

SPECIAL SPECIFICATION

SECTION 02812S

IRRIGATION SYSTEM

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CONSTRUCTION SPECIAL SPECIFICATION

SECTION 02812S

IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Sustainable design conserves and protects our natural resources, water, being an important one of these. Properly designed irrigation systems save water by delivering the appropriate amounts of water, while minimizing evaporation, runoff and overspray. Drought-resistant native plants need only to receive the amount of water they require. They require supplemental water during the first year or two to get established then watering can usually be diminished and in some cases eliminated altogether except during periods of severe drought.
- B. This section covers the requirements for the repair of the existing underground, automatically controlled irrigation system, to include drip systems, bubblers, and spray irrigation for areas delineated on the Contract Landscape Drawings impacted by construction including but are not limited to the following:
- | | |
|---------------------------|--|
| 1. Backflow Preventer | 7. Fittings/Clamps |
| 2. Bubblers | 8. Piping [Poly Pipe or Poly Tubing is not Acceptable] |
| 3. Controllers | 9. Sprinkler Heads |
| 4. Control Wiring | 10. Valves |
| 5. Electrical Connections | 11. All Necessary Accessories |
| 6. Emitters | |
- C. Related Sections: The following sections contain requirements that relate to this Section.
1. Applicable sections of Division 2 – Site Construction.
 2. Applicable section of Division 15, Mechanical.
- D. Perform trenching, excavation, boring, backfilling, sleeving, and compacting as required.

1.02 REFERENCES

- A. Reference publications are listed by the manufacturer's technical data and product literature and are not referred to within the specification.

Drip Irrigation Design for Landscapes, by Joseph Y.T. Hung, Paper Number 88-2066 presented at the American Society of Agricultural Engineers, Rapid City, SD, 1988

Determining Drip Emitter Spacing and Watering Time for Maximum Water Use Efficiency, by Joseph Y.T. Hung, Paper presented at the Irrigation Association, San Diego, CA, 1993

Estimating Water Requirements of Landscape Plantings: The landscape Coefficient Method, Cooperative Extension University of California, Division of Agriculture and natural Resources, Leaflet 21493

Water Use Classification of Landscape Species, (WUCOLS Project), Cooperative Extension University of California, February 1992

Landscape Drip Irrigation Design Manual, by Keith Shepersky, Rain Bird Sales, Inc., 1984

Irrigation Principles and Practices, Fourth Edition, by Vaughn E. Hansen, Orson W. Israelsen, Glen E. Stringham, 1979

Rain Bird Trickle Irrigation Design, First Edition, by Jack Keller, Ph. D. and David Karmeli, Ph. D., Rain Bird Sprinkler Manufacturing Corp., 1975

Turf Irrigation Manual, Fifth Edition, Richard B. Choate

- B. The following publications are referenced in this Section:

1. American Society for Testing and Materials (Latest Edition) – ASTM.

D-1784 Std. Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl (CPVC) compounds

D-1785 Std. Specification for Poly Vinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, & 120.

D-1875 Std. Test Method for Density of Adhesives in Fluid Form

D-2241 Std. Specification for Poly Vinyl Chloride (PVC) Pressure-Rated Pipe.

D-2464 Std. Specification for Threaded Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

- D-2466 Std. Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
- D-2467 Std. Specification for Poly Vinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
- D-2564 Std. Specification for Solvent Cements for Poly Vinyl Chloride (PVC) Plastic Piping Systems.
- D-2774 Std. Practice for Underground Installation of Thermoplastic Pressure Piping.
- D-2855 Std. Practice for Making Solvent-Cement Joints with Poly Vinyl Chloride (PVC) Pipe & Fittings.
- D-3139 Specification for joints for Plastic Pressure Pipe using Flexible Elastomeric Seals.

- 2. National Electric Code.
- 3. Uniform Plumbing Code.
- 4. National Sanitation Foundation.

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: Licensed landscaping and irrigation system contracting firm with not less than five [5] years experience in the type and scale of work required in this Section.
- B. All irrigation work shall be performed by a single firm specializing in this type of work.
- C. Manufacturer Qualifications: Provide underground irrigation system as a complete unit produced by acceptable manufacturers, including heads, valves, piping circuits, controls, and accessories and as specified in this Section.

1.04 STORAGE & HANDLING

- A. Follow manufacturer's recommended procedures in loading, unloading, stacking, transporting and handling of all materials to be used.
- B. Protect PVC piping and fittings from exposure to direct sunlight.

1.05 SYSTEM DESCRIPTION

- A. Sandia landscape irrigation system is computer controlled from a central location by a CALSENSE control system. The system is known as Central Irrigation Control System or CICS. All existing are connected to CICS via CALSENSE field controllers. Coordinate this effort with Dept. 10843-3

1.06 SUBMITTALS

- A. All required submittals shall be per Sandia Construction Standard Specification Section 013100S, "Descriptive Submittal Procedures" and in accordance with conditions of the Contract.
- B. Product Data: All pipe and tubing materials, valves, emitter, bubblers, sprinkler heads, equipment, and accessories shall be submitted for approval. Data shall indicate the maximum allowable operating pressures of each component and any related manufacturing standards and recommendations.
 - 1. Submit manufacturer's literature, technical data, and recommendations for the System as specified.
- C. Shop Drawing: Submit detailed shop drawing showing complete repair work layout to include irrigation piping and sizes, sprinkler and bubbler heads, emitters, wiring diagram, valves, and controllers (to include mounting detail).
- D. As-Built Drawings
 - 1. Upon completion of the work, the Contractor shall revise all drawings to agree with the construction materials, capacities, locations, and routing as actually accomplished. The notation "As-Built" shall be entered in the revision block, dated and initialed. Furnish the complete As-Built drawing set to the SDR.
- E. Pipe materials, valves, equipment, and accessories not listed in this specification under PART 2 – PRODUCTS shall be submitted for approval.
- F. Submit controller chart, as built of existing control charts will be provided by SNL.
- G. Pressure Test.
 - 1. Contractor is responsible for conducting water pressure flow test at point of connection to main and lateral lines and furnishing results to the SDR. PT shall be conducted for a two-hour period at a minimum pressure of 100psi
 - a. Prior to testing, main and lateral lines trenches shall be partially backfilled, leaving all joints and connections exposed.
 - b. Flush lines free of debris and filled with water to remove air.

- c. A pressure gauge and temporary valve shall be installed at the end of mainline to permit air pressure test.
 - d. Test lateral line system prior to installing flex nipples or swing joints. Cap all open fittings.
 - e. Upon completion of a successful two-hour test heads, [flex nipples and swing joints if any] shall be installed and backfill operation completed.
 - f. Any leaks resulting during the two-hour pressure test or hydrostatic test shall be repaired and the system retested until test is successful.
2. No other work is to proceed until the SDR has received and approve pressure test data.

1.07 PERFORMANCE

- A. Design Pressure: The system requires a total design pressure of 10-50 psi for drip and bubbler systems, and up to 60 psi for spray irrigation systems. Design pressure is defined as maximum pressure required overcoming all pressure losses and leaving a residual pressure at the emitters, bubblers, and spray heads not less than the manufacturer's minimum pressure recommendations.

1. Precipitation Rate

- a. Determine location of emitters, bubblers, and spray heads based on location of proposed plant material layout and native grassland areas shown on the Contract Drawings.
- b. Layout: Locate emitters, bubblers, and spray heads to provide uniform water distribution to all plant material and native grassland areas.
- c. Perform testing & flushing. Refer to Section 3.04.

1.08 JOB CONDITIONS

A. Existing Conditions:

1. Utilities: Verify the locations and sizes of all irrigation system components and for stub-outs for water sources of water supply to the underground irrigation system. Prior to excavation, determine the locations of all newly constructed and existing cables, conduits, sewers, water lines, irrigation lines and equipment, and other underground utilities. It is the Contractor's responsibility to obtain all necessary spotting services thru the SDR. Do not damage or disturb underground utilities. If a conflict exists between the location of underground utilities and the proposed work, notify the SDR in writing and

arrange for field and design adjustments and relocations. Proceed in the above manner if a rock layer or other unanticipated conditions are encountered underground. Repair utility damage as directed by the SDR.

2. Construction: Use extreme caution when working near existing construction. Do not damage existing features not specifically indicated to be removed. Repair any accidental damage as directed by the SDR.
 3. Sequencing/Scheduling: Coordinate irrigation system with related work. Grade site within 1-inch of finish grade prior to trenching. Install irrigation system prior to plant installation.
 4. Adjust trenching beyond drip lines of existing trees whenever possible.
- B. Prior to installing irrigation heads, stake or otherwise locate replacement trees and shrub planting areas per the Contract Drawings, or as adjusted in the field under the SDR's direction. Coordinate bubblers and shrubs pop-up heads with tree and shrub locations. Do not lay irrigation lines in root ball zones.
- C. Coordinate tree, shrub, and plant layout with the SNL Grounds Team Representative – Dept. 10843-3 and the project SDR.

1.09 DELIVERY, STORAGE & HANDLING

- A. Delivery and Storage: Coordinate delivery and on-site storage location with the SDR. Do not store PVC pipes and fittings in direct sunlight.
- B. Product Handling: Follow manufacturer's recommended procedures for loading, unloading, stacking, transporting and handling materials and equipment. PVC pipe shall lay flat during transport and storage.

1.10 WARRANTY

- A. General: Warranty underground irrigation system through the specified warranty period [one-twelve month growing season] against operational deficiencies due to inferior material or workmanship. Correct deficiencies immediately as directed by the SDR at no additional cost to SNL, including damage caused by such defects.
- B. Settlement: Warranty underground irrigation system through the specified warranty period against settlement damage. Adjust, restore, or replace pipes, valves, sprinkler heads, planting, paving, or other improvements at no additional cost to SNL.

1.11 MAINTENANCE

- A. Extra Materials: Provide two sets of special wrenches and keys [from the same manufacturer] designed for installing, removing, and adjusting heads, valves and nozzles. All valves shall be NSF (National Sanitation Foundation) Certified for potable water.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Replacement/Repair Products

- 1. Replacement and repair products for the irrigation system shall match the existing and the following requirements.

B. Flow Meter

- 1. Calsense FM flow meter: Re-install as recommended by manufacturer. Additional information can be obtain at <http://www.calsense.com> or [800] 573.8608.

C. Inline Emitter Tubing

- 1. Linear Low Density Polyethylene – LLDPE.
- 2. Pressure compensating.
- 3. Dual Outlet Ports.
- 4. Operating Pressure from 10-50 psi.
- 5. Flow Rate: 0.92 GPH, 120-mesh Filtration.
- 6. 0.63" O.D., 0.54" I.D. with a 0.045" Wall Thickness.
- 7. Multi-Outlet Emission Device: Rainbird Xeri-Bird XBD-80 or approved equal.

D. Point Source Drip System

- 1. Pressure Compensating Emitters, 8-60 psi.
- 2. Single Outlet Ports.
- 3. 120 – Mesh Filtration.

E. Pipe and Pipe Fittings

- 1. Polyvinyl Chloride Pipe (PVC).
 - a. Schedule 40 complying with ASTM D 1785, continuously marked with identification of the manufacturer, type, class, and size. Provide pipes in 20-foot lengths, free of holes, foreign material, blisters, wrinkles or dents.

- b. PVC compounds are restricted to PVC-1120 and PVC-1220.
2. PVC Pipe Fittings: Schedule 40 PVC socket fitting, Type 1, Cell Classification 12454-B, complying with ASTM D 2466, D 2467, and D 1784.
3. Threaded Nipples: Schedule 80 PVC pipe, Type 1, Cell Classification 12454, complying with ASTM D 2467.
4. Risers: Schedule 80 PVC pipe.
5. Cleaner, Primer, and Solvent Cements:
 - a. Cleaner: Uni-Weld 7300 cleaner, ASTM F 656, or approved equal.
 - b. Primer: Uni-Weld 8700, Hi-Etch purple primer, ASTM F656, or approved equal.
 - c. Solvent Cements: Uni-Weld 2200 clear, light viscosity type, for lateral lines, Uni-Weld 1700 gray, heavy duty viscosity type, for lateral lines larger than 2-1/2" diameter, and Uni-Weld 6700 clear, light viscosity type for Flex/PVC connections or approved equal – ASTM D 2564.
6. Sealing Tapes and Pastes:
 - a. Threaded Connections between PVC and Metal Pipe: Rectorseal No. 100 virgin heavy duty sealing paste, Plastojoint Stick as manufactured by Lake Chemical Company, or Teflon tape.
 - b. Metal-to-Metal Connection: Rectorseal No. 5 slow dry, soft set pipe thread compound.
 - c. PVC-to-PVC Connections: Teflon tape.
 - d. Plastic Irrigation Head or Plastic Valve to Pipe Connections: Teflon tape.
7. Pipe Lubricant: As provided by pipe manufacturer for "O" ring gasket and pipe spigot ends. If not provided, use I.P.S. Weld-On No. 787 gasket/joint lubricant as manufactured by Industrial Polychemical Service.
8. Flexible Nipples: COBRA CONNECTOR, U.S. Patent #s 5,039,011 & 5,221,114, with 1/2" Nominal I.P.S. heavy wall flexible hose, as manufactured by F. P. Parker Manufacturing Co. Inc., 230-A Coney Island Dr., Sparks, Nevada, 89431, (702) 358-7900 or (510) 657-1641, Fax (800) 372-6272, or approved substitute. Material is available from Neumark Inc., Albuquerque, New Mexico.
9. Sleeves: Class 200 PVC.
 - a. Poly pipe is not acceptable.

F. Remote Control Valves

1. Control Valve: PEB Series as manufactured by Rainbird.
2. Master Valve: PEB Series as manufactured by Rainbird.
3. Provide valves of heavy-duty plastic housing body and cover with stainless steel spring and metal parts of brass.
4. 24 VAC electrically operated solenoid, balanced-pressure diaphragm, angle type, 150 psi CWP rating.
5. External bleed.
6. ~~Solenoid complying with Class II National Electric Code.~~
7. Energy-efficient, low-power encapsulated solenoid with captured plunger and 90-mesh solenoid filter.
8. Buna-N-diaphragm with belt-cleaning 90 mesh pilot water filter and capture spring.
9. Label all Master Valves.
10. Permanently label or tag all valves and controllers with its corresponding zone/station number.

G. Isolation Valves

1. O-rings on true union ball valves shall be EPDM or Viton®.
2. All valves shall have a double stop polypropylene handle.
3. All 3/4" through 2" valves shall be pressure rated at 235 psi and all 2 1/2" through 6" valves shall be pressure rated at 150 psi.

~~H. Pressure Regulating Valves~~

1. Adjustable brass pressure regulating valve (PRV).

I. Backflow Preventer Valve

1. Refer to Section 15051 for installation.
2. Use RP or PVB valves.
3. Automatic drain valves are **not** permitted.

J. Manual Drain Valve

1. Install at system's low points when required. Install in a standard 12-inch valve box with a gravel sump.

K. Quick Coupler Valves

1. Provide quick coupler valves approximately every 50 FT or as indicated on the Contract Drawings. Provide coupler keys, swivel ells, and hose bibs in the quantity of one for every five quick coupler valves installed.

L. Risers

1. Use schedule 80 PVC.

M. Flush Valves

1. Provide one flush valve per zone for drip systems.

N. Valve Boxes

1. Specification grade valve boxes, bottom extensions, and locking covers as manufactured by Carson Industries LLC.
2. Size all valve boxes to allow ease of maintenance or as indicated on Contract Drawings.
3. Use a 10-inch round box for all isolation valves. Use 10-inch round PVC for extension.
4. Use a rectangular valve box for all single electrical control valves and wire splices.
5. Permanently label valve boxes lid [topside] for identification of contents.

O. In-Line Drip Emitters

1. Single outlet pressure compensating emitters complete with flow control disk, 5/16" diameter emitter ball and cap seal. Emitter shall be constructed of black, heat resistant plastic
2. Self-flushing.
3. Pre-set to emit .5 to-12 gallons per hour at operating pressures of 10-50 psi.

P. Bubblers

1. Spring Loaded pop-ups.

Q. Rotary Sprinklers

1. Pressure compensating.
2. Low discharge trajectory angle.
3. Filter Screen.
4. Use 6 - 9 inch pop-ups in seeded areas.

R. Fixed Sprinklers

1. Filter screen.
2. Use 4 – 6 inch pop-ups.
3. Matched Precipitation Rates Nozzles.
4. Adjustable arc nozzles: Use only when odd arcs are required.
5. Use 6 - 9 inch pop-ups in seeded areas.

S. Wye Filters

1. 150-psi pressure rated.
2. Cap with Sealing O-ring.
3. Flow rate of 0 to 30 GPM.
4. 200 Mesh Filter Element.
5. Size range from ¾" to 1"

T. Inline Pressure Regulator

1. Install above or below ground.
2. Outlet pressures of 30 psi, 40 psi or 50 psi.
3. ¾" or 1" female threaded inlet and outlet.

U. Automatic Controller

1. Calsense Controller ET-2000-8, 24 or 40 MLR (or current model) with local radio, rain sensor and grounding rod. Specify size based on project. Coordinate with Dept. 10843-3.

V. Wire

1. Provide #12RW color-coded wiring to electric control valves from automatic controller, which is UL approved for direct underground burial.
2. Provide a single wire to each solenoid from controller and a common neutral wire to all solenoids from controller as power supply.
3. Multi-strand wire **is not** acceptable.
4. Provide 36-inch loops in all valve boxes.
5. Wire path and size shall match existing.

- W. Dry Splice Connectors
 - 1. Scotch-Lok Connector Sealing Packs, Rainbird Snap-Tite wire connectors or Spears DS-500 Dri-Splice connectors or approved equal.
- X. Rain Sensor
 - 1. As manufactured by Calsense.
- Y. Freeze Sensor
 - 1. As manufactured by Calsense.
- Z. Soil Moisture Sensor
 - 1. As manufactured by Calsense.

PART 3 - EXECUTION

3.01 EXAMINATION AND GENERAL REQUIREMENTS

- A. Refer to Section 02955S – Landscape, Trees, Plants, and Groundcover for the pre-construction walk-thru procedures for landscape and irrigation system.
- B. During the walk-thru the existing irrigation system shall be identified and located. Based on the location of the existing system components, the Contractor shall notify the SDR in writing the portions of the irrigation system that will be impacted by the construction.
- C. SNL will isolate the irrigation zones impacted to minimize the potential for irrigation leaks.
- D. The Contractors shall locate all lines and temporarily cap as required. The Contractor shall prevent debris from entering the existing irrigation system.
- E. The Contractor shall repair and replace all damage to the existing irrigation system.
- F. Examine grading and existing conditions under which irrigation system is to be installed. Proceed with installation if conditions are satisfactory. Examine related work and surfaces before installing the work. Report in writing to the SDR conditions which will prevent proper execution.

3.02 TRENCHING

- A. Stake out all replacement sprinkler head and valve locations prior to trenching for review and approval by the SDR. Spaced Sprinkler heads to achieve uniform coverage.
- B. Excavate trenches straight and true with bottom uniformly sloped to low points. Make excavations of sufficient depth and width to permit proper handling and installation of the pipe and fittings. Clean trenches of all soil, rocks, and debris before installing pipe and fittings. In areas where trees are present, adjust trench location beyond the dripline of the trees or as indicated by the SDR.
- C. Trench depths shall be sufficient to provide the specified pipe cover as described elsewhere in these specifications or as noted on the Contract Drawings. Trench depths in rocky areas shall be 6-inches below required depth to allow for pipe bedding.
- D. Provide a minimum of 24-inches and a maximum of 26-inches of cover for all constant pressure mainlines. Provide a minimum of 18-inches and a maximum of 20-Inches of cover for all mainline located downstream of the master valve. Provide a minimum of 18-inches and a maximum of 20-inches of cover for all lateral lines not under constant pressure. Provide a minimum of 6-inches of cover for all drip poly tubing.
- E. Accurately trim trenches to provide a uniform bed, free from rocks, or other sharp-edged objects.
- F. Provide adequate pitch for pipe drainage to low points.
- G. Keep bottom of trench or excavation free and clear of water during installation.
- H. Where existing pavement must be cut to install landscape irrigation system, cut smoothly to straight lines 6-inches wider than trench.
 - 1. Repair and replace pavement cuts and damage to existing surfacing with equivalent materials and finishes – match existing.

3.03 INSTALLATION

- A. General
 - 1. Install irrigation material and equipment and provide necessary hardware in accordance with the Contract Drawings, as specified herein, and in accordance with manufacturer's instructions, the Uniform Plumbing Code, and ASTM D 2774. Do not use damaged or dented pipe.

2. Additional information for Calsense equipment can be obtained at <http://www.calsense.com> or by calling (800) 572.8608.

B. PVC Pipe

1. Main Line: Verify static water pressure at PoC with pressure noted on Contract Drawings. Notify SDR with any discrepancies prior to proceeding.
2. Cut pipe square with the axis, using a fine-tooth hand saw, or ratcheting PVC cutter. Blade edge of cutter shall be straight and sharp to assure square burr-free cuts through PVC pipe. Cutter shall have a pipe supporting-plate that adjusts to PVC size, and aids in eliminating pipe deformation and cracking.
3. Inside of pipes shall be clean and free of dirt, debris and any foreign matter.
4. Apply cleaner and solvent in accordance with ASTM D 2855 and manufacturer's recommendations.
5. Avoid electric conduits, storm drain lines, and other existing utilities, all of which have the right-of-way.
6. Minimum cover over mains and control valves shall be 24-inches (30-inches max). Minimum cover over laterals shall be 18-inches (24-inches max).
7. All piping in planters is to rest on a gravel filtration layer and placed prior to placement of soil.
8. Use PVC sleeves beneath paved surfaces, through planter walls, and at locations shown on the Contract Drawings.
9. Do not cut sidewalks, drives, or curbs during installation of pipes unless otherwise noted.
10. Cover and protect open pipe ends, fixtures and equipment from dirt, water and chemical or mechanical damage during installation.
11. Do not lay pipe in water or in trench when weather conditions are unsuitable for work or when temperature is 32^o F or below. Pump out or otherwise remove water encountered or accumulated in excavation to keep the bottom of the trench or excavation free and clear of water during the progress of the work.
12. Compression or flow span couplings are not permitted.
13. Avoid having irrigation pipes cross-over. When pipes cross there shall be a minimum vertical clearance of 4-inches between the pipes and trenching shall be adjusted accordingly.
14. Saddle taps are not permitted.

15. Drain entire system to a manual drain valve(s) placed at the low point(s) in the system.
16. Place 12"x 6" gravel pit around outlet end of all automatic drains. Gravel drain backfill shall be of cleaned gravel or crushed stone, graded from ¾-inch min. to 1-1/2 inch maximum.
17. At completion of work, thoroughly clean fixtures, exposed materials and equipment.
18. Vertical stacking of irrigation lines is not permitted unless directed by the SDR.

C. Thrust Blocks (TBs):

1. Install thrust blocks on all lines 2-inches or larger. Size TBs in accordance with ASAE standard S376.1. TBs shall be installed against undisturbed earth. Thrust blocks shall be constructed at all direction changes, size changes, valves and terminations or at any other points of the system that will result in an unbalanced thrust.

D. Laying PVC Pipe:

1. Snake pipe at least 1 foot per every 100 feet to allow for thermal expansion.
 - a. Solvent weld socket type.
 - b. Threaded Type: Apply liquid Teflon thread lubricant to Teflon thread type.
2. Sleeve pipe and wiring under sidewalks, roadways, or parking lots in Class 200 PVC pipe. Sleeves shall be twice the size of pipe to be sleeved.
3. Where trenching extends thru rocky soil, piping shall be bedded in 2-inches of sand or approved backfill material extended to a minimum of 2-inches over the top of piping.
4. Provide 24-inch clearance between top of pipe and finish grade for pressure lines, and 18-inches for non-pressure lines, except where otherwise indicated on Contract Drawings. When two or more pipes are to be placed in the same trench, maintain a minimum of 4-inches horizontal distance between the pipes.
5. Installing pipe in curving trenches, which can cause excessive bending and stress on pipe and fittings is not permitted.

E. Laying Inline Emitter Tubing:

1. Make all connections according to manufacturer's instructions.

2. Provide cover as specified in Section 3.02.D. However, tubing may be laid at grade below mulch and weed fabric where deeper cover is not feasible.

F. Bubblers, Emitters, & Sprinkler Heads:

1. Sprinkler heads shall be installed 6-inches away from any building structure, walls, sidewalks, and curbs.
2. Fixed Sprinklers: Use fixed arc nozzles. Use adjustable arc nozzles only when odd arcs are required.
3. Sprinkler heads shall be spaced to achieve uniform coverage and shall not exceed spacing shown on Contract Drawings.
4. Fully flush entire system prior to the installation of sprinkler and bubbler heads. Cap risers as deemed necessary to achieve adequate flushing.

G. Wiring:

1. Keep splicing to a minimum. All continual wire shall be of one color (match existing). Splicing of different color wires **is not** permitted. All splicing, connectors, and splice boxes shall be of a water proof type.
2. Provide 12-inch expansion loops in wiring at each wire connection or change in wire direction.
3. Provide 36-inch expansion loop at remote control valves.
4. Install 24-volt control valve wiring in same trench as main line 2-inches below and to one side of irrigation line. Tape together at 10-foot intervals. Run control wiring through conduit in areas designated on the Contract Drawings. Direct burial is acceptable when/where approved by the SDR. Run control valve wiring in lateral trench in same manner as in main line trench **only** when it is not possible to use main line trench.
5. Do not run power wiring in the same conduit as control wiring.
6. Indicate wire path and size on Contract Drawings.
7. All electrical connections shall be protected with Scotch-Lok Sealing Pack, Spears Dri-Splice DS-500, or Rainbird Snap-Tite connectors or approved equal.
8. Control wires shall be identified with E-Z Coder WDR series tape or approve equal. Mark wires at all splices and valves. Valves shall be numbered according to the Contract Drawings. Permanently mark valve box lids to correctly indicate the valve number(s) in the box.

H. Setting of Valves:

1. Do not locate valves beneath paved surfaces.
2. Install valves in a level position.
3. Install all valves, except backflow preventer, with minimum 24-inches cover.
4. Provide key for manual operation of remote control valves.
5. Install an isolation valve at the PoC, and at loop or zone isolation points.
6. Install an isolation valve upstream of each electric control valve. Isolation valve may be installed in same valve box with automatic valve.
7. Provide manual rubber seated valves or true union ball valves where piping is two (2") inches or less.
8. Provide push on ring and gasket type isolation valves where piping is two and one half (2½") inches or larger.
9. Install rubber seated valve or true union ball valve as needed. At a minimum, one shall be installed at every hundred feet of mainline in a 12-inch valve box with 3/8-inch gravel.
10. Manual Drain Valves: install at end and low points of the irrigation system. Additional manual drain valves must be installed if there are multiple low points along the system's run of pipe where water collection may occur.
11. Install RPs or PVBs in accordance with Section 15051- Piping Systems.
12. Drip Irrigation Systems: Install one Flush Valve per zone at high or low end of zone in a 10-inch round box..

I. In-Line Pressure regulator

1. Install above or below grade.

J. Sleeving: Class 200, SDR-21 [Belled-End].

1. Furnish and install PVC sleeving where control wires or pipe pass under paved surfaces and through concrete planter walls.
 - a. Provide sleeving of twice the size of pipe to be sleeved.
 - b. Provide separate sleeving for each run of irrigation wiring.
 - c. Extend sleeving 12 inches beyond end of paving at each end.

- d. Bed sleeves, installed by open cut, in sand to 6" above pipe.
- e. Install pipe with 24-inches of cover.
- f. Seal joint between sleeves and pipe through planter walls with waterproof caulking.
- g. Tape sleeve ends closed.

3.04 INSPECTION - TEST & FLUSHING

- A. Provide for inspection of work by the SDR at any time. Whenever testing or approval is required, provide notification to the SDR 24 hours in advance. Should work requiring testing or approval is backfilled prior to notification, the Contractor, at the Contractor's expense, shall uncover, retest and reset the surface if directed by the SDR.
- B. Should any portion of the Work done or any materials delivered fail to comply with requirements of the Specification or Contract Drawings, such work or materials shall be rejected and shall be immediately removed from the site. Defective work or materials shall be corrected satisfactorily.
- C. Flushing: Prior to testing, the entire System shall be partially backfilled, leaving all joints and connections exposed and the entire System shall be flushed clear of all debris and foreign matter.
 - 1. Flush In-Line System completely to remove debris from line with in-line emitter tubing and pop-up heads removed.
 - 2. Replace in-line emitter heads and run system again checking for proper operation.
- D. Flushing: Prior to testing, the entire System shall be partially backfilled, leaving all joints and connections exposed and the entire System shall be flushed clear of all debris and foreign matter.
- E. A pressure test of main and lateral lines at 100 psi for 2 hours is required.
 - 1. Center-load the piping with a small amount of backfill material, leaving joints and connections exposed. Cap all outlets and hydrostatically test the normally pressurized part of the system at a pressure of 100 psi as specified in the Uniform Plumbing Code. Maintain pressure test for two hours.
 - 2. Test laterals in the same manner used for main line. Leave joints exposed for inspection during the pressure test. **Do not** install swing joints or flexible nipples prior to pressure test. Maintain pressure tests on plastic pipe for not less than 2 hours. **Do not** use air pressure test.

3. If pressure loss or leaks occurs, affected line or connection shall be repaired and test shall be repeated until the entire system has been proven tight. Conceal lines passing hydrostatic pressure test the same day if nighttime temperatures are to be 32° Fahrenheit and below. Install pressure gauges on the line being tested.
- F. Following System's testing and adjustments, operate the entire installation to demonstrate the complete and successful operation of all equipment. Re-adjust [as required] all valves, sprinkler heads, and bubblers for proper operating pressures, uniform coverage and even flow.

3.05 BACKFILLING

- A. Prior to backfilling trenches, contact the SDR to have valves and other landscape equipment located by Global Positioning System [GPS].
- ~~B. After pipe joints have been visually inspected, flushing and pressure testing, and GPS procedure has been accomplished and approved, backfilling may begin. Begin backfilling when the piping is not in an expanded condition due to heat or pressure. Cooling of the piping can be accomplished by operating the system for a short time or by backfilling in the cool a.m. hours of the day. Place backfill in horizontal layers not exceeding 8-inches in loose depth and thoroughly hand-tamp to 85% in unpaved areas and 90% in paved areas of maximum density at optimum moisture so that minimum settlement will result. Place backfill to the original grade level or to the limits designated on the Contract Drawings and use topsoil to fill to finish grade.~~
- C. Backfill material shall be free from construction rubbish, rock, large stones, brush, sod, frozen material or other unsuitable substances. When material from excavation or trenching is unsuitable for use as backfill it shall be disposed of, and suitable material which is capable of attaining the required relative density shall be furnished.
- D. Install Line Marking Tape on all lines ¾-inch and larger. Place tape in 6-inches above piping.

3.06 OPERATION AND MAINTENANCE

- ~~A. Maintain and adjust the irrigation system in coordination with the plant materials requirements until substantial completion. Irrigation maintenance shall include repair and replacement of parts or workmanship not operating properly and adjustment of timing and coverage of heads.~~
1. Provide site consultation with Sandia's operating personnel for a period of 3 months, not to exceed 4 hours per month, at no additional charge to Sandia.

B. Record Drawings and Controller Chart:

1. Maintain a **complete** set of up-to-date As-Built drawings and provide a copy to the SDR.
2. Locate chart inside controller door. Seal chart between two pieces of plastic.
3. Locate all sections, valves, lateral lines, and routes of control wires.
4. Prepare a controller chart showing:
 - a. Location of all sections, valves, lateral lines, and routes of control wires.
 - b. Identify all valves by size, station, and number.
 - c. Provide chart as a blue-line print with a different color used to show area of coverage for each station.
 - d. Controller chart shall be hermetically sealed between two sheets of 10 mil plastic and located inside controller door.
5. Provide an O&M Manual.

3.07 ACCEPTANCE

- A. When work is completed, including cleaning and maintenance, the SDR will, upon request, make an inspection to determine system acceptability.
- B. Where inspected irrigation work does not comply with the requirements of the Specification and Contract Drawings, replace rejected work and continue specified maintenance until re-inspected by the SDR and the SDR and work is found to be acceptable. Remove rejected equipment and materials promptly from project site.

END OF SECTION