provide the contractor with Form LA-17, "Report of Chemical Spray Operations."
- Obtain a completed chemical spray report from the contractor each week. Retain one copy in the project files, and forward other copies in accordance with district procedures.
- Early enough in the contract so a good weed kill can be obtained, ensure the contractor has applied the specified pesticide to problem weeds, such as Bermuda grass.

4-2003C (3) Preparing Planting Areas

After roadside clearance, irrigation system installation, trench testing and backfilling, the preparation of planting areas begins. During this preparation, the resident engineer must do the following:

- Using the plan sheets for plant layout, ensure the location for plants and the perimeter of ground cover areas are designated with gypsum, small wire-mounted

flags or other suitable markers. The contractor must furnish the labor materials, and transportation for placing stakes or other suitable markers to indicate the designated locations. This phase of designating locations is when necessary changes can be made with the least inconvenience and cost to the contractor or to Caltrans.

- When establishing plant locations, ensure compliance with the guidelines in Chapter 900, “Landscape Architecture,” of the *Highway Design Manual*, which contains planting design standards.
- Ensure plant locations meet the minimum setbacks from the traveled way, pavements, fences, walls, and ditches, as shown on the Plant List and Planting Specifications chart in the contract plans. However, plant locations on the ground do not need to match the plans exactly. The contractor may need to adjust the locations of shrubs and trees for proper setback from the traveled way. Whenever possible, also avoid extremely rocky or poorly drained areas, old roadbeds, sign locations, and utility lines. Keep in mind the intended purpose of the planting, and visualize the size, shape and characteristics of the mature plants. Select locations so branches of mature plants will not extend into the roadway or over a right-of-way fence.
- If cultivation will be required, the plans or special provisions will say so.
- Ensure the soil is loosened to the specified depth, and prohibit rubber-tired equipment on cultivated areas.
- When rocks are encountered in an area of predominantly fine native materials, most rocks larger than 65 mm should be removed. In predominantly rocky areas, consult with the project landscape architect for alternatives to removing rocks.
- If rocks need to be removed, prepare a contract change order to pay for disposal. Consider using the rocks at drainage outlets or other areas to prevent erosion.
- To support payment, maintain adequate records of cultivation. When the contract item for cultivation includes payment for soil amendments and fertilizer, ensure these materials are incorporated at the specified rates. Note your observations in the daily report.

4-2003C (4) Header Boards

Measure header boards, and ensure they are installed as the contract requires. Ensure that nails, lag screws, and hardware are galvanized and that lumber is of the specified quality.

4-2003C (5) Planting

Inspect the planting operation, and ensure the requirements specified in the plant list are met for the following:

- Hole size
- Basin type
- Iron sulfate

- Soil amendment or fertilizer
- Mulch
- Plant stakes, if required

Observe the general planting operation to ensure the following:

- No more plants are distributed along the roadside than can be planted and watered on the same day.
- Containers are not cut until delivered to the planting area.
- Roots of plants not in containers remain covered and moist.
- Before transporting the plants to the planting area, nursery stakes are removed from the plants at the project site.
- Before ground cover is planted, trees and shrubs for such areas are planted, watered, mulched, and staked (if required).

For ground cover, make sufficient observations to ensure the following:

- Cuttings are placed to the required depth.
- The soil is moist at the time of planting.
- Plants are watered as specified.
- The specified spacing is provided.

Also, the resident engineer must do the following during the course of planting:

- Note all observations, including any pertinent instructions given to the contractor, in the daily report.
- Before planting in holes or trenches, ensure the contractor has prepared backfill and has applied water as specified. Before backfill is tamped down, ensure the plants are straight in their holes.
- Review planted areas to ensure plants have been staked and tied in the specified manner.
- Mulch, if required, must be placed as soon as possible after planting. It will help to retain moisture and discourage weeds. Ensure the removal of wood chips that are longer than the specifications allow. Keep mulch away from drainage channels and away from plant stems. Postpone placing mulch in extremely wet weather when trampling the areas would compact the soil and the mulch would hold excessive moisture around the plant.
- Decide on test areas for counting plants as specified. Prepare adequate records for progress payments.
- When it is obvious that plants will not survive or will be damaged severely due to weather, consider allowing a delay of planting until a more favorable period. If planting, delayed because of unfavorable weather conditions, is the controlling operation you may grant nonworking days in accordance with Section 8-1.06, "Time of Completion," of the *Standard Specifications*.

4-2003C (6) *Watering*

For watering, the resident engineer must do the following:

- Ensure the contractor applies sufficient water so the plants will develop properly. Too much water, improperly applied, can cause damage. Factors such as weather, soil, and plant type determine the amount of water and frequency of application.
- Beginning with the initial watering, closely check the amount of water applied and the manner in which it is applied. Most plants should be watered immediately after they are planted. Do not allow initial watering to be delayed until the following day.
- To ensure watering requirements are met, periodically observe planted areas after initial watering.
- Ensure the irrigation system distributes water evenly. To ensure proper coverage and to ensure water does not reach the traveled way, routinely check the sprinklers' water distribution.

4-2003C (7) Replacement

A plant need not die before the contractor replaces it. Ensure the contractor replaces any plants that have been injured or damaged sufficiently to render them unsuitable.

When a replacement plant obviously will not survive because of weather or other predictable causes, consider delaying replacement until a more favorable time.

To substitute an alternative species, seek authorization through a contract change order and obtain concurrence from the project landscape architect.

4-2003C (8) Plant Establishment Work

The objective of plant establishment is to ensure that, before contract acceptance, plants are healthy and established and the irrigation system works as planned.

Caltrans has two categories of plant establishment, described as follows:

- Type 1, which is normally used on projects where highway planting is a major portion of the work.
- Type 2, which is used on projects where highway planting is incidental to other work.

Plant establishment consists of caring for the project as specified. Establishment work begins with each plant after it is planted and watered for the first time. Therefore, new highway planting must be properly maintained both before and during plant establishment. During the course of plant establishment, the resident engineer must do the following:

- When it is necessary to replace poorly cared for plants, order replacement promptly. However, do not allow replacement as a substitute for proper maintenance. A plant that was planted earlier and maintained for a longer period of time will be more developed and will require less maintenance upon completion of the contract than one planted late in the plant establishment period.
- Ensure the contractor follows specifications requiring plants and planted areas to be well watered. The words "well watered" mean more than just enough

water to keep a plant alive. It is intended that the plant will flourish during plant establishment. Once the root systems become established, watering can be reduced.

- Ensure the contractor maintains sufficiently formed basins around each plant to permit the ponding of irrigation water and to provide ample room for the required mulch. During wet weather, the contractor may need to create temporary openings in the basin walls to drain excess water from the plants.
- Ensure the contractor controls weeds as specified. Without weed control, the weeds' rapid growth will reduce the availability to the plants of moisture and nutrients in the soil. If plants have to compete with weeds for moisture, nutrients, and sunlight, they will not develop properly
- Within basins or header boards and adjacent to fences, ensure ground cover is removed from paved areas, as specified.
- From roadside clearing and planting areas, ensure the contractor removes surplus earth, paper, trash, and debris, as specified.
- Ensure commercial fertilizer is applied at the specified time, in the required amounts, and in a workmanlike manner. Prohibit the concentration of commercial fertilizer at the base or stem of the plant; otherwise, injury to the plant will result.
- Require the contractor to give instructions on the use and adjustment of the irrigation controllers as required in the specifications. Invite the appropriate landscape maintenance personnel to the instructional session.
- When all work except plant establishment is complete, require the contractor to remove construction area signs. If appropriate, use temporary traffic control signs during plant establishment work.

4-2003C (8a) Administering plant establishment time requirements:

In administering the time requirements for plant establishment, the resident engineer must take the actions below.

- Notify the contractor of the beginning of the plant establishment period. On Form CEM-2701, "Weekly Statement of Working Days," under "Remarks," note the date of the first day of the plant establishment period.
- During plant establishment, credit the contractor with one plant establishment working day for each day except Saturdays, Sundays, and legal holidays when plant establishment work is satisfactory.
- Ensure that all required work is complete before beginning to give credit for plant establishment working days.
- Judge carefully when deciding whether or not to give credit for a plant establishment day. Base the decision on whether the planted areas are maintained as specified. When necessary, order corrective work in writing. If the contractor does not correct deficiencies within a reasonable period, do not give credit for plant establishment days. In most cases, you may consider a response time within two weeks as reasonable. For normal conditions, order corrections no more often than once each week. Whenever progress is being made toward correcting deficiencies, allow credit for

plant-establishment working days. However, when deficiencies appear faster than they are corrected, prohibit credit.

4-2003C (8b) Tracking time for Type 1 plant establishment:

For Type 1 plant establishment, the contractor must complete all work except plant establishment before the plant establishment period begins. Only plant establishment may be in progress during the plant establishment period. The special provisions require plant establishment to be performed satisfactorily for a specified number of working days.

Until plant establishment begins, track contract time on Form CEM-2701, “Weekly Statement of Working Days,” in the normal manner. After plant establishment begins, continue filling out the upper part of the form as before. Show all days except Saturdays, Sundays, or legal holidays as working days, regardless of weather or other conditions. Track the progress of plant establishment under “Remarks” in the manner similar to that shown for Type 2 plant establishment shown in the sample weekly statements of working days in Example 3-8.6 and Example 3-8.7 in Section 3-8, “Prosecution and Progress,” of the *Construction Manual* (manual). Credit all working days as plant establishment days except for days on which the contractor fails to satisfactorily perform plant establishment.

4-2003C (8c) Tracking time for Type 2 plant establishment:

Two time limits are specified for projects with Type 2 plant establishment. An amount for liquidated damages is also specified for each time period. The following are the two time periods:

- The number of working days for all work except plant establishment.
- The total number of working days for all contract work, including the plant establishment period.

For Type 2 plant establishment, the contractor must complete all highway planting before plant establishment begins. In addition to plant establishment, other contract work may be in progress during the Type 2 plant establishment period.

For examples of how to track contract time when both time periods are running concurrently, see Example 3-8.6 in Section 3-8, “Prosecution and Progress,” of this manual. Show the “working days specified in the contract” as the number of days specified for all work except plant establishment. Fill in the weekly statement in the normal manner, and track the progress of plant establishment as shown under “Remarks.”

Example 3-8.7 in Section 3-8 shows the method of tracking contract time and plant establishment days after the contractor has completed all work except plant establishment. After all work except plant establishment has been completed, show the “working days specified in the contract” as the total number of days specified. In the last weekly statement occurring while work other than plant establishment is in progress, record any overrun in contract time for the shorter contract time period.

4-2003D Measurement and Payment

The specifications may specify that highway planting be paid for as a single lump sum contract item or as individual contract items. Resident engineers and assistant resident engineers must carefully determine the methods for measurement and payment for each element of highway planting.

When highway planting is paid for as a single lump sum contract item and the special provisions specify a “cost breakdown,” ensure the contractor submits the required information. Until you have approved the cost breakdown, do not make partial payments for highway planting. Use the cost breakdown to determine payment for increases and decreases in the units of work within lump sum contract items for highway planting.

When a lump sum contract item is used for payment, you will usually need to measure some of the units of work performed to verify the contractor completed the planned work. Record these units of work in the project records. As an example of the need to measure a unit of work included in a lump sum item, the designer may include ground cover in the lump sum contract item for highway planting. The plans will indicate the number of cuttings to be planted in each area. You must ensure and document that the correct number is planted by measuring the cuttings as specified in Section 20-4.09, “Measurement,” of the *Standard Specifications*, and recording the result in the daily report.

When a single lump sum contract item is used, you should not need to measure items such as pipe for supply lines, as long as the plan remains unchanged. However, you must measure and record quantities of items such as plants, fertilizer, and mulch.

When individual contract items are used, measure quantities in accordance with the specified methods.

4-2004 Irrigation Systems

Irrigation systems may be manual or automatic, as specified in Section 20-5, “Irrigation Systems,” of the *Standard Specifications*. The special provisions may require the installation of radio equipment that can communicate with a centrally located computer and radio base station.

4-2004A Components of Irrigation Systems

The following are the major components of an irrigation system:

4-2004A (1) Water Meter

The water meter measures the quantity of water delivered to the project. The water may be from a local water district providing domestic potable water or reclaimed water from a water treatment facility.

4-2004A (2) Backflow Preventer

The backflow preventer protects the domestic water system from contamination by preventing water within the irrigation system from siphoning back into the domestic water supply. All domestic water irrigation systems are required to have backflow prevention. The backflow preventer is installed downstream from the water meter in a domestic potable water system.

4-2004 Irrigation Systems

4-2004A (3) Wye Strainers

Wye strainers filter solid particles from irrigation water. They are installed as part of backflow preventer assemblies and at other locations in the supply lines.

4-2004A (4) Main Supply Line

The main supply line is installed downstream from the water meter and backflow preventer. The supply line carries water under pressure to quick coupling valves and the remote control valves.

4-2004A (5) Master Remote Control Valve

The master remote control valve is located downstream from the backflow preventer. Its purpose is to control the flow of water to supply lines so that they are not under constant pressure when irrigation is not taking place. The master remote control valve is activated when any remote control valve is activated.

4-2004A (6) Remote Control Valves

Remote control valves control the flow of water to the lateral water supply lines and sprinklers. When not operating, they are closed. Remote control valves are usually grouped for ease of maintenance.

4-2004A (7) Quick Coupling Valve

A quick coupling valve is used to attach a hose to the irrigation system.

4-2004A (8) Gate Valve

Gate valves are manually operated to shut off water to allow repairs or modifications to the irrigation system.

4-2004A (9) Lateral Supply Line

Lateral supply lines are pipes that carry water between the remote control valves and the sprinklers. Lateral supply lines are only under pressure when the remote control valve is open.

4-2004A (10) Emitters and Sprinklers

Emitters are watering devices used with drip irrigation systems. They require additional filtration of the water being used in the system because they are easily clogged. Because they apply water at a slow rate, potential erosion of the plant basins is almost nonexistent. Requirements for emitters will be included in the special provisions and on the plans. The plans will specify flow rates and operating pressures for emitters. Sprinklers apply water in a spray pattern to the soil around plants. The special provisions and the plans specify the sprinklers by type, pattern, material, and operating characteristics. Emitters and sprinklers are installed on the lateral supply line.

4-2004A (11) Filter Assembly Unit

Filter assembly units prevent small particles from clogging sprinklers or emitters.

4-2004A (12) Irrigation Crossovers

Irrigation crossovers consist of conduit and pipe used to carry irrigation water under roadways. They are often installed as part of a highway construction project before

the highway landscaping project begins.

4-2004A (13) Irrigation Controllers

Electrically operated irrigation controllers supply low voltage to activate the remote control valves. The controllers may operate on 110-volt electrical circuits, batteries, or solar power. Irrigation controllers are placed inside heavy-duty metal enclosures bolted to concrete pads.

4-2004A (14) Electrical Conduit, Pull Boxes, and Conductors

These electrical components of the irrigation system supply electrical power to operate irrigation controllers and valves.

4-2004B Before Work Begins

Before the irrigation system is installed, the resident engineer must do the following:

- Verify the receipt and proper distribution of Form CEM-3101, “Notice of Materials to be Used,” which lists all irrigation system materials.
- When existing irrigation systems are to be maintained, review the systems with the appropriate landscape maintenance personnel. Check existing systems for proper operation and state of repair.
- Review with the contractor the requirements for maintaining existing irrigation systems. When Caltrans maintenance forces are involved, ensure that the contractor and Caltrans maintenance personnel are aware of each other’s responsibilities.
- For correspondence with the serving utility companies, contact the project landscape architect. Ensure that, when Caltrans must do so, all orders for water and electrical service have been placed with the serving utility. If services have not been completed, check service points and meter locations with the field representative of the serving utility. Verify the availability of water in the quantities and the pressure required for the irrigation system.
- Verify with the appropriate district unit the availability of any specified state-furnished material.
- As required by Section 20-5.027B, “Wiring Plans and Diagrams,” of the *Standard Specifications*, obtain from the contractor working drawings of wiring plans for the electrical portions of the irrigation systems . Ensure that the manufacturer of the controller has approved the wiring plans. Also send the plans to the district landscape architect for review. After review and approval, forward a copy to the contractor with the following written statement:

“The plans are approved pursuant to Section 5-1.02, Plans and Working Drawings,” of the *Standard Specifications*.”

- The Office of Structure Design’s Office of Electrical, Mechanical, Water and Wastewater usually designs the more complex electrical and mechanical work, such as pump installations. Contact that office to arrange for periodic inspections of the work as it progresses.

- Inspect irrigation system materials as they are delivered to the project site. For most irrigation system materials, the Office of Materials Engineering and Testing Services (METS) will assign responsibility for this type of inspection to the resident engineer. Ensure the contractor furnishes certificates of compliance, when required. For all material not inspected and released by DMETS, inspect the material for contract compliance and complete Form CEM-4102, “Material Inspected and Released on Job.” File the form with the project records.
- Before doing any other irrigation work, locate existing conduits to be used as part of a new irrigation system. Determine the locations using as-built plan information, physical evidence such as Type A pavement markers, and metal detectors. After you have determined the locations as closely as possible, require the contractor to excavate and backfill exploratory holes. Process a contract change order, if necessary, to pay for additional exploration in accordance with Section 20-5.03B, “Conduit for Irrigation Crossovers,” of the *Standard Specifications*. After the ends of existing conduits for irrigation crossovers are exposed, examine them for damage. Ensure the conduits are free of obstructions. Process a contract change order to pay for any necessary repair or replacement.
- Check the planned location of valves, sprinklers, and automatic controllers and, if necessary, make the following revisions:
 1. Move sprinklers and valves away from areas adjacent to shoulders, where public traffic could damage them.
 2. Locate irrigation controllers behind guardrail or at other locations where they will be protected from public traffic.
 3. Locate sprinklers away from signposts, existing trees, or other obstructions affecting coverage.
 4. Locate sprinklers to obtain full coverage without overspray.
 5. Locate sprinklers so that irrigation controllers and pump housings are not soaked.
 6. Locate irrigation controllers and backflow preventers within a reasonable distance from safe and legal parking. Also locate them in high visibility areas to deter vandalism.
- When the irrigation lines are laid out and before trenches are backfilled, schedule a meeting on the project site to meet with the project landscape architect. This meeting provides an opportunity to look at the overall layout of the landscape system and make any desirable changes.

4-2004C During the Course of Work

Use the following guidelines to ensure the various components of irrigation systems are installed and constructed as required:

4-2004C (1) Water Lines and Conduit

During the course of installing water lines and conduit, the resident engineer must do the following:

- Inspect the installation and location of backflow preventers to ensure they conform to the requirements of local codes and to the plans and specifications. Pay particular attention to the installation of gate valves and unions on each side of the backflow preventer.
- To protect soil from eroding, ensure the contractor directs the outlets of the wye strainer or pressure relief valve toward the concrete pad.
- Observe trenching and the placement of conduit and pipe. Make measurements to determine that pipe and conduit are installed at the specified depths and setbacks.
- Ensure the contractor does not use excessive water when jacking or drilling conduit. Excessive water is any amount that would damage the roadway or create future maintenance problems.
- When rocks or other debris are brought to the surface during trenching operations decide whether such material should be removed. Base the decision on the same factors considered when preparing planting areas, as previously covered in Section 4-2003C(3), "Preparing Planting Areas" in this section. However, whether or not you order rock removal, the contractor must protect the pipe from sharp objects and must not place rocks directly on, under, or around the pipe. Ensure the contractor backfills in the specified manner, and make notes in the daily report of all inspections.
- When rocks must be removed, prepare a contract change order to cover payment, and keep the required extra work records.
- If excavated material is not suitable for placing around the pipe, prepare a contract change order to pay for supplying and placing a clean bedding material.
- Trench widths must be such that plastic pipe that is not connected by rubber type fittings can be snaked. Snaking means placing the pipe in an undulating line to provide for expansion and contraction.
- For installing plastic pipe supply lines, thrust blocks, plastic pipe irrigation lines, and fittings, obtain a copy of the manufacturer's instructions from the contractor. Observe the installation to ensure the contractor completes it according to those instructions.
- Where supply lines or conduits are installed through existing paved areas, advise the contractor of acceptable replacement material. Ensure the contractor performs such replacement.

- Ensure the contractor installs dielectric couplings or bushings as specified where two dissimilar metals, such as galvanized steel and brass, are joined.
- For solvent cement welding of plastic pipe, obtain the manufacturer's printed instructions from the contractor. Ensure the contractor completes solvent cement welding according to those instructions. For plastic pipe joined with solvent or glue, good workmanship includes immediately wiping off excess solvent or glue from the pipe. When left exposed on the surface, such material will cause rapid deterioration of the pipe.
- Ensure the contractor places the specified pavement markers to show the location of crossover conduits.
- Observe whether unattached ends of pipes, fittings, and valves are plugged or capped pending attachment of additional pipes or fittings. Use judgment in ordering compliance, but as a minimum, expect all such plugs or caps to be in place at the end of each workday.
- Ensure the contractor tests all pipe supply lines for leakage as specified. To hold water lines in place, partial backfill is usually allowed during testing as long as all fittings are left uncovered. Observe the testing, and note in the daily report the time when the pressure test on any segment of the irrigation system begun and the results of this test. The contractor must locate and repair any leaks and repeat the test as many times as necessary.
- After backfilling and ponding or jetting, examine trenches. Require the contractor to refill trenches that have settled below the level of the surrounding area.
- Ensure the contractor tests backflow preventers as specified. File the test results in the project records.
- Observe the operation of the entire irrigation system. Before planting work begins, ensure adequate coverage. If coverage is not adequate to water the planting areas, consider ordering revisions. Be aware that the valves and pipes are designed to accommodate a certain flow at a certain pressure. If the contractor adds sprinklers or increases the sprinkler nozzle size, coverage of each sprinkler will be reduced. If necessary, prepare and process a change order to make revisions to the planned irrigation system.
- Ensure the contractor replaces any existing plants that are removed or damaged during installation of the irrigation system.

4-2004C (2) Electrical Installations

During the course of installing water lines and conduit, the resident engineer must do the following:

- Observe the installation of sprinkler control crossovers to ensure they comply with the size and type specified. When specified, ensure that pull wire or pull rope is installed.
- Ensure that electric service installations conform to the plans and specifications. Consult with district electrical specialists.

- Ensure that controllers are installed as specified. For each type of controller, obtain the maintenance and operations manual. Give the manual to the maintenance landscape supervisor responsible for the irrigation system after contract acceptance.
- Ensure the contractor places a schematic wiring diagram and irrigation as-built plan in the controller enclosure as specified. The inspection date and expiration date for the guarantee must be marked on the inside face of the controllers.
- Observe the installation of conduit, conductors, and pull boxes to ensure compliance with the specifications.
- After trench backfilling to the required depth, observe the specified testing of conductors. Record the results of tests in the daily report.
- Before the beginning of plant establishment, witness a satisfactorily completed, functional test of the irrigation system. Advise the contractor of the lengths and frequencies of the cycles to be used during the functional test. Record the test results in the daily report.

4-2004D Measurement and Payment

The specifications may require irrigation system work to be paid for as a single lump sum item or as individual contract items.

When a single lump sum item is used for payment and the special provisions specify a “cost breakdown,” ensure the contractor submits the required information. For completeness and accuracy, review the cost breakdown. Until you have approved the cost breakdown, do not make partial payments for irrigation system items. Use the cost breakdown to determine payment for increases and decreases in the units of work within lump sum contract items for highway planting.

When irrigation system work is paid for as individual contract items, use the methods of measurement specified for each contract item.