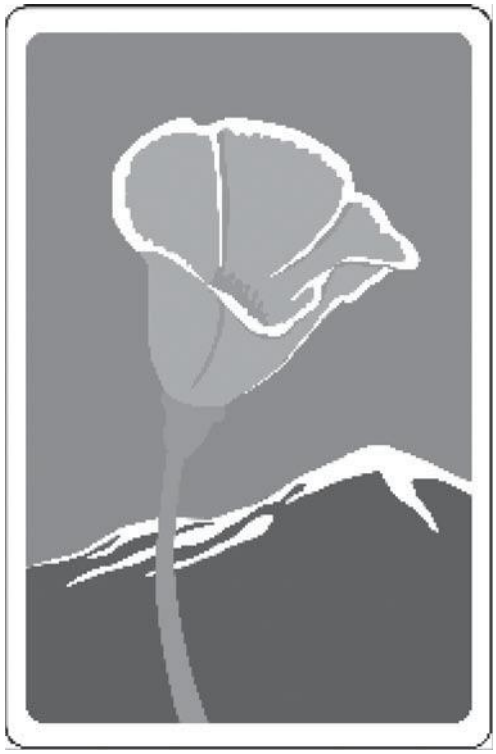
State of California
Department of Transportation

Landscape Inspection



DIVISION OF CONSTRUCTION
CALIFORNIA DEPARTMENT OF TRANSPORTATION

State of California
Department of Transportation

Landscape Inspection

Division of Construction

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NOTICE - Manual update September 2013: The content of this manual has been updated from its original printing to be compatible with a web-based format rather than a classroom delivery. Content has been update to reflect current standards.

March 2009, Version 3.03

Acknowledgement

The California Department of Transportation expresses our appreciation to the numerous people that have contributed informational resources, consultation, time and effort to the compiling of this training and resource binder.

Edward Boll, Retired
Landscape Architect
District 07

The original class was compiled by District 12 in 2003 with the assistant of the following people.

External -
- Larry Workman of Lasco Fittings, Inc.
- John Ramin of Pacific Plastic of Brea, California
- Richard Macy of Rain Bird, Inc.
- International Society of Arboriculture
- Thomas Christy of T. Christy Enterprises
- Dan Patterson of Bel-Aire West
- Deano Wolslagle of Hydro-Scape Irrigation Co.
- Leemco, Inc.

Internal –
- Arnold Rand, Liz Anderson, and Lamomi Dacay of District 12 Maintenance Branch
- John Brann of District 10
- Sandy Ankhasirisan, Patricia Watanabe, and Danielle Pakenham of District 12 Landscape Architect Branch
- Octavio Rivas, Jim Decker, and Scott Wang of District 12 Field Construction Branch

Disclaimer

By reference to any names and/or products in this manual, the California Department of Transportation is not endorsing such companies and/or products.

March 2009, Version 3.03

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Preface

0-1 Course Introduction

0-1.01 Goals

Students will learn basic principles of landscaping to understand, inspect, and administer landscape projects.

This training will give an insight to the overall picture of landscape construction inspection. The training proceeds in the normal sequence of construction.

A person knowledgeable in the basics of landscape construction inspection will make a more confident administrator and enhances the goal of turning over to Maintenance a project that will protect the highway investment; minimize additional maintenance work and maximize the aesthetics and safety of the highway.

0-2 Introduction to Landscaping

0-2.01 Why Does Caltrans Landscape?

Highway planting is vegetation placed for aesthetic, safety, environmental mitigation, storm water pollution prevention, or erosion control purposes, and includes necessary irrigation systems, inert materials, mulches, design for safety features and appurtenances.

In addition, highway planting is used to satisfy the need for headlight glare reduction, fire retardant, windbreak protection, or graffiti reduction on retaining walls and noise barriers.

Aesthetics

Highway planting should integrate the transportation facility with the adjacent community or natural surroundings; buffer objectionable views of the facility from adjacent homes, schools, parks, etc.; soften visual impacts of large structures or graded slopes; screen objectionable or distracting views; frame or enhance good views; and provide visually attractive interchanges as entrances to communities.

Materials and planting compositions should be regionally appropriate and visually compatible with local indigenous plant communities or surrounding landscape planting. Contour grading, with careful preservation and enhancement of existing plants and natural features should be integrated into the overall composition.

Traveler & Worker Safety

Plants are selected and located to maintain sight distance and clear recovery zone setbacks. A clear recovery zone provides areas for errant vehicles to regain control. Planting shall not interfere with the function of safety features such as shoulders, barriers, guardrail, traffic or regulatory devices, warning and guide signs or with motorists' view of the road.

Planting and irrigation facilities are designed to ensure the safety of both maintenance workers and the public. Highway planting projects incorporate safety concepts that include, but are not limited to, the following:

Access

- Access gates for maintenance personnel from local streets and frontage roads.
- Paved maintenance vehicle pullout areas away from traffic on high volume highways and other areas where access cannot be made from local streets and roads.
- Maintenance access roads provide access to the center of loop areas or other wide, flat areas.

Minimize Exposure to Traffic and Reduce the Need for Shoulder or Lane Closures

- Irrigation system components and vegetation are located away from shoulder areas, gore areas, and narrow island areas between ramps and traveled way to reduce the need for shoulder or lane closures, to perform pruning or other maintenance operations.
- Irrigation components that require regular maintenance, such as valves and controllers outside are placed outside the clear recovery zone or behind safety devices.
- Narrow areas and areas behind the gore are paved.

Automated Irrigation systems and remote control devices are used to minimize worker exposure and allow for effective water management. Irrigation components
are clustered and located adjacent to access gates, maintenance vehicle pullouts, maintenance access roads or other areas away from traffic.

Functional

Landscaping reduces erosion, dust, and fire hazard. Well established planting will prevent weeds which presents a fire hazard. It can be used to reduce headlight glare in median and ramp areas and to delineate the traveled way.

0-2.02 Site Distance & Clear Recover Zone

Sight distance and safety are of primary importance, and are not to be subordinate to aesthetics. Two types of safety setbacks affect the placement of landscape elements:

- To keep the continuous length of highway ahead visible to the driver (sight distance).
  In interchange areas, generally, from the edge of traveled way, a 50-foot setback within the loops is considered as the sight distance setback for trees and shrubs that will grow above a 2-foot height.

- To keep the clear recovery zone free of physical obstructions.
  Recovery zone setbacks provide areas for errant vehicles to regain control. The policy along freeways and expressways, including interchange areas, is to strive for 40 feet or more of clearance between the edge of traveled way and large trees, but with a minimum clearance of 30 feet. The 30-foot distance is measured horizontally to the trunk of the tree. For setback purposes, large trees are defined as plants which at maturity, or within 10 years, have trunks 4 inches or greater in diameter, measured 4 feet above the ground.

  Large trees may be planted within the 30-foot limit where they will not constitute a fixed object; for example, on cut slopes above a retaining wall or in areas behind guard railing which has been placed for reasons other than the tree planting.

0-2.03 Current Policies & Regulations

Caltrans policy is to replace plants removed by freeway construction. Either plants that were present prior to the freeway or freeway planting removed by subsequent construction.

There is a shortage of water, so how do we maximize this limited resource? Utilize measures such as the use of regionally appropriate plants, compost, mulches, nonpotable water, automated irrigation systems, remote irrigation control systems (RICS), and moisture sensors to help achieve this goal.

Highway planting should be able to withstand roadside conditions and become established on limited water with minimal maintenance.

Government regulations to consider:

- Outdoor Advertising Act requires that trees are not to be planted in front of existing signs.
- Environmental Protection Agency (EPA) enforces pesticide reduction policy and only the pesticides listed in the special provisions are to be used on the project and the usage shall be monitored very closely.
- The Safe Drinking Water Act of 1986 requires Caltrans to reduce herbicide usage to 20% of the 1992 level by 2012.

Reference *Maintenance Manual* C2.03 and the Caltrans Vegetation Control Policy.

0-3 Types of Projects

Landscape projects contain only landscape work and can be new highway planting, highway planting restoration, irrigation restoration, functional (tree planting or screening only with minimal irrigation), erosion control and environmental mitigation.

Highway construction projects that contain landscaping include new freeways, widening, soundwalls, bridge rehabilitation, etc.

Landscape maintenance projects restore irrigation, restore plants, weeding, erosion, etc.

0-4 Local Contacts

Construction Landscape Specialist

_____
(Name & Telephone Number(s))

District Landscape Architect

_____
(Name & Telephone Number(s))

You should contact both of the above plus the Maintenance Landscape Superintendent for the project. Who your Maintenance contact is should be included in the Resident Engineer Pending File provided by Design to the resident engineer.

0-5 Review Questions

[Solution key located at back of manual]

1. Why does Caltrans Landscape

_____

2. What policies maximize the limited water available?

_____

_____

_____

_____

_____

_____

3. What government regulations do you need to be aware of?

_____

_____

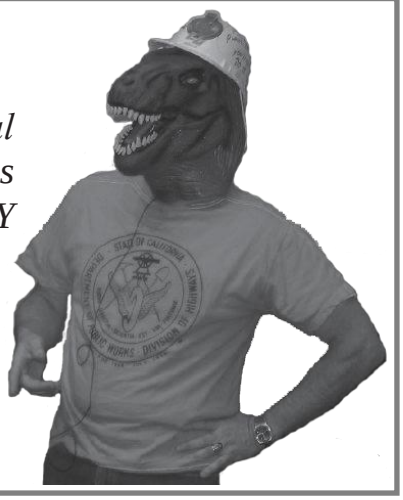
_____

4. What are the three general types of landscape projects?

_____ _____ _____

"Thou shall know the plans, special provisions, Standard Specifications and Standard Plans better than ANY Contractor"

T. Rex, Resident Engineer



Back to T of C

Chapter 1: Before Start of Work

1-1 Job Site Review

You, the inspector, should thoroughly review field areas to be planted. Include the Landscape Architect, Construction Landscape Specialist and the Maintenance Landscape Supervisor if time permits.

- Look for areas where little or no weeds are growing because the lack of weeds may indicate sterile ground and a soil analysis might be in order.
    - Check if there is a blanket service contract for soil analysis.
    - Check with Maintenance Landscape Supervisor to see if areas were sterilized; if so, when, what chemicals were used and rate of application.
    - Request assistance from Construction Landscape Specialist for corrective measures.
- Take photos of all areas, especially where sterile soil and damaged facilities are evident.
- Look for stolon-type grass such as Bermuda and St. Augustine and mark locations on plans.
- Check Special Provisions for methods of removal and/or control, Contractor's chemical weed control program, and with Construction Landscape Specialist.
- Look for eroded areas and washouts. Determine if permanent corrective measures are needed if landscaping will not eliminate reoccurrence. Take pictures.
    - Maintain existing plants (Reference: Special Provisions, if applicable):
        - Check if plants shown on plans to be maintained are still there and living.
        - Take Pictures
        - Check with Construction Landscape Specialist for pruning recommendations, chances of survival, methods of maintaining, watering, etc.
        - Check methods of payment for pruning work, etc. Reference: Special Provisions and *Standard Specifications*.
- Maintain existing irrigation systems:
    - Check with Landscape Maintenance Foreman and Maintenance Landscape Specialist.
    - Check out systems for proper operation and repairs needed.
- Identify areas that have excessive rodent activity (gophers, ground squirrels, rats). Check special provisions for responsibility for rodent control.

- Locate existing irrigation conduits with metal detector if a detector is available. If conduits cannot be located or are not where shown, contact Landscape Architect for possible redesign recommendations.
- Gate locations should be reviewed with the Maintenance Landscape Supervisor for easy access. Gates are usually located next to water meters, backflow preventers or controllers.
- Check contract for maintenance responsibility. If not covered, State Force will have to continue maintenance work within limits of project or by extra work performed by Contractor.

An internal (Kick-off) meeting is held with the Landscape Architect, Construction Landscape Specialist and the Maintenance Landscape Supervisor. Activities include:

- Transferring the start of project information, referred to as the RE Pending File, from Design to Construction. See *Construction Manual* Section 5-001.
- Reviewing bidders questions to formulate an answer for the Contractor, if asked, at the pre-construction meeting.
- Reviewing commitments made to adjacent properties and/or communities.
- Utilize contract plans to identify problem areas.

This meeting is important so that there are no surprises or disagreements when the pre- construction meeting is held with the contractor.

1-2 Utility Services

As soon as the project is assigned, review the project plans and the RE File from Design to determine what services (water, electrical or communication) will be required on the project. New utility services require the processing of a service request and existing services should be verified in the field. The serving utility for the project will be noted in the RE File.

1-2.01 Water

Locate the water meters on the project plans and if new meters are to be installed ~~"b~~by others," begin processing a service request with the water company. Check field location with the serving utility field representative and verify that they will be installing the meter. If the serving utility company is unable to do the installation, and they authorize the State to install it; write a contract change order for the contractor to do the work.

Have the water service turned on only when you need it, not before. No sense in paying for months of water service when you aren't using it. Verify availability of water pressure to operate the irrigation system.

Water service pressure is tested at the backflow preventer for potable water or at the closest quick coupling valve to the reclaimed water meter. Water pressure is checked as a static pressure; line is full and no valves or sprinklers are operating. The purpose of the test is to see if the pressure matches the design pressure noted on the plans for all location. If there are new service installations, pressure tests can not occur until after work has begun and the contractor has installed the backflow preventer.

If the test pressure is higher or lower than the design pressure, contact the landscape architect. If the test pressure is higher than the design pressure, a pressure reducing valve may be needed for the entire system or only for the low flow drip type systems. If the test pressure is lower than the design pressure, a booster pump may be required. Both corrections will require a contract change order.

1-2.02 Electrical

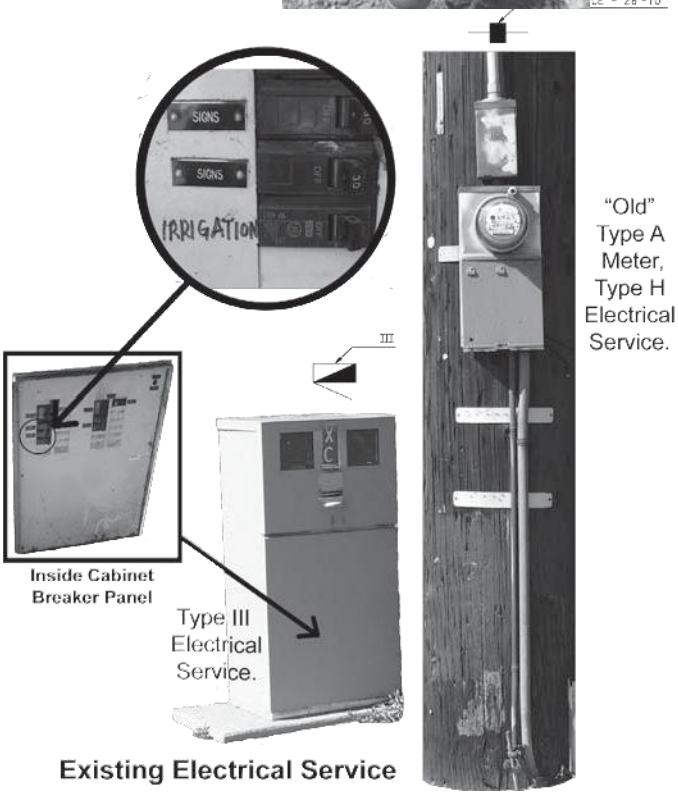
Landscape projects, in general, will use the existing electrical service available on the project. If a new electrical service is required, contact the Construction Electrical Specialist for assistance.

For existing electrical services verify;

- Location show on the plans.
- Cabinet is energized (voltage is still being supplied).
- Space for the additional circuit breaker.

Contractor should test for voltage at the electrical service cabinet and at the irrigation controller (IC) cabinet to verify that the conductors were installed properly.

If the contractor's test shows a voltage drop from the electrical cabinet to the IC cabinet, then the wires were scraped and there is a short or the wrong size conductors were installed. Either way the results is that there is too much resistance and potentially unsafe. Also, there is not sufficient voltage to run the IC. The IC operates on 120-V, 60 Hz AC and supplies 24-V to 50-V, 60 Hz AC for operating the remote control valves.



Existing Electrical Service

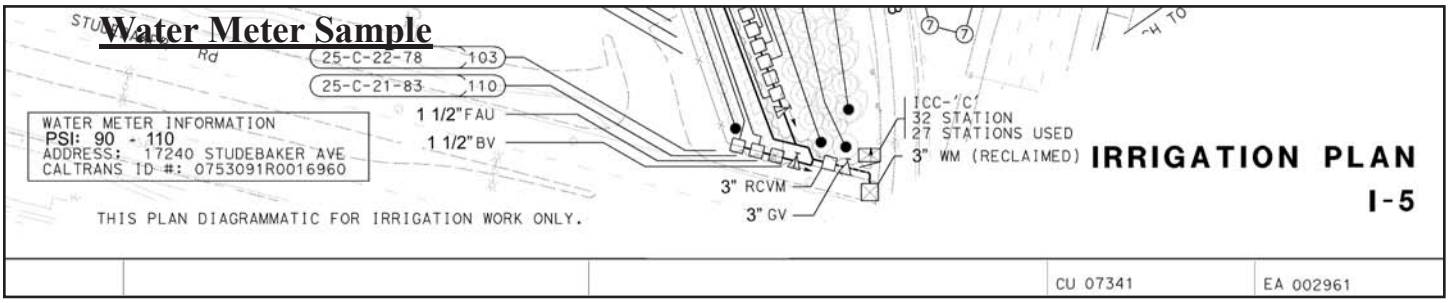
1-2.03 Communication

On a landscape project the request for a communication service would be for a telephone or radio relay for the remote irrigation control system (RICS) that is either already available or to be installed with the project. Requirements for communication utilities will be detailed in the special provisions. Any additional information required to complete the service request, see the RE File.

1-2.04 Service Request

Service requests responsibility include:

- Turn-on notice: contact service utility, providing Construction cost expenditure authorization (EA).
- Monitor project utility service expenditures, because the utility billings come out of the project contingency funds.
- Transfer notice: to transfer utility billings from Construction EA to Maintenance EA.
- Termination notice: shut off utility if service is no longer needed.



The above is a portion of a project plan showing the water meter information. On the opposite page is a Utility Service Request, Form FA-2134, preliminary completed based on the plan provided and a list of each item to be completed on the form.

1. Highway Utilities
2. Water/Irrigation
3. New
4. See Irrigation Plans.
5. See RE Files.
6. Provided by utility company.
7. Provided by utility company.
8. See Irrigation Plans.
9. Provided by utility company.
10. Provided by utility company and field verified after installation.
11. Provided by utility company.
12. Anticipated date service will be needed, meaning the RE and the Contractor will determine a date at the Pre-job meeting. But, the processing of the service request should start as soon as possible. Expect a minimum of two to three weeks wait, even if expedited.
13. Date for service to be turned-off or transferred to Maintenance.
14. Left blank, the Cost Coding information for Highway Utilities will be completed in Section 18.
15. Resident Engineer's name and phone number.
16. Not used for Highway Utilities.
17. Please use this field for any special instructions that the form does not address.
18. Indicate the appropriate cost coding for Highway Utility Service Only. If the service is transferring from Construction to Maintenance after completion of a project, please indicate the correct Maintenance Cost Coding as well.
19. Authorized Construction Personnel, the resident engineer.
20. Authorized Maintenance Personnel.
21. See RE File for metered or flat rate. Reclaimed water is usually flat rate.
22. Please inform the utility company to include the Caltrans I.D. in the Billing Address Field and mail all invoices to the P.O. Box indicated on the form.
23. The Landscaping/Water Coordinator must approve all Water/Landscape Highway Utilities. See RE File.
24. Indicate the Utility Company Representative that initiated or installed the utility service.
25. Distribute a copy of the Service Request Form to all programs indicated on the form.

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

UTILITY SERVICE REQUEST

FA-2134 (NEW 7/2005)

Copy Form for Saving

CALTRANS ID MUST APPEAR ON INVOICE IN ADDRESS FIELD UNDER CALTRANS NAME.

1. ☐ RE Office ☐ CT Facility ☐ R/W Property ☒ * Highway Utilities
2. ☐ Electrical ☒ Water/Irrigation ☐ Gas ☐ Other
3. ☒ New ☐ Modify ☐ Terminate ☐ Relinquishment

4. CALTRANS ID (*ID Number, Facility Name or R/W Number)* Please limit to 15 Characters

0	7	5	3	0	9	1	R	0	0	1	6	9	6	0

5. UTILITY COMPANY NAME: Cerritos Water Company

6. UTILITY ACCOUNT NUMBER:

7. RATE SCHEDULE:

8. UTILITY SERVICE ADDRESS: 17240 Studebaker Avenue, Cerritos, CA 90703

9. UTILITY SERVICE DESCRIPTION *(If applicable)*:

10. UTILITY METER NUMBER *(If applicable)*:

11. UTILITY CONTRACT NUMBER *(If applicable)*:

12. PROPOSED TURN ON DATE:

13. PROPOSED PROJECT COMPLETION:

14.

Srce. Dist	Unit	Chg. Dist.	EA	Subjob	Spec. Des.	FA	Object

15. REQUESTED BY: I. R. Engineer PHONE: (562) 555-1234

16. **Billing Instructions:** For all Utility Services except Highway Utilities, please instruct the Utility Company to mail the first Utility Invoice to the person requesting the service. Forward the invoice and a copy of this form to the Utility Payment Section (Fax: 916-227-4245).

17. SPECIAL INSTRUCTIONS

HIGHWAY UTILITY INFORMATION ONLY

18.	Srce. Dist.	Unit	Chg. Dist.	EA	FA	Object	Spec. Des.	Approved By:	Phone
CONST.	07	500	07	002963	2	003		19. I. R. Engineer	(562) 555-1234
MAINT.								20.	

21. **SERVICE TYPE** — ELECTRICAL — WATER

EXISTING ☐ METERED ☐ FLAT RATE ☒ VOLTAGE — POTABLE ☐

LUMINAIRES — **TYPE** — RECLAIMED ☒

WATTS	70	100	175	180	200	250	310	400	700	1K	HPS	LPS	MV
EXISTING													
NEW													
REMOVE													

OTHER ☐

SIGN NUMBERS	WATTAGE

22. ***MAIL BILLING TO:*** CALTRANS
ID# 0753091R0016960
P.O. Box 168020
Sacramento, CA 95816-8020

23. DISTRICT UTILITY COORDINATOR: D. U. Coordinator TELEPHONE: (213) 555-4321

24. UTILITY COMPANY REPRESENTATIVE: U. C. Representative TELEPHONE: (562) 555-3333

25. Distribution: Construction, Maintenance, Traffic/Electrical Design, Utility Coordinator, Utility Payment Section (916-227-4245)

* Highway Utilities include: Street Lights, Ramp Meters, Traffic Signals, Irrigation Systems, etc.

ADA Notice For individuals with sensory disabilities, this document is available in alternate formats. For information call (916) 654-6410 or TDD (916) 654-3880 or write Records and Forms Management, 1120 N Street, MS-89, Sacramento, CA 95814.

1-3 Pre-Construction Meeting

1-3.01 Attendees

A pre-construction meeting for a landscape project is the same as for any construction project with the addition of the Landscape Architect and the Maintenance Landscape Supervisor. They are there to answer any landscape specific questions that the Resident Engineer cannot answer or for them to discuss later before getting back to the Contractor.

1-3.02 Safety

Based on traffic uniform codes, "Landscaping Ahead" signs, for temporary traffic control, are no longer permissible. Use of a "Right Shoulder Closed Ahead" sign will provide the traveling public with an awareness that work or workmen are off to the sides of the roadway and not on the roadway. A shoulder closure must be used if workers stop their vehicles on the shoulder within 6' of traveled way to do work.
The *Construction Manual* states that construction warning signs should be removed at the start of plant establishment.

1-3.03 Submittals

Plant Material Order Reference Standard Specifications Section 20- 3.01A(3)(b).
The contractor should submit proof of ordering the plant materials. The plant material submittal is to insure that the correct plants required for the project will be delivered at the proper time. Commonly used ornamental plants are available year around from the nursery, but native plants are time sensitive. Check with the Construction Landscape Specialist for which of the project's plants are native.

Review the plant order list for completeness and check with the Contractor's nursery suppliers to make sure all plant species are available. If not, check with Landscape Architect for substitutions.

Pesticide Program Reference *Standard Specifications* Section 20-1.01D(1).and *Construction Manual* Section 4-2003B(1).
Obtain and review a copy of the contractor's recommendations for pesticide use, as submitted to the contractor by a licensed pest control adviser. Review and approval will be by the construction 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.

Booster Pump Reference *Standard Specifications* Section 74-4.01.
When a booster pump is required by the special provisions, the contractor submits 5 sets of drawings. The drawings are sent to the Division of Engineering Services, Office of Electrical, Mechanical, Water and Wastewater Engineering, Electrical Engineering Branch in headquarters (Sacramento). Four sets are returned by headquarters marked approved and to be distributed as follows: Contractor, Irrigation Controller Cabinet, Construction Project File, and Landscape Maintenance Pending File.

Solvent Cement Reference *Standard Specifications* Section 20-2.01A(3)(b).
The contractor must submit printed instructions from the manufacture for use of solvent cement prior to any joints being made.

Wiring Plans and Diagrams Reference *Standard Specifications* Section 20-2.01A(3)(a) and *Construction Manual* Section 4-2004B.
Obtain from the contractor working drawings of wiring plans for the electrical portions of the irrigation systems not less than 30 days prior to installation. 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 5-1.23, Submittals," of the *Standard Specifications*."

1-3.04 Contract Time

Reference *Standard Specifications* Section 20-4 and *Construction Manual* Section 4-2003C(8).

Review the contract time of the Notice to Bidders to determine the limits of the construction planting period and the plant establishment period. Plant establishment work is routine maintenance to insure that the plants grow, the irrigation systems functions properly and weeds and trash are controlled.

Be aware of other restrictions in the Standard Specifications that restrict the contractor to working on one metered system at a time. If the plans shows 4 meters and the special provisions has 125 working days for the construction planting period, that equals an average of only 31-1/4 days per metered system to complete all the work necessary to enter plant establishment without liquidated damages being assessed.

Rain days during the construction planting period are usually considered non-working days. Rain, fog, wind, or snow days during the plant establishment period are work days, because these weather conditions do not stop the plants from growing.

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.

Type 1 plant establishment is usually on landscape only projects. Construction planting period is calculated by subtracting the number of plant establishment days from the total number of working days.

875	Total Working Days
-750	Plant Establishment Period
125	Construction Planting Period

Type 2 Plant Establishment

Type 2 plant establishment is on construction projects that includes landscape work. 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.

1-3.05 Contractor's Yard

The contractor may request to establish a work yard within the State's right of way. Check the special provisions and plans to see if it is allowed. The contractor must submit to the resident engineer the location and limits of the contractor's yard marked on a set of plans identifying ingress/egress and a written plan for maintenance and removal of the yard. When this documentation is received, the resident engineer may consider approving this request.

1-3.06 Equipment

Working equipment must have required safety equipment: seat belts, roll-over bars, emergency stop bars for shredders, etc. Working vehicles must have the contractor's logo and the equipment identification number shown on the contractor's equipment list. Personal vehicles are not allowed on the right of way.

1-4 Contract Change Orders

The following is a list of potential change order work.

- Locate existing irrigation conduit (Reference *Standard Specifications* Section 20-2.08A(1))
- Remove and dispose of rock and debris (Reference *Standard Specifications* Section 20-2.01C(2))
- Furnish and place pipe bedding material (Reference *Standard Specifications* Section 20-2.01C(2))
- Repair damage to existing slopes and other facilities (Reference *Standard Specifications* Section 5-139C)
- Additional application of pre-emergent herbicide (Reference special provisions)
- Maintain existing plants (Reference *Standard Specifications* Section 20-3.02C(4))
- Maintain existing irrigation systems (Reference *Standard Specifications* Section 20-2.02)

Concurrences from the appropriate functional units are required.

1-5 Review Questions

1. What are the two preliminary construction meetings?

_____

_____

2. List five (5) contractor required submittals unique to Landscape Projects.

_____

_____

_____

_____

_____

3. A landscape project jobsite review consists of:

_____

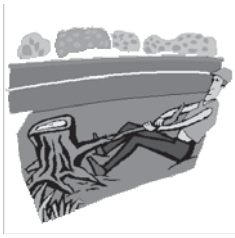
_____

_____

"At all times when in the field doing inspection, thou shall have the project plans, special provisions, Standard Specifications and Standard Plans with thee"

T. Rex, Resident Engineer

Back to T of C



Chapter 2: During Construction

2-1 Roadside Clearing

Roadside clearing includes removing trash and debris, killing, removing, or mowing weeds and other vegetation, and controlling rodents. The special provisions usually require that the roadside clearing is to be completed for the entire project prior to beginning of the work for the irrigation system. Roadside clearing areas must be maintained until the start of plant establishment period.

2-1.01 Review with Contractor

Review the job site with the contractor. Show the contractor areas with stolon-type weeds and decide on method of removal and control. Decide on extent of removal and disposal of cut weed growth and trash. Discuss the contractor's safety procedures relating to chemical weed control program. If excessive rodent activity is apparent, discuss methods of control with the contractor and the construction landscape specialist.

Limits

The extent of the roadside clearing will be defined by the special provisions or the project plans. The project may contain existing landscape areas where no work is to be done. It will be maintained either by Maintenance or by the contractor as stated in the special provisions.

Areas to be maintained within the project limits may consist of:

- New landscaped areas
- Existing landscape areas
- No landscape work areas
- Disturbed Soil Areas (DSA)
- Environmentally Sensitive Area (ESA)

2-1.02 Slope Repair

Inspect slope areas with the contractor, discuss repairs and estimate cost for contract change order (CCO) to make repairs if necessary. Often light erosion will be corrected during cultivation.

Give due consideration to the requirements for water pollution control. It may be desirable to leave some vegetation on the slopes (do not denude slopes) to reduce the potential for storm water pollution during the rainy season. Coordinate vegetation removal work and scheduling with your District Construction Stormwater Coordinator.

2-1.03 Mowing

Normal clearing sequence starts with trash pick-up and then on to mowing. The height to be mowed will be stated in the Standard Specifications. Ensure that mowed weed growth and trash, etc., is regularly removed from job site.

2-1.04 Pest Control

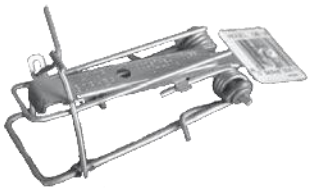
After mowing the contractor will begin their pest control through spraying, removal and trapping. All pest control should be completed prior to planting. Pest, for the purpose of the manual, are divided into three categories:

- Rodents
- Insects
- Invasive Plants

Rodents

Rodents have sharp incisors that they use to gnaw wood, break into food, and bite predators. Most eat seeds or plants, though some have more varied diets. Some species have historically been pests, eating human seed stores and spreading disease. The rodents requiring control are gophers, ground squirrels and rats.

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. When the first gophers are trapped and killed, leave the carcass in the covered hole, it will chase the rest from the area.



Ground squirrels eat the tops of plants and make burrows, but not tunnel systems. Trap or poison.

Rats will eat the cambium layer (bark) of shrubs and trees leading to eventual plant death. Trap or poison.

Insects

Many insects are considered pests by humans. We will be covering those insects common to state projects that can harm landscape workers or plants. Insects not only destroy plants, but they transmit plant diseases.

Red Imported Fire Ants (RIFA) are more aggressive than most native ant species and have a painful sting. A person typically encounters them by inadvertently stepping into one of their mounds, which causes the ants to swarm up the person's legs, attacking en masse. The ants respond to pheromones that are released by the first ant to attack. The ants then swarm and immediately sting when any movement is sensed. The sting of the RIFA has venom which causes both pain and the formation of white pustules which appear one day after the sting.

RIFA are still on the move, often traveling from one area to another in turf, root balls of nursery plants, and other agricultural products. They are a pest, not only because of the physical pain they can inflict, but because their mound-building activity can damage plant roots. Their stings are rarely life-threatening to humans and other large animals, but they often kill smaller animals such as birds.

Red imported fire ants are extremely resilient and have adaptations to contend with both flooding and drought conditions. If the ants sense increased water levels in their nests, they will come together and form a huge ball or raft that is able to float on the water, with the workers on the outside and the queen inside. Once the ball hits a tree or other stationary object, the ants swarm onto it and wait for the water levels to recede. To contend with drought conditions, their nest structure includes a network of underground foraging tunnels that extends down to the water table. Also, despite the fact that they do not hibernate during the winter, colonies can survive cold conditions as low as 16o F (-9o C).

A number of products are available, which can be used on a mound-by-mound basis to destroy ant colonies when they appear. With all such efforts, it is important to reach and kill the queens, which may be as far as six feet underground; otherwise, some queens may simply move a short distance away and quickly re-establish the colony.

Africanized Honey Bees (AHB) look exactly the same as the more docile European Honey Bee, but there is a marked difference in their behavior. The AHB is much more aggressive and territorial and can become agitated if a disturbance occurs within 1/4 mile of the colony. Once agitated and in pursuit, the AHB will respond in much greater numbers than the European Honey Bee and pursue intruders for a 1/4 mile or more. They can remain in this agitated state for as long as 24 hours. While the venom of the AHB is no more potent than the European Honey Bee, the greater number of stings can be dangerous. 500 or more stings can be life threatening.

The adult ***Lerp Psyllid*** insects are small (1/8 inch long), slender and pale-green. They are sucking insects, can jump and fly, and are hard to see. Adults and larvae feed primarily on Eucalyptus trees. Mostly, what is seen are the sugar-like 1/8 inch wide white cones called ~~l~~lerps." Larvae are found beneath these lerps or bumps they have built.

Both adults and especially larvae suck sap from the leaves and stems thus weakening the Eucalyptus. Heavy infestations are even more harmful causing leaf drop and severely stressing trees.

Glassy-winged sharpshooter is about 0.50 of an inch in length. Its color is dark brown to black with a black-and-yellow underside. It has yellow eyes, and the upper parts of the head and back are speckled with ivory or yellowish spots. The wings are transparent with reddish veins.

The glassy-winged sharpshooter feeds on a wide variety of plants; grapes, citrus, almond, stone fruit, and oleanders. Once it feeds on an infected plant, the sharpshooter carries the bacterium to the next plant and transmits the disease while feeding. The bacterium Xylella fastidiosa is linked to many plant diseases, including phoney peach disease in the southern United States, oleander leaf scorch and Pierceis disease in California, and citrus X disease in Brazil.

Aphids feed by sucking up plant juices through a food channel in their beaks. At the same time, they inject saliva into the host. Cause leaf curl, wilting, stunting of shoot growth, and delay in production of flowers and fruit, as well as a general decline in plant vigor. Some aphids are also important vectors of plant diseases, transmitting pathogens, particularly viruses, in the feeding process.

Whiteflies are tiny, soft bodied insects. Whiteflies can seriously injure plants by sucking juices from them causing wilting, stunting, or even death. Whitefly adults can also transmit several viruses from diseased to healthy plants.

Mealybugs get their name because the white wax on their bodies makes them look like they were rolled in flour. They feed on plants by inserting long straw like mouthparts (called stylets) into plant tissue. Besides producing a white wax, mealy bugs secrete a sticky honeydew that adheres to leaf surfaces and attracts unsightly dust and molds.

Snails and slugs feed on a variety of living plants as well as on decaying plant matter. On plants they chew irregular holes with smooth edges in leaves and flowers and can clip succulent plant parts.

Noxious Weeds

Noxious weeds are introduced species that can thrive in areas beyond their natural range of dispersal. These plants are characteristically adaptable, aggressive, and have a high reproductive capacity. Their vigor combined with a lack of natural enemies often leads to outbreak populations. Some examples are:

Bermuda Grass is a very hardy perennial, creeping grass with a deep root system, it reproduces through seeds, runners, and rhyzomes. It moves fast: it can put out seeds within three months of implantation, the seeds germinate when temperatures reach 68 degrees F., and will begin growing within two weeks. Though it prefers 16”+ of rain per year, once established it is highly resistant to drought (going into dormancy above-ground while its rhizomes extend toward the water table), it can spread in poor soils, and it is strongly fire-adapted. Its flowering season is long (September through May), a problem to allergy sufferers since its pollens are highly allergenic.

Castor bean establishes itself easily as an apparently ~~–n~~ative” plant It has large leaves which are long-stalked, alternate and palmate with coarsely toothed segments. Terminating stems are panicle-like inflorescences of green monoecious flowers, the stalked female flowers above the male flowers below, both without petals. The fruit is a spiny, greenish capsule with large, oval, shiny, bean-like, highly poisonous seeds with variable brownish mottling. It is a fast-growing suckering, perennial shrub, which can reach the size of a small tree.

Castor bean displaces native plant species in riparian areas and drainages. Its seeds are among the first to germinate following fire. Plants colonize disturbed areas, and they grow rapidly, shading out native seeds and seedlings and producing monospecific stands in areas with previously healthy native vegetation.

Pulling plants by hand when small or in wet sandy soils is a feasible technique in most areas. The bulk of the root should be removed. Plants broken at the root crown will regenerate with multiple shoots. Gloves should be worn for hand pulling. Foliar-sprayed 2 percent glyphosate (as Roundup®) can be used to kill mature shrubs. Cut-stump treatment with loppers or saws and 25 percent glyphosate can also be used to kill mature shrubs.

The typically large size and spiny nature of ***artichoke thistle*** plants make physical removal very challenging. Grubbing is possible when plant densities are low but is impractical on large infestations. New shoots will emerge from the tap root and must be repeatedly removed. Completely digging out the tap root is extremely difficult, since it may extend to a depth of eight feet. An alternative is cutting and removing the seed heads to prevent seed production when complete plant removal is not possible. Large scale mechanical removal requires repeated plowing or cultivation. Heavy leather gloves and chainsaw chaps are generally recommended when doing hand removal.

Star Thistle is a grayish-green plant with multiple rigid stems that extend in all directions from the base, forming a bushy-looking cluster that can reach 6 feet in height and more than that in diameter. It produces bright yellow flowers ringed with long, sharp spines. The plant grows quickly and is very competitive. It bears a taproot that can reach 3 feet deep into the soil, allowing it to thrive during dry, hot summers. It is versatile in its growth patterns, and can adapt to drought or low soil moisture content by producing smaller plants with fewer seeds during dry years.

Arundo donax was introduced from the Mediterranean to California in the 1820s for roofing material and erosion control in drainage canals in the Los Angeles area. It is among the fastest growing terrestrial plants in the world (nearly 4 inches/ day). It damages California's riparian ecosystems by out competing native species, such as willows, for water. Minor infestations can be removed manually, as long as the entire root mass and all rhizome parts are removed. Rhizome pieces buried under 6-10 feet of soil may resprout, and the disturbance caused by physical removal to the soil and surrounding communities may be severe. Pull or dig plants, from seedlings to 6 feet tall, ideally after heavy rains loosen the soil. Cut the stems of larger plants and dig up the roots. Systemic herbicides may be applied after flowering as a cut-stump treatment or foliar spray to kill the root mass.

2-1.05 Pesticides

Pesticides are any chemical used for killing insects, rodents or plants; herbicides, insecticides, fungicides, rodenticides, germicides, nematocides, bactericides, inhibitors, fumigants, defoliants, soil sterilants and repellants.

Ensure that chemicals are being applied as specified and at the proper time in accordance with the Contractor's chemical weed control program. It is recommended to have the construction landscape specialist check out the contractor's early spray operation.

The pesticides that will be used in the field are:
Herbicides – agents used to destroy or inhibit plant growth.
Insecticides – any agent used to kill insects.

The more common herbicides are:

- Pre-emergence – soil action – Use after planting to prevent weed growth through soil (surflan).
- Contact (Diquat) – non soil acting – Use for killing broad leaf weeds or grasses.
- Systemic (Glyphosate - Round-Up) – non soil acting – Use on Bermuda grass, kills from roots up.
- Sterilants – long lasting soil acting - Used under asphalt concrete or rock blanket areas; use only when specified in the special provisions.
- Amonia Sulphate (Fertilizer) – non soil acting – foilage burn – use only on edule (ice plant) to kill weeds.
- Fumigants: methyl bromide or vapam … gas that is highly toxic – kills seeds and plants.

The Construction Safety Orders require that Material Safety Data Sheets (MSDS) must be submitted for any hazardous materials stockpiled on the job site. Pesticide labels and their MSDS are the best source of information available and include:

- Product name.
- Active ingredients – total toxic material.
- Adequate directions how to use and for types of plants and pests.
- Method of application – spray, broadcast, etc.
- Recommended dosage rates.
- An adequate danger-caution, warning statement, very important to post this on the jobsite and in the project job files.

- Hazards of skin absorption, breathing of fumes or environmental contaminants, and oral ingestion (a study by the California Department of Health and the California Department of Food and Agriculture has revealed the most hazardous jobs to be the ~~"m~~ixer loader" and ~~"g~~round applicators" and the most hazardous activity to be pouring the pesticide out of its original container).
- Label must list name and address of manufacturer and the registration number.

All persons handling pesticides should know what the term LD-50 means. LD-50 means lethal dose of the chemical in milligrams per kilograms of body weight that will kill 50% of a large population of test animals. A pesticide having a low LD-50 number is very poisonous. The higher the LD-50 number, the less poisonous.

1,000 milligrams	=	1 gram
1,000 grams	=	1 kilogram
1,000,000 milligrams	=	1 kilogram
1 kilogram	=	2.2 pounds

Danger – Poison – Skull and X bones	0-50
Warning – Moderately toxic	50-500
Caution – Slightly toxic	500-5000

If illness occurs, supply product name and registration number to the doctor. Personnel can be exposed by dermal (skin) contact, oral, or respiratory ingestion.

Fifteen (15) days prior to use of pesticides, the contractor must submit to the resident engineer for approval a *Recommendations of Pesticides Usage* signed by a licensed Pest Control Advisor with a copy of the Pest Control Advisor's license. Reference *Standard Specification* Section 20-1.01D. The *Recommendations of Pesticides Usage* contains:

- Types of pesticides to be used.
- Rate of application.
- How to be applied?
- Where to be applied?
- Who will apply?

Some counties have areas where special requirements or prohibitions may apply, so check for any special county regulations. Some concerned agencies are Department of Agriculture, Environmental Protection Agency, Cal OSHA, Water Quality. Use of pesticides that are not in the special provisions requires headquarters approval and a contract change order. Pesticides must be stored in a secured structure or away from the jobsite.

The most hazardous exposure time for the pesticides is during the mixing of the pesticides, so stay clear. The spray applicator should use a face shield, rubber gloves, boots, and protective clothing. To insure the use of proper rates, have the spray applicator explain what their plans for mixing are. Check the following for proper mixing:

- Photosensitive dyes of a contrasting color that disappears between 2 and 3 days.
- Surfactant: liquid agent added to chemical spray to enhance adherence of chemical to foliage
- Tank and equipment for leaks and cleanliness.
- Any chemicals not to be used on project.

Applications are influenced by:

- Wind – check for spray drift – 5-7 mph.
- Gun pressure affects drift.
- Spray drift to adjacent property.
- Re-check area to be covered by the calculated amount in spray rig.

The contractor has to clean the tank when the spraying is completed in an area designated by the County Agriculture Department, per Proposition 65. Pack equipment in safe place.

Contractor is required to notify the resident engineer at least 24 hours before each application and to fill out Form LA-17 –Report of Chemical Spray Operations" each week applications are made. Establish a separate file category in the project records to file the Pest Control Recommendations and the Report of Chemical Spray Operations, LA-17. File 2nd copy in the project records, and forward other copies in accordance with district procedures. Include notes about the pesticide application in the assistant resident engineer's daily report.

Pesticides should be used 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.

2-1.06 Review Questions

1. List normal roadside clearing sequence

_____

_____

_____

_____

2. What are the 6 basic types of chemicals used for weed control?

_____ _____

_____ _____

_____ _____

3. How long is roadside clearing performed?

_____

_____

"Thou shall write a neat, legible, accurate and complete daily report and properly follow all standard procedures"

T. Rex, Resident Engineer

Back to T of C

2-2 Hardscape

Hardscape work can be done at any time prior to the plant establishment period, but best done immediately after roadside clearing and before beginning irrigation work. Having hardscape in place will aid in irrigation layout. Keep track of hardscape costs as any changes to this item, which is expensive, will affect your contingency balance.

Types of hardscape:

- Rock blanket.
- Colored stamped concrete.
- Slope paving under structures.
- Air blown mortar on vertical slopes for stability.
- Maintenance access pullouts provide a safe off road parking place and access to valve clusters. They may be Portland cement concrete or asphalt concrete.

Do a constructability check before the work and a field check after the work to make sure that the finished product is appropriate to the site. The contractor may request a relief of maintenance for the hardscape before the entire project is completed.

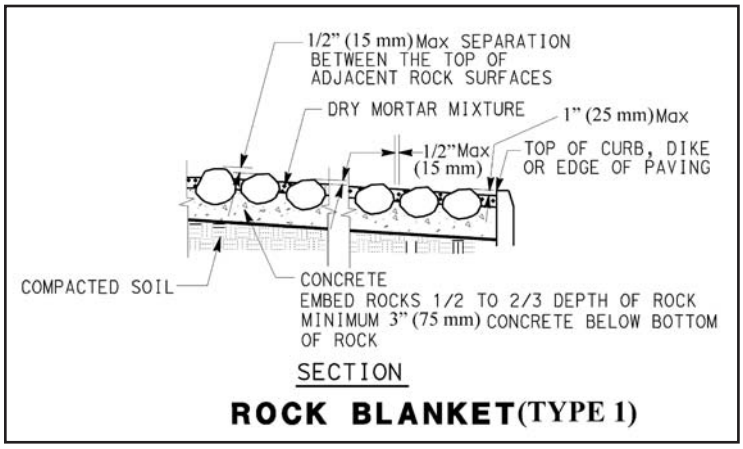
2-2.01 Soil Treatment

See Standard Specifications Section 20-5.03A(3)(c).

2-2.02 Rock Blanket

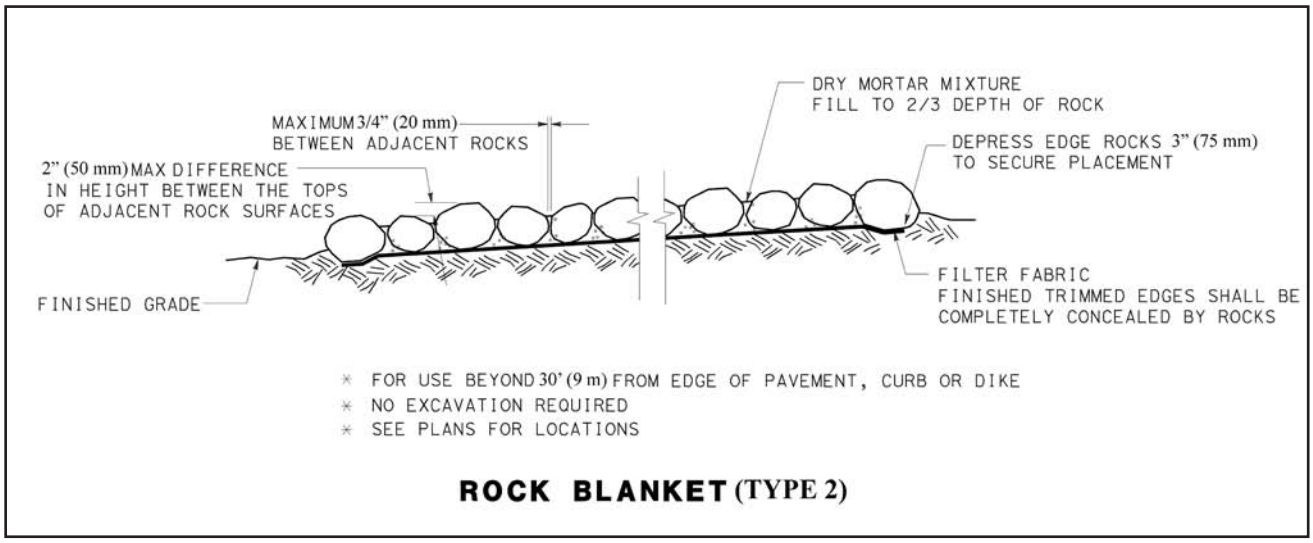
See Standard Specifications Section 20-5.03B.

Any rejected rock material may be used within the job limits at culverts and bridge drains as energy absorbers (rip rap) to eliminate erosion.



Rock blanket (Type 1) is used for areas adjacent to traveled way or shoulder and where accessible by pedestrians. It is more labor intensive and slower production. The concrete is laid first, and then the rocks are set in the wet concrete. After all wet concrete work is done; the final phase is the application of the dry mortar mix and watering it in.

Paving of rock blanket (Type 1) shall be scheduled so that the work, including placement of rock, finishing, and application of a curing compound is completed in any section on the same day that the work is started in that section.



Rock blanket (Type 2) is for areas 30 or more feet from traffic and where it will not be accessible by pedestrians. It is placed on grade, except the perimeter is 3" embedded. The filter fabric shall be placed such that the finished trimmed edges shall be completely concealed by rock. The rocks are spread first, then dry mortar mix is spread, and then the area is watered. Rock blanket (Type 2) is installed much faster than rock blanket (Type 1).

2-2.03 Stamped Concrete

Stamped concrete may be natural or colored as specified in the special provisions. Prior to beginning concrete work, areas to receive the concrete shall be cleared as required in roadside clearing. After clearing, the areas shall be graded to a smooth uniform surface and compacted to a minimum relative compaction of 90 percent. After compaction, the areas receive a soil treatment in accordance with the Standard Specifications and special provisions.

2-2.04 Slope Paving

Slope paving should be installed with freeway or bridge projects. It is more expensive to do it under a landscape project, but is becoming more prevalent with projects in older sections of our freeways before slope paving became standard.

Solve slope paving problems by reviewing before work starts. When it is on a skew and the downhill side, increase area at item so it is perpendicular to the slope. This will keep water from running over the edge drain and it will also eliminate an acute angle (< 90 degrees) in the planted area which will reduce the planting by a small amount and a sprinkler head or two, but it will make the irrigation system more efficient.

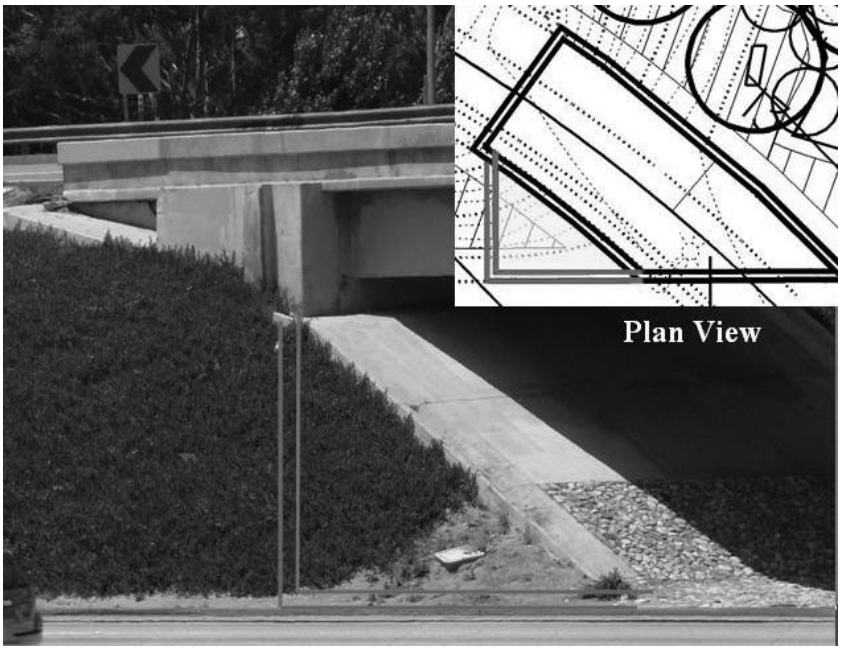


Photo
Water is actually running over the edge drain. Look closely, the ice plant has started to cover the eroded area by growing up the exposed edge of the drain. This is 3 years after installation. Maintenance must haul away soil from the bottom of the slope after every rain event.

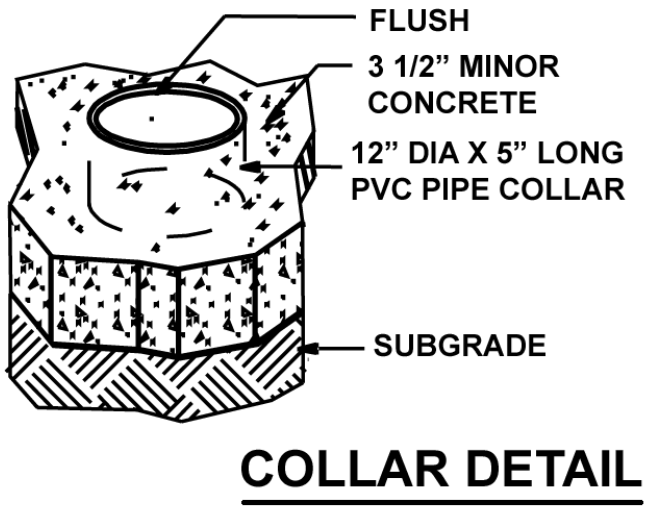
The three most important items to check:

- Slope paving and edge drains are outside the bridge rail limits.
- Edge Drains are perpendicular to the slopes on the downhill side of bridges on a skew.
- Edge Drains extend beyond the edge of the bridge rail at the top of slope.

2-2.05 Trapped Sign Post

A common problem with hardscape is trapped sign posts. This is something you should just take care of. If there is no detail, ask your Landscape Architect for one!

Take care to not encase guardrail posts in concrete or more than 2” of asphalt. These posts need to rotate to function correctly as a traffic safety device.



2-2.06 Review Questions

1. How many types of Rock Blanket are there? _____

2. Where is each type used? _____

_____

3. Rock Blanket is covered in the Standard Specifications and the plans- True or False?

4. What is a good use for rejected Rock Blanket material (rocks)?

_____

_____

5. What are the 3 most important areas (limits) to check for on Slope Paving?

_____

"Thou shall conduct thyself in a calm, professional, fair and honest manner at all times"

T. Rex, Resident Engineer

Back to T of C

2-3 Irrigation

2-3.01 Introduction

The irrigation system is to provide a safe, even and appropriate distribution of water either by manual or automatic systems to accommodate the planted landscape areas. The special provisions may require the installation of radio equipment that can communicate with a centrally located computer and radio base station. Irrigation plans are schematic drawings. Pipe and valves drawn in the roadway are to be installed in the roadside.

Check planned location of valves, sprinklers and automatic controllers. Consult with the Designer to change locations if:

- Located on shoulder area where normal traffic could damage them.
- Sprinkler controllers are not protected from traffic damage by guard rail or bridge abutments.
- Sprinklers located in front of signs or existing trees affecting coverage.
- Sprinklers spaced too far apart for adequate coverage.
- Sprinkler coverage too much. (Example: 30-foot radius sprinkler in a 10-foot wide planting area.)
- Sprinklers will wet controller and pump housing while sprinklers are in operation.
- There is no safe and legal parking area within a reasonable distance from controllers and backflow preventers: also, if there will be any hazard to employees gaining access - try to locate controllers for visual viewing of system.

Manual System	Automatic System
A manual system must be turned on and off by a person and contains the following components: Source of Water (Water Meter (WM)) Irrigation Conduits Backflow Preventer Assembly (BPA) Wye Strainer (WS) Supply lines, Main and Lateral Manual Control Valve (MCV) Quick Coupler Valve (QCV) Ball Valve (BV) Gate Valve (GV) Pressure Relief Valves (PRLV) Filter Assembly Unit (FAU) Valve Boxes Emitters and Sprinklers	An automatic system uses electrical devices that once properly installed and programmed will turn on and off the irrigation components without any human contact. It uses all the manual system components plus the following: Booster Pump (BP) Flow Sensor (FS) Master Remote Control Valve (RCVM) Remote Control Valve (RCV) Irrigation Controller (IC) Electrical Service Pull Boxes (PB) Low Voltage (LV) Conductors

Source of Water

The source of water is from water meters for potable or reclaimed water (which may or may not be metered), from an existing underground system, or from wells in outlying areas.

2-3.02 Irrigation Conduits

Reference *Standard Specification* Section 20-3.03C.

Prior to beginning irrigation work, the existing irrigation conduits should be located and verified that they are usable or if a new installation is needed as shown on the plans. Locating existing conduits or installing new conduits is usually the first order of work and required to be completed even before roadside clearing.

Existing irrigation conduits are located 1-1/2 foot below top of curb or sidewalk or a minimum of 40" below grade at all other locations. Look for the Type A pavement maker at the edge of pavement. If existing conduits are not at the locations shown, the contractor must excavate the first 2-1/2 feet wide x 5 feet deep x 10 feet parallel with the roadway. If the irrigation conduit is not located within these limits, the State will pay for all additional work to locate the conduits.

New irrigation conduits are installed according to the *Standard Plans* H9. Some of the details are:

- Type A marker at the edge of pavement may be the only visible locator after a few years when the plant material grows over the pull box.
- Waterline crossovers are Schedule 40 Pipe and Schedule 80 fittings.
- Long sweep elbows are for pulling future conductors through. It is next to impossible to pull conductors through a 90 degree elbow.
- Thrust blocks to prevent movement of the water lines.
- Bushing prevents the skinning of the insulation when pulling wires through.
- Cap is to prevent debris from clogging the conduit.
- Pull box will have a gate or ball valve that can be used to isolate the areas when repairs are necessary.

Jack and Drill Reference *Standard Specification* Section 20-2.08C(2)(c).and *Standard Plans* H9
Jack and drill is an industry standard for installing conduit under existing pavement. If the project was new freeway construction, then the conduits would be installed by trench and cover method.

The conduit to be jack and drill is typically an 8" welded steel pipe. For a normal dry bore (jack), a pit, 20 feet long by 10 feet wide, is excavated to accommodate the equipment and personnel. The conduit is placed on rails in front of a hydraulic machine that pushes (jacks) the conduit while the drilling auger bits, placed within the conduit, pulls soil back through the casing. Other methods and devices may be used depending upon the size of the conduit and the existing conditions. A ramp closure is required for safety due to the large jacking pit.

2-3.03 Backflow Preventer

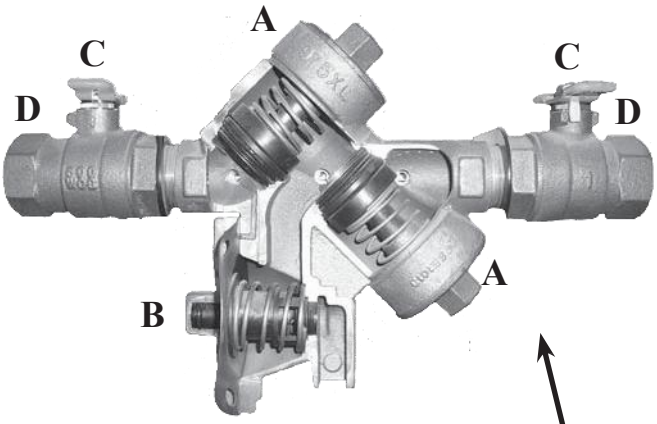
Reference *Standard Specifications* Section 20-2.03.

All domestic water irrigation systems are required by the Department of Health Services to have backflow prevention devices. Backflow preventers are designed to allow water to travel in only one direction (away from the source). They can be:

- Atmospheric vacuum breaker or anti-siphon valves are the least expensive backflow preventer. They must be installed 6 inches higher than the highest sprinkler head, and there must be no other control valves between them and the sprinklers or drip emitters. This is the most common type of backflow preventer used on residential irrigation systems.
- A double check backflow preventer is simply two spring-loaded check valves in a row, with a shut-off valve on either end and test cocks to allow the unit to be tested for proper operation. The double check backflow preventer is the only true backflow preventer which does not have a vent to allow air to enter the lines or to allow water to escape when backflow occurs. It relies entirely on the tight seal of the two check valves to prevent backflow. Even in areas where double check backflow preventers are approved for use they may not be used on any irrigation system where chemicals (fertilizers, pesticides, fungicides) are injected into the irrigation water.
- Reduced pressure backflow preventer is the king of the backflow preventers, made for high-hazard uses and required by the Standard Specifications. The reduced pressure unit must be installed 12 inches above ground, but it does not have to be higher than any of the sprinklers. A single reduced pressure unit is installed upstream of all the valves. Reduced pressure units may spit out water if they detect backflow; they also spit water if they are broken.

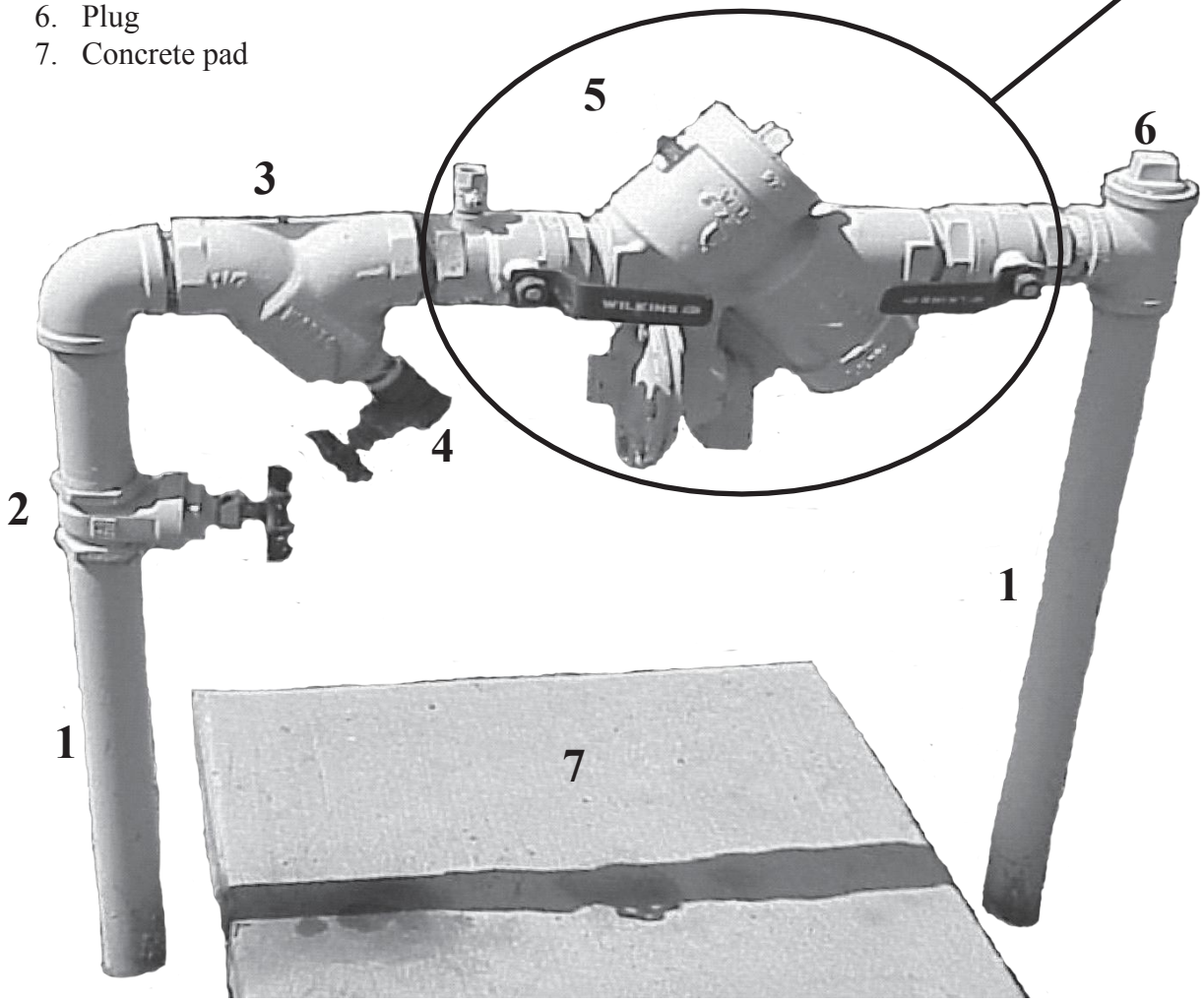
Unit Components:

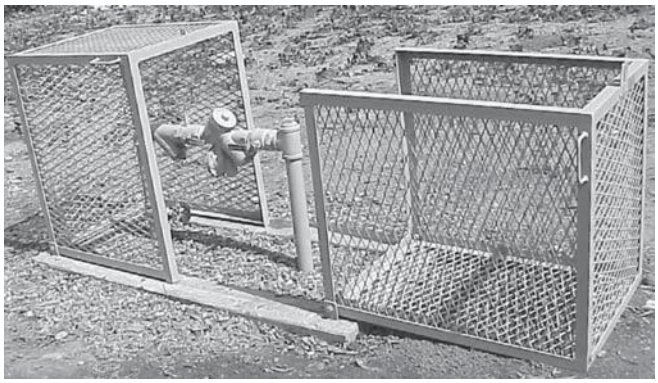
A. Check Valves
B. Pressure Differential Relief Valve
C. Shut-off Valves
D. Union on one side of each shut-off valve.
E- Test cocks, 4 required (not shown)



Assembly Components: Reference *Standard Plans* H8

1. Galvanized steel pipe from meter to backflow preventer and all above ground installations.
2. Gate valve
3. Wye strainer (Reference *Standard Specifications* Section 20.2.11B(11))
4. Wye strainer blow out valve. The valve outlet must be field modified (threads destroyed with a chisel) by the contractor so no attachments can be made to the fitting. Gate valve pictured.
5. Backflow Unit
6. Plug
7. Concrete pad





Backflow Preventer Enclosure

2-3.04 Booster Pump

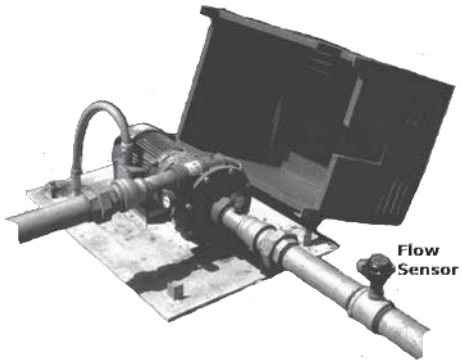
Booster Pumps (BP) are used when the static pressure supplied at the source is not sufficient to fully operate the entire or certain sprinklers of the irrigation system. Pumps are usually powered by 110/220 v services but may be powered by individual diesel or gas powered generators. There are 3 axis of installation:

- Inlet to pump
- Outlet from pump
- Motor to pump

All 3 must be correct or pump will fail within a short time instead of 20+ years of service. Housing unit is preferable to minimize vandalism and protection the pump from the elements.

Flow Sensor

The flow sensor is a mechanical device installed in the water supply line to measure flow and pressure. It is necessary to be used in conjunction with booster pumps and controllers to ensure proper operating pressure for the sprinklers and also provide protection for the booster pump. It will shut off the pump if insufficient water is flowing to prevent the pump from "burning up".



The location of flow sensor is critical! The distance from any fitting is a set formula depending on size of pipe and design flow of the pump. The length of the "paddle blade" of the flow sensor must be the proper length to be in the proper location inside the pipe. Armor clad (shielded cable) conductors are required to connect the flow sensors, so that a false current is not induced. For assistance with pumps and review of submittals, contact the following:

Division of Engineering Services
Office of Structure Design Services and Earthquake Engineering
P.O. Box 168041
Sacramento, CA

2-3.05 Supply Lines

Main supply lines serve the entire system of valves and sprinklers from the meter and is under pressure when any one of the valves is in operation. It is the water line between the water meter and the remote control valves.

Lateral supply lines connect only the sprinklers of one remote control valve (RCV) and is only under pressure when that valve is scheduled to operate. It is the water line from the remote control valve to all of the sprinklers.

Trenching

When trenching in existing landscape areas, prune as necessary to install, clear ground cover as necessary, but no more than 6 feet wide, and replace plants per *Standard Specifications* Section 20-2.01C(2).

Rocks brought to the surface during trenching are at the contractor's expense. Removal of large rocks, as specified, will be at extra work. Backfill by ponding or jetting is preferred until the trench backfill is level with the grade. Backfill trench with removed material. If new material is required, then it is paid as extra work. Having moisture in trench backfill helps reduce the amount of expansion or contraction of PVC pipe; 30 degrees temperature differential equals 1-3/4" expansion per 20 feet length. Snaking pipe in trenches allow for expansion and movement to prevent breaking of the pipe joints. Flush lines to remove PVC sawdust and other containments (dirt) before installation of the sprinkler heads to prevent clogging of the sprinklers.

PVC Trench Requirements	Solvent Weld	Ring and Gasket
Depth (cover)	12"	18"
Width	Allow snaking	Accommodate Installation
Setback, supply lines	4' from Edge of Shoulder, curbs and dikes	

Reference *Standard Specifications* Section 20-2.01C(2).

All pipe supply lines are pressure tested for leakage. Lines that are installed by trenching and backfilling which are fully visible may be tested by Method A or Method B. All others will be tested by Method A.

Method A: Pipe is filled with water, pressurized to 125 psi for 1 hour, max 5 psi drop. Conduits must be tested under Method A, except for 0.5 hour and no drop in pressure.

Method B: Water supply, at full pressure from the source, is turned on for 8 hours after all air has been removed from the line.

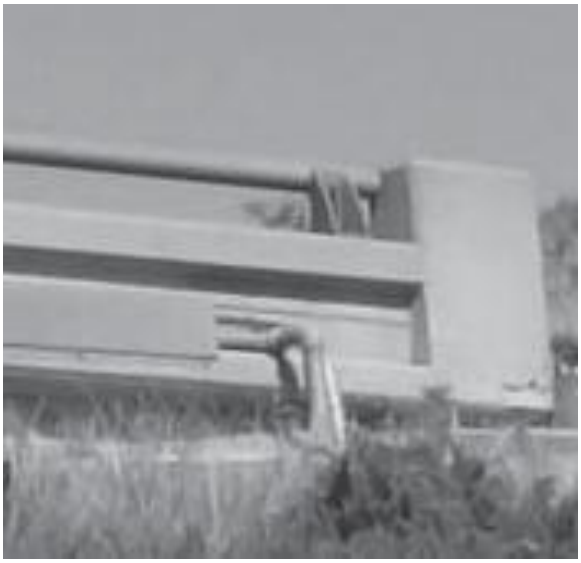
Reference *Standard Specifications* Section 20-2.01A(4)(b).

Galvanized Pipe

Galvanized steel water pipe is used only in exterior, above grade applications and between the water meter and 2 feet beyond the backflow preventer. Galvanized steel water pipe has tapered threads and available in 21 foot lengths. Galvanized rigid steel electrical (sprinkler control) conduit has non-tapered threads and available in 10 foot lengths. Dielectric couplings are needed if attached to any other type of metal pipes; i.e. copper.

Galvanized pipe is required for each service that crosses an existing structure.

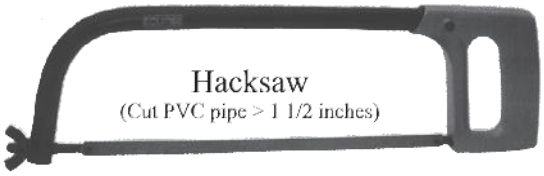
Old Installation: The pipes were ~~"g~~anged" in the Type I pipe anchor bracket to minimize the intrusion of the galvanized steel water conduit, 120 V electrical conduit and the low voltage (LV) electrical conduit on the bridge rail.



Current Installation: Galvanized steel water conduit and low voltage (LV) electrical conduit are attached to the exterior of existing bridges with a shield for aesthetics.

Plastic (PVC) Pipe - Solvent Weld Reference *Standard Specifications* Section 20-2.09B(5).

Plastic (PVC) Pipe comes in 20 feet or 10 feet lengths. PVC pipe 1 ½ inch pipe or less in diameter shall not be cut by sawing, but shall be cut with "PVC Cutters." Using a saw (hacksaw) is the most common way to cut PVC pipe, however it creates PVC sawdust that must be flushed from the pipes so as not to clog the sprinkler nozzles in the future.



PVC Pipe is rated by schedule or pressure rated (PR).

- Schedule refers to wall thickness. Regardless of the pipe diameter, the wall thickness is the same for all schedules, therefore pressure rating declines as the size of the pipe increases.
- Pressure rated (PR) is the allowable pressure of the pipe, thus PR 200 will withstand 200 psi and PR 315 will withstand 315 psi. The wall thickness will vary on the different pipe sizes of the same pressure rating.

PVC pipe fittings are either Schedule 40 or Schedule 80. Schedule 40 fittings are used on PR 160 and PR 200 pipe. When PR 315 pipe is called for, Schedule 80 fittings must be used.

PVC pipe can be straight or bell end, one end only. Bell end pipe reduces the number of slip by slip (SxS) fittings required in long runs of pipe, but requires slightly more linear feet of pipe. The bell end is deeper than an SxS fitting to compensate for the thinner wall thickness of the bell portion of the pipe.

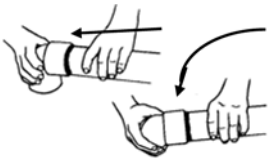
PVC Pipe codes (from left to right): manufacture's name, pipe size, pipe schedule or PR rating, Type of PVC, ASTM Designation, date of manufacture, time of manufacture, where made, bar code for material lot.

Purple PVC pipe is used for reclaimed water systems. Purple reclaimed warning tape may be placed in the trench above white PVC pipe in lieu of the purple pipe.

Joints are glued by using a primer and a solvent cement. Primers are usually a light purple color and the solvent cement (glue) is either clear, blue or grey and 2 to 3 shades darker than any of the primers on the market. Each is applied with a dauber or brush. The basic installation procedures are:

1. Cut pipe square.
2. Deburr pipe with a file, knife, or reamer.
3. Wipe pipe clean with a clean, dry cloth.
4. Make trial fit; pipe should go easily into fitting socket about one-half of the socket depth. Select the proper size applicator; 1½" diameter pipe and larger requires a brush or roller.

COMPLETE THE FOLLOWING STEPS WITHIN 30 SECONDS TO ASSURE A SECURE JOINT!



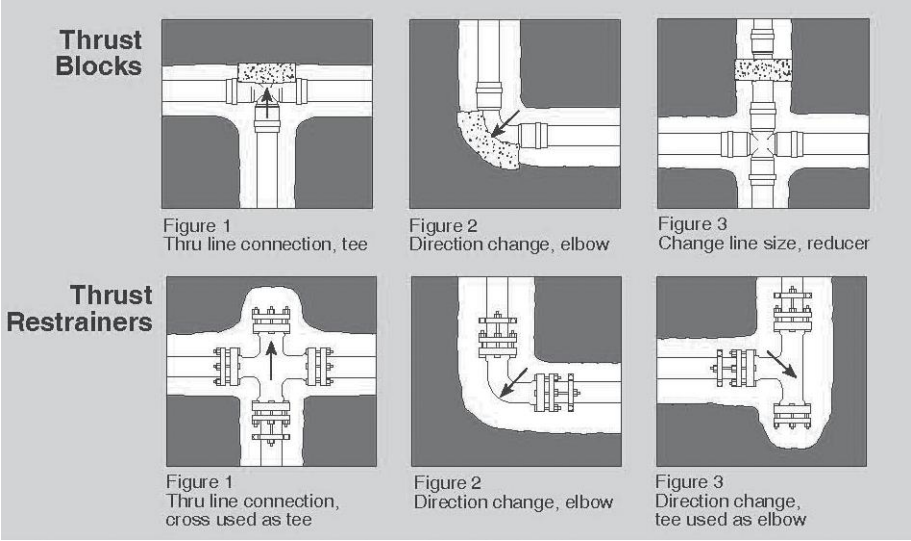
5. Apply a full, even coat of primer to inside of fitting and outside of pipe in a width slightly larger than the depth of the fitting.
6. Apply a full, even coat of cement to inside of fitting and outside of pipe. Avoid puddles and voids.
7. Push pipe into to full depth, and rotate one-quarter turn into position.
8. Hold the joint together firmly for 30 seconds. This will prevent the joint from pushing apart.
9. Remove excess cement and leave joint undisturbed for at least thirty minutes. Full joint strength should be reached within 24 hours, depending on existing temperature and humidity.

Assembly Instructions:

1. Make certain pipe ends and gasket areas are free of dirt and debris. Support spigot end of pipe above ground to prevent dirt contamination when lubricant is applied.
2. Apply a light coating of recommended lubricant to spigot end and sealing section of gasket.
3. Align pipe ends. Push spigot end into gasket bell so that the reference mark is even with the entrance of the gasket bell.

Plastic (PVC) Pipe - Ring and Gasket

Ring and gasket PVC pipe requires more care to install. For example the lubricant needs to be kept clean and the pipe must be properly inserted to insure a proper seal. So, it is a more labor intensive and expensive then solvent weld pipe, but it is superior in some applications. The designers will not use this type of pipe unless necessary, as noted in the Trenching section, ring and gasket must be installed deeper and takes more care in joining.



2-3.06 Valves

Remote Control Valves

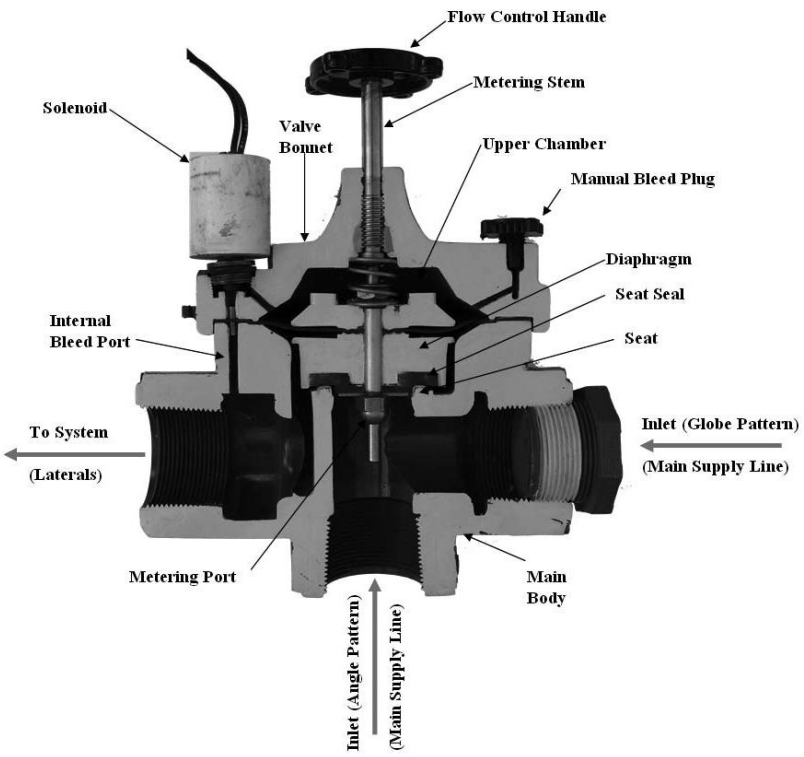
The remote control valve (Master) (RCVM) is located downstream from the backflow preventer. The RCVM controls the flow of water to supply lines so that they are not under constant pressure when irrigation is not taking place. The RCVM turns on the entire main supply line whenever any individual remote control value is scheduled for watering.

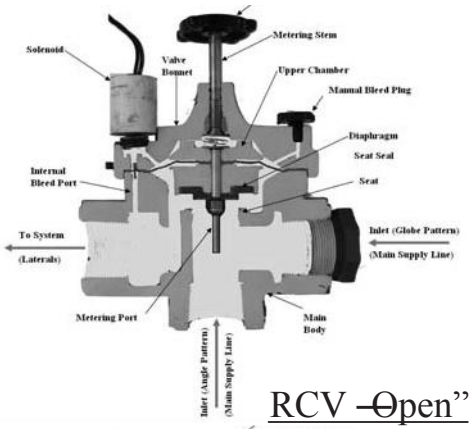
Individual remote control values (RCV) control the flow of water to the lateral water supply lines and sprinklers. They open and close when and for what period of time as directed by the irrigation controller (IC).

RCV valve boxes are labeled by the IC letter and the Station number. The picture to the left shows a C8 tag, which means that the RCV is controlled by irrigation controller C and the valve is station number 8 or eighth in the watering sequence.

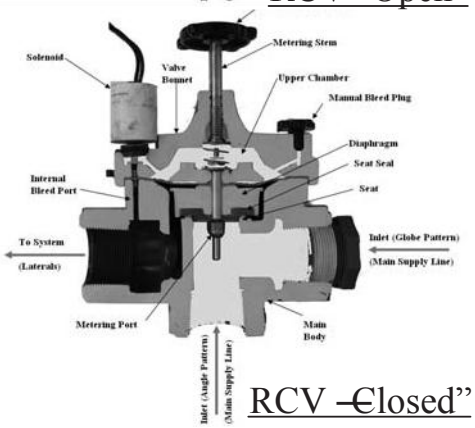
STATION

Each remote control valve (RCV) and the spray heads it controls are called a station. Station numbers should start with all the valves with heads at the shoulders then to interior systems and lastly to the low flow systems (emitters). This is so that the shoulders are watered early in the day before winds come up, then to areas where wind has little or no chance of spray onto the traveled way. The numbering sequences may have to be adjusted due to wind or local water company restrictions. Contact your Construction Landscape Specialist for assistance. If changes are made to station sequencing, be sure to contact the Designer and have the irrigation controller (IC) plans corrected before they are laminated.





RCV –Open"



RCV –Closed"

When first installed, water from the main line enters the upper chamber of the RCV through the metering port in the center of the valve. When the upper chamber is filled, the diaphragm seal closes against the seat and prevents water from flowing through the valve. The RCV is in the –normally closed" (static) position. Normally closed means that when under water pressure the RCV is closed until activated by the IC to open.

The RCV opens (flowing), when the IC sends current to the solenoid, it lifts, by magnetic force, the spring loaded pin that seals the upper chamber bleed port. The bleed port is approximately three times the size of the metering port, so the upper chamber drains faster than the water flowing through the metering port can refill the chamber. The main line pressure pushes the diaphragm to the top of the upper chamber allowing water to flow through the valve at a rate controlled by the metering stem. When the electrical current stops, the spring loaded sealing pin reseals the upper chamber and the water flowing through the metering port refills the upper chamber and forces the seal down on the seat and water stops flowing. The valve is closed (static).

The *Standard Specifications* Section 20-2.11B(10) requires the RCV to be internally operated with all operations internal, no exterior operating parts or water leakage. With internal diaphragms the valves close slowly, so that the shut off of the water flow will not cause –water hammer" (like the inertia in a speeding car that comes to an abrupt stop, everything inside still moves forward) that can break parts of the pipe system.

For manual operation, the manual bleed plug on the valve accomplishes the same thing as the solenoid, except bleeding the chamber to the atmosphere and will not shut off till manually closed, so it will fill up the valve box. Some valves use a moveable solenoid that moves its sealing pin internally for manual operation but it then must be returned to the automatic position to shut off the water flow.

The flow control handle is not an on and off handle, but too often will use as one it and wear out the diaphragm or damage the seat or seal. The flow control handle, attached to the metering stem, controls the flow by limiting the amount of travel of the diaphragm. The handle is turned clockwise to minimize the flow and counterclockwise to increase the flow to match the number of sprinklers shown for each station (valve).

Most common malfunctions of RCV and their causes are:

Failure to Open: No current to solenoid; Solenoid sealing pin is frozen shut; Solenoid pin port is clogged shut (lack of proper care in installation or a previous repair of the diaphragm/seat allowing debris into upper chamber); The metering stem has been turned all the way down sealing the diaphragm against the seat; Make sure the backflow preventer is not closed, the RCVM is in operation and main line is under pressure.

Failure to Close: Current is bleeding from another station from a short in the controller or in the wires to the solenoids; Solenoid pin is stuck in the open position; There is some obstruction in the valve on the seat that prevents sealing and shutting off, There is a hole or tear in the diaphragm or the seating seal that allows water to continue to flow.

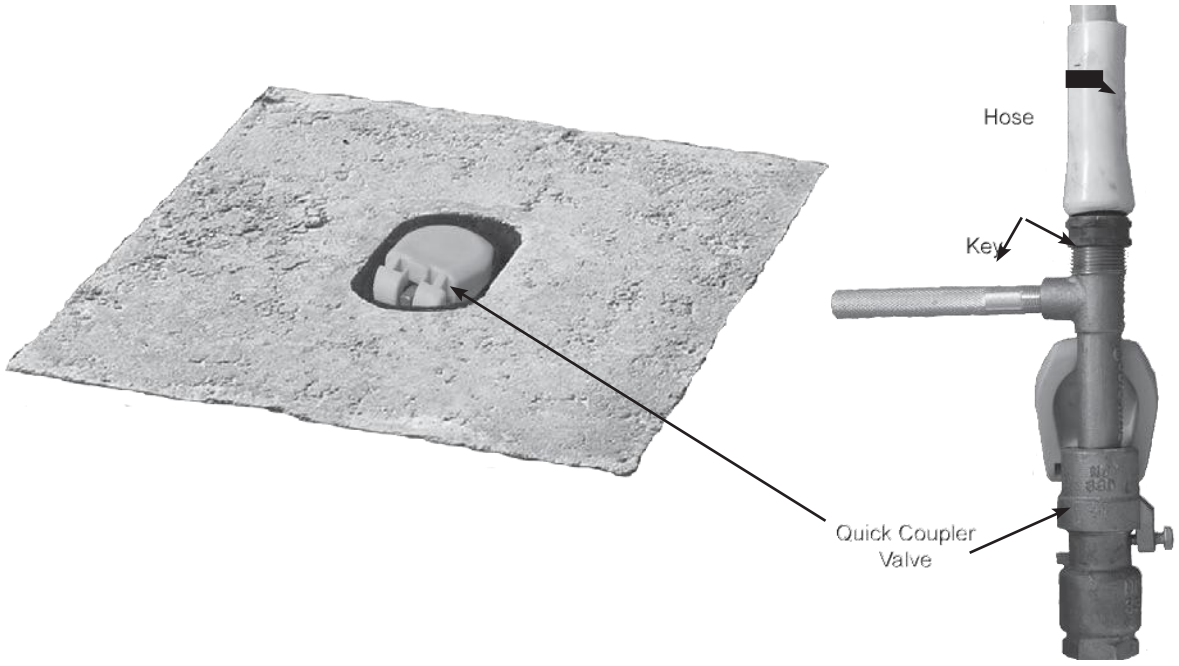
Reference *Standard Specifications* Section 20-2.11B(10).

Manual Control Valve (MCV)

When manual control valves (MCV) are used a person has to turn them on & off to allow water to flow from the main supply line through the laterals to operate the spray heads and emitters. MCV can be a gate valve (GV), ball valve (BV), etc.

Quick Coupler Valve (QCV)

A quick coupler valve (QCV) is a manual device installed on the main supply line and used to attach a hose to the irrigation system. It usually requires a concrete type protector.



Ball Valve (BV)

Ball valves have a 90 degree turn on and off operation. They are an efficient, round ball with a hole in the center of Teflon seats, and the narrow body fits well in valve boxes. Ball valves are used to isolate valve clusters. The valve handle indicates the position of valve;

- Parallel (In-line) - flow
- Perpendicular (Across-line) - no flow.

Since water passes only through the center of the ~~"b~~all" they are less likely to corrode than gate valves. For above grade application, ball values must be brass. PVC ball valves with unions are used for in ground application installed in valve boxes.

Gate Valve (GV)

The gate valve is a general service valve used primarily for on--off, non-throttling service. The valve is closed by a flat face, vertical disc, or gate that slides down through the valve to block the flow.

A gate valve is excellent for service that requires either full or no flow. It has essentially no flow restriction when fully open. They are used most often at irrigation conduits and backflow assemblies.

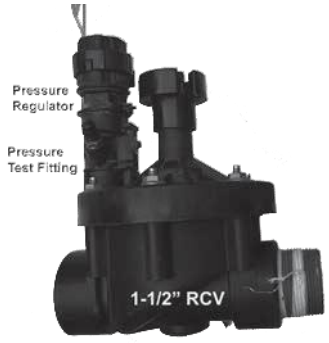
Debris or corrosion can build up in the gate area, preventing complete closure. If corrosion exists, the valve will leak when closed. They often corrode to an immovable condition in either the completely open or closed position, because water is running through the entire inner portion of valve stem and seat.

Reference *Standard Specifications* Section 20-2.11B(6).

Reducing Pressure Valve (PRV)

A pressure reducing valve (PRV) does just that, reduces pressure. They can be of any size, and are usually installed near the backflow preventer for systems with high static pressure.

Pressure Regulators



Pressure regulators may be required on RCVs to reduce the pressure for the low flow sprinkler stations. High pressures in the low flow emitters would cause excessive ~~"m~~isting" of the spray pattern, an inefficient use of water, and eventual damage to the low flow spray, drip or emitters.

Wye Strainer Assembly (WSA)

The wye strainer assembly (WSA) is downstream from the RCV and is used with the low flow spray, drip and emitters systems to prevent clogging of the heads. Low flow heads have very small nozzle openings (often in microns) and are easily plugged. It is very important to flush the main supply lines and the lateral supply lines before the filters and sprinkler heads are installed. WSAs are available in various sizes and are dependent upon the flow (gpm or gph) requirement.

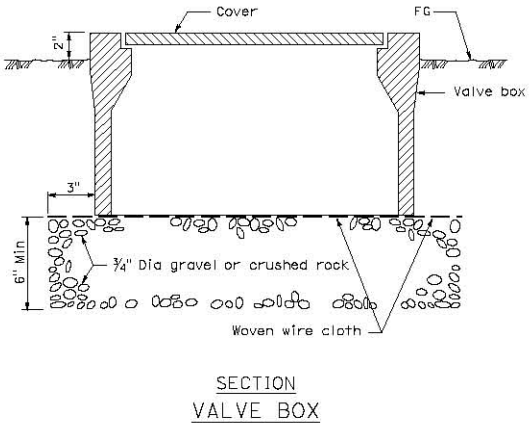
Pressure Relief Valve (PRLV)

Pressure relief valves are preset protection devices that open at a set pressure to prevent damage to the main and lateral supply lines. They are most commonly located at the end of the supply lines or the lowest elevation. They are usually set to 150 psi and are not generally called for in most urban areas as ~~"n~~ormal" pressures are in the 40-60 psi range. PRLV will be called for in high pressure areas, areas of great elevation changes, or high pressures at the source point.

Valve Boxes

Remote control valves, remote control valves (master), manual control valves, flow sensor, gate valves, pressure reducing valves, pressure regulating valves, pressure relief valves, ball valves, wye strainers are installed in valve boxes. Valve boxes are clustered adjacent to the shoulder, maintenance vehicle pullout(s) (MVP) or access roads.

Control valves are 6-1/2 to 8 feet from curbs, dikes, sidewalks and paved shoulders and 3 feet from fences and walls.



SECTION
VALVE BOX

Reference *Standard Specifications* Section 20-2.01B(7).

Important features of the valve box are:

- Precast portland cement concrete or metal covers, one piece, except when the weight of a valve box cover exceeds 35 pounds the cover shall be cut into equal sections so that no section exceeds 35 pounds in weight.
- 6" bedding of gravel or crushed rock for drainage.
- Woven wire cloth, 1/4 inch to 1/2 inch mesh, 19 gage minimum galvanized, continuous piece to keep rodents out.

Valve boxes are identified by attaching a label with the valve's abbreviation to the cover. The identifying abbreviation for the RCV is the IC letter and the station number. Reclaimed water labels and plates may be State furnished materials, so check your special provisions. Plastic valve box covers might be drained in lieu of attaching the label.

The tops of valve boxes installed in walkway and paved areas shall be flush with finished grade. The tops of valve boxes in other areas shall be installed 2 inches above finished grade.

Reference *Standard Specifications* Section 20-5.03F and *Standard Plans* H7.

2-3.07 Emitters and Spray Heads (Sprinklers)

The ~~–~~Sprinkler Schedule" for the project will state:

- Symbols for sprinkler types
- Sprinkler Specifications
- Nozzle size in gallons per minute
- Sprinkler radius
- How close to shoulders, plants
- Perpendicular to slope
- Height & type of risers
- Type of Swing joints required
- Other information (material, etc.)

Sprinkler heads are installed 6-1/2 to 8 feet from curbs, dikes, sidewalks and paved shoulders and 3 feet from fences and walls.

Reference *Standard Specifications* Section 20-5.03A.

Individual sprinklers (bubblers or emitters) are for shrubs or trees and meant to supply water to small areas directly at the root zone. Usually a supplemental system to ensure growth of specific plants (trees and large shrubs) within large areas of ground cover that is irrigated by overhead spray heads and as a back-up for the overhead sprinklers if they fail or are turned off in drought conditions. Bubblers are also used as the primary irrigation system for just tree and shrub plantings for water conservation.

- Bubblers (gallons per minute (gpm))
- Emitters (drip or low flow spray in gallons per hour (gph))

Overhead spray heads (Radius 5 ft - 50 ft) for large ground cover or shrub areas are:

- Impact or gear driven (full circle & part circle)
- Fixed pattern (Spray or Stream
- Pop-up (can be all of the above)

Individual Sprinklers

Bubblers usually have a flow in gallons per minute (gpm) and require basins around the individual plants they are to water.

Emitters are in gallons per hour (gph) and do not always require the plants to have a basin. They provide a metered efficient use of water to the root zone by the low flow (gph) that prevents erosion. Emitters are pressure compensating; therefore multiple heads may be used for one RCV over changing elevation. This would not be possible with overhead spray heads.

Color coded inserts determine the gpm or gph for bubblers and emitters, so check the Sprinkler Schedule and the manufacturer's literature.

Overhead Sprinklers

Impact Sprinklers operate by the impact of water leaving the nozzle of the sprinkler and hitting ~~–s~~poons" or ~~–f~~lappers" to drive the sprinkler. They have collars, and spring mechanisms for radius and arc adjustment. Impact sprinklers are adjustable in arch and radius, full or part circle.

The disadvantages of impact sprinklers are that they have a ~~–b~~acksplash" to areas not wanted to be watered; since it uses an ~~–i~~mpact" for drive to move through its arc, they can go out of arc adjustment and spray unwanted areas such as the roadway. They are usually constructed of brass, expensive to buy and are a target for theft for the scrap value of the metal.

Gear driven sprinklers are made of plastic construction. They operate by water flowing through the internal "gears" of the sprinkler for arc and radius. Once arc and radius are set, rarely do they go out of adjustment. Gear driven sprinklers are adjustable in arch and radius, or preset to full or part circle (i.e. 90°, 120°, 150°, 180°, 210° or 270°). Since plastic has no scrap value, they are generally left alone other than just malicious damage or vandalism.

Fixed pattern spray heads are made of either plastic or brass. Their arc is set, but their radius can be adjustable by turning the screw to achieve the desired radius, it will have a slight affect on flow (gpm).

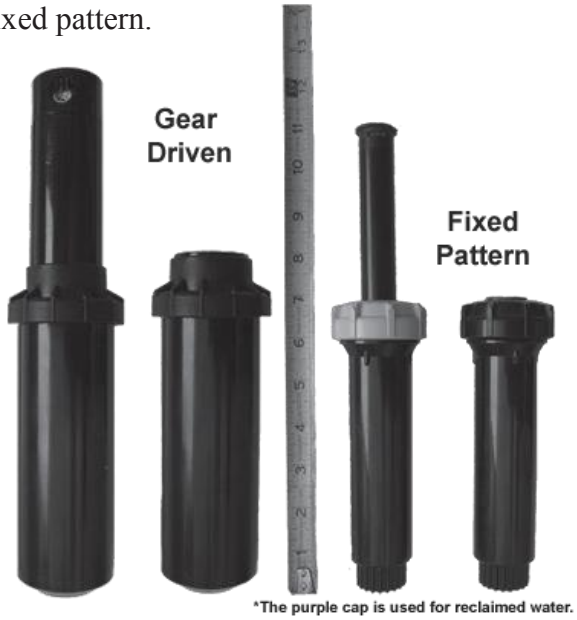
The stream spray nozzle holes are less susceptible to wind. Note the "SS" code on top of the sprinkler for stream spray.

Fan sprays are more susceptible to wind. Note the shape of nozzle and arc is indicated on top of the nozzle.

"Pop-up" means that when not operating under pressure they are flush with grade (out of sight) and only pop-up and operate under the design pressure for their particular size. When pressure is removed they retreat back to flush with the grade. "Pop-Up" would be listed under the remarks column on the Sprinkler Schedule along with the concrete protector symbol used on plans. They can be either impact, gear driven or fixed pattern.

Gear driven pop-up sprinklers are used for larger areas and adjacent to pull-off areas due to the potential of a high number of "hits" by traffic. These are slimmer and less prone to malfunctioning and damage than an impact pop- up sprinkler. They are adjustable in arch and radius.

Fixed Pattern pop-up sprinklers can be stream or fan sprays. Spray refers to a fan type pattern and stream is like spokes of a wheel. They are fixed pattern with adjustable radius and are used for narrow areas adjacent to traffic.



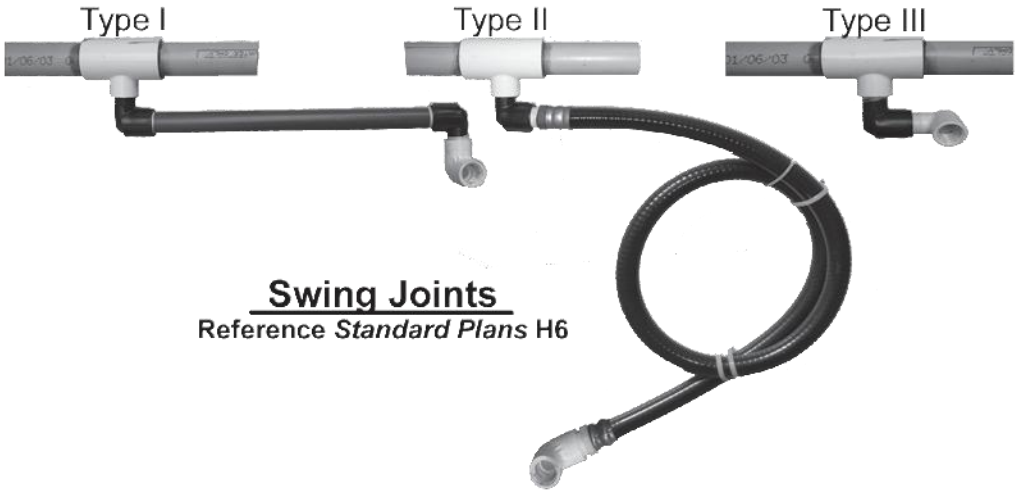
*The purple cap is used for reclaimed water.

Concrete Protection —◎— is used to protect pop-up sprinklers and quick coupling valves that are installed close to traffic. Pictured is a Type I concrete proctor that is installed a maximum of 1" above grade. A Type II sprinkler protector is domed and installed flush with grade.

2-3.08 Swing Joints and Risers

Swing Joints

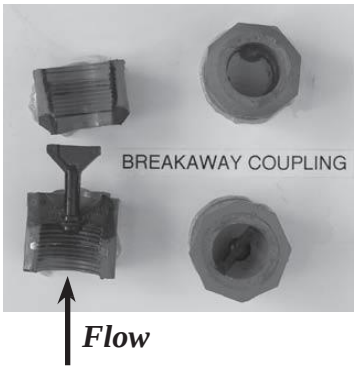
Swing Joints are installed between the riser and the lateral to allow movement. Swing joints allow the sprinkler head location to be easily adjusted and they deflect to prevent breakage.



Flow Shut-Off Device

Proper installation of the riser and shut off device is required for the shut-off device to work properly.

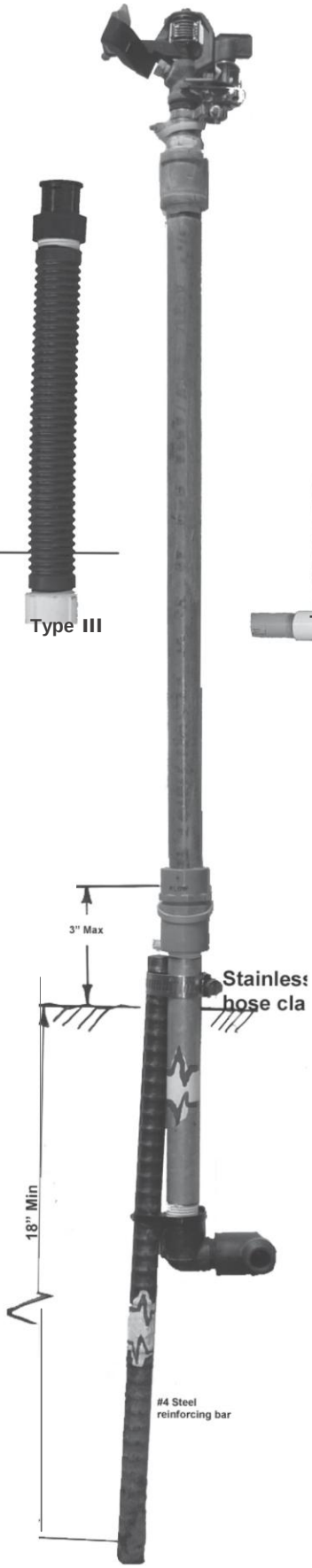
- Top threads, see flow arrow, must be threaded to the full depth in order to prevent the Y-ball from rising and shutting off the flow until it is broken away.
- Bottom threads (metal banded) must be threaded to the full depth in order to break in the proper location (center).



When broken and the water comes on, only a small ~~–s~~quirt" will shoot in the air, as the Y-ball stopper seats against the remaining portion of the device rather than a stream of water (at 30 psi, about 15' high and almost 20 gpm) to run on to the highway.

Risers

Risers are the pipe and fittings used to attach the sprinkler to the lateral pipe.

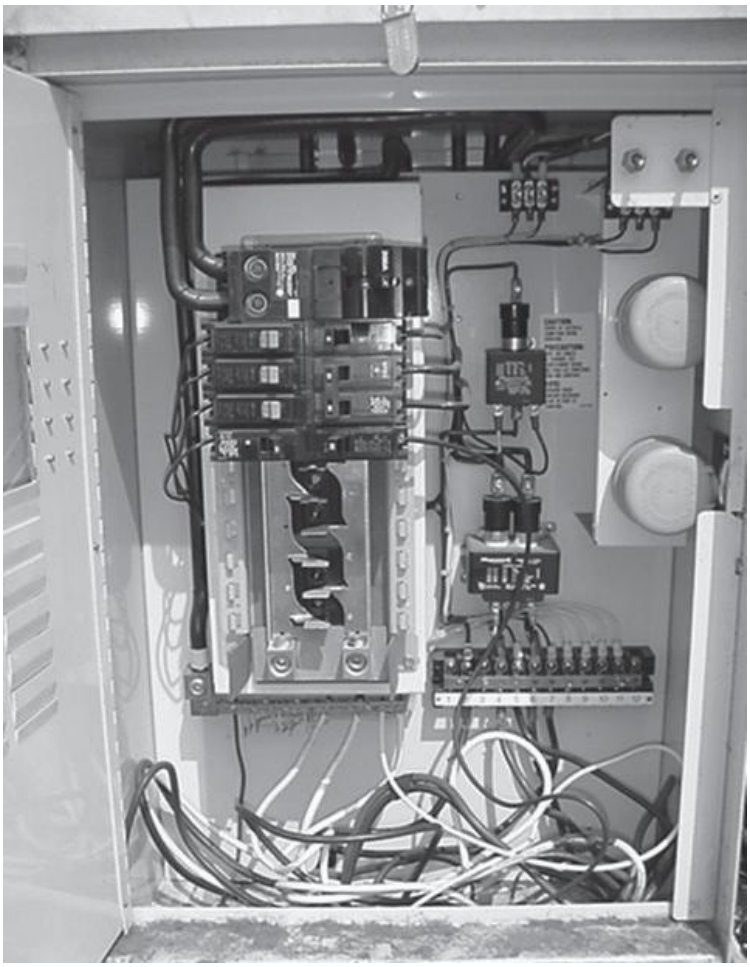


Type IV

2.3.09 Electric Service

Service Cabinet

Installation of the electrical service from the service cabinet to the irrigation control must meet the requirements of *Standard Specifications*, Section 86, Electrical Systems.



Only qualified personnel should open up the breaker (dead front) panel due to the risk of electrocution. Electrical service is the same as your house current, 120 V alternating current (AC) and it can kill you. So, touch nothing, ever! But, you, the inspector, needs to be present when the contractor installs the work. Even the most qualified electrician may try to take short cuts from the specifications.

When you open up the breaker (dead front) panel you'll see exposed bus bars that are live and can kill you on contact. You really have no reason to touch anything here. If you need to inspect it, ask the contractor to show you around. WARNING: Each of the bus bars are 120V to ground.

Conduit - Type 1

Reference *Standard Specifications* Section 86-2.05

Special provisions will usually require the conduit to be Type 1, hot dip galvanized, rigid metallic conduit. Conduit shall be 1 ½ inch unless specified in the contract documents. Conduct is cut square and reamed to remove burrs and rough edges. Conduit thread and damaged surfaces shall be painted with 2 applications of zinc-rich primer. Properly connected sections of conduit will show no threads between the coupling points.

There shall not be more than 4 – 90 degree angles or a total of 360 degrees of bends in a single conduit run. Conduit runs consist from pull box to pull box, pull box to cabinet or pull box to foundation. Any individual conduit run shall not exceed 200 feet.

Trenching Reference *Standard Specifications* Section 86-2.01 and 86-2.05C
Conduit is laid to a depth of not less than 18 inches under concrete sidewalks paved median areas and not less than 30" for all other areas. Trenches on outside slopes and not under pavement are backfilled with native material and compacted to 90% compaction. Trenches on slopes or under pavement are backfilled with SE20 material and compacted to 95% compaction. Compact with a powder puff or Wacker.

Pull Boxes Reference *Standard Plans* ES-8
Typically landscape will use a Type 3-1/2 pull box, for two conduits.

- Pull boxes are spaced no more than 200 feet apart
- Pull boxes are labeled "Irrigation".
- Pull boxes are installed on a crushed rock base for non-structure installations.
- Pull box must be installed to grade in paved areas like gores, pavement or sidewalks.
- Pull box must be 1 inch above grade in dirt areas as shown.
- Pull boxes installed on steep slopes should be installed to conform to the slope.
- Conduits should protrude 2 inches above the crushed rocks.

- Conduits must be grounded. All metallic components must be all grounded together by means of bonding jumpers or straps to maintain these units at the same ground potential.
- Conduits require bushings to protect conductors from the sharp edges and to bond the conduits together.
- Conduits in every pull box must be sealed with compound.

Conductor Splicing
Splicing is only permitted in pull boxes. Running splices within conduit is not permitted. Splicing conductors and pulling the spliced conductor within a conduit run is prohibited.

You must actually watch the electrician do the splicing. Contractors do not always follow all the steps of the splice. When stripping the conductors: Cut off insulation with electrician's knife. Wire cutters may nick the wire if the cutting slot used is smaller than the wire.

No open flame torches allowed for splicing conductors. It will damage the insulation and it is a fire hazard. Contractors must use soldering guns or heat guns that require them to bring their truck with a generator and extension cord to use them.

Standard Specification Section 86-2.09E states that the Contractor can use either Method B or Heat-shrink tubing, but most special provisions will require the use of Method B splice only.

Method B Splice

Step 1: Strip insulation

Step 2: Crimp wires with a butt type crimp.

Step 3: Coat splice area with approved sealin material and allow to d

Step 4: Apply 2 layers of rubber splicing tape.

Step 5: Apply 3 layers of vinyl tape, half lapped.

Step 6: Coat entire splice with approved sealing material and allow to dry.

Heat-Shrink Tubing Splice

Step 1: Stripinsulation

Step 2: Crimp wires with a butt type crimp.

Step 3: When 3 or more conductors are spliced together, coat each conductor with mastic.

Step S: Shrink tubing with a heat gun. No open flame torches allowed.

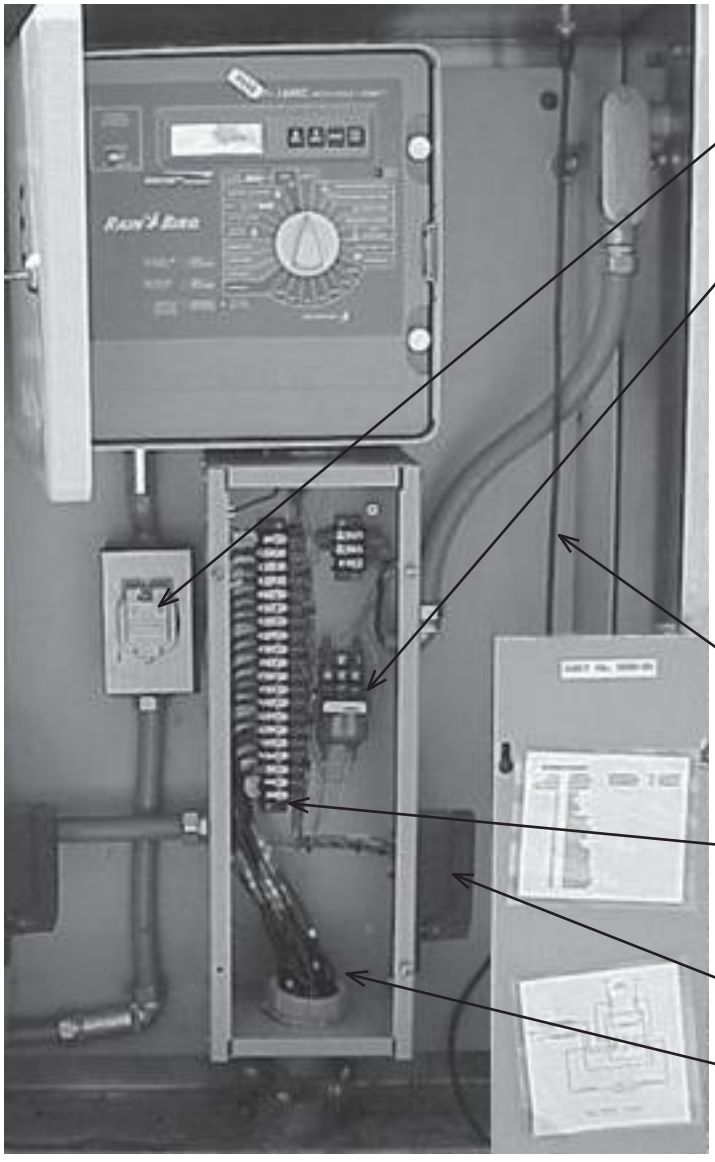
Step 6: Brush ends and seams of heat-shrink tubing with electrical insulation coating. (ScotchkoterM)

Step 4: Wrap the conductors with polyolefin heat shrink tubing (medium to heavy weight, 3 to 1 shrink, containing an adhesive mastic inner wall). Tubing shall overlap conductor installation by at least 1 %" after shrinking.

2-3.10 Electric Automatic Irrigation Components

Irrigation Controllers (IC)

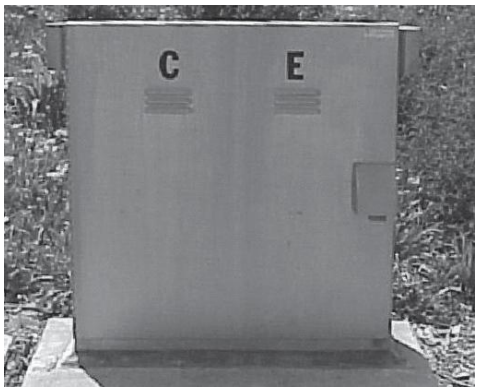
The irrigation controller (IC) is a fancy name for a timer to supply low voltage to activate the RCV at a set time, for a set period. They are identified by a letter and the number of stations that they will control. The controllers may operate on 110-volt electrical circuits, batteries, or solar power. Irrigation controllers are placed inside heavy-duty metal enclosures bolted to concrete pads.



Irritation Controller Cabinet (Inside)
Control "E" has 16 stations.

- On/off switches (one per each controller)
- Control Relay, required when 2 or more controllers operate the same master remote control valve (RCVM).
- Rain gauge (not shown, located on the outside of the cabinet) to stop the controller from operating any of the valves during the rain. Functions as an override, and it does not change the program of the controller.
- Antenna lead for a valve actuator system if required by the special provisions.
- Terminal strips with open ended crimp terminals on the low volt conductors.
- Valve Actuator Connector
- Low Voltage (LV) conductors, a bushing is required to protect the wires coming up through the conduit.

There are three (3) main types of controller systems that meet State specifications: Weathermatic (Valcon), Rainbird and Rainbird Maxi Con.



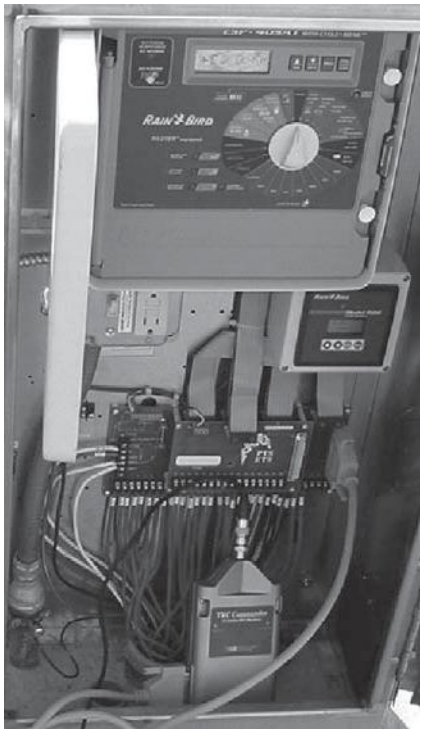
They are usually pre-wired in the controller cabinets before delivery to the job site. So, only the electrician hooks up the 110 volt service and the Landscape crew attaches the low volt conductors to the terminal strip.

Cabinets are stainless steel and pictured is a single cabinet with 2 controllers inside: "C" & ~~"E"~~

Operation

After the IC is programmed, it turns the RCVs on and off to allow watering (irrigation) to satisfy the plant needs for each zone of planting. Some valves and sprinklers will water ground cover areas, while other valves and sprinklers will water trees and shrubs. Each zone will have different requirements, meaning different frequencies and running times to get the proper amount of water to the plants at the proper times. Ground cover plants need frequent short term (shallow) watering while trees and shrubs need infrequent long term (deep) watering. The IC must be able to perform these functions of different start and station run times and different days for the various valves to operate. This also includes turning on the RCVM and any BP, if required. Other functions include a rain sensor and value actuator components. A rain sensor will shut off the system during rain periods when the controller is programmed to operate.

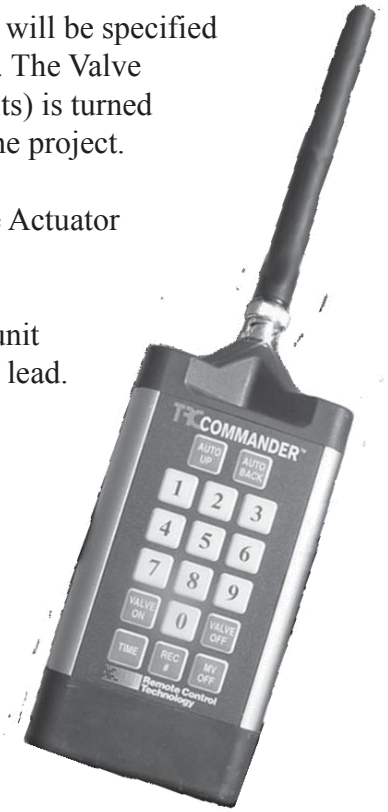
Valve Actuator System



Valve actuator system allows one person to test and verify that the system works. These will be specified in the special provisions if required. The Valve actuator system (hand and slave units) is turned over to Maintenance at the end of the project.

Right Picture: Hand Unit of a Valve Actuator System.

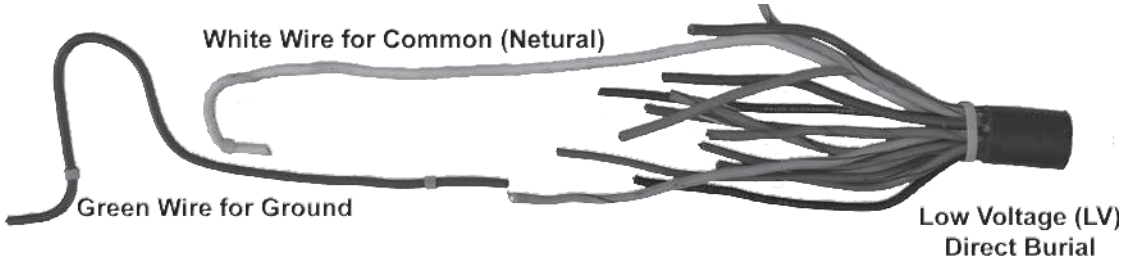
Left Picture: Valve Actuator Slave unit attached to a controller and antenna lead.



Low Voltage (LV) Conductors

Low voltage (LV) conductors are electrical wiring with a current of less than 50 volts. Wiring plans and diagrams of the irrigation system shall be submitted not less than 30 working days prior to the installation of any electrical materials and shall be:

- Reproducible.
- Same scale as the project irrigation plans.
- IC manufacturer written approval.
- Show wire and conduit sizes.
- Show wire routes between electrical components.



Conductors must be rated for direct burial and the insulation must be:

- 56 mils (1.4mm) for conductors No. 10 and smaller
- 70 mils (1.8mm) for conductors No. 8 and larger.

Reference *Standard Specifications* Section 20-2.05

Low voltage (LV) conductors may be identified by a solid color or of basic colors with permanent colored stripe insulation. If color coded conductors are not used, then non-spliced wire is marked with "C" clips in the pull boxes. The color of the conductors shall be uniform from any one controller to its valves. Neutral conductors shall be white and green shall be ground. White or green shall not be used for control conductors. Coding is very important in operating the system, especially correcting or changing the order of operation, and finding and correcting malfunctions.

Low voltage (LV) conductors are buried directly in the ground without conduit, except when:

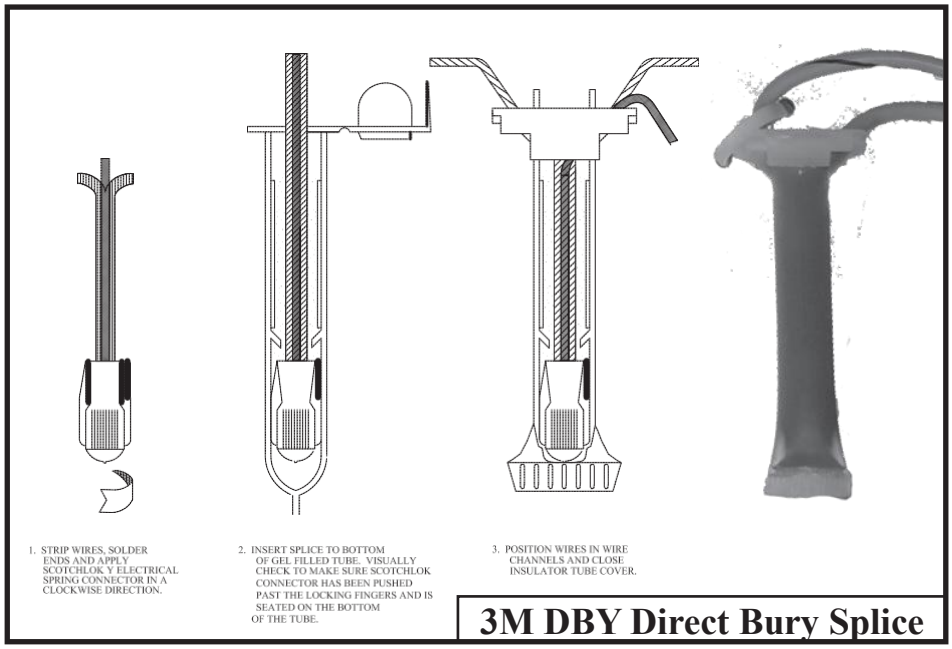
- Surface mounted (PVC conduit)
- Installed in or on bridge structures (rigid steel conduit)
- Installed under paved areas (PVC conduit, except if installed by jacking or drilling, then rigid steel conduit)
- Installed in irrigation conduits (PVC sprinkler control crossover)
- Placed in concrete (rigid steel conduit)
- Required by special provisions for high rodent areas (PVC conduit)

Where conductors are installed in the same trench as supply lines, the conductors shall be placed at the same depth as the pipe. At other locations the conductors shall be installed not less than 12 inches below finished grade and located at least 4 feet from curbs, dikes and paved shoulders. Low voltage (LV) conductors installed in a trench, and not in a conduit, are wrapped together with electrical tape at 5-foot intervals.

Armor clad wire should be used in areas of high rodent activity and usually between BP controls and FS to provide mechanical protection and false signal initiation. Reference *Standard Specifications* Section 20-2.05B

In the industry, there are three common types of splices for low voltage conductors, not all are allowed in every district, check the special provisions.

- Unless changed by the special provisions, heat-shrink tubing splice is the only approved splice per the Standard Specifications.
- DBY Direct Bury Splice are about as "fool-proof" as possible.
- Epoxy Bags are not used as much. If not properly mixed, by squeezing, the material will not harden and provide the proper seal. If they do not harden within a day they need to be replaced



Epoxy Bag Splice

NOTE:

When temperature is below 50° F (10°C), keep resin in a warm place prior to mixing (for example, in an inside pocket next to the body).

1. Thoroughly clean and dry the surface of the substrate to which the material is desired to bond.
2. Remove guard bag, using caution not to damage inner bag.
3. Grip both edges of bag at the center barrier (FIG. 1) and wrinkle and flex the bag across the barrier. This will weaken the barrier.

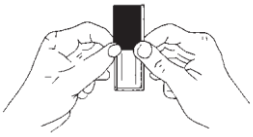


FIG. 1

4. Squeeze the clear side of the resin, forcing the resin through the center barrier.
5. Mix thoroughly to a uniform color by squeezing contents back and forth 25-30 times.
6. Squeeze resin to one end of bag, and cut off other end. (FIG. 2)

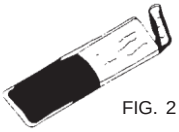


FIG. 2

7. Slowly insert connection into sealing pack until it fits snugly against the opposite end. (FIG. 3)

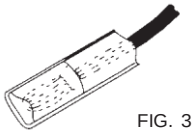


FIG. 3

8. Wrap open end of bag with Scotch® Super 33+ Vinyl Electrical Tape and position the taped end up until resin gels. (FIG. 4)

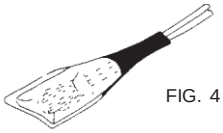
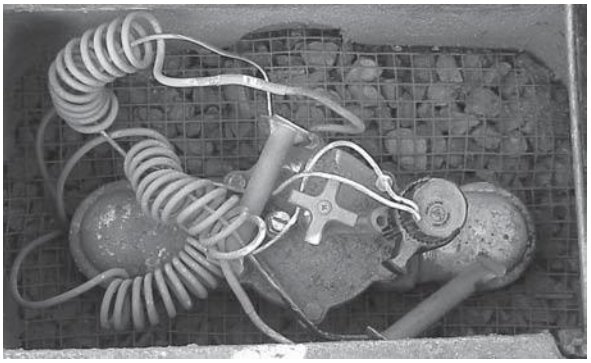


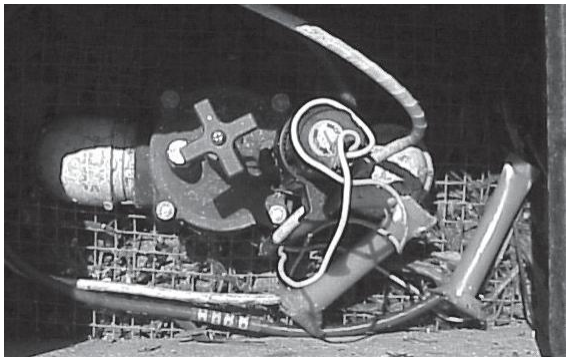
FIG. 4

Splices shall be made only in pull boxes or valve boxes.

Conductors in irrigation controller cabinets shall not be spliced. Temporary splices used for testing valve circuits shall not be used as permanent splices. All permanent splice connections shall be made with freshly cut and skinned conductors.

Meager test the resistance of the wires to check if any wires or splices were damaged or improperly done during installation. This test is usually performed at the controller.





Reference *Standard Specifications* Section 20-2.05

Valve & Low Voltage Electrical Pull Boxes

Low voltage pull boxes are installed the same as valve boxes. See *Standard Plans* H7.

At least 2 feet of slack shall be left for each conductor at each pull box.

- Direct burial wire is flexible and by using 11+ coils around a 1/2" pipe, equal to the 2' of slack, keeps the box neater.

- Armor clad is harder to coil, so just leave a big coil in the box.

Reference *Standard Specifications* Section 20-2.01B(5).

Low Voltage (LV) Wiring - Inspection Check List

- Wiring Size
- Wiring Identification
- Proper Splicing
- Taped w/Electrical Tape @ 5' intervals in trenches
- 2' Slack @ Pull Boxes & RCVs
- LV Pull Boxes every 500'
- LV Pull Boxes at irrigation conduits

2-3.11 System Tests

The testing of the irrigation system is important to ensure that new planted material will be watered properly and that irrigation systems will not have to be repaired or adjusted through the plant establishment period (PEP) and beyond.

Pressure Tests Reference *Standard Specifications* Section 20-2.01A(4)(b).
For the pressure tests, the main, laterals and risers (capped) are installed and the trenches remain open. Pressure tests are either:

Method A: 125 psi for 1 hour supply side, max 5 psi drop (Irrigation conduits must use this type).

Method B: water pressure for 8 hours supply side or for 1 hour lateral side …"full pressure from the source…"

Conductor Testing Conductors are tested with a megohmmeter (megger), which is a small hand-operated or battery-operated generator, which usually generates about 500 volts. Conductors are tested for:

- Continuity for each circuit
- Ground for each circuit
- Insulation resistance for each circuit

Functional Testing Reference *Standard Specifications* Section 20-2.01A(4)(d).
Functional Test occurs after every component of the irrigation system has been installed.

One Cycle: The controller automatically starts on the day and time selected. Starting with station 1, run station 1 for its pre-selected duration, shuts off and proceeds to station 2, repeats, station 3, etc. till all stations have operated. The station sequence must match the contractor's colored plans.

Testing Cycle time: Stations do not need to operate for their full duration, but sufficient time to tell that the laterals and all sprinklers on the station (valve) are operating at the intended pressure. Suggested durations for testing are:

Overhead Spray 20-50' Radius: 3-5 Minutes Overhead Spray 5'-15' Radius: 10-15 minutes Individual < 4' Radius: 20-25 minutes.

The rain sensor is checked by running one of the stations again and pouring water over the sensor to see if the station will shut –off.

RCV Opening/Closing: As the valves turn on and off, check to see that they are slow closing.

The sprinklers —slow down" and no –water hammer" occurs when they shut off.

Water Hammer results when water that is flowing through a system shuts off too quickly. The inertia of the moving water slams against the valve (or port) that shut off with a shock wave resulting in an audible –bang" of the water in the system. Water hammer can easily break PR200, even PR 315, pipe despite its normal operating pressure of 30 – 60 psi. Thus the reason for regulating and adjusting the flow through the control valves are to slow down the flow and prevent damage to the system components when shut off occurs.

On systems immediately adjacent to one another, the second station's (valve) sprinklers may start before the first station's (valve) sprinklers completely shut off.

Adjust RCV Flow: As the valves open and the sprinklers start to operate, check the flow. If the valve is too wide open the sprinklers may be –misting" rather than spraying onto the

ground. If not open enough, the sprinklers will "dribble" and not throw water to the radius called for on the sprinkler schedule. Now is the time to use the Flow Control Handle to "adjust" the flow for each station (valve) to the proper setting.

Sprinkler Pattern Coverage: Once the flow control is set and as the sprinklers are operating you check the ground again to see that the proper radius is being thrown from the sprinklers.

2-3.12 Review Questions

1. What type of backflow preventer is use on State landscape projects?

   _____

2. What type of pipe is installed between the water service and the backflow preventer?

   _____

3. Supply line should be how far behind the shoulder? _____

4. Supply line should be how deep? _____

5. Sprinklers should be how far behind shoulders? _____

6. What are the low voltage wiring items to check (7)?

   _____ _____

   _____ _____

   _____ _____

   _____

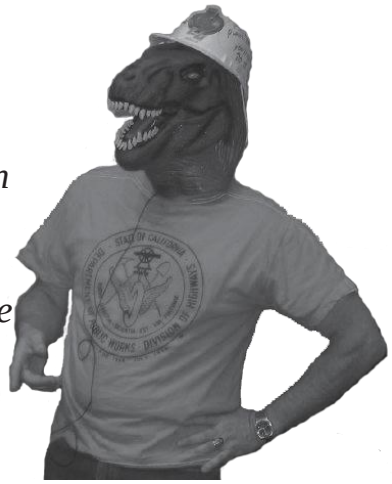
7. Must controllers be capable of manual and automatic operation? _____

8. When shall conductors be color coded according to controller?

   _____

"Thou shall wear thy seat belt at all times when in the state vehicle and wear thy hard hat and vest when on the job site, nor shall thy be under the influence of any illegal substance or be in excess of any legal limits"

T. Rex, Resident Engineer



Back to T of C

2-4 Planting

No planting shall be done in any area until:

- Area is prepared in conformance to specifications and presents a neat and uniform appearance, grading, weed clean-up, etc.
- Irrigation system is installed and checked for coverage to the satisfaction of the Engineer prior to planting.

2-4.01 Preparing Planting Areas

Reference *Standard Specifications* Section 20-3.03C(2).

Review the limits of planting areas with the Contractor (cultivation limits, distances from edge of pavement and fence lines for trees and shrubs).

Cultivation

Planting areas to be cultivated will be designated in the special provisions or show on the project plans. Outer limits of cultivation areas shall be 12 inches beyond outer rows. Till the ground t a loose condition to a depth of 6 inches and soil clod size of 2 inches or less.

If soil amendment is to be incorporated into cultivated areas; make sure the Contractor spreads the amendment at the proper rate and mixes it in thoroughly.

After cultivated areas are completed, no rubber tired equipment is allowed. If compaction results from contractor's equipment, then it should be re-cultivated. Cultivated soil must be loose at time of planting.

Rock Removal

Rock and debris encountered during cultivation or plant hole excavation are brought to the surface at the Contractor's expense; disposal of rock and debris is paid for as extra work on a contract change order. Use removed rock in the job limits as energy absorbers to prevent erosion rather than haul away and pay dump fees at extra work.

Germinate Weeds

A weed germination period may be desirable; check the special provisions for requirements. Areas to be germinated are watered daily during the period specified in the special provisions (usually minimum 14 day days), to get the weeds to grow. The weeds then can be killed by use of a systemic (Roundup) pesticide spray prior to planting.

Plant Layout

The Contractor provides the manpower and materials for plant layout and you, the inspector, directs the plant layout in accordance with the planting plans. Plants are commonly marked by colored flags; using a different color for each type of plant.

Plant layout is according to the setbacks noted on the project plan sheet, Plant List, or as stated in the *Standard Specifications*.

- Do not plant trees or shrubs within close proximity (8 feet) of overhead type sprinklers, impact, rotary, gear driven, or pop-up sprinkler. When the tree or shrub matures, the sprinkler will be blocked by them.

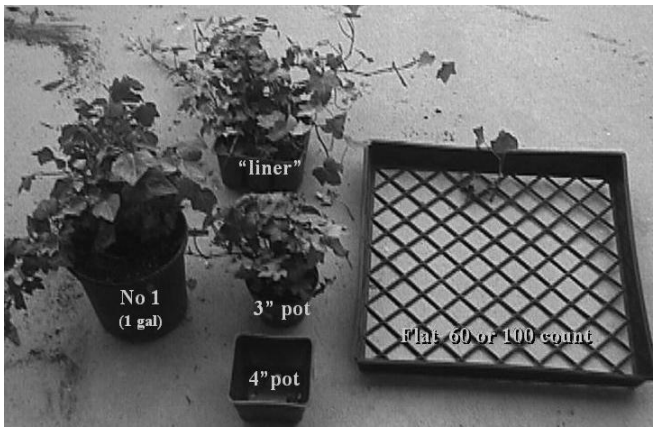
- Try to visualize plant size at maturity. Is the plant size appropriate to area it is being planted in? A plant that is sized at 10 feet on center, planted in an area that is only 5 feet wide will outgrow the area.

- Plant rows are staggered, triangular spacing, so that the landscape areas will be covered faster to reduce weeds and to eliminate erosion by not providing a straight path for runoff.

- Irrigation should be brought to the plant; not plant to irrigation. Individual plant irrigation is placed on the uphill side of plants.

Prepare Holes

Plant holes are dug to fit the root ball or to the diameter and depth stated on the Plant List in the project plan sheets. Any holes dug in cultivated areas must maintain the cultivation. The contractor can dig the holes prior to cultivation or don't use heavy equipment, try a shovel.



Depth of hole to receive the root ball usually depends on the container size. Be familiar with the type of containers designated on the project plan sheet, Plant List.

The purpose of hole preparation is to loosen the dirt and mix in additives; dirt stays in hole. Additives, if stated on the project plan sheet, Plant List, or required by the special provision, is to improve the native soil. Certificate of compliance is required for all additives. Common additives are:

- Iron Sulfate: Lack of results in yellow plants, aka keeps the plants green.

- Soil Amendments: to improve the structure of the soil, i.e. organic materials to improve sandy soils or break up clay soils.

Measure all trucks carrying soil amendment, upon arrival at job site, for payment purposes. Disregard any settlement during transporting; measure what you get at job site. Ensure that soil amendment is prevented from being blown by wind onto private property or traffic lanes by covering stockpiles or watering down. If manure is used make certain it is not stockpiled in planting area.

Install any root protectors, if required by the special provisions to protect the roots from rodents, see *Standard Plans* H4.

To ensure that the soil is moist at time of planting, the plant holes are jetted. To jet a hole, use a piece of galvanized pipe attached to the end of the hose and inserted to the bottom of the hole so that water will flow up and fully saturate the hole. Moisture is added to the hole from the bottom up.

2-4.02 Plant Inspection

Reference *Standard Specifications* Section 20-3.01A(4).

Inspection of plants may be done at nursery site or at the project site before plant material is to be planted. When time permits, go to the nursery with the Construction Landscape Specialist and check out all plant materials. It is advisable to mark the plant lots at nursery (have nursery tag them) to ensure you will get the same plants at job site. Check out plants upon delivery to be sure they comply with contract requirements and that they are the plants previously reviewed. Don't hesitate with problem plants - reject them.

Plants furnished by the Contractor shall be healthy, shapely and well-rooted, and roots shall show no evidence of having been restricted or deformed at any time. Plants shall be well-grown, free from insect pests and disease, and shall be grown in nurseries which have been inspected by the State Department of Food and Agriculture and have complied with the regulations thereof.

Invoices

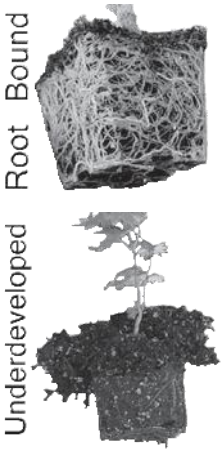
Review invoices to verify that the plants delivered are the contract specified type, including number and size according to the plant list. Check to make sure that plant material comes from a commercial nursery. All commercial nurseries must have regular inspection by the County Agriculture Department and they have a license number on the invoice. Plant material must have a certificate of compliance from the nursery. If the plant material comes from outside the county, it must have an inspection stamp from the county agriculture department (i.e. infestation-free). The exception to requiring invoices is *Edule* (ice plant) cuttings, that are picked by permit on state property. Be sure to get a copy of the permit.

Identification Tags

Identification tags are required on all plants identifying the plant by species and variety. Make sure the plant is the variety called for on the project plans.

Root System

Root condition of plants furnished by the Contractor in containers will be determined by removal of earth from the roots of not less than 2 plants or more than 2 percent of the total number of plants of each species or variety.



- Root bound plants will survive, but, will not develop a healthy root/support system—blow over in wind, will not grow to normal expected size, and be short lived long enough to get through a 3 year PE, but not much more and die long before reaching normal size. Plant will ~~"e~~choke itself" as roots will squeeze off flow of nutrients.

- Plants with insufficient roots will not be able to pick up the nutrients/water available in the hole, sized for the pot, and may die. Should have remained in the nursery to develop further where its nutrients/water is feed directly into the pot.

- Plants that are of the proper size and height are healthy, shapely and well rooted. The root system is evenly developed. Make sure that the plant has the proper size of foliage for the pot and that there is no evidence of the plant being cut back or pruned (big stem).

Disease and Pest Free

The plants must be disease and pest free. Review Section 2-1.04, Pest Control, of this student manual for common plant pests. Some of the common diseases are:

- Oleander gall is caused by the bacterium Pseudomonas syringae pv. savastanoi. The bacterium is systemic in the plant, and causes galls to form on flowers, leaves and stems. The bacterium must have a wound site to enter the plant, and freeze damage to flowers in early spring after a rain is a common circumstance under which infection takes place. The bacterium enters through the damaged flowers and galls form on the inflorescences. Severe infections are most common after a cool wet spring.

- A Lerp Psyllid invasion will eventually result in the plant's death. The psyllids, small insects that suck sap from leaves, are, like the eucalyptus, native to Australia. They cause leaf damage, which may stress trees and make them susceptible to fatal attack by other insects. Psyllids also produce a sticky substance called honeydew, which drops to the ground on cars and sidewalks.

- Pulvinaria species (Ice Plant Scale): There are more than a dozen different species of pulvinaria. They are either fungi virus or insects.

2-4.03 Planting Work

Reference *Standard Specifications* Section 20-3.03.

Make sure Contractor waters and cares for all plants properly during storage prior to planting. Container plants in ground cover areas should be planted first, to limit walking in planted ground cover areas.

Trees, Shrubs, and Vines

Water: Contractor should thoroughly wet plants prior to transporting to planting area.

Nursery Stakes: Contractor shall remove all nursery stakes from container prior to transporting to planting area. If left in, they tend to break root system apart during handling and/or planting.

Delivery: Deliver only as many plants to the plant area as can be planted that day. Roots must be kept moist at all times. Remove plants from containers prior to planting.

Containers should not be removed until just prior to placing plant in plant hole, Careful removal of plant from container is necessary to prevent breaking the root ball.

Place in Hole: Roots of plants should not be exposed to air any longer than is absolutely necessary. Ensure that they are planted and backfilled as fast as possible. Ensure that plant crown (base of trunk) is not buried under backfilled soiled as this might kill the plant. The plant is placed 1 inch above the ground.

Too high: If the root ball is exposed (2 inches are more), it will dry out and there will be loss of plant support, results in death.

Too Low: If the root ball (level of soil from original container) is plant to low it will suffocate and die. Accumulation of moisture and soil leads to crown rot (death).

Sprinkler: Check the sprinkler schedule for the distance specified of the sprinkler head from the plant.

Construct Basin: Basins hold water to get the plants well established and get the roots to spread beyond the original root ball and dug hole. See *Standard Plans* H3.

Type I: Basins are 3 inch deep around the plant or behind the plant if on a slope. Usually used for smaller (No 1 and No 5 containers) plant material. Smaller plant material requires less water to start growing and become established.
Type II: Basins are 3" deep around the plant or behind the plant if on a slope and they have an additional 3 inch berm to increase the holding capacity (mulch & water) of the basin. Usually used for larger (No 15 and up containers) plant material. Larger plant material needs additional water to start growing and get established.
Type III: The basin is constructed the same as a Type I, only it is a half circle because it is against a fence or wall.

Stake Plants: See *Standard Plans* H3.

Tree Staking

- Staking should be perpendicular to prevailing wind, Stakes shall be 2 inch nominal (1½ inch) size round or 2 inch x 2 inch nominal (1½ inch x 1½ inch) size square Redwood or equivalent (1 1/4" lodge pole pine). To check the pole strength; swing the stake like a baseball bat against the ground, it should not break.
- The tie is 1 inch wide and 10 mils thick. The ties are installed at the lowest point to support the plant. Each tie forms a figure 8 for flexibility and to allow the tree to grow and makes 1 ½ turns on each stake. The tie is 2 inches down from the top of the stake.

Vine Staking: 2 each of 1 inch x 1 inch x 18 inch stakes are required. Tie material is the same as for trees.

Fertilize: Check contract requirements for timing and method of applying commercial fertilizer. Contractor must notify the Engineer 5 days prior to application of fertilizer. You should save the bags in order to check the ratios and quantities. Fertilizer is applied with a cyclone spreader for ground cover and measured doses for trees, shrubs and vines.

Water*:* Thoroughly water immediately after planting. Apply water until the backfill material around and below the root ball is thoroughly saturated. When watering is done with a hose, a water disbursement device or pressure reducing device is required. Under no circumstance shall the full force of the water from the end of the hose be used.

Mulch*:* Mulch retains moisture in root zone, acts as a weed barrier, and aids in erosion control. The depth of much will be as stated on the project plans or in the special provisions. Excessive mulch is not better. If too deep, vehicles can get stuck and it causes crown rot on plants. Consider adding more mulch toward end of a 3 year plant establishment to maintain the desire depth, if funding is available.

If required by the special provisions, apply a preemergent under the mulch to prevent weeds growing up through the mulch.

Foliage Protector: Install a foliage proctor if it is required by the special provisions to protect the foliage from rodents.

Remove Containers: Until the nursery containers are picked up and the area has a neat appearance, Plant Establishment cannot start.

Count Plants: Plants are grouped and paid by size, regardless of variety.

Group A is No.1 (1 gallon) - Individual Count
Group F is flats or cuttings (ground cover) - Density Count
Group U is No. 15 (15 gallon) - Individual Count

Fertilizer: What's in the Bag?

All fertilizers are labeled with three numbers, giving the percentage (by weight) of nitrogen (N), phosphorus (P), and potassium (K). A 100 pound bag of fertilizer labeled 0-20-10 has 0 pounds of nitrogen, 20 pounds of phosphorus, 10 pounds of potassium, and 70 pounds of filler. Filler is added to make the fertilizer easier to spread and to reduce the likelihood of burning plants with too much fertilizer. A fertilizer may contain secondary nutrients or micronutrients not listed on the label.

Nitrogen (N) is a primary component of proteins and is a part of every living cell. This nutrient is usually more responsible for increasing plant growth than any other nutrient. Shortages can cause slow growth, reduced leaf size, yellowing, short branches, premature fall color and leaf drop, and increases the likelihood of some diseases. An over abundance can cause excessive shoot and foliage growth, reduced root growth, low plant food reserves, and increased susceptibility to environmental stresses and some plant diseases.

Phosphorus (P) plays a role in photosynthesis, respiration, energy storage and transfer, cell division, and cell enlargement. It promotes early root formation and growth, and the production of flowers, fruits, and seeds. Many of our urban soils are low in phosphorus. Cultivated farm land often has a high phosphorus level from years of fertilization. In these cases, the addition of more phosphorus is not going to increase yields and can potentially harm the environment.

Potassium is involved in many plant growth processes; it is vital to photosynthesis and helps regulate water in plants. Potassium fertilization helps plants overcome drought stress, increases disease resistance, and improves winter hardiness. Potassium can be leached through the soil by water, but not as quickly as nitrogen.

Ground Cover

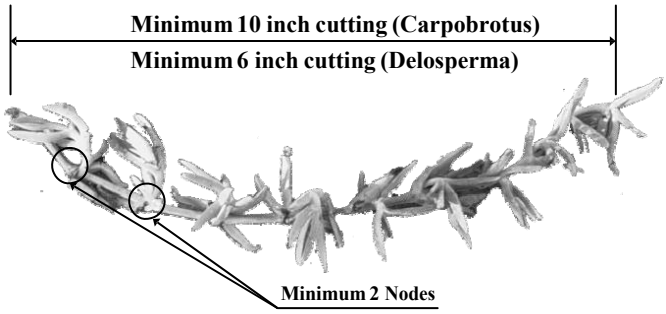
The area to be planted with ground cover is watered with the irrigation system one station (remote control valve) at a time until the soil is moist. The plants are planted at ground level and at the spacing shown on plant list sheet. Plant rows are staggered as described previously in Plant Layout. Plants are from liners, flats, or cuttings. Liner and flats are planted at grade level and cuttings (ice plant) as noted below.

Fertilize if required and water immediately after planting. Pick up all nursery containers. To count ground cover, you do a density count on 3% to 5% of the area. To do a density count, use a fiberglass tape to make a 10 foot square. Count the number of plants within the square. Quantities should be approximately:

- 96 to 100 plants planted 12 inches on center
- 40 to 46 plants planted 18 inches on center
- 20 to 25 plants planted 24 inches on center

Ice Plant

Edulis (Ice Plant) cuttings are by permit from existing State landscape areas. This is a dual benefit to state: cheaper prices for plant material and an existing area (under permit, so we choose the area) will be thinned as needed. Edulis cuttings must be planted not more than 2 days after cutting.



Delosperma is smaller, lighter green in color, slower growing, but a more attractive abundant red flower. Cuttings are 6 inches in length and not less than two nodes are planted 2 inches below grade.

Carpobrotus (pictured) is larger, dark green, more abundant, faster growing, but very sporadic purple or white flowering. Cuttings are 10 inches in length and not less than two nodes are planted 4 inches below grade.

2-4.04 Review Questions

1. Who directs where the plant locations are to be placed? _____

2. Plant locations for trees and shrubs shall be at what distance from an impact, rotary, gear driven or pop-up sprinkler? _____

3. Rocks brought to the surface during soil preparation and not shown on contract plans shall be removed at whose cost? _____

4. Prior to planting, what must be completed? _____

5. What are 4 things to look for in plant inspection?

_____ _____

_____ _____

6. Must soil be moist prior to planting? _____

7. When holes are augured or drilled, the holes must be moistened in what manner?

_____

8. Do nursery stakes have to be removed from the plant material? _____

9. When planting ground cover, what do you look for (8 items)?

_____ _____

_____ _____

_____ _____

_____ _____

When asked by the contractor (Newbie, Snaky, or Argumentative): "What do you want done?" Your first answer shall be: "What do the project plans and special provisions say?"

T. Rex, Resident Engineer

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Chapter 3: Plant Establishment

3-1 Before

At this point, all the knowledge of how to build a landscape project has been covered. The Plant Establishment Period (PEP) is just applying all that you have learned and requiring the contractor to keep the project healthy, clean and neat.

Ask Landscape Maintenance and Landscape Architect if they wish to review project and make comments or recommendations. The Construction Landscape Specialist should be present if review takes place.

3-1.01 Irrigation System

- Make certain that sprinklers provide 100% coverage and the functional test has been satisfactorily completed.
- Automatic sprinkler systems are functional and operating on automatic cycle.
- Contractor develops and provides a copy of the watering schedule.
- Contact the State Plumber (Maintenance Branch) to check backflow preventers yearly.
- Make sure all changes are shown on ~~"as~~-builts."

3-1.02 Planting Areas

- Thoroughly check all areas for dead plants - have them replaced and remake plant basins if necessary.
- The contractor should spray the project with pre-emergent (prevents the germination of any seed, but not harmful to plants) in order to minimize any weed growth during the PEP.
- Entire project should be clean and present a neat appearance. All dead weeds, plants and trash (including wire and rebar) should be removed prior to start of plant establishment. Work should be completed on a project as if ready for job acceptance.

3-1.03 Roadside Clearing

Roadside clearing is from the start of the project until the start of the PEP. It is continuous, not a one shot operation.

- Chemical weed control program should be in full operation.
- Weed growth should be controlled within specified limits throughout project limits.

3-2 During

3-2.01 Correspondence

Start of PEP
At the start of the PEP a letter and a copy of the Weekly Statement of Working Days (WSWD) is sent to the Contractor to notify them of the first day of the PEP. Be sure to reference the *Standard Specifications* and special provisions sections requiring the irrigation system to be operated at all times in automatic mode.

Corrective Work
When corrective work is required, give the Contractor notice and allow 10 working days for correction. The 10 working days are needed in order for plants to be attained and scheduled for planting. If the Contractor fixes all items within the time limit, no further action is needed and there is no interruption in crediting PEP days.

Off PEP
If the Contractor fails to correct deficiencies after the written notice time expires, immediately send a letter and the WSWD stating that PEP is no longer being credited. Continue the WSWDs showing no credit for PEP until the Contractor has made all corrections.

PEP Resume
When the Contractor is off PEP and all corrections are complete, send a letter and the WSWD resuming of crediting PEP.

3-2.02 Requirements

- The watering schedule submitted by the contractor must be reasonable to attain healthy growth; plants will be stunted and not grow in normal manner if sufficient water is denied plants. Sometimes the contractor will limit watering to reduce weed growth.

- Unsuitable plants are replaced in accordance with the *Standard Specifications* replacement schedule. Up-sizing of the plant is often required in order that the plant growth size is maintained. The 10 days allowed for repair of facilities stated in the *Standard Specification* include plants.

- Special provisions will identify degree (height, locations, etc.) of weed maintenance. Special provisions may require additional preemergent to be applied before the end of the PEP. Why are weeds controlled?
  - Safety and fire hazard.
  - Plants must compete with the weeds for water, nutrients, sunlight, and growth.
  - Noxious weeds are mandated removal.
  - Nuisance: Unsightly and complaints from the Public.

- Rodent control is a continuous effort. Check for rodent damage: gophers, ground squirrels and rabbits can become a very big problem if not controlled properly.

- Pest control spraying, don't forget Form LA-17.

- Trash pickup, keep the area neat and clean.

- Trim ground cover outer edges as needed to maintain setbacks from fences, shoulders, plants, and ditches.

- Fertilize as required by the special provisions.

- Maintain basins as shown in the Standard Plans or project detail sheets to keep water in the root zone.

- Some species may require pruning to maintain the intent of the plant use as shown on the plant list. If what is normally a tree is listed as a shrub, then it has to be topped to force it to be a shrub, or vice versa.

- Additional staking or removal of the stakes may be required as the plants grow. Bigger tree supports may be needed or the stakes may not be needed at all.

- Irrigation System in the automatic mode. When you do make any changes during PEP be sure that plans are corrected before lamination and "As-builts" and Landscape Maintenance Pending file (Red File) sets are corrected also.

- Testing of Backflow Preventers in accordance with Section 20-2.03A(4) of the *Standard Specifications* and should be once per year by certified Tester (AWWA /Local Code).

3-2.03 Inspection

Inspect to ensure the contractor is complying with the requirements of PEP on an as-needed basis or as listed in the special provisions as bench mark inspections. Inspections may be daily, weekly or the specified bench marks.

Get out of the vehicle and walk the job site. Be hands-on! Document all observations during PEP inspection and review at bench mark inspections with the contractor. Portions that were trouble spots during construction may require more attention during PEP. An area prior to roadside clearing that had no weeds has a potential for no or slow plant growth.

Review all the plants on the low flow irrigation systems for condition indicators for proper watering, i.e.: are the leaves turning yellow or brown, or are curling. This can indicate clogged emitters or insufficient time of watering.

Contact the Maintenance Landscape Specialist and Landscape Architect sometime during PEP and request they review the project with you. On projects with one-year plant establishment periods, a 6-month review and 11-month review would be appropriate.

Sometime during PEP, if an automatic irrigation system is part of project, Landscape Maintenance should be requested to send a person out to become familiar with the operation of the system.

3-2.04 Final Walk Through

Walk through the job site with Maintenance. Do this 20 working days prior to the calculated end of PE to allow 10 days for correction and 10 days to make sure the repairs last.

Irrigation System

- All components of the irrigation system should be in good working order. Check that:
    a. All sprinklers are in place, working and in adjustment.
    b. All features of automatic controllers are in working order, including the ones Contractor hasn't been utilizing (i.e. pump start when no pump was needed, but may be needed in the future).
    c. All valves are properly adjusted for flow rate.
    d. Valve boxes have covers and cover markings.
    e. Irrigation conduits marked.

- Contact the State Plumber (Maintenance Branch) to check backflow preventers two weeks prior to acceptance.

- Make sure that Maintenance has had an opportunity to become familiar with the irrigation system (location of valves, backflow preventers, etc.) even if it is not automatic system.

- Laminated irrigation and wiring plans for each controller with a sticker showing warranty time frame are in controller cabinet and an additional copy (complete set of all controllers) provided to be included in the Landscape Maintenance Pending File.

- RICS Systems will have requirements in the special provisions for training of Maintenance personnel prior to final acceptance.

Planting Areas

- All plants are healthy.
- Plant basins are in proper shape.
- Clean all areas of trash and debris.
- Check entire project that all pests (Bermuda grass, gophers, weeds) are under proper control.
- Be certain all required fertilizer, iron sulfate, herbicides and extra work have been completed.
- Check for additional ground cover edging and tree pruning.

Hardscape

Stamped concrete, MVPs, Shoulders, Rock Blankets, Slope Paving.

3-3 Project Completion

3-3.01 Correspondence

When all PEP work is done, send the Contractor a letter and the final WSWD.

3-3.02 Landscape Maintenance Pending File

- As-built Plans (by RE): Keep 2 sets of plans for as-built and correct plans as changes occur. Submit a set of red-lined as-built to the district office and place 2nd set in Landscape Maintenance Pending file.
- Spray Reports (LA-17)
- Pertinent CCOs (Planting, Irrigation, etc.)
- Unusual problems reported during construction.

- Submit service requests for water meters to Maintenance (contact area Maintenance Superintendent for billing address), about three weeks prior to acceptance. Be sure service is not turned off. Have meter read on or about completion date and closing billing sent so as to finalize construction costs.

- Equipment Check SPs in case there are additional irrigation units (sprinklers, calve keys, valves, etc.) or special equipment (valve actuator systems - hand held remote control units) to be turned over to the Maintenance Branch.

- Manuals: controllers, booster pumps, RICS, valve actuator systems.

3-4 Review Questions

1. When spraying a pre-emergent chemical, is a dye required? If so, what kind?

   _____

2. What are the 2 types of plant establishment?

   _____ _____

3. What are the 5 important correspondences to contractor for/during plant establishment? _____

   _____ _____

   _____ _____

4. How often must backflows be tested? _____

5. When project is completed, what 3 items are placed in controllers?

   _____ _____

   _____

When the contractor argues that.."I've been doing this for x years…, or …on the other job I did xyz…"

Your first response shall be:
"I do not know what those projects were about, SO on THIS project we'll follow the project plans and specials (and any CCO's WE have written)…"

T. Rex, Resident Engineer

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References

Glossary

Annual– is a plant living one growing season.

Backflow Preventer Assembly (BPA) – is a device that will allow water to flow in only one direction, it must be installed above ground for proper operation. 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. They are rarely required for reclaimed water sources-check plans and special provisions.

Ball valve (BV)– is a valve that opens by turning a handle attached to a ball inside the valve. The ball has a hole, or port, through the middle so that when the port is in line with both ends of the valve, flow will occur. When the valve is closed, the hole is perpendicular to the ends of the valve, and flow is blocked. The handle or lever will be in-line with the port position letting you –see" the valve's position.

Bark– is the outer woody layer of the plant stems. Bark is composed of two layers, the outer and inner bark.

Biennial– is a plant living two growing seasons.

Booster Pumps (BP) – are used when the static pressure supplied at the source is not sufficient to fully operate the entire or certain sprinklers of the irrigation system. Pumps are usually powered by 110/220 v services but may be powered by individual diesel or gas powered generators.

Bud– is an undeveloped stem or branch on a plant.

Bulbs– are short underground plant stems filled with food. Chlorosis– a loss of green color in plant foliage due to lack of iron. Conifers– are cone bearing trees, the Gymnosperms.

Deciduous– a plant having leaves that are shed at the end of that particular plant's growing period.

Electrical Service Points– are an existing electrical service (street lighting) or a new electrical service to provide power for irrigation controllers and pumps

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, gallons per hour (gph), 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. Emitters are installed on the lateral supply line.

Evergreen – a plant that is never without foliage.

Family – In plant classification, the breakdown between genus and order. Families consist of Genera.

Fibrous – A mass of fine plant roots.

Flow Sensor (FS) – a mechanical device installed in the water supply line to measure flow and pressure. It is necessary to be used in conjunction with booster pumps and controllers to ensure proper operating pressure for the sprinklers and also provide protection for the booster pump. It will shut off the pump if insufficient water is flowing to prevent the pump from —burning up".

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.

Gate Valve (GV) – is a manually operated valve to shut off water to allow repairs or modifications to the irrigation system.

Genus (plural Genera) – In plant classification, the breakdown between species and family.

Genera consist of species. Habitat – The place where a plant grows.

Herbicide – A phytotoxic chemical used for killing or inhibiting (stunting) the development or growth of plants.

Hybrid – A cross between two different but related plant species.

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.

Irrigation Controllers (IC) – is a fancy name for a timer to turn on/off remote control valves (RCV) at a set time for set periods; aka supply low voltage to activate the remote control valves (RCV). They are identified by the numbers of stations that they will control. Stations refer to the number of RCVs that the particular IC will be able to operate. 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.

Irrigation Conduits– consist of conduit and pipe used to carry irrigation water and low voltage conductors under roadways. They can be existing or new installation. They are often installed as part of a highway construction project before the highway landscaping project begins.

Lateral Supply Lines– are pipes that carry water between the remote control valves (RCV) and the sprinklers. Lateral supply lines are only under pressure when the remote control valve is open. Lateral supply lines are usually PVC pipe.

Legume – A plant pod.

Low Voltage (LV) Conductors – 50 volts or less, connect the irrigation controller (IC) to remote control valves (RCVs) and to the pumps. They are either direct burial wire or armor clad wire cable.

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

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. Main supply lines carry water for all valves on that system. Main supply lines are usually PVC pipe, but galvanized steel pipe (GSP) is used between the water meter and the backflow preventer and is used for above grade installations for mechanical protection.

Manual Control Valve (MCV) – a person turns on & off the valve to allow water to flow from the main supply line thru the laterals to operate sprinklers. i.e. gate, ball, etc.

Miscible – Cable of being mixed. Usually refers to liquids. Necrosis – The death of plant tissue.

Node – The place at which a leaf, bud, branch or flower is attached to the plant stem.

Nodule – A small node.

Order – In plant classification, the breakdown between family and class. Orders consist of families.

Perennial – plant growing many years or seasons (lasting three or more seasons).

Phytotoxic – Poisonous or injurious to plants.

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.

Pressure Relief Valves (PRLV) – A preset protection device that opens at a set pressure to prevent damage to the main supply lines.

Pull Boxes (PB) – are used along the length of the low voltage (LV) conductors (wires) at 500 feet intervals from the controllers to the individual remote control valves (RCVs).

Quick Coupler Valve (QCV) – is a manual device installed on the main supply line and used to attach a hose to the irrigation system.

Remote Control Valves (RCV) – control the flow of water to the lateral water supply lines and sprinklers. They open and close when and for what period of time as directed by the irrigation controller (IC). When not operating, they are closed. Remote control valves are usually grouped for ease of maintenance. They also have a manual capability.

Remote Control Valve (Master) (RCVM) – 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.

Rhizome – An elongated underground plant stem.

Rib – In leaves, the primary vein.

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.

Runner – slender plant shoot taking root at nodes from surface or just below surface on ground; a rooting branch.

Serrate – Having a saw-like edge with teeth turned forward. Shrub – Low-growing, woody plant producing shoots at its base.

Soil Amendment– is any material added to a soil to improve its physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure. The goal is to provide a better environment for roots.

Source of Water– is usually from water meters for potable or reclaimed water (may or may not be metered) from an existing underground system, or from wells in outlying areas.

Species – A group of plants that will breed true and reproduce their own kind.

Specimen – A tree that has outstanding characteristics or that serves as a center of interest.

Sprinklers – are a device that applies water in a spray pattern to the soil around plants. The special provisions and the plans (Sprinkler Schedule) specify the sprinklers by type, pattern, material, and operating characteristics. Sprinklers are installed on the lateral supply line.

Stem – Generally, a cylindrical plant structure supporting leaves and flowers, conducting water and minerals and carrying elaborate plant food. Stolon – A plant branch that is low-growing and has roots at the nodes.

Sucker – A rabid-growing plant shoot starting either from the roots or branches.

Surfactant – Material used to impact emulsifiability, spreading, wetting, dispensability or other surface modifying properties.

Taproot – The main central root of the tree, usually extending straight down on a line with the trunk.

Tree – Woody plant with one main trunk and an elevated head.

Tuber– A modified branch, usually underground and for storage of food.

Twig – The ultimate (last) division of the plant branch.

Valve Boxes – a small "vault" usually made of concrete or plastic with steel, concrete or plastic lids. Check the special provisions for the requirement of each project.

Variegated – plants having stripes or blotches, or some color other than the basic color. Variety – A group of plants.

Virus – Ultramicroscopic protein bodies. Their presence in plant tissue may cause abnormal growth.

Water Meter (WM) – 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.

Well Pump– is necessary to get underground water from the aquifer (naturally occurring below ground water) to be used for the irrigation systems.

Wetting agent– A compound which, when added to a spray solution, causes the spray to spread and wet surfaces more thoroughly (a surfactant).

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.

Solution Key

Preface: 1) Functional, Safety, and Aesthetics. 2) Use more water efficient or native plants-- Utilize reclaimed water whenever possible and/or night watering (minimize demand during peak water usage) Use of inert materials, rockscaping, wood chips.--- Provide safe and even distribution. of water w/auto. controllers and RICS. 3) Outdoor Advertising Act; Pesticide reduction; Safe Drinking Water Act; Protection of Endangered Species; Storm Water Pollution Prevention Program. 4) Landscape ONLY Contracts; Roadway Construction Contracts with landscaping included; Landscape maintenance contracts.

Chapter 1: 1) Internal & Pre-construction Meeting. 2) Plant Materials Order, Pesticide Program, Booster Pump, Solvent Cement, Wiring Diagram. 3) Photograph all areas, check field items for: existing plants and irrigation, fences and drainage facilities, signs, markers for irrigation conduit, sterilized areas, stolen type weeds, erosion, gophers, and ground squirrels.

Chapter 2a: 1) Trash pickup, mowing and weed pickup, spraying weed for kill, varmint control. 2) Pre-emergent, Contact, Systemic, Sterilant, Fertilizer, Fumigant. 3) Until the start of plant establishment period.

Chapter 2b: 1) Two - Type 1 and Type 2. 2) Type 1 adjacent to traveled way and w/ pedestrian access. Type 2 in areas 30' from traveled way and w/o pedestrian access. 3) True. 4) Use as energy absorbers (rip rap) within job limits. 5) Slope paving and edge drains are outside the bridge rail limits; Edge Drains are perpendicular to the slopes on the downhill side of bridges on a skew; Edge Drains extend beyond the edge of the bridge rail at the top of slope.

Chapter 2c: 1) Reduced pressure w/ double check valve. 2) Galvanized steel pipe. 3) Minimum of 4 feet. 4) 12" of cover for solvent weld; 18" of cover for ring-type. 5) 6.5' to 8'. 6) a) Wire sizing; b) Wire identification ; c) Proper Splicing; d) Taped w/ Electrical tape at 5' intervals in trenches; e) 2' slack at pull boxes and at splices; f) LV Pull boxes every 500' – Valve Boxes are not included as part of the 500'. g) Pull boxes at sprinkler control crossovers. 7) Yes. 8) When two or more controllers are in the same enclosure and when conductors from different controllers share a common trench.

Chapter 2d: 1) Resident Engineer. 2) 8 feet. 3) If ordered by the Engineer as Extra Work 4) Irrigation system and preparing planted areas 5) Review Invoices, Identification tag, Root System, Disease and Pest Free. 6) Yes. 7) Jetting. 8) Yes. 9) Water before planting, stagger rows, proper depth, proper spacing, fertilize, water after planting, container pick-up, count plants

Chapter 3: 1) Yes, …contrasting color and dissipate in 2-3 days. 2) Type 1 – landscape projects; Type 2 – landscape work w/ roadway construction contract. 3) Begin plant establishment letter and WSWD; Corrective work necessary with time limit for correction; Written Notice of non-credit plant establishment days and WSWD; Resuming of PEP Crediting days and WSWD; Notice of completion of PEP and Final WSWD; 4) Once per year. 5) Laminated irrigation plans for that particular controller; irrigation wiring plans; sticker showing warranty time frame.