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If there is a revised standard specification, bracketed section numbers refer to the 2010 followed by the 2006 *Standard Specifications*. If there is no revised standard specification, the 2010 *Standard Specifications* reference is followed by a bracketed 2006 reference.

Section 20 Landscape

Section 20 Landscape

4-2001 General

Landscaping is covered under Section 20, "Landscape," of the *Standard Specifications*. Landscaping includes highway planting and installing irrigation systems. It involves preparing areas for planting, furnishing and planting plants, and performing plant establishment work. Landscaping is sometimes combined with erosion control. Erosion control is covered under Section 21, "Erosion Control," of the *Standard Specifications*. For guidelines refer to Section 4-21, "Erosion Control," of this manual.

For questions about the acceptability of materials and work for landscaping, consult the district landscape architects and landscape specialists.

4-2001 General

4-2002 Planting

Planting consists of preparing areas for planting, applying pesticides, furnishing and planting plants, and maintaining plants.

4-2002 Planting

4-2002A Materials

The following provides general information on materials used for planting.

4-2002A (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.

4-2002A (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.

4-2002A (3) Lumber

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

4-2002A (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.

4-2002A (5) *Foliage Protectors*

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

4-2002A (6) *Root Protectors*

Wire mesh root protectors serve a similar purpose as the foliage protectors, providing below-ground protection from burrowing rodents.

4-2002A (7) *Mulch*

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 cover within mass planting areas until the plants fill in and cover the ground. Mulch has the following benefits:

- Retains soil moisture to assist in healthy plant development.
- Acts as a weed barrier.
- Reduces surface erosion.

Section 20-5.03 [20-7.02D(6); 20-2.08], “Inert Ground Covers and Mulches,” of the *Standard Specifications*, specifies the materials and size requirements for mulch. Ensure the receipt of a certificate of compliance for mulch.

4-2002B *Before Work Begins*

Before work begins, do the following:

- Review the plans and specifications to determine the requirements for highway planting.
- Verify that Form CEM-3101, “Notice of Materials to Be Used,” includes highway planting materials. Refer to Section 6-202, “Responsibilities for Acceptance of Manufactured or Fabricated Materials and Products,” of this manual for additional information.
- 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.

4-2002B (1) Pesticides

Before any work using pesticides begins, 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 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 application of granular pesticides unless they are covered by mulch. Without mulch, these pesticides can be carried to other locations by runoff.
- Upon completion of the necessary reviews, advise the contractor in writing that the pest control adviser’s recommendations have been authorized subject to the provisions of Section 20-1.01C [20-1.01C; 7-1.01H], “Submittals,” of the *Standard Specifications*.

4-2002B (2) Plants

Before any work with plants begins, 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 20-7 [20-2.13], “Highway Planting,” 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. Reject plants that are 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 soil from the roots of container-grown plants to determine the condition of the roots. Ensure enough roots have grown so that the soil and root ball will hold together when planting.
5. Do not accept root-bound plants. Refer to Figure 4-20.1 “Roots,” for an example of acceptable and unacceptable 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 in the ground.

Figure 4-20.1. Roots

<p style="text-align: center;">Good Roots Acceptable</p>	
<p style="text-align: center;">Root-Bound Plant Unacceptable</p>	

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 large containers have not recently been transplanted from a smaller container. Roots should be 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.

4-2002C During the Course of Work

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

4-2002C (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 stormwater 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.

4-2002C (2) Pesticides

During pesticide use, 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.

4-2002C (3) *Preparing Planting Areas*

After roadside clearance, irrigation system installation, and pressure testing and backfilling, the preparation of planting areas begins. During this preparation, 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 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.
- When rocks are encountered in an area of predominantly fine native materials, most rocks larger than 2.5 inches 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 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.

4-2002C (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.

4-2002C (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 work shift.
- 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.

Do the following during the course of planting:

- Note all observations in the daily report, including any pertinent instructions given to the contractor.
- 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 [8; 8-1.06], "Prosecution and Progress," of the *Standard Specifications*.

4-2002C (6) *Watering*

For watering, 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.

4-2002C (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 change order and obtain concurrence from the project landscape architect.

4-2002C (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 planting as specified. The plant establishment period begins on the date stated in your written notification to the contractor. However, each plant must still be maintained after it is planted and watered for the first time. Planting must be properly maintained both before and during plant establishment. During the course of plant establishment, do the following:

- Ensure that the contractor replaces plants that have not been properly maintained. 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 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.

4-2002C (8a) Administering Plant Establishment Time Requirements

In administering the time requirements for plant establishment, do the following:

- 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 the plant establishment period, credit the contractor with one plant establishment working day for each day that plant establishment work is satisfactory. Saturdays and holidays are not included.
- Ensure that all required establishment work is complete before beginning to give the contractor 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 2 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, do not give credit for plant establishment days.

4-2002C (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 and holidays (holidays include Sundays) as working days, regardless of weather or other conditions. Track the progress of plant establishment under “Remarks” in a manner similar to that shown for Type 2 plant establishment in the sample weekly statements of working days in Examples 3-8.6 and 3-8.7 in Section 3-8, “Prosecution and Progress,” of this manual. Credit all working days as plant establishment days except for days on which the contractor fails to satisfactorily perform plant establishment work.

4-2002C (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, refer to 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.

4-2002D Measurement and Payment

The specifications normally require that planting is paid for by measurable contract items rather than lump sum. Use the methods of measurement specified for each contract item.

4-2003 Irrigation

Irrigation systems may be manual or automatic, as specified in Section 20-2 [20-3; 20-5], "Irrigation," of the *Standard Specifications*. The special provisions may require the installation of equipment that can communicate with a centrally located computer.

4-2003A Components of Irrigation Systems

The following are the major components of an irrigation system.

4-2003A (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.

4-2003A (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.

4-2003A (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.

4-2003A (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.

4-2003A (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 opened when any remote control valve is activated.

4-2003A (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.

4-2003A (7) Quick Coupling Valve

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

4-2003A (8) Gate Valve

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

4-2003 Irrigation

4-2003A (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.

4-2003A (10) Emitters and Sprinklers

Emitters are watering devices used for drip irrigation. 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.

4-2003A (11) Drip Valve Assembly

Drip valve assemblies prevent small particles from clogging sprinklers or emitters.

4-2003A (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.

4-2003A (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.

4-2003A (14) Electrical Pull Boxes and Conductors

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

4-2003B Before Work Begins

Before the irrigation system is installed, do the following:

- Verify that Form CEM-3101, “Notice of Materials to Be Used,” includes all irrigation system materials. Refer to Section 6-202, “Responsibilities for Acceptance of Manufactured or Fabricated Materials and Products,” of this manual for additional information.
- 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 20-2.01A(3) [20-3.01C(4); 20-5.027B], “Submittals,” of the *Standard Specifications*, obtain from the contractor shop 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 authorization, forward a copy to the contractor with the following written statement:

**The plans are authorized pursuant to Section 5-1.23
[5-1.02], “Submittals,” 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 METS, 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 conduit 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 change order, if necessary, to pay for additional exploration in accordance with Section 20-2.08 [20-3.03B; 20-5.03B], “Irrigation Conduit,” of the *Standard Specifications*. After the ends of existing conduits are exposed, examine them for damage. Ensure the conduits are free of obstructions. Process a 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 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 with the project landscape architect. This meeting provides an opportunity to look at the overall layout of the landscape system and make any desired changes.

4-2003C During the Course of Work

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

4-2003C (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 4-2002C (3), "Preparing Planting Areas," of this manual. 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 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 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 in accordance with 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 in accordance with 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 began 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 has the backflow preventers tested 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.

4-2003C (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.

4-2003D Measurement and Payment

The specifications normally require that irrigation system work is paid for by measurable individual contract items rather than lump sum. Use the methods of measurement specified for each contract item.