

SECTION 50 - CONSTRUCTION MATERIALS

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SECTION 50-CONSTRUCTION MATERIALS

This Section indicates the requirements for various classes and types of materials used in construction. Materials not included in this Section must be as described and specified in other Sections of these Specifications or in the Special Provisions.

All sewer facilities constructed within the Sacramento Area Sewer District service area (<http://www.sacsewer.com/pdf/map-servicearea.pdf>) must be constructed in accordance with the Sacramento Area Sewer District Standards and Specifications available at <https://www.sacsewer.com/standards-specifications/>

50-1 **CEMENTITIOUS MATERIALS**

Cementitious material includes portland cement and supplementary cementitious materials. Unless otherwise specified in the Special Provisions, cementitious material shall conform to the most current edition of Section 90 of the State Specifications.

Unless otherwise specified in the Special Provisions, calcium chloride must not be used in any concrete containing steel reinforcement or other embedded metals.

When directed by the Agency, the Contractor must furnish certificates of compliance stating that the cementitious material delivered to the work complies with these Specifications.

50-2 **CONCRETE AGGREGATES**

Unless otherwise specified in the Special Provisions, concrete aggregates shall conform to the most current edition of Section 90 of the State Specifications.

50-3 **WATER FOR CONCRETE**

Water used for mixing and curing concrete must be clean, free from oil, acid, alkalis, vegetable matter, or other deleterious matter. No water containing excessive amounts of salts, sulfates, or chlorides must be used.

50-4 **PREMOULDED EXPANSION JOINT FILLER**

Unless otherwise specified in the Special Provisions, premoulded expansion joint filler material must conform to ASTM D1751.

50-5 **CONCRETE**

50-5.01 Composition

Portland cement concrete must be composed of portland cement, cementitious material, fine aggregate, coarse aggregate, admixtures (if used), water; and shall be designated as one of the following classes:

- Class "A" Concrete—Shall contain a minimum of six (6) sacks (564 pounds) of cementitious material per cubic yard and shall have a maximum size of coarse aggregate inch (1").
- Class "B" Concrete—Shall contain a minimum of five (5) sacks (470 pounds) of cementitious material per cubic yard and shall have a maximum size of coarse aggregate of one inch (1").
- Class "C" Concrete—Shall contain a minimum of four (4) sacks (376 pounds) of cementitious material per cubic yard and shall have a maximum size of coarse aggregate of one inch (1").
- Supplementary cementitious content shall conform to the most current edition of Section 90 of the State Specifications.

Should the quantity of ingredients designed to produce a cubic yard of finished concrete result in a yield greater than 1 cubic yard, the relative proportions of fine and coarse aggregates must be adjusted as necessary to maintain a consistent quantity of portland cement cementitious material in each cubic yard of concrete.

A mix design must be submitted to the Agency for approval at least 7 Working Days prior to the proposed portland cement concrete being incorporated into the Work. Mineral admixture, when approved by the Agency, must conform to the State Specifications.

50-5.02 Proportioning

Unless otherwise specified in the Special Provisions, concrete proportioning shall conform to the most current edition of Section 90 of the State Specifications.

50-5.03 Mixing and Transporting

Unless otherwise specified in the Special Provisions, concrete mixing and transporting shall conform to the most current edition of Section 90 of the State Specifications. Control of water (slump) shall conform to section 50-5.04 of these specifications. Transporting of concrete in nonagitating hauling equipment or trailers will not be permitted.

50-5.04 Water Control

Within the limits hereinafter specified, the amount of water required for the proper consistency of concrete will be determined by the slump test, in accordance with ASTM C143.

The Allowance for slump, unless otherwise directed by the Agency, is as follows:

- Concrete paving and unreinforced structures—Not more than 3 inches 3 to 5 inches
- Reinforced structures and columns—Not more than 4 inches 3 to 5 inches
- Concrete placed under water—Not less than 6 nor more than 8 inches

Do not add water into the concrete mixture during hauling or after arrival at the delivery point, unless authorized by the Agency. If the Agency authorizes additional water to be incorporated into the concrete, the drum must be revolved at least 30 revolutions at mixing speed after the water is added and before discharge is commenced.

If the concrete is mixed in transit, the control equipment must be at the proportioning plant and there must be no water added after the mixture leaves the plant, unless directed by the Agency.

The Contractor must furnish, without charge, materials required for making tests of concrete during the progress of the Work. The tests will be made at the Agency's expense.

50-6 CURING COMPOUNDS FOR CONCRETE

Concrete curing compounds must be used where specified in these Specifications and the Special Provisions.

The compounds must meet the requirements of the State Specifications.

50-7 AGGREGATE BASES

Aggregate bases must conform to the requirements of the State Specifications, and these Specifications.

The combined aggregate must conform to the gradation requirements specified for the 3/4- inch maximum aggregate for Class 2 aggregate base, unless otherwise specified in the Special Provisions.

50-8 PIT RUN BASE (GRADED)

Pit run base is a processed pit run material from local sources that might be specified on the Plans or in the Special Provisions for work where ordinary earth fill may not be satisfactory.

Pit run material must have a minimum sand equivalent of 25, as determined by California Test 217.

Pit run base must have the following limits of gradation:

<u>Sieve Size</u>	<u>Percentage Passing</u>
2-1/2"	100
2"	75-100
1"	50-75
No.4	20-50
No. 200	0-10

50-9 COBBLES

Cobbles must measure a minimum 4 inches in the least dimension and a maximum of 12 inches in the greatest dimension.

50-10 GEOTEXTILE FABRIC**50-10.01 Nonwoven Geotextile Fabric**

Nonwoven geotextile fabric must be of nonwoven construction and consist of long-chain polymeric fibers composed of polypropylene, polyethylene, or polyamide. The fibers must be oriented into a random web and stabilize so they retain their relative positions. The geotextile must be free of any chemical treatment or coating and must be inert to chemicals commonly found in soil.

The geotextile must conform to the physical property requirements listed in the table below:

TABLE 50-1 REQUIRED NONWOVEN GEOTEXTILE PROPERTIES		
Physical Property	Test Method	Acceptable Minimum Test Results
Tensile strength, lb	ASTM D 4632	200 lbs.
Elongation, %	ASTM D 4632	50%
Permittivity, sec ⁻¹	ASTM D 4491	1.5 sec ⁻¹
Puncture strength, lb	ASTM D 4833	120 lbs.
Mullen Burst strength, psi	ASTM D 3786	380 psi
Note: Tension testing machine with ring clamp, steel ball replaced with a 5/16-inch-diameter solid steel cylinder, with flat tip and beveled edges, centered within the ring clamp.		

50-10.02 Woven Geotextile Fabric

The woven geotextile fabric must be a high modulus woven fabric consisting of long chain polymeric monofilaments, slit film tapes, or multifilaments of tape and nonwoven yarn of polypropylene, polyester or nylon, and must be inert to commonly encountered chemicals, rot- proof and resistant to ultraviolet light exposures, insects, and rodents. The fabric must be woven into a stable network and the edges of the fabric must be selvaged or surged in such a way that fabric will not unravel or fray during installation or usage.

The geotextile must conform to the physical property requirements listed in the table below:

**TABLE 50-1
REQUIRED WOVEN GEOTEXTILE PROPERTIES**

Physical Property	Test Method	Acceptable Minimum Test Results
Grab tensile strength (any direction), lb	ASTM D 4632	200 lbs.
Weight, oz/yd ³	ASTM D 5261	6.0 oz/yd ³
Permittivity, sec ⁻¹	ASTM D 4491	0.5 sec ⁻¹
Mullen Burst strength, psi	ASTM D 3786	400 psi

The fabric must have an Equivalent Opening Size no larger than U.S. Standard Sieve Number 50 as determined by U.S. Corps of Engineers Specification CW-02215. Geotextile fabric must be Mirafi 600X, or equal.

Each roll of fabric used must be labeled in accordance with ASTM D 4873. Sampling and testing of geotextile fabric must conform to the requirements of ASTM D 4354. Specification conformance for geotextile fabric must conform to the requirements of ASTM D 4759. Storage and handling of the geotextile fabric must conform to the requirements of ASTM D 4873. Geotextile fabric must be handled and placed in accordance with the manufacturer's recommendations.

50-11 CEMENT-TREATED BASES

Road-mixed and plant-mixed cement treated base must comply with the State Specifications.

50-12 LIME TREATED BASE

Lime treated base must be constructed by mixing lime and water with existing subgrade materials. The lime must be a commercial hydrated lime conforming to the requirements of ASTM C51. When sampled by the Agency at the point of delivery, the sample of hydrated lime must contain at least 85 percent of calcium hydroxide as determined by California Test 414.

A Certificate of Compliance and certified weight slips for each delivery must be submitted to the Agency.

50-13 SAND

50-13.01 River Sand

River sand must be free from vegetable matter, lumps, balls of clay, or adherent films of clay. The material must not have more than 20 percent passing a 200 hundred mesh screen.

50-13.02 Graded Sand

Graded sand must be free from vegetable matter, lumps, balls of clay, or adherent films of clay, and must have a minimum Sand Equivalent of 60 as determined by California Test 217. The percentage composition by weight of graded sand must conform to the following gradations:

Sieve Size	Percentage Passing by Weight
9.5 mm (3/8")	100
4.75 mm (#4)	92-100
2.36 mm (#8)	90-100
1.18 mm (#16)	80-100
600 µm (#30)	65-100
300 µm (#50)	40-80
150 µm (#100)	0-40
75 µm (#200)	0-12

If approved in writing by the Agency, sand bedding in accordance with Section 19-3.02F(2) of the State Specifications may be substituted for graded sand. Contractor must provide written notification in accordance with Section 5-14 of these Specifications. The written notification must include documentation that the graded sand specified herein is not available at the time or in the quantities required to complete the Work. No additional payment will be made for the substitution.

50-14 CRUSHED ROCK

See Section 50-16.

50-15 CONTROLLED LOW STRENGTH MATERIAL

50-15.01 Not Used

50-15.02 Controlled Low Strength Material (CLSM)

CLSM is a workable mixture of aggregate, cementitious materials, admixtures (if used), and water. All CLSM must conform to these specifications and ACI report 229R-13. The contractor must submit to the Agency for approval a mix design and test data that demonstrate the mix design complies with the following:

- Cementitious materials must conform to Section 50-1 of these specifications with the exception that cementitious material may be any combination of portland cement and supplementary cementitious materials.
- Admixtures must conform to the most current edition of Section 90 of the State Specifications.
- Aggregate must be one hundred percent fine aggregate conforming to Section 50-2 of these specifications. One hundred percent must pass the 3/8" sieve.
- The 28-day compressive strength must be between 50 psi and 300 psi as determined by ASTM D4832.
- The entrained air content of CLSM must be a minimum of 8 percent as determined by ASTM D6023.

50-15.02.A Properties

Flowability: High flowability: Between 8 and 10 inches per ASTM C143 (slump cone) method.

Segregation: The separation of constituents in the mixture during fluid movement is not permitted.

50-15.02.B Proportioning, Mixing, Transporting, And Placing

The proportioning, mixing, transporting, and placing of CLSM must conform to Section 50-5.02 and Section 50-5.03 of these specifications.

Prior to placement of the CLSM:

- The trench or excavation must be free of loose soil
- The trench or excavation bottom must be stable and non-yielding
- There must be no excess moisture present
- Pipe bells must be supported so they maintain a minimum 3-inch separation from the bedding material

- All bedding material must be removed from any pipe haunches

CLSM must be placed in a uniform manner that will prevent voids in, or segregation of, the backfill. Foreign material that falls into the trench prior to or during placing of the CLSM must be immediately removed.

The CLSM must be placed to the full width and length of the trench or excavation and must cover the top of pipe bells. The CLSM must be placed on both sides of pipe simultaneously to minimize the potential for lateral displacement of the pipe.

Pipe sections may need to be secured against flotation during CLSM placement. The CLSM may be placed in lifts to reduce the potential for flotation to occur.

50-15.02.C Backfill

Backfill above the CLSM can commence only when placement and compaction of the backfill will not cause deformation of the CLSM, or at the direction of the Agency.

When CLSM is to be placed within the traveled way or otherwise to be covered by paving, the material must achieve a maximum indentation diameter of 3 inches prior to covering and opening to traffic. Penetration resistance must be as measured by ASTM D6024.

50-15.02.D Quality Control

Sampling must be in accordance with ASTM D 5971. The testing of CLSM cylinders must be per ASTM D 4832.

Protect the area where the CLSM has been placed. The liquid CLSM will have characteristics similar to quicksand until solidification occurs.

50-16 CLEAN CRUSHED ROCK

Clean crushed rock of the type shown or specified in the Contract must be the product of crushing rock or gravel. The percentage composition by weight of clean crushed rock must conform to the following gradations for the Type specified:

Sieve Size	Type A (1/2" crushed)	Type B (3/4" crushed)	Type C (1" crushed)	Type D (1-1/2" crushed)
2"	--	--	--	100
1-1/2"	--	--	100	--
1"	--	100	90-100	--
3/4"	100	70-100	30-60	0-17
1/2"	70-100	5-55	0-20	--
3/8"	10-50	0-15	--	0-10
No.4	0-15	0-5	0-5	0-10
No.8	0-5	0-2	--	0-2

Clean crushed rock must have a minimum Cleanliness Value of 60 as determined by California Test 227. At least 75 percent of the crushed rock particles must have 2 or more fractured faces.

50-17 ASPHALT, LIQUID ASPHALT, AND ASPHALTIC EMULSION

Asphalt as required by these Specifications or by the Special Provisions means asphalts as specified in the State Specifications. Liquid asphalts as required by these Specifications or by the Special Provisions, means liquid asphalts as specified in Section 93, "Liquid Asphalts", of the State Specifications.

Asphaltic emulsion must conform to the State Specifications and these Specifications.

Emulsified asphalt must be Cationic type polymer modified grade PMCRS-2H.

Test results of the proposed emulsified asphalt and aggregate, including date of testing, must be submitted in writing to the Agency. Samples of the proposed emulsions and aggregate must be

provided to the Agency upon request. The required tests must conform to those specified in the State Specifications, and the following:

TEST	TEST METHOD	REQUIREMENT
Viscosity @ 122°F	AASHTO T-59	100-250 sec.
Demulsibility	AASHTO T-59	60% - 95%
Penetration @ 77°F (100g 5 sec)	AASHTO T-49	40-65
Ductility @ 77°F (5 cm/min.)	AASHTO T-51	60 cm/min.
Percent Residue	Cal Test 331	65% min.
Torsional Recovery	Cal Test 332	18% min.
Oil Distillate (by volume of emulsion)	AASHTO T-59	3% max.
Solid Polymer Content (by weight)	Cal Test 401	2.5%
Ring and Ball Softening Point	AASHTO T-53 1-2	125°F min.

The binder must conform to the aggregate with a 10 percent minimum film stripping as tested by California Test 302.

The laboratory used to develop the job mix formula and to perform quality control must meet the requirements of ASTM D 3666. A certification signed by the manager of the laboratory stating that it meets these requirements must be submitted to the Agency prior to the start of work.

At the option of the Contractor, polymer can be Neoprene, Ultrapave, or SBR. The polymer must be added to either the asphalt or the emulsion at their locations of manufacture. The temperature of the polymer modified asphaltic emulsion at the time of application must be between 130°F and 180°F.

The Contractor must maintain a quality control system that will provide reasonable assurance that all materials submitted for use conform to these Specifications. The Contractor must perform 2 random samples each day to verify compliance with the operation's quality control. Samples must be taken from the spray bar of the distributor truck at mid-load. The tests shown above must be performed on each sample taken. The Agency reserves the right to suspend Contractor activities and reject material until it can be shown that the material is in compliance with these Specifications.

Penalties will be assessed for nonconformities as follows:

TABLE 50-9	
Nonconformity	Penalty
Viscosity is between 75 and 100 seconds or between 250 and 300 seconds.	5 percent deduction from the bid price per ton for emulsified asphalt
Torsional recovery exceeds 11 percent but is less than 18 percent.	5 percent deduction from the bid price per ton for emulsified asphalt
Torsional recovery is less than 11 percent.	10 percent deduction from the bid price per ton for emulsified asphalt

Test results must be identified by the production date and time of sample and must be submitted in writing to the Agency within 2 Working Days of the sample date. The Agency reserves the right to witness the quality control testing performed by the testing lab and to test any material at any time during the course of the Work.

Each distributor truck must be equipped with a proper measuring stick and calibration card. On-site calibration of distributor trucks, for determining actual spread rate of asphaltic emulsion, must be performed when directed by the Agency. The asphaltic emulsion must be stored in heated circulation

tanks at controlled temperatures, between 140 and 180 degrees F, for a period not to exceed 7 Calendar Days. The temperature of the asphaltic emulsion must be between 130 and 180 degrees F at the time of application.

50-18 VITRIFIED CLAY PIPE (VCP)

Vitrified clay bell and spigot pipe and fittings must conform to ASTM C700 and Section 207-

8.5.3 of the latest version of the “Standard Specifications for Public Works Construction” (“Greenbook”). A Certificate of Compliance must be furnished by the pipe manufacturer.

Joints must be factory-applied resilient-type, polyurethane, mechanical compression joints conforming to ASTM C425.

Field repair of vitrified clay pipe segments, joints and fittings must be limited to removal and replacement of the unacceptable portions of the pipeline.

50-19 SUBSURFACE DRAINS

Subsurface drains must comply with the State Specifications.

50-20 NONREINFORCED CONCRETE PIPE (CP)

Nonreinforced concrete pipe must conform to ASTM C14.

50-21 REINFORCED CONCRETE PIPE, DRAINAGE (RCPD)

Reinforced concrete pipe must conform to ASTM C76 for Class I, II, III, IV, or V. The class of pipe will be specified in the Contract.

Sections of circular pipe with elliptical reinforcing must have the location of the minor axis of the reinforcing indicated by 3-inch wide waterproof painted stripes on the inside and outside of the pipe at the top and bottom, at least 12 inches long at each end of the pipe section.

Unless otherwise indicated in the Contract, joints for concrete pipe must be bell and spigot and must be of a design that, when properly laid, has a smooth and uniform interior surface. Each joint must be sealed to prevent leakage. Unless otherwise indicated in the Contract, joints must be sealed with a rubber profile gasket conforming to ASTM C443. Compression couplings capable of the same performance are allowed where splices are needed. RCPD must be Wall C and each piece of pipe must successfully pass a vacuum test as a part of its manufacturing process to a pressure of 25 feet of head (11psi) for a minimum of ten seconds.

50-22 NOT USED

50-23 CONCRETE CYLINDER PIPE (CCP) AND CEMENT MORTAR LINED AND COATED STEEL PIPE (CLCS)

Concrete cylinder pipe must conform to Federal Specifications SS-P-381a and cement mortar lined and coated steel pipe must conform to Federal Specifications SS-P-385a, each subject to the following modifications:

- a. Minimum steel cylinder thickness is 0.109 inch.
- b. Mortar coating must provide a minimum of $\frac{3}{4}$ inch cover over all structural steel.
- c. Cement mortar lining must be of Type II portland cement and must be centrifugally applied. Minimum lining thickness is $\frac{1}{2}$ inch. The finished inside diameter of the lined pipe must be the diameter shown on the Plans and must match the inside diameter of the adjoining pipe sections to within 1 percent, or $\frac{1}{4}$ inch, whichever is greater.
- d. Pipe must be Class 100, unless otherwise shown or specified in the Contract.
- e. Deflection of the pipe cross section is limited to 1 percent of the inside diameter when the pipe is placed under full external design load.
- f. Pipe sections of less than standard length are only allowed with the written approval of the Agency.

Joints for concrete cylinder pipe and cement mortar lined and coated steel pipe must be O-ring rubber gasket type with grout “diaper” finish, bolted flange type, “Dresser” or “Victaulic” couplings.

50-24 ACRYLONITRILE-BUTADIENE-STYRENE (ABS) PIPE

Four-inch and 6 inch ABS pipe and fittings must conform to ASTM D2680. Joints must be solvent cemented in accordance with ASTM D2235.

50-25 DUCTILE IRON PIPE (DIP), AND CAST IRON AND DUCTILE IRON FITTINGS

50-25.01 General (Does not Apply to Water Pipe)

Ductile iron pipe must conform to ANSI A21.51 (AWWA C151) for a minimum working pressure of 150 psi unless otherwise specified. Ductile iron casting must conform to and be tested in accordance with ASTM A536. Casting grade for pipe must be 60-42-10. Laying length must be the manufacturer's standard length, normally 18 feet. Shorter lengths may be used for closures and proper location of special sections.

The interior surface of all ductile Iron pipe must be cement-mortar lined and seal coated in conformance with AWWA C104 and the exterior surface must have a bituminous coating of either coal tar or asphalt base, approximately 1 mil thick or as directed by the Agency or specified in the Special Provisions.

Fittings must have push-on, mechanical joints or flanged ends. Four-inch through 12-inch fittings must be ductile iron, fittings larger than 12 inches must be cast iron or ductile iron. All fittings must conform to ANSI 21.10 (AWWA C110), ANSI 21.11 (AWWA C111), or AWWA C153 designed for a working pressure of 250 or 350 psi. Coating and lining requirements must be the same as specified for the pipe.

Joints must be push-on or mechanical type and must conform to ANSI 21.11 (AWWA C111) with rubber gaskets unless otherwise specified. Gasket lubricant must be minimum required plus 10 percent.

50-25.02 NOT USED

50-25.03 Water Pipe, Fittings, and Joint Restraints

50-25.03.A Water Pipe

Pipe must be the regular product of a firm that has successfully manufactured comparable pipe for at least 3 years, and must be certified by the manufacturer.

The material, manufacturing, fabrication, testing, and inspection of pipe must comply with the requirements of AWWA C151, as modified herein. Except for specials required to meet the laying conditions, pipe must be furnished in standard lengths suiting the manufacture's shop practice and in accordance with Section 51-4.2 of AWWA C151.

Joints must be push-on or mechanical joint, except where flanged spools are called out in the Plans or Standard Drawings. Push-on and mechanical joints must conform to ANSI 21.11 (AWWA C111) with rubber gaskets. Gasket lubricant must be the minimum required plus 10 percent. Flanged spools must comply with the requirements of AWWA C115.

The interior surfaces of all ductile iron pipe must be cement-mortar lined in conformance with AWWA C104. The interior surfaces of all ductile iron pipe must receive the seal coat listed as "optional" in Section 4.12 of AWWA C104. The exterior surface must have a bituminous coating of either coal tar or asphalt base, approximately 1 mil thick, unless the pipe will be installed above ground or partially above ground, in which case the pipe must be furnished without an exterior bituminous coating. The exterior surfaces of pipes installed above ground or partially above ground must be prepared in accordance with SSPC SP-6 (Commercial Blast Cleaning) and coated with 2 coats of red oxide primer.

50-25.03.B Water Fittings

This Section specifies fittings for ductile iron pipe and C900 PVC pipe.

Fittings must be ductile iron. Fittings must have mechanical joint or flanged ends, and must comply with the requirements of the Plans and Standard Drawings, and must comply with the following requirements:

- Valve Connections: The end of a tee, cross, reducer, elbow, or adapter facing an adjacent valve must be flanged and bolted directly to the valve.
- Elbow Connections to Plain-End Pipe: Elbows that are not adjacent to a tee, cross, reducer, or valve must be MJ x MJ.
- Other Connections to Plain-End Pipe: Other connections to plain-end pipe must be made by use of a fitting with an MJ end, or by use of a FL x MJ adapter.
- Reducers: The end of a reducer facing an adjacent tee, cross, elbow, flange adapter, or valve must be flanged and bolted directly to the tee, cross, elbow, flange adapter, and valve.
- Above-Ground Fittings: Above-ground fittings must have flanged ends only.
- Plain-End Fittings: Plain end fittings are not permitted.
- Special Order Fittings: Unless otherwise specified, fittings that are normally available only by special order must not be used.

Fittings must conform to ANSI 21.10 (AWWA C110), ANSI 21.11 (AWWA C111), or AWWA C153 designed for a working pressure of 250 or 350 psi. Coating and lining requirements must be the same as specified for ductile iron pipe in Section 50-25.03.A, "Water Pipe," of these Specifications. As an alternate, at the Contractor's option, fittings may be coated with a 6 to 8 mil nominal thickness fusion bonded epoxy conforming to the requirements of ANSI/AWWA C550 and C116/A21.16 and certified to ANSI/NSF Standard 61.

Flange gaskets must be no older than 1 year from the date of manufacture at the time of delivery to the job site and must have been continuously protected from sunlight and ozone degradation up to the time of installation.

All buried metal must be encased with 8 mil polyethylene so that no soil is in contact with metal, in compliance with Section 41-5.03, "Polyethylene Encasement."

50-25.03.C Joint Restraints for Ductile Iron Water Pipe

Joint restraints must be rated for a water working pressure of not less than 350 psi with a minimum of 2:1 safety factor. Joint restraining devices must be listed by Underwriters Laboratories (UL) and approved by Factory Mutual (FM).

Push-On Joints: Restrained push-on joints must be a single gasket push-on type joint meeting applicable requirements of ANSI/AWWA C111/A21.11 and must be bell and spigot joints with U.S. Pipe Field Lok Gaskets, or U.S. Pipe TR Flex joint pipe, or approved equal. Only factory spigot ends of pipes or "greenlined" O.D. pipe must be placed into the gasket restraints; field cut pipe exceeding the O.D. tolerances for spigot ends of ductile iron pipe must not be inserted into gasket type restraints.

Mechanical Joints: Restrained mechanical joints must utilize pipe and pipe fittings conforming to ANSI/AWWA C151/A21.51. A retaining gland must provide restraint with lugs that embed 'teeth' into the pipe. Restrained mechanical joints for ductile iron pipe must be EBAA Megalug 1100, Star Pipe Products StarGrip 3000, or approved equal only.

50-26 POLYVINYL CHLORIDE (PVC) WATER AND DRAINAGE PIPE

50-26.01 NOT USED

50-26.02 PVC Pipe for Drainage

Polyvinyl Chloride Pipe for drainage must conform to one of the following Standards:

Diameter (inches)	Standard Designation
12 – 36	ASTM D2241 SDR 32.5
12 – 15	ASTM D3034 SDR 35
18 – 48 (Solid Wall)	ASTM F679
12 – 36 (Profile Wall)	ASTM F949
18 – 60 (Profile Wall)	ASTM F1803
12-48	AWWA C900 DR 25
12— 24	AWWA C909

Substitution (at no extra cost to Agency) of a thicker walled pipe (lower SDR number) is acceptable.

Joints of PVC pipe must consist of either an elastomeric gasket coupling or an integral bell and spigot with an elastomeric gasket. The elastomeric gasket seal must conform to ASTM F477. The assembly of joints must be in accordance with the pipe manufacture's recommendations and the requirements of ASTM D3139 or D3212. The quality of material and installation of all PVC pipe must meet or exceed the requirements of Section 38-10, "Testing of Pipe", of these Specifications.

PVC pipe is not allowed downstream of the last manhole or junction structure to an open channel, detention facility or a daylight condition.

50-26.03 PVC Water Pipe, Fittings, and Joint Restraints

50-26.03.A PVC Water Pipe

Pipe must be the regular product of a firm that has successfully manufactured comparable pipe for at least 3 years, and must be certified by the manufacturer.

The material, manufacturing, testing, and inspection of PVC water pipe must comply with AWWA Standard C900. Pipe must be furnished in minimum standard lengths of 20 feet.

Polyvinyl chloride pipe must have integral wall-thickened bell ends designed for joint assembly using elastomeric gasket seals. The minimum wall thickness of the integral wall-thickened bell, at any point between the ring groove and the pipe barrel, must conform to the DR requirements for the pipe barrel. The minimum wall thickness in the ring-groove and bell-entry sections must equal or exceed the minimum wall thickness of the pipe barrel. The pipe must have a pipe stop indicated on the barrel that will accurately position the pipe end within the joint.

Pipe for potable water must be listed by Underwriters Laboratories (UL).

Pipe Color: Pipe for potable water mains must be blue or white. Pipe for recycled, reclaimed, and non-potable water mains must be purple. Pipe for raw water must be green or white.

50-26.03.B Fittings for PVC Water Pipe

Fittings for C900 PVC water pipe must be ductile iron and must comply with Section 50- 25.03.B, "Water Fittings," of these Specifications.

50-26.03.C Joint Restraints for PVC Water Pipe

Restrained joints must be rated for a working pressure of not less than 150 psi with a minimum of 2:1 safety factor. Joint restraining devices must be listed by Underwriters Laboratories (UL) and approved by Factory Mutual (FM).

50-26.03.C.(1) Restrained Push-on Joints

PVC-to-PVC push-on joint restraints are not permitted. Where a push-on joint is required to be restrained, ductile iron pipe must be used.

50-26.03.C.(2) Restrained Mechanical Joints

Restrained mechanical joints for PVC C900 pipe must utilize pipe and fittings having mechanical joint bells conforming to ANSI/AWWA C110/A21.10 or AWWA C153. A retaining gland must provide restraint with lugs that embed 'teeth' into the pipe. Restrained mechanical joints for PVC pipe must be EBAA Megalug 2000PV, or approved equal only.

50-27 CORRUGATED STEEL PIPE (CSP)

Corrugated steel pipe must conform to the material and fabrication methods of the State Specifications, except as modified in these Specifications. Corrugated steel pipe can only be used for driveway culverts and when specified in the Contract. CSP may not be used for mainline drainage facilities. All corrugated steel pipe must be fabricated with helical corrugations and with a continuous lock or weld seam extending from end to end of each length of pipe. Steel must be zinc coated unless otherwise specified. Helically corrugated steel pipe must be fabricated using corrugation profiles as shown in the following table:

TABLE 50-3 CORRUGATION PROFILE			
Diameter (Inches)	Normal Pitch (Inches)	Maximum Pitch (Inches)	Minimum Depth (Inches)
8 and 10	1-1/2	1 - 7 / 8	1/4- 4
12 through 96	2-2/3	2 - 3 / 4	1/2- 2
48 through 120	3	3-1/4	1
Note: The corrugation profile of 2-2/3" x 1 1/2" must be used for all pipes from twelve-inch (12") through ninety-six-inch (96") diameter, unless otherwise shown on or specified in the Contract.			

Lock or welded seams must develop the full strength of the pipe in accordance with the herein referenced Specifications.

Pipe that has been patched will be rejected.

The pipe must have a minimum maintenance-free service life of 50 years in accordance with the methods specified in Sections 854.3 and 854.4 of the latest version of the California Department of Transportation Highway Design Manual.

Corrugated steel products must be shipped, handled, and placed in such a manner as to prevent scaling, bruising, or breaking of the galvanized surface or protective coating.

Couplings for corrugated steel pipe must be of durable gasket design. Couplings must be galvanized steel coupling bands fitted with gaskets fabricated from neoprene or butyl rubber or other durable resilient material approved by the Agency, and assembled to form a sealed joint. The Agency might require that the coupling design be submitted for approval prior to placing, and might require supporting data showing that the coupling is tight and durable. Heat-shrinkable plastic couplings are not permitted.

Corrugated steel pipe fittings must be constructed of the thickness of steel called for in the Contract.

The fittings must conform to the details shown on the Plans or Standard Drawings.

Mitered joints must be welded from the inside where practicable. Welded joints must be as smooth and even as practicable. Welded joints must be repaired according to the State Specifications.

All fabrication must be done in accordance with generally accepted practice for good workmanship. The Contractor must notify the Agency at least 48 hours before delivery of the fittings so the Agency

may inspect the fittings at the fabrication plant.

Diameter of fittings depends on the pipe option selected by the Contractor. Upstream diameter of fittings must match upstream pipe diameter; downstream diameter of fittings must match downstream pipe diameter.

If the size of the corrugated pipe fitting is too large to conveniently fabricate or transport in 1 piece, the fitting may be fabricated in 2 or more pieces that will be jointed at the site with couplings. The joint must be located sufficiently distant from a welded joint so that there is no interference between the coupling and the welded joint.

50-28 RIBBED STEEL PIPE (RSP)

Ribbed steel pipe must meet the requirements for corrugated steel pipe in the State Specifications, except as modified in these Specifications. Ribbed steel pipe can only be used for driveway culverts and when specified in the Contract. RSP may not be used for mainline drainage facilities. Steel must be zinc coated unless otherwise specified. Ribbed steel pipe must be fabricated to one of the following configurations:

- a. The pipe must be fabricated to meet the requirements for Type IR pipe as specified in ASTM A760, Sections 4, 7, 8, and 10; or
- b. The pipe must consist of pipe with $\frac{3}{4}$ by $\frac{3}{4}$ inch inside dimensions, outward projecting reinforcing ribs located on approximately 7-1/2 inch centers. The ribs must be located symmetrically between lockseams, which must be on approximately 22-1/2 inch centers. All ribs must be helical and continuous.

Ribbed steel pipe must be fabricated with a continuous helical lock seam in accordance with the State Specifications. Lock seams must develop the full strength of the pipe.

The pipe must be furnished with re-rolled ends to produce a profile for connecting with the approved coupling band.

Any pipe that has been damaged during fabrication, handling, or construction will be rejected or repaired to the satisfaction of the Agency.

Lateral field connections between metal pipes must be welded and any galvanizing damaged by welding must be repaired according to the State Specifications.

The pipe must have a minimum maintenance-free service life of 50 years in accordance with the methods specified in Sections 854.3 and 854.4 of the latest version of the California Department of Transportation Highway Design Manual.

Ribbed steel pipe must be shipped, handled, and laid in such a manner as to prevent bruising, scaling or breaking of the galvanized surface or protective coating.

Coupling bands for ribbed steel pipe must be manufactured from 0.064 inch thick galvanized steel conforming to the State Specifications. The coupling bands must be a hat shaped band, winged band, annular band, or other approved design, and must be fitted with gaskets fabricated from neoprene or butyl rubber or other durable, resilient material approved by the Agency, and assembled in such a manner as to form a sealed joint.

Hat shaped band and winged band couplers must conform to the following table:

TABLE 50-4 BAND COUPLER/RIBBED STEEL PIPE (Dimensions in Inches)					
Pipe Size	Band Type	Band Minimum Thickness	Flange Height	Band Width	Bolt Diameter
24— 36	Hat	0.064	5/8	2-3/4	1/2-2
42— 90	Winged	0.064	5/8	7-1/2	1/2-2* *(2 required)

Ribbed steel pipe fittings must conform to the requirements for corrugated steel pipe fittings specified in Section 50-27, "Corrugated Steel Pipe (CSP)", of these Specifications, except that the material must be ribbed steel.

50-29 CORRUGATED ALUMINUM PIPE (CAP)

Corrugated aluminum pipe must conform to the material and fabrication methods of AASHTO M196 and as modified herein. Corrugated aluminum pipe can only be used for driveway culverts and when specified in the Contract. CAP may not be used for mainline drainage facilities. All corrugated aluminum pipe must be fabricated with helical corrugations and with a continuous lock seam extending from end to end of each length of pipe. Helically corrugated aluminum pipe must be fabricated using corrugation profiles as shown in the following table:

TABLE 50-5 CORRUGATION PROFILE			
Diameter (Inches)	Normal Pitch (Inches)	Maximum Pitch (Inches)	Minimum Depth (Inches)
8 and 10	1-1/2	1 - 7 / 8	1/4
12 through 96	2-2/3	2 - 3 / 4	1/2
48 through 120	3	3-1/4	1
Note: The corrugation profile of 2-2/3" x 1/2" must be used for all pipes from twelve-inch (12") through ninety-six-inch (96") diameter, unless otherwise shown on or specified in the Contract.			

Couplings for corrugated aluminum pipe must be of a durable, tight design. Couplings must be aluminum coupling bands fitted with gaskets fabricated from neoprene or butyl rubber, or other durable resilient material approved by the Agency and assembled to form a tight joint. The Agency might require that the coupling design be submitted for approval prior to placing, and might require supporting data showing that the coupling is tight and durable. Heat-shrinkable plastic couplings are not permitted.

Corrugated aluminum pipe fittings must be constructed of the gauge aluminum indicated on the

Plans.

The fittings must conform to the details shown on the Plans or Standard Drawings.

All fabrication must be done in accordance with generally accepted practice for good workmanship. The Contractor must notify the Agency at least 48 hours before delivery of the fittings so that the Agency may inspect the fittings at the fabrication plant.

Diameter of the fittings will depend on the pipe option selected by the Contractor. Upstream diameter of the fittings must match upstream pipe diameter; downstream diameter of fittings must

match downstream pipe diameter.

If the size of the corrugated pipe fitting is too large to conveniently fabricate or transport in one piece, the fitting may be fabricated in 2 or more parts, which will then be jointed at the site with couplings. The joint must be located sufficiently distant from a welded joint so that there is no interference between the coupling and the welded joint.

50-30 POLYPROPYLENE PIPE (PP)

Polypropylene Pipe (PP) shall conform to ASTM F2764 for 12-60 inch diameter pipe or ASTM F2881 for 12-30 inch diameter pipe. PP joints must be watertight in accordance with ASTM D3212 with gaskets conforming to ASTM F477. PP connections to manholes must conform to ASTM F2510 and all PP connections must conform to Standard Drawing 9-39. Maximum cover exceeding 20 feet must be reviewed and approved on a case-by-case basis by the Agency.

50-31 FIELD ASSEMBLED PLATE CULVERT

Field assembled plate culverts must conform to the State Specifications and can only be used for driveway culverts or if specified in the Contract. They cannot be used for mainline drainage.

50-32 REINFORCING STEEL

Reinforcing steel must conform to the State Specifications. Unless shown or specified in the Contract, bar reinforcement must be deformed Grade 60 conforming to ASTM A615.

Welded steel wire fabric for concrete reinforcement must conform to ASTM A185. The gauge of the wire and the dimensions of the mesh will be as shown or specified in the Contract.

50-33 CURB DOWEL AND TIE BARS

Dowel and tie bars for curbs must be bar reinforcement conforming to Section 50-32, "Reinforcing Steel", in this Section of these Specifications. At the Contractor's option, either Grade 60 or Grade 40 may be used.

50-34 STORM DRAIN CASTINGS

Castings for manhole frames and covers, drop inlet frames, gutter drain frames, open-back hoods, or other purposes must be tough gray iron, free from cracks, holes, swells, and cold sheets, and be of workmanlike finish. A "Certificate of Compliance" signed by an authorized agent of the manufacturer or supplier is required and must be provided to the Agency. Each certificate must be accompanied by a copy of test results stating that the material has been sampled, tested, and inspected in accordance with the provisions of ASTM A48, Gray Iron Castings Class 35B.

Test bars must be cast and tested for the first lot of casting and every 4 months thereafter. If production is interrupted for any period longer than 4 months, test bars must be cast and tested from the initial lot after production is resumed and every 4 months thereafter. The first lot is defined as the first castings produced after January 1 every year. The tension tests specified must be performed and the results certified by an independent testing laboratory.

The cast iron must meet the requirements of ASTM A 48, Class 35. The seating faces of manhole covers and frames must be machined as shown on the Standard Drawings or Plans to assure a tight fit and prevent rocking. The name of the manufacturer and the day, month, and year of manufacture must be cast on the manhole cover and frame.

Twenty-four inch diameter manhole frames and covers must conform to Standard Drawings 9-9A, 9-9B and 9-11, unless otherwise shown on the Plans or specified in the Special Provisions.

Thirty-six inch diameter manhole frames and covers must conform to Standard Drawings 9- 9B and 10, unless otherwise shown on the Plans or in the Special Provisions.

When required by the Agency, proof-load tests must be performed on manhole frames and covers in accordance with Section 3.3 of Federal Specification A-A-60005.

When locking type covers are specified for storm drain manholes, they must be standard covers drilled and tapped on 120 degree centers and bolted to the frame with 7/16 by 1-1/4 inch brass hex head cap screws.

Exposed edges of castings must be chamfered or rounded, and exposed surfaces must be smooth

unless otherwise shown.

Manhole frames and covers must be clearly marked with the country of origin as specified in the Trade of Tariff Act of 1984.

At the Contractor's option, drop inlet frames and open back hoods may be fabricated from steel plate as structural shapes in lieu of cast iron. If the Contractor elects to use fabricated steel drop inlet frames or open back hoods, the Contractor must submit Working Drawings to the Agency for approval prior to fabrication. This submittal requirement does not apply to the drop inlet frame shown on Standard Drawing 9-14.

50-35 WATER PIPE

Water distribution system pipe must be of the material type as shown or specified in the Contract and must conform to these Specifications.

All pipes must be the regular product of a firm that has successfully manufactured comparable pipe for at least 3 years.

All pipe, valves, fittings, connections, and appurtenances must conform to the provisions of these Specifications or the Special Provisions. The Agency maintains a list of approved hydrants and water service material and fittings, and material used in the Work must be limited to those listed. Alternative material items may be added to this list upon review and testing by the Agency.

All testing requirements of the ASTM and AWWA specifications must be conducted by the pipe manufacturer or the manufacturer's representative within the State of California. The resulting tests must be certified by an established reputable firm operating in the testing materials field. The certification must accompany the delivery of the materials to the work site.

Joints must be push-on or mechanical type and must conform to ANSI 21.11 (AWWA C111) or ASTM D3139 with elastomeric gaskets unless otherwise specified in the Contract. Gasket lubricant must be minimum required plus 10 percent.

Ductile iron pipe must conform to the requirements of Section 50-25, "Ductile Iron Pipe (DIP), and Cast Iron Pipe and Ductile Iron Fittings", of these Specifications, unless specified otherwise in the Contract. Ductile iron pipe must be encased in 8-mil polyethylene in accordance with AWWA C105.

Polyvinyl Chloride (PVC) Pipe for water distribution systems must conform to Section 50-26 "Polyvinyl Chloride (PVC) Water and Drainage Pipe", of these Specifications, unless specified otherwise in the Contract.

50-36 WATER PIPE FITTINGS

Fittings for ductile iron and C900 water pipe must be ductile iron and must comply with Section 50-25.03, "Water Fittings", of these Specifications.

50-37 FIRE HYDRANTS

Fire hydrants must comply with Standard Drawings 8-2A and 8-2B. Fire hydrants must be wet barrel type meeting the requirements of AWWA Standards C503. Wet barrel hydrants must have a replaceable flanged spool "breakable" section to be installed 2 inches above the ground. Use solid bolts on "breakable" spool sections.

Delivery classification is two-hose and one-pumper nozzle, having "National Standard Fire Hose Coupling Screw Threads" conforming to NFPA 194 and ANSI B 26. Hose nozzles must be for 2-1/2 inch hose and pumper nozzle must be for 4-1/2 inch hose. The operating nuts and nozzle caps must be National Standard pentagon dimensions, open left (counter clockwise).

Hydrants must be furnished with two layers of factory-applied white coatings. Coatings must be polyurethane epoxy, Alkyd, or epoxy base coat with Acrylic topcoat. Coating thickness must be in accordance with coating manufacturer's requirements. Epoxy topcoats must not be allowed.

Field touch-ups of damage to coating must be done with coating sample provided by the manufacturer and must be the same type and color as the factory applied coating.

50-38 VALVES

Types of valves to be installed will be specified on the Plans. Unless otherwise shown on the Plans, valves provided must open to the left (counterclockwise), and be furnished with flange, mechanical or

push-on joint. Valves must bear the registered certification mark of the AWWA, be NSF certified, and be listed by Underwriters Laboratories (UL), and approved by Factory Mutual (FM). All installed valves must operate smoothly with no more than 25 foot-pounds torque. Valves operating at torques greater than 25 foot-pounds require approval by the Agency. Valves 3" through 8" must be gate valves. Ten-inch valves may be gate or butterfly valves. Valves 12" and larger must be butterfly valves. Valves with an operating nut deeper than 10 feet below grade must be provided with an extension stem with operating nut and centering disk. Gaskets for flanged valve connections must be type SBR elastomer per ANSI/AWWA C111/A21.11 and 1/8-inch thick. Gaskets for mechanical joint connections must be type SBR elastomer per ANSI/AWWA C111/A21.11. Gaskets must not be any older than one year from the date of manufacturer.

50-38.01 Gate Valves

Gate Valves must be ductile iron body, with bronze stem nuts, glands and bushings, non-rising stem (NRS), working water pressure of 200 psi, conforming to the requirements of AWWA Standard C509 or C515. Resilient-seated gate valves must have resilient seats bonded or mechanically attached to the gate. The valve must have a 2-inch square operating nut. Unless otherwise specified or shown on the Plans, valves must be furnished with ends flanged or mechanical joint, using an elastomeric-gasket seal, and must conform in dimensions and style to the pipe and/or fitting requirements. All gate valves must be coated and lined with a fusion bonded epoxy in accordance with AWWA Standard C550. Metal surfaces to be coated or lined must be sandblasted in accordance with SSPC-SP10. Finished or bearing surfaces must not be painted. Exposed machined surfaces must be covered with slush grease or other readily removable protective coating before shipment.

50-38.02 Butterfly Valves

Butterfly valves must meet AWWA Standard C504 Standard for Rubber-Seated Butterfly Valves, Class 150B, Short Body and the requirements of this Section. Butterfly valves must be rated at 150 psi working pressure and provide drip tight shut-off at 150 psi of pressure. Butterfly valves must have flanged ends that meet the requirements of AWWA C207 Class D flanges. Valves must be provided with manual actuators, sized for bi-directional 150B service and must open counter-clockwise.

Butterfly valves must be constructed of the following materials:

- Shaft—Type 304 Stainless Steel, ASTM A276
- Disc—Cast Iron, ASTM A-126 Class B or ASTM A-48 Class 40 Disc Edge—Type 316 Stainless Steel
- Rubber Seat—Neoprene or Buna-N Body—Cast Iron, ASTM A126, Class B
- Lining and Coating—Polyamide epoxy, minimum dry thickness six (6) mils, NSF approved for potable water

Valve body must be a one-piece casting and must include two integral B16.1 Class 125 flat-face flanges, two bearing trunnions and a pad for mounting bonnet with actuator. Raised marking plate must be welded or riveted to the valve body showing the manufacturer's name or mark, the year of valve casting, the valve diameter and the AWWA class rating.

Valves seats must be mechanically retained in or suitably cemented to the valve body so as to adhere without leakage under all conditions of service. Valve seats must be Buna N rubber or Neoprene located on the valve body. For valve sizes 20 inches and smaller, valves must have bonded seats that must withstand a 70 pound pull under ASTM D429 test procedure. Bonded seats must be located in recessed groove in the valve body. Seating edge must be 316 stainless steel metal, ground smooth and polished. Seating edge must be located on the valve disc. Rubber seats must be no older than 1 year from date of manufacturer at the time of delivery to the job site and must be protected from sunlight and ozone degradation prior to installation.

Since the entire valve and actuator will be coated for corrosion resistance, a cast-iron spacer will be provided between the actuator and valve body, which will completely seal off their interconnecting shaft and the main valve shaft stuffing box, if present.

The valve shaft seals must be self-adjusting, Chevron V-Type packing seals. Shaft seals must be designed to allow replacement of the seals without having to remove the valve shaft.

Valve actuator must be of the buried and submersible, permanently lubricated traveling nut type for valves 12 inches and smaller terminating in a water works standard 2 inch square operating nut marked for direction of opening. The manual actuator must be designed to produce the required maximum torque at the operating nut of 150 foot-pounds.

The valve actuator must be fully greased-packed and have stops in the open/close position. The actuator must have a mechanical stop that will withstand an input force of 450 foot-pounds. The mechanism must be inherently self-locking and must hold the valve disc rigidly in position, free of flutter, for any degree of valve opening.

Machining and fitting of each part must be held to a close tolerance to minimize backlash and lost motion. The mechanism must be totally enclosed in a rugged lubricant tight and watertight case. The actuator must have a bleed-off connection to protect against leakage past the shaft packing from entering the actuator housing. A gasketed removable cover plate must be provided for maintenance purposes. All moving parts must work completely submerged in a petroleum based grease. The case must be filled with the proper lubricant and sealed before shipment.

The operating screw rod must be high strength steel. External bolts and nuts on the actuator housing must be cadmium plated high strength steel.

Butterfly valves must be coated and lined with a two-part polyamide epoxy in accordance with AWWA Standard C550. Metal surfaces to be coated or lined must be sandblasted in accordance with SSPC-SP10. Finished or bearing surfaces must not be painted. Exposed machined surfaces must be covered with slush grease or other readily removable protective coating before shipment.

50-38.03 Air Release/Vacuum Valves

Air valves must be air release/vacuum type valves. The body and cover of the valve must be cast iron unless otherwise approved by the Agency. All interior parts must be stainless steel. Air release/vacuum valves must be fully automatic and requiring no regular maintenance.

Air release/vacuum valves must be capable of automatically releasing accumulated air from a water system while that system is in operation and under pressure. Also, the valve must automatically allow air to reenter the pipeline when the internal pressure of the pipeline becomes negative due to draining of the pipeline, a power outage, pipeline break, etc.

Air release/vacuum valves must be set plumb, and properly fitted to the high points on the water main. Air release/vacuum valves will be required at other locations on long stretches of pipe as shown on the plans. A vault with adequate venting and drainage must be provided as required. The air release/vacuum valve and appurtenances must be of material listed and must be installed as shown in Standard Details 8-14A or 8-14B.

50-39 VALVE BOXES, COVERS, DROP CAPS, AND SERVICE VALVE BOXES

Valve boxes for traffic service must be precast concrete and must have a cast iron face and a cast iron traffic lid. Valve boxes out of traffic areas must be precast concrete, with a cast iron lid. Covers must be marked "WATER" and must have a loose fit in the box. Valve box risers must be PVC C900 (blue or white for potable water mains). Materials must be provided and installed in accordance with Standard Drawing 8-5.

50-40 WATER SERVICE CONNECTION MATERIALS

50-40.01 General

Water services and meters must conform to Standard Drawings 8-1 and 8-6A, 8-6B or 8-6C, depending on size and type of service. Residential water service lines must be 1-1/2 inches in diameter with a 1 inch water meter unless otherwise specified.

Water service pipe material up to and including 2 inches in diameter must be polyethylene pressure pipe meeting standards of AWWA C901, or copper water tubing, "Type K", soft tempered, meeting ASTM B88 and AWWA C800. Polyethylene pipe must be high density, ultra- high molecular weight and

meet all applicable requirements, including testing, of Type III, Grade P33 or P34, Class C, designated as PE 3408 in ASTM D2239 and D1248. The polyethylene pipe must have a minimum pressure rating of 200 psi, must be homogeneous throughout and free of cracks, holes, foreign inclusions or other defects, must be uniform in color, opacity, density and other physical properties. Polyethylene pipe must be supplied with markings, at intervals of not more than 5 feet, indicating nominal pipe size, designation, pressure class, and manufacturer's name or trademark. Polyethylene must be manufactured to iron pipe size (IPS).

Material for service lines 3 inches in diameter and larger must be ductile iron between the water main and the meter. Hot tap materials for services connections 3 inches and larger must comply with Section 41.14, "Connection to Existing Water Mains", of these Specifications. All buried metal must be wrapped in 8 mil polyethylene so that no soil is in contact with metal in compliance with Section 41-5.03, "Polyethylene Encasement", of these Specifications.

The Agency maintains a listing of approved water service connection fittings that establish a standard of material quality. Only fittings from the list are allowed to be used.

50-40.02 Water Meters and Meter Boxes

Water meters, boxes, and appurtenances must comply with Standard Drawings 8-6A, 8-6B, and 8-6C. The size of the meter must be as specified in the Plans. If not specified in the Plans, the size of the meter must be the same size as the service line at the connection to the main.

50-41 JOINT MATERIALS FOR MANHOLES

Joint materials for precast reinforced concrete manhole sections must conform to one of the following:

1. Mortar proportioned as 1 cubic foot of portland cement to 2 cubic feet of concrete sand. All mortar must be used within 30 minutes after the mixing water has been added.
2. Preformed plastic sealing compound must conform to Type 1 - Rope Form, one and 1-1/2-inch diameter, Federal Specification SS-S-210A.
3. Pre-Extruded concrete joint sealant per ASTM C-990 (RAM-NEK (K.T. Snyder), QUIKSEAL (Associated Concrete Products), or equal).
4. Rubber Gaskets, ASTM C443

50-42 FENCING - CHAIN LINK

Chain link fence and gate materials must conform to the State Specifications, and these Specifications.

The carbon content of steel posts must not exceed 0.82 percent.

Chain link fence fabric must meet the requirements of zinc-coated steel chain link fence fabric, ASTM A392 with Class 1 zinc coating. Unless otherwise shown on the Plans or specified in the Special Provisions, the fabric must be a 2-inch mesh of 9 gauge wire, with a minimum breaking strength of 1,290 pounds.

Vinyl coated chain link fence fabric, when shown on the Plans or specified in the Special Provisions, must be black polyvinyl chloride coated steel link fabric and fittings. Polyvinyl chloride must be applied by the thermal extrusion process.

Slats must be as specified in the Special Provisions.

Base material for the manufacture of steel pipe used for posts, braces, rails and gate frames must be commercial quality, or better, weldable steel, conforming to the specifications of ASTM A120. At the option of the Contractor, and upon approval of the Agency; high-strength tubing fabricated by cold rolling and radio frequency welding from steel conforming to ASTM A446, Grade D, may be used provided that the product of the yield strength and the section modulus is not less than that of pipe conforming to ASTM A120.

The base material for the manufacture of other steel sections used for posts and braces must conform to ASTM A572, Grade 45, with a minimum yield strength of 40,000 psi. All posts, braces, rails and gate frames must be hot dipped galvanized in accordance with ASTM A123, or ASTM A525, Coating Designation G235 plus chromate conversion coating and 0.4 mils minimum thickness finish

coat of clear, cross-linked acrylic.

Posts and rails for vinyl coated chain link fence must be hot dipped galvanized and covered with 2 coats of black metal paint applied over a metal primer.

Posts and rails must be as specified in the following Table 50-7, unless otherwise shown or specified in the Contract. The Contractor has the option of section types to be used with the condition that the option exercised must be uniform throughout the Work.

TABLE 50-7 CHAIN LINK FENCING – POSTS AND RAILS				
Fence Member		Section Type	Dimension O.D.	Minimum Weight (Pounds Per Linear Foot)
Line Posts		C-Section	1.875"	2.15
		Sch. 40 pipe	2.375"	3.65
		Hi-Strength tubing	2.375"	3.12
Terminal, Corner & Latch Posts		Sch. 40 pipe'	2.875"	5.79
		Hi-Strength tubing	2.875"	4.64
Horizontal & Diagonal Braces, Top Rails		C-Section	1.825"	1.35
		Sch. 40 pipe	1.660"	2.27
		Hi-Strength tubing	1.660"	1.82
Gate Frames		Sch. 40 pipe	2.375"	3.65
		Hi-Strength tubing	2.375"	3.12
Gate Posts	Gate width up through 6'	Sch. 40 pipe	2.875"	5.79
	Gate width over 6' through 12'	Sch. 40 pipe	4.500"	10.79
	Gate width over 12' through 18'	Sch. 40 pipe	5.563"	14.62
	Gate width over 18' to 24' max	Sch. 40 pipe	6.625"	18.97

Fittings must be hot-dip galvanized malleable iron, wrought iron, or pressed steel.

A Certificate of Compliance must be furnished to the Agency prior to the installation of any chain link fencing, gates, or components.

50-43 LANDSCAPING MATERIALS

50-43.01 Topsoil

Topsoil must be sandy loam of an even texture and must pass through a 1/2-inch screen.

The topsoil must be reasonably free refuse, roots, heavy or stiff clay, stones larger than one inch in diameter, coarse sand, noxious weed seeds, sticks, litter, insects, animal life, and other deleterious substances or any toxic substances that may be detrimental to the growth of vegetation. Topsoil must be capable of sustaining healthy plant life.

Soil sterilizers or weed killers must permit growth of nursery stock planted 3 weeks after application. Compounds containing cyanide or arsenic are not allowed.

The Contractor must provide a soils report to the Agency for approval prior to placement of topsoil. The report must indicate the source and location of the topsoil, and the date the sample or samples were obtained and analyzed. The soils fertility test shall be completed no earlier than the date

of the project preconstruction meeting, or three months from delivery of topsoil to the site, whichever date is more recent. Providing topsoil from more than one supplier or from a non-commercial source is subject to Agency approval. A high proportion of clay texture will not be accepted. All topsoil imported must be uniform in nature and obtained from a single source, unless otherwise approved by the Agency. Topsoil must be in conformance with these Specifications and the following:

SOIL ELEMENTS	ACCEPTABLE RANGE
pH	6.6 - 8.0
CEC (Cation Exchange Capacity)	12.00 - 35.00 meg/100g
SAR (Sodium Absorption Ratio)	less than 5.00
ESP (Exchangeable Sodium Percentage)	less than 5.00
EC (Electronic Conductivity)	Less than 2.0 mmho/cm
SP (Saturation Percentage)	less than 45%
Percentage Organic Matter	2% - 5%

Soils analysis must include measurements in parts per million (ppm) of the following trace elements: nitrate, phosphorus, potassium, sulfur, chloride, carbonates, sodium, calcium magnesium, boron, copper, iron, manganese, and zinc.

Topsoil found with trace element amounts excessive or at levels detrimental to plant health may not be used.

In addition to providing a soils fertility report, the Contractor shall provide a one-quart size sample of the topsoil for review and approval, prior to delivery on site. A transmittal or label clearly identifying the source, source address of the topsoil, and name of the project, plus an extra copy of the soils fertility test shall accompany sample.

Topsoil analysis and amendment recommendations must be performed by an approved agronomic soils lab. Soil sampling must be conducted in accordance with laboratory protocol, including industry practices regarding adequate sampling depth and quantity.

Topsoil must be delivered reasonably dry and in a workable condition.

Sandy loam of low fertility, even though mixed with leaf mold, manure, or other fertilizers, is not acceptable unless prior approval has been granted by the Agency. The Contractor must attach soil and plant lab reports for the Agency's approval.

50-43.02 Commercial Fertilizer

Commercial fertilizer must conform to the requirements of the California Food and Agricultural Code.

Plant tablets or packets for planting trees and shrubs must be non-burning, controlled slow release fertilizer, weighing between 5 and 21 grams of the following guaranteed analysis range:

Total Nitrogen	16.0 to 20.0 percent
Phosphoric Acid, available	8.0 to 10.0 percent
Potash, soluble	5.0 to 8.0 percent
other minor micronutrients	as approved by Agency

Quantities of planting tablets or packets per plant must be based on the manufacturer's recommendation unless otherwise specified in the Special Provisions.

Fertilizer used for planting maintenance must have a minimum guaranteed chemical analysis of 21 percent nitrogen, 0 percent phosphoric acid, and 0 percent soluble potash.

Fertilizer for turf installation, unless otherwise specified, must have a minimum guaranteed chemical analysis of 21 percent nitrogen, 10 percent phosphoric acid and 10 percent soluble potash.

Fertilizer for tree, turf, and shrub plantings must be in granular or pellet form, must conform to the standards of the Association of Official Agricultural Chemists, and must provide the minimum percentage of available nutrients specified in the Plans or Special Provisions. A liquid fertilizer may be used if specified in the Special Provisions.

Fertilizer used for erosion control work must be in a form that will readily disperse into the slurry, and must have a minimum guaranteed chemical analysis of 6 percent nitrogen, 20 percent phosphoric acid, and 20 percent soluble potash.

50-43.03 Soil Amendments

Soil amendments shall be a ground wood product such as bark, redwood fortified with nitrogen and treated to absorb water quickly, or a relatively dry organic compost derived from recovered organic waste products processed at a permitted facility participating in the US Composting Council Seal of Testing Assurance (STA) Certified Compost program. Soil amendments shall be friable and free of weed seed, dust and other objectionable materials. Soil amendments shall pass a one inch (1") sieve and shall comply with the requirements in the California Food and Agricultural Code.

For compost derived from recovered organic waste, a fertility test shall be completed no earlier than the date of the project preconstruction meeting or three months from delivery of compost to the site, whichever date is more recent, and shall be provided as part of the Contract. The compost sample shall be submitted to the same testing facility as the soil sample (refer to Section 20-2.02, "Topsoil," of these Specifications). The testing facility shall provide recommendations for using the compost in amending the soil based on the findings.

50-43.04 Iron Sulfate

Iron sulfate must be ferrous sulfate in pellet or granular form containing at least 18.5 percent iron expressed as metallic iron. Iron sulfate must conform to the requirements of the California Food and Agricultural Code.

50-43.05 Pre-emergent Herbicide

Selective pre-emergent herbicide must be in granular form and applied in the manner recommended by the manufacturer. Pre-emergent must be appropriate type for the control of annual grasses and broadleaf weeds in shrub, ground cover, and turf areas. Pre-emergent must conform to the requirements of the California Food and Agricultural Code.

50-43.06 Straw

Straw must be derived from wheat, rice, or barley. The Contractor must furnish to the Agency evidence that clearance has been obtained from the Sacramento County Agricultural Commissioner, as required by law, before straw obtained from outside the County is delivered to the site of the Work. Straw that has been used for stable bedding must not be used.

50-43.07 Fiber

Fiber used for hydroseeding must be wood fiber, or a combination of wood and cellulose fiber. Cellulose fiber, if blended with wood fiber, must not exceed 50% of the fiber mix. Fiber for bonded fiber matrix must be 100 percent wood fiber. Use of an alternate fiber material must be approved by the Agency.

Wood fiber must be a long strand, whole wood fiber thermo-mechanically processed from clean whole wood chips. Cellulose fiber must be made from natural or recycled pulp fiber, such as wood chips, sawdust, newsprint, chipboard, corrugated cardboard, or a combination of these materials. Wood and cellulose fiber must be free of synthetic or plastic materials.

Fiber must contain three-quarter inch (3/4") strands for at least 25 percent by total volume; have at least 40 percent retained when passed through a no.25 sieve; contain less than 250 parts per million (ppm) of boron; and less than seven percent (7%) ash, as tested under Technical Association of the Pulp and Paper Industry (TAPPI Standard T413). Fiber must disperse uniformly into slurry when mixed with water. Fiber must be colored to contrast with the area on which the fiber is to be applied, must not stain concrete or painted surfaces, and must be biodegradable, nontoxic, and free from copper,

mercury and arsenic. The slurry, when hydraulically applied to the ground, must form an absorptive mat of mulch uniformly impregnated with seed and other ingredients. No materials that inhibit growth or germination must be present in the mixture. Material must be nontoxic to plants and animal life.

50-43.08 Mulch

Unless otherwise specified in the Contract, mulch shall consist of wood chips, tree bark, or shredded bark, or any combination thereof. Shredded redwood bark ("gorilla hair") or materials deemed highly flammable or a potential fire hazard by the Agency must not be used.

Wood chips must be manufactured from clean wood. They must be between 1/2 and 3 inches long, at least 3/8 inch wide, and 1/16 inch thick. At least 85 percent, by volume, of the chips must conform to the sizes specified.

Tree bark must be between 1/2 and 1-1/2 inches and must be free of salt and foreign materials such as clods, coarse objects, sticks, rocks, weeds, or weed seeds.

Shredded bark must be a mixture of shredded bark and wood; must measure between 1/8 and 1-1/2 inches thick and 1 to 8 inches long; and must be free of salt and deleterious materials such as clods, coarse objects, and rocks. At least 75 percent, by volume, of shredded bark must conform to the sizes specified.

50-43.09 Planting Mix

Planting mix for backfilling planting holes shall consist of 3 parts of soil excavated from the planting holes free of rocks over 1/2 inch in diameter and 1 part soil amendment, thoroughly mixed. 50-43.10 Seed.

Seed must be furnished separately or in mixtures in standard sealed containers labeled with the seed name, lot number, net weight, percentage of purity, germination and hard seed, and percentage of maximum wildflower or grass seed content for each kind of seed furnished and, in the case of a mixture, the proportions of each kind of seed.

The Contractor must furnish the Agency duplicate signed copies of a certificate of compliance from the vendor certifying that each lot of seed has been tested by a recognized seed testing laboratory within 6 months of date of delivery to the job site. The testing must be in conformance with test procedure standards of the Association of Official Seed Analysts and the provisions of the Agricultural Code of the State of California. The certificate of compliance must include the name and address of the laboratory, the date of the test, the lot number for each kind of seed, and results of tests by name, percentages of purity and of germination, and percentage of wildflower or grass content for each kind of seed furnished and, in case of a mixture, the proportions of each kind of seed.

Seed with less than the specified purity or germination can be used under the following conditions:

- a. The application rate for such seed must be increased to compensate for the less than specified purity or germination.
- b. Prior to using such seed, the Contractor must submit to the Agency the purity and germination percentages, and the proposed increased application rate for such seed.
- c. No such seed must be used before the Agency has approved, in writing, the use of such seed and the increased application rate.
- d. The additional seed required because of the increased application rate must be furnished and applied at the Contractor's expense.

Seed specified without a purity or germination requirement must be labeled to include the name, date (month and year) collected and name and address of the supplier. Seed must be, at the time of sowing, from the previous or current year's harvest.

Seeds that become wet, moldy, or otherwise damaged in transit or in storage will be subject to retest at the discretion of the Agency.

50-43.10.A Turf Seed

Turf seed or mixtures of seed are classified by type according to species or variety of grass. Types of seed or seed mixtures must be as shown on the Plans or specified in the Special Provisions.

Lawn seed must be true to species or variety for the type as specified and must conform to the Agricultural Code of the State of California and the standards of the Association of Official Seed Analysts.

50-43.10.B Wildflower Seed for Hydroseeding

Wildflower seed type to be used for hydroseeding must be as indicated in the Plans or Special Provisions.

Seed must be labeled in accordance with the California Department of Agriculture, State Seed Law requirements, effective on the date of invitation for bids. The seed must be supplied in unopened containers from a commercial seed dealer and may either be mixed or in separate containers for each lot. Tags must be given to the Agency. Final acceptance will not be considered unless all tags are produced and verified.

50-43.11 Tackifier

Tackifier must be a concentrated liquid chemical stabilizing emulsion that forms a plastic film upon drying and allows water and air to penetrate. The film must be nonflammable and must have an effective life of at least one year.

Stabilizing emulsion must be nontoxic to plant and animal life and non-staining to concrete and painted surfaces. In the cured state, the tackifier may not be re-emulsified. Tackifier must be miscible with water at the time of mixing and application.

50-43.12 Lumber

Lumber must be construction grade cedar, pressure treated Douglas fir, or heart redwood, rough cut, from sound timber. It must be straight and free from loose or unsound knots, shakes in excess of 1/3 the thickness of the lumber, splits longer than the thickness of the lumber, or other defect that would render the lumber unfit structurally for the purpose intended. Knots in lumber must be sound, tight, well-spaced, and must not exceed 2 inches on any face. Sweep must not exceed 0.08 foot in 6 feet.

50-43.13 Tree Stakes and Ties

Stakes for support of trees must be lodge-pole pine, unless otherwise specified in the Special Provisions. Stakes for trees up to 15 gallon must be 2-inch diameter by 10 feet long. Stakes for 24-inch box trees or larger must be 2-inch diameter by 12 long. Tree ties must be black rubber cinch ties, unless otherwise specified in the Special Provisions.

50-43.14 Root Control Barrier

Root control barrier must be an injection molded or extruded modular component made of high density polypropylene or polyethylene plastic with ultraviolet inhibitors. Panels must have a minimum thickness of 0.080 inch (2.032 mm). Each panel must have molded vertical ribs (4 minimum) and locking strips or integral male/female sliding locks. Locking strips or integral self slide locks must have a close tolerance to restrict any slippage between panels. Vertical root deflecting ribs or channels must be 1/2 to 3/4 inch high on one side, perpendicular to the panel, and not more than 8 inches apart. Panels must be 24 by 24 inches unless otherwise specified in the Contract. The Contractor shall use Deep Root, Century Products, or an approved equal.

50-43.15 Plants

Plants shall be of the variety, size, age, and condition shown on the Plans or specified in the Special Provisions and conform to the requirements of these Specifications. The Contractor shall work in cooperation with the nursery to provide plant material that meets the requirements of these Specifications and the Special Provisions. Plant material not meeting the specifications will be rejected and shall be removed from the site. There will be no additional payment for removal of plant material that is not in conformance with the specifications or for additional deliveries involved with replacing them. If plant material does not appear available that can meet County standards, the Contractor shall bring this to the attention of the Agency immediately.

Plants must be vigorous, first class representations of the species and cultivars specified, and must conform to State and local laws governing the sale and transportation of plant materials. Only plants of the size and type shown on the Plans or designated in these Specifications or the Special Provisions with normal plant and root structures will be accepted.

All plants must be nursery grown in containers, unless otherwise shown on the Plans or designated in the Special Provisions and must have been grown in the specified containers for at least 6 months. They must have straight, single trunks, unless otherwise specified on the Plans. No pruning must be undertaken before planting. Plants specified as multi-trunk must have at least 3 main leaders from the base.

Plants shall have well developed root systems and not be rootbound or show sunscald, injuries, abrasions, or other objectionable disfigurements. Plants that are under-sized, have broken or split limbs, and/or exhibit stress through discoloration of their foliage will be rejected. Plants shall be free of disease, insects, pests, eggs or larvae.

Substitution of plants or sizes for those listed on the Plans are not allowed except with prior written consent of the Agency. Plants delivered to the work site that are found to be not true to name or unsuitable in growth or conditions must be removed from the site and replaced with acceptable plants. In the event tags are not present, and/or tags and load slip do not match, Contractor must provide written confirmation of species from the supplying nursery.

Plants that are not thoroughly wet throughout the root ball must not be transported to the planting area. Any plant that, in the opinion of the Agency, has a damaged root ball or is dry or in a wilted condition when delivered to the planting area will be rejected and must be replaced by the Contractor at the Contractor's expense. Trucks used for transporting plants must be equipped with covers to protect plants from windburn.

One plant of each bundle or lot must be tagged with the name and size of the plant, in accordance with the standards of practice recommended by the American Association of Nurserymen.

All plant materials must meet the specifications of Federal, State, and County laws requiring inspection for plant disease and insect infestations. Inspection certifications required by law must accompany each shipment, invoice, or order for stock, and when the plants arrive at the site of the Work, the certificate of inspection must be provided to the Agency.

Plants must be classified by type as to species, variety and genus and will be specified by scientific name conforming to the publication "Standard Plant Names" as adopted by the American Joint Committee on Horticultural Nomenclature.

50-43.15.A Turf

Grass sod must be well established mown lawn grass turf and must be free of weeds and other harmful or deleterious matter.

At least 80 percent of the grass plants in the cut sod must be composed of the species or varieties specified in the Special Provisions.

Grass sod must be grown, inspected, and shipped in accordance with the provisions of the Agricultural Code of the State of California.

Sod must be machine stripped or cut of a uniform soil thickness of 1 inch plus-or-minus 1/4- inch. The measurement for thickness excludes top growth and thatch and must be determined at the time of cutting in the field.

50-43.15.B Trees

Trees are classified by genus, species, and variety as well as common name. The tree varieties to be planted must be as shown on the Plans or described in the Special Provisions.

Trees will be specified by container size in the Contract and must meet the height and caliper of trunk requirements indicated in Table 50-8 or they will be rejected. For shade trees of recognized slower growth, as identified by the Agency, the height and caliper must be not less than 2/3 the height and caliper indicated in Table 50-8.

**TABLE 50-8
TREE CALIPER-HEIGHT RATIO**

Container Size (gallons)	Caliper of Trunk (inches)	Average Height Range (feet)
5	3/8 to 1/2	4 to 5
5	1/2 to 5/8	5 to 6
7	5/8 to 3/4	6 to 7
7	3/4 to 1	7 to 8
7	1 to 1-1/4	8 to 9
15	1-1/4 to 1-1/2	9 to 10
15	1-1/2 to 1-3/4	10 to 12
15	1-3/4 to 2	12 to 14

In size grading of container grown trees, caliper measurements will take precedence over height measurement, unless otherwise specified in the Special Provisions.

Caliper measurement must be taken 5 inches above soil level. If the tree is budded or grafted to a root system, the measurement must be taken 2 inches above the bud or graft union.

Trees to be planted as street trees must be free of branches for approximately the lower half of their height.

Tree shall have reasonably straight stems and be well-branched and symmetrical in accordance with their natural habits of species growth. Tree trunks shall be sturdy and well “hardened off”. Trees with poor branching structure, lacking a defined central leader (on standards), a broken leader, dense internal cross-branching, and/or lopsided canopy will be rejected. Trees with unbalanced canopies that will not remain upright without their nursery stakes will be rejected.

If possible, container grown trees must be capable of standing upright without staking and must have been grown in the container sufficiently long for the fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the container.

Trees must not be rootbound or show evidence of girdling or kinked root systems. Trees must not exhibit co-dominant trunks or branching with included bark. Trees must not be severely topped or headed. Trees must not have surface roots larger than 1/4-inch diameter. Trees must not exhibit evidence of sunscald or pest infestation. Upon inspection, trees not meeting these requirements will be rejected.

The container must be sufficiently rigid to protect the root mass during shipping.

At least one tree of each species or variety delivered to the work site must be identified by scientific name and size on a legible waterproof label securely attached to the tree.

Trees are subject to inspection by the Agency at any time during the Project—at the place of growth, upon delivery, or during planting operations. Such inspections are not final or conditional acceptance.

The Contractor must establish the necessary quality control and inspection practice to assure compliance with these specifications. The Contractor must furnish a California Nursery Stock Certificate for each shipment of trees.

50-43.16 Water

Water must be of such quality that it will promote germination of seeds and growth of plants.

50-43.17 Irrigation Pipe

Pipe and fittings for irrigation systems must be as specified in these Specifications and the Special Provisions.

Unless otherwise shown on the Plans, risers and threaded nipples for irrigation systems must be Schedule 80, PVC 1120 or PVC 1220, or PVC pipe conforming to the requirements of ASTM D1785.

50-43.17.A Steel Pipe

For installation of backflow preventers, steel pipe and couplings and wrought iron couplings must conform to AWWA standard C200 and the specifications of ASTM A53, standard weight, galvanized, except that the weight of zinc coating must be not less than 90 percent of the weight specified in said ASTM Designation. Fittings, except couplings, must be galvanized malleable iron, banded and threaded, conforming to ANSI Standard: B16.3, 150 pound class.

Steel pipe below grade must be wrapped with 6 mil plastic tape.

50-43.17.B Plastic Pipe

Plastic pipe for irrigation systems will be shown on the Plans as main line and lateral line (non-pressure).

Solvent cement and primer for PVC plastic pipe and fittings must be of commercial quality specifically manufactured for use with rigid PVC plastic pipe and fittings. The solvent cement and primer used must be made by the same manufacturer. The color of the primer must contrast with the color of the pipe and fittings.

The pipe must be furnished in minimum standard lengths of 20 feet.

Plastic pipe must be continuously and permanently marked with the following information—manufacturer's name, kind of pipe, material, size, NSF approved, schedule or type, and the date of extrusion. The extrusion date must agree with the manufacturer's records, covering quality control tests, raw material batch numbers, and any other information deemed necessary by the manufacturer. The records must be held by the manufacturer for 2 years.

50-43.17.B.(1) Main Line

Main line must be PVC of the types and classifications shown on the plans or specified in the Special Provisions. Main line pipe must be approved by the National Sanitation Foundation, and must conform to the requirements of either ASTM D2241 or D2672, except that main line with a bell socket formed as an integral part of the pipe for use with rubber ring gaskets must conform to the requirements of ASTM D2241. The belled portion of the pipe must conform to the requirements of ASTM D3139 (except for the dimensional ratio), must be formed to maintain uniformity in alignment and roundness and must be free of irregularities and defects.

The wall thickness of the bell must not be less than the specified minimum wall thickness of the pipe.

The wall thickness of the bell end of the pipe may exceed maximum allowable wall thickness of the pipe for a length not to exceed 24 inches from the end of the pipe.

Main line and fittings on the pressure side of control valves that are 2 inches or larger in diameter must be either the rubber ring gasket type or the solvent cemented type, except that all pipe and fittings installed in conduits or sleeves must be the solvent cemented type.

Threaded fittings and fittings to be solvent cemented to the main line must be injection molded PVC, Schedule 40. Fittings equipped with rubber ring gaskets for then main line must be either injection molded PVC plastic pipe fittings or machined pipe stock fittings.

50-43.17.B.(2) Lateral Lines

Lateral lines shall be of the types and classifications specified in the Contract. Pipe shall be approved by the National Sanitation Foundation (NSF) and conform to the requirements of ASTM D2241.

Class 200 Polyvinyl chloride (PVC) lateral pipe shall be solvent weld and manufactured of Type 1, Grade I or II, compound designated as PVC 1120 or 1220, and shall conform with to ASTM D1784.

Schedule 40 PVC lateral pipe shall be solvent weld and manufactured of Type 1, Grade I or II, compound designated as PVC 1120 or 1220, and shall conform with to ASTM D1785.

Polyethylene tubing lateral line shall be black UV-resistant polyethylene resin material (.60" ID x .70" OD) with a minimum pressure rating of 60 pounds per square inch (p.s.i.).

PVC fittings shall be molded fittings manufactured of the same material as the pipe and suitable for either solvent weld or threaded connections. Solvent weld fittings shall be of a pressure rating equal to or greater than that of the pipe. Schedule 40 fittings shall comply with ASTM D2466.

50-43.18 Subsurface Dripperline

Subsurface dripperline must be 1/2 inch low density linear polyethylene tubing, with internal pressure compensating self-cleaning integral drip emitters.

The dripperline tubing itself shall be brown or coppery in color, ultraviolet (UV) resistant and conform to an outside diameter (O.D.) of sixty-six hundredths of an inch (0.66") and an inside diameter (I.D.) of fifty-six hundredths of an inch (0.56"). The emitter discharge rate shall match the flow designated in the Irrigation Legend utilizing a combination turbulent flow/reduced pressure compensation cell mechanism and a diaphragm to maintain uniform discharge rates.

The dripperline emitter spacing and discharge rates must be as specified in the Contract.

50-43.19 Irrigation Sleeve Conduit

Irrigation sleeve conduit must be Schedule 40 PVC pipe.

50-43.20 Sprinklers and Emitters

Sprinklers and emitters must be the type and model as specified in the Contract.

50-43.21 Automatic Irrigation Controllers

Automatic irrigation controllers must be the type and model specified in the Contract.

Automatic irrigation controllers must be fully automatic, with solid state electronic components. The controller shall be rated for 120 volt, 60 cycle AC input and 26.5 volt, 2.2 amp output for continuous operation of 24 volt valves, with 14-day programming capability.

The controller shall have the following standard features: an electrical circuit to operate a master valve, a reset circuit breaker to protect the controller from damage due to excessive voltage surges, the ability to self-adjust and schedule irrigation events using either evapotranspiration (weather-based) or soil moisture data, two sensor inputs (weather-based/moisture and flow), and a master "on-off" switch for turning controller off during rainy weather while allowing day and hour clocks to continue operation. The use of weather-based or soil moisture sensing devices may be substituted for a central control and/or the use of communication devices (where available) if authorized by the Agency.

Irrigation controllers must be housed in pedestal or wall-mounted enclosures as specified in the Contract.

Irrigation controllers must conform to NEC Class 2 requirements. The controller output must be less than 110 volt-amperes to qualify for direct burial of output wires.

The irrigation controller enclosure shall be the type and model specified in the Plans and Special Provisions. The enclosure shall be mounted on a 4-inch (4") thick concrete pad with minimum dimensions indicated in the Contract documents.

50-43.22 Quick Coupling Valve

Quick coupling valves must be of brass or bronze construction with 1-inch IPS female pipe connections. The valve body must be of two-piece construction, consisting of an upper and a lower piece body. The upper valve body must be easily removable for replacement.

Quick coupling valves must have a durable locking rubber or vinyl cover, yellow in color for potable systems and purple in color for non-potable or reclaimed water systems. Covers must be marked with "Do Not Drink" warnings.

All quick coupling valve keys must be from the same manufacturer as the quick coupling valve, and must be the proper size to fit the valves. Valve key must be of brass or bronze construction with a replaceable stainless steel lug.

50-43.23 Control Valves

Control valves shall be electric remote control, battery-operated remote control or manual type straight or angle pattern globe valves, and shall be of glass filled nylon, plastic, brass, bronze, or cast iron construction as specified in the Contract. All metal parts of glass filled nylon valves shall be stainless steel or brass. Control valves must be capable of withstanding a cold water working pressure of 150 psi.

Automatic valves must have a manual flow control adjustment with shut-off provisions. The valves must also have an external and internal "bleed" to enable manual operation. Automatic actuation shall be by means of an encapsulated type solenoid with a minimum rating of 24 volts, 60 cycle and 2 to 5 watts.

50-43.24 Flow Sensor

The flow sensor shall be sized as shown on the Plans with a monitoring range of one-quarter (0.25) to 15 feet per second (FPS) and a maximum pressure rating of 240 pounds per square inch (PSI). Components shall include a high-density polyethylene (HDPE) impeller, O-ring, tungsten carbide shaft, Type 1 white PVC sensor insert and mounting tee.

50-43.25 Valve Boxes

Valve boxes and valve box lids must be precast portland cement concrete when installed in concrete or other paving. Valve boxes and valve box lids must be reinforced green plastic when installed in turf or planter areas. Concrete valve box lids must be marked "IRRIGATION" in cast-in letters not less than 1 inch high. Unless otherwise indicated in the Special Provisions, valve boxes for irrigation equipment shall be as follows:

1. Remote control valve assemblies with wye-filter- green HDPE, bolt-down, and 32 inches long by 19-1/2 inches wide by 18 inches deep with three by four inch knock-outs.
2. Remote control valve assemblies without a wye-filter- green HDPE, bolt-down, and 17 inches by 11-3/4 inches by 12 inches deep with three by four inch knock-outs.
3. Flow sensors and master valves- green HDPE, bolt-down, and 21-1/2 inches long by 15 inches wide by 18 inches deep.
4. Gate valves and quick couplers- green HDPE, bolt-down, and round with 10 inch diameter.
5. Drip and dripper line flush valves- green HDPE, bolt-down, and round with 10 inch diameter.

Label type for valve boxes shall be one of the following throughout:

1. Engraved letters and numbers on a two-layer white over black, UV-resistant exterior sign-plate plastic. The dimensions of the labels shall be a minimum of two-inches by three-inches by one-eighth inch thick (2" x 3" x 1/8").
2. Hot-stamped black letters on a yellow background of UV-resistant polyurethane Behr Desopan. The dimensions of the labels shall be a minimum of two-and-one-quarter

| inches by two-and-three-quarter inches (2-1/4" x 2-3/4").

The letters shall be a minimum of one and one-eighth inches (1-1/8") in height. Labels shall be bolted to the valve box covers with commercial quality brass or stainless steel machine screws, nuts and washers.

The tags attached to control valves shall be water resistant with legible text identifying the assigned station number that corresponds with the valve box lid label.

50-43.26 Backflow Preventers

Backflow preventers must be reduced-pressure type as approved by the Sacramento County Environmental Health Division.

Backflow preventers shall have a low-lead bronze main valve body and relief valve body. Backflow preventers must be factory-assembled and must consist of two independently operating, center-guided, spring-loaded, "Y" pattern check valves, one hydraulically dependent differential relief valve, 2 shut-off valves and 4 test cocks.

Backflow preventers must be the same size as the service line in which they are installed, unless otherwise specified in the Contract.

Insulated protection shall be provided for each backflow prevention device as specified in the Contract. A backflow preventer enclosure shall be manufactured from 1-3/4" x 1-3/4" x 3/16" angle iron and 1-1/2" nine gauge (#9) expanded metal screen, welded every six-inches (6") minimum. Enclosure shall have freeze protection provided by one-inch (1") R-7 non-absorbent polyurethane foam bonded to 22 gauge galvanized sheet metal. Enclosure shall be powder coated with a Hunter Green color.

An insulated protection blanket shall be of the appropriate size to fit the backflow prevention assembly specified. Blankets must be the appropriate size to fit the backflow prevention assembly specified. Blanket fabric must be heavy-duty resin or vinyl coated 100 percent polyester plain weave. Fabric must be water, mildew and flame resistant. Insulation must be a layer of Radiant Barrier Foil (BF) consisting of a layer of polyethylene bubbles bonded to and sandwiched between two industrial strength foil sheets with a minimum R-value of R-9. This material is impervious to moisture and is unsuitable for rodent nesting material. Blanket must have a water repellent lining of nylon fabric to resist tearing from backflow parts. Blanket must be machine stitched with metal grommet reinforcement for installation of an individual lock. Blanket must be forest green in color and have a manufacturer's five-year warranty.

50-43.27 Concrete

Unless otherwise specified in the Special Provisions, concrete for irrigation facilities must be Class "B" concrete as specified in Section 50-5, "Portland Cement Concrete", in this Section of these Specifications. Hand mixing of the concrete will be permitted.

50-43.28 Filter Assembly Units

Wye filter for dripline control valve assembly shall have a 150-mesh screen, shall be Spin Clean Type, and rated for 150 pounds per square inch (p.s.i.). The Contractor shall install filter for ease of access and cleaning. The Contractor shall add Schedule 80 PVC ball valve at the end of filter body for manual flush out and connect ball valve to wye-filter flush outlet with a Schedule 80 union.

50-43.29 IPS Flexible PVC Hose

IPS flexible PVC hose must be nonrigid polyvinyl chloride (nonrigid PVC) hose conforming to the specifications of ASTM D2287, Cell-type 66404006.

The hose must provide leak-free, non-separating connections suitable for the purpose intended when connected to the fittings specified herein. Flexible hose must be algae resistant.

Fittings for flexible hose must be injection molded PVC, Schedule 40, conforming to the specifications of ASTM D2466. Fittings must be solvent cemented type.

Solvent cement and primer for flexible hose and fittings must be of commercial quality as specified for use with rigid PVC pipe and plastic pipe fittings.

50-43.30 Gate Valves

Gate valves must be either flanged, threaded or ring type, iron or bronze body, bronze trimmed valves with rising (internally threaded) or non-rising stem, and must withstand a cold water working pressure of 150 psi. Gate valves must be of the same size as the pipeline that the valves serve, unless otherwise shown on the Plans.

Gate valves 3 inches and smaller must be bronze or brass. Gate valves 4 inches and larger must be cast iron.

Isolation ball valves shall be Schedule 80 PVC body with threaded ends, ABS handle, and have a non-shock cold working pressure rating of 150 pounds per square inch (p.s.i.).

50-43.31 Air Vacuum Relief Valve

Air vacuum relief valve must be non-corrosive plastic with 1/2 inch MPT threads. Maximum operating pressure of air vacuum relief valve must be 140 psi. Valve must eliminate negative pressure and vacuum within subsurface dripperline systems that may draw contaminants into the system.

50-43.32 Flush Valve Assembly

Flush valve must be non-corrosive plastic with 1/2 inch MPT threads, unless otherwise indicated on the Plans. Maximum operating pressure of flush valve at ends of dripperline must be 57 psi. Valve must flush approximately 1 gallon per cycle. Valve must reduce sediment build-up within the dripperline system.

50-43.33 Unions

Unions must be brass or malleable iron. All unions must withstand the working pressure range requirements of the pipes with which they are used.

50-43.34 Irrigation Control Wires

Control wire for automatic control valves must be #10, #12, or #14 as necessary for operation, must be UL rated for direct burial, and must be underground feeder type identified as (UF). Control wire must have 4/64 inch (56 mils) minimum thickness of TW grade polyvinyl chloride insulation. Control wire must be able to withstand a crush test of 5000 psi. Common or neutral conductors must be white. The control wires to the automatic control valves must be red. The spare wires must be yellow.

Splices for control wire must be specifically designed to insure waterproof underground direct bury wire connection, and must be UL listed "Water Resistant Wire Connector Rated 60c, 600v for PVC insulated copper wires". Each connector must consist of a crimp sleeve, base socket, sealing plug, and inert sealer.

50-43.35 Pull Boxes

Pull boxes for irrigation control wiring shall be No.5 unless otherwise shown on the Plans and shall conform to these Specifications.

Pull boxes must be precast portland cement concrete boxes with concrete covers, unless otherwise noted. Concrete covers shall be locking with five-eighths inch (5/8") vandal resistant bolt.

Pull box covers for pull boxes used solely for irrigation control wiring must be marked "IRRIGATION" or "IRRIGATION CONTROL" in cast-in letters. Cover markings must be clearly defined and uniform in depth and may be placed parallel to either the long or the short sides of the cover. Marking letters must be between 1 and 3 inches high.

50-43.36 Pressure Gauges

Pressure gauges shall be liquid filled with glycerin or silicone oil, hermetically sealed, water tight, and dust proof. Gauge must be a 2-inch bottom-connected gauge with 1/4-inch brass standard pipe thread and shatterproof face. Gauge must be rated for 100 psi.

50-44 ENGINEERING FABRICS

Engineering fabrics must conform to the State Specifications.

50-45 PAINT

Unless otherwise specified in the Special Provisions, paint must conform to the State Specifications. Colors must be as specified in the Contract.

50-46 NOT USED

50-47 NOT USED

50-48 EPOXY

Epoxy must conform to the State Specifications.