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PART 01100 - WATER SUPPLY SYSTEMS

Section 01120 - Irrigation Systems

Description

01120.00 Scope - This work consists of installing irrigation systems and associated equipment at locations shown or specified and as directed.

01120.01 Qualifications - In order to install certain kinds of equipment or systems, manufacturer's certifications may be required, if described in the Special Provisions.

Materials

01120.10 General - Furnish only commercial quality materials and equipment. All items proposed for use will be subject to testing to ensure compliance with the Specifications. Provide materials of the same function that are of the same type and the same manufacturer.

Submit a list of proposed materials for approval as soon as practicable after Award and before arranging for procurement of any materials, especially those materials or products not shown or specified. If any initially proposed materials are not approved, submit substitutes for approval. Any materials installed without approval will be subject to removal and replacement with acceptable material at the Contractor's expense.

Materials may be designated by trade name or by manufacturer's catalogue information as shown or specified. The use of a substitute material may be permitted if a written request for substitution and proof of equivalent quality and suitability are furnished. Make any request for substitution with ample time for approval without delaying the work.

When alternate equipment, such as sprinkler heads, is proposed for use with hydraulic characteristics differing from that originally shown, the following will be required:

- A redrafted, legible plan that shows the redesigned layout, location, or sizes of every affected system element as required for proper operation as originally designed. Furnish a plan showing every relevant system element, site feature, and plan element that was shown on the original plan. A plan made by marking up the original plan will not be accepted.
- A hydraulic calculation table for the alternate equipment. At a minimum, show a complete calculation for one average sprinkler zone (section) and a complete calculation for the "worst case" sprinkler zone (i.e., the section that is farthest from the point of connection (P.O.C.), is the largest, or otherwise presents the most challenging hydraulics). Starting from the P.O.C., show the calculation with a step-down method with flow and loss at each piece of equipment and length of pipe run between equipment. Show the new total water required for each zone and the total for all zones to ensure that maximums for meter size, pipe sizes, and watering times will not be exceeded.
- Where any controller run-time change will be required, submit a separate page showing the total timing per controller required for each section, to show that timing changes will still allow all zones to be run within a reasonable time period.
- A cost page showing the Contractor's actual discount cost from the supplier(s), comparing the original plan costs versus the proposed equipment costs for each type of item, such as pipe by size, where there is a change required. Show the line total of each type of item and the grand total for the proposed change.

01120.11 Pipe, Tubing and Fittings - Furnish galvanized iron or steel, PVC, or polyethylene pipe as shown or specified that meets the following requirements:

(a) Galvanized Pipe and Fittings - Furnish pipe of standard weight, hot-dip galvanized iron or steel, standard threaded, coupled, and that meets the requirements of ASTM A 53/A 53M. Non-standard threaded fittings will be rejected.

(b) Polyvinyl Chloride Pipe and Fittings - Furnish PVC pipe and fittings of PVC compound Type 1, Grade 1, conforming to ASTM D 2241 and certified approved by the National Sanitation Foundation. Provide pipe and fittings free from defects caused by poor materials, low quality of work, or rough handling. Dimensional and quick burst tests of pipe and fittings may be required after arrival at the job site before materials will be accepted.

Furnish pipe and fittings as follows:

Used for	Class or Schedule
Main and lateral lines	Class 200 PVC
Irrigation sleeves	Schedule 40 PVC
Caps	Schedule 80 PVC
Direct bury pipe, not in sleeves, placed under road beds or other paved areas	Schedule 40 PVC

Furnish PVC threaded pipe of PVC 1120, schedule 80 material conforming to ASTM D 1785.

Provide PVC solvent-weld pipe of PVC 1120 materials having a 1370 kPa (200 psi) minimum pressure rating with SDR 21 walls that conform to ASTM D 2241.

Furnish PVC pipe fittings conforming to ASTM D 2466, Type I, Grades 1 or 2.

Pipe may be belled on one end with the dimensions of the tapered bell conforming to ASTM D 2672.

Install PVC pipe with walls heavier than SDR 21 when shown or specified.

(c) Non-Potable Colored Coded Pipe - Wherever non-potable, reclaimed or reuse water is used, furnish PVC pipe that is tinted purple and imprinted with the warning "Caution: Reclaimed Water - Do Not Drink". Provide pipe meeting the same AWWA and ASTM specifications as the potable water pipe sizes on which they are based.

(d) Polyethylene Pipe - Furnish polyethylene pipe of Class 80, SDR 15, medium density, meeting the requirements of ASTM D 2239, conforming to U.S. Commercial Standard CS-255, and approved by the National Sanitation Foundation (NSF).

(1) Micro Tubing and Fittings - Where drip emitters are not required, furnish a blank type and provide any connections necessary. Provide tubing consisting of nominal-sized linear, low-density, minimum 6 mm (1/4 inch) outside diameter (OD) polyethylene.

(2) Low Volume (Drip) Tubing - Furnish drip tubing manufactured from specially formulated, chemical-resistant, low to medium density, virgin polyethylene or polybutylene which is selected for excellent weatherability and stress cracking resistance, and is designed specifically for use in drip irrigation systems. Provide drip tubing having a minimum wall thickness of 1.14 mm (0.044 inch).

01120.12 Automatic Controllers - Provide Underwriter's Laboratories (UL) approved controller(s) as shown or specified. Furnish each outdoor controller with either a pedestal or wall mount brackets when appropriate. Provide and install the controller in a weatherproof and vandal-proof cabinet of

corrosion-resistant metal. Furnish the controller housing or cabinet with hasp and lock or locking device. Provide locks or locking devices that are master-keyed and include three sets of keys for the locks. If the irrigation system serves both lawns and planting beds, furnish a controller that has a dual programming capability. Provide controllers that are compatible with and capable of operating the irrigation system as constructed.

The following are definitions of some controller-associated equipment:

Rain Sensor - A sensor able to interrupt the power from the irrigation controller to the valves when the rainfall exceeds a pre-selected amount. Furnish rain sensors that are compatible with the system controller and are fully adjustable.

Soil Moisture Sensor - A sensor that interrupts programmed irrigation cycles until the soil moisture reaches a predetermined condition at the sensor's probe location.

Central Controller - A computer system programmable to receive data from and provide commands to multiple irrigation systems remotely located from the central system location.

Satellite Controller - A satellite controller similar to a normal stand-alone controller and able to operate as one, but designed to be operated by a central controller located off-site.

Flow Sensor - The hardware located in a pipeline that senses water flow and sends resulting data by electronic pulses to the pulse output transmitter.

Pulse Output Transmitter - A device that reads electronic pulses from the flow sensor and sends data to the pulse-decoding device.

Pulse Decoder - A microprocessor-based device designed to read electrical pulses originating at the flow sensor (or other type of monitoring device) and send the data to a central control system for analysis and action. When reading water flow data, the pulse decoder may also be referred to as a flow monitor.

Weather Station - A field station that collects and stores various weather data for access and use by a central control system in modifying an irrigation program for weather conditions. Typical data collected over a time period are wind speed, wind direction, relative humidity, rainfall, solar radiation and air temperature.

01120.13 Quick-Coupling Equipment - Furnish quick coupling equipment with a body of cast leaded semi-red brass alloy No. C84400 conforming to ASTM B 584, and a service rating not less than 850 kPa (125 psi) for non-shock cold water. Provide couplers having standard male pipe threads at the top and standard female pipe threads at the base. Ensure that the valve is designed to open only upon inserting a coupler key and close completely after removing the key, with absolutely no leakage of water between the coupler and valve body. Provide valve bodies to receive couplers that are designed with double worm slots to allow smooth opening and closing action with a minimum of effort. Ensure that slots notched at the base will hold the coupler firmly in the open position. Furnish couplers of one piece construction with steel reinforced side handles attached, a locking top and of the same material as the valve body. The coupler shall have stainless steel double guide lugs to fit the worm slots. Furnish two couplers and two hose swivels for operation of the valves, and two keys for the locking caps if quick-coupling valves are required. For non-potable water systems, furnish a color-coded, purple tinted cap that bears the printed warning "Caution: Reclaimed Water - Do Not Drink".

01120.14 Hose Bibs - Furnish bronze or brass hose bibs, with angle-type thread to accommodate a 19 mm (3/4 inch) hose connection, and with a key- operated design that prevents operation by wrench or pliers.

01120.15 Cross-Connection Control Devices - Cross-connection control devices will be shown on the plans. Furnish and install cross-connection control devices meeting the requirements of the Oregon Health Division and the local water authority.

01120.16 Water Meter - Water meter procurement, installation, and associated costs will be the responsibility of the Agency. Be responsible for coordinating water meter needs in a timely fashion with the Agency.

01120.17 Valves:

(a) Gate Valves - Furnish gate valves of heavy-duty bronze conforming to the requirements of ASTM B 62. Provide valves of the same size as the pipes on which they are placed and install with union or flange connections. Service rating (for non-shock cold water) shall be 1000 kPa (150 psi). Valves shall be of the double disk, taper seat type, with rising stem, union bonnet and hand wheel or suitable cross wheel for standard key operation. The valves shall have the manufacturer's name, type of valve, and size clearly cast on them.

(b) Drain Valves - Furnish bronze or brass drain valves, 12 mm (1 inch) or 19 mm (3/4 inch) in size, manual angle globe type, with rising stem, hex brass union, removable bonnet and stem, and adjustable packing gland. Ensure that valves are designed for underground installation with a suitable cross wheel operable with a standard key. The valves shall have a service rating of not less than 1000 kPa (150 psi) non-shock cold water. Furnish three standard operating keys.

(c) Check Valves - Furnish heavy duty bronze or steel check valves which function by means of a hinged disc suspended from the body, and which is able to close of its own mass. Furnish valves that are of the same size as the pipes on which they are placed, unless otherwise specified, and with union or flanged connections. Provide valves that are rated for non-shock cold water service of not less than 1000 kPa (150 psi). The valves shall have the manufacturer's name, valve type, and size cast on them.

(d) Pressure-Reducing Valves - Furnish pressure-reducing valves with a minimum of 1000 kPa (150 psi) working pressure and an adjustable outlet range of 130 kPa to 480 kPa (20 to 70 psi), rated for non-shock cold water service up to 1200 kPa (175 psi). The valves shall be factory set as shown or specified.

(e) Isolation Valve - Furnish isolation valves as shown on the plans or Special Provisions. If no isolation valve is shown, furnish ball valves as shown below.

(f) Ball Valves - Furnish bronzed-bodied ball valves conforming to ASTM B 62 and with a hard, chrome plated ball conforming to ASTM B 124/B 124M. The valve shall be non-shock cold water service-rated at not less than 2750 kPa (400 psi). Plastic valves will not be accepted.

(g) Air Relief Valve - The air relief valve automatically relieves air pressure to break an air vacuum in the pipe section where it is located. Install air relief valves at the exact high point of each pipe section where relief is needed. (Note - air relief valves are not associated with backflow prevention).

(h) Control Valves:

(1) Manual Control Valves - Furnish manual valves of bronze or brass, angle type, with hex brass union, and with a service rating not less than 1000 kPa (150 psi) non-shock cold water. Provide valves for underground installation designed with a cross wheel suitable for operation with a standard key. Furnish three suitable operating keys per irrigation system. Furnish valves that have removable bonnet and stem assembly, with adjustable packing gland housing for the long acme-threaded stem to ensure full opening and closing. Provide valves with discs that are full floating with replaceable seat washers.

(2) Automatic Control Valves - Furnish automatic control valves of a normally closed design, operated by an electric solenoid of the required rating, but not more than 6.5 W and operating on 24 V AC power. Ensure that solenoids directly attached to the valve bonnets or bodies have completely internal control parts. Provide bodies that are not less than 1000 kPa (150 psi) if brass or bronze and not less than 850 kPa (125 psi) if plastic, with a manual control bleed cock to operate the valve without electric current. Ensure that the closing speed is not less than five seconds and the opening speed is not less than three seconds. Both shall be at a constant rate of opening and closing so the water flow is completely stopped when the valve is either manually or electrically closed. Provide valves having manual shutoff stems with cross handles that will adjust the valve from fully closed to wide open with the valve automatically operable in the adjusted position.

(3) Automatic Control Valves with Pressure Regulator - Furnish valves of the same manufacture as the automatic control valves, capable of reducing the inlet pressure to a constant lower pressure regardless of supply fluctuations, and which are fully adjustable.

01120.18 Valve Boxes and Protective Sleeves - Provide automatic control valves, flow control valves, pressure reducing valves, backflow preventers, filters and other serviceable fixtures with valve boxes that are extendable to obtain the depth required. Furnish boxes constructed of thermoplastic, with locking lids, green in color, and of the type shown or specified. Include a protective sleeve and cap with all manual drain valves and manual control valves.

01120.19 Electrical Wire and Splices - Unless otherwise specified, furnish electrical wiring used as a hot wire for each zone between the automatic controller and automatic valves of copper, minimum size AWG No. 14, and red in color. Furnish common wire that is a minimum AWG No.12 and white in color. Furnish type USE that is chemically cross-linked Polyethylene or Thermoplastic. Furnish Type UF that is color-coded or marked with number identification.

Make low voltage splices with one of the following:

- Furnish a kit containing a "T" shaped open cell with a centering device and a plastic bag of urethane and hardener, which is mixed at the time of installation. The resin used with the "T" shaped centering device shall be a quick curing, flexible compound with a set-up time of about four minutes at 22 °C (70 °F). Acceptable kits are "3-M DBY", "RainBird Snap-Tite", "Pen-tite PVC Socket and Sealing Plus" or approved equal.
- Heat-shrinkable insulating tubing manufactured for use in irrigation electrical systems. Furnish heat-shrink tubing of a mastic-lined, heavy-wall, polyolefin cable sleeve.

Provide and install an extra wire with all wiring runs that is the same gauge, but of a different color than the hot wire and common wire. The extra wire will be reserved for future use or modifications to the system.

01120.20 Communication Cable - Furnish communication wire in central satellite control systems that is 18 gauge polyethylene (PE) 89, minimum 6 pair, or approved equal. Provide sufficient pairs to connect all decoding, sensing and monitoring devices to the Central Control Unit.

01120.21 Detectable Marking Tape - Use detectable marking tape consisting of inert polyethylene plastic that is impervious to all known alkalis, acids, chemical reagents and solvents likely to be encountered in the soil, with a metallic foil core to provide the most positive detection by pipeline locators. Furnish color-coded tape with the type of line buried below and the word "Caution" imprinted continuously over its entire length in permanent black ink. Provide tape of the width recommended by the manufacturer for the depth of installation used.

Construction

01120.40 General - The irrigation plans are a schematic design and may require adjustment. Do not install the sprinkler system as shown if it is evident that obstructions, grade differences, or differences in area dimensions create conditions different than anticipated in the design. Bring all such obstructions or differences to the attention of the Engineer. In the event this notification is not performed before construction begins on a part of the system where discrepancies exist, any revisions necessary to make the system operate as designed will be the Contractor's responsibility.

(a) Plumbing - Install all parts of the irrigation system according to the Oregon Plumbing Code and State and local laws. Make water service connections as shown and specified. Conform to the requirements of the jurisdictional water authority. Ensure that water velocities in PVC pipe do not exceed 1.5 m/s (5 feet per second), unless approved in writing by the Agency. Bring any velocities exceeding 1.5 m/s (5 feet per second) created by pipe sizes shown on the plans to the attention of the Agency before beginning construction. Correct excess velocities existing after construction, or caused by changes from the plans, at the Contractor's expense, unless a written agreement has been made authorizing otherwise.

(1) Double Check Valve Assembly (DCVA) - Install, inspect, and test the DCVA according to applicable regulations of the Oregon Health Division and the local water authority. Furnish test records on forms approved by the Oregon Health Division. Furnish forms filled out by a State-licensed Backflow Device Tester documenting that the DCVA is in good operating condition before any flushing and testing of downstream water lines. During the life of the Contract, test the DCVA annually, or more often if successive inspections indicate repeated failure. Repair or replace the DCVA whenever it is found to be defective.

(2) Reduced-Pressure Backflow Device (RPBD) - Install, inspect, and test the RPBD according to the applicable portions of the Oregon Plumbing Code and applicable regulations of the Oregon Health Division and the local water authority. Apply the same specific testing requirements as stated for the DCVA above.

(b) Electrical Service - Install electrical service according to 00960.49, the National Electrical Code, and all State and local laws. Power sources will be as shown or as directed. Be responsible for coordination and installation of electrical service. Furnish and install meter bases at the power source conforming to the requirements of the power supplier. Give the power supplier's representative notice before making any installation. Provide a separate, dedicated circuit for the controller.

01120.41 Layout of Irrigation System - Stake the irrigation system, following the schematic design on the plans, before construction begins. With prior approval, make alterations and changes in the layout to conform to ground conditions and to obtain adequate coverage of water. Call before you dig. Comply with the requirements of 00150.50.

01120.42 Excavation - Excavate trenches no wider than necessary to lay the pipe or install the equipment. Keep the top 150 mm (6 inches) of topsoil, if applicable, separate from subsoil and replace this topsoil as the top layer when backfilling. Provide smooth trench bottoms of sand or other material, free from rocks and unsuitable material. Excavate trenches in rock or other unsuitable material at least 150 mm (6 inches) below the required depth and backfill with sand or other suitable material free from rocks.

Exercise care when excavating near existing trees. Where roots are 50 mm (2 inches) and greater in diameter, except in the direct path of the pipe, hand excavate and tunnel the pipe trench. When large roots are exposed, wrap them with heavy burlap for protection and to prevent excessive drying. When digging trenches by machine adjacent to trees having roots 50 mm (2 inches) and less in diameter, hand trim the sides of the trench, making a clean cut of the roots. Treat all cut and trimmed roots

10 mm (1/2 inch) or larger in diameter with an approved tree wound dressing. Backfill trenches having exposed tree roots within 24 hours unless protected by continuously moist burlap or canvas.

Place detectable marking tape in the trench directly above, parallel to, and along the entire length of all nonmetallic water pipes and all nonmetallic and aluminum conduits installed under existing or planned pavement. Use tape widths recommended by the manufacturer for the burial depth.

Pipe installation using a "pipe puller" may be approved if there is adequate topsoil depth and the topsoil is free of rock. Obtain the Engineer's approval before using a pipe puller. Include any resultant changes in material or design with the request for use of this method.

If unforeseen bedrock is encountered during excavation that prevents the pipe from being buried at the specified depth, immediately bring it to the attention of the Engineer.

01120.43 Piping - Backfill all pipe between the top of the pipe and finished grade with a minimum of 500 mm (18 inches) of fill according to 01120.49. Where possible, place mains and laterals or section piping in the same trench. Separate all pipes by at least 50 mm (2 inches). Place all pipe lines a minimum of 1 m (3 feet) from the edge of concrete sidewalks, curbs, guardrail, fences, traffic barriers or walls unless otherwise approved.

Place marking tape above all pressurized mainline, according to the manufacturer's instructions.

Place all live mains to be constructed under existing pavement in sleeves jacked under the pavement, unless otherwise shown. Place all PVC pipe installed under pavement in pipe sleeves of Schedule 40 PVC, unless steel sleeving is shown or specified. Furnish pipe caps of Schedule 80 PVC. Install sleeves 600 mm (2 feet) below subgrade when passing under roadways. Extend sleeves 600 mm (2 feet) beyond the edge of gravel, edge of sidewalk or back of curbs. Mark sleeves with a 600 mm (2 feet) piece of #13 (#4) rebar driven flush with the ground or other adjacent surface. Place PVC caps over both ends of sleeves but do not glue. Solvent-weld sleeve sections. Pipe bedding and backfill shall conform to Section 00405. Extend the sleeve a minimum of 300 mm (12 inches) beyond the edge of pavement. Perform all jacking operations according to an approved jacking plan. If obstacles are encountered during required jacking, notify the Engineer, who may authorize corrective measures according to 00140.60. Provide for complete drainage of all pipe lines with manual drain valves installed at section low points. Drain valves may not be shown on the plans.

01120.44 Pipe Jointing:

(a) General - During construction, plug or cap pipe ends to prevent entry of dirt, rocks and other debris.

(b) Galvanized Steel Pipe - Ensure that galvanized steel pipe has clean cut, well fitted standard pipe threads. Ream all pipe to its full diameter and remove burrs before assembly. Construct threaded joints using either a non-hardening, non-seizing multipurpose sealant, Teflon tape, or paste as recommended by the pipe manufacturer. Make all threaded joints tight with wrenches, without using handle extensions. Clean and remake joints that leak with new material. Use of caulking or thread cement to make joints tight will not be permitted.

(c) PVC Pipe - Handle and install PVC pipe, couplings and fittings according to the manufacturer's recommendations. Chamfer the outside of the PVC pipe to a minimum of 1.5 mm (1/16 inch) at approximately 22 degrees. Join pipe and fittings by solvent welding. Use only solvents that penetrate the surface of both pipe and fitting with a result of complete fusion at the joint. Use solvent and cement only as recommended by the pipe manufacturer. On plastic to metal connections, work the metal connection first. Use a non-hardening compound on threaded connections. Thread connections between metal and plastic using only female threaded PVC adapters with threaded schedule 80 PVC nipples.

01120.44(d)

(d) Polyethylene Pipe - Install polyethylene pipe and fittings according to the manufacturer's recommendations. Cut the ends of the polyethylene pipe square and insert the fitting to its full depth. Use stainless steel clamps for insert fittings.

01120.45 Installation:

(a) Sprinkler Heads - Position turf heads and other pop-up heads between 15 mm and 25 mm (1/2 inch and 1 inch) above finish grade, measured from the top of the sprinkler. Place sprinklers as close as practical to walks, curbs, pavement and lawn edges, but leave enough space to allow height adjustment. Do not place heads on risers in areas with any potential for pedestrian traffic, unless otherwise shown. Use swing riser assemblies that allow positioning for correct sprinkler height.

(b) Drip Emitters - Install emitters directly above the root mass of the plant being watered, according to the plans or the manufacturer's recommendations.

(c) Low Volume Drip Tubing - Install drip irrigation tubing according to the plans or the manufacturer's recommendations.

(d) Controllers - Install controllers according to the manufacturer's recommendations and as shown. Receive approval of the location before installing. Since the controller will need to be accessed frequently, install it at a height, position, and location that allow ease of access.

(e) Valve Boxes and Quick Couplers - Position the tops of valve boxes, capped sleeves, and quick coupler valves between 15 mm and 25 mm (1/2 inch and 1 inch) above finish grade or mulch.

(f) Valves - Install valves so that access for maintenance is maintained.

(g) Central Control Equipment - If shown or specified, install the following equipment according to the manufacturer's recommendations:

- Rain sensors
- Soil moisture sensors
- Flow meters
- Central control system with satellite controllers
- Weather stations

01120.46 Low Voltage Electrical Installation - Use direct burial wiring between the automatic controller and automatic valves. The wiring may share a common neutral. When more than one automatic controller is required, provide a separate common neutral for each controller and the automatic valves it controls. Run separate control conductors from the automatic controller to each valve. Provide and install an extra wire according to 01120.40.

Install wire adjacent to or beneath the irrigation pipe. Use plastic tape or nylon tie-wraps to bundle wires together at 3 m (10 foot) intervals. Snake the wire from side to side in the trench to provide slack in the wire run. When it is necessary to run wire separate from the irrigation pipe, bundle and place the wire under detectable marking tape. Splices will be permitted only at junction boxes, valve boxes, pole bases, or control equipment. Leave a minimum of 0.5 m (2 feet) of excess conductor at all splices, terminals and control valves to facilitate inspection and future splicing.

01120.47 Flushing and Testing:

(a) General - Provide gauges used in the testing of water pressures that are certified correct by an independent testing laboratory immediately before use on the Project. Retest gauges when directed. Test automatic controllers by actual operation for a period of two weeks under normal operating

conditions. Should adjustments be required, adjust according to the manufacturer's direction and test until operation is accepted as satisfactory.

(b) Sprinkler Head Flushing - Flush all sprinkler heads as recommended by the manufacturer.

(c) Sprinkler Head Testing - Test for leaks in heads and connections and correct as required.

(d) Main Line Flushing - To remove debris that may have entered the line during construction, flush main supply lines twice with the supply valve fully open. Flush first before placing valves and again after placing valves and before pressure testing.

(e) Main Line Testing - Purge all main supply lines of air and test with static water pressure of at least 1000 kPa (150 psi) for 60 minutes without introduction of additional service or pumping pressure. Test with one pressure gauge installed on the line where directed. Install an additional pressure gauge at the pump when directed. Lines showing loss of pressure exceeding 35 kPa (5 psi) at the end of the specified test period will be rejected. Correct rejected installations and retest for leaks.

(f) Lateral Line Flushing - Flush all lateral lines once with the supply valve fully open prior to placement of sprinkler heads, emitters and drain valves. Flush long enough to remove any debris that enters the lateral lines during construction.

(g) Lateral Line Testing - Purge all lateral lines of air and test under operating line pressures with risers capped and drain valves closed. Maintain operating line pressures for 30 minutes through open valves and pressure regulating devices. Lines showing leaks when visually inspected at the end of the specified test periods will be rejected. Correct and retest lateral line installations that have been rejected.

(h) Lateral Line Alternate Test Method - When conditions prevent effective visual inspection of lateral lines, the Engineer may require that the lines be tested by use of pressure gauges. In that event, maintain the static water pressure equal to the operating line pressure in the lines for 30 minutes, with valves closed and without introduction of additional service pressure. Lateral lines showing loss of pressure exceeding 35 kPa (5 psi) at the end of the specified test period will be rejected. Correct and retest lateral line installations that have been rejected.

(i) Testing of Micro Tubing - Micro tubing will be tested by visual inspection while operating and before burial. Tubing that has obvious leaks or that doesn't operate as designed will be rejected. To fully test micro tubing, a water collection procedure recommended by the manufacturer may be required. Correct all faults before retesting.

01120.48 Adjusting System - Before final inspection, adjust and balance all sprinklers to provide adequate and uniform coverage. Balance spray patterns by adjusting individual sprinkler heads with the adjustment screws or by replacing nozzles to produce a uniform pattern. Unless otherwise specified, water spray will not be permitted on pavement, walks or structures.

01120.49 Backfill - Do not start backfill until all piping has been inspected, tested and approved. Complete backfilling as soon as possible after approval. Ensure that backfill material placed within 150 mm (6 inches) of the pipe is free of rocks or other unsuitable material that might cut or otherwise damage the pipe. Backfill from the bottom of the trench to approximately 150 mm (6 inches) above the pipe with continuous compaction in a manner that will not damage the pipe or wiring, and proceed evenly on both sides of the pipe. Thoroughly compact the remainder of the backfill without using heavy equipment within 500 mm (18 inches) of any pipe. Ensure that the top 150 mm (6 inches) of the backfill is topsoil material or, if suitable, is the first 150 mm (6 inches) of material removed in the excavation.

Pipe bedding material conforming to 00405.12 may be authorized in quantities determined by the Engineer. When authorized to proceed, fill the bottom 50 mm (2 inches) of the trench with approved

bedding before laying pipe. After the pipe is in position, add enough bedding material to bring the backfill height to 50 mm (2 inches) above the pipe. Continue backfilling as usual.

If sufficient suitable backfill material is not available from trench excavation or other sources on the Project, notify the Engineer. Provide an estimate of imported backfill required, if possible. Unless otherwise shown or specified, imported pipe bedding material will be authorized according to 00140.60.

Maintenance

01120.60 System Operation - Repair, flush and test all main and lateral lines that sustain a break or disruption of service. Upon restoration of the water service, bring the affected lines up to operating pressure. After pressurizing, conduct a thorough inspection of all sprinkler heads, emitters, and other fittings, located downstream of the break or disruption of service, and repair. This inspection is required to ensure that the entire irrigation system is operating properly.

Completely install and test the irrigation system, and make it automatically operable before planting in a unit area except where otherwise shown, specified, or approved. Be fully responsible for all maintenance, repair, testing, inspection and automatic operation of the entire system until all work is complete and approved.

This responsibility includes, but is not limited to, draining the system before winter and reactivating the system in the spring and at other times as directed.

Be responsible for having annual inspections and tests performed on all cross connection control devices as required by the State Health Division.

In the spring, when the drip irrigation system is in full operation, make a full inspection of all emitters. This involves visual inspection of each emitter under operating conditions. Make all adjustments, flushing or replacements to the system at this time to ensure the proper operation of all emitters.

01120.61 Drip Line Warranty - The warranty of 00170.85(b) applies to drip tubing installed under this Section. Provide a written warranty from the manufacturer against defects in manufacturing, rot, electrolytic corrosion, and stress cracking for at least five years from the time of installation.

Finishing and Cleaning Up

01120.70 As-Built Plans and System Orientation - Upon completion of the work, submit corrected working drawings, schematic circuit diagrams, or other drawings necessary for the Engineer to prepare corrected plans showing the work as constructed. Provide drawings of sizes conforming to 00150.35(b). Prepare and present a training and orientation session covering the operation, adjustment and maintenance of the irrigation system. Review corrected drawings and explain all features. At this session, provide the Engineer with parts lists and service manuals for all equipment. Notify the Engineer in writing two weeks before the proposed date of the training and orientation session. The date and time of the session will be mutually agreed to.

Measurement

01120.80 General - There will be no separate measurement of work done under this Section.

Payment

01120.90 General - Payment will be made at the Contract lump sum amount for the pay item "Irrigation System", which will be payment in full for furnishing and placing all materials, equipment, labor, and Incidentals necessary to complete the work, including excavation and backfill, electrical service and system orientation.

Section 01140 - Potable Water Pipe and Fittings

Description

01140.00 Scope - This work consists of constructing potable water pipe and fittings 400 mm (16 inches) and smaller in diameter.

Install pipe in the kinds, sizes and lengths and at the locations shown or as directed to the lines and grades established. Furnish and construct joints, fittings, and connections to other potable water systems, as necessary, for complete installation.

Materials

01140.10 General - Materials shall meet the following requirements:

Ductile iron pipe	02470.20
Steel pipe - 150 mm (6 inch) and larger	02470.30
Steel pipe - under 150 mm (6 inch)	02470.35
Polyvinyl chloride (PVC) pipe - 100 mm (4 inch) and larger	02470.40
Polyvinyl chloride (PVC) pipe - under 100 mm (4 inch)	02470.45
Polyethylene encasement	02470.50
Detectable marking tape or wire	02470.60
Ductile iron pipe fittings	02475.20
Steel pipe fittings - 150 mm (6 inch) and larger	02475.30
Steel pipe fittings - under 150 mm (6 inch)	02475.35
Polyvinyl chloride (PVC) pipe fittings - 100 mm (4 inch) and larger	02475.40
Polyvinyl chloride (PVC) pipe fittings - Under 100 mm (4 inch)	02475.45
Restrained joints	02475.50
Bolted, sleeve-type couplings for plain end pipe	02475.60
Tie rods	02485.60
Commercial grade concrete in thrust blocks	00440
Reinforcement	00530

01140.11 Handling Pipe and Fittings - Handle pipe and fittings so as to prevent damage to the pipe, fitting, lining, or coating. Load and unload pipe and fittings using hoists and slings so as to avoid shock or damage, and under no circumstances allow them to be dropped, skidded, or rolled against other pipe or fittings. If any part of the coating or lining is damaged, repair in a manner satisfactory to the Engineer. Damaged pipe and fittings will be rejected. Immediately separate all damaged pipe and fittings and remove from the job site.

Protect threaded pipe ends with couplings or other means until laid. Inspect the pipe and fittings for defects.

Store pipe on cradles to prevent entry of dirt or other foreign material. Keep the pipe or pipe joint free of dirt or other foreign material during handling or laying operations. Remove, clean, and relay any pipe or fitting that has been installed with dirt or foreign material in it. At times when pipe laying is not in progress, close the open ends of pipe with watertight plugs or by other approved means to ensure cleanliness.

01140.12 Cutting Pipe - Use short lengths of pipe supplied by the manufacturer whenever possible to provide the proper spacing of valves, tees or special fittings.

Cut pipe with abrasive saws or by special pipe cutters. Square all pipe ends with the longitudinal axis of the pipe. Ream and otherwise smooth the cut ends so that good connections can be made. Cut threads cleanly. Flame cutting of ductile iron pipe will not be allowed.

Construction

01140.40 Trench Work - Excavate trench, prepare bedding, install pipe zone material, backfill, and dispose of excavated material according to Section 00405 and the following:

(a) Dewatering Trenches - Remove water encountered in the trench during pipe laying operations and maintain the trench until the ends of the pipe are sealed and provision is made to prevent floating of the pipe. Do not allow trench water or other deleterious materials to enter the pipe at any time.

(b) Bedding and Pipe Zone - For the purpose of these Specifications, all potable water pipes are considered flexible pipes. Use bedding and pipe zone material for flexible pipes as described in 00405.12 and 00405.13.

(c) Extra Trench Excavation - Changes in the alignments or grades of the potable water pipes from those shown or specified may be necessary because of unplotted utilities, or for other reasons. If directed to adjust, correct, relocate, or in any way change the line and grade, make such changes according to these Specifications.

When pipeline grade is lowered in excess of 0.3 m (12 inches) below the grade shown, or when pipeline horizontal alignment is changed by more than 0.3 m (12 inches) after the original trench has been excavated, the additional excavation and backfill so required will be classified as extra trench excavation. The additional backfill material shall match the class used in the original trench.

(d) Installation in Paved Areas - If pipe is installed within paved areas to be preserved, perform the installation according to Sections 00405 and 00495.

01140.41 Laying Pipe:

(a) General - Lay pipe to the lines and grades shown and established.

(b) Ductile Iron Pipe - Install ductile iron pipe according to AWWA C600 and the manufacturer's recommendations.

Lay long radius curves, either horizontal or vertical, with standard pipe by deflecting the joints. If the pipe is shown curved in the plans and no special fittings are shown, assume that the curves can be made by deflecting the joints with standard lengths of pipe. If shorter lengths are required, the plans will indicate maximum lengths that can be used. Do not exceed the manufacturer's printed recommendations for the amount of deflection at each pipe joint when pipe is laid on a horizontal or vertical curve. Where field conditions require deflection or curves not anticipated by the plans, the Engineer will determine the methods to be used.

When ductile iron pipe is laid on a curve, join the pipe in a straight alignment and then deflect it to the curved alignment. Make trenches wider on curves for this purpose.

(c) Polyethylene Encasement - Where shown, lay ductile iron pipe with a polyethylene encasement. Install polyethylene encasement according to AWWA C105 and the manufacturer's recommendations.

(d) Steel Pipe - Install steel pipe according to the manufacturer's recommendations. Lay steel pipe on curves in the same manner described above for ductile iron pipe.

(e) Polyvinyl Chloride (PVC) Pipe - Install PVC pipe according to AWWA C605 and the manufacturer's recommendations.

Bend PVC pipe 300 mm (12 inches) and smaller to allow for slight changes in direction. The minimum bending radius shall be according to AWWA C605 and the manufacturer's recommendation. Axial deflection at the pipe joints will not be allowed.

For 350 mm (14 inch) and 400 mm (16 inch) diameter pipe, accomplish slight changes in direction by axial deflection of the pipe joint according to the manufacturer's recommendation. Use fittings for joint deflections greater than the manufacturer's recommendation.

01140.42 Jointing Pipe:

(a) General - Clean all parts of the pipe ends, couplings, fittings, and appurtenances to remove oil, grit, or other foreign matter from the joint. Keep the joint from contacting the ground. When assembling gasketed joints, apply an approved lubricant as specified by the pipe manufacturer.

Mark pipe not furnished with a depth mark before joint assembly.

(b) Steel Pipe: Under 150 mm (6 inch) - Brush-coat exposed threads after jointing with an approved asphalt coating.

01140.43 Polyethylene Encasement - Install polyethylene encasement according to AWWA C105 except as modified herein. Wrap polyethylene encasement loosely around the pipe, fittings, and couplings, and secure with 50 mm (2 inch) wide polyethylene adhesive tape. Cover joints or seams in the polyethylene encasement using 50 mm (2 inch) wide polyethylene adhesive tape. The polyethylene encasement need not be watertight, but do not expose any part of the pipe or coupling to the backfill. Exercise care during backfilling to prevent puncturing or otherwise damaging the polyethylene encasement.

When connecting to existing polyethylene-encased pipe, cut the existing encasement within 0.3 m (1 foot) of the connection couplings or fittings. After the connections are made, overlap the exiting polyethylene encasement a minimum of 1 m (3 feet) and seal the overlaps with 50 mm (2 inch) wide polyethylene adhesive tape.

01140.44 Concrete Thrust Blocks - Place concrete thrust blocks as shown, at bends, tees, dead ends, and crosses. Pour concrete thrust blocks in place against solid, undisturbed earth at the sides and bottom of the trench excavation. Shape the blocks so as not to obstruct access to the joints of the pipe or fittings.

01140.45 Detectable Marking Tape or Wire - Install detectable marking tape or wire over all nonmetallic water lines, including service connections. Place the tape or wire approximately 0.3 m (1 foot) above the top of the pipe for its full length.

Make ends of tape or wire accessible in water meter boxes, valve boxes or casings, or outside the foundation of buildings where the pipe enters the building. Provide detectable marking tape or wire access at locations less than 300 m (1,000 feet) apart.

01140.46 Blowoff Assemblies - Construct blowoff assemblies as shown and at the locations shown.

01140.47 Connections to Existing Mains - Make necessary arrangements with the Engineer in advance of connections to existing water mains. Assemble all materials, equipment and labor necessary to properly complete the work before starting.

If the connection to the existing system involves turning off the water, notify the residents affected by the shutoff. The Engineer will advise which property owners are to be notified.

The work to perform the connection may need to be carried out during times other than normal working hours. Do not operate any valves on the existing system without specific permission of the Engineer.

Piping arrangements shown are suggestions. For connection by any other arrangement, furnish a detailed sketch for approval not less than two weeks prior to the expected construction.

Once work is started on a connection, proceed continuously without interruption, and as rapidly as possible, until completed. Shutoff of mains will not be permitted overnight, over weekends, or on holidays.

Cut existing water mains according to 01140.12. Remove the portions of pipe to provide for the installation of the required fittings at the points of connection. Repair all damage to existing joints in piping to remain in-service. Determine the exact length of the existing water main that must be removed. Bevel pipe ends to prevent damage to the transition coupling gasket during installation of the coupling. Clean the exterior of the existing pipe end to a sound, smooth finish before installation of the coupling.

01140.48 Maintaining Service - Where existing services are to be transferred from old to new mains, plan and coordinate the work with that of the Utility so that service will be resumed with the least possible inconvenience to the public.

Allow the Utility to make connections into the new pipe at such locations as the Utility may elect to supply customers with water, after the affected section of pipe has passed hydrostatic and bacteriological tests. The installation of any such connections by the Utility shall not be construed as an acceptance by the Agency of any part of the work required under the contract.

01140.49 Backfilling - After the pipe is installed and inspected, backfill the trench according to Section 00405.

Field Testing

01140.50 Filling and Flushing - Fill pipes slowly with potable water at a maximum flow rate of $0.3 \text{ m}^3/\text{s}$ (10 cubic feet per second) while venting all air. Take all required precautions to prevent entrapping air in the pipes.

Flush sections of pipe to be tested and disinfect to remove any solids or contaminated material that may have become lodged in the pipe. If no hydrant is installed at the end of the main, provide a tap large enough to develop a flow rate of at least $0.75 \text{ m}^3/\text{s}$ (25 cubic feet per second) in the main.

Provide taps for temporary or permanent release of air, flushing, or chlorination.

Dispose of treated water flushed from mains. Neutralize the waste water for protection of aquatic life in the receiving water before disposal into any natural drainage channel. Dispose of disinfecting solution to the satisfaction of the Engineer and local authorities. If approved by the Engineer and the Utility, disposal may be made to any available sanitary sewer provided the rate of disposal will not overload the sewer.

01140.51 Hydrostatic Testing:

(a) General - Test all water mains and appurtenances in sections of convenient length under a hydrostatic pressure equal to one and one-half times the working pressure, but at least 1050 kPa (150 psi), measured at the highest point of the test section. Furnish and operate all pumps, gauges, plugs, saddles, corporation stops, miscellaneous hose and piping, and measuring equipment necessary for performing the test. Provide certifications of accuracy for gauges used in the test from an approved laboratory.

Backfill the pipeline sufficiently to prevent movement of the pipe under pressure. Place all thrust blocks and allow time for the concrete to cure before testing. Where permanent blocking is not required, furnish and install temporary blocking and remove it after testing.

Fill the mains with water and allow to stand under pressure a sufficient length of time to allow the escape of air and to allow the lining of the pipe to absorb water. The Agency will furnish the water necessary to fill the pipelines for testing, at a time of day when sufficient quantities of water are available for normal system operation.

Test by pumping the main up to the required pressure for at least two hours. Provide additional pumping during the test period to continuously maintain pressure within 35 kPa (5 psi) of that required. During the test, observe the section being tested to detect any visible leakage. Use a clean container to hold water for pumping up pressure on the main being tested. Sterilize this makeup water by adding chlorine to a concentration of 25 mg/L.

Accurately determine the quantity of water required to maintain and restore the required pressure at the end of the test period by pumping through an approved positive displacement water meter.

The quantity of water lost from the main shall not exceed the number of L/h (gallons per hour) determined by the formula:

METRIC

$$L = \frac{ND(P)^{1/2}}{130\,400}$$

where:

- L = allowable leakage in L/h
- N = number of joints in the length of pipeline tested
- D = nominal diameter of the pipe in mm
- P = average test pressure during the leakage test in kPa

ENGLISH

$$L = \frac{ND(P)^{1/2}}{7,400}$$

where:

- L = allowable leakage in gallons per hour
- N = number of joints in the length of pipeline tested
- D = nominal diameter of the pipe in inches
- P = average test pressure during the leakage test in psi

There shall be no appreciable or abrupt loss in pressure during the test period.

Correct any visible leakage regardless of the allowable leakage specified above. Should the actual leakage exceed the allowable amount, locate and repair the leaks and retest the pipeline.

Make all tests with the hydrant auxiliary gate valves open and pressure against the hydrant valve. After the pipe test has been completed, test each gate valve in turn by closing it and relieving the pressure beyond. This test of the gate valve will be acceptable if there is no immediate loss of pressure on the gauge when the pressure beyond the valve is relieved. Verify that the pressure differential across the valve does not exceed the rated working pressure of the valve.

01140.51(a)

Limit sections to be tested to 450 m (1,500 feet), unless longer test sections are approved. The Engineer may require that the first installed section of pipe installed by each crew, not less than 300 m (1,000 feet) in length, be tested. Do not continue pipe laying more than an additional 300 m (1,000 feet) until the first section has been tested successfully.

Prior to calling out the Engineer to witness the pressure test, set up all equipment completely ready for operation and successfully perform the test to ensure that the pipe is in a satisfactory condition.

Replace defective materials or workmanship discovered during hydrostatic field testing. Whenever it is necessary to replace defective material or correct the workmanship, repeat the hydrostatic test until a satisfactory test is obtained.

(b) Testing Extensions from Existing Mains - When an existing water main is extended with new pipe to a new valve, and the distance from the existing pipe to the new valve is 5.5 m (18 feet) or less, no hydrostatic test will be required if the section of new pipe between the new valve and the end of the existing main is installed with pretested, prechlorinated pipe. When the required hydrostatic tests are conducted in the new main section beyond the installed new valve in the closed position, the normal pressure of the existing main may be present against the other side of the new valve.

Where the distance between the end of an existing water main pipe extension and the new valve is more than 5.5 m (18 feet), do not connect the new pipe to the existing pipe until after hydrostatic tests have been made to the required pressure in both directions against the new valve. Test after installing a temporary cap or plug on the end of the new pipe, beyond the new valve, as close as possible to the existing pipe. Make the final connection to the existing main with pretested, prechlorinated pipe.

(c) Testing Sections with Hydrants Installed - When hydrants are included with the section of main pipe to be tested, conduct three separate tests as shown in the following table:

	Water Main Gate Valves	Hydrant Auxiliary Gate Valves	Hydrant Operating Stem Valves	Hose Ports
Test No. 1	Closed	Closed	Wide Open	Wide Open
Test No. 2	Closed	Wide Open	Closed	Wide Open
Test No. 3 ¹	–	Closed	Wide Open	Closed

¹ Test each hydrant to the required test pressure. When testing a hydrant singly, pressure in the supply main beyond the hydrant auxiliary gate valve shall be 175 kPa (25 psi).

(d) Testing Hydrants Installed on Existing Mains - For hydrants installed and connected to existing mains, install the hydrant connection, including hydrant tee, connection pipe and auxiliary gate valves, with pretested materials.

Before the hydrant connection is made to the existing main, subject the hydrant installation to hydrostatic Test No. 3 in 01140.51(c).

01140.52 Disinfecting:

(a) General - Before placing new water mains in service, chlorinate new mains and repaired portions of, or extensions to, existing mains and obtain a satisfactory bacteriological report.

The initial chlorine content of the water shall be not less than 25 mg/L. A chlorine residual of not less than 10 mg/L shall remain in the water after standing 24 hours in the pipe.

(b) Chlorine Application - Apply chlorine by one of the following methods:

(1) Gaseous Chlorine - Apply a chlorine gas-water mixture by means of a solution-feed chlorinating device, or feed the dry gas directly through proper devices for regulating the rate of flow and providing effective diffusion of the gas into the water within the pipe being treated. Chlorinating devices for feeding solutions of the chlorine gas, or the gas itself, shall provide means for preventing the backflow of water into the chlorine.

(2) Calcium Hypochlorite - Apply a mixture of water and high-test calcium hypochlorite (65 - 70% Cl). First mix the dry powder as a paste and then thin to a 1% chlorine solution by adding water to give a total quantity of 62.5 L/kg (7.5 gallons per pound) (water to dry powder).

(3) Sodium Hypochlorite - Apply sodium hypochlorite, commercial grade (12.5% Cl) or in the form of liquid household bleach (5% - 6% Cl). This liquid chlorine compound may be used full-strength or diluted with water.

(c) Point of Application - Apply the chlorinating agent at the beginning of the pipeline extension or any valved section of it, through a corporation stop inserted in the horizontal axis of the pipe. Supply the water injector for delivering the chlorine-bearing water into the pipe from a tap on the pressure side of the gate valve controlling the flow into the pipeline extension. Alternate points of applications may be used when approved.

(d) Rate of Application - Control water from the existing distribution system, or other source of supply, to flow very slowly into the newly laid pipeline during application of the chlorine. The rate of chlorine application shall be in such proportion to the rate of water entering the newly laid pipe that the initial chlorine content of the water will be at least 25 mg/L.

(e) Cross Connection Control - Make no connections between the existing distribution system and non-disinfected pipelines constructed under this contact, unless a State Health Division approved backflow preventer is installed in the connecting line.

(f) Retention Period - Retain chlorinated water in the pipe at least 24 hours. After this period, the residual chlorine at pipe extremities and at other representative points shall be at least 10 mg/L.

(g) Chlorinating Connections to Existing Water Mains - Follow the chlorinating procedure specified in Section 9 of AWWA Standard C651. Swab all closure fittings with a chlorine solution at least as strong as liquid household bleach (5% - 6% Cl).

(h) Flushing and Testing - Following the retention period, flush all chlorinated water from the newly laid pipe until the replacement water throughout its length shows, upon test, an absence of chlorine or a residual no greater than that normally found in the source of supply.

Install a sampling tap ahead of the flushing hose for convenient sanitary sampling.

Do not place the lines into service before a satisfactory report is received from the local or State health department on samples collected from representative points in the new system. Samples will be collected and bacteriological tests obtained by the Engineer.

(i) Repetition of Chlorinating and Testing - Should the initial treatment result in a chlorine residual of less than 10 mg/L at the end of the retention period or an unsatisfactory bacteriological test, repeat the original chlorination procedure until satisfactory results are obtained.

Measurement

01140.80 Trench Work - There will be no separate measurement for trench excavation, bedding, pipe zone material and trench backfill for potable water pipes installed at the alignments and depths shown.

Removal and backfill of extra trench excavation as defined in 01140.40(c) will be measured by the m³ (cubic yard) for each backfill class. The backfill classes will be as defined in Section 00405. The depth will be the actual depth removed for the changed line or grade as directed by the Engineer. The width will be the actual width removed for the changed line or grade, but in no case shall the measured width exceed the allowable widths specified in 00405.41(c).

01140.81 Installation Under Pavement - Quantities for replacement of pavement will be measured according to Section 00495.

When the pipe is installed under pavement by tunneling, jacking, or boring methods, measurement will be according to Section 00406.

01140.82 Pipe - The quantities of pipe of the various kinds, types, sizes and backfill classes furnished, placed and accepted will be measured by the meter (foot). Measurement will be horizontal measurement along the top of the finished trench, with no deduction for fittings, valves and couplings. There will be no separate measurement for polyethylene encasement or restrained joints.

01140.83 Fittings and Couplings - In addition to measurement of pipe as described above, an allowance of 12 pipe diameters will be made for each factory-fabricated bend, sleeve, reducer or coupling, and an allowance of 18 pipe diameters of the larger diameter pipe will be made for each factory-fabricated tee or cross. The allowance will be added to the quantity for pipe of the same diameter.

01140.84 Blowoff Assemblies - Blowoff assemblies will be measured on the unit basis, per each, by actual size and count of units in place as specified.

01140.85 Incidental Basis - There will be no separate measurement for concrete thrust blocks; detectable marking tape or wire; connections to existing mains; or flushing, hydrostatic testing and disinfection.

Payment

01140.90 General - The accepted quantities will be paid for at the contract unit price per unit of measurement for each of the pay items listed in the Schedule of Items. Payment will be payment in full for furnishing and placing the materials, including all equipment, labor and Incidentals necessary to complete the work as specified.

There will be no separate payment for trench excavation, bedding, pipe zone material and backfill work for potable water pipes installed at the alignments and depths shown. Payment for these items will be included in the appropriate pipe pay item(s).

The Contract unit price for the appropriate pay items reflects plan requirements or the Contractor's choice from the applicable options listed on the Pipe Data Sheets (if provided in the plans).

01140.91 Pipe, Fittings, and Couplings - Pipe, fittings and couplings will be paid for by the meter (foot), for one or more of the following pay items:

- (a) ___ mm (Inch) Potable Water Pipe, Fittings and Couplings with Class ___ Backfill
- (b) ___ mm (Inch) Potable Water Pipe, Fittings and Couplings with Restrained Joints and Class ___ Backfill

The nominal diameter of pipe, fittings and couplings will be inserted in the first blank. The class of backfill will be inserted in the second blank. The total pay quantities will include the quantities of pipe measured according to 01140.82 plus the pay quantity allowance defined in 01140.83 for fittings and couplings.

01140.92 Extra Trench Excavation - Payment for the item "Extra Trench Excavation with Class ___ Backfill" will be payment in full for removing and backfilling of extra trench excavation according to 01140.40(c). The class of backfill will be inserted in the blank.

01140.93 Installation Under Pavement - Replacement of pavement will be paid for according to Section 00495.

When pipe is installed under pavement by tunneling, jacking or boring methods, payment will be made according to Section 00406.

01140.94 Blowoff Assembly - Payment for the item "Blowoff Assembly, ___ mm (inch)" will be payment in full for furnishing and placing all materials, and performing all earthwork not covered as trench excavation.

01140.95 Incidental Basis - There will be no separate payment for the following, which are considered incidental to the appropriate pipe pay items:

- Polyethylene encasement
- Concrete thrust blocks
- Detectable marking tape or wire
- Connections to existing mains
- Flushing, hydrostatic testing and disinfection, and water for testing

Section 01150 - Potable Water Valves

Description

01150.00 Scope - This work consists of furnishing and installing valves in potable water systems at the locations shown or at other locations as directed.

Materials

01150.10 General - Materials shall meet the following requirements:

Gate valves.....	02480.20
Butterfly valves.....	02480.22
Ball valves.....	02480.23
Power-actuating devices.....	02480.24
Valve boxes.....	02480.25
Valve stem extensions.....	02480.26
Tapping sleeve and valve assemblies.....	02480.30
Swing check valves.....	02480.40(a)
Spring-loaded plug or disc check valves.....	02480.40(b)
Hydraulic cushion check valves.....	02480.40(c)
Hydraulically operated valves.....	02480.50
Combination air release/air vacuum valves.....	02480.60
Backflow prevention devices.....	02480.70
Commercial grade concrete in thrust blocking.....	00440
Commercial grade concrete in precast concrete blocks.....	00440

01150.11 Handling - Handle valves so as to prevent damage to the valve, lining or coating. Load and unload valves using hoists and slings so as to avoid shock or damage, and under no circumstances allow them to be dropped or skidded. Damaged valves will be rejected. If damage is confined to the coating or lining, it may be repaired in a manner satisfactory to the Engineer. Immediately place all damaged valves apart from the undamaged and remove the damaged valves from the site as soon as possible.

01150.12 Connecting Ends - Furnish valves with connecting ends as shown and as required for connection to pipe and fittings furnished.

Construction

01150.40 General - Install valves according to the plans and the manufacturer's recommendations. Joint to the pipe as set forth in Section 01140 and AWWA Standards for the type of connecting ends furnished. Set valves and valve boxes plumb. Install valve stem extensions when required. Place valve boxes over the valve or valve operator so that the valve box does not transmit shock or stress to the valve. Install the lower casting of the unit first, supported by backfill or by a closed-cell foam collar not less than 50 mm (2 inches) in thickness. Do not allow the casting to rest directly on the body of the valve or on the water main. Carefully tamp backfill around the valve box to a distance of 1 m (3 feet) on all sides or to the undisturbed face of the trench, whichever is closer. Set the cast iron valve box cover flush with the roadbed or finished paved surface.

01150.41 Combination Air Release/Air Vacuum Valves - Install combination air release/air vacuum valves as shown. Slope all piping to permit escape of any entrapped air. Perform trenching and backfilling according to 01170.40 and Section 00405.

01150.50 Field Testing - After installation, operate valves from full open to full closed to make sure valves do not bind during operation. Correct any malfunction in the operation of the valves. Verify the number of turns from full open to full closed and provide to the Engineer for the Agency's records.

01150.51 Hydrostatic Testing - Subject valves to hydrostatic testing according to 01140.51. Correct any defects in design, materials or workmanship to the satisfaction of the Engineer.

01150.52 Disinfection - Disinfect valves according to 01140.52.

Measurement

01150.80 General - The quantities of valves will be measured on the unit basis, per each by actual type, size and count of units in place as specified. There will be no separate measurement for valve boxes or valve stem extensions.

Payment

01150.90 General - The accepted quantities will be paid for at the Contract unit price per unit of measurement for each of the pay items listed in the Schedule of Items. Payment will be payment in full for furnishing and placing the materials, including all equipment, labor and Incidentals necessary to complete the work as specified.

01150.91 Valves - The pay items for valves will be as follows:

Pay Item	Unit of Measurement
(a) ____ mm (Inch) ____ Valve	Each
(b) ____ mm (Inch) ____ Valve With ____ Actuator.....	Each
(c) ____ mm (Inch) ____ Check Valve.....	Each
(d) ____ mm (Inch) ____ Backflow Prevention Assembly	Each
(e) ____ mm (Inch) Hydraulically Operated Valve.....	Each
(f) ____ mm (Inch) Combination Air Release/Air Vacuum Valve Assembly .	Each
(g) ____ mm (Inch) Tapping Sleeve and ____ mm (Inch) Valve Assembly...	Each

In items (a) through (f) the size of the valve or assembly will be inserted in the first blank.

In items (a) through (d) the type of valve, check valve or assembly will be inserted in the second blank.

In item (b) the type of actuator will be inserted in the third blank.

In item (g) the size of tapping sleeve will be inserted in the first blank. The size of valve assembly will be inserted in the second blank.

Payment will be payment in full for furnishing and installing the valves complete in place, including all earthwork not covered under other pay items, jointing, blocking of valves, protective coatings, valve boxes, valve stem extensions and hydrostatic testing.

Section 01160 - Hydrants and Appurtenances

Description

01160.00 Scope - This work consists of furnishing and installing dry-barrel fire hydrants and appurtenances in potable water systems at the locations shown or at other locations as directed.

Materials

01160.10 General - Materials shall meet the following requirements:

Fire hydrants	02485.10
End connections	02485.20
Hydrant dimensions	02485.30
Hydrant extensions	02485.40
Traffic flange	02485.50
Tie rods	02485.60
Guard posts	02485.70
Auxiliary gate valves	02480.20
Valve boxes	02480.25
Valve stem extensions	02480.26
Commercial grade concrete in thrust blocking	00440

01160.11 Handling of Hydrants - Handle hydrants so as to prevent damage to the hydrant, lining or coating. Load and unload hydrants using hoists and slings so as to avoid shock or damage, and under no circumstances allow them to be dropped, skidded or rolled against other hydrants. Damaged hydrants will be rejected. If damage is confined to the coating or lining, it may be repaired in a manner satisfactory to the Engineer. Immediately place all damaged hydrants apart from the undamaged and remove the damaged hydrants from the site as soon as possible.

Construction

01160.40 Setting Hydrants - Inspect all hydrants upon delivery in the field to ensure proper working order. Provide a minimum 1 m (3 foot) radius unobstructed working area around all hydrants. Set the traffic flange 50 mm (2 inches) above finish grade. Allow the hydrant barrel drain to waste into a pit of porous gravel material situated at the base of the hydrant.

After all installation and testing is complete, paint the exposed portion of the hydrant with one coat of the type and color coating designated by the Engineer.

Identify any hydrant not in service by covering with a burlap or plastic bag properly secured.

01160.41 Hydrant Laterals - Install hydrant laterals, consisting of 150 mm (6 inch) ductile iron pipe, from the auxiliary gate valve at the main to the hydrant, according to Section 01140 and as shown.

01160.42 Hydrant Restraints - Restrain the thrust created in the hydrant lateral as shown. If applicable, clean tie rods after installation and paint with two coats of coal tar epoxy or other approved bituminous coating.

01160.43 Auxiliary Gate Valves and Valve Boxes - Install auxiliary gate valves and valve boxes according to Section 01150, except that the end connections shall be provided with lugs for tie rods, or the bells shall provide sufficient clearance between the body of the valve and the hub to permit the installation of tie rods.

01160.44 Hydrant Guard Posts - Construct hydrant guard posts at the locations shown. Excavate holes 0.4 m (16 inches) in diameter for hydrant guard posts to a depth of 1.0 m (36 inches). Install hydrant guard posts plumb, and center in the holes. Backfill the holes and fill the hydrant guard posts with Commercial grade concrete. Paint the exposed portion of each guard post with one coat of the type and color coating designated by the Engineer.

01160.45 Resetting Existing Hydrants - Where existing hydrants are shown for adjustments to conform to a new street alignment or grade, or both, relocate the hydrant without disturbing the location of the hydrant lateral tee at the main.

Determine the method for thrust restraint for the hydrant lateral according to the conditions found in the field, and construct as directed.

01160.46 Moving Existing Hydrants - Move existing hydrants where shown. When the existing hydrant lateral tee does not accommodate a new hydrant location, install a new hydrant lateral tee in the main. Remove the existing hydrant lateral tee from the main if the main is to remain active, and insert a new section of pipe into the water main in place of the existing hydrant lateral tee. Where the existing main to which the existing hydrant lateral tee is connected is to be abandoned or temporarily activated after the existing hydrant is moved, plug the open end of the hydrant lateral pipeline. Provide temporary thrust restraint if temporarily reactivated.

01160.47 Reconnecting Existing Hydrants - Reconnect existing hydrants where shown. Leave the location and elevation of the existing hydrant unchanged, but change the existing hydrant lateral to connect with a new auxiliary gate valve and hydrant tee provided in a new main. Install new hydrant lateral according to Section 01140 where the lateral must be extended to connect to the new main. Where existing hydrants were not restrained with tie rods to the old main, restrain the new connections with tie rods as shown, or by other joint restraint method as directed.

01160.48 Hydrant Extensions - Install hydrant extensions where required. Set the traffic flanges 50 mm (2 inches) above finish grade.

Field Testing Installations

01160.50 General - After installation, operate hydrants from full open to full closed to make sure they do not bind during operation. Correct any malfunction in the operation of the hydrants.

01160.51 Hydrostatic Testing - Subject hydrants to hydrostatic testing according to 01140.51. Correct any defects in design, materials or workmanship to the satisfaction of the Engineer.

01160.52 Disinfection - Disinfect hydrants according to 01140.52.

Measurement

01160.80 General - The quantities of hydrant assemblies, resetting existing hydrants, moving existing hydrants, reconnecting existing hydrants, hydrant extensions, and hydrant guard posts will be measured on the unit basis, per each, by actual count of units in place as specified.

Payment

01160.90 General - The accepted quantities will be paid for at the Contract unit price per unit of measurement for each of the pay items listed in the Schedule of Items. Payment will be payment in full for furnishing and placing the materials, including all equipment, labor and Incidentals necessary to complete the work as specified.

01160.90

New pipe for hydrant connections to existing mains and/or lateral tees will be paid for according to Section 01140.

01160.91 Hydrant Assemblies - The accepted quantity of hydrant assemblies will be paid for at the Contract unit price per each for the item "Hydrant Assemblies". Payment will be payment in full for all work to furnish and install fire hydrant assemblies, including all costs for auxiliary gate valve, tie rods, concrete blocks, gravel, and painting required for the complete installation of the hydrant assembly as specified.

01160.92 Resetting Existing Hydrants - The accepted quantity of existing hydrants that are reset will be paid for at the Contract unit price per each for the item "Resetting Existing Hydrants". Payment will be payment in full for all work to reset the existing hydrant, including tie rods, painting, and reconnecting to the main.

01160.93 Moving Existing Hydrants - The accepted quantity of existing hydrants that are moved will be paid for at the Contract unit price per each for the item "Moving Existing Hydrants". Payment will be payment in full for all work to move the existing hydrant, including new hydrant lateral tee, tie rods, painting, reconnecting to the main, and plugging abandoned laterals if needed.

01160.94 Reconnecting Existing Hydrants - The accepted quantity of existing hydrants that are reconnected will be paid for at the Contract unit price per each for the item "Reconnecting Existing Hydrants". Payment will be payment in full for all work to reconnect the existing hydrant.

01160.95 Hydrant Guard Posts - The accepted quantity of hydrant guard posts will be for at the Contract unit price per each for the item "Hydrant Guard Posts". Payment will be payment in full for all work to furnish and install hydrant guard posts, including excavation, backfill and painting.

01160.96 Hydrant Extensions - The accepted quantity of hydrant extensions will be paid for at the Contract unit price per each for the item "Hydrant Extensions". Payment will be payment in full for all work to extend the hydrants vertically.

Section 01170 - Potable Water Service Connections, 50 mm (2 Inch) and Smaller

Description

01170.00 Scope - This work consists of furnishing and installing service connections, 50 mm (2 inch) in diameter and smaller, from the main to the water meter, and furnishing and installing sampling stations. The water meter will be furnished and installed by others unless specified otherwise in the Special Provisions or on the plans.

Materials

01170.10 General - Materials shall meet the following requirements:

Saddles	02490.20
Corporation stops.....	02490.30
Copper tubing service pipe	02490.40(a)
Polyethylene tubing service pipe.....	02490.40(b)
Service fittings.....	02490.40(c)
Meter setters.....	02490.50
Bronze nipples and fittings.....	02490.60
Meter boxes	02490.70
Sampling stations.....	02490.80

Construction

01170.40 General - Make all service connections to water mains, except to ductile iron pipe, Thickness Class 52 or thicker, using saddles as specified and of the size and type suitable for use with the pipe being installed. Direct tap ductile iron pipe, Thickness Class 52 or thicker, for corporation stops according to the recommendations of the Ductile Iron Pipe Research Association (DIPRA), unless direct taps are prohibited by the Special Provisions. Install service pipelines perpendicular to the main, unless shown otherwise.

Construct the depth of trench for service connection piping to provide a minimum of 0.75 m (30 inches) of cover over the top of the pipe. Exercise care to ensure that the main is not damaged by the work undertaken to install the service. Excavate and backfill for service connections according to Section 00405, except install the service pipeline under pavement, curbs and sidewalks by boring methods approved by the agency having jurisdiction over the roadway.

Install either copper tubing or polyethylene tubing service pipes, unless otherwise shown or specified. Cut service pipes using tools specifically designed to leave a smooth, even and square end on the pipe. Ream cut ends to the full inside diameter of the pipe. Clean pipe ends to be connected using couplings that seal to the outside surface of the pipe to a sound, smooth finish before the couplings are installed. Adjust the meter box to the finished grade after the surface has been acceptably restored.

01170.41 Reconnecting Existing Services - Where shown, reconnect existing service connections to the new mains. Verify the location of existing service connections in the field. Notify affected customers of the service interruption at least 24 hours prior to service interruption.

01170.42 Sampling Stations - Install sampling stations at the locations shown or as directed. Set at the depth shown or specified. Perform trenching and backfilling according to 01170.40.

Field Testing Installations

01170.50 Flushing and Disinfection - Chlorinate all service pipe, appurtenances and sampling stations prior to installation. Flush the service connections and sampling stations after installation.

Measurement

01170.80 General - The quantities of service connections, reconnecting existing services, and sampling stations will be measured on the unit basis, per each, by the actual size and count of units in place as specified.

Payment

01170.90 General - The accepted quantities will be paid for at the Contract unit price per unit of measurement for each of the pay items listed below, when appearing in the Schedule of Items. Payment will be payment in full for furnishing and placing the materials, including all equipment, labor and Incidentals necessary to complete the work as specified.

Pay Item	Unit of Measurement
(a) ___ mm (Inch) Water Service Connections.....	Each
(b) Reconnecting Existing Water Services, ___ mm (Inch)	Each
(c) Water Sampling Stations.....	Each

In items (a) and (b), the size will be inserted in the blank.

Item (a) includes payment in full for all work to install the service connection, including but not limited to, excavating, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, testing, flushing and disinfection of the service connection.

Item (b) includes payment in full for all work to reconnect the existing services to the new main, including but not limited to, excavation, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, testing, flushing and disinfection of the reconnected service connection.

Item (c) includes payment in full for all work to install the sampling station, including but not limited to, excavating, tapping the main, laying and jointing the pipe and fittings and appurtenances, backfilling, concrete pad, testing, flushing and disinfection of the sampling station.