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DARTMOUTH, NOVA SCOTIA	APPLICATIONS	
PROJECT NO. R.082155.001		2017-07-24

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 31 05 16 - Aggregate Materials.
- .2 Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .3 Section 33 11 16 - Site Water Utility Distribution Piping.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM C 117-13, Standard Test Method for Materials Finer than 75- μm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C 136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM C 518-15, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - .4 ASTM D 638-14, Standard Test Method for Tensile Properties of Plastics.
 - .5 ASTM D 698-12e2, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .6 ASTM D 1505-10, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
 - .7 ASTM D 1621-16, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
 - .8 ASTM D 1622-14, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - .9 ASTM D 2657-07, Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
 - .10 ASTM D 2842-12, Standard Test Method for Water Absorption of Rigid Cellular Plastics.
 - .11 ASTM D 3574-17, Standard Method of Testing Flexible Cellular Materials - Slab, Bonded and Molded Urethane Foams.
 - .12 ASTM D 6226-15, Standard Test Method for Open Cell Content of Rigid Cellular Plastics.
 - .13 ASTM E 96/E 96M-16, Standard Test Methods for Water Vapour Transmission of Materials.
 - .14 ASTM F 714-13, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
 - .15 ASTM G 14-04(2010)e1, Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-88, Sieves, Testing, Woven Wire, Metric.

- .3 CSA Group
 - .1 CSA B137 Series-13, Thermoplastic Pressure Piping Compendium. (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12).
 - .2 CAN/CSA-C22.2 No.130-03(R2013), Requirements for Electrical Resistance Heating Cables and Heating Device Sets.

1.3 ADMINISTRATIVE REQUIREMENTS

- .1 Pre-Installation Meetings: convene pre-installation meeting 1 week prior to beginning work of this Section and on-site installation, with contractor's representative and Departmental Representative in accordance with Section 01 32 16.07 - Construction Progress Schedule - Bar (GANTT) Chart to:
 - .1 Verify project requirements.
 - .2 Review installation and substrate conditions.
 - .3 Co-ordination with other building subtrades.
 - .4 Review manufacturer's installation instructions and warranty requirements.
- .2 Scheduling:
 - .1 Schedule work to minimize interruptions to existing services.
 - .2 Submit schedule of expected interruptions for approval by Departmental Representative and adhere to interruption schedule as approved by Departmental Representative.
 - .3 Notify Departmental Representative building superintendent minimum of 24 hours in advance of interruption in service.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for factory pre-insulated or assembled piping systems for utility applications and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Submit complete heat tracing system calculation provided by the equipment manufacture. Calculation to be provided for each heat tracing circuit and to include as minimum:
 - .1 Heat loss and cable rating/type.
 - .2 Circuit lading and breaker sizing.
 - .3 Bill of materials.
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- .3 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.
- .4 Test reports: submit certified test reports for specified materials from approved independent testing laboratories, indicating compliance with specifications for specified performance characteristics and physical properties.
- .5 Manufacturer's Instructions: submit manufacturer's installation instructions and special handling criteria, installation sequence, cleaning procedures.
 - .1 Departmental Representative will make available 1 copy of systems supplier's installation instructions.
- .6 BACnet integration manual: Submit a BACnet integration manual for the BACnet interface supplied with or integral to the EHT controller.

1.5 OPERATION AND MAINTENANCE MANUEL

- .1 Provide heat tracing system operation and maintenance data.

1.6 MAINTENANCE MATERIALS

- .1 Provide maintenance materials in accordance with Section 01 78 00 - Closeout Submittals.

1.7 TRAINING

- .1 Provide on-site lectures and demonstration by heat tracing equipment manufacturer to train operational personnel in use and maintenance of heat tracing system.
- .2 Provide minimum of six (6) hours of training. The time schedule of the training sessions to be coordinated with Departmental Representative.

1.8 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
 - .2 Operation and Maintenance Data: submit operation and maintenance data for insulated piping systems for incorporation into manual.
 - .3 Record Drawings: submit data necessary to produce record drawings on project completion and following requirements:
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.1 Give details of pipe material, location of fittings, maintenance and operating instructions.

1.9 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials off ground and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect insulated piping system materials from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
- .4 Develop Construction Waste Management Plan Waste Reduction Workplan related to Work of this Section.
- .5 Packaging Waste Management: remove for reuse and return by manufacturer of pallets, crates, padding, and packaging materials as specified in Construction Waste Management Plan Waste Reduction Workplan in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.

PART 2 - PRODUCTS

2.1 CARRIER CORE PIPE

- .1 Polyethylene pressure pipes: in accordance with Section 33 11 16 - Site Water Utility Distribution Piping.

2.2 APPLIED INSULATION

- .1 Clean pipes of surface dust or dirt and treat to assure positive bond of foam to entire pipe surface.
- .2 Material: rigid polyurethane foam factory applied.
- .3 Insulation thickness: 50 mm.
- .4 Density: to ASTM D 1622, to be a minimum of 0.032.
- .5 Closed cell content: to ASTM D 6226, 90% minimum.

- .6 Water absorption: to ASTM D 2842, maximum 4.25% by volume.
- .7 Compressive strength: to ASTM D 1621, minimum of up to 200 kPa.
- .8 Thermal conductivity: to ASTM C 518, a maximum of .022 W/m. degrees C.
- .9 Service temperature: minus -45 degrees C to plus +40 degrees C.
- .10 Centering of pipe within insulation: no more than plus or minus 6 mm off centre.
- .11 Protect insulation on both ends of pipe from moisture and sunlight by 3 mm thick continuous concentration of black asphalt mastic compound.
- .12 Insulation must completely fill space between pipe and conduit.

2.3 OUTER JACKET FOR BURIED AND ABOVE GROUND APPLICATIONS

- .1 Material: factory applied high density polyethylene jacket, black in colour (UV inhibited).
- .2 Density of HDPE jacket: to ASTM D 1505, 0.940 gm/cm³ minimum.
- .3 Sealant: synthetic polymers or modified rubber mastic.
- .4 Jacket thickness: 1.14 mm minimum.
- .5 Elongation: to ASTM D 638, 400% maximum 6 month test.
- .6 Service temperature: minus 45 degrees C to plus 40 degrees C maximum.
- .7 Water vapour transmission rate: 3 gm/m² /24 hours average.
- .8 Tensile strength: 25 kg/cm width minimum.
- .9 Impact strength: to ASTM G 14, 7.79 N/m at minus 40 degrees C minimum.

2.4 INSULATED PIPE JOINTS FOR ABOVEGROUND AND BURIED APPLICATIONS

- .1 Material: rigid polyurethane half shells with heat shrink sleeves to provide strong, moisture-proof seal as described in this Section.
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- .2 Silicone caulking: circumferentially beaded around outer jacket of pipe 50 mm from pipe end as specified.
- .3 Rolled steel sheet: 0.889 mm thick, wrapped around and strapped into place to complete joint.
- .4 Pre-formed rigid polyurethane halves: as indicated, with properties specified.
- .5 Heat shrink sleeves: adhesive coated cross linked polyethylene sleeve.
- .6 Sleeves: to cover entire exposed joint length plus overlap of about 76 mm of pipe coating on either side.
- .7 Waterproof mastic sealant for coating exposed ends of insulation after field cutting or trimming: as specified.

2.5 INSULATION KITS FOR FITTINGS

- .1 Material: rigid polyisocyanurate foam with fully bonded FRP glass reinforced polyester or polymer protective coating on exterior surfaces including ends.
 - .1 Supply kits complete with silicone caulking for seams, stainless steel attachment straps and clips, and heat shrink sleeves to seal between pipe and insulation cover.
- .2 Rigid polyisocyanurate foam insulation.
 - .1 Density: to ASTM D 1622, 0.03 gm/cm³ minimum.
 - .2 Compressive strength: to ASTM D 1621, 137 kPa minimum.
 - .3 Closed cell content: 92% minimum.
 - .4 Water absorption: to ASTM D 2842, 0.02 g/m².
 - .5 K Factor: to ASTM C 518, 0.02 W/m. degrees C maximum.
- .3 Polymer coating: to ASTM D 3574.
 - .1 Two component high density polyurethane coating, black in colour.
 - .2 Density: 1170 kg/m².
 - .3 Abrasion: durometer D scale: 60.
 - .4 Tensile strength: 11,000 kPa minimum.
 - .5 Tear strength: 26.5 N/mm minimum.

2.6 INSULATION FOAMED IN PLACE

- .1 Material: two component polyurethane Class I foam, supplied in portable, disposable, pressurized container.
 - .2 Density: to ASTM D 1622, 0.035 to 0.039 gm/cm³.
 - .3 Closed cell content: to ASTM D 6226, 90% minimum.
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- .4 Thermal conductivity: to ASTM C 518, 0.022 to 0.024 W/m. degrees C.
- .5 Compressive strength: to ASTM D 1621, 103 to 172 kPa at 10% deflection minimum.
- .6 Water absorption: to ASTM D 2842, 4.25% maximum by volume.

2.7 INSULATION ACCESSORIES

- .1 Heat shrink tape for sealing insulation half shells against moisture adaptable to flexible installations.
 - .1 Crosslinked polyolefin backing with a hot melt adhesive coating.
 - .2 Backing thickness: 0.35 mm minimum.
 - .3 Adhesive thickness: 0.51 mm.
 - .4 Service temperature: minus 18 to plus 20 degrees C maximum.
 - .5 Tensile strength: 16 N/mm.
 - .2 High density polyethylene tape for minor repair of the outer jacket or completion of straight insulation joints in field where irregular surfaces are not involved.
 - .1 Adhesive backed tape: heated to approximately 50 degrees C prior to installation.
 - .2 Backing thickness: 0.50 mm average.
 - .3 Adhesive thickness: 0.127 mm average.
 - .4 Service temperature: minus 34 to plus 82 degrees C.
 - .5 Tensile strength: 10 N/mm.
 - .6 Colour: black.
 - .3 Asphalt mastic vapour barrier coating to waterproof exterior surfaces of half shells sprayed in place foam.
 - .1 Colour: black.
 - .2 Solids by volume: 62%.
 - .3 Coverage: 14 L at 9.0 m².
 - .4 Drying time to touch: 4 hours maximum.
 - .5 Drying time firm: 48 hours maximum.
 - .6 Service temperature: minus 29 to plus 93 degrees C.
 - .7 Application temperature: 4.4 degrees C minimum.
 - .8 Moisture permeability: 3.2 mm wet film at 37.3 degrees C.
 - .9 90% relative humidity: to ASTM E 96, 02 perms.
 - .10 Shelf life: 12 months.
 - .4 Silicone caulking for joining faces of rigid urethane insulation.
 - .1 Colour: black.
 - .2 Specific gravity: 1.07.
 - .3 Tensile strength: 25 kg/cm².
 - .4 Tear strength: 8 kg/cm².
 - .5 Service temperature: 205 degrees C maximum.
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2.8 ELECTRIC HEAT TRACING

- .1 Heat tracing conduits:
 - .1 Consisting of extruded plastic moulding and applied to pipe prior to application of insulation.
 - .2 Fasten securely to pipe and seal to prevent ingress of foam during insulation.
 - .3 Check conduit after insulating to ensure they are not plugged.
 - .4 Seal ends prior to shipping to prevent foreign material from entering conduit while in transit or during installation.

 - .2 Electric tracing cable:
 - .1 Resistive parallel circuit type: to CAN/CSA-C22.2 No.130, self-regulating with semi-conductive core heating element.
 - .2 Fluoropolymer inner and outer insulation jackets, and suitable for cutting to length in field.
 - .3 If pipe being traced is plastic, heat trace cable to have metallic grounding overbraid of sufficient conductivity to carry fault current and secondary Fluoropolymer extruded overjacket to CAN/CSA-C22.2 No.130.
 - .4 Manufacturer to ensure that specified electric tracing cable and heat tracing conduit size are compatible, so that cable may be pulled in with relative ease.
 - .5 For use on nonmetallic piping with 240 V power supply.
 - .6 Heating capacity: as indicated on drawings and verified by the heat tracing equipment manufacturer. For use on metallic and nonmetallic piping with 240 V power supply.
 - .7 Cable to vary its power (heat) output all along its length relative to the temperature of the pipe surface, designed to be crossed over itself without overheating, cut to length in the field.
 - .8 Cable accessories used to attach heating cable onto pipes and connection components used to terminate heating cable, including power connectors, splices, tees, and end connectors shall be approved for the application and for the use with the particular type of heating cable. Enclosure rating CSA Type 4X.
 - .9 Aluminum tape for fastening heating cable to metallic and nonmetallic pipes. Aluminum tape, lengthwise over the cable for nonmetallic pipes as a heat-transfer aid. Cable ties where the pipe surface prevents proper tape adhesion.
 - .10 Heat tracing components from one manufacturer throughout project.

 - .3 Thermostatic controller:
 - .1 Heat controller capable of monitoring and controlling two independent heat trace circuits based on two temperature inputs.
 - .2 Low temperature sensor control: factory preset at 5.0 degrees C.
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- .4 Terminal end seal kits: certified for installation in damp conditions to CAN/CSA-C22.2 No.130 and consisting of:
 - .1 Self-regulating:
 - .1 Two heat-shrinkable tubes.

 - .5 Power connection kits: connect to pipe and to CAN/CSA-C22.2 No.130 as indicated.
 - .1 Self regulating:
 - .1 Base.
 - .2 Top.
 - .3 Sealing gasket.
 - .4 Terminal block.
 - .5 Locknuts.

 - .6 Multicircuit microprocessor based temperature control and monitoring unit. Unit to individually monitor and control two heat tracing circuits. Expandable, modular system with:
 - .1 Full text LCD display to display temperatures and operating parameters (heater current, ground leakage current) for each heat tracing circuit.
 - .2 LED's to indicate power-on, present status, and alarm status.
 - .3 Integral keypad for field operational programming, review and re-programming.
 - .4 Input: Two 3-wire RTD's for each heat tracing circuit.
 - .5 Output: 30A, 240V and 120V solid-state relays, soft start to minimize inrush.
 - .6 Alarm and control relays rated 1A at 240 V for remote alarm and annunciation.
 - .7 Non-volatile memory.
 - .8 Alarms (for each heat tracing circuit):
 - .1 High temperature.
 - .2 Low temperature.
 - .3 High heating cable current.
 - .4 Low heating cable current.
 - .5 High voltage.
 - .6 Low voltage.
 - .7 Low heating cable resistance.
 - .8 High heat cable resistance.
 - .9 Ground leakage current.
 - .10 Damaged RTD sensors.
 - .9 Operating temperature: -40°C to 60°C.
 - .10 Temperature control range: -40°C to 60°C, programmable in 1 degree increments.
 - .11 Relative humidity: 0% to 90%.
 - .12 Operating current alarm: 0 to 30 amps.
 - .13 Ground leakage alarm: set at 30mA.
 - .14 Communication: the controller shall be provided with a communication interface compatible with BACnet IP or BACnet MSTP and capable of relaying all signals and alarms herein specified.
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.15 Trip: selectable for high current, high temperature, and high ground leakage current.

.16 Enclosure: lockable, CSA type 4X.

.7 Resistance temperature detector (RTD): platinum, insulated and shielded, 3-wire 100 ohms at 0°C with 1800mm lead wire and connection box CSA type 4X. Sensor accuracy +/- 0.5°C. Lead wire compensation.

.8 RTD extension cable: 3 conductor #18 AWG tinned copper insulated, twisted, shielded, c/w tinned copper drain wire, PVC jacket, and in accordance with manufacturer recommendation, Belden 8770 or approved equal.

2.9 WARNING TAPE

.1 Polyethylene tape: 150 mm wide by 0.15 mm thick as approved by Departmental Representative.

.2 Tape for water line: blue in colour with factory applied markings at one metre intervals, i.e. "Caution Heat Traced Water Line".

2.10 PIPE BEDDING AND SURROUND MATERIALS

.1 Refer to Section 33 11 16 - Site Water Utility Distribution Piping.

2.11 BACKFILL MATERIALS

.1 Refer to Section 31 23 33.01 - Excavating, Trenching and Backfilling.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install heat trace system in accordance with manufacturer's instructions. Distribute and fasten cable evenly on pipe at maximum spacing 305 mm. Bond shield to ground. Coordinate heat trace system installation with insulation application.

.2 In addition to cable fastening tape, use aluminum tape for non-metallic pipes as a heat transfer aid. Tape lengthwise over the heading cable.

.3 Use cable ties where the pipe surface prevents proper tape adhesion.

- .4 Install heat tracing system components and required mounting accessories.
- .5 Install sensors and associated connections boxes. Bond shield of lead an extension wires to ground as per manufacturer recommendation.
- .6 Program temperature control and monitoring unit. Engage heat tracing equipment manufacturer for programing the unit as specified.
- .7 Install power and control wiring and make connections.
- .8 When the insulation and weatherproofing are complete, attach heat tracing caution labels on the outside of the insulation so they are visible. Place labels at alternate sides about every 3 meters.
- .9 Provide equipment and conduit/cable identification in accordance with Section 26 05 00 - Common Work Results For Electrical.
- .10 Provide identification nameplates on each heat tracing component's box. Nameplate: lamicoid 3mm thick, red face and white core, size 7, indicate component designation, heat tracing or RTD circuit number, and system voltage.

3.2 HEAT TRACING FIELD QUALITY CONTROL

- .1 Perform tests in accordance with Section 26 05 00 - Common Work Results For Electrical.
 - .2 Test electric heat tracing in accordance with cable suppliers instructions and as follows:
 - .1 500 2500 VDC insulation tester on each circuit for insulation value, and record readings before, during and after installation.
 - .2 Resistance values to be in accordance with Table 24 of Canadian Electrical Code, Part 1.
 - .3 Testing procedure: carried out by cable supplier and witnessed by Departmental Representative.
 - .4 Should insulation resistance be less than values specified in Table 24 of Canadian Electrical Code, part 1, installer to determine and rectify cause of resistance drop, and then re-test circuit.
 - .5 Procedure to be repeated until acceptable values are attained.
 - .6 Protect piping from freezing if testing at temperatures lower than minus 5 degrees C.
 - .7 Protect piping from freezing if testing at temperatures lower than minus 5 degrees C.
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- .3 Arrange and pay for field testing of ground fault equipment protection for new or affected by this work circuits by heat tracing equipment manufacturer before commissioning services. Demonstrate simulated ground fault tests.
- .4 Arrange and pay for field testing of operation and commissioning service of heat tracing system by heat tracing equipment manufacturer.
- .5 Submit report of test to Departmental Representative and certificate that system is installed meets criteria specified.
- .6 Departmental Representative to inspect and approve heat trace cable installation prior to installation of insulation on pipe.

3.3 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for pre-insulated piping systems installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.4 REPAIRING DAMAGED PRE-INSULATED PIPE

- .1 Repair damage to outer jacket by applying heat shrink sleeve as reviewed by Departmental Representative or cover using heated HDPE UV resistant adhesive backed tape.

3.5 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.6 GRANULAR BEDDING AND SURROUND

- .1 Refer to Section 33 11 16 - Site Water Utility Distribution Piping.
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3.7 PIPE INSTALLATION

- .1 On dry ground, assemble shipping lengths of pipe into suitable installation lengths by heat butt-fusion.
- .2 Provide trained personnel and jointing machine approved by pipe manufacturer for butt-fusion jointing of polyethylene pipe.
 - .1 Obtain services of trained technician from pipe manufacturer to certify and train Contractor's personnel on jointing procedures and inspect jointing machine.
 - .2 Obtain letter from manufacturer certifying that Contractor's representatives who will perform jointing, are qualified and that jointing equipment has been inspected and is suitable for pipe supplied.
- .3 Follow manufacturer's instructions in butt-fusion of joints.
- .4 Join pipes at flanged ends in accordance with manufacturer's recommendations.
- .5 Recheck pipe joints assembled above ground after placing in trench to ensure no movement of joints has taken place.
- .6 Complete installation of rigid polyurethane halves on joints after laying pipe in trench and after successful pressure testing of pipe.
 - .1 Trim half shells to required length with handsaw to provide tight-fit in insulation gap between ends of factory insulation.
 - .2 Do not allow seam to exceed 3 mm in width at joint.
 - .1 Match outer surface of shell with outer surface of installation on pipe within tolerance of plus or minus 6 mm.
 - .2 Shave off any sharp edge with rasp.
 - .3 Hold half shells in place with masking tape while installing heat shrink sleeve.
- .7 Install heat shrink sleeves using large broad flame propane torch to produce 600 mm flame.
 - .1 Peel back release liner 12 cm from end, centre sleeve over joint and press firmly down.
 - .1 Wrap sleeve around pipe, removing release liner as it is wrapped.
 - .2 If corner on underlap is not precut, then cutoff about 25 mm from each corner.
 - .2 Before completing overlap wrapping, warm underlap area approximately 12 cm until adhesive starts to appear at edge.
 - .1 Smooth out wrinkles with gloved hand.
 - .3 Remove remaining release liner and complete wrapping.
 - .4 Remove release paper from closure seal, prewarm adhesive slightly, centre seal over overlap and press down until well bonded.

- .1 Heat closure seal, and press down with gloved hand to remove bubbles and wrinkles.
- .5 Shrink sleeve around joint with torch: start at centre of sleeve.
 - .1 Keep torch moving using broad circumferential strokes to avoid burning.
 - .2 Continue shrinking sleeve toward one end until about 50 mm is left.
 - .3 Then aim torch inward towards centre and shrink edges.
 - .4 Repeat this operation on other end of sleeve.
 - .5 Finish off by applying long horizontal strokes of torch all around sleeve.
- .6 Pay special attention to sleeve overlap area, ensuring no void remains along underlap edge.
 - .1 Use roller, or gloved hand to firmly and thoroughly press down along underlap edge.
 - .2 Start in centre and work outwards.
- .7 Joint and sleeve cool for at least 30 minutes before lowering pipe into trench.
- .8 Lay pipes on prepared bed, true to line and grade as indicated.
 - .1 No deviations without written approval of Departmental Representative.
 - .2 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .3 Take out and replace defective pipe.
 - .4 Correct pipe which is not in true alignment or grade, or pipe which shows undue settlement after installation.
 - .5 Change method or equipment for setting alignment or grade if requested by Departmental Representative.
- .9 Do not lay pipe on frozen bedding.
- .10 Do not let rocks or other foreign material, which might damage insulation jacket, fall on pipe.
- .11 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
 - .1 Install removable watertight bulkhead at open end of pipe to prevent entry of foreign materials.

3.8 INSULATION OF FITTINGS

- .1 Cut pipes as required to accommodate fittings and fitting insulation kits without damaging pipe insulation or its jacket.
 - .1 Leave smooth end at right angles to pipe axis.
 - .2 Cracks larger than 6.4 mm to be filled with insulation foamed-in-place in following manner:
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.1 Use strip of thin galvanized sheet metal wide enough to overlap both insulation kit and pipe by at least 8 cm and long enough to wrap around pipe leaving 2.5 cm opening on top.

.2 Hold metal in place with two tension metal or nylon straps, one at either end.

.3 Spray foam through opening on top into cavity.

.4 Spray until cavity is almost half-filled on both sides of pipe.

.1 Foam will rise to complete filling.

.5 Allow to cure for 10 to 15 min.

.6 Trim top and apply waterproofing sealant asphalt mastic, HDPE tape or heat shrink tape.

3.9 ELECTRIC TRACING

.1 Seal heat trace channel at fittings and flanged joints, with silicone caulking.

.2 Cable conduit: in lengths as indicated.

.1 Splicing of heat-trace cable is not allowed unless approved by Departmental Representative.

.3 Install tracer cable conduit prior to installation of half shell joints, terminal seal kits, power connector kits, thermostatic controllers, in accordance with system supplier's instructions and as indicated.

3.10 PIPE BACKFILLING

.1 Do backfilling work in accordance with Section 31 23 33.01 - Excavating Trenching and Backfilling.

3.11 FIELD QUALITY CONTROL

.1 Site tests, and inspections:

.1 Test water mains for leakage in accordance with Section 33 11 16 - Site Water Utility Distribution Piping.

.2 Leakage test sewage force mains in accordance with Section 33 34 00 - Sanitary Utility Sewerage Force Mains.

.3 Flush and disinfect water mains in accordance with Section 33 11 16 - Site Water Utility Distribution Piping.

.4 Test water mains force mains sanitary sewers for obstructions using "pig" test.

.1 Provide labour, tools, ropes, pigs and other equipment necessary to examine all work as required by Departmental Representative.

.2 Unobstructed pipes: when wood or metal ball, having diameter 19 mm less than inside diameter of pipe can be readily pulled through pipe line.

- .3 Repair or replace mains which do not pass pig test.
- .4 If O-ring connections are used, provide temporary thrust blocks prior to hydrostatic pressure testing of piping system.
- .5 Place bedding and backfill around center portion of piping system, leaving thrust blocks and field joints clear for observation.
- .6 After successful completion of hydrostatic pressure test cast concrete thrust blocks.
- .5 After completion of repair Work, redo leakage infiltration exfiltration tests and pig test.

3.12 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

3.13 BACnet INTERFACE

- .1 The intent is to interconnect the heat trace control panel to the BIO Campus existing EMSC system. Interconnection to EMCS system will be integrated through the addition of wireless transmission by others. This Contractor shall be responsible to provide the following:
 - .1 Provide heat trace control panel c/w BACnet capability.
 - .2 Coordinate with the EMCS provider during construction. Make arrangement for a minimum of one coordination meeting with the EMCS provider after final review of heat trace control panel shop drawing.
 - .3 Advise the EMCS provider a minimum of 4 weeks in advance before the functional performance testing of the heat trace control panel. The final testing of the heat trace control panel shall be scheduled and tested at the same time as the testing of the BACnet wireless integration to provide a complete working system. Allow for a manufacturer certified technician site visits for functional performance testing as required until complete BACnet integration is achieved.

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- .1 Section 31 05 16 - Aggregate Materials.
- .2 Section 31 23 33.01 - Excavating, Trenching and Backfilling.

1.2 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA B300-10, Standard for Hypochlorites.
 - .2 ANSI/AWWA B301-10, Standard for Liquid Chlorine.
 - .3 ANSI/AWWA B303-10, Standard for Sodium Chlorite.
 - .4 ANSI/AWWA C110/A21.10-12, American National Standard for Ductile-Iron and Gray Iron Fittings for Water.
 - .5 ANSI/AWWA C500-09, Standard for Metal-Seated Gate Valves for Water Supply Service.
 - .6 ANSI/AWWA C502-14, Standard for Dry-Barrel Fire Hydrants.
 - .7 ANSI/AWWA C651-05, Standard for Disinfecting Water Mains.
 - .8 ANSI/AWWA C800-12, Standard for Underground Service Line Valves and Fittings.
 - .9 ANSI/AWWA C900-07, Standard for Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 Inch through 12 Inch (100 mm - 300 mm), for Water Transmission and Distribution.
 - .2 ASTM International
 - .1 ASTM A 123/A 123M-13, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - .2 ASTM A 307-14, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile.
 - .3 ASTM B88M-13, Standard Specification for Seamless Copper Water Tube Metric.
 - .4 ASTM B418-12, Standard Specification for Cast and Wrought Galvanic Zinc Anodes.
 - .5 ASTM C117-13, Standard Test Methods for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .6 ASTM C136-14, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .7 ASTM C478M-15a, Standard Specification for Precast Reinforced Concrete Manhole Sections Metric.
 - .8 ASTM D698-12e2, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - .3 American Water Works Association (AWWA)/Manual of Practice
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- .1 AWWA M17-2006, Installation, Field Testing, and Maintenance of Fire Hydrants.
- .4 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .5 CSA International
 - .1 CAN/CSA-A3000-13, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .2 CAN/CSA-B137 Series-13, Thermoplastic Pressure Piping Compendium. (Consists of B137.0, B137.1, B137.2, B137.3, B137.4, B137.4.1, B137.5, B137.6, B137.8, B137.9, B137.10, B137.11 and B137.12).
 - .1 CAN/CSA-B137.1-13, Polyethylene Pipe, Tubing, and Fittings for Cold-Water Pressure Services.
 - .2 CAN/CSA-B137.3-13, Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications.
 - .3 CSA G30.18-09, Carbon and Steel Bars for Concrete Reinforcement.
- .6 Underwriters' Laboratories of Canada (ULC)
 - .1 CAN/ULC-S520-07, Standard for Fire Hydrants.
 - .2 CAN/ULC-S543-09, Standard for Internal-Lug, Quick Connect Couplings for Fire Hose.
 - .3 CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
- .7 Nova Scotia Transportation and Infrastructure Renewal (NSTIR)
 - .1 Standard Specification for Highway Construction and Maintenance (latest edition).
- .8 National Fire Protection Association (NFPA)
 - .1 NFPA 291-16, Recommended Practice for Fire Flow Testing and Marking of Hydrants.
- .9 Halifax Regional Water Commission (HRWC)
 - .1 Design and Construction Specifications (Water, Wastewater & Stormwater Systems), 2016 Edition.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for distribution piping materials and include product characteristics, performance criteria, physical size, finish and limitations.
 - .2 Pipe certification to be on pipe.
-

- .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Nova Scotia, Canada.

- .4 Samples:
 - .1 Inform DCC Representative of proposed source of bedding materials and provide access for sampling at least 4 weeks prior to commencing work.
 - .2 Submit manufacturer's test data and certification that pipe materials meet requirements of this section 4 weeks minimum prior to beginning work. Include manufacturer's drawings, information and shop drawings where pertinent.

1.4 CLOSEOUT SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.

- .2 Submit data to produce record drawings, including directions for operating valves, list of equipment required to operate valves, details of pipe material, location of air and vacuum release valves, hydrant details.
 - .1 Include top of pipe, horizontal location of fittings and type, valves, valve boxes, valve chambers and hydrants.

- .3 Operation and Maintenance Data: submit operation and maintenance data for pipe, valves, valve boxes, valve chambers and hydrants for incorporation into manual.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.

 - .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

 - .3 Storage and Handling Requirements:
 - .1 Store materials off ground indoors in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect water distribution piping from nicks, scratches, and blemishes.
 - .3 Replace defective or damaged materials with new.
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1.6 SCHEDULING OF WORK

- .1 Schedule Work to minimize interruptions to existing services.
- .2 Submit schedule of expected interruptions for approval and adhere to interruption schedule as approved by Departmental Representative.
- .3 Notify Departmental Representative building occupants superintendent minimum of 5 days in advance of interruption in service.
- .4 Do not interrupt water service for more than 3 hours and confine this period between 10:00 and 16:00 hours local time unless otherwise authorized.
- .5 Notify Fire Department of planned or accidental interruption of water supply to hydrants.
- .6 Provide and post "Out of Service" sign on hydrant not in use.
- .7 Advise Police Department of anticipated interference with movement of traffic.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- .1 Submit in accordance with Section 01 78 00 - Closeout Submittals.
- .2 Tools: provide tools as follows:
 - .1 Service post wrenches for curb stops.
 - .2 Hydrant wrenches.
 - .3 Tee-handle operating keys for valves.

PART 2 - PRODUCTS

2.1 PIPE, JOINTS AND FITTINGS

- .1 Ductile iron pipe: to ANSI/AWWA C151/A21.51, special class 52, cement mortar lined to ANSI/AWWA C104/A21.4.
 - .2 Joints and fittings for ductile iron pipe.
 - .1 Joints:
 - .1 Push-on joints: to ANSI/AWWA: C111/A 21.11.
 - .2 Rubber gaskets for mechanical pipe joints: to ANSI/AWWA C111/A21.11.
 - .3 Rubber gaskets for flange pipe joints 1.6 mm thick: to ANSI/AWWA C111/A21.11.
 - .4 Bolts, nuts, hex head with washers: to ASTM A 307, heavy series.
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- .5 Ensure electrical conductivity across joints.
- .2 Fittings:
 - .1 Mechanical joint cast iron and ductile iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.
 - .2 Flanged cast iron fittings NPS 3 and larger: to ANSI/AWWA C110/A21.10.

2.2 PROTECTION

- .1 Provide means of protection for iron fittings in corrosive soils in accordance with local practices and authorities having jurisdiction to ANSI/AWWA C105/A21.5 utilizing both:
 - .1 Anode: Z-24-48 conforming to ASTM B418, Type II.
 - .2 Polyethylene Encasement to be performed on all buried ductile iron pipe, valves, fittings and other appurtanances. Encasement to be made using 200 micron polyethylene sleeve manufactured and installed in accordance with ANSI/AWWA C105/A21.5 Latest Edition.

2.3 VALVES AND VALVE BOXES

- .1 Valves to open counter clockwise.
- .2 Gate valves: to ANSI/AWWA C500, standard iron body, brass bronze mounted wedge double disc valves with non-rising stems, suitable for 1 MPa with mechanical flanged push-on grooved type coupling joints.
- .3 Cast iron valve boxes: bituminous coated screw type three piece sliding type adjustable over minimum of 450 mm complete with valve operating extension rod, 30 mm minimum diameter, 25 x 25 mm cross section, of such length that when set on valve operating nut top of rod will not be more than 150 mm below cover.
 - .1 Base to be large round type with minimum diameter of 300 mm.
 - .2 Top of box to be marked "WATER"/"EAU".

2.4 SERVICE CONNECTIONS

- .1 Copper tubing: to ASTM B 88M type K, annealed.
 - .1 Joints: compression type suitable for 1 MPa working pressure.
 - .2 Polyethylene pressure pipe: to ASTM F 714, Type PE, series DR11.
 - .1 Joints:
 - .1 Thermal butt fusion joined to ASTM D 2657.
 - .2 To CAN/CSA B137, with stainless steel liner.
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- .3 Brass corporation stops: brass to ASTM B62, NSF 61-G, compression type having threads to ANSI/AWWA C800.
- .4 Brass inverted key-type curb stops: red brass to ASTM B 62, compression type with drains.
 - .1 Curb stops to have adjustable bituminous coated cast iron service box with stem to suit depth of bury.
 - .2 Top of cast iron box marked "WATER"/"EAU".
- .5 Service clamp: bronze body, confined O-ring seal cemented in place and straps suitable for connection main. Outlet tapped and treaded to AWWA C800.

2.5 HYDRANTS

- .1 Dry barrel type: to AWWA C502, ANSI/NSF 61 and as follows:
 - .1 Depth of bury: as indicated.
 - .2 Barrel: two-piece with safety break-away flange and breakway stem rod coupling.
 - .3 Main valve: compression type, 134 mm minimum diameter.
 - .4 Inlet connection: mechanical joint, 150 mm diameter.
 - .5 Nozzles: two (2) hose and one (1) pumper, with threads as follows: two 2 1/2 inch hose nozzles nominal size 3 7/32 inch with 5 threads/inch, and one pumper nozzle nominal size 4 15/16 inch with 5 threads/inch.
 - .6 Direction of opening: counter-clockwise.
 - .7 Operating nut: 32mm square.
 - .8 Acceptable products:
 - .1 Clow Brigadier "M67"
 - .2 Canada Value "Century"
 - .3 Mueller "Super Centurion 250"
- .2 Hydrant paint: exterior enamel to CAN/CGSB-1.88-92. Colour to match local standard.

2.6 PIPE BEDDING AND SURROUND MATERIAL

- .1 Granular material to: Section 31 05 16 - Aggregate Materials and following requirements:
 - .1 Type 1 Gravel, in accordance with Division 3, Section 2.4.0 of NSTIR's Standard Specifications for Highway Construction and Maintenance.
 - .2 Type C5 Clear Stone, in accordance with Division 3, Section 4.4.0 of NSTIR's Standard Specifications for Highway Construction and Maintenance.
 - .1 Obtain Departmental Representative's approval for use of clear stone as bedding and surround.
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2.7 BACKFILL MATERIAL

- .1 As indicated, select backfill material in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.8 PIPE DISINFECTION

- .1 Liquid chlorine to ANSI/AWWA B303 to disinfect water mains.
- .2 Disinfect water mains in accordance with ANSI/AWWA C651.

2.9 THRUST RESTRAINT

- .1 Thrust Blocks and Anchors: 20 MPa concrete and 15 M, grade 400 reinforcing steel where indicated.
- .2 Mechanical thrust restraints: to AWWA C111 and C153 for mechanical and push-on joints with multiple wedge or gripper ring restraining mechanism, minimum working pressure rating 240 kPa and minimum safety factor of 2:1.
 - .1 Acceptable products:
 - .1 Ebba Iron Megalug.
 - .2 Star StarGrip.
 - .3 Mueller Aquagrip.
 - .4 Clow Tyler Union TUFGrip.

2.10 PIPE TRENCH INSULATION

- .1 50 mm Extruded polystyrene, to CAN/ULC-S701, Type 4, minimum 100 psi compression strength.

2.11 YARD HYDRANT

- .1 Exposed, non-freeze yard hydrant as indicated.

2.12 HOSE BIB

- .1 1/2" x 12" frost-free hose bib, chrome plated, complete with integrated backflow preventer, and 3/4" staight thread hose connection.
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2.13 TRACER WIRE

- .1 #10 Gauge AWG single or seven strand, insulated copper tracer wire to be provided along entire length of watermain and brought to surface at hydrants and valves as determined by Departmental Representative. Contractor to provide conductivity test to Departmental Representative's satisfaction.

PART 3 - EXECUTION

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for distribution piping installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Clean pipes, fittings, valves, hydrants, and appurtenances of accumulated debris and water before installation.
 - .1 Inspect materials for defects to approval of Departmental Representative.
 - .2 Remove defective materials from site as directed by Departmental Representative.

3.3 TRENCHING

- .1 Do trenching work in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
 - .2 Ensure trench depth allows coverage over pipe to the minimum from finished grade as indicated.
 - .3 Trench alignment and depth require Departmental Representative's approval prior to placing bedding material and pipe.
-

3.4 GRANULAR BEDDING

- .1 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .2 Do not place material in frozen condition.
- .3 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .4 Shape transverse depressions in bedding as required to suit joints.
- .5 Compact each layer full width of bed to 100% maximum density to ASTM D 698.
- .6 Fill authorized or unauthorized excavation below design elevation of bottom of specified bedding in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling with compacted bedding material.

3.5 PIPE INSTALLATION

- .1 Lay pipes to manufacturer's standard instructions and specifications.
 - .1 Do not use blocks except as specified.
 - .2 Join pipes in accordance with manufacturer's recommendations.
 - .3 Bevel or taper ends of PVC pipe to match fittings.
 - .4 Handle pipe by methods approved by Departmental Representative recommended by pipe manufacturer. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends.
 - .5 Lay pipes on prepared bed, true to line and grade.
 - .1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.
 - .2 Take up and replace defective pipe.
 - .3 Correct pipe which is not in true alignment or grade or pipe which shows differential settlement after installation greater than 10 mm in 3 m.
 - .6 Face socket ends of pipe in direction of laying. For mains on grade of 2% or greater, face socket ends up-grade.
 - .7 Do not exceed permissible deflection at joints as recommended by pipe manufacturer.
 - .8 Keep jointing materials and installed pipe free of dirt and water and other foreign materials.
-

.1 Whenever work is stopped, install a removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

- .9 Position and join pipes with equipment and methods approved by Departmental Representative.
 - .10 Cut pipes in approved manner as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.
 - .11 Align pipes before jointing.
 - .12 Install gaskets to manufacturer's recommendations. Support pipes with hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
 - .13 Avoid displacing gasket or contaminating with dirt or other foreign material.
 - .1 Remove disturbed or contaminated gaskets.
 - .2 Clean, lubricate and replace before jointing is attempted again.
 - .14 Complete each joint before laying next length of pipe.
 - .15 Minimize deflection after joint has been made.
 - .16 Apply sufficient pressure in making joints to ensure that joint is completed to manufacturer's recommendations.
 - .17 Ensure completed joints are restrained by compacting bedding material alongside and over installed pipes or as otherwise approved by Departmental Representative.
 - .18 When stoppage of work occurs, block pipes in an approved manner to prevent creep during down time.
 - .19 Recheck plastic pipe joints assembled above ground after placing in trench to ensure that no movement of joint has taken place.
 - .20 Do not lay pipe on frozen bedding.
 - .21 Do hydrostatic and leakage test and have results approved by Departmental Representative before surrounding and covering joints and fittings with granular material.
 - .22 Backfill remainder of trench.
 - .23 Where a minimum pipe cover of 1.6 m cannot be achieved, water pipe shall be insulated as indicated.
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3.6 VALVE INSTALLATION

- .1 Install valves to manufacturer's recommendations at locations as indicated.
- .2 Support valves located in valve boxes or valve chambers by means of concrete located between valve and solid ground. Bedding same as adjacent pipe. Maximum length of pipe on each end of valve shall be 1 m. Valves not to be supported by pipe.
- .3 Install underground post-type as indicated.

3.7 SERVICE CONNECTIONS

- .1 Do not install service connections until satisfactory completion of hydrostatic and leakage tests of water main.
- .2 Construct service connections at right angles to water main unless otherwise directed. Locate curb stops as indicated.
- .3 Tappings on PVC-C900 pipe may be threaded without service clamps, and shall confirm to the following:

Pipe Diameter (mm)	Maximum Tap Without Clamp (mm)	Maximum Tap With Clamp (mm)
100	20	25
150	20	40
200	25	50
250	25	50
300	40	75

- .4 Tappings on PVC pipe to be either PVC valve tees or bronze type service clamps, strap type with "O" ring seal cemented in place.
- .5 Employ only competent workmen equipped with suitable tools to carry out tapping of mains, cutting and flaring of pipes.
- .6 Install single and multiple tap service connections on top half of main, between 45 degrees and 90 degrees measured from apex of pipe.
- .7 Install multiple corporation stops, 30 degrees apart around circumference of pipe and minimum of 300 mm apart along pipe.
- .8 Tap main at 2:00 o'clock or 10:00 o'clock position only; not closer to joint nor closer to adjacent service connections than recommended by manufacturer, or 1 m minimum, whichever is greater.

- .9 Leave corporation stop valves fully open.
- .10 In order to relieve strain on connections, install service pipe in "Goose Neck" form "laid over" into horizontal position.
- .11 Install rigid stainless steel liners in small diameter plastic pipes with compression fittings.
- .12 Install curb stop with corporation box on services NPS 2 or less in diameter.
 - .1 Equip larger services with gate valve and cast iron box.
 - .2 Set box plumb over stop and adjust top flush with final grade elevation.
 - .3 Leave curb stop valves fully closed.

3.8 HYDRANTS

- .1 Install hydrants at locations and in orientation as indicated.
- .2 Install hydrants in accordance with AWWA M17.
- .3 Install gate valve and cast iron valve box on hydrant service leads as indicated.
- .4 Set hydrants plumb, with hose outlets parallel with edge of pavement or curb line, with pumper connection facing roadway and with body flange set at elevation of 50 mm above final grade.
- .5 Place concrete thrust blocks as indicated and specified ensuring that drain holes are unobstructed.
- .6 To provide proper draining for each hydrant, excavate pit measuring not less than 1 x 1 x 0.5 m deep and backfill with coarse gravel or crushed stone to level 150 mm above drain holes.
- .7 Place appropriate sign on installed hydrants indicating whether or not they are in service during construction.

3.9 THRUST BLOCKS AND RESTRAINED JOINTS

- .1 For thrust blocks: do concrete Work in accordance with Section 03 30 00 - Cast-in-Place Concrete.
 - .2 Place concrete thrust blocks between valves, tees, plugs, caps, bends, changes in pipe diameter, reducers, hydrants and fittings and undisturbed ground as indicated or as directed by Departmental Representative.
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- .3 Keep joints and couplings free of concrete.
- .4 Do not backfill over concrete within 24 hours after placing.
- .5 For restrained joints: only use restrained joints approved by Departmental Representative.
 - .1 Install mechanical restraints at all joints along hydrant lead between watermain and hydrant.
- .6 Where thrust blocks cannot be laid on undisturbed ground due to excessive excavation or fill conditions, mechanical thrust restraints will be used.

3.10 CATHODIC PROTECTION

- .1 Install sacrificial zinc anodes on all directly buried metallic fittings including bends, tees, crosses, valves, and hydrants and each copper service pipe.

3.11 HYDROSTATIC AND LEAKAGE TESTING

- .1 Do tests in accordance with ANSI/AWWA C600.
 - .2 Provide labour, equipment and materials required to perform hydrostatic and leakage tests hereinafter described.
 - .3 Notify Departmental Representative at least 24 hours in advance of proposed tests.
 - .1 Perform tests in presence of Departmental Representative.
 - .4 Where section of system is provided with concrete thrust blocks, conduct tests at least 5 days after placing concrete or 2 days if high early strength concrete is used.
 - .5 Test pipeline in sections not exceeding 365 m in length, unless otherwise authorized by Departmental Representative.
 - .6 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes between joints with approved granular material placed to dimensions indicated as directed by Departmental Representative.
 - .7 Leave hydrants, valves, joints and fittings exposed.
 - .8 When testing is done during freezing weather, protect hydrants, valves, joints and fittings from freezing.
-

- .9 Strut and brace caps, bends, tees, and valves, to prevent movement when test pressure is applied.
- .10 Open valves.
- .11 Expel air from main by slowly filling main with potable water.
 - .1 Install corporation stops at high points in main where no air-vacuum release valves are installed.
 - .2 Remove stops after satisfactory completion of test and seal holes with plugs.
- .12 Fill asbestos cement pipe and concrete pipe at least 24 hours before testing to allow water absorption by pipe material.
- .13 Thoroughly examine exposed parts and correct for leakage as necessary.
- .14 Apply hydrostatic test pressure of 1375 kPa (200 psi) minimum based on elevation of lowest point in main and corrected to elevation of test gauge, for period of 1 hour.
- .15 Examine exposed pipe, joints, fittings and appurtenances while system is under pressure.
- .16 Remove joints, fittings and appurtenances found defective and replace with new sound material and make watertight.
- .17 Repeat hydrostatic test until defects have been corrected.
- .18 Apply leakage test pressure of 1035 kPa minimum after complete backfilling of trench, based on elevation of lowest point in main and corrected to elevation of gauge, for period of 2 hours.
- .19 Define leakage as amount of water supplied from water storage tank metre in order to maintain test pressure for 2 hours.
- .20 No leakage is permitted by the test process.
- .21 Locate and repair defects if leakage is greater than amount specified.
- .22 Repeat test until leakage is within specified allowance for full length of water main.

3.12 PIPE SURROUND

- .1 Upon completion of pipe laying and after Departmental Representative has inspected Work in place, surround and cover pipes as indicated.
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- .2 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
- .3 Place layers uniformly and simultaneously on each side of pipe.
- .4 Do not place material in frozen condition.
- .5 Compact each layer from pipe invert to mid height of pipe to at least 100% maximum density to ASTM D 698.
- .6 Compact each layer from mid height of pipe to underside of backfill to at least 98% maximum density to ASTM D 698.

3.13 BACKFILL

- .1 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .2 Do not place backfill in frozen condition.
- .3 Under paving and walks, compact backfill to at least 100% maximum density to ASTM D 698.
 - .1 In other areas, compact to at least 98% maximum density to ASTM D 698.

3.14 HYDRANT FLOW TESTS

- .1 Conduct flow tests on new/replaced hydrant to determine fire flows prior to painting hydrant caps and ports.
- .2 Conduct flow tests on existing hydrants as indicated, following completion of work,
- .3 Conduct hydrant flow testing in accordance with requirements of NFPA 291.

3.15 PAINTING OF HYDRANTS

- .1 After installation, paint hydrants in accordance with Departmental requirements.
 - .2 After hydrant flow tests, paint caps and ports as per NFPA 291.
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3.16 FLUSHING AND DISINFECTING

- .1 Flushing and disinfecting operations: witnessed by Departmental Representative.
 - .1 Notify Departmental Representative at least 4 days in advance of proposed date when disinfecting operations will begin.
 - .2 Prior to flushing, two (2) swabs to be launched and propelled through watermain.
 - .3 Flush and disinfect water mains to AWWA C651 and as herein specified.
 - .4 Flush water mains through available outlets with a sufficient flow of potable water to produce velocity of 1.5 m/s, within pipe for minimum 10 minutes, or until foreign materials have been removed and flushed water is clear.
 - .5 Flushing flows as follows:

Pipe Size NPS	Flow (L/s) Minimum
6 and below	38
8	75
10	115
12	150
 - .6 Provide connections and pumps for flushing as required.
 - .7 Open and close valves, hydrants and service connections to ensure thorough flushing.
 - .8 When flushing has been completed to Departmental Representative approval, introduce strong solution of chlorine as approved by Departmental Representative into water main and ensure that it is distributed throughout entire system.
 - .9 Rate of chlorine application to be proportional to rate of water entering pipe.
 - .10 Chlorine application to be close to point of filling water main and to occur at same time.
 - .11 Operate valves, hydrants and appurtenances while main contains chlorine solution.
 - .12 Flush line to remove chlorine solution after 24 hours.
 - .13 Measure chlorine residuals at extreme end of pipe-line being tested.
-

- .14 Perform bacteriological tests on water main, after chlorine solution has been flushed out.
 - .1 Take samples daily for minimum of 2 days.
 - .2 Should contamination remain or recur during this period, repeat disinfecting procedure.
- .15 Take water samples at hydrants and service connections, in suitable sequence, to test for chlorine residual.
- .16 After adequate chlorine residual not less than 50 ppm has been obtained leave system charged with chlorine solution for 24 hours.
 - .1 After 24 hours, take further samples to ensure that there is still not less than 25 ppm of chlorine residual remaining throughout system.

3.17 SURFACE RESTORATION

- .1 After installing and backfilling over water mains, restore surface to original condition as directed by Departmental Representative.

3.18 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
- .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction/Demolition Waste Management and Disposal 01 47 15 - Sustainable Requirements: Construction.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.

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PART 1 - GENERAL

1.1 SECTION INCLUDES

- .1 This section specifies requirements for constructing pressure sewers and appurtenances. Work includes supply, installation and testing of pipe, fittings and service connections.

1.2 RELATED REQUIREMENTS

- .1 Section 31 05 16 - Aggregate Materials.
- .2 Section 31 23 33.01 - Excavating, Trenching and Backfilling.

1.3 REFERENCES

- .1 American National Standards Institute/American Water Works Association (ANSI/AWWA)
 - .1 ANSI/AWWA C901-08, Polyethylene (PE) Pressure Pipe and Tubing, 1/2 in. (13mm) Through 3 in. (76mm), for Water Service.
 - .2 ANSI/AWWA C906-15, Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100mm) Through 63 in. (1,600mm), for Water Distribution and Transmission.
 - .3 ANSI/AWWA C9110/A21.10-12, Ductile-Iron and Gray-Iron Fittings, 3 in. Through 48 in. (75mm Through 1200mm) for Water and Other Liquids.
- .2 ASTM International
 - .1 ASTM C136-14, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM C117-13, Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing.
 - .3 ASTM D698-12e2, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort ((12,400 ft-lbf/ft³) (600kN-m/m³)).
 - .4 ASTM F714-13, Standard Specification for Polyethylene (PE) Pipe (SDR-PR) Based on Outside Diameter.
 - .5 ASTM D3350-14, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - .6 ASTM F2657-07(2012), Standard Practice of Heat Fusion Joining of Polyolefin Pipe and Fittings.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves Testing, Woven Wire, Metric.
 - .3 CAN/CGSB-34.1-M94, Asbestos-Cement Pressure Pipe.

- .4 Nova Scotia Transportation and Infrastructure Renewal (NSTIR)
 - .1 Standard Specification for Highway Construction and Maintenance (latest edition).
- .5 Halifax Regional Water Commission (HRWC)
 - .1 Design and Construction Specification (Water, Wastewater & Stormwater Systems), 2016 Edition.

1.4 ADMINISTRATIVE REQUIREMENTS

- .1 Scheduling:
 - .1 Schedule Work to minimize interruptions to existing services.
 - .2 Submit schedule of expected interruptions and adhere to schedule approved by Departmental Representative.
 - .3 Notify Departmental Representative and building manager superintendent a minimum of 24 hours in advance of interruption in service.

1.5 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
 - .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pipes and backfill and include product characteristics, performance criteria, physical size, finish and limitations.
 - .3 Shop Drawings:
 - .1 Submit drawings stamped and signed by professional engineer registered or licensed in Province of Nova Scotia, Canada.
 - .2 Submit shop drawings showing proposed method of installation for sewage force main in undercrossing.
 - .4 Samples:
 - .1 Submit 4 weeks minimum before beginning Work, with proposed source of bedding materials and provide access for sampling.
 - .2 Submit for testing 2 weeks before beginning Work, samples of materials proposed for use.
 - .5 Certification to be marked on pipe.
 - .6 Test and Evaluation Reports: submit manufacturer's test data and certification at least 2 weeks prior to beginning Work.
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- .7 Manufacturer's Instructions: submit to Departmental Representative 1 copy of manufacturer's installation instructions.
- .8 For fusion butt jointing for polyethylene pipe provide certification that personnel are trained by manufacturer in current methods and use of equipment.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with Section 01 61 00 - Common Product Requirements and with manufacturer's written instructions.
- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations.
 - .2 Store and protect pipes from damage.
 - .3 Replace defective or damaged materials with new.

PART 2 - PRODUCTS

2.1 MATERIALS

- .1 High density polyethylene (HDPE) pipe: to ASTM D3350.
 - .1 DR 11 (160psi).
 - .2 Minimum cell classification of PE 345464C for PE 3408 materials.
 - .3 Raw material carbon black content: 2% min, well dispersed.
 - .4 Pipe Joints: thermal butt fusion to ASTM D2657.
 - .1 Where thermal butt fusion is not possible, electro-fusion coupling or mechanical connections with polyethylene flange end with metal back-up ring are acceptable.
 - .5 Fittings:
 - .1 Polyethylene: to AWWA C901 and AWWA C906.
 - .2 Flanged cast-iron: to AWWA C110.

2.2 PIPE BEDDING AND SURROUND MATERIALS

- .1 Granular material to Section 31 05 16 - Aggregate Materials and following requirements:
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.1 Type 1 Gravel, in accordance with Division 3, Section 2.4.0 of NSTIR's Standard Specification for Highway Construction and Maintenance.

.2 Type Cf Clear Stone, in accordance with Division 3, Section 4.4.0 of NSTIR's Standard Specification for Highway Construction and Maintenance.

.1 Obtain Departmental Representative's approval for use of clear stone as bedding and surround.

.2 Concrete mixes and materials for cradles for undercrossing and thrust blocks to Section 03 30 00 - Cast-in-Place Concrete.

2.3 BACKFILL MATERIAL

.1 As indicated, select backfill material in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

.2 Unshrinkable fill where required in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.4 TRACER WIRE

.1 #10 Gauge AWG single or seven strand, insulated copper tracerwire to be provided along entire length of forcemain and brought to surface at tracer wire test stations as determined by Departmental Representative. Contractor to provide conductivity test to Departmental Representative's satisfaction.

PART 3 - EXECUTION

3.1 EXAMINATION

.1 Verification of Conditions: verify conditions of substrate previously installed under other Sections or Contracts are acceptable for pipe installation in accordance with manufacturer's written instructions.

.1 Visually inspect substrate in presence of Departmental Representative.

.2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Departmental Representative.

3.2 PREPARATION

- .1 Pipes and fittings to be clean and dry.
- .2 Prior to installation, obtain Departmental Representative's approval of pipes and fittings.

3.3 TRENCHING

- .1 Do trenching Work, in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.
- .2 Trench alignment and depth require approval from Departmental Representative prior to placing bedding material or pipe.

3.4 GRANULAR BEDDING

- .1 Place granular bedding in unfrozen condition.
- .2 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth as indicated.
- .3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe.
- .4 Shape transverse depressions as required to suit joints.
- .5 Compact each layer full width of bed to at least 100% maximum density to ASTM D698.
- .6 Fill excavation below design elevation of bottom of specified bedding with compacted bedding material.

3.5 INSTALLATION

- .1 Lay pipes in accordance with manufacturer's recommendations.
 - .2 Join pipes in accordance with manufacturer's recommendations.
 - .3 Avoid damage to machined ends of pipes in handling and moving pipe.
 - .4 Maintain grade and alignment of pipes.
 - .5 Align pipes carefully before jointing.
 - .6 Joint deflection permitted within limits in accordance with pipe manufacturer's written recommendations.
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- .7 Support pipe firmly over entire length, except for clearance necessary at couplings.
 - .1 Do not use blocks to support pipe.
- .8 Keep pipe and pipe joints free from foreign material.
- .9 Avoid bumping gasket and knocking it out of position, or contaminating with dirt or other foreign material. Remove disturbed gaskets, clean, lubricate and replace before jointing is attempted.
- .10 Support pipes using hand slings or crane as required to minimize lateral pressure on gasket and maintain concentricity until gasket is properly positioned.
- .11 Apply sufficient pressure in making joint to ensure that joint is complete to manufacturer's recommendations.
- .12 Apply restraint to pipe to ensure that joints when completed are held in place, by tamping fill material under and alongside pipe, or otherwise as approved by Departmental Representative.
- .13 When stoppage of Work occurs, block pipe as directed by Departmental Representative to prevent creep during downtime.

3.6 TRACER WIRE

- .1 Install the wire in such a manner so as to be able to properly trace the pipe without loss or deterioration of signal or without the transmittal signal migrating off the tracer wire.
- .2 Lay trace wire flat and securely affix to the pipe at 3 m intervals. Protect the wire from damage during the excavation of the works. No breaks or cuts in the tracer wire installation will be permitted.
- .3 Except for approved splices in connections, tracer wire must be continuous and without splices between tracer wire test stations.
- .4 Test the tracer wire system for functionality after it has been confirmed and demonstrated that the entire tracer wire system is installed and is functioning properly.

3.7 THRUST BLOCKS

- .1 Restrain bends, tees and fittings using concrete thrust blocks.
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- .2 Keep pipe couplings free of concrete.
- .3 Bearing area of thrust blocks to be as indicated.

3.8 PIPE SURROUND

- .1 Place surround material in unfrozen condition.
- .2 Upon completion of pipe laying, and after Departmental Representative has inspected pipe joints, surround and cover pipes as indicated. Leave joints and fittings exposed until field testing is completed.
- .3 Hand place surround material in uniform layers simultaneously on each side of pipe not exceeding 150 mm compacted thickness as indicated.
 - .1 Do not dump material within 0.3 m of pipe.
- .4 Compact each layer from pipe invert to mid height of pipe to at least 100% maximum density to ASTM D698.
- .5 Compact each layer from mid height of pipe to underside of backfill to at least 100% maximum density to ASTM D698.
- .6 When field test results are acceptable to Departmental Representative, place surround material at pipe joints.

3.9 BACKFILL

- .1 Place backfill material in unfrozen condition.
- .2 Place backfill material, above pipe surround in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.
- .3 Under paving and walks, compact backfill to at least 100% maximum density to ASTM D 698. In other areas, compact to at least maximum density to ASTM D698.
- .4 Place unshrinkable fill in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

3.10 FIELD TESTING OF FORCE MAIN

- .1 Testing of force main to be carried out in presence of Departmental Representative.
 - .2 Strut and brace caps, bends and tees, to prevent movement when test pressure is applied.
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- .3 Expel air from force main, by slowly filling main with water.
 - .1 Drill and tap high points and install suitable cocks to vent air and to be shut when pressure is applied.
 - .2 Remove cocks after satisfactory completion of test and seal holes with tight fitting plugs.
- .4 Apply hydrostatic test pressure of 1035 kPa based on elevation of lowest point in line and corrected to elevation of test gauge for hydrostatic test and 1035 kPa for leakage test.
- .5 Apply pressure for 1 hour for pressure test and 2 hours for leakage test.
- .6 Examine exposed pipe, joints and fittings while system is under pressure.
- .7 Remove defective joints, pipe and fittings and replace with new sound material.
- .8 Define leakage as amount of water supplied from water storage tank in order to maintain test pressure for 2 hours.
- .9 Do not exceed allowable leakage as defined in ANSI/AWWA C600.
- .10 Locate and repair defects if leakage is greater than amount specified.
- .11 Repeat test until leakage is within specified allowance for full length of force main.
- .12 Complete backfill.
- .13 Repeat test after completing backfill. Locate and repair defects and backfill. Repeat tests, repairs and backfills as needed until leakage is less than amount specified.

3.11 CLEANING

- .1 Progress Cleaning: clean in accordance with Section 01 74 11 - Cleaning.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 01 74 11 - Cleaning.
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- .3 Waste Management: separate waste materials for reuse and recycling in accordance with Section 01 74 21 - Construction /Demolition Waste Management and Disposal.
 - .1 Remove recycling containers and bins from site and dispose of materials at appropriate facility.