

City of Canton
Supplemental Standard Specifications
for
Sanitary Sewer Construction
Section 100

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Section 100

City of Canton Supplemental Standard Specifications for Sanitary Sewer Construction

1.0 GENERAL

1.1 SCOPE OF WORK

The Contractor shall furnish all the necessary labor, materials, equipment, tools, and supplies that are necessary to install a complete sanitary sewer system, as shown on the plans and/or called for in the specifications or its addenda. It is the intent of the specifications to install a complete system or job.

1.2 TERM OF WARRANTY

See Section 500 for warranty for construction activity.

1.3 QUALITY CONTROL AND SUBMITTALS

Retesting of work required because of nonconformance to the specified requirements shall be performed by the same independent firm on the instructions of the Engineer. Payment for retesting performed during the contract period and during the warranty period will be charged to and will be the responsibility of the Contractor.

Shop drawings and data shall be submitted for, but not be limited to, the following items:

Manholes, pipe, pipe fittings, bedding material, stabilization material, granular material, and any other pertinent information concerning construction materials that the Engineer deems necessary for the review of the materials used on the project in accordance with the specifications and drawings.

Manhole shop drawings shall be submitted for each manhole and shall indicate the sections to be used with sizes and heights. A drawing showing the profile of the manhole must be submitted and shall be detailed to scale to show all segments of the manhole in a profile view.

The Contractor shall submit the number of copies that the Contractor requires plus three copies which the Engineer will retain. The Contractor shall obtain shop drawing approval before any of the work related to that material is performed.

A comprehensive Sanitary Sewer Bypass Plan shall be submitted before or at the preconstruction meeting when sewer bypassing is necessary.

1.4 PAYMENT

Payments to the Contractor shall be made in accordance with the General Conditions.

1.5 ACCEPTANCE

Acceptance of the work shall be in accordance with the General Conditions.

1.6 SEWAGE LIFT STATION

The sewage lift station specifications shall be as specified in the Special Provisions.

1.7 REFERENCES

- A. ASTM A48-83—Gray Iron Castings (Class 35).
- B. ASTM A53—Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.
- C. ASTM C478—Precast Reinforced Concrete Manhole Sections and Steps.
- D. ASTM F679—Standard Specification for Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.
- E. ASTM C923—Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
- F. ASTM C-990—Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
- G. ASTM D1248—Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
- H. ASTM D1784—Standard Specifications for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.

- I. ASTM D1785—Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- J. ASTM D2241—Standard Specification for Poly (Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series).
- K. ANSI/ASTM D2321—Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
- L. ASTM D2680—Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- M. ANSI/ASTM D3034—Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.
- N. ASTM D3212—Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seal.
- O. ANSI/AWWA C105—Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- P. ANSI/AWWA C111—Rubber Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
- Q. ANSI/AWWA C151—Ductile Iron Pipe, Centrifugally Cast, for Wastewater and Other Liquids.
- R. ANSI/AWWA C600—Installation of Ductile Iron Water Mains and Their Appurtenances.
- S. ANSI/AWWA C905—Standard Specification for Polyvinyl Chloride (PVC) Water Transmission Pipe (Nominal Diameters 14–36 inches).
- T. AASHTO M-198.
- U. Federal Specifications CRD-D-572.
- V. Federal Specifications SS-S-210A.
- W. Federal Specifications TT-S-001657.
- X. South Dakota Department of Transportation Standard Specifications for Roads and Bridges.

2.0 MATERIALS

2.1 SANITARY SEWER GRAVITY PIPE

- 2.1.1 POLYVINYL CHLORIDE (PVC) Sewer Pipe and Fittings. PVC pipe 15 inches in diameter or smaller shall meet the requirements of ASTM D-3034, Type PSM, SDR 35 minimum; PVC pipe 18 inches through 36 inches in diameter shall meet the requirements of ASTM F-679, minimum wall thickness T-1. The pipe shall be made of PVC plastic having a cell classification of 12454-B or 12454-C or 12364-C or 13364-B.

Wyes and service line bends installed at a depth of greater than 14 feet shall be SDR 26. All other wyes shall be SDR 35 minimum.

- 2.1.2 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS, AWWA C905, PVC pipe, 30 inches in diameter and greater, shall meet the requirements of AWWA C905, dimension ratio (DR) 32.5. All pipes shall have the same outside diameter as ductile iron pipe.

- 2.1.3 Ductile Iron Pipe and Fittings (DIP). Ductile iron pipe shall be acceptable for use on 54-inch diameter pipe and larger and as specified in the Special Provisions. Ductile iron pipe shall be push-on joint type and shall be coated on the outside with bituminous coating (minimum 1 mil thickness). The wall thickness shall be determined based on the laying condition and the depth of cover required. Ductile iron pipe shall meet the requirements of ANSI A21.51AWWA C151 standards. All ductile iron pipe shall be furnished with a fusion bonded polyethylene lining in accordance with ANSI/ASTM D1248. The lining shall have a minimum thickness of 60 mils. All ductile iron pipe shall be installed with polyethylene encasement in accordance with AWWA C105 unless otherwise directed by the Engineer. Ductile iron pipe thickness class shall be as specified on the drawings and/or in the Special Provisions.

2.2 PIPE JOINT MATERIALS

- 2.2.1 Polyvinyl Chloride (PVC) Sewer Pipe. PVC Sewer Pipe shall have a flexible elastomeric seal (O-ring or rubber sealing elastomeric gasket joint), and conform to the latest revisions of ASTM D3212. Solvent cement joints **will not** be allowed for pipe and fittings.
- 2.2.2 Polyvinyl Chloride (PVC) Pipe, AWWA C905. PVC AWWA C905 pipe joints shall conform to the same standards as PVC Sewer Pipe.

- 2.2.3 Ductile Iron Pipe. Ductile Iron Pipe joints shall be Push-On Joints conforming to AWWA C111-80 Standards. Installation procedures shall conform to AWWA C600 Standards.

2.3 SANITARY SEWER FORCE MAIN PIPE

2.3.1 POLYVINYL CHLORIDE (PVC) PIPE

All pipe for sanitary sewer pressure piping (force mains) shall conform insofar as appropriate to the City of Canton Supplemental Standard Specifications for water main.

2.3.2 DUCTILE IRON PIPE (DIP)

All pipe for sanitary sewer pressure piping (force mains) shall conform insofar as appropriate to the City of Canton Supplemental Standard Specifications for water main.

2.4 MISCELLANEOUS PIPE MATERIALS

2.4.1 PIPE COUPLINGS

Clamp style couplings shall be "Power Seal Model 3541" as manufactured by Power Seal Pipeline Products Corporation, Adjustable Repair Coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., "Strong Back RC Series Repair Coupling," as manufactured by Fernco, Inc., or approved equal shall be used on all pipe.

All couplings shall bear the manufacturer's identifying mark and size.

Reducing couplings will not be allowed.

2.4.2 TAPPING SADDLES

Tapping saddles shall be the "Inserta Tee" as manufactured by Inserta Fittings Company or approved equal for use on all pipes.

2.4.3 CAPS / PLUGS

PVC caps and plugs shall be the gasketed or solvent welded sewer fitting type. Caps and plugs for clay pipe shall be made using nonshrink grout placed continuously for a 1-foot distance into the pipe.

2.4.4 INSULATION

Type IV Styrofoam Brand—"Square Edge" as manufactured by Dow Chemical Company or approved equal shall be used for insulating sewer pipes where required. The thickness and dimensions shall be specified on the drawings or in the Special Provisions.

Approved equal products from other manufacturer's shall be Extruded Polystyrene Board Insulation formed from polystyrene base resin by an extrusion process using hydro chlorofluorocarbons as blowing agent to comply with ASTM C578, Type IV, with 1.60 lb./cu. ft. minimum density and a compressive strength of 25 lb./sq. in. as specified in ASTM D1622 and ASTM D1621 respectively. The maximum thermal conductivity of the insulation shall conform with ASTM C518, C177, and C578. The maximum water absorption percentage by volume shall be 1 percent in accordance with ASTM D2842. The range of water vapor permeance shall be 0.4 to 1.0 perm in accordance with ASTM E96.

2.4.5 SANITARY SEWER SERVICE WYES

Refer to Section 2.1 for material type. Wyes with the same main line and branch line diameter will not be allowed (example: 4x4, 6x6, 8x8, etc.).

2.4.6 SANITARY SEWER FORCE MAIN TRACER WIRE AND TERMINAL BOXES

Force main tracer wire shall be in accordance with the supplemental specifications for Water Main Tracer Wire. The force main tracer wire shall also conform to the Standard Plate for sanitary sewer force main tracer wire. The tracer wire color shall be green. The tracer wire shall be 10 AWG, solid-strand, soft-drawn copper per ASTM B-3. The tracer wire terminal boxes shall be placed at no more than 1,000 feet apart from one another or as specified on the drawings.

2.5 MANHOLE MATERIALS

- 2.5.1 Precast Manholes. Precast concrete manholes shall conform to ASTM Designation C478 with all current revisions. The inside diameter shall be 48 inches unless otherwise stated in the plans or Special Provisions. The wall thickness shall be a minimum of 5 inches with one cage reinforcing with a minimum of 0.12 square inches of reinforcement per lineal foot of wall. The upper section of the manhole shall be a special precast cone made expressly for this purpose providing a 24-inch diameter opening at the top. The cone section shall be eccentric (offset).

All manholes shall be constructed **without** steps or ladders. Upon request from the City, the Contractor and/or supplier shall supply the City with a test report from an independent testing laboratory showing compliance with this specification.

O-ring gaskets, "Tylox Super Seal" gasket as manufactured by Hamilton Kent, or continuous butyl rubber rope gasket shall be provided for constructing watertight manhole joints. The butyl rubber rope gasket shall conform to or exceed all requirements of Federal Specification SS-S-210A and AASHTO M-198.

Lift holes shall not extend through the manhole walls on 48-inch diameter manholes. Lift holes shall be filled with nonshrink grout. Nonshrink grout shall conform to the following requirements:

Premixed compound consisting of no-metallic aggregate, cement, water reducing, and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days. Approved manufacturers are:

"Supreme Grout" – by Hanson Pipe and Products
"Crystex" – by L & M Construction Chemicals
"588 Non-Metallic, Nonshrink Grout" – by W.R. Meadows
"Master Flow 713" – by Master Builders
"Songrout" – by Sonneborn
"Five Star Grout" – U.S. Grout Corp.
or approved equal.

On manholes where the lift holes extend through the wall sections, a lift hole plug as manufactured by Press Seal Corporation or approved equal and nonshrink grout shall be installed at each lift hole.

2.5.2 Cast-in-Place Manholes. Concrete used for poured manhole bases, pipe cradles, or other monolithically poured structures shall conform to the requirements of Class M6 Section 462 of the "Standard Specifications for Roads and Bridges of the South Dakota Department of Transportation." Water stops for the manhole base and wall sections shall conform to the following requirements:

Polyvinyl Chloride: Federal Specifications CRD-D-572 W.R. Meadows Inc.; B.F. Goodrich Company; Progress Unlimited or approved equal.

- a. Construction joints—Use flat profile mechanical ribbed ends 7 inches wide, 5/16 inch minimum thickness.
- b. Expansion joints—Use split center bulb with mechanical ribbed ends 9 inches wide, 1/2 inch minimum thickness.

c. Use on all new pours.

2.5.3 Reinforcement. Reinforcement bars for manholes shall be structural grade, manufactured by the open hearth process from new billets. All bars shall be deformed and Grade 60.

2.5.4 Manhole Liners

2.5.4.1 General

HDPE manhole liners shall be used only where directed specifically by the City. PVC T-Lock liner will not be allowed.

Manhole liners shall be "GSE Studliner" as manufactured by GSE Lining Technologies, Inc., "AGRU Sure-Grip" as manufactured by AGRU America or approved equal.

The manhole liner specified in this section shall be furnished by a manufacturer who is fully experienced, reputable, and qualified in the manufacturing of the materials and who has in their employ a full-time field service representative with at least five years field experience. The manhole liner shall be designed, constructed, and installed using techniques recommended by the manufacturer.

The manufacturer of the lining shall attest to the successful use of its product as a lining for sewer pipes, manholes or pump stations in sewage conditions, or other chemical environments recognized as corrosive or otherwise detrimental to concrete.

2.5.4.2 Materials and Dimensions

The material used in the embedment liner and in all welding strips shall be made from 97–98 percent virgin high-density polyethylene and 2–3 percent carbon black or pigmentation for the purpose of an otherwise specified color. Plasticizers shall not be added to the resin formulation. The material color shall be yellow, white, or off-white. Dark colors will not be acceptable.

Embedment sheets for field installation shall be produced in rolls that are a minimum of 6.5 feet (2 m) in width with 2.0 mm thickness for precast concrete pipe and manholes.

Locking studs of the same material as that of the liner shall be integrally extruded with the sheet and have a minimum height of 0.40 inches (10 mm). The maximum distance between studs shall be 2.127 inches. A minimum of 39 studs per square foot square shall be installed on the liner.

2.5.4.3 LINER PHYSICAL PROPERTIES

All plastic embedment sheets and welding strips shall have the following physical properties when tested in accordance with the following table.

Nominal Properties for Manhole Liner		
Property	Test Method	Value
Thickness (Min)	ASTM D 751	+/- 10%
Density g/cm ³ (Min)	DIN 53479 / ASTM D 792	0.94
Tensile Properties	DIN 53455 / ASTM D 638	
Tensile Strength at Yield, lb/in ² (Min)		2200
Tensile Elongation at Break, % (Min)		600
Tensile Strength at Break, lb/in ² (Min)		3600
Carbon Black Content % (Max)	ASTM D 1603	2-3
Dimensional Stability, %	DIN 53515	+/-2
Linear Coefficient, in/in/°C	ASTM D 696	1.2x10-4
Service Temperature		-70 to 176 °F
Stud Pull Out Strength (Min)		>4,300 psf

Embedment sheets and welding strips shall be free of cracks, cleavages, or other defects adversely affecting the protective characteristics of the material. The Engineer may reject any materials which may be defective.

Liner shall have demonstrated good chemical resistance via testing in accordance with EPA 9090.

Weld strips shall have good impact resistance, be flexible, and have an elongation sufficient to bridge up to 0.5-inch settling cracks, which may occur in the manhole/pipe or in the joint after installation without damage to the strip. The lining shall be repairable at any time after installation in pipe, manholes, or structures by methods approved and recommended by the manufacturer.

2.5.4.4 SUPPLY OF MATERIAL

Manhole/pipe embedment sheets shall be supplied as pipe size sheets or tubes fabricated by shop welding the basic size sheets

together. For tank containment structures, either roll goods or prefabricated panels shall be supplied. Shop welds shall be made by a butt weld and fusing the sheets together by a thermal process such as an extrusion weld, fusion weld, or equal so as to produce continuous welded seams. Specimens taken from shop welded seams shall show no cracks or separations and shall be tested in tension. Each specimen shall withstand a minimum shear strength of 60 percent of parent tensile yield strength.

During installation of the embedment sheet onto the forms, there shall be no cuts made within the liner for purposes such as strapping of sheet. If straps are utilized they shall be placed so that the straps are positioned between embedment studs. Sheets may be supplied in prefabricated, pipe sized tubular shaped sheets, ready to install onto the inner form, or roll goods having specified dimensions listed in the Materials and Dimensions section.

Joint strips for pipe seaming shall be approximately 4 inches wide with a minimum width of 3.75 inches. Thickness of joint strips shall be 3.0 mm.

HDPE plastic adjusting rings shall be used on all lined manholes where necessary. Concrete adjusting rings will not be allowed unless otherwise specified.

- 2.5.5 Bench and Inverts. All manhole bench and inverts shall be preformed at the manufacture. Hand forming of manhole bench and inverts will not be allowed on new manholes, except as approved by the City. Bench and inverts shall be polyethylene preformed invert as manufactured by Royal Environmental Systems or approved equal. Bench and inverts may also be formed by using a bench and invert forming system as manufactured by Press Seal, A-Lok or approved equal.
- 2.5.6 Manhole Castings. All frame and covers shall be constructed with gray iron having a tensile strength of not less than 35,000 pounds per square inch. The frame and covers shall conform to ASTM A48, Class 35B. The castings shall be heavy-duty type, designed for H2O loading conditions. The castings shall be free from cracks, blowholes, porosity, shrinkage distortion, or other imperfections. They shall be true to pattern and free from warpage. The frame and covers shall fit together in a satisfactory manner. Machined bearing surfaces shall be provided to prevent rocking and rattling. All covers shall be supplied with concealed pick holes as specified in the standard plates. All covers shall be letter marked "SANITARY SEWER."

All covers shall be supplied with self-sealing type "T" gaskets as manufactured by Neenah Foundry Company or approved equal.

The covers shall be delivered from the manufacturer with pre-installed glued-in gaskets. The gasket shall be installed in a machined groove and be continuous around the perimeter. The gasket material shall be oil resistant Nitrile (60 DURO) glued in the groove, and have a maximum swell of 90 percent when tested in accordance with ASTM D471 using ASTM No. 3 oil. The glue shall be Lock-rite Black Max as manufactured by 3M Products.

Manhole frame and covers shall be installed in accordance with the standard plates or as specified. Neenah R1772A manhole frame and covers shall be installed at all manholes unless otherwise specified. Neenah R1713 manhole frame and covers shall be installed where manholes are located into concrete pavement thicker than 6 inches. Neenah R1712 bolt down type manhole frame and covers shall be installed in specified areas outside of the street ROW which are in areas without hard surfacing. Neenah R1916C bolt down type manhole frame and covers shall be installed in specified areas outside of the street ROW which are in areas with hard surfacing.

Covers and frames shall be dimensioned as follows:

Neenah R1772A as manufactured by Neenah Foundry Company or approved equal. The cover diameter = 22 3/4 inches, cover height = 1 3/4 inches, frame height = 7 inches.

Other frame and covers that are acceptable, but shall only be installed where specified and in specific conditions are:

Neenah R1713 as manufactured by Neenah Foundry or approved equal. The cover and frame shall be dimensioned as follows: 22 3/4 inches, cover height = 1 3/4 inches, frame height = 9 inches.

Neenah R1712 (with bolt down cover plate) as manufactured by Neenah Foundry or approved equal. The cover and frame shall be dimensioned as follows: 22 3/4 inches, cover height = 1 3/4 inches, frame height = 9 inches. See Standard Plates for bolt-down cover plate dimensions.

Neenah R1916C bolt down type as manufactured by Neenah Foundry or approved equal dimensions shown on Standard Plates.

2.5.7 Manhole Adjusting Rings

2.5.7.1 Materials for Concrete Adjusting Rings

Bricks, blocks, or shimming devices will not be allowed for use in adjusting manholes.

Adjusting rings: Concrete adjusting rings shall be in accordance with ASTM C478. The inside diameter of the ring shall be 24 inches.

Mortar: Mortar shall be Standard Portland Cement Type I, hydrated lime, and clean, sharp, well-graded sand, free from foreign materials. The minimum design compressive strength shall be no less than 4,000 psi.

2.5.7.2 Materials for Plastic Adjusting Rings

Sealant: Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK #3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.

Plastic Adjusting rings: The adjusting rings shall be injection molded HDPE as manufactured by Ladtech, Inc. or approved equal. The adjusting rings shall be manufactured from polyethylene plastic as identified in ASTM D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Material properties shall be tested and qualified for usage in accordance with the ASTM Test Methods referenced in ASTM D-1248. The plastic adjusting rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers). The adjusting rings shall be tested to assure compliance with impact and loading requirements in accordance with the AASHTO Standard Specification for Highway Bridges. The adjusting rings shall meet and exceed the static load requirements of ASSHTO highway Bridge Specification HS-25 (21,280 lbs). The rings must withstand 1,000,000 plus full load cycles of 10 seconds or less duration. The rings must perform without failure to a minimum of 150 percent of these load values. The adjusting rings shall be sized to conform to the standard 24-inch manhole opening.

2.5.8 Manhole Boots

Manhole boots for connecting pipes to the manholes shall be a watertight flexible connection meeting the requirements of ASTM C923. The rubber boots shall be supplied with two stainless steel

clamps for attaching the boot to the pipe. A stainless steel “power sleeve” shall be supplied for connecting the boot to the manhole. The boots shall be type PSX as manufactured by Press Seal Corporation or approved equal.

2.5.9 Manhole External Frame Seal

Manhole external frame seals shall be Infi-Sheild as manufactured by Sealing Systems Inc., Wrapid Seal as manufactured by CANUSA-CPS, Cretex or approved equal. Infi-Sheild manhole external frame seals manufactured by Sealing Systems will only be allowed in street pavement areas. The seal (for the Sealing Systems, Inc. product) shall be a continuous band made of high quality EPDM (Ethylene Propylene Diene Monomer) rubber with a minimum thickness of 60 mils. Each unit shall have a 2-inch-wide mastic strip on the top and bottom of the band. The mastic shall be nonhardening butyl rubber sealant with a minimum thickness of 3/16 inch and shall seal to the cone/top of the manhole section and over the flange of the casting.

2.5.10 Drop Manholes

The “Reliner Inside Drop System” as manufactured by Duran, Inc. or approved equal shall be used for all drop manhole connections with an incoming pipe size of 12 inches or less. For all incoming pipes that are greater than 12 inches, which require drop manhole sections, a pipe section shall be used to construct the drop manhole section. See the Standard Plates for details.

Clamping brackets: The clamping brackets shall be stainless steel “Reliner” adjustable clamping brackets with stainless steel fasteners as Manufactured by Duran, Inc. or approved equal as shown in the Standard Plates.

Pipe and fittings: PVC

Couplings: Fernco rubber coupling or approved equal for the drop manhole assembly.

2.5.11 Manhole Markers

Two types of manholes markers shall be used were indicated. Type 1 Manhole markers shall be a minimum of 3 3/4 inches wide and 78 inches in length. The markers shall be green in color. The markers shall be ultraviolet resistant and stable in all weather conditions. The markers shall be Composite Composition Utility Markers as manufactured by Carsonite International or approved equal. The markers shall be labeled “CAUTION SANITARY SEWER PIPELINE / MANHOLE CALL BEFORE DIGGING.”

Type 2 manhole markers shall be in accordance with the SDDOT standard specifications and the standard plates. Type 2 manhole markers shall be used in all interstate and highway ditch right-of-way areas and where specified. Type 1 manhole markers shall be used in all other installations.

2.5.12 Manhole Construction Plate Marker

Manhole construction plate markers shall be constructed in accordance with the Standard Plates detail. The manhole construction plate marker shall be constructed using "Flex-Guide 300 Series" delineator post and base as manufactured by Davidson Traffic Control Products or approved equal.

2.6 BEDDING MATERIAL

The bedding material for all sanitary sewer pipes shall be ¼ inch to ¾ inch clean angular, crushed rock with the following gradation requirements:

95 percent passing ¾ inch sieve
95 percent retained in the No. 4 sieve.
and well graded.

2.7 TRENCH STABILIZATION MATERIAL

The trench stabilization for all sanitary sewer trenches where necessary shall be ¾ inch to 4 inches crushed angular, well graded material. Larger material may be used if necessary and required to stabilize the bottom of the trench.

2.8 GEOTEXTILE FABRIC

Geotextile fabric shall be as specified in the Special Provisions.

2.9 GRANULAR MATERIAL

Granular material shall be "well graded subbase material" in accordance with the Standard Specifications (SDDOT Standard Specifications for Roads and Bridges). Sand may be used if approved by the Engineer.

2.10 K-CRETE

K-Crete shall be a controlled low strength concrete that is highly flowable without segregation.

2.11 CASING PIPE AND BORING MATERIALS

2.11.1 Casing Pipe: Steel seamless casing pipe, Grade B ASTM A53. With joints butt welded around the entire pipe. Wall thickness shall be designed and specified with each individual project.

- 2.11.2 Casing Spacers: Shall be as specified on the Standard Plates.
- 2.11.3 End Seals: Shall be as specified on the Standard Plates.
- 2.11.4 Carrier pipe: Shall be as specified in the Supplemental Standard Specifications, Special Provisions, or drawings.

2.12 SANITARY SEWER SERVICE LINES

2.12.1 GENERAL

Pipe: Refer to Section 2.1 for material type.

Pipe: Schedule 40 PVC, for cleanouts

2.12.2 SANITARY SEWER SERVICE BENDS

Refer to Section 2.1 for material type. Bends greater than 45 degrees will not be allowed.

2.12.3 SANITARY SEWER SERVICE CLEANOUTS

2.12.3.1 PIPE

Pipe: Schedule 40 PVC.

2.12.3.2 PROTECTIVE CAP AND COVER

Cover: Neenah R1976 or approved equal. The cover shall be labeled "SEWER."

See Standard Plates for details

2.12.4 SANITARY SEWER SERVICE PIPE COUPLINGS

The clamp style coupling shall be "Power Seal Model 3541" as manufactured by Power Seal Pipeline Products Corporation, Adjustable Repair Coupling with 300 series stainless steel shear ring as manufactured by Mission Rubber Company, Inc., "Strong Back RC Series Repair Coupling" as manufactured by Fernco, Inc., or approved equal will be allowed for sewer services.

All couplings shall bear the manufacturer's identifying mark and size.

2.12.5 REDUCERS

Where reducers are necessary and approved for connections to existing service lines, reducers shall be eccentric type manufactured of approved pipe material. Coupling connections

shall not be made to the reducers and reducing couplings will not be allowed. Reducers will only be allowed for special situations as determined necessary by the City.

2.12.6 SANITARY SEWER SERVICE PIPE LINING REPAIRS

Two types of sanitary sewer service pipe lining repairs will be allowed for services, Sliplining and CIPP.

2.12.6.1 SANITARY SEWER SERVICE SLIPLINING

Pipe: Refer to Section 2.1 for material type and also HDPE pipe will be allowed with a minimum SDR rating of 17. HDPE pipe shall not be coiled type. HDPE pipe shall have joints at 20 or 40 segments. HDPE pipe shall be PE 3608 sanitary sewer pipe.

Couplings: Refer to Section 2.12.4

HDPE fusion connection: Butt welded fusion and electrofusion will be allowed for connections of the HDPE pipe.

2.12.6.2 CURED IN-PLACE SANITARY SEWER SERVICE PIPE LINING

Materials:

Tube: The liner tube material shall be designed for use in gravity sanitary sewers and shall be in strict conformance with all applicable sections of ASTM F1216, F2019, or a seamless version of F2019. All materials and procedures used in the cured-in-place pipe rehabilitation process shall be equal to or exceed the manufacturer's standards. The tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and length of the original sewer pipe. Allowance should be made for circumferential stretching during the installation process. The tube shall consist of one or more layers of flexible nonwoven felt, compatible with the resin system used and capable of carrying the resin, withstanding installation pressure and conforming to offset joints, bells, 45- and 90-degree bends, and disfigured pipe sections.

Resin: The resin used shall be compatible with the CIPP system used, and designed for use in gravity sanitary sewers. The resin shall be a two-part epoxy resin system producing a final CIPP product resistant to shrinkage, shall not corrode or oxidize, and shall also be resistant to

abrasion for solids, grit, and sand in wastewater. The resin shall have proven resistance to municipal wastewater environment.

Design Calculations and Physical Properties:

The Cured in place pipe (CIPP) material shall meet the following requirements:

Chemical Resistance: The pipe shall be resistant to a variety of chemical effluents as described in ASTM D543.

Flexural modulus: Test method D790, 300,000 psi minimum.

Flexural strength: Test method D790, 4,500 psi minimum.

Design pipe thickness: Shall be a minimum of 6 mm for 4- and 6-inch pipe. The CIPP liner thickness shall be calculated and designed based on the below listed conditions of the existing pipe to be rehabilitated. All design calculations shall be based on ASTM F1216 Appendix X1, and design calculation documentation shall be submitted to the City for review prior to installation. All design calculations shall be based on the following:

1. All pipes shall be considered fully deteriorated.
2. Ground water to the ground surface.
3. 2 percent ovality / deviation.
4. Soil load of 120 lbs/cubic foot with applicable live load.
5. Safety factor of 2.0.

2.12.7 SANITARY SEWER SERVICE PIPE BEDDING MATERIAL

The bedding material for all sanitary sewer pipes shall be ¼ inch to ¾ inch clean angular, crushed rock or pea rock with the following gradation requirements:

95 percent passing ¾ inch sieve

95 percent retained in the No. 4 sieve.

and well graded.

3.0 CONSTRUCTION REQUIREMENTS

3.1 ALIGNMENT AND GRADE

The Engineer will furnish all the necessary line and grade stakes, benchmarks, or other necessary control. It is the responsibility of the Contractor to protect these stakes, and any replacement of stakes shall be at the expense of the Contractor. The Contractor shall carry line and grade into the trench by means of an approved laser beam system and by a surveying level instrument. At no time shall the Contractor change the grade without approval of the Engineer. If underground interference is encountered at the assigned grade, the Contractor shall notify the Engineer and wait until the revised grade for the sewer has been determined, if necessary. As a secondary check to the laser beam device, the Contractor shall check the grade from the grade stake to pipe invert a minimum of every 100 feet using a surveying level instrument.

3.2 UNDERGROUND INTERFERENCE

The location of underground public or private utilities may be shown on the plans, as reported by the various utility companies and the City, but this **does not** relieve the Contractor of the responsibility of determining the accuracy or completeness of said locations. The Contractor shall determine the location of all underground ducts, conduits, pipes, cables, or structures which will be affected by the work, and shall take steps necessary to support and protect said structures by any means suitable to the owners of the structure involved and the Engineer. When necessary, the Contractor shall conduct operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the work.

Portions of utilities which are found to interfere with the line and grade of the sewer will be relocated, altered, or reconstructed by the owners, or the Engineer may order changes in the work to avoid interference. Such changes will be considered to be extra work and will be paid for through a change order. When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work unless a separate bid item is provided. Temporary or permanent relocation or alteration of utilities requested by the Contractor for the Contractor's convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs. In those instances where utility relocation or reconstruction is impractical, the Engineer may order a deviation from line and grade.

The Contractor shall be responsible for notifying the various utility companies if the Contractor's work will expose, affect, or endanger any existing utility. All cost of investigation and any necessary protection, support, removal, or relocation of said structures shall be included in the contract bid price for installing pipe or manholes. The Contractor shall not begin construction until all utility companies have been contacted and their respective underground utilities have been located and marked.

The bid item “locating utilities” will be used to locate sanitary sewer services only if the service location marked exceeds the actual service location by 4 feet in either direction and additional excavation is required. The bid item “verify utilities” will be used only when it is necessary to excavate down to the utility to determine if any vertical and/or horizontal conflicts exist between existing utilities and the proposed new sewer to be installed as shown on the plans. All costs of other exploratory investigation/excavation necessary for determining the location and depth of utilities shall be included in the contract bid price for installing pipe.

3.3 EXCAVATION AND TRENCHING

3.3.1 GENERAL

Excavation shall be classed as either earth or rock excavation. Rock excavation shall consist of solid rock lying in its natural bed which requires fracturing for its removal and boulders of 1 yard or more in volume. All other material shall be classed as earth excavation.

3.3.2 EARTH EXCAVATION

All sewers shall be built in open cut, except that where conditions warrant, the Engineer may permit the use of short tunnels.

The Contractor may use any means he desires to excavate to the proper depth and width necessary for the construction of the sewer according to the plans and specifications. The width of the trench at the top of the pipe shall be a minimum of 6 to 9 inches on each side of the pipe. Trenches shall be excavated with vertical sides from pipe flowline to a point 1 foot above top of pipe where possible.

3.3.3 SHEETING AND BRACING

If City, state, or federal regulations dictate the necessity of sheeting, bracing, or pulling a trench box or shield, the cost of such sheeting, unless a special price is called for in the contract proposal form, shall be included in the contract bid price for installing pipe.

3.3.4 EXCAVATION BELOW PIPE GRADE

Trench excavation below pipe grade shall be backfilled with bedding material approved by the Engineer and thoroughly tamped to provide a uniform and continuous bearing and support for the pipe.

3.3.5 EXCAVATION IN UNSTABLE OR UNSUITABLE SOIL

The Contractor shall notify the Engineer when material considered unstable for the pipe foundation is encountered and where additional support, stabilization, and undercutting of the pipe trench are necessary. If the Contractor cannot assure a product in accordance with the specifications, the Contractor may request the use of trench stabilization material and/or geotextile fabric where the trench base is not structurally adequate or otherwise unstable to provide a uniform stable pipe foundation and requires additional undercutting for placement of trench stabilization material and/or geotextile fabric.

The undercutting and use of trench stabilization material and/or geotextile fabric shall only be approved for use in extreme conditions where it is obviously necessary. Approval for the limits of the payment lines for use of trench stabilization material and geotextile fabric must be obtained from the Engineer, prior to installation. If trench stabilization material and/or geotextile fabric is necessary to stabilize the trench foundation, they shall be installed by the Contractor at the unit bid prices for those respective items.

If geotextile fabric is used, it should be placed on the neutral soils and extended up the trench sidewalls to a level of at least the mid-point of the pipe. Placement of the fabric should then be followed by placement of the stabilization material.

The Contractor will be fully responsible for constructing the sanitary sewer on a stable base and any defects resulting from improperly preparing the pipe foundation shall be the Contractor's responsibility.

The Contractor will be required to furnish weigh tickets for trench stabilization material on a daily basis.

Pipe bedding material will always be required in addition to trench stabilization material where trench stabilization material is used.

3.3.6 ROCK EXCAVATION

All rock excavation shall be under one classification. It shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and also boulders that exceed 1 cubic yard in volume.

When rock is encountered in the trench, it shall be stripped of earth and the Engineer shall be notified by the Contractor and given ample time to make a profile before removal operation begins.

Procedures for rock removal operations shall be subject to the approval of the Engineer. The use of explosives shall be limited to the magnitude of the charge that will not cause damage to the adjoining property through shock vibrations or other stress loadings. Also, the Contractor shall provide adequate blanket protection to assure that there will not be fragments of rock or other debris flying through the air when discharging explosives. The Contractor shall employ personnel certified to execute blasting operations.

The entire rock removal operations shall be the responsibility of the Contractor, and the Contractor shall pay for any damages caused by the rock removal operations. Adequate insurance protection, in addition to the standard liability insurance required, shall be purchased by the Contractor for payment of any damages that may be caused by the use of explosives.

The Contractor shall notify the City one week prior to rock removal on any project so the City can televise any sanitary sewer lines in the area that might be disturbed. Once all rock removal is complete, the Contractor shall notify the City so the City can re-televise the line.

Contractor shall obtain all necessary permits prior to commencing blasting operations.

3.3.7 DEWATERING

Pipe jointing shall be accomplished in a relatively dry trench condition. **Joints shall not be connected under water.** If ground water is encountered, the Contractor shall dewater the trench with suitable pumps and equipment. Lowering of the groundwater level shall be by means of wells, well points, or other suitable means.

Water resulting from the dewatering operation shall be disposed of in a manner approved by the Engineer and South Dakota Department of Environment and Natural Resources. It shall not be pumped onto private property without the property owner's approval. Any damage to property, either public or private, shall be rectified to the satisfaction of the owner and the City. All applicable permits must be obtained by the Contractor before the dewatering operation begins.

The water discharged from the dewatering operations shall not be allowed to wash through any excavated material. The Contractor shall be responsible for any damages that might result from this operation.

3.3.8 SANITARY SEWER TEMPORARY BYPASS

The Contractor shall be responsible for continuity of sanitary sewer service to each facility connected to the affected section(s) of sewer main and shall also bypass the main sewer flow around the pipe being replaced, or into adjacent sanitary sewers. No sewage will be allowed outside of the sanitary sewer collection system (sewage will not be allowed to be discharged onto the ground). The Contractor shall be responsible for the design, installation, and operation of the temporary bypass system. The temporary bypasses, automated or otherwise, shall be of adequate capacity and size to handle all flows without sewage backup into property. The Contractor shall be solely responsible for cleanup, repair, property damage costs, and claims resulting from failure of the bypass system.

The Contractor shall (as an incidental part of the project) contact all property residents (that are at the property at the time of construction/service interruption) along any sanitary sewer project where the property residents have the potential to discharge sanitary sewer into the construction area due to an open service line in the trench or other means. The Contractor shall inform the residents not to discharge sanitary sewer during the time(s) when the resident's sewer service is not connected to the City sanitary sewer system. The Contractor shall inform the resident of the estimated time that the service will not be functional and inform them **immediately** (by door hanger if not home) when their service can be used.

The Contractor shall also install (as an incidental part of the project) door hangers (furnished by the City) on each affected property residents door. The door hanger shall indicate the time of when the property will not be allowed to discharge sewage to the sanitary sewer system and a phone number for answering questions.

The Contractor shall submit a detailed temporary bypass plan in writing to the Engineer for approval before or at the preconstruction meeting. The Contractor shall also provide the Engineer a detailed drawing showing the location of temporary bypasses for each line segment(s) around which flows are being bypassed.

The Contractor shall submit the specifications for all pumping equipment to the Engineer for approval when requested. The submittal shall include the following information:

- The size (pumps and piping), quantity, capacity, and location of all pumping equipment.
- The pump manufacturer's pump performance curves.

- A list of all backup pumping equipment to be held in reserve on the job site shall also be submitted.

The pumps and bypass lines shall be of adequate capacity and size to handle all flows. The Contractor shall demonstrate that the pumping system is in good working order and is sufficiently sized to successfully handle flows by performing a test run prior to beginning the work. The Contractor shall cease temporary bypassing operations and return flows to the new and/or existing sewer when directed by the Engineer. All temporary bypass pumping operations shall be manned continuously during operation.

All pumps used for bypassing shall be fully automatic self-priming units that do not require the use of foot valves in the priming system. All pumps used must be constructed to allow dry running for extended periods of time to accommodate the cyclical discharge of wastewater flows.

Manholes that are used for the pump suction and discharge points shall be adequately protected to prevent storm water from entering the manholes.

3.3.9 INSTALLATION OF PIPE

Sewer pipe shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe.

Pipe shall be carefully installed to line and grade in accordance with line and grade stakes set by the Engineer so that the finished sewer will present a uniform bore. Any noticeable variations from true alignment or grade will be cause for rejection of the work.

All pipe shall be installed upgrade with spigot ends pointing in the direction of flow. The bottom of the trench shall be freed of all rocks and stones and shall be hand shaped and bedded with bedding material as hereafter specified, and the pipe shall be in firm contact with the bedding material for its entire length. At each joint of bell and spigot pipe, a hole shall be dug of sufficient size so that the weight of the pipe will rest on the barrel of the pipe and not on the bells, and the bell hole shall not be compacted. All pipe must be properly fitted together. A suitable stopper shall be kept in the end of the pipe so as to prevent any dirt or water from entering during the progress of the work at all times. Any dirt, loose material, or cement mortar which may accumulate in the pipe shall be removed as the work progresses. The backfilling around and to a depth of 1 foot over the pipe shall be completed and thoroughly hand tamped as the pipe installation progresses as hereafter specified in bedding and backfill requirements. Whenever pipe is installed in

rock trenches it shall be bedded to at least a 4-inch depth, and then shall be covered to a depth of at least 1 foot with bedding material or granular material.

Standard length pipe shall be utilized for all installations. Shorter lengths will only be allowed for use at manhole terminations and service line tie-ins to service connections. A full standard length pipe shall be used upstream of all manholes.

3.3.10 SANITARY SEWER SPOT REPAIR

Sanitary sewer spot repair shall be done in accordance with the specifications and details for each individual repair.

3.4 SANITARY SEWER PIPE JOINTS

3.4.1 JOINTS IN PVC SANITARY SEWER PIPE

All PVC Sewer Pipe shall be jointed utilizing elastomeric gaskets as referenced in ASTM D3034 and ASTM F679 and meeting the requirements of ASTM D3212. All pipe, fittings, and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and as specified in the latest revision of ASTM D2321. The joint surfaces (external and internal) shall be wiped free of all foreign materials, and the spigot end shall be centered on grade into the bell end and the joint shall be properly seated in accordance with the manufacturer's recommendations. Any pipe that is field cut shall have a square end with beveled edge equal to a factory cut and all field repairs shall be performed per manufacturer's recommendations.

3.4.2 JOINTS IN DUCTILE IRON PIPE (DIP)

All Ductile Iron pipe shall be jointed utilizing a push-on type joint in accordance with the requirements of AWWA C111. All pipe, fittings, and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and the latest revision of the ANSI/AWWA C600 standard.

When making joints, the gasket and gasket seal inside the socket shall be wiped clean before the gasket is inserted. A film of lubricant shall be applied to the gasket and the outside of the spigot end of the pipe. The spigot shall then be positioned inside the socket and pushed home. Lubricant other than that furnished with the pipe shall not be acceptable.

3.5 WYE BRANCHES

“Wye” branches for house connections, multiple dwellings, and commercial connections shall be built into the sewers at such points as shown on the drawings, as the Engineer shall designate and approved by the City. It will be the Contractor’s responsibility to keep accurate records of the location of each wye and stubout measurement and give the information to the Engineer or Inspector at the end of each day for City projects and at the end of each phase for subdivision projects or as requested by the Engineer or Inspector. All wye locations shall be recorded on the grade sheets by the Engineer where necessary, and all grade sheets shall be turned in to the City for subdivision projects. Stubout locations shall be recorded on a permit drawing for all CIP projects.

All measurements shall be: (1) Provided on a plat drawing in new subdivision work areas; (2) legible; (3) measured from the property line for stubouts (ex: 20' SNPL); (4) measured from the downstream manhole for wye locations (ex: y-79'); (5) given to the inspector within 30 days of the installation of the pipe (deflection test will not be accepted by the City until after the wye and stubout measurements have been submitted in proper format).

Measurements not properly submitted will be rejected.

All wyes which are not to be immediately connected shall be closed with a watertight cap or plug. **All** wyes and stubouts shall be marked with a marker (see detail in Standard Plates) to help relocate it and prevent breakage when excavating. All stubouts shall be capped and sealed, and the Contractor shall be responsible for the measurement(s) recorded on the permits.

3.6 MANHOLES

3.6.1 GENERAL

All manholes shall be constructed to meet the requirements of the latest revision of ASTM C478, “Precast Reinforced Concrete Manhole Sections,” and all related ASTM Specifications. All manholes shall be waterproof.

All manholes are to be built to the dimensions shown in the plans, special information, detail plates, or cut sheets furnished by the Engineer. All manhole sections shall be numbered and/or measured by the Contractor prior to installation to assure that the finished manhole will be to the grade specified on the grade sheet as there may be variations between plan sheet depths and the final depths shown on the grade sheet.

Construction of all cast-in-place manholes shall conform to the South Dakota Department of Transportation “Standard Specifications for Roads and Bridges” and Standard Plates, unless otherwise indicated.

3.6.2 BASE AND SECTIONS

Where precast concrete sections are used, the base section shall be cast with proper cutouts to accommodate the required sewer pipes. Precast sections shall be connected together using a specified gasket material and shall be in place on all manhole joints to assure watertight joints. All lift holes on the interior and exterior of the manhole sections shall be filled with nonshrink grout. Where installation of lift hole plugs is required, they shall be installed into the center of the manhole wall. The area on either side of the lift hole plug shall be filled with nonshrink grout.

All manholes shall be constructed of precast base, barrel, and cone sections. The joints between sections shall be of watertight construction utilizing a specified gasket material.

All manholes that are constructed, unless otherwise specified, shall be built with the base and bottom barrel section being precast together in one integral concrete pour. Such will provide for no joint between the base and barrel section ensuring a watertight seal. This section shall be constructed to meet the Specifications of the latest revision of ASTM C478 and the manhole details in the Standard Plates.

Manholes shall not be constructed at the manufacturer or in the field with piping installed in the manhole boots prior to setting the manhole in the trench. This type of installation will be cause for rejection of the work.

3.6.3 BENCH AND INVERT

All inverts shall be formed to the diameter of the incoming and outgoing pipe diameter up to the pipe centerline and vertical beyond that point. The invert shall be formed to a depth of one-half to two-thirds the pipe diameter. The forming of the bench and invert shall allow for the City sewer television camera with skids to be installed in the invert and into any pipe connection into the manhole. Where lateral connections are required into the manhole, a gradual change in the direction of the manhole invert for each lateral shall be formed. Sharp angles without gradual changes in direction will not be allowed. Flat bottomed manholes will not be allowed. Such work will be cause for rejection of the work. The City Standard Plates for the manhole bench and invert construction illustrates the construction for a typical manhole.

Where hand formed and reconstructed manhole bench and inverts are determined necessary by the Engineer, they shall be constructed with concrete. The manhole invert shall be shaped and finished in a glass smooth-like finish (a steel trowel will give this finish). The bench shall have a broomed finish.

3.6.4 ADJUST MANHOLE

There shall be at least one 2-inch adjusting ring, and a maximum of 14 inches of adjustment used on each manhole. Unless otherwise specified, the manhole cover shall be set approximately 6 inches below the finished street elevation by the sewer contractor to be raised to finished grade elevation by the contractor prior to paving.

Plastic adjusting rings may be used in lieu of concrete adjusting rings. The plastic adjusting rings shall be installed as recommended by the manufacturer. No shims or other leveling devices, other than leveling rings provided by the manufacturer, will be permitted with use of the plastic adjusting rings. The annular space between the adjusting rings shall be sealed using an approved butyl rubber sealant. The first plastic adjusting ring on existing manholes may require leveling with concrete mortar, and therefore the first plastic ring may be set in mortar.

The installation for concrete adjusting rings shall be in accordance with the Standard Specifications for Roads and Bridges produced by the SDDOT unless otherwise specified. The manhole frame and adjusting rings where concrete adjusting rings are used shall be set in a full bed of mortar to the elevation set by the Engineer as shown on the grade sheet. The mortar shall be tuck-pointed between rings and shall not be applied to the inside diameter surface of the adjusting rings. Smearing of mortar on the inside of the adjusting rings will be cause for rejection of the work.

3.6.5 MANHOLE EXTERNAL FRAME SEAL

Manhole external frame seals shall be used on all new concrete surfacing street projects and on existing concrete surfacing street projects where the manholes are adjusted to the corbel section. Manhole external frame seals shall also be required for all manholes located outside of the street ROW area, in unpaved areas, and where specified. The manhole external frame seal shall extend onto the casting and the cone section a minimum of 2 inches. Manhole external frame seals shall be installed in accordance with the manufacturer's recommendations.

3.6.6 FRAME AND COVER

Manhole frame and covers shall be installed in accordance with the Standard Plates or as specified.

Manhole frames that are installed onto plastic adjusting rings shall be installed using the manufacturer's recommended sealant between the frame and adjusting rings to form a watertight seal.

Manhole frames that are installed onto concrete adjusting rings shall be installed in a full bed of mortar to form a watertight seal. Manhole frames shall be set on a butyl rubber sealant where the manhole is located in an unpaved area.

Bolt-down type manhole frames and covers shall be installed on the corbel section without adjusting rings and bolted to the corbel section as shown in the Standard Plates to form a watertight seal, unless otherwise indicated.

Manhole frames offset by more than 2 inches from the adjusting rings or corbel section will be rejected.

Manhole frames and covers shall be set to the grade specified on the grade sheet and plans.

Manhole frame and covers in permanent gravel surfaced streets shall be vertically installed so that the manhole rim is set 6 to 8 inches below the finished street grade.

3.6.7 MANHOLE BOOTS

The precast base-barrel section shall also contain watertight gaskets, adaptors, or sealers to assure a leak-proof connection between the manhole and the sewer pipes entering the manhole. Such connections shall be flexible and/or pliable enough to allow for deflection from shifting or settling of the manholes and to accommodate the pipe on grade. The connections shall also be capable of adapting to the various sizes and types of sewer pipe that may be used. The manhole boot shall be a PSX gasket, as manufactured by the Press Seal Gasket Corporation, or approved equal. When futures are specified, a short pipe length with a cap shall be installed and sealed. This section of pipe will need to be removed and replaced when the pipe is extended from the manhole.

3.6.8 DROP MANHOLES

Drop manholes will be permitted only when approved or specified by the Engineer. Where changes in elevation within the manhole are not sufficient for a drop section, the manhole invert shall be filleted so that a smooth channel is formed from the end of the drop pipe throughout the length of the drop. Connections to a drop manhole will require ASTM D2241 Class 200 psi pipe to be laid through the excavation area.

The drop manhole shall be constructed in accordance with the manufacturer recommendations and as shown on the Standard Plates. A V-notch shall be cut into the flow line of the incoming pipe end. The V-notch is to provide improved flow control.

3.6.9 MANHOLE MARKERS

Manhole markers shall be installed for all manholes outside of the street ROW that are not in paved areas unless otherwise indicated. Manhole markers shall be installed as detailed on the Standard Plates.

3.6.10 MANHOLE RECONSTRUCTION

Any manhole that cannot be adjusted within the 14-inch height limit of the bid item for adjusting manholes shall be reconstructed. When an existing manhole is lower than the proposed finished grade elevation, the manhole shall be required to be reconstructed by:

Removal of the cone section and adding the appropriate height of barrel section(s) to increase the manhole height to a level that the manhole can be adjusted using the appropriate height of adjusting rings.

When an existing manhole is higher than the proposed finished grade elevation, the manhole shall be required to be reconstructed by:

Removal of the cone and barrel section(s) and installing the appropriate height of barrel section to decrease the manhole height to a level that the manhole can be adjusted using the appropriate height of adjusting rings.

3.6.11 MANHOLE LINERS

3.6.11.1 General

The work shall include furnishing all labor, materials, equipment, and incidentals required to install manhole sheet liner with studded backside in concrete manholes, concrete structures, and appurtenances to effectively protect the exposed concrete surfaces from corrosion in those areas shown on the drawings or specified. The liner shall be continuous and free of pinholes at the joints and in the liner itself.

All work for and in connection with the installation of the lining, field seaming, and welding of joints shall be done in strict conformity with all applicable instructions and recommendations of the liner manufacturer unless otherwise specified.

Installation of the lining and the welding of all joints shall be done in strict accordance with the manufacturer's instructions and recommendations and the details and methods indicated on approved shop drawings by an experienced and qualified installer acceptable to the manufacturer and the Engineer. Lining welders shall be trained and certified by the lining manufacturer prior to the start of welding. All pipe joints and other lined areas where welding is performed shall be numbered and initialed by the welder. The Contractor shall record on a daily basis at the end of each working day the identification of the joint areas and the welder who performed the work.

Coverage of the lining shall not be less than the minimum specified or as shown on the Plans. Manholes and concrete structures shall be fully lined on the interior, including man-way openings, unless otherwise shown or specified.

When needed, the lining shall be held snugly in place against inner forms by means of steel banding straps or other means recommended by the manufacturer. Banding straps must be located in the interstitial space between studs to prevent crushing or tilting of the embedment studs.

If liner is extended for the purpose of joint overlap, embedment studs shall terminate not more than 1/2 inch from the end of the inside surface of the pipe section. Joint flaps shall extend approximately 4 inches beyond the end of the inside surface.

Concrete poured against lining shall be vibrated in a careful manner so as to protect the lining and produce a dense, homogenous concrete, securely anchoring the locking studs into the concrete.

Forms shall be properly cleaned and prepared to remove any abrasive areas that may damage the liner when removing forms. In removing forms, care should be taken to protect the lining from damage. Sharp instruments shall not be used to pry forms from lined surfaces. When forms are removed, any nails that remain in the lining shall be pulled, without tearing the lining, and the resulting holes clearly marked. Form tie holes shall be marked before ties are broken off and all areas of abrasion or damage shall be marked.

Hot joint compounds, such as coal tar, shall not be poured or applied to the lining. Solvents or adhesives shall not be used in fusion of material in any manner.

The Contractor shall take all necessary measures to prevent damage to installed lining from equipment and materials used in or taken through the work area and shall immediately repair any damage.

All welding shall be performed in accordance with the published directives and procedures of the manufacturer and by welders certified by the manufacturer. Completion of welding shall provide a one-piece monolithic concrete protective liner system that will provide excellent resistance to hydrogen sulfide attack and will not pull off the wall in the event that infiltration occurs.

3.6.11.2 Submittals

Submit to the Engineer for review, as provided in the General Conditions, complete shop drawings showing liner materials and typical installation details of all liner work and details of materials of construction and installation. The shop drawings shall include manufacturer's detailed drawings, directions, and specifications for construction and all special and typical installations.

Included with shipment of liner, submit certified test reports that the liner and material were manufactured in accordance with standards specified herein.

3.6.11.3 Joints in Lining for Concrete Structures

No lining of joints shall be made until after the trench has been backfilled and the joints pressure tested. Lining at joints shall be free of all mortar and other foreign material and shall be clean and dry before joint are made.

Field joints in the lining shall be of the following types used as prescribed:

- a. Strip Type: The joint shall be made with a separate 4-inch-wide joint strip and two welding strips. The 4-inch joint strip shall be centered over the joint, and then extrusion welded to the liner. The width of the space between adjacent sheets shall not exceed 1 inch. The 4-inch joint strip shall lap over each sheet a minimum of 1.5 inch. It may be used at any transverse or longitudinal joint.
- b. Lap Type: The joint shall be made by lapping sheets not less than 1 inch. The upstream sheet shall overlap the one downstream. The lap shall be tack-welded into place, and then welded with an extrusion bead over the adjoined materials.
- c. Butt Type: Butt type welds will not be allowed for field welding of joints.

All welding is to be in strict conformance with the instruction of the liner manufacturer. Welding shall fuse both sheets together to provide a continuous joint equal in corrosion resistance and permeability to the liner plate.

3.6.11.4 INSTALLATION

3.6.11.4.1 General

Field seaming involves bonding of adjacent panels using approved thermal methods such as extrusion welding. Testing and verification of the resulting welds will be required.

3.6.11.4.2 Trial Seams

a. General

Prior to any field welding of lined surface, trial seams shall be performed to ensure that the technician and method is adequate. Trial seams shall be performed on materials from the current project, a minimum of 3 feet in length. Trial weld seams shall then be tested to ensure equipment settings are sufficient to produce quality welds. Testing shall consist of both nondestructive and destructive methods.

b. Nondestructive Seam Testing

Nondestructive testing shall consist of spark testing. Spark testing of the finished seams is required; a copper wire may be set into the weld joint prior to welding. This will allow for spark testing for the welded seam for determination of the presence of possible leaks in the weld. This process is not necessary but may provide an alternative method for nondestructive testing of the welds. Spark testing can be performed with approved instrumentation when set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found should be marked and repaired according to approved repair methods.

Repairs of pinholes and defective areas shall be performed by extruding a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

c. Destructive Seam Testing

When job requirements mandate destructive seam testing of trial seams, an appropriate number of samples should be determined by the Engineer. Weld seams should then be tested for shear strength according to standard industry guidelines. When proper welding techniques are followed, the weld shall exhibit approximately 80 percent of the parent tensile yield strength in shear when tested in accordance to ASTM D 4437.

3.6.11.4.3 Field Seams

a. Nondestructive Seam Testing

Nondestructive testing shall consist of spark testing. Spark testing allows for the welded seam to be tested for determination of the presence of possible leaks in the weld. Spark testing may be

performed over the entire surface of the weld and liner sheet. Spark testing shall be performed with approved instrumentation set at approximately 20,000 to 35,000 volts depending upon apparatus. Any defects found shall be marked and repaired according to approved repair methods. The spark testing device shall be equipped with an audible alarm indicator for signaling any defects.

Repairs of pinholes and defective areas shall be performed by extruding a bead of molten plastic over the surface, or if too large, a patch shall be utilized. Once complete, retest using the spark tester when applicable.

3.6.12 MANHOLE CONSTRUCTION PLATE MARKER

The manhole construction plate markers shall be used on **all City projects or where designated**. Manhole construction plate markers will be required on development projects where designated by the City. Manhole construction plate markers shall be installed on existing manholes immediately after construction surfacing removals have been completed and on new manholes immediately after installation. The markers, on asphalt streets, shall remain on the manhole until after the first lift of asphalt is installed (with exception to when any internal manhole construction work may need to be performed). The markers on concrete streets shall remain on the manhole until concrete paving occurs. The Contractor shall ensure that all manholes are secured, protected, and watertight at the end of each work day. Under no circumstances shall an uncompleted or completed manhole be left uncovered, unprotected, or not watertight overnight.

3.6.13 MANHOLE BENCH AND INVERT RECONSTRUCT

Manhole bench and invert reconstruct shall be done in accordance with the specifications and details for each individual repair.

3.7 CONNECTIONS TO EXISTING MANHOLES

Wherever new sewers connect with existing sewer manholes or structures, the Contractor shall cut the necessary openings into the existing manholes and make the connections thereto in a neat and workmanlike manner. The connections shall be made so as to make the joints around the entering sewers watertight and an approved smooth channeled flow line shall be

constructed. All existing cast-in-place, precast, and block-type manholes shall be core drilled, and manhole boots shall be installed for the pipe connection.

Where existing manholes are constructed of brick, cobblestone, or other materials determined by the Engineer that cannot be core drilled, pipes shall be grouted into the manhole wall with nonshrink grout and a water seal. The water seal shall be placed continuously around the pipe to form a seal. The water seal shall be a butyl rubber rope type material.

All manhole bench and inverts shall be reconstructed as a part of the connection to the existing manhole. The manhole bench and invert reconstruct shall be paid for under the bid item for Manhole Bench and Invert Reconstruct.

3.8 CONNECTIONS TO EXISTING SANITARY SEWER PIPES

Pipe couplings shall be used where it is necessary to connect two spigot ends of the same diameter pipe together and where bell and spigot connections are not possible.

3.9 STUBS AND FUTURES FROM MANHOLES FOR FUTURE EXTENSIONS

Futures from manholes shall be defined as piping and plugs that extend longer than one standard 13-foot section of pipe. Stubs from manholes shall be defined as piping and plugs/caps that extend less than a 5-foot section of pipe. Stubs and futures from a manhole shall be installed to the grade staked and/or specified. Futures shall be plugged with a suitable watertight plug at a bell end section of pipe.

Stubs can be plugged at the bell end section of pipe or capped on a plain end section of pipe. Connecting onto stubs will not be allowed. Stubs must be removed from the existing manhole when connections to the manhole are installed and a full section of pipe must be installed. Stubs shall not extend more than 5 feet and no less than 3 feet in length from the manhole unless otherwise specified.

3.10 SERVICE CONNECTIONS

In all new sanitary sewer mains, prefabricated wyes shall be installed at all service stubout locations and sealed with an approved watertight cap or plug. Wyes with the same branch pipe diameter as the main line sewer will not be permitted.

Taps on existing pipes shall be made by tapping the line and using a saddle to connect the service pipe to the main line. Cutting out a section of main line pipe and installing a wye and couplings will not be permitted.

3.11 BEDDING, BACKFILL, AND COMPACTION

3.11.1 GENERAL

Installation of PVC pipe, including bedding and backfill of the pipe, shall conform to the latest revision of ASTM D2321 "Standard Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe," the City of Canton specifications and the City of Canton Standard Plates.

All bedding and backfill areas shall be subject to compaction testing by nuclear or standard methods according to the latest applicable ASTM Specifications. In addition to the construction and testing procedures outlined in other sections of the specifications, the Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent (see pipe testing section) and the materials surrounding the pipe shall be compacted to the required Standard Proctor Densities outlined in D2321. The areas requiring compaction shall include the bedding, initial backfill, and final backfill areas, as defined in the following sections. The Engineer may take random compaction tests of the material. If any of these tests indicate that the material has not been compacted to the required density, the Contractor shall recompact said material at no additional cost to the Owner, and the Engineer shall then have the right to take additional compaction tests to assure that this or other material is compacted to the proper density without any additional cost to the Owner.

The City will pay for the first density tests taken at a given location. If the first test fails, the Contractor shall recompact the area and a second density test will be taken. If the second test passes, the City will pay for the second test. If the second test fails, the contractor shall pay for the second test and any test taken thereafter until a passing test is obtained. This procedure will be applied to each test location.

Material for all areas of backfilling is to be free of rock, frozen materials, and hard clay. Care shall be taken in placing backfill over the crown of the pipe to avoid damage to the pipe.

3.11.2 BEDDING OF PIPE

The trench base shall be undercut a minimum of 4 inches or one-fourth of the outside diameter of the pipe barrel (whichever is larger) below the grade line of the pipe and uniformly backfilled with

bedding material to the grade-line of pipe. After the pipe has been installed on top of the first layer of bedding material, the haunching area shall be backfilled with bedding material up to the "spring-line" (halfway) on the pipe (bedding material shall be used to the top of the pipe for all pipes with a diameter of 12 inches or less). The bedding material shall be "shovel-sliced" or hand tamped around and under the haunches of the pipe to assure adequate and uniform support along the bottom of the pipe. Care shall be taken to prevent dislodging and misalignment of the pipe and to provide adequate bell hole for the pipe.

All sewer service lines shall be installed with bedding material from 2 inches below the pipe to the top of the pipe.

When the foundation material is not suitable to provide a uniform base for the pipe, the trench shall be undercut to sufficient depth to build an acceptable base. Such areas shall be backfilled with trench stabilization and/or geotextile fabric material to build a uniform foundation. The trench stabilization material shall be brought up to the bottom of the bedding material specified for the pipe and the bedding material shall be used up to the spring line (bedding material shall be used to the top of the pipe for all pipes with a diameter of 12 inches or less).

3.11.3 INITIAL BACKFILLING OF PIPE TRENCH

All sewer pipe installed in an open trench shall be initial backfilled to at least 12 inches above the top of the pipe. The initial backfill shall be placed evenly so as not to disturb the grade or line of the pipe. Above the bedding area the pipe shall be backfilled with acceptable native material (Class I, II, and III as described in ASTM D2321), approved by the Engineer, or with granular material to a minimum of 90 percent Standard Proctor Density to 12 inches above the top of the pipe.

Where no suitable backfill material is available, the initial backfilling shall be constructed with granular material.

3.11.4 FINAL BACKFILLING OF TRENCH TO GRADE

All final backfill material shall consist of approved excavation material, granular material, or as otherwise specified. Sand may be used if approved by the Engineer. The final backfill shall be placed in layers and compacted by suitable and approved compaction methods in a manner approved by the Engineer to at least 95 percent Standard Proctor Density, or as otherwise specified.

Excess material not required for final backfilling shall be removed by the Contractor or otherwise disposed of as ordered by the Engineer.

If the material encountered in the trench excavations is unsuitable to be used as final backfill material, it shall be replaced with other suitable material available at the project site or with granular material, as approved by the Engineer. In final backfill areas below pavement, the Engineer may direct the Contractor to use native material a specified distance below the pavement elevation to ensure a consistent material is utilized under the pavement section.

At least 36 inches of cover shall be placed over the top of the pipe before the trench is wheel-loaded, and 48 inches of cover shall be placed over the top of the pipe before the trench is hydro-hammered for compaction.

3.12 SURFACE RESTORATION

3.12.1 GENERAL

Unless stated specifically to the contrary in the Special Provisions, the Contractor shall replace all surface material and shall restore paving, curbing, sidewalks, gutters fences, trees, sod, topsoil, and other items disturbed to a condition equal to that before the work began, furnishing all labor, materials, and equipment necessary to do this work. Traveled streets shall be kept open and maintained by the Contractor after backfilling and before surfacing or final inspection. The cost of all such work shall be absorbed in the unit price bid for pipe installation unless otherwise specified in the Special Provisions or Bid Proposal.

3.12.2 USE AND REPAIR OF STREET

The Contractor shall carry on the work in such a manner as to interfere as little as possible with the use of the street for public travel and as specified in the Special Provisions.

Wherever any paved gutters, pavements, graveled highways or street crossings, or other improvements are interfered with or removed, they must be replaced by the Contractor and left in as good condition as previously. The Contractor shall also remove all surplus material leaving the streets clean and in good order.

No more than 300 feet of trench will be opened at any one time in advance of the complete construction of the sewers and the backfilling shall follow up the installation of the sewers.

All street repairs and cleaning shall be promptly done as the work progresses. The Contractor shall not obstruct any street gutters, but shall provide for the passage of surface water along the same at all times.

It shall be the Contractor's responsibility to protect all sanitary sewer pipes, manholes, and trenches from extraneous water and storm water entering the sanitary sewer system at all times during construction.

3.12.3 CONCRETE PAVEMENT REMOVAL AND REPLACEMENT

The surface of all concrete pavements shall be sawed with a concrete saw to the full pavement depth. The width of pavement removed shall be 12 inches wider than the trench excavation to provide a shoulder on all sides. Where within 2 feet of existing joint, concrete shall be removed to the joint.

The Contractor shall place a 6-inch gravel cushion unless otherwise specified and replace the concrete pavement to the same thickness as the original pavement, with a minimum thickness of 6 inches. The concrete shall be Class M6 as specified by SDDOT and shall be finished the same as the existing pavement.

The cost of pavement removal, replacement, and sawing of the concrete shall be included in the unit price bid for pipe unless otherwise provided for in the Bid Proposal or specified in the Special Provisions.

All concrete pavement shall be removed and replaced in accordance with the Supplemental Standard Specifications and Standard Plates.

3.12.4 ASPHALT PAVEMENT REMOVAL AND REPLACEMENT

Where streets are asphalt surfaced, the Contractor shall cut the asphalt surfacing to a minimum depth of 4 inches by an approved method to a width of 12 inches wider than the trench excavation.

When asphalt surfacing has a concrete base, the asphalt shall be cut in the previously described manner and the concrete base removed with a pneumatic or mechanical type hammer or by similar means.

Unless otherwise specified, the Contractor shall place a 6-inch gravel cushion under the concrete base; replace the concrete base with a minimum of 6 inches of Class M6 concrete; and then place a minimum of 2 inches of asphalt surfacing meeting City Standards

and Standard Specifications on top of the concrete base, or as otherwise specified in the Special Provisions.

On all excavations in asphalt surfaces without concrete base, there shall be a minimum of 6 inches aggregate base course and a minimum of 4-inch asphalt mat or the thickness of the existing mat whichever is the greater.

All asphalt surfacing shall be replaced and rolled in accordance with the Standard Specifications and Supplemental Standard Specifications.

All street surfacing cuts, asphalt or concrete, shall be in a straight line parallel to the existing curb and gutter or perpendicular to the centerline of the street. No jagged, skewed, or irregular cuts will be allowed. All asphalt cuts shall be in an approved manner and not ripped out with the bucket. Such work lifts the remaining mat away from the base material and shall be cause for widening the street cut and increasing the amount of surfacing replaced at the Contractor's expense.

3.13 REMOVAL AND ABANDONING SEWER PIPE AND MANHOLES

3.13.1 REMOVAL OF PIPE AND MANHOLES

This work shall consist of removal and disposal of pipe and manholes which are not designated or permitted to remain and which are not removed and disposed of under other items in the contract. Removals shall be in accordance with the Standard Specifications. Manholes that are to be removed shall be entirely removed and disposed of unless otherwise indicated.

3.13.2 ABANDONING OF PIPE AND MANHOLES

Abandon sanitary sewer pipe that is to remain in-place shall be entirely filled with K-crete unless otherwise indicated. Manholes that are to be abandon in-place shall be abandon by removing the top 3 feet below finish grade elevation, seal off any incoming piping with K-crete, install a 2-inch minimum diameter hole in the base section of the manhole, and fill the manhole with sand.

3.14 PIPE INSULATION

Pipe insulation shall be required on all sanitary sewer pipe installations where the cover depth to finished grade elevation is 5 feet or less above the pipe. The insulation work shall be in accordance with the Special Provisions, drawings, and manufacturer's recommendations.

3.15 JACKING, BORING, AND TUNNELING

It shall be the responsibility of the Contractor to maintain the alignment and grade specified. The jacking, boring, and tunneling specifications shall be in accordance with the standard plates, drawings, and Special Provisions.

3.16 SANITARY SEWER SERVICES

3.16.1 GENERAL

Glued connections will only be allowed at the connection between the SDR 35 and the Schedule 40 PVC pipe at the building. 45-degree bends shall not be located closer than 3 feet from each other.

3.16.2 CLEANOUTS

Cleanouts shall be used only on service lines in approved locations. Cleanouts used for service lines shall be covered at finished grade with a Neenah R1976 frame and cover except for cleanouts located adjacent (within 5 feet) to the structure it services. The cleanout shall be constructed as shown on the Standard Plates.

Cleanouts must be located within 5 feet of all commercial buildings. At least one cleanout shall be provided for all commercial buildings. The size of the cleanout piping shall be in accordance with the South Dakota Utility Contractor Handbook.

3.16.3 COUPLINGS

Couplings, on new construction, will not be allowed unless the building sewer stubout exists before the service from the property line to the building is installed. If couplings are determined to be necessary, only one coupling for each service line will be allowed on new construction.

3.16.4 COMMON TRENCH FOR SERVICE LINES

All sewer service lines within public street right-of-way shall be installed at least 10 feet horizontally from any existing or proposed water service line. Any variation to this requirement is subject to the approval of the City. On private property, a sewer service line may be laid in the same trench with a water service line. In such a case, the elevation of the crown of the sewer service line shall be at least 12 inches below the invert of the water service line. The water service will be allowed to be benched or additional pipe bedding material may be used to create the separation between water and sanitary sewer services. The sewer service line and

water service line shall not have less than 1-foot horizontal distance between the piping.

Whenever sewer service lines must cross under water service lines, the sewer service line shall be laid at such an elevation that the crown of the sewer service line is at least 12 inches below the invert of the water service line.

3.16.5 RECONNECT SEWER SERVICE *(Reconnecting sewer service lines where new main line sewer pipe is installed to replace existing main line sewer.)*

All new service lines to be connected into the new sewer main line pipe shall be made with an approved wye connection. A tap and tapping saddle will only be allowed where determined necessary by the Engineer. A coupling will be allowed for connecting the new service line to the existing service line.

3.16.6 CAPS AND PLUGS

Existing clay service lines that are to be abandoned shall be capped with nonshrink grout placed continuously for a 1-foot distance into the pipe.

New PVC service lines that are to be plugged shall be plugged at a bell end section of pipe.

3.16.7 SANITARY SEWER SERVICE PIPE LINING REPAIRS.

3.16.7.1 GENERAL

Bypass Pumping: The Contractor shall furnish, install, and operate pumps, plugs, conduits, and other equipment to divert the flow of sewage around the lined pipe line for which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flow plus additional flow that may occur during a wet weather event.

Cleaning: The Contractor shall thoroughly clean the sewer pipe that is to be relined prior to installation of the repair liner pipe. The cleaning shall constitute removal of all debris, solids, roots, and other deposits in the sewer line that could prevent installation of the liner pipe. If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, the Contractor shall make a point repair excavation to remove the repair or obstruction.

Pre-inspection and Measuring of Service Connections, bends, etc.: The Contractor shall inspect the sewer pipe immediately before the installation of the liner to assure that the pipe is clean and existing pipe conditions are acceptable for the liner installation. The Contractor shall also create a log as well as video tape documentation with exact measurements of each service connection in the sewer pipe, in order to reopen the service connections after the installation by means of a robotic cutter for CIPP lining or excavation and a wye connection for sliplining repair projects. The service connection log shall at a minimum state the exact distance from a designated point to the middle of each service connection and where the connection is located along the service line (i.e., 9 o'clock, etc.).

Post inspection: The Contractor shall videotape the service line repairs for CIPP projects and submit a copy to the property owner and the City for review. All measurements for the repairs shall be provided to the Inspector at the time of inspection.

3.16.7.2 SANITARY SEWER SERVICE SLIPLINING

Sliplining of sanitary sewer service lines shall be performed by pulling or pushing liner pipe into existing sewers by use of mechanical or hydraulic equipment. Once in place, the liner pipe shall be connected at one or more ends with a coupling to the existing pipe. Annular spaces between the liner pipe and existing pipe shall be sealed at the ends with a chemical seal or nonshrink grout. The liner pipe shall not obstruct the City main line sanitary sewer. Pipes protruding into the City main line sewer will be required to be cut off flush or back from the main line sewer.

3.16.7.3 CURED IN-PLACE SANITARY SEWER SERVICE PIPE LINING

The following documents (latest additions) shall be a part of this specification.

ASTM F1216. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube.

ASTM F2019. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Pull-in Place Installation of Glass Reinforced Plastic (GRP) Cured-in-Place Thermosetting Resin Pipe (CIPP).

ASTM F1743. Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pull in and inflate and Curing of a Resin-Impregnated Tube.

ASTM D638. Standard Test Method for Tensile Properties of Plastics.

ASTM D790. Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

ASTM D792. Standard Test Methods for Density and Specific Gravity of Plastics by displacement.

ASTM D5813. Standard Specification for Cured-in Place Thermosetting Resin Sewer Pipe.

NASSCO. Specification Guidelines.

The installation of the CIPP shall be in accordance with the manufacturer's recommendations and ASTM F1216, ASTM F2019, or ASTM F1743. The resin shall be distributed into the tube in strict conformance with the ASTM and NASSCO standards. After installation of the liner is completed, the Contractor shall cure, cool down, and finish the liner in accordance with the ASTM standards. When required, the Contractor shall reinstate all connections to their original diameter. The CIPP shall provide a smooth bore interior throughout the length and a uniform wall thickness. The CIPP shall be wrinkle-free. The CIPP shall not obstruct the City main line sanitary sewer.

3.17 INSPECTION AND TESTING

3.17.1 GENERAL

The Engineer shall have access at all times to all parts of the job, and the Contractor must furnish such personnel, facilities, equipment, tools, and materials as are necessary to make whatever tests and inspection that are deemed necessary.

3.17.2 PIPE MATERIAL TESTING

The Engineer may require a test of specimens not to exceed 5 percent of the quantity of pipe to be furnished in order to prove the acceptability of the pipe. The manufacturer shall provide an approved testing stand near the site of the plant.

3.17.3 PIPE INSPECTION

Prior to being lowered into the trench, each pipe shall be carefully inspected by the Contractor and those not meeting the specified requirements shall be removed from the site immediately.

Rejections may be made for any of the reasons as stated in the specifications for each specific type of pipe. Pipe having minor flaws not serious enough to cause rejection shall be installed so as to bring such flaws in the top half of the sewer. Pipe shall be protected during handling against impact, shocks, and free fall.

3.17.4 TELEVISION INSPECTION

The City will perform an inspection of the completed sewer line within the two-year warranty period through the use of a television camera. The expense of the initial television inspection and one additional reinspection will be borne entirely by the City. If defective workmanship of material or construction is noted, the deficiency shall be corrected by the Contractor at no expense to the City. The City will perform additional television inspections to review if the repairs were made properly and in accordance with the specifications. The expense of any additional television inspections beyond the initial inspection and one additional reinspection will be borne entirely by the Contractor.

The Contractor shall be responsible for all related costs, including concrete or asphalt resurfacing, if the street has been surfaced. The Contractor shall be required to repair all areas of infiltration and other deficiencies.

3.17.5 CLEANING

The Contractor shall be responsible for all work necessary to make the sewer acceptable for usage including removal of all mud, silt, rocks, or blockages that might hinder the flow and make said sewer unacceptable for final acceptance and usage. Also included is all work necessary in the manholes and all cleanup work required prior to final acceptance.

The City will not be responsible for cleaning lines prior to televising the sewer. In the event that the line is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to make arrangements to clean the sewer and make it acceptable for the television work.

3.17.6 BACKFILL DENSITY TEST

The Contractor shall expose the compacted soil layers, as required by the Engineer, to enable the Engineer to perform density tests. The cost of exposing the soil layers for testing shall be incidental to the pipe and/or manhole installation.

3.17.7 PIPE AND MANHOLE LEAKAGE FIELD TESTING—GENERAL

All manholes and piping shall be tested and inspected for leakage by the Contractor. In addition to the testing and inspection for leakage in the manhole, the Contractor shall perform manhole vacuum tests when the ground water table elevation is lower than 2 feet above the top of the pipe. Exfiltration testing with water will only be allowed where specifically specified.

Piping shall be tested using one of two methods: infiltration test or pipe exfiltration test (low pressure air test). The pipe infiltration test shall be used when the ground water table elevation is greater than 2 feet above the top of the pipe as determined by the Engineer. The pipe exfiltration test (water test or low pressure air test) shall be used when the ground water table elevation is less than 2 feet above the top of the pipe as determined by the Engineer. Exfiltration testing of the pipe with water will only be allowed where specifically specified.

After each section of sanitary sewer between manholes has been completely installed and backfilled, the line and manholes shall be inspected by the Contractor for leakage. All visual leakage at individual joints or other parts of the sewer and/or leakage in excess of that specified shall be repaired by the Contractor at the Contractor's expense before the sewer is accepted. The repair of leaks may require the removal and replacement of manhole sections and pipe sections. The gasket shall be the sole element depended upon to make the joint leak proof. The use of grout to repair leaks will not be allowed. The actual method of correction shall be approved by the Engineer prior to performing the repair.

When existing sanitary sewers which have service connections are being reconstructed or replaced (example: street reconstruction projects), the leakage test requirements may be waived or other testing methods substituted, subject to the approval of the City.

The Contractor shall notify the Engineer 24 hours prior to performing the test to enable the Engineer to be present during the testing operations. All data will be recorded and evaluated by the Engineer. All lined manholes and pipe shall be tested prior to welding the joints.

3.17.8 INFILTRATION TEST

This test shall be performed by the Contractor using a V-notched weir in the downstream manhole of a line segment to measure the upstream sewer leakage. The test shall be maintained for not less than 24 hours before the measurement is performed. The test shall be performed one line segment at a time (a line segment shall be defined as the line from one manhole to the next adjacent manhole). The V-notched weir shall have volumetric calibrations (gallons/24 hours) and shall be easy to read.

The Engineer may waive the use of the V-notched weir if the Engineer determines that the leakage flow is obvious or nonexistent through visual inspection. The maximum allowable infiltration or exfiltration for any new sanitary sewer section, including all manholes, shall be 50 gallons per inch of diameter per mile of pipe per day. All visible leakage at individual locations (including the amounts less than the 50 gallons per inch of diameter per mile of pipe per day) as determined by the Engineer shall still be the Contractor's responsibility to repair. Payment for the infiltration test will be incidental to the pipe and manhole installation.

3.17.9 PIPE EXFILTRATION (WATER) TEST

The low pressure air test shall be used for the exfiltration test unless otherwise specified. The pipe exfiltration (water) test shall only be allowed where specified.

The pipe exfiltration (water) test shall be performed by sectionalizing the test so that interior pressure in pipe does not exceed 5 feet of water pressure. The test will be performed by the Contractor as follows:

1. Place watertight bulkhead in inlet of the upstream and downstream manholes of sewer to be tested.
2. Fill section of sewer and upstream manhole with water until the elevation of water in the upstream manhole is 2 feet higher than the top of the pipe in the line being tested or 2 feet above the existing ground water in the trench—whichever is the higher.
3. Allow the water to stabilize for one-half hour, then fill the manhole with water to the original level and begin the test.
4. The amount of water lost in the manhole during one hour will be measured and used to determine the exfiltration. The maximum allowable drop in vertical water height in the

manhole shall be 1/4 inch for all diameter manholes. If the water level in the manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

3.17.10 PIPE EXFILTRATION (LOW PRESSURE AIR) TEST

The pipe exfiltration (low pressure air) test shall be performed in accordance with ASTM F1417 standards. The following procedure is summarized from ASTM F1417 and shall be followed in conjunction with ASTM F1417 unless modified by the Engineer. Repair of leaks may require the removal and replacement of manhole sections. The use of grout to repair leaks will not be allowed.

Procedure

1. Clean the section of sewer line to be tested by flushing or other means prior to conducting the low-pressure air test. This cleaning serves to eliminate debris and produce the most consistent results.
2. Isolate the section of sewer line to be tested by inflatable stoppers or other suitable test plugs.
3. Plug or cap the ends of all branches, laterals, tees, wyes, and stubs to be included in the test to prevent air leakage. All plugs and caps shall be securely braced to prevent blow-out. One of the plugs or caps should have an inlet tap, or other provision for connecting a hose to a portable air control source.
4. Connect the air hose to the inlet tap and portable air control source. The air equipment shall consist of necessary valves and pressure gauges to control an oil-free air source and the rate at which air flows into the test section to enable monitoring of the air pressure within the test section.
5. Add air slowly to the test section until the pressure inside the pipe reaches 4.0 psig.
6. After the pressure of 4.0 psig is obtained, regulate the air supply so that the pressure is maintained between 3.5 to 4.0 psig for at least 2 minutes depending on air/ground temperature conditions. The air temperature should stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained; however, a minimum of 3.5 psig is required.
7. Determine the rate of air loss by the time-pressure drop method.

8. Time-Pressure Drop Method—Air is slowly introduced into the section of pipe to be tested, until the air pressure is raised to approximately 4.0 psi and the test pipe section is stabilized as in 8.1. Disconnect the air supply and decrease the pressure to 3.5 psi before starting the test. Determine the time required for the pressure to drop from 3.5 psi to 2.5 psi, and compare this interval to the required time to decide if the rate of air loss is within the allowable. Minimum holding times required by pipe diameter are shown in Table 3.17.10 and are also listed in ASTM 1417.
9. Upon completion of the test, open the bleeder valve and allow all air to escape. Plugs should not be removed until all air pressure in the test section has been reduced to atmospheric pressure.

Table No. 3.17.10 below indicates the minimum test period durations, length of test section for minimum test durations, and the formula to calculate the testing time when the test section length exceeds the length for minimum test time (in accordance with ASTM F1417). Repair of leaks may require the removal and replacement of pipe sections. The use of grout to repair leaks will not be allowed.

The Engineer may reduce the testing time to one-half the testing time if the pressure drop is less than 0.5 psi for the first one-half the test period listed in Table 3.17.10.

Table No. 3.17.10

Nominal Pipe Diameter, in.	Minimum Time, min:s	Length for Minimum Time, ft.	Time for Longer Length, s
4	3:46	597	0.380 L
6	5:40	398	0.854 L
8	7:34	298	1.520 L
10	9:26	239	2.374 L
12	11:20	199	3.418 L
15	14:10	159	5.342 L
18	17:00	133	7.692 L
21	19:50	114	10.470 L
24	22:40	99	13.674 L
27	25:30	88	17.306 L
30	28:20	80	21.366 L
33	31:10	72	25.852 L
36	34:00	66	30.768 L

3.17.11 MANHOLE EXFILTRATION TEST

The manhole vacuum test shall be used for testing manholes for leakage defects. The manhole water exfiltration test shall only be allowed where specified.

To perform this test, the inlet and outlet of the manhole shall be plugged and the manhole filled with water to a depth equal to that used for the sanitary line water test, or in the case when the air test was run on the line, a minimum depth of 2 feet above the top of the sewer line or 2 feet above the existing ground water—whichever is the higher. Allow the water to stabilize for one-half hour and refill the manhole to the original elevation. Mark the initial depth of the water and after one hour, record the drop in the water level in the manhole. The maximum allowable drop in vertical water height in the manhole shall be 1/4 inch for all diameter sizes of manholes. If the water level in the manhole drops below the allowable drop amount, the Contractor shall repair the leak and retest.

3.17.12 MANHOLE VACUUM TEST

The manhole vacuum test shall be performed in accordance with ASTM C1244. The following procedure is summarized from ASTM C1244 and shall be followed in conjunction with ASTM C1244 unless modified by the Engineer. The vacuum test shall include testing the top of the manhole, excluding the adjusting rings and manhole frame and cover. Testing will be allowed after backfilling has occurred or as specified in the Special Provisions. Manhole vacuum tester assembly and vacuum pumps shall be as manufactured by Cherne Industries, Inc. or approved equal. Repair of leaks may require the removal and replacement of manhole sections. The use of grout to repair leaks will not be allowed.

Procedure

1. All lift holes shall be plugged.
2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
3. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
4. A vacuum of 10 in. of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to 9 in. of mercury.

5. The manhole shall pass if the time for the vacuum reading to drop from 10 in. of mercury to 9 in. of mercury meets or exceeds the values indicated in Table 3.17.12.
6. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

**Table 3.17.12
Minimum Test Times for
Various Manhole Diameters in Seconds**

Depth, (ft)	Diameter, in.		
	48	60	72
	Time, in seconds		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

3.17.13 PIPE DEFLECTION TEST

Deflection tests shall be performed by the Contractor on all PVC sewers. Deflection tests shall be conducted after the final backfill has been in place at least 30 days. Deflection tests shall be conducted no more than 45 days after the final backfill has been in place. Deflection tests shall be made using a deflection gauge (mandrel) device or other approved method. The diameter of the deflection gauge device shall be 95 percent of the undeflected inside diameter of the flexible pipe. The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent. All pipes exceeding the 5 percent deflection within the two-year warranty period shall be re-laid or replaced by the Contractor at no additional cost to the Owner.

4.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 REMOVAL OF SEWER PIPE

The removal of sewer pipe shall be measured as lineal foot of pipe removed. The removal footage shall be rounded up to the nearest 1-foot increment.

The removal of a sewer pipe shall be paid for at the contract unit price for each foot of sewer removed. Payment for removal of sewer pipe shall be full compensation for excavation, removal and disposal of the pipe, and all appurtenances necessary for the proper removal of the pipe.

4.2 REMOVAL OF SEWER MANHOLE

The removal of sewer manhole shall be measured as a unit for each manhole removed.

The removal of a sewer manhole shall be paid for at the contract unit price for each sewer manhole removed. Payment for removal of sewer manhole shall be full compensation for removal and disposal of the manhole, frame and covers, boots, and all appurtenances necessary for the proper removal of the manhole.

4.3 ABANDONING OF SEWER PIPE

The abandoning of sewer pipe shall be measured as cubic yards of K-Crete fill in the pipe. K-Crete shall be measured to the nearest 0.1 cubic yard.

The abandoning of sewer pipe shall be paid for at the contract unit price per cubic yard for K-Crete. Payment for K-Crete shall be full compensation for abandoning the pipe, filling the pipe with K-Crete, excavation for allowing insertion holes for filling the K-Crete into the pipe, backfilling to finished grade elevation, and all appurtenances necessary for properly abandoning the sewer pipe.

4.4 ABANDONING OF MANHOLE

The abandoning of a manhole shall be measured as a unit for each manhole abandoned.

The abandoning of a manhole shall be paid for at the contract unit price for each manhole abandon. Payment for abandoning of sewer manholes shall be full compensation for abandoning the manhole, breaking the manhole down to the required height, constructing a hole in the manhole base section, filling the manhole with sand, backfilling to finished grade, and all appurtenances necessary for properly abandoning the manhole.

4.5 ROCK EXCAVATION

The removal of rock shall be measured as cubic yards of rock removed. The cubic yards removed shall be rounded to the nearest 0.1 increment. All rock excavation shall be under one classification. The classification shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and also boulders that exceed 1 cubic yard in volume.

Pay lines for computing rock excavation shall be described as follows for trench widths:

Pipe Size	Trench Width Pay Limits
Pipe equal to or less than 24 inches in diameter	4 feet
Pipe greater than 24 inches in diameter	The outside pipe diameter plus 24 inches

Pay lines for computing depth of the rock excavation shall be described as the distance from top of rock to 12 inches below the pipe invert elevation. The top of the rock profile will be measured and determined by the Engineer and used to determine the rock quantities.

The accepted quantities of rock excavation shall be paid for at the contract unit price per cubic yard. Payment for rock excavation shall be full compensation for permits, excavation, blasting, removal and proper disposal of the rock offsite, and all appurtenances necessary for the proper removal of the rock. **Furnishing and installing suitable fill material to replace the rock removed (except in locations where bedding material is required) will be paid for with the Granular Material bid item.**

4.6 GRANULAR MATERIAL

The furnishing and installing of granular material shall be measured as tons of granular material to the nearest 0.1 ton.

The accepted quantities of furnished and installed granular material will be paid for at the contract unit price per ton. Payment for granular material will be full compensation for furnishing and installing of granular material and all appurtenances necessary for the proper installation of it.

4.7 TRENCH STABILIZATION MATERIAL

The furnishing and installing of trench stabilization material shall be measured as cubic yards of trench stabilization material to the nearest 0.1 ton.

The accepted quantities of furnished and installed trench stabilization material will be paid for at the contract unit price per ton. Payment for trench stabilization material will be full compensation for furnishing and installing of trench stabilization material, excavation, removal and disposal of unstable soils, and all appurtenances necessary for the proper installation of it.

4.8 GEOTEXTILE FABRIC

The furnishing and installing of geotextile fabric material shall be measured as square yards of geotextile fabric material to the nearest 1 square yard.

The accepted quantities of furnished and installed geotextile fabric will be paid for at the contract unit price per square yard. Payment for geotextile fabric will be full compensation for furnishing and installing of geotextile fabric and all appurtenances necessary for the proper installation of it.

4.9 K-CRETE

The furnishing and installing of K-Crete shall be measured as cubic yards of K-Crete to the nearest 0.1 cubic yard.

The furnishing and installing of K-Crete will be paid for at the contract unit price for K-Crete. Payment for K-Crete will be full compensation for furnishing and installing of K-Crete and all appurtenances necessary for the proper installation of it.

4.10 ADJUST MANHOLE

The furnishing and installing of manhole adjustments shall be measured as a unit for the manhole adjustment at each manhole.

The furnishing and installing of adjusting rings shall be paid for at the contract unit price for each manhole adjustment. Payment for adjust manhole will be full compensation for furnishing and installing of the manhole adjusting rings, sealant, mortar, and all appurtenances necessary for the proper installation of the manhole adjusting rings. Payment for adjust manhole will also be full compensation for replacement of all or a portion of the existing adjusting rings if necessary or required. Manhole adjustments will be paid for at new and existing manholes where necessary.

4.11 MANHOLE RECONSTRUCTION

The work of reconstructing manholes shall be measured by each respective manhole reconstruction unless otherwise indicated.

The work of reconstructing manholes shall be paid for at the contract unit price for each manhole reconstruction unless otherwise noted. Payment for reconstructing manholes will be full compensation for furnishing and installing of the manhole sections, gaskets, manhole sealant, and all

appurtenances necessary for the proper installation of the manhole reconstruction.

4.12 MANHOLE FRAME AND COVER

The furnishing and installing of manhole frame and covers shall be measured as a unit for each type of manhole frame and cover installation.

The furnishing and installing of frame and covers shall be paid for at the contract unit price for each type of manhole frame and cover. Payment for manhole frame and covers will be full compensation for furnishing and installing of the manhole frame and covers, sealant, mortar, and all appurtenances necessary for the proper installation of the manhole frame and cover.

4.13 MANHOLE EXTERNAL FRAME SEAL

The furnishing and installing of manhole frame seal shall be measured as a unit for each manhole frame seal installation at a manhole.

The furnishing and installing of the manhole frame seal shall be paid for at the contract unit price for each manhole frame seal. Payment for manhole frame seal will be full compensation for furnishing and installing of the complete manhole frame seal and all appurtenances necessary for the proper installation of the manhole frame seal for the manhole. Payment will be made for a complete frame seal system and not be made for individual extensions unless otherwise specified.

4.14 MANHOLE RESTORATION

The work of manhole restoration shall be measured by each respective manhole restoration unless otherwise indicated.

The work of manhole restoration shall be paid for at the contract unit price for each manhole restoration unless otherwise noted. Payment for manhole restoration shall be full compensation for restoring the manhole with the specified methods and materials and all appurtenances necessary for the proper restoration of the manhole.

4.15 STYROFOAM INSULATION

Styrofoam insulation shall be measured by the lineal foot of the pipe length that is insulated and for different sizes of insulation. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of Styrofoam insulation shall be paid for at the contract unit price per lineal foot for the sizes furnished and accepted of Styrofoam insulation. Payment for Styrofoam insulation will be full compensation for furnishing and installing of the Styrofoam insulation and all appurtenances necessary for the proper installation of it.

4.16 SANITARY SEWER PIPE

Sanitary sewer pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe at 2-foot depth increments. Sanitary sewer pipe depths will be measured from the plan finished grade elevation to the pipe invert unless the constructed grade elevation differs. Piping shall be measured from end to end with no deduction for length through manholes. Where two or more pipes of different size enter a manhole, each pipe will be measured to the center of the manhole. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of sanitary sewer pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sanitary sewer pipe will be full compensation for furnishing and installing of the sanitary sewer pipe, gaskets, trench dewatering (unless otherwise specified), excavation, backfilling, and all appurtenances necessary for the proper installation of the sanitary sewer pipe.

4.17 BEDDING MATERIAL

Pipe bedding material shall be measured by the lineal foot of the respective type and sizes of pipe. Bedding material shall be measured from pipe end to end with no deduction for length through manholes. Where two or more pipes of different size enter a manhole, bedding material for each pipe will be measured to the center of the manhole. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of pipe bedding material shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for pipe bedding material will be full compensation for furnishing and installing of the pipe bedding material and all appurtenances necessary for the proper installation of it.

4.18 SANITARY SEWER SERVICE PIPE

Sanitary sewer service pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe. The measured length shall be rounded up to the nearest 1-foot increment. Unless otherwise shown on the plans, couplings, bends, or other fittings will be included in the length of measurement.

The furnishing and installing of sanitary sewer service pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sanitary sewer service pipe will be full compensation for furnishing and installing of the sanitary sewer service pipe, gaskets, bedding material, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the sanitary sewer service pipe.

4.19 SEWER WYE/TAP

Sanitary sewer wyes and taps shall be measured by each unit of the respective type and size of pipe.

The furnishing and installing of sanitary sewer wyes and taps shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer wyes and taps will be full compensation for furnishing and installing of the sanitary sewer wyes and taps, gaskets, bands, cutting of pipe openings, and all appurtenances necessary for the proper installation of the sanitary sewer wyes and taps.

4.20 SEWER COUPLINGS

Sanitary sewer couplings shall be measured by each unit of the respective type and size of pipe.

The furnishing and installing of sanitary sewer couplings shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer couplings will be full compensation for furnishing and installing of the sanitary sewer couplings, bands, pipe, and all appurtenances necessary for the proper installation of the sanitary sewer couplings.

4.21 SEWER CAPS/PLUGS

Sanitary sewer caps/plugs shall be measured by each unit of the respective type and size of pipe.

The furnishing and installing of sanitary sewer caps/plugs shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for sanitary sewer caps/plugs will be full compensation for furnishing and installing of the sanitary sewer caps/plugs and all appurtenances necessary for the proper installation of the sanitary sewer caps/plugs.

4.22 SEWER SERVICE CLEANOUT ASSEMBLY

The furnishing and installing of clean-outs shall be measured as a unit for each clean-out assembly for the designated pipe size.

The furnishing and installing of clean-outs shall be paid for at the contract unit price for each sewer clean-out assembly unless otherwise noted. Payment for the sewer clean-out assembly will be full compensation for furnishing and installing of the piping, fittings, protective covers, manhole covers, and all appurtenances necessary for the proper installation of the cleanout.

4.23 MANHOLE

Manholes shall be measured as each unit, by inside nominal diameter, and at 2-foot depth increments. Manhole depths will be measured from the top of the rim to the lowest pipe invert.

The furnishing and installing of manholes shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for manholes will be full compensation for furnishing and installing of the manhole sections, gaskets or butyl rubber rope sealant, futures (pipe, plugs and/or caps), and all appurtenances necessary for the proper installation of the manhole.

4.24 LINED MANHOLE

Lined manholes shall be measured as each unit, by inside nominal diameter, and at 2-foot depth increments. Lined manhole depths will be measured from the rim to the lowest pipe invert.

The furnishing and installing of lined manholes shall be paid for at the contract unit price per each for the types and sizes furnished and accepted. Payment for lined manholes will be full compensation for furnishing and installing of the lined manhole sections, gaskets or butyl rubber rope sealant, lining, welding lining, testing lining, and all appurtenances necessary for the proper installation of the lined manhole.

4.25 DROP MANHOLE

The furnishing and installing of drop manhole sections shall be measured as a unit for each separate drop manhole installation. Each manhole drop section will be described in the bid item description by the location and by the footage difference between the vertical drop length as measured from the incoming pipe invert to the lowest outgoing pipe invert elevation in the manhole.

The furnishing and installing of each manhole drop section shall be paid for at the contract unit price for each drop section. Payment will be full compensation for furnishing of the pipe and fittings, drop manhole assembly, clamping brackets, stainless steel, setting of the drop section in concrete in the bottom of the manhole, and all appurtenances necessary for the proper installation of the drop manhole section.

4.26 MANHOLE BOOTS

Manhole boots shall be measured by each unit of the respective size of pipe.

The furnishing and installing of manhole boots shall be paid for at the contract unit price per each for the sizes furnished and accepted. Payment for manhole boots will be full compensation for furnishing and installing of

the manhole boots onto the manhole and pipe, bands, and all appurtenances necessary for the proper installation of the sanitary sewer couplings.

4.27 SEWER SERVICE RISER PIPE

Sewer service riser pipe shall be measured by the lineal foot of the respective type, classes, and sizes of pipe. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of sewer service riser pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for sewer service riser pipe will be full compensation for furnishing and installing of the sanitary sewer service pipe, gaskets, bedding material, bends, caps/plugs, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the sewer service riser pipe.

4.28 RECONNECT SEWER SERVICE

(Reconnecting Sewer Service lines where new main line sewer pipe is installed to replace existing main line sewer.)

Bid item, "Sewer Wye/Tap" (for each specified size), shall be used for payment for the furnishing and installing of the wye or tap and tapping saddle. The wye or tap and tapping saddle size shall be indicated on the drawings and in the bid form. Bid item, "Reconnect Sewer Service," shall be used for payment for furnishing and installing pipe, fittings, couplings necessary for performing the service reconnection. All services shall be installed to the curb line along the street and connected to the existing service line unless otherwise noted. The pipe for extending services from the main line sewer to the curb line shall be furnished and installed and paid for under bid item "4-inch Sanitary Sewer Service," bid item "6-inch Sanitary Sewer Service," or as specified.

4.29 CONNECTION INTO EXISTING MANHOLE

Connections into existing manholes shall be measured by each unit connection.

The furnishing and installing of connections into existing manholes shall be paid for at the contract unit price per each furnished and accepted. Payment for connections into existing manholes will be full compensation for furnishing and installing of the pipe into the manhole, core drilling of the manhole, manhole boot(s), grout, water seal, and all appurtenances necessary for the proper installation of the connection into existing manhole.

4.30 MANHOLE EXFILTRATION/VACUUM TEST

Manhole exfiltration/vacuum test shall be measured by each acceptable unit test.

The manhole exfiltration/vacuum test shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole exfiltration/vacuum test will be full compensation for testing of the manhole and all appurtenances necessary for the proper manhole exfiltration/vacuum testing.

4.31 SANITARY SEWER EXFILTRATION TEST

Sanitary sewer exfiltration test shall be measured by lineal foot of pipe tested that is acceptable and shall be measured from end to end with no deduction for length through manholes. Service line testing shall be measured as incidental to the main line testing. The lineal footage shall not include the length of connected sanitary sewer service pipes. The measured length shall be rounded up to the nearest 1-foot increment.

The sanitary sewer exfiltration test shall be paid for at the contract unit price per lineal foot furnished and accepted. Payment for sanitary sewer exfiltration test will be full compensation for testing of the pipe and all appurtenances necessary for the proper sanitary sewer exfiltration testing.

4.32 PVC SEWER PIPE DEFLECTION TEST

PVC sewer pipe deflection test shall be measured by lineal foot of pipe tested that is acceptable. The lineal footage shall not include the length of connected sanitary sewer service pipes. The measured length shall be rounded up to the nearest 1-foot increment.

The PVC sewer deflection test shall be paid for at the contract unit price per lineal foot furnished and accepted. Payment for PVC sewer deflection test will be full compensation for testing of the pipe and all appurtenances necessary for the proper PVC sewer deflection test.

4.33 TRENCH DEWATERING

Trench dewatering shall be measured lump sum where trench dewatering is necessary and as indicated on the Bid Proposal. If trench dewatering is not indicated on the bid form and is necessary, measurement shall be incidental to the pipe and manhole installation. Service line dewatering shall be measured as incidental to the main line dewatering where main line sewer is installed in conjunction with service lines.

Payment for trench dewatering will be for lump sum price unless otherwise noted on the drawings or Special Provisions and/or Bid Proposal. If trench dewatering is not indicated on the bid form and is necessary, payment for

trench dewatering shall be incidental to the pipe and manhole installation unless otherwise noted. Payment for trench dewatering will be full compensation for furnishing, installing, maintaining of the trench dewatering, and all appurtenances necessary for the proper operation of trench dewatering.

4.34 SANITARY SEWER TEMPORARY BYPASS

Sanitary sewer temporary bypass shall be measured by lump sum for the work.

The furnishing, installing, operating, and maintaining of sanitary sewer temporary bypass shall be paid for at the contract lump sum price for the sanitary sewer temporary bypass furnished and accepted. Payment for sanitary sewer temporary bypass will be full compensation for furnishing, installing, operating, and maintaining of the sanitary sewer temporary bypass system and all appurtenances necessary for the proper operation of sanitary sewer temporary bypass. Payment for sanitary sewer temporary bypass will be included with the payment for the price per lineal foot of pipe or manholes unless otherwise noted on the drawings or Special Provisions.

4.35 MANHOLE MARKERS

Manhole markers shall be measured by each unit furnished and installed.

The furnishing and installing of manhole markers shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole markers will be full compensation for furnishing and installing of the manhole markers, concrete, and all appurtenances necessary for the proper installation of the manhole markers.

4.36 JACKING, BORING, AND TUNNELING

The basis of measurement shall be by the lineal foot for casing pipe, linear foot for carrier pipe, each for end seals, each for casing spacers, and each for boring obstructions. The measured length of carrier and casing pipe shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of casing pipe and carrier pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. The furnishing and installing of end seals and casing spacers shall be paid for at the contract unit price per each for the types and sizes furnished and accepted.

Payment for casing pipe will be full compensation for furnishing and installing of the casing pipe by boring, jacking or tunneling, excavation and backfilling of bore pits, welding, trench dewatering (unless otherwise specified), and all appurtenances necessary for the proper installation of the casing pipe.

Payment for carrier pipe will be full compensation for furnishing and installing of the carrier pipe, gaskets, grouting of the annular pipe space (unless otherwise specified), and all appurtenances necessary for the proper installation of the carrier pipe.

Payment for the end seals and casing spacers will be full compensation for furnishing and installing of the end seals and all appurtenances necessary for the proper installation of the end seals and casing spacers.

Payment for boring obstruction will be full compensation for the labor, equipment, and materials needed for removal of the obstruction. Payment for boring obstructions will be paid only for boring operations with mechanical equipment. If the project work is performed by a hand-mining operation, all such obstructions will be considered part of the normal operation and will not be paid for as a boring obstruction.

A boring obstruction shall be defined as any rock, boulder, etc., or similar material, which is encountered during the excavation that cannot be removed by the boring machine and requires shutdown of the equipment for removal. The Contractor shall be aware that all quantities are estimates and that there may be no obstructions or could be a large number of obstructions on the project. The Contractor will only be paid for obstructions encountered and reported to and verified by the Engineer. The bid item quantities are not guaranteed items.

4.37 MANHOLE CONSTRUCTION PLATE MARKER

Manhole construction plate markers shall be measured by each unit furnished and installed. The project quantity for manhole construction plate markers shall be measured for each location the manhole construction plate markers are used. Measurement will be made twice at locations where new manholes are installed at existing manhole locations. Only one measurement will be made at existing manhole reconstruction locations.

The furnishing and installing of manhole construction plate markers shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole construction plate markers will be full compensation for furnishing, installing, and removal of the manhole construction plate marker and all appurtenances necessary for the proper installation of the manhole construction plate marker.

4.38 MANHOLE BENCH AND INVERT RECONSTRUCT

Manhole bench and invert reconstruct shall be measured by each unit furnished and installed.

The furnishing and installing of manhole bench and invert reconstruct shall be paid for at the contract unit price per each furnished and accepted. Payment for manhole bench and invert reconstruct will be full compensation

for furnishing, installing, and removal of the manhole bench and invert, and all appurtenances necessary for the proper installation of the manhole bench and invert.

4.39 SANITARY SEWER SPOT REPAIR

Sanitary sewer spot repair shall be measured by each unit furnished and installed.

The furnishing and installing of the sanitary sewer spot repair shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer spot repair will be full compensation for furnishing, installing, and removal of the defective pipe section, and all appurtenances necessary for the proper installation of the sanitary sewer spot repair.

4.40 SANITARY SEWER PIPE LINING REPAIRS

Sanitary sewer pipe lining repairs shall be measured by each unit furnished and installed.

The furnishing and installing of the sanitary sewer pipe lining repairs shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer pipe lining repairs will be full compensation for furnishing and installing the liner pipe, pipe cleaning, pre- and post-inspections, and all appurtenances necessary for the proper installation of the sanitary sewer pipe lining repair.

4.41 SANITARY SEWER FORCE MAIN TRACER WIRE

Sanitary sewer force main tracer wire shall be measured by lineal foot of wire furnished and installed. The measured length shall be rounded up to the nearest 1-foot increment.

The sanitary sewer force main tracer wire shall be paid for at the contract unit price per lineal foot furnished and installed. Payment for sanitary sewer force main tracer wire will be full compensation for furnishing, installing, and all appurtenances necessary for the proper installation of the sanitary sewer force main tracer wire.

4.42 SANITARY SEWER FORCE MAIN TRACER WIRE TERMINAL BOX

Sanitary sewer force main tracer wire terminal boxes shall be measured by each unit furnished and installed.

The furnishing and installing of the sanitary sewer force main tracer wire terminal box shall be paid for at the contract unit price per each furnished and accepted. Payment for sanitary sewer force main tracer wire terminal box will be full compensation for furnishing, installing, and all appurtenances necessary for the proper installation of the sanitary sewer force main tracer wire terminal box.

City of Canton
Supplemental Standard Specifications
for
Storm Sewer Construction
Section 200

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SECTION 200
CITY OF CANTON SUPPLEMENTAL STANDARD
SPECIFICATIONS FOR STORM SEWER
CONSTRUCTION

1.0 GENERAL

1.1 SCOPE OF WORK

The Contractor shall furnish all the necessary labor, materials, equipment, tools and supplies that are necessary to install a complete storm sewer system, as shown on the plans and/or called for in these specifications or its addenda. It is the intent of these specifications to install a complete system or job.

1.2 TERM OF WARRANTY

See Section 500 for warranty construction activity.

1.3 PAYMENT

Payment to the Contractor shall be made in accordance with the General Conditions.

1.4 FINAL ACCEPTANCE

Acceptance of the work shall be in accordance with the General Conditions.

1.5 REFERENCES

- A. Standard Specifications for Road and Bridges produced by SDDOT.
- B. American Society of Testing Materials.
- C. Polyvinyl Chloride (PVC) Pipe.

All pipe for storm sewer piping shall conform insofar as appropriate, to the City of Canton Supplemental Standard Specifications for Sanitary Sewer, Section 100

2.0 MATERIALS

2.1 STORM SEWER PIPE

- 2.1.1 Reinforced Concrete Pipe: Reinforced concrete storm sewer pipe shall conform to the Standard Specifications for Road and Bridges produced by SDDOT and ASTM C-76.
- 2.1.2 Corrugated Metal Pipe: Corrugated metal pipe shall conform to the Standard Specifications for Road and Bridges produced by SDDOT and AASHTO M36 or M196. Corrugated metal pipe is only allowed in specified locations or rural roadway sections.
- 2.1.3 Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: PVC pipe 15 inches in diameter or smaller shall meet the requirements of ASTM D-3034, Type PSM, SDR 35 minimum; PVC pipe 18 inches through 30 inches in diameter shall meet the requirements of ASTM F 679, minimum wall thickness T-1. The pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 12364 C or 13364 B.

Storm sewer pipes and bends installed at a depth of greater than 14 feet shall be SDR 26. All other bends shall be SDR 35 minimum.

Polyvinyl chloride (PVC) is allowed only in specified locations.

- 2.1.4 Corrugated Polyethylene Pipe, Smooth Wall (Corrugated Polyethylene Pipe, Type S): Polyethylene pipe shall conform to requirements of the Standard Specifications for Road and Bridges produced by SDDOT, 12 inches to 30 inches diameter, and AASHTO M294.

2.2 PIPE JOINT MATERIALS

- 2.2.1 Reinforced Concrete Pipe: If concrete pipe tongue and groove joints are tight and true, as determined by the Engineer, they need not be grouted; but when such joints are open and/or skewed, they shall be mortared both inside and outside. The specified joints shall be jointed with cement mortar composed of one (1) part Portland cement and two (2) parts of sand and enough water to make a workable mixture, unless otherwise stipulated on the plans or by the Special Information. All lift holes in RCP Storm Sewer shall be plugged with a concrete mortar plug and sealant or with a flexible butyl lift hole patch. All RCP storm sewer pipe joints shall be sealed with mastic material or butyl rope.

- 2.2.2 Corrugated Metal Pipe: Corrugated metal pipe shall be jointed using either one or two-piece corrugated coupling bands of same diameter and gauge as the pipe unless otherwise shown on the plans or specified.
- 2.2.3 Polyethylene Pipe, Type S: Polyethylene Pipe, Type S, shall have separate manufacturer coupling bands or the pipe will be manufactured with a bell and spigot joint system.
- 2.2.4 Polyvinyl Chloride Sewer Pipe: PVC Sewer Pipe shall have a flexible elastomeric seal (O ring or rubber sealing joint), and conform to the latest revisions of ASTM D3212. Solvent cement joints shall not be allowed for pipe and fittings.

Polyvinyl Chloride (PVC) Pipe, AWWA C905. PVC AWWA C905 Pipe joints shall conform to the same standards as PVC Sewer Pipe.

2.3 STRUCTURES

Curb-type drop inlets and junction boxes shall be constructed in accordance with the standard plates or as detailed on the construction drawings.

2.3.1 Structure Adjusting Rings.

- 2.3.1.1 Bricks and Blocks: Bricks, blocks, or shimming devices will not be allowed for use in adjusting manholes.
- 2.3.1.2 Concrete adjusting rings: Concrete adjusting rings shall be in accordance with ASTM C478. The inside diameter of the ring shall be 24 inches.
- 2.3.1.3 Sealant: Butyl Rubber Sealant in trowelable form shall be used. EZ-STIK #3 as manufactured by Pre-seal Gasket Corporation or approved equal. The material must meet or exceed the requirements of Federal Specification TT-S-001657, ASTM C-990 and AASHTO M-198.
- 2.3.1.4 Plastic Adjusting rings: The adjusting rings shall be injection molded HDPE as manufactured by Ladtech, Inc. or approved equal. The adjusting rings shall be manufactured from polyethylene plastic as identified in ASTM D-1248 (Standard Specification for Polyethylene Plastic Molding and Extrusion Materials). Material properties shall be tested and qualified for usage in

accordance with the ASTM Test Methods referenced in ASTM D-1248. The plastic adjusting rings shall be manufactured utilizing the injection molding process as defined by SPE (Society of Plastic Engineers). The adjusting rings shall be tested to assure compliance with impact and loading requirements in accordance with the AASHTO Standard Specification for Highway Bridges. The adjusting rings shall meet and exceed the static load requirements of AASHTO highway Bridge Specification HS-25 (21,280 lbs). The rings must withstand 1,000,000 plus full load cycles of 10 seconds or less duration. The rings must perform without failure to a minimum of 150 percent of these load values. The adjusting rings shall be sized to conform to the standard 24-inch manhole opening.

2.3.1.5 Mortar: Mortar shall be Standard Portland Cement Type I, hydrated lime, and clean, sharp, well-graded sand, free from foreign materials. The minimum design compressive strength shall be no less than 4000 psi.

2.3.2 Bedding Material

Bedding material shall meet the requirements as stated on the City of Canton Standard Plates.

On-site material may be used if approved by the Engineer.

2.3.3 Select Backfill Material

Select backfill material shall meet the requirements stated on the City of Canton Standard Plates.

On-site material may be used if approved by the Engineer.

3.0 CONSTRUCTION REQUIREMENTS

3.1 ALIGNMENT AND GRADE

The Engineer will furnish all the necessary line and grade stakes, benchmarks, or other necessary control. It is the responsibility of the Contractor to return all grade sheets prior to completion, final acceptance, and payment for the project. It is the responsibility of the Contractor to protect these stakes, and any replacement of stakes shall be at the expense of the Contractor. The Contractor shall carry line and grade into the trench by means of an approved laser beam system. At no time shall the Contractor or his employees change the

grade without approval of the Engineer. If underground interference is encountered at the assigned grade, the Contractor shall notify the Engineer and wait until he has determined the revised grade for the sewer. The Contractor shall periodically check the grade from the grade stake to pipe invert.

3.2 UNDERGROUND INTERFERENCE

The location of underground public or private utilities may be shown on the plans, as reported by the various utility companies and the City, but this does not relieve the Contractor of the responsibility of determining the accuracy or completeness of said locations. The Contractor shall determine the location of all underground ducts, conduits, pipes, cables, or structures which will be affected by the work, and shall take steps necessary to support and protect said structures by any means suitable to the owners of the structure involved and the Engineer. When necessary, the Contractor shall conduct operations as to permit access to the work site and provide time for utility work to be accomplished during the progress of the work.

Portions of utilities, which are found to interfere with the line and grade of the sewer, will be relocated, altered, or reconstructed by the owners, or the Engineer may order changes in the work to avoid interference. Such changes will be considered to be extra work and will be paid for through a change order. When the plans or specifications provide for the Contractor to alter, relocate, or reconstruct a utility, all costs for such work shall be included in the bid for the items of work necessitating such work unless a separate bid item is provided. Temporary or permanent relocation or alteration of utilities requested by the Contractor for the Contractor's convenience shall be the Contractor's responsibility, and the Contractor shall make all arrangements and bear all costs. In those instances where utility relocation or reconstruction is impractical, the Engineer may order a deviation from line and grade.

The Contractor shall be responsible for notifying the various utility companies if the Contractor's work will expose, affect, or endanger any existing utility. All cost of investigation and any necessary protection, support, removal, or relocation of said structures shall be included in the contract bid price for installing pipe or structures. The Contractor shall not begin construction until all utility companies have been contacted and their respective underground utilities have been located and marked.

The bid item "locating utilities" will be used to locate storm sewer connection services only if the service location marked exceeds the actual service location by 4 feet in either direction and additional

excavation is required. The bid item “verify utilities” will be used only when it is necessary to excavate down to the utility to determine if any vertical and/or horizontal conflicts exist between existing utilities and the proposed new sewer to be installed as shown on the plans. All costs of other exploratory investigation/excavation necessary for determining the location and depth of utilities shall be included in the contract bid price for installing pipe.

3.3 EXCAVATION

Excavation shall be classed as either earth or rock excavation. Rock excavation shall consist of solid rock lying in its natural bed, which requires fracturing for its removal, and boulders of one yard or more in volume. All other material shall be classed as earth excavation.

3.4 EARTH EXCAVATION

All sewers shall be built in open cut, except that where conditions warrant, the Engineer may permit the use of short tunnels.

Unless specified in the Special Provisions, earth excavation costs are included in the cost of placing the pipe.

The width of the trench shall comply with City of Canton Standard Plates.

3.5 SHEETING AND BRACING

If City, State, or Federal regulations dictate the necessity of sheeting, bracing, or pulling a trench box or shield, the cost of such sheeting, unless a special price is called for in the contract form, shall be included in the contract bid price for installing pipe.

3.6 EXCAVATION BELOW PIPE GRADE

If required, trench excavation below pipe grade shall be backfilled with bedding material approved by the Engineer and thoroughly tamped to provide a uniform and continuous bearing and support for the pipe.

3.7 EXCAVATION IN UNSTABLE OR UNSUITABLE SOIL

The Contractor shall notify the Engineer when material considered unstable for the pipe foundation is encountered and where additional support, stabilization and undercutting of the pipe trench are necessary. If the Contractor can not assure a product in accordance with the specifications, the Contractor may request the use of trench stabilization material and/or geotextile fabric where the trench base is not structurally adequate or otherwise unstable to provide a uniform

stable pipe foundation and requires additional undercutting for placement of trench stabilization material and/or geotextile fabric.

The undercutting and use of trench stabilization material and/or geotextile fabric shall only be approved for use in extreme conditions where it is obviously necessary. Approval for the limits of the payment lines for use of trench stabilization material and geotextile fabric must be obtained from the Engineer, prior to installation. If trench stabilization material and/or geotextile fabric is necessary to stabilize the trench foundation, they shall be installed by the Contractor at the unit bid prices for those respective items.

If geotextile fabric is used, it should be placed on the neutral soils and extended up the trench sidewalls to a level of at least the mid-point of the pipe. Placement of the fabric should then be followed by placement of the stabilization material.

The Contractor will be fully responsible for constructing the storm sewer on a stable base and any defects resulting from improperly preparing the pipe foundation shall be the Contractor's responsibility.

The Contractor will be required to furnish weigh tickets for trench stabilization material on a daily basis.

Pipe bedding material will always be required in addition to trench stabilization material where trench stabilization material is used.

3.8 ROCK EXCAVATION

All rock excavation shall be under one classification. It shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and also boulders that exceed one-cubic yard in volume.

When rock is encountered in the trench, it shall be stripped of earth and the Engineer shall be notified by the Contractor and given ample time to make a profile before removal operation begins.

Rock excavation will be to the trench limits of these Supplemental Standard Specifications, Section 4.3, for the specified pipe.

Procedures for rock removal operations shall be subject to the approval of the Engineer. The use of explosives shall be limited to the magnitude of the charge that will not cause damage to the adjoining property through shock vibrations or other stress loadings. Also, the Contractor shall provide adequate blanket protection to assure that there will not be fragments of rock or other debris flying through the air when discharging explosives. The Contractor shall employ personnel

certified to execute blasting operations.

The entire rock removal operations shall be the responsibility of the Contractor, including payment, for any damages caused by his operations. Adequate insurance protection, in addition to the standard liability insurance required, shall be purchased by the Contractor for payment of any damages that may be caused by the use of explosives.

Contractor shall obtain all necessary permits prior to commencing blasting operations.

3.9 DEWATERING

Pipe jointing shall be accomplished in a relatively dry trench condition. No joints may be connected under water. If ground water is encountered, the Contractor shall dewater the trench with suitable pumps and equipment. The cost of dewatering, unless a bid item is called for on the proposal, shall be absorbed in the contract bid price for installing pipe.

Water resulting from dewatering operation shall be disposed in a manner approved by the Engineer and South Dakota Department of Environmental and Natural Resources. It shall not be pumped onto private property without the property owner's approval. Any damage to property, either public or private, shall be rectified to the satisfaction of the owner and the City. All applicable permits must be obtained by the Contractor before the dewatering operation begins.

3.10 INSTALLATION OF PIPE

Sewer pipe shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe until the joints have been sealed and structure bases are adequately hardened.

Pipe shall be carefully installed to line and grade in accordance with line and grade stakes set by the Engineer so that the finished sewer will present a uniform bore. Any noticeable variations from true alignment or grade will be cause for rejection of the work.

All pipe shall be installed upgrade with spigot ends pointing in the direction of flow. The bottom of the trench shall be freed of all rocks and stones and shall be hand shaped and bedded with bedding material as specified and the pipe shall be in firm contact with the bedding material or earthen surface for its entire length. At each joint of bell and spigot pipe, a hole shall be dug of sufficient size so that the weight of the pipe will rest on the barrel of the pipe and not on the bells, and the bell hole shall not be compacted. All pipe must be properly fitted together as no chipping of bell or spigot will be allowed.

A suitable stopper shall be kept in the end of the pipe so as to prevent any dirt or water from entering during the progress of the work at all times. Any dirt, loose material, or cement mortar which may accumulate in the pipe shall be removed as the work progresses by means of a swab. The backfilling around the pipe shall be completed as per City of Canton Standard Plates. Whenever pipe is installed in rock trenches, it shall be bedded in select material of at least 12-inch depth.

3.11 PIPE JOINTS

Sewer pipe installed on a curve shall adhere to the manufacturer's recommendations depending upon the curve radius.

3.11.1 RCP Storm Sewer Pipe. All RCP storm sewer pipe shall be sealed with mastic material or butyl rope. Seating of pipe shall conform to manufacturer's recommendations.

3.11.2 Corrugated Metal Storm Sewer Pipe. All bands attaching corrugated metal pipes shall be drawn firmly together with bolts and shall firmly clamp each pipe to prevent separation of the pipe, as per manufacturer's recommendations.

3.11.3 PVC Storm Sewer Pipe. All PVC Sewer Pipe shall be jointed utilizing elastomeric gaskets as referenced in ASTM D3034 and ASTM F679 and meeting the requirements of ASTM D3212. All pipe, fittings, and joints shall be installed in full compliance with the recommended practices of the pipe manufacturer and as specified in the latest revision of ASTM D2321. The joint surfaces (external and internal) shall be wiped free of all foreign materials, and the spigot end shall be centered on grade into the bell end and the joint shall be properly seated in accordance with the manufacturer's recommendations. Any pipe that is field cut shall have a square end with beveled edge equal to a factory cut and all field repairs shall be performed per manufacturer's recommendations.

3.11.4 Corrugated Polyethylene Pipe, Type S.

All bands attaching polyethylene pipes shall be drawn firmly together and clamped per manufacturer's specifications to prevent separation of the pipe. If a bell and spigot pipe is used, the pipe shall be drawn together and seated per manufacturer's specifications.

3.12 ADJUST STRUCTURE

There shall be at least one two-inch adjusting ring, and a maximum of 14 inches of adjusting rings used on each junction box. Unless otherwise specified, the structure cover shall be set approximately 6 inches below the finished street elevation by the contractor, to be raised to finished grade elevation by the contractor prior to paving.

The installation for concrete adjusting rings shall be in accordance with the Standard Specifications for Roads and Bridges produced by the SDDOT unless otherwise specified. The structure frame and adjusting rings where concrete adjusting rings are used shall be set in a full bed of mortar to the elevation set by the Engineer as shown on the grade sheet. The mortar shall be tuck pointed between rings and shall not be applied to the inside diameter surface of the adjusting rings. Smearing of mortar on the inside of the adjusting rings will be cause for rejection of the work.

Plastic adjusting rings may be used in lieu of concrete adjusting rings. The plastic adjusting rings shall be installed as recommended by the manufacturer. No shims or other leveling devices, other than leveling rings provided by the manufacturer, will be permitted with use of the plastic adjusting rings. The annular space between the adjusting rings shall be sealed using an approved butyl rubber sealant. The first plastic adjusting ring on existing manholes may require leveling with concrete mortar and therefore the first plastic ring may be set in mortar.

3.13 FRAME AND COVER

Structure frame and covers shall be installed in accordance with the City of Canton Standard Plates or as specified.

3.14 CONNECTIONS TO EXISTING SEWERS

Wherever new storm sewers connect with existing storm sewers, the Contractor shall without extra compensation cut the necessary openings in the existing structures and make the connections thereto in a neat and workmanlike manner. The connections shall be made so as to make the joints around the entering storm sewers watertight.

The connection shall be constructed as not to obstruct the flow area of the main line storm sewer pipe.

3.15 STUBS FROM STRUCTURES FOR FUTURE EXTENSIONS

Futures from a structure shall be installed to the staked elevation. The extension shall be plugged as specified.

3.16 BEDDING AND BACKFILL

Bedding and backfill shall be performed as shown in the standard detail drawing.

3.17 USE AND REPAIR OF STREET

The Contractor shall carry on the work in such a manner as to interfere as little as possible with the use of the street for public travel, and as specified in the Special Provisions.

Wherever any paved gutters, pavements, graveled highways or street crossings or other improvements are interfered with or removed, they must be replaced by the Contractor or left in as good condition as previously existed. The Contractor shall also remove all surplus material leaving the streets clean and in good order.

No more than three hundred feet (300') of trench will be opened at any one time in advance of the complete construction of the sewers and the backfilling shall follow up the installation of the sewers.

All street repairs and cleaning shall be promptly performed as the work progresses. The Contractor shall not obstruct any street gutters but shall provide for the passage of surface water along the same at all times.

3.18 JACKING, BORING, AND TUNNELING

It shall be the responsibility of the Contractor to maintain the alignment and grade specified. The jacking, boring, and tunneling specifications shall be in accordance with the drawings and Special Provisions.

3.19 INSPECTION AND TESTING

3.19.1 General.

The Engineer shall have access at all times to all parts of the job and the Contractor must furnish such personnel, facilities, equipment, tools, and materials as are necessary to make whatever tests and inspection that are deemed necessary.

3.19.2 Pipe Testing.

The Engineer may require a test of specimens not to exceed five (5) percent of the quantity of pipe to be furnished in order to prove the acceptability of the pipe. The manufacturer shall provide an approved testing stand near the site of the plant.

3.19.3 Pipe Inspection.

Prior to being lowered into the trench, each pipe shall be carefully inspected by the Contractor and those not meeting the specified requirements shall be removed from the site immediately. Rejections may be made for any of the reasons as stated in the specifications for each specific type of pipe. Pipe having minor flaws not serious enough to cause rejection shall be installed so as to bring such flaws in the top half of the sewer. Pipe shall be protected during handling against impact, shocks, and free fall.

3.19.4 Television Inspection.

The City will perform an inspection of the completed sewer line within the two (2) year warranty period through the use of a television camera. The expense of the initial television inspection and one additional reinspection will be borne entirely by the City. If defective workmanship of material or construction is noted, the deficiency shall be corrected by the Contractor at no expense to the City. The City will perform additional television inspections to review if the repairs were made properly and in accordance with the specifications. The expense of any additional television inspections beyond the initial inspection and one additional reinspection will be borne entirely by the Contractor.

The Contractor shall be responsible for all related costs, including concrete or asphalt resurfacing if the street has been surfaced. The Contractor shall be required to repair all areas of deficiencies.

3.19.5 Cleaning.

The Contractor shall be responsible for all work necessary to make the sewer acceptable for usage including removal of all mud, silt, rocks, or blockages that might hinder the flow and make said sewer unacceptable for final acceptance and usage. Also included is all work necessary in the structures and all cleanup work required prior to final acceptance. Structures will have all concrete forms removed prior to final acceptance.

In the event that the line is not acceptable for televising, due to the Contractor's operations, the Contractor will be notified. It will be the Contractor's responsibility to make arrangements

to clean the sewer and make it acceptable for the television work.

3.19.6 Backfill Density Test.

The Contractor shall expose the compacted soil layers, as required by the Engineer, to enable the Engineer to perform density tests. The cost of exposing the soil layers for testing shall be incidental to the pipe and/or structure construction.

3.19.7 Quality Control and Submittals

Retesting of work required because of nonconformance to the specified requirements shall be performed by an independent firm based on the instructions of the Engineer. Payment for retesting performed during the contract period and during the warranty period will be charged to and will be the responsibility of the Contractor.

As required, shop drawings and data shall be submitted for, but not be limited to, the following items:

Structures, pipe, pipe fittings, bedding material, stabilization material, granular material, and any other pertinent information concerning construction materials that the Engineer deems necessary for the review of the materials used on the project in accordance with the specifications and drawings.

The Contractor shall submit three copies to the Engineer. The Contractor shall obtain shop drawing approval before any of the work related to that material is performed.

3.20 PIPE DEFLECTION

3.20.1 Pipe Deflection Test, Corrugated Polyethylene Pipe, Type S.

At the discretion of the Engineer, deflection testing will be performed by the Contractor. For pipe diameters through and including 24 inches in diameter, deflection testing is to be performed using a mandrel with at least five points approved by the Engineer. The diameter of the mandrel shall be as shown in the table below. The mandrel must be pulled through by hand without the use of excessive force. Pipe through which the mandrel does not pass shall be examined more closely to determine the reason for non-passage. For pipe diameters 30 inches and above, pipe diameters may be

physically measured by a means approved by the Engineer. Deflection testing shall be performed no earlier than thirty days after installation or upon completion of construction of the roadway or the development area to the final grading elevation, whichever occurs first. Pipe that is determined to be over deflected shall be removed and reinstalled if the pipe is not damaged, or replaced with acceptable pipe. All pipe exceeding the 5 percent deflection within the two-year warranty period shall be reinstalled or replaced by the Contractor at no additional cost to the Owner.

DEFLECTION TABLE

PIPE DIAMETER (Inches)	MANDREL DIAMETER (Inches)
12	11.01
15	13.77
18	16.52
24	22.02
	MINIMUM DIAMETER (Inches)
30	27.53

3.20.2 Polyvinyl Chloride (PVC) Pipe Deflection Test.

At the discretion of the Engineer, deflection testing will be performed by the Contractor.

Deflection tests shall be conducted after the final backfill has been in place at least 30 days. Deflection tests shall be made using a deflection gauge (mandrel) device or other approved method. The diameter of the deflection gauge device shall be 95 percent of the undeflected inside diameter of the flexible pipe. The Contractor shall be required to install the pipe in such a manner so that the diametric deflection of the pipe shall not exceed 5 percent. All pipe exceeding the 5 percent deflection within the two-year warranty period shall be reinstalled or replaced by the Contractor at no additional cost to the Owner.

4.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 REMOVAL OF STORM SEWER PIPE

The removal of sewer pipe shall be measured as lineal foot of pipe removed. The removal footage shall be rounded up to the nearest one-foot increment.

The removal of a sewer pipe shall be paid for at the contract unit price for each foot of sewer removed. Payment for removal of sewer pipe shall be full compensation for excavation, removal and disposal of the pipe and all appurtenances necessary for the proper removal of the pipe.

4.2 REMOVAL OF STORM SEWER STRUCTURE

The removal of a structure shall be measured as a unit for each structure removed.

The removal of a structure shall be paid for at the contract unit price for each structure removed. Payment for removal of a structure shall be full compensation for removal and disposal of the structure, frame and covers, and all appurtenances necessary for the proper removal of the structure.

4.3 ROCK EXCAVATION

The removal of rock shall be measured as cubic yards of rock removed. The cubic yards removed shall be rounded to the nearest 0.1 increment. All rock excavation shall be under one classification. The classification shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and /or blasting for its removal and also boulders that exceed one cubic yard in volume.

Pay lines for computing rock excavation shall be described as follows for trench widths:

Pipe Size	Trench Width Pay Limits
Pipe equal to or less than 24 inches in diameter	4 feet
Pipe greater than 24 inches in diameter	The outside pipe diameter plus 24 inches

Pay lines for computing depth of the rock excavation shall be described as the distance from top of rock to 12 inches below the pipe invert elevation. The top of the rock profile will be measured and determined by the Engineer and used to determine the rock quantities.

The accepted quantities of rock excavation shall be paid for at the contract unit price per cubic yard. Payment for rock excavation shall be full compensation for permits, excavation, blasting, removal and proper disposal of the rock offsite, and all appurtenances necessary for the

proper removal of the rock. Furnishing and installing suitable fill material to replace the rock removed (except in locations where bedding material is required) will be paid for with the Granular Material bid item.

4.4 SELECT BACKFILL MATERIAL

Select backfill material shall be measured and paid by the lineal foot. Material shall be measured from pipe end to end with no deduction for length through the structure. The measured length shall be rounded up to the nearest one-foot increment.

Payment for select material will be full compensation for furnishing and installing of the material and all appurtenances necessary for the proper installation of the select material.

4.5 ADJUST STRUCTURE

The furnishing and installing of structure adjustments shall be measured as a unit for the structure adjustment at each structure.

The furnishing and installing of adjusting rings shall be paid for at the contract unit price for each structure adjustment. Payment for adjust structure will be full compensation for furnishing and installing of the structure adjusting rings, sealant, mortar, and all appurtenances necessary for the proper installation of the structure adjusting rings. Structure adjustments will be paid for existing structures.

4.6 STORM SEWER PIPE

Storm sewer pipe shall be measured by the lineal foot of respective type, class, and size of pipe to the nearest foot.

4.7 BEDDING MATERIAL

Pipe bedding material shall be measured and paid by the lineal foot. Bedding material shall be measured from pipe end to end with no deduction for length through the structure. The measured length shall be rounded up to the nearest one-foot increment.

Payment for pipe bedding material will be full compensation for furnishing and installing of the pipe bedding material and all appurtenances necessary for the proper installation of the bedding material.

4.8 STRUCTURES

Structures shall be measured and paid for at the contract unit price of reinforcement steel, concrete, and castings.

4.9 JACKING, BORING, AND TUNNELING, POLYVINYL CHLORIDE (PVC) AND POLYETHYLENE

The basis of measurement shall be by the lineal foot for casing pipe, linear foot for carrier pipe, each for end seals, each for casing spacers, and each for boring obstructions. The measured length of carrier and casing pipe shall be rounded up to the nearest one-foot increment.

The furnishing and installing of casing pipe and carrier pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. The furnishing and installing of end seals and casing spacers shall be paid for at the contract unit price per each for the types and sizes furnished and accepted.

Payment for casing pipe will be full compensation for furnishing and installing of the casing pipe by boring, jacking or tunneling; excavation and backfilling of bore pits, welding, trench dewatering (unless otherwise specified) and all appurtenances necessary for the proper installation of the casing pipe.

Payment for carrier pipe will be full compensation for furnishing and installing of the carrier pipe, gaskets, grouting of the annular pipe space (unless otherwise specified) and all appurtenances necessary for the proper installation of the carrier pipe.

Payment for the end seals and casing spacers will be full compensation for furnishing and installing of the end seals and all appurtenances necessary for the proper installation of the end seals and casing spacers.

Payment for boring obstruction will be full compensation for the labor, equipment, and materials needed for removal of the obstruction. Payment for boring obstructions will be paid only for boring operations with mechanical equipment. If the project work is performed by a hand-mining operation, all such obstructions will be considered part of the normal operation and will not be paid for as a boring obstruction.

A boring obstruction shall be defined as any rock, boulder, etc., or similar material, which is encountered during the excavation that can not be removed by the boring machine and requires shut-down of the equipment for removal. The Contractor shall be aware that all quantities are estimates and that there may be no obstructions or could be a large number of obstructions on the project. The Contractor will

only be paid for obstructions encountered and reported to and verified by the Engineer. The bid item quantities are not guaranteed items.

4.10 JACKING, BORING, & TUNNELING, REINFORCE CONCRETE PIPE

The furnishing and installing pipe shall be measured and paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted.

Payment for pipe will be full compensation for furnishing and installing of the pipe by boring, jacking or tunneling; excavation and backfilling of bore pits, welding, trench dewatering (unless otherwise specified) and all appurtenances necessary for the proper installation of the casing pipe.

Payment for boring obstruction will be full compensation for the labor, equipment, and materials needed for removal of the obstruction. Payment for boring obstructions will be paid only for boring operations with mechanical equipment. If the project work is performed by a hand-mining operation, all such obstructions will be considered part of the normal operation and will not be paid for as a boring obstruction.

A boring obstruction shall be defined as any rock, boulder, etc., or similar material, which is encountered during the excavation that can not be removed by the boring machine and requires shut-down of the equipment for removal. The Contractor shall be aware that all quantities are estimates and that there may be no obstructions or could be a large number of obstructions on the project. The Contractor will only be paid for obstructions encountered and reported to and verified by the Engineer. The bid item quantities are not guaranteed items.

City of Canton
Supplemental Standard Specifications
for
Water Main Construction
Section 300

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Section 300

City of Canton Supplemental Standard Specifications for Water Main Construction

1.0 GENERAL

1.1 SCOPE OF WORK

The Contractor shall furnish all the necessary labor, materials, equipment, tools and supplies that are necessary to install a complete water main system, as shown on the plans and/or called for in these specifications or its addenda. It is the intent of these specifications to install a complete system or job.

1.2 TERM OF WARRANTY

Reference Section 500 – Warranty for Construction Activity.

1.3 QUALITY CONTROL AND SUBMITTALS

Retesting of work required because of nonconformance to the specified requirements shall be performed by the same independent firm on the instructions of the Engineer. Payment for retesting performed during the contract period and during the warranty period will be charged to and will be the responsibility of the Contractor.

Shop drawings and data shall be submitted for, but not be limited to, the following items:

Fire hydrants, pipe, pipe fittings, bedding material, stabilization material, granular material, and any other pertinent information concerning construction materials that the Engineer deems necessary for the review of the materials used on the project in accordance with the specifications and drawings.

The Contractor shall submit the number of copies that the Contract requires plus three copies which the Engineer will retain. The Contractor shall obtain shop drawing approval before any of the work related to that material is performed.

1.4 BIDS

Unless a lump sum is called for, bids shall be received on a unit price basis.

The unit price bid per lineal foot for water main shall include the complete construction with the tracer wire system and other items as specified, including trench dewatering when necessary. The lineal footage will be determined by measuring from the center of one fitting or valve to the center of the next fitting or valve. When PVC pipe is used, the price bid shall include the cost of encasing the fittings in polyethylene. When ductile iron pipe is used, the price bid shall include the cost of encasing the fittings and the pipe in polyethylene.

The unit price bid per cubic yard for rock excavation shall include all permits, labor, tools, equipment, explosives, protective mats, disposal of rock, and replacement backfill material.

1.5 PAYMENT

Payments to the Contractor shall be made in accordance with the General Conditions.

1.6 ACCEPTANCE

Acceptance of the work shall be in accordance with the General Conditions.

2.0 MATERIALS

2.1 WATER MAIN PIPE

Water main pipe and service lines 4 inches in diameter and greater shall be Ductile Iron or Poly Vinyl Chloride (PVC) with a push on joint. Pipe shall sustain a working pressure of 150 pounds per square inch (psi) with a minimum cover of 6 feet. Pipe classes shall be as follows:

Pipe Size (Inches)	Ductile Iron Thickness Class	PVC
4	52	C900 DR 18
6	52	C900 DR 18
8	50	C900 DR 18
12	50	C900 DR 18
16	50	Not Allowed
20	50	Not Allowed
24	50	Not Allowed

Ductile Iron

Ductile iron pipe shall meet the requirements of AWWA C150 and C151 and be lined with cement mortar in accordance with AWWA C104. Ductile iron pipe shall be coated on the outside with a 1-mil thick asphaltic coating. Rubber gasket joints for ductile iron pipe shall meet the requirements of AWWA C111.

PVC

PVC pipe shall meet the requirements of AWWA C900. Sealing pipe joints for PVC pipe shall use the Rieber joining system, which has the gasket formed into the pipe during the manufacturing process.

2.2 WATER MAIN FITTINGS

Fitting types applicable to this specification consist of bends, crosses, tees, reducers, plugs, caps, and sleeves. Ductile iron fittings shall meet the requirements of AWWA C110 or C153, with a minimum working pressure of 250 psi. Ductile iron fittings shall be mechanical joint meeting the requirements of AWWA C111, except as noted. Fittings shall be bid complete with gaskets, glands, bolts, and nuts. Bolts shall be fluorocarbon coated cor-ten steel t-bolts and nuts equal to NSS cor-blue or approved equal low alloy corrosion-resistant high-strength steel in accordance with ANSI/AWWA C111/A21.11. Fittings shall be lined with cement mortar in accordance with AWWA C104 and coated on the outside with a 1-mil thick asphaltic coating. Slip joint plugs are required to have "ears."

Acceptable manufacturers are American, Griffin, Sigma, Star, Tyler/Union, and U.S. Pipe.

2.3 MECHANICAL JOINT RESTRAINER DEVICES

Restraining mechanisms shall provide wedges or full circle contact and support of the pipe wall. Restraint shall be accomplished by a series of ring or wedge segments mechanically retained inside the gland housing and designed to grip the pipe wall in an even and uniform manner. Restraining devices shall be actuated by bolts featuring twist off heads to ensure proper installation torque is applied. All components of the restrainer, including the gland, bolts, and restraint segments, shall be of high-strength ductile iron, ASTM A536. Bolts shall be fluorocarbon coated cor-ten steel t-bolts and nuts equal to NSS cor-blue or approved equal low alloy corrosion-resistant high-strength steel in accordance with ANSI/AWWA C111/A21.11. Appropriate restrainer devices shall be supplied for the specific type of piping material being used on the project.

Restrainer devices shall be MEGALUG® by EBBA Iron, Uni-Flange® by The Ford Meter Box Company, Stargrip® by Star, or One Lok™ by Sigma. Restrainer devices for Ductile Iron Pipe can be Romac Industries “Romagrip.”

2.4 VALVES

Valves 4 inches through 12 inches shall be gate valves and valves 16 inches and larger shall be butterfly valves.

Gate and Tapping Valves

Gate and tapping valves shall meet the requirements of AWWA C509 or C515 and have a pressure rating of 250 psi. Valves shall be resilient seated and ferrous components shall be ductile iron. Gate valves shall be mechanical joint meeting the requirements of AWWA C111 and tapping valves shall have a mechanical joint end and a flanged end to correspond to the branch flange of the tapping sleeve. Bolts shall be fluorocarbon coated cor-ten steel t-bolts and nuts equal to NSS cor-blue or approved equal low alloy corrosion-resistant high-strength steel in accordance with ANSI/AWWA C111/A21.11.

All internal and external ferrous surfaces shall have a fusion bonded epoxy coating applied electrostatically prior to assembly meeting the requirements of AWWA 550. Valves shall have a ductile iron wedge encapsulated with nitrile rubber or an EPDM rubber compound. Stems shall be nonrising, bronze or stainless steel, and shall be sealed by three o-rings. Valves shall have a 2-inch ductile iron operating nut and open left (counter-clockwise). Bonnet and stuffing box bolts shall be stainless steel. Resilient seats shall be bonded or mechanically attached to the gate.

Acceptable manufacturers are American Flow Control Series 2500 or approved equal.

Butterfly Valves

Butterfly valves shall meet the requirements of AWWA C504, Class 150B for buried installation. Valves shall be the short body type, tight closing, have a pressure rating of 150 psi, and have mechanical joint ends meeting requirements of AWWA C111. Bolts

shall be fluorocarbon coated cor-ten steel t-bolts and nuts equal to NSS cor-blue or approved equal low alloy corrosion-resistant high-strength steel in accordance with ANSI/AWWA C111/A21.11. Valve body and disc shall be cast or ductile iron. The disc shall have a stainless steel edge and seat at 90 degrees to the pipe axis. The shaft shall be stainless steel. The seat shall be located in the valve body and be Buna-N. Valves shall be complete with a manual operator and a 2-inch square operating nut suitable for buried service. Valves shall open right (clockwise).

Acceptable manufacturers are DeZURIK, M&H/Clow, Mueller, and Pratt.

2.5 FIRE HYDRANTS

Fire hydrants shall be dry barrel and meet the requirements of AWWA C502. The rated working pressure shall be 250 psi and the rated test pressure shall be 500 psi. The nozzle section, upper and lower barrels, and the hydrant base shall be ductile or gray iron. The main valve closure shall be of the compression type, opening against the pressure and closing with the pressure. The main valve opening shall not be less than 5¼ inches and be designed so that removal of all working parts can be accomplished without excavating.

The bronze seat shall be threaded into mating threads of bronze for easy field repair. The draining system of the hydrant shall be bronze and be positively activated by the main operating rod. All threads shall be National Standard threads. Internal travel stop nut shall be bronze or zinc plated steel. Hydrant operating threads to be factory lubricated and sealed from the waterway with o-rings. Operating nuts shall be pentagon shaped and measure 1½ inches point to flat. Hydrants shall open left (counter-clockwise).

Hydrants shall have a 6-inch mechanical joint inlet and the barrel shall be sized for a trench depth of 7 feet. Hydrants shall have two 2½-inch hose nozzles and one 4½-inch pumper nozzle, all located on the same horizontal plane. The centerline of the nozzles shall be a minimum of 18 inches above the ground line groove. Nozzle cap nuts shall be the same dimension and shape as the operating nuts described above, and the nozzle caps shall be furnished with security chains. The section of the hydrant above ground shall be painted Canton RED. Hydrants shall be capable of being extended in 6-inch increments and shall be equipped with traffic features that include a breakaway flange and stem with a shaft coupling.

All buried body parts are to be 304 Stainless steel. Bolts shall be fluorocarbon coated cor-ten steel t-bolts and nuts equal to NSS cor-blue or approved equal low alloy corrosion-resistant high-strength steel in accordance with ANSI/AWWA C111/A21.11

Fire hydrants shall be the Waterous Pacer WB-67-250 by American Flow Control or approved equal.

2.6 VALVE BOXES

Valve boxes shall be cast iron and screw-type adjustable with a 5¼-inch shaft. Lids shall be standard drop type labeled "WATER" with a 1½-inch long skirt.

Valve boxes shall be Mueller H-10360, Buffalo Type or equal, 5-1/4" shafts, two piece, screw type, extension length as required. Valve boxes shall include a Valve Box Adapter II by Adapter Inc., or equal operating nut centering device.

2.7 TRACER WIRE

The components of the tracer wire system shall be suitable for direct bury applications. The conductor shall be 12 AWG, solid-strand, soft-drawn copper per ASTM B-3. The conductor shall be insulated with high molecular weight polyethylene. The minimum insulation thickness shall be 0.045 inches and the color shall be blue. Splices and/or connectors shall be capable of handling from two to four wires per connection and be designated at "water proof." Ground rods shall be a 3/8-inch diameter, 60-inch-long steel rod uniformly coated with metallicly bonded electrolytic copper. Ground rod clamps shall be a high-strength, corrosion-resistant copper alloy.

Acceptable manufacturers of the tracer wire are Coleman Cable, Kris-Tech Wire, or an approved equal. Splice kits/connectors shall be Scotchlok™ DBY by 3M, LV 9000 by SNAPLOC™, or an approved equal.

2.8 INSULATION

Water main insulation shall be an extruded polystyrene board and meet the requirements of ASTM C578, Type IV. The minimum R-value shall be 5.0 as determined by ASTM C518. The minimum compressive strength shall be 25 psi as determined by ASTM D1621. The maximum water absorption shall be 0.1 percent by volume as determined by ASTM C272. The maximum water vapor permeance shall be 1.1 perm as determined by ASTM E96.

Water main insulation shall be STYROFOAM™ Square Edge by the Dow Chemical Company, STYROFOAM™ Brand Scoreboard by the Dow Chemical Company, or an approved equal.

2.9 CASING PIPE SPACERS AND END SEALS

Casing spacers shall be Model SSI-8 for carrier pipes 24 inches in diameter and smaller and Model SSI-12-2 for carrier pipes 30 inches in diameter and greater as manufactured by Advance Products & Systems, Inc., Lafayette, Louisiana, or an approved equal. Casing spacers shall be constructed of circular T-304 stainless steel segments, which bolt together forming a shell around the carrier pipe. The spacers shall be designed with risers (when needed) and runners to support and center the carrier pipe within the casing pipe and maintain a minimum clearance of 1 inch between the casing pipe inside diameter (ID) and the spacer outside diameter (OD). On carrier pipes

with an OD of 16 inches or less, each spacer shall have four riser/runner combinations—two on each half. On carrier pipes with an OD of 20 inches and greater, the number of riser/runner combinations shall be as recommend by the manufacturer, with four being the minimum. T-304 stainless steel bolts and nuts shall be supplied with the spacers.

The band shall be manufactured of 8-inch (SSI-8) or 12-inch (SSI-12-2) wide, 14 gauge T-304 stainless steel. The risers shall be constructed of T-304 stainless steel having a minimum length of 6 inches (SSI-8) or 10 inches (SSI-12-2). Abrasion-resistant runners, having a minimum length of 7 inches (SSI-8) or 11 inches (SSI-12-2), and a minimum width of 2 inches, shall be attached to each riser to minimize friction between the casing pipe and the carrier pipe as it is installed. Runner material shall be of glass reinforced plastic with the following minimum properties: compression strength of 25,000 psi, flexural strength of 32,000 psi, and tensile strength of 22,000 psi. The ends of all runners shall be beveled to facilitate installation over rough weld beads or the welded ends of misaligned or deformed casing pipe.

Interior surfaces of the stainless steel shell shall be lined with EPDM having a minimum thickness of 0.090 inches with a hardness of durometer “A” 85-90. Placement of the spacers shall be a maximum of one foot on each side of the bell joint and one every 6–8 feet thereafter. End seals shall be Model AW Wraparound casing end seals as manufactured by Advance Products & Systems, Inc., Lafayette, Louisiana, or an approved equal. Full conical-shaped wraparound seals made of 1/8-inch-thick neoprene rubber shall be provided for each end of the casing pipe. T-304 stainless steel banding straps with a 100 percent nonmagnetic worm gear mechanism and pressure sensitive butyl mastic strips shall be provided to seal edges.

2.10 SELECT FILL AND WATER MAIN BEDDING

The material for standard water main bedding shall be a clean washed sand. The material for select fill shall be minus 1 inch with not more than 10 percent passing the No. 200 sieve. The select fill will be bid per ton and will only be used on a limited basis for replacement material to aid in gaining acceptable trench compaction. Water main bedding material will be used for both PVC and ductile iron water main.

2.11 TRENCH STABILIZATION MATERIAL

The material for trench stabilization shall consist of ¾- to 4-inch crushed angular, well-graded material. Larger material may be used if necessary to stabilize the bottom of the trench. The trench stabilization material will be used as directed by the Engineer. The use of trench stabilization material will not eliminate the need for water main bedding material.

2.12 VALVE BOX MARKERS

Valve box markers shall be a minimum of 3¾ inches wide and 78 inches in length. The markers shall be blue in color. The markers shall be ultraviolet resistant and stable in all weather conditions. The markers shall be Composite Composition Utility Markers as

manufactured by Carsonite International or approved equal. The markers shall be labeled "CAUTION WATER PIPELINE—CALL BEFORE DIGGING."

2.13 WATER SERVICES

Water service lines 2 inches in diameter and smaller shall be U.S. Government Type K soft copper tubing. Tubing material for Type K soft copper shall be 1¼ inches in diameter and smaller shall be supplied in 60-foot single or double pancake coils, with the minimum diameter of the center coil to be 16 inches. Tubing material for Type K soft copper 1½ inches in diameter and greater shall be supplied in 20-foot lengths with the ends of the tubing cut off evenly. Fittings and valves shall meet the requirements of AWWA C800 and ASTM B62 for Type K soft copper. All connections shall be made with flared copper fittings.

SDR17 Certa-Lok Yelomine Restrained Joint PVC pipe may be used for services 2 inches and smaller when the service is located outside of City right-of-way or easement..

Approved manufacturers of copper tubing are Cerro, Mueller, Halstead, and Wolverine. Approved manufacturer of restrained joint PVC pipe is CertainTeed.

Water service lines 4 inches in diameter and greater shall be ductile iron or C900 PVC pipe as specified in Section 2.1. Water service lines greater than 2 inches in diameter that extend vertically through building floors shall be ductile iron pipe as specified in Section 2.1.

Corporation stops shall be installed with a pipe saddle. Saddles shall be Ford S90 or approved equal.

Corporation Stops shall be Ford Ballcorp Corporation Stop or approved equal. Match size of service line.

Curb Stops shall be Ford Ball Valve Curb Stop with Minneapolis Pattern Valve or approved equal.

Curb boxes with shut-off rods shall be Minneapolis pattern base, length 6-1/2 feet, size 1-1/4 inch.

3.0 CONSTRUCTION REQUIREMENTS

3.1 INTERRUPTION OF SERVICE

No valve or other control on the existing water distribution system shall be operated for any purpose by the Contractor. The Contractor shall notify all consumers affected by any interruption of water service at least 24 hours before the interruption of water service. Consumers shall be verbally notified when possible. In the event a consumer cannot be verbally notified, the Contractor shall secure a door hanger provided by City to the most frequently used entrance.

3.2 ALIGNMENT

The Engineer will stake all water main alignment and inspect all water main installation. **All fittings, valves, hydrant extensions, etc., will be left open until inspected and measured by the Engineer.** When necessary, the Engineer will provide grade stakes for alignment. The Contractor shall carry line and grade into the trench by means of approved survey methods.

At no time shall the Contractor or his employees change the grade without approval of the Engineer. If underground interference is encountered at the assigned grade, the Contractor shall notify the Engineer for alternate alignment.

The Contractor shall furnish help when requested to stake and measure water main.

3.3 UNDERGROUND INTERFERENCE

The location of existing underground public or private utilities may be shown on the plans, as reported by the various utility companies and the City, but this does not relieve the Contractor of the responsibility of determining the accuracy or completeness of said locations. The Contractor shall determine the location of all underground ducts, conduits, pipes, or structures which will be affected by the work, and shall take steps necessary to support, protect, remove, or relocate said structures by any means suitable to the owners of the structure involved and the Engineer. In those instances where their relocation or reconstruction is impracticable, a deviation from line and grade may be ordered by the Engineer. The Contractor shall be responsible for notifying the various utility companies if the Contractor's work will expose, affect, or endanger any existing utility. All cost of investigation and any necessary protection, support, removal, or relocation of said structures shall be included in the contract bid price for installing water main unless specifically provided for in the bid items. The Contractor shall not begin construction until all utility companies have been contacted and their respective underground utilities have been located and marked.

The bid item "locating utilities" will be used to locate water lines only if the service location marked exceeds the actual service location by 4 feet in either direction and additional excavation is required. The bid item "verify utilities" will be used only when it is necessary to excavate down to the utility to determine if any vertical and/or horizontal

conflicts exist between existing utilities and the proposed new water lines to be installed as shown on the plans. All costs of other exploratory investigation/excavation necessary for determining the location and depth of utilities shall be included in the contract bid price for installing pipe.

3.4 EXCAVATION

Trenches shall be excavated on lines furnished by the Engineer. Excavation shall be classed as either rock or earth excavation. Rock excavation shall consist of solid rock lying in its natural bed which requires fracturing for its removal, as defined under "Rock Excavation," and boulders one cubic yard in volume or greater. All other materials shall be classed as earth excavation.

Rock Excavation

All rock excavation shall be under one classification. It shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and boulders one cubic yard in volume or greater.

When rock is encountered in the trench, it shall be stripped of earth and the Engineer shall be notified by the Contractor and given ample time to make a profile thereof, before removal operation begins, to determine quantities. Prior to installing water main through a rock excavation, a 6-inch cushion of bedding material will be placed to protect the pipe.

Procedures for rock removal operations shall be subject to the approval of the Engineer. The use of explosives shall be limited to the magnitude of the charge that will not cause damage to the adjoining property through shock vibrations or other stress loadings. In addition, the Contractor shall provide adequate protection to ensure that there will not be fragments of rock or other debris flying through the air when discharging explosives. The entire rock removal operation shall be the responsibility of the Contractor and the Contractor shall pay for any damage caused by the rock removal operations. Adequate insurance protection, in addition to the standard liability insurance required, shall be purchased by the Contractor for payment of any damage that may be caused by the use of explosives. Contractor shall obtain all necessary permits prior to commencing blasting operations.

Earth Excavation

Water mains shall be installed using the open cut method, except that where conditions warrant, the Engineer may permit the use of short tunnels. In unstable soil, the trench shall be supported by shoring or sheeting as required to prevent caving. Sheeting shall be withdrawn after the pipe has been properly covered.

Wherever, in the opinion of the Engineer, the bottom of the trench does not afford a reliable or suitable foundation, the trench shall be excavated to such additional depth as is required and replaced with trench stabilization material. Pipe bedding material will always be required in addition to trench stabilization material.

3.5 SHEETING AND BRACING

If City, state, or federal regulations dictate the necessity of sheeting, bracing, or pulling a trench box or shield, the cost of such sheeting, unless a special price is called for in the contract proposal form, shall be included in the contract bid price for installing water main.

3.6 DEWATERING

Water main installation shall be accomplished in a relatively dry trench. Joints shall not be connected under water. If ground water is encountered, the Contractor shall dewater the trench with suitable pumps and equipment. Lowering of the groundwater level shall be by means of wells, well points, or other suitable means.

Water resulting from the dewatering operation shall be disposed of in a manner approved by the Engineer and South Dakota Department of Environment and Natural Resources (DENR). It shall not be pumped onto private property without the property owner's approval. Any damage to property, either public or private, shall be rectified to the satisfaction of the owner and the City. If dewatering operations are expected, construction documents shall describe methods for providing temporary erosion control devices or note that a dewatering permit has been issued by the South Dakota DENR.

3.7 WATER MAIN

Water main shall be installed in the locations shown on the plans or as directed by the Engineer. Ductile iron water main shall be installed in accordance with AWWA C600 and PVC water main shall be installed in accordance with AWWA C605. Ductile iron water main shall be encased in polyethylene in accordance with AWWA C105. Water main shall not be installed in frozen ground or in water, and no water will be allowed to run into or through the pipe. Before installing water main, it shall be cleaned of all foreign matter and kept clean thereafter. Open ends shall be protected at all times to prevent the entrance of dirt, trench water, animals, or foreign matter into the pipe. The bell and spigot shall be wiped clean and sufficient lubrication placed on the gasket and spigot before the pipe is pushed fully into the bell. The lubricant shall be approved for use with potable water.

Field cut spigot ends of push-on joints shall have a square end with beveled edge equal to a factory cut prior to being pushed into the bell. Every pipe shall be bedded uniformly throughout its length with water main bedding material. Reference Standard Detail Plate 900.12 for water main bedding installation. Care shall be taken to not have any part of the pipe bearing on rocks or stones. Water main shall have a minimum of 6 feet of cover unless otherwise noted on the plans. If 6 feet of cover cannot be achieved/maintained, the Engineer shall be notified. If less than 4 feet of cover is expected, insulation shall be used to protect the water main from freezing. Cover between 4 and 6 feet will be evaluated on a case-by-case situation for insulation requirements. Whenever insulation is required for water main, individual water services should be evaluated for insulation requirements. The insulation work shall be in accordance with the special provisions, drawings, and manufacturer's recommendations.

Extra depth water main shall be installed in the locations shown on the plans or as directed by the Engineer. Extra depth water main is water main that is installed using the open cut method resulting in 8 feet or more of cover as measured from the top of pipe to the finished surface elevation. Water main installed with 6 to 8 feet of cover is considered normal depth water main installation.

3.8 VALVES AND FITTINGS

Valves and fittings shall be installed at the locations shown on the plans or as directed by the Engineer. Valves and fittings shall be installed in accordance with AWWA C600 and encased in polyethylene in accordance with AWWA C105. Valve and fitting locations shall be field verified and recorded on the as-built drawings by the Engineer. Valves and fittings shall remain exposed until the Engineer has visually inspected and measured the as-built locations.

Proper concrete blocking shall be installed under all valves. In addition, valves 12 inches in diameter and greater shall be installed with two restrainer devices per valve. A valve nut extension shall be installed on valves with more than 8 feet of cover as measured from the top of the pipe to the finished surface elevation. Gate valves in PVC water main shall be installed in conformance with Standard Detail Plate 900.08.

3.9 FIRE HYDRANTS

Fire hydrants shall be installed at the locations shown on the plans or as directed by the Engineer and in accordance with AWWA C600. The centerline of the nozzles shall be a minimum of 18 inches above the finished surface elevation. The bottom of the breakaway flange shall be 2 to 4 inches above the finished surface elevation. Fire hydrants shall be installed 2 feet behind the back of curb, stand plumb, and have their nozzles parallel with or at right angles to the street center line, with the pumper nozzle facing the street.

Flushing hydrants installed for testing purposes shall be removed once testing has been completed. If the flushing hydrants will remain in place for the duration of a winter season, they shall be installed behind proposed curb and gutter.

Hydrant leads shall be a minimum of 6 inches in diameter and have a gate valve located as close as possible to the tee. Hydrant lead valve shall be attached to the tee with $\frac{3}{4}$ -inch threaded rods. In situations where it is not appropriate to have the valve located close to the tee, the valve should be at least 30 feet from the fire hydrant. Restrainer devices will be required on all vertical bends. Hydrants shall be set on a concrete block to prevent settlement. Sufficient size concrete thrust blocks shall be installed against undisturbed soil to prevent.

Hydrant bases shall be backfilled with a minimum of $\frac{1}{3}$ cubic yard of $1\frac{1}{2}$ -inch crushed rock to facilitate drainage. The crushed rock shall extend to 6 inches above the weep hole and be covered with two layers of heavy felt paper or heavy construction plastic. Before installing the ground rod or tracer wire, the fire hydrant barrel shall be encased in polyethylene up to the ground surface. The weep holes shall not be covered by the polyethylene. A 60-inch ground rod shall be taped to the fire hydrant barrel at a

minimum of four locations and be extended to the bottom of the breakaway flange. Tracer wire shall be attached to the bottom of the ground rod. Fire hydrants and the tracer wire system shall be installed in conformance with Standard Detail Plates 900.06 and 900.07.

3.10 VALVE BOX MARKERS

Valve markers shall be installed for all valves outside of the street right-of-way that are not in paved areas unless otherwise indicated. Valve box markers shall be installed in conformance with Standard Detail Plate 900.13.

3.11 POLYETHYLENE ENCASEMENT

All buried ductile iron water main, fittings, valves, rods, and appurtenances shall be encased in polyethylene in accordance with AWWA C105, Method A. The polyethylene shall be cut 2 feet longer than the pipe section and shall overlap the ends of the pipe by 1 foot. The polyethylene shall be gathered and lapped to provide a snug fit and shall be secured at quarter points and each end with polyethylene tape.

The polyethylene shall prevent contact between the pipe and bedding material, but is not intended to be a completely airtight and watertight enclosure. Damaged polyethylene shall be repaired in a workmanlike manner using polyethylene tape or shall be replaced. The polyethylene encasement is considered to be a part of the price bid for the water main.

3.12 CONNECTIONS TO EXISTING WATER MAIN

Water main shall be connected to and extended by utilizing three different methods: removal of an appurtenance and extending, cutting in an appurtenance and extending, or smith tapping and extending. When a water main needs to be connected, a method that will minimize the interruption of service to surrounding properties should be utilized. When a connection is made utilizing methods other than smith tapping, the Contractor shall have all materials for the connection on site, and to the extent possible, shall have fittings assembled and tied prior to cutting the existing water main and making the connection. When necessary, pipe cutting shall be neat and completed in a workmanlike manner without damage to the pipe, interior lining, or exterior coating. Cutting shall be performed with an approved mechanical cutter, using a wheel cutter when applicable and practical.

When a smith tap connection is necessary, the Contractor will furnish the tapping sleeve and valve and complete the tap. The Contractor will be responsible for excavating and backfilling the trench for completion of the tapping process and for furnishing and installing the tapping sleeve, valve, and valve box.

3.13 SERVICE CONNECTIONS

All service connections or taps to the water main system shall be made by the Contractor. Service taps to new or existing water mains will not be permitted until the subject water main has passed the necessary disinfection requirements as specified within this document.

Where new service line pipe and curb boxes are installed for future connections, the Contractor shall furnish and install a 6-foot metal t-post next to the curb box for location purposes. The top 12-inches of the t-post shall be painted blue. The cost of furnishing and installing the t-post shall be incidental to the installation of the curb stop and box and no separate measurement or payment for the t-post shall be made.

3.14 TRACER WIRE

Tracer wire shall be installed with PVC and ductile iron water mains. The wire shall be installed along the lower quadrant of the pipe, but the pipe shall not be laid directly on the wire. Ground rods shall be installed adjacent to connections to existing piping and in the locations specified on the plans. The tracer wire shall be brought to each fire hydrant and connected to a 60-inch ground rod that extends up to the bottom of the breakaway flange. The ground rod shall be taped to the fire hydrant barrel in at least four locations below the ground surface. The tracer wire shall be spliced only if approved by the Engineer. All underground splices shall be inspected by the Engineer prior to backfilling. The tracer wire system is considered to be a part of the price bid for water mains.

The Contractor shall be responsible for testing the tracer wire system for conductivity. Testing for conductivity shall be completed after the service lines have been tapped. If the tracer wire system does not function as intended, the Contractor shall repair the system to the satisfaction of the Engineer. Fire hydrants and the tracer wire system shall be installed in conformance with Standard Detail Plates 900.06 and 900.07.

3.15 CONCRETE THRUST BLOCKS

The Contractor shall brace all fittings by means of precast concrete thrust blocks. No poured concrete, wood shimming or bracing will be allowed in conjunction with the concrete blocks. If a concrete thrust block cannot be placed due to poor soil condition or inadequate support for blocking, restrained joints shall be utilized. The cost for concrete blocking is considered to be a part of the cost of the fittings.

3.16 BACKFILLING

Water main and service lines installed in an open trench shall be backfilled and compacted in 6-inch lifts to a height of 6 inches above the pipe. The first lift shall not exceed the springline of the pipe. Native material may be used for this portion of the backfilling in lieu of water main bedding material if approved by the Engineer. The backfill from 6 inches above the pipe to the street grade shall consist of approved excavated material. The backfill shall be placed in lifts at a depth suitable to the material encountered and compacted by methods approved by the Engineer to a density of at least 95 percent of Standard Proctor Density, unless otherwise specified.

The City will pay for the first density test taken at a given location. If the first test fails, the Contractor shall recompact the area and a second density test will be taken. If the second test passes, the City will pay for the second test. If the second test fails, the Contractor shall pay for the second test and any test taken thereafter until a passing test is obtained. This procedure will be applied to each test location. Backfill material is to be free of rock, frozen material, and hard clay. Care shall be taken in placing backfill over the crown of the pipe to avoid damage. If the material encountered in the trench excavations is unsuitable to be used as backfill material, it will be replaced or blended with select fill, as approved by the Engineer. During freezing weather, the Contractor shall remove and dispose of frozen material and replace it with a suitable fill material for water main.

3.17 DISINFECTION AND BACTERIOLOGICAL TESTING

Water main installed shall be disinfected in accordance with AWWA C651 or as directed by the Engineer. The Contractor shall place sufficient chlorine tablets or chlorine powder in the water main as it is installed. Once water main construction is complete, the Contractor shall request to have the pipe segment filled by City personnel. Once the pipe segment has been filled, the Contractor can begin the hydrostatic pressure testing requirements (Section 3.18).

The chlorinated water shall remain in the water main for a minimum of 24 hours. Upon completion of the minimum contact time, the Contractor shall request to have the water main flushed by City personnel. In order to prevent corrosion damage to the pipe lining, heavily chlorinated water shall not remain in contact with the water main for more than 72 hours. The water main shall be adequately flushed to remove all heavily chlorinated water and remaining particulates. The Contractor shall be responsible for the dechlorination and/or disposal of heavily chlorinated water.

Once flushing is complete, the Contractor shall collect a water sample from an acceptable source for coliform bacteria testing. A minimum of two samples taken approximately 24 hours apart will be required for every 1,200 feet of water main installed. If both of the coliform bacteria tests pass (coliform bacteria absent), the water main can be put into service and service lines tapped. If either of the coliform bacteria tests fails (coliform bacteria present), the Contractor must request that the water main be reflushed. The Contractor shall then resample. Two consecutive tests must pass before the water main can be put into service. If the coliform bacteria test fails after the second attempt, the Contractor shall rechlorinate the water main by the continuous feed or slug method (liquid chlorine injection through a service tap) until two consecutive coliform bacteria tests pass.

The Contractor shall be responsible for furnishing water sample bottles and for delivery of the samples to a City approved laboratory for testing. Testing services performed by the laboratory shall be paid by the Contractor.

Costs for disinfecting the water main shall be included in the unit price bid for water mains.

3.18 HYDROSTATIC PRESSURE TESTING

Upon completion of the water main installation, it shall be hydrostatically tested at a pressure of 120 psi. This pressure shall be maintained for a period of two hours. The test pressure shall not vary by more than +/- 5 psi for the duration of the test. Before applying the specified test pressure, all air shall be expelled from the section of pipe being tested. The Engineer shall observe the pressure gauge readings before acceptance of the test.

New water main will have an allowable leakage equal to the amount of makeup water that must be supplied to maintain pressure within 5 psi of the specified test pressure. The allowable leakage shall not exceed the values as calculated by the following formulas:

Ductile Iron Pipe

$$L = \frac{SD\sqrt{P}}{133,200}$$

- L = testing allowance (makeup water), in gallons per hour
- S = length of pipe tested, in feet
- D = nominal diameter of the pipe, in inches
- P = average test pressure during the hydrostatic test, in pounds per square inch (gauge)

PVC Pipe

$$L = \frac{ND\sqrt{P}}{7,400}$$

- 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 pounds per square inch (gauge)

Should the test disclose damaged or defective materials or leakage greater than that permitted, the Contractor shall at his own expense locate and repair and/or replace defective materials. The test shall be repeated until the leakage is within the permitted allowance. The Contractor shall furnish all pumping equipment, labor, and gauges required for the pressure test and any added costs for this test shall be included in the unit price bid for water mains.

3.19 SURFACE RESTORATION AND CLEANUP

Unless stated specifically to the contrary in the Special Information Provisions, the Contractor shall replace all surface material and shall restore paving, curb and gutter, sidewalks, fences, trees, sod, topsoil, and other items disturbed to a condition equal to that before the work began, furnishing all labor, materials, and equipment necessary to do this work. Traveled streets shall be kept open and maintained by the Contractor after backfilling and before surfacing or final inspection. The cost of all such work shall be absorbed in the unit price bid for pipe installation unless otherwise specified in the Special Information Provisions or Bid Proposal.

3.20 GENERAL

The Engineer or his/her representatives shall have access at all times to all parts of the job, and the Contractor must furnish such personnel, facilities, equipment, tools, and materials as are necessary to make whatever tests and inspection that are deemed necessary.

4.0 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

4.1 REMOVAL OF WATER MAIN PIPE

The removal of water main shall be measured as lineal foot of pipe removed. The removal footage shall be rounded up to the nearest 1-foot increment.

The removal of water main shall be paid for at the contract unit price for each foot of water main removed. Payment for removal of water main pipe shall be full compensation for excavation, removal and disposal of the pipe, and all appurtenances necessary for proper removal. Payment for removal of water main pipe shall only be made if the respective bid item is on the bidding form. If no water main removal bid item is on the bidding form, the removal of water main pipe shall be considered incidental work and no separate measurement or payment shall be made.

4.2 REMOVAL OF WATER MANHOLE

The removal of a water manhole shall be measured as a unit for each manhole removed. The removal of water manhole shall be paid for at the contract unit price for each water manhole removed. Payment for the removal of a water manhole shall be full compensation for removal and disposal of the manhole, frame and cover, and all appurtenances necessary to complete the work.

4.3 ABANDONMENT OF WATER MANHOLE

The abandonment of a water manhole shall be measured as a unit for each manhole abandoned. The abandonment of a manhole shall be paid for at the contract unit price for each manhole abandoned. Payment for the abandonment of water manholes shall be full compensation for abandoning the manhole, breaking the manhole down to the required height, filling the manhole with sand, backfilling to finished grade, and all appurtenances necessary for proper abandonment of the manhole.

4.4 ROCK EXCAVATION

The excavation of rock shall be measured as cubic yards of rock removed, rounded to the nearest 0.1 increment. All rock excavation shall be under one classification. The classification shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or blasting for its removal and boulders 1 cubic yard in volume or greater. Pay lines for computing rock excavation shall be described as follows:

Pipe Size	Trench Width Pay Limits
Pipe diameter \leq 24 inches	4 feet
Pipe diameter $>$ 24 inches	Pipe diameter plus 24 inches

Pay lines for computing depth of the rock excavation shall be described as the distance from top of rock to 12 inches below the pipe invert elevation. The top of the rock profile will be measured and determined by the Engineer and used to determine the rock quantities.

The accepted quantities of rock excavation shall be paid for at the contract unit price per cubic yard. Payment for rock excavation shall be full compensation for permits, excavation, blasting, removal and proper disposal of the rock offsite, and all appurtenances necessary for the proper removal of the rock. Furnishing and installing suitable fill material to replace the rock removed (except in locations where bedding material is required) will be paid for with the Granular Material bid item.

4.5 WATER MAIN BEDDING MATERIAL

Water main bedding material shall be measured by the lineal foot of material furnished and installed for the respective types and sizes of pipe. Water main bedding material shall be measured from pipe end to end. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of water main bedding material shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for water main bedding material will be full compensation for furnishing and installing the water main bedding material and all appurtenances necessary for the proper installation of the material.

4.6 TRENCH STABILIZATION MATERIAL

The furnishing and installing of trench stabilization material shall be measured as cubic yards of trench stabilization material to the nearest 0.1 ton. The accepted quantities of furnished and installed trench stabilization material will be paid for at the contract unit price per ton. Payment for trench stabilization material will be full compensation for furnishing and installing the trench stabilization material, excavation, removal and disposal of unstable soils, and all appurtenances necessary for the proper installation of the material.

4.7 SELECT FILL FOR WATER MAIN

The furnishing and installing of select fill for water main shall be measured as tons of select fill for water main material to the nearest 0.1 ton. The accepted quantities of furnished and installed select fill for water main will be paid for at the contract unit price per ton. Payment for select fill for water main will be full compensation for furnishing and installing the select fill for water main and all necessary work for the proper installation of the material.

4.8 WATER MAIN INSULATION

Water main insulation shall be measured by the lineal foot of the pipe length that is insulated and for different sizes of insulation.

The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of water main insulation shall be paid for at the contract unit price per lineal foot for the sizes furnished and accepted. Payment for water main insulation will be full compensation for furnishing and installing the insulation and all appurtenances necessary for the proper installation of it.

4.9 WATER MAIN

Water main shall be measured by the lineal foot for the respective types, classes, and sizes of pipe. Pipe shall be measured from center to center of fittings or to the end of pipe. The measured length shall be rounded up to the nearest 1-foot increment. The furnishing and installing of water main shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for water main will be full compensation for furnishing and installing the water main pipe, gaskets, trench dewatering (unless otherwise specified), excavating and backfilling, and all appurtenances for the proper installation of water main.

4.10 EXTRA DEPTH WATER MAIN

Extra depth water main shall be measured by the lineal foot for the respective types, depths, classes, and sizes of pipe. Piping shall be measured from center to center of fittings or to the limits of pipe installed at extra depth as defined previously. The measured length shall be rounded up to the nearest 1-foot increment.

The furnishing and installing of extra depth water main shall be paid for at the contract unit price per lineal foot for the types, depths, classes, and sizes furnished and accepted. Payment for extra depth water main will be full compensation for furnishing and installing the extra depth water main pipe, gaskets, trench dewatering (unless otherwise specified), excavation, backfilling, and all appurtenances for the installation of extra depth water main to the depths as described in project plans and specifications.

4.11 VALVES AND BOXES

Valves and boxes shall be measured as each unit of respective type and size. The furnishing and installing of valves and boxes shall be paid for at the contract unit price per each for type and size furnished and accepted. Payment for valves and boxes will be full compensation for furnishing and installing the valve, operating nut centering device, box, gaskets, bolts, operator, excavating, backfilling, blocking, dewatering, and all appurtenances necessary for proper installation of the valves and boxes.

4.12 WATER MAIN (INSTALL ONLY)

Water main for installation only shall be measured by the lineal foot for the respective types, classes, and sizes of pipe. Piping shall be measured from center to center of fittings or to the end of the pipe. The measured length shall be rounded up to the nearest 1-foot increment. The installed water main shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes installed and accepted. Payment for water main installation will be full compensation for installing the water main pipe, furnishing and installing the new gaskets, trench dewatering (unless otherwise specified), excavating, backfilling, and all appurtenances for the proper installation of the water main.

4.13 MECHANICAL JOINT FITTINGS

Mechanical Joint (MJ) Fittings shall be measured as each unit of respective type and size. Fittings include elbows, tees, reducers, crosses, plugs, and sleeves. The furnishing and installing of MJ fittings shall be paid for at the contract unit price per each for the types, classes, and sizes installed and accepted. Payment for MJ fittings will be full compensation for furnishing and installing the MJ fittings, cor-blue bolts, gaskets, trench dewatering (unless otherwise specified), excavating, blocking, backfilling, and all appurtenances for the proper installation of MJ fittings.

4.14 FIRE HYDRANT

Fire hydrants shall be measured as each unit. The furnishing and installing of fire hydrants shall be paid for at the contract unit price per each for type furnished and accepted. Payment for fire hydrants will be full compensation for furnishing and installing the hydrant, gaskets, blocking, excavating, backfilling, and all appurtenances necessary for proper installation of the fire hydrant.

4.15 REMOVE AND SALVAGE FIRE HYDRANT

The item for remove and salvage fire hydrant shall be measured as a unit for each hydrant that has been removed and salvaged. The removal and salvage of fire hydrants shall be paid for at the contract unit price per each for the locations indicated on the project plans and specifications. Payment for removal and salvage of fire hydrants shall be full compensation for excavation, disconnection, removal, salvaging to designated location, and all necessary appurtenances for proper completion of the work item.

4.16 REMOVE AND RELOCATE FIRE HYDRANT

The item for remove and relocate fire hydrant shall be measured as a unit for each hydrant that is removed and relocated. The removal and relocation of fire hydrant shall be paid for at the contract unit price per each for the locations indicated on the project

plans and specifications. Payment for removal and relocation of fire hydrant shall be full compensation for excavation, disconnection, reconnection, removal, relocation to designated location, blocking, and all necessary appurtenances for proper completion of the work item.

4.17 FIRE HYDRANT EXTENSION

The item for fire hydrant extension shall be measured as a unit for each respective size and type of extension. The fire hydrant extension shall be paid for at the contract unit price per each for the locations, types, and sizes indicated on the project plans and specifications. Payment for fire hydrant extension shall be full compensation for the extension, removal and reinstallation of the top section of the fire hydrant, and all necessary appurtenances for proper completion of the fire hydrant extension.

4.18 TEMPORARY FIRE HYDRANT

Temporary fire hydrants shall be measured as a unit for each respective hydrant required. The temporary fire hydrant shall be paid for at the contract unit price per each for the locations, types, and sizes indicated on the project plans and specifications. Payment for temporary fire hydrant shall be full compensation for the temporary fire hydrant, excavation, gaskets, connection, subsequent removal, backfilling, and all necessary appurtenances for proper completion of the temporary fire hydrant.

4.19 COMBINATION AIR VALVE MANHOLE

Combination air valve manholes shall be measured as a unit for each respective manhole required. The combination air valve manhole shall be paid for at the contract unit price per each for the locations, types, and sizes indicated on the project plans and specifications. Payment for combination air valve manhole shall be full compensation for precast manhole, concrete footings, $\frac{3}{4}$ -inch crushed rock, excavation, backfill, frame and cover, gaskets, valves, and all necessary appurtenances for proper completion of the air release manhole.

4.20 SMITH TAP AND BOX

Smith tap and box shall be measured as a unit for each respective size and type required. Payment for smith tap and box shall be paid for at the contract unit price per each for the locations, types, and sizes indicated on the project plans and specifications. Payment for smith tap and box shall be full compensation for excavation and backfilling and furnishing and installing the tapping sleeve, valve, valve box and all necessary appurtenances for proper completion of the smith tap and box installation.

4.21 WATER MAIN ADJUSTMENT

Water main adjustment shall be measured as a unit for each respective size and type of adjustment completed. The water main adjustment shall be paid for at the contract unit price per each for the types, classes, and sizes of water main adjusted. Payment for water main adjustment shall be full compensation for excavating, dewatering of the water main and trench, additional time required for the installation of materials, backfilling, and all necessary appurtenances for proper completion of the water main adjustment. **Note: All materials required for the water main adjustment are paid for under their respective bid item. Water main adjustment is considered as additional pay required to complete the adjustment.**

4.22 CONNECT TO EXISTING WATER MAIN

Connect to existing water main shall be measured as each unit connection. The connection to existing water main shall be paid for at the contract unit price per each for the connection to existing water mains for the purpose of extending an existing water main. Payment for connection to existing water main shall be full compensation for excavating, backfilling, dewatering of the water main and trench, removing the plug or hydrant, and all necessary appurtenances for proper completion of the connection to existing water main.

4.23 CUT AND TIE TO EXISTING WATER MAIN

Cut and tie to existing water main shall be measured as a unit for each respective connection made. Payment for cut and tie to existing water main shall be at the contract unit price per each for cutting and tying to existing water main. Payment for cutting and tying to existing water main shall be paid for at the contract unit price per each for the locations indicated on the project plans and specifications. Payment for cutting and tying to existing water main shall be full compensation for excavating, backfilling, dewatering of water main and trench, cutting water main, tying to water main, and all necessary appurtenances for proper completion of the cutting and tying work item. **Note: All materials required for the connection to the existing water main shall be paid for separately under their respective bid items.**

4.24 VALVE BOX ADJUSTMENT

Valve box adjustment shall be measured as each unit adjusted. The valve box adjustment shall be paid for at the contract unit price per each for the valve boxes adjusted. Payment for valve box adjustment shall be paid for at the contract unit price per each for the locations indicated on the project plans and specifications. Payment for valve box adjustment shall be full compensation for adjusting the valve box to the desired finished grade as indicated on the project plans and specifications and all necessary appurtenances for proper completion of the valve box adjustment. Valve box adjustment will only be paid for once per valve per project.

4.25 VALVE BOX EXTENSION OR REPLACEMENT

Valve box extension and replacement shall be measured as each unit extended or

replaced. The furnishing and installing of valve box extensions or replacements shall be paid for at the contract unit price per each installed and accepted. Payment for valve box extension or replacement shall be full compensation for furnishing and installing valve box extension or replacement, excavating, backfilling, and all necessary appurtenances for proper completion of the valve box extension or replacement.

4.26 WATER SERVICES

Water service pipe shall be measured by the lineal foot for the respective types, classes, and sizes of pipe. Pipe shall be measured from center to center of fittings or to the end of pipe. The measured length shall be rounded up to the nearest 1-foot increment. The furnishing and installing of water service pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted.

Payment for water service pipe will be full compensation for furnishing and installing the water main pipe, fittings, trench dewatering (unless otherwise specified), excavating and backfilling, and all appurtenances for the proper installation of the water service pipe.

Corporation stops and pipe saddles shall be measured as a unit. The furnishing and installing of corporation stops and pipe saddles shall be paid for at the contract unit price per each for type and size furnished and accepted. Payment for corporation stops and pipe saddles will be full compensation for furnishing and installing the corporation stop, pipe saddle, excavating, backfilling, tapping of the water main and all appurtenances necessary for proper installation of the corporation stop and pipe saddle.

Curb stops shall be measured as each unit. The furnishing and installing of curb stops shall be paid for at the contract unit price per each for type and size furnished and accepted. Payment for curb stops will be full compensation for furnishing and installing the curb stop, curb box with extension rod, excavating, backfilling, blocking and all appurtenances necessary for proper installation of the curb stop and box.

4.27 WATER SERVICE RECONNECT

Water service reconnect shall be measured by each unit of respective size and type. The water service reconnect shall be paid for at the contract unit price per each water service reconnected. The Contractor shall complete all water service reconnections. Payment for water service reconnect shall be paid for at the contract unit price per each at the locations indicated on the project plans or identified in the field. Payment for water service reconnect shall be full compensation for excavating, backfilling, coordination with City, and all necessary fittings and appurtenances for proper completion of the water service reconnection.

4.28 WATER MAIN BYPASS PIPE

Water main bypass pipe shall be measured by the lineal foot for the respective types, classes, and sizes of pipe. Piping shall be measured from end to end with no deduction for length through fittings. The measured length shall be rounded up to the nearest 1- foot increment.

The furnishing and installing of water main bypass pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and accepted. Payment for water main bypass pipe shall be full compensation for furnishing and installing the bypass piping, pressure testing, bacteria testing, and all necessary appurtenances for proper completion of the water main bypass piping.

4.29 PRECAST WATER METER VAULT WITH CASTING

Precast water meter vault with casting shall be measured by each unit of the respective type, class, and size of vault constructed. The furnishing and installing of precast water meter vault with casting shall be paid for at the contract unit price per each for the types, classes, and sizes furnished and accepted. Payment for water meter vault with casting shall be full compensation for excavation, drain rock, subgrade preparation, precast vault, backfilling, gaskets, rubber rope sealant, casting, and all necessary appurtenances for proper completion of the water meter vault with casting.

4.30 CLEAN AND LINE WATER MAIN

Clean and line water main shall be measured by the lineal foot for the respective types, classes, and sizes of cleaned and lined water main. The pipe shall be measured along the centerline of the pipe without deduction for valves and fittings. The measured length shall be rounded up to the nearest 1-foot increment.

The cleaning and lining of water main shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes cleaned and lined in accordance with the specifications, and accepted. Payment for cleaning and lining water main shall be full compensation for dewatering the water main, cutting and opening the pipe, mechanically cleaning the interior of the pipe, lining the pipe with cement mortar, replacing and coupling all open pipe, sterilizing and thoroughly flushing the lined pipes, and all necessary appurtenances for proper completion of the water main cleaning and lining.

4.31 ABANDONMENT OF VALVES

Abandonment of valves shall be measured by each unit of respective type, class, and size of valve abandoned. The abandonment of valves shall be paid for at the contract unit price per each for the types, classes, and sizes abandoned in accordance with the specifications, and accepted. Payment for abandonment of valves shall be full compensation for removing the top section of the valve box, top 2 feet of manhole (if applicable), select fill material to fill the remaining section of valve box, and all necessary appurtenances for proper completion of the abandonment of valves.

4.32 RESTRAINER DEVICES

Restrainer devices shall be measured by each unit of respective type, class, and size. Furnishing and installing restrainer devices shall be paid for at the contract unit price per each for the types, classes, and sizes installed in accordance with the specifications, and accepted. Payment for restrainer devices shall be full compensation for excavation, restrainer device, gaskets, and all necessary appurtenances for proper completion of restrain device furnish and installation.

4.33 VALVE BOX MARKER

Valve box markers shall be measured by each unit furnished and installed.

The furnishing and installing of manhole markers shall be paid for at the contract unit price per each furnished and accepted. Payment for valve box markers will be full compensation for furnishing and installing the valve box markers and all necessary appurtenances for the proper installation of the valve box markers.

4.34 JACKING, BORING, AND TUNNELING

The basis of measurement shall be by the lineal foot for casing pipe and carrier pipe. The measured length of carrier pipe and casing pipe shall be rounded up to the nearest 1-foot increment.

Furnishing and installing of casing pipe and carrier pipe shall be paid for at the contract unit price per lineal foot for the types, classes, and sizes furnished and installed in accordance with the specifications, and accepted. Furnishing and installing end seals and casing spacers shall be considered incidental to the installation of the carrier pipe. Payment for casing pipe will be full compensation for furnishing and installing of the casing pipe by boring, jacking or tunneling, excavating and backfilling of bore pits, welding, trench dewatering (unless otherwise specified), and all necessary appurtenances for proper installation of casing pipe.

Payment for carrier pipe will be full compensation for furnishing and installing of the carrier pipe, gaskets, and all other appurtenances necessary for the proper installation of the carrier pipe.

Payment for boring obstruction will be full compensation for the labor, equipment, and materials needed for removal of the obstruction. Payment for boring obstructions will be paid only for boring obstructions with mechanical equipment. If the project work is performed by a hand-mining operation, all such obstructions will be considered part of the normal operation and will not be paid for as a boring obstruction.

A boring obstruction shall be defined as any rock, boulder, etc., or similar material, which is encountered during the excavation that cannot be removed by the boring machine and requires shutdown of the equipment for removal. The Contractor shall be aware that all quantities are estimates and that there may be no obstructions or could be a large number of obstructions on the project. The Contractor will only be paid for obstructions encountered and reported to and verified by the Engineer. The bid item quantities are not guaranteed items.

4.35 WATER SERVICE DISCONNECT

Water service disconnects shall be measured by each service line disconnected. If more than one service can be disconnected in any one trench, then only one water service disconnect payment will be made.

The water service disconnect shall be paid for at the contract unit price per each. Payment for water service disconnect shall be paid for at the contract unit price per each at the locations indicated on the project plans or identified in the field. Payment for water service disconnect shall be full compensation for excavating, backfilling, and all necessary fittings and appurtenances for proper completion of the water service disconnect.

4.36 WATER SERVICE SETBACK

Water service setbacks shall be measured by each curb stop box setback. If more than one service can be setback in any one trench, then only one water service setback payment will be made.

The water service setback shall be paid for at the contract unit price per each. Payment for water service setback shall be paid for at the contract unit price per each at the locations indicated on the project plans or identified in the field. Payment for water service setback shall be full compensation for excavating, backfilling, fittings and all necessary appurtenances for proper completion of the water service setback.

City of Canton
Supplemental Standard Specifications
for
Lights Construction
Section 400

Adopted: _____

SECTION 400 LIGHTS TO BE ADDED AT A LATER DATE

City of Canton

Supplemental Standard Specifications

for

Warranty for Construction Activity

Section 500

Adopted: _____

1.0	TERM OF WARRANTY	1
1.1	UTILITY CONSTRUCTION ACTIVITY	1
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Section 500

City of Canton Supplemental Standard Specifications Addressing Warranty for Construction Activity

1.0 TERM OF WARRANTY

1.1 UTILITY CONSTRUCTION ACTIVITY

The warranty shall cover the contract as to workmanship and materials for a period of two (2) years for the following utility construction:

- A. Storm sewer and sump pump collection systems.
- B. Sanitary sewer.
- C. Water main.
- D. City lights systems.
- E. City traffic signal system.

The Contractor shall maintain all trenches and backfill any settlement and provide and place any necessary base and/or surfacing needed due to trench settlement for the maintenance period, which shall run for two (2) years after the completion and acceptance of the system. The Contractor shall repair and/or replace all defective workmanship and materials, and correct all deficiencies noted in the system in a method approved by the Engineer.

City-furnished materials, unless otherwise specified, shall be warranted by the product manufacturer. This warranty shall apply to workmanship only when materials are furnished by the City of Canton.

1.2 SURFACE CONSTRUCTION ACTIVITY

The warranty shall cover the contract as to workmanship and materials for a period of one (1) year for the following construction activity:

- A. Grading—Subgrade and fill.

- B. Base course.
- C. Pavement
- D. Curb and gutter.
- E. Driveways and sidewalks.

The Contractor shall maintain any deficiencies in workmanship and materials for the maintenance period, which shall run for one (1) year after the completion and acceptance of the construction. The Contractor shall repair and/or replace all deficiencies noted in the construction in a method approved by the Engineer.

1.3 REVEGETATION ACTIVITY

Vegetative cover shall include seeding, sodding, shrubbery, and trees.

The warranty for vegetative cover shall be as follows:

- A. Seeding and sodding shall be warranted for a period of one year from completion of the contract.
- B. Shrubby and trees shall be warranted for a period of one year from completion of the contract.

City of Canton
Standard Specifications
for
Traffic Signs and Delineators
Section 632

Revised: _____

632.1 DESCRIPTION

This work consists of furnishing materials, making and preparing traffic signs and delineators, and performing incidental work, including erection and installation of signs, hardware, and posts.

632.2 MATERIALS

A. Traffic Signs

1. **Sheet Aluminum:** Sheet aluminum shall meet the requirements of ASTM B 209 for alloy 5052-H38 or 6061-T6. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating. Sheet aluminum thickness requirements shall be based on the maximum horizontal in place dimension of each sheet aluminum sign in accordance with the following:

HORIZONTAL DIMENSION OF IN PLACE SIGN BLANK	REQUIRED SIGN BLANK THICKNESS
(English Units)	
18" and less	0.080"
Over 18" through 30"	0.080"
Over 30"	0.100"
Street Name Signs	0.125"

B. Perforated Tube Posts and Flanged Channel Posts

Post material shall meet impact performance (change in momentum) requirements for small sign supports contained in the current AASHTO "Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals."

Anchor plates for Perforated Tube Posts and Flanged Channel Posts shall be galvanized in accordance with ASTM A123, or painted with a dark green high quality enamel. The steel plates shall be trapezoidal in shape with bases of 6 and 12 inches, a depth of 6 inches, and shall be either 10 gauge, 1/8 inch, or 1/4 inch in thickness. The steel shall meet the requirements of ASTM A36 or ASTM A1011 Structural Steel Grade 36. Bolt holes of 3/8 inch shall be provided centered on the plate with a spacing of 4 inches.

1. **Perforated Tube Posts:** Perforated tube posts shall conform to ASTM A1011 Structural Steel Grade 50.

Posts shall be a square tube formed of 12 gauge steel, 0.105 inch thick, rolled to size. The tubing shall be molded so the weld or flash does not interfere with telescoping. The posts shall be hot dipped galvanized with a 1.25 ounce per square foot coating conforming to ASTM A653. As an alternate, the post shall be given a triple coated protection by application of hot dip galvanized zinc conforming to ASTM A 53, followed by a chromate conversion coating and a

polyurethane exterior coating, with inside surfaces given corrosion protection by in-line application of zinc base organic coating after fabrication.

The posts shall be punched, bored, or have knockouts with 7/16-inch diameter holes on 1-inch centers of all four sides for the entire length of the posts. The post sections shall be straight, with a smooth uniform finish and a minimum amount of play between telescoping sections. Holes and cutoff ends shall be free of burrs and ragged edges. Bolts, nuts, and washers shall conform to ASTM A 307 and shall be galvanized.

2. **Flanged Channel Posts:** Posts and bases shall be a flanged channel section fabricated from either hot rolled carbon steel bars or carbon steel bars and shapes produced from standard rail steel. The posts and bases shall meet the minimum physical properties of ASTM A499, Grade 60 except that the minimum yield strength shall be 70,000 psi. The post shall meet chemical properties of ASTM A1 for rails 30 pounds per foot and heavier.

The weight of posts shall be as specified and shall be 2.00 (Post) or 3.00 (Base) pounds per foot plus or minus 5.0 percent before punching. The posts and bases shall be painted with a high quality baked on dark green enamel. All punching, boring, cutting, or shearing shall be performed prior to painting. The posts shall be punched with continuous 3/8-inch diameter holes on 1-inch centers for the entire length of the post. The first hole shall be 1 inch from the top.

The post may consist of two parts, a sign post and a base post. The sign post lengths shall be supplied in 1-foot increments up to 10 feet. The base posts shall be 42 inches in length and have holes in the base post, starting 1 inch from the top and continuing in 1 inch increments.

The posts shall be machine straightened and have a smooth uniform finish, free from defects affecting strength, durability, or appearance. The allowable tolerance for straightness shall be 1/4 inch in 5 feet.

The splice hardware shall consist of two fully threaded, 5/16 inch by 1 1/2 inch, Grade 9, plated hex head bolts, with flat washers and hex nuts per post. In addition, two 3/4-inch by 5-inch by 1/2-inch plated spacers shall be used per post to stiffen the splice connection. Each spacer shall be drilled and tapped with 5/16 inch by 18 UNC threads. The spacer shall be fabricated from hot rolled carbon steel bars conforming to ASTM A 36 or AISI M 1020. A Grade G flanged lock nut (5/16-inch, 18 thread) may be substituted for the lock washer and hex nut.

C. Reflective Sheeting:

1. **Grade:** All Stop Signs, Yield Signs and Street Name Signs shall use DG3 (Diamond Grade Cubed) sheeting material.

All warning signs shall use Florescent DG3 sheeting material.

All school signs shall use Florescent Yellow/Green DG3 sheeting material.

All other signs shall use HIP (High Intensity Prismatic) sheeting material.

2. **General Characteristics:** The reflective sheeting shall be free from ragged edges, cracks, and extraneous materials. There shall be no splices in the reflective sheeting.
3. **Fabrication:** The background for signs shall be sheet reflective material applied to aluminum backing. The preparation of the aluminum surface and the sheeting application shall be in complete compliance with the recommendations of the manufacturer.
4. **Application:** Reflective sheeting shall be applied to properly prepared aluminum (degreased and etched or treated with a light, tight, amorphous chromate coating) with mechanical equipment in a manner prescribed by the sheeting manufacturer.
5. **Legend:** Message and borders shall be type, reflective material, and color specified. Nonremovable copy may be screen processed or direct applied.
 - a. **Nonremovable Copy:** (For use on sheet aluminum signs.)
 - 1) **Screen Process:** Message and borders shall be processed on reflective sheeting using mechanical equipment, materials, and operational methods and procedures as prescribed by the sheeting manufacturer. Processing shall be accomplished by the direct or reverse screen method using opaque or transparent processing material as required. Screening may be accomplished either before or after application of the sheeting to the base panels, conditional upon the method recommended by the sheeting manufacturer. Freehand painting will not be permitted on any part of the finished sign face.
 - 2) **Direct Applied:** Cut-out message and borders shall be reflective sheeting or opaque lettering film applied directly to clean, dust free, reflective sheeting background. Message and borders shall be applied in accordance with the operational methods and procedure prescribed by the sheeting manufacturer. The finished letters, numerals, symbols, and borders shall be cut with smooth regular outline, free from ragged or torn edges.

Mounting holes will not be drilled or punched in any part of the nonremovable copy.

6. **Color:** The reflective sheeting shall meet the color specification limits and luminance factors listed in Tables 1–4 when tested in accordance with ASTM E1347 or ASTM E1349. Fluorescent retroreflective materials shall be

tested in accordance with ASTM E991. The reflective sheeting shall maintain the colors and luminance factors provided in the appropriate tables throughout its service life.

Table 1

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.303	0.300	0.368	0.366	0.340	0.393	0.274	0.329
Red	0.648	0.351	0.735	0.265	0.629	0.281	0.565	0.346
Orange	0.558	0.352	0.636	0.364	0.570	0.429	0.506	0.404
Brown	0.430	0.340	0.430	0.390	0.518	0.434	0.570	0.382
Yellow	0.498	0.412	0.557	0.442	0.479	0.520	0.438	0.472
Green	0.026	0.399	0.166	0.364	0.286	0.446	0.207	0.771
Blue	0.078	0.171	0.150	0.220	0.210	0.160	0.137	0.038

Daytime Color Specification Limits for Retroreflective Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.475	0.452	0.360	0.415	0.392	0.370	0.515	0.409
Red	0.650	0.348	0.620	0.348	0.712	0.255	0.735	0.265
Orange	0.595	0.405	0.565	0.405	0.613	0.355	0.643	0.355
Brown	0.595	0.405	0.540	0.405	0.570	0.365	0.643	0.355
Yellow	0.513	0.487	0.500	0.470	0.545	0.425	0.572	0.425
Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782
Blue	0.033	0.370	0.180	0.370	0.230	0.240	0.091	0.133

Nighttime Color Specification Limits for Retroreflective Material with CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

Table 3

Color	Chromaticity Coordinates (corner points)								Luminance Factor (Y %)	
	1		2		3		4		Min	Max.
	X	Y	X	Y	X	Y	X	Y		
Fluorescent Orange	0.583	0.416	0.535	0.400	0.595	0.351	0.645	0.355	25	None
Fluorescent Yellow	0.479	0.520	0.446	0.483	0.512	0.421	0.557	0.442	45	None
Fluorescent Yellow/Green	0.387	0.610	0.369	0.546	0.428	0.496	0.460	0.540	60	None
Fluorescent Green	0.210	0.770	0.232	0.656	0.320	0.590	0.320	0.675	20	30

Daytime Color Specification Limits and Luminance Factors for Fluorescent Retroreflective Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65.

Table 4

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
Fluorescent Orange	0.625	0.375	0.589	0.376	0.636	0.330	0.669	0.331
Fluorescent Yellow	0.554	0.445	0.526	0.437	0.569	0.394	0.610	0.390
Fluorescent Yellow-Green	0.480	0.520	0.473	0.490	0.523	0.440	0.550	0.449
Fluorescent Green	0.007	0.570	0.200	0.500	0.322	0.590	0.193	0.782

Table 4: Nighttime Color Specification Limits for Fluorescent Retroreflective Material With CIE 2° Standard Observer and Observation Angle of 0.33°, Entrance Angle of +5° and CIE Standard Illuminant A.

D. Delineators:

- Description:** Delineators shall be adhesive coated reflective sheeting permanently bonded to sheet aluminum backing.

The aluminum shall be 6061-T6 (ASTM B 209) 0.063-inch-thick sheet properly degreased and etched, or treated with a light, tight, amorphous chromate coating.

Type I Object Marker shall consist of a yellow 18" x 18" reflector unit.

Type II Object Marker shall consist of a 4" x 8" or size specified reflector unit.

Type III Object Marker shall consist of a 12" x 36" reflector unit.

- Reflective Sheeting:** The reflective sheeting shall be Florescent DG3 sheeting.

In exception to the requirements stated above, the reflective sheeting shall maintain the colors provided in the appropriate tables contained in Section 982.2.G.6 throughout its service life.

- Fabrication:** The aluminum shall be 6061-T6 or 5052-H38 0.063-inch-thick sheet conforming to ASTM B 209. The aluminum shall be properly degreased and etched or treated with a light, tight, amorphous chromate coating.

The reflective sheeting shall be applied to properly treated base panels with mechanical equipment in a manner specified by the sheeting manufacturer.

- Shape and Holes:** Delineators shall be punched or sheared to size with 3/4-inch radius corners. Mounting holes shall be as follow:

- a. The 4 x 8-inch delineators shall have two 1/4-inch holes, 5 inches center to center along the vertical axis.
5. **General Requirements:** The finished delineators shall be free of burrs, scratches, or damaged reflective sheeting and shall have essentially a plane surface.
6. **Delineator Posts:** Posts shall be flanged channel section fabricated from hot rolled carbon steel bars or carbon steel bars and shapes produced from standard rail steel. The posts shall meet the minimum physical properties of ASTM A499, except that the minimum yield strength shall be 70,000 psi. The posts shall meet the physical properties of ASTM A499 and the chemical properties of ASTM A1 for rails 30 pounds per foot and heavier.

The posts shall be coated with a high quality dark green material. All punching, boring, cutting, or shearing shall be done prior to coating. Prior to any punching or boring, the weight of the post shall be a minimum of 1.12 pounds per foot with a tolerance of plus or minus 5 percent. The post length shall be as specified within a tolerance of plus or minus 1 inch. The delineator post shall be punched or bored with thirty 3/8-inch diameter holes on 1.0 inch centers beginning 1.0 inch from the top of the post.

The bottom of the post shall be pointed for ease of installation. The posts shall be machine straightened and have a smooth uniform finish, free from defects affecting strength, durability, or appearance. The allowable tolerance for straightness shall be 1/4 inch in 5 foot.

632.3 CONSTRUCTION REQUIREMENTS

Highway signs and delineators shall comply with the most current MUTCD and Standard Highway Signs, issued by the U.S. Department of Transportation, FHWA.

A. Remove or Salvage Signs and Delineators

1. **Remove Traffic Sign:** The Contractor shall be responsible to remove traffic or other signs as specified in the contract. The signs and the associated posts and bases will be removed and disposed of by the Contractor.
2. **Salvage Traffic Sign:** The Contractor shall be responsible to salvage traffic signs as specified in the contract. The signs, posts, and bases will be removed; disassembled and returned to the Canton Shop in the same condition they were prior to the project. All signs must be removed from the post prior to the removal of the post and base. Care shall be taken to prevent damage to any of the reflective sheeting. Any signs, posts, or bases damaged during transportation will be replaced at the expense of the Contractor.

3. **Salvage Traffic Sign for Reset:** The Contractor shall be responsible to salvage and store traffic signs to be reset by the Contractor as specified in the contract. The Contractor shall remove the sign prior to removal of the post and base. The post and bases shall be returned to the Canton Shop unless otherwise specified. Special care shall be taken by the Contractor to prevent damage to any of the reflective sheeting during storage. Any signs, posts, or bases damaged during storage or transportation will be replaced at the expense of the Contractor.
4. **Salvage Delineator or Object Marker:** The Contractor shall be responsible to salvage delineators or object markers as specified in the contract. The delineators or object markers and associated posts and bases will be removed undamaged and returned to the Canton Shop. Any delineators, object markers, or associated posts and bases damaged during transportation will be replaced at the expense of the Contractor.

B. Traffic Sign Installation:

1. **Location and Position:** The location of each sign shall be established by a stake bearing the sign number as determined from the plans.

Traffic signs shall be installed on posts, light poles, or mast arms as specified in the contract. The Contractor will be responsible to furnish the necessary stainless steel mounting hardware for each sign.

All R7 and R8 series signs with arrows shall be installed at a 45 degree angle to the street.

2. **Sign mounting hardware**

- a. All bolts and washers used for mounting signs shall be stainless steel and minimum of 5/16" diameter.
- b. Plastic / nylon washers shall be inserted between the sign face and the stainless washer.
- c. Stainless washers must meet MS 813 standards.
- d. Zinc coated nyloc nuts shall be used to secure signs to the posts

C. Object Markers: Object markers of the type specified shall be erected as shown in the plans.

D. Delineators: Delineators shall be mounted as shown in the plans.

E. Perforated Tube Posts and Flanged Channel Posts: Post size will be specified in the contract for each type of sign. Sign post lengths shown in the contract are estimates for bidding purposes only. The exact post lengths will be determined during construction. Posts shall be in a plumb position. Unless otherwise specified all signs, including those salvaged for reset by the Contractor will be placed on new posts.

632.4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- A. Remove Traffic Sign:** Removed signs will be measured per each sign removed. Multiple signs removed on the same post will be measured as one. Removed signs will be paid for at the contract unit price per each. Payment will be full compensation for all labor and incidentals to remove and dispose of the sign and associated posts and bases.
- B. Salvage Traffic Sign, Salvage Traffic Sign for Reset, and Salvage Delineator or Object Marker:** Salvaged signs will be measured per each sign salvaged. Multiple signs salvaged on the same post will be measured as one. Salvaged signs will be paid for at the contract unit price per each. Payment will be full compensation for all labor, materials, and incidentals including transporting and storing the signs, delineators, and object markers.
- C. Furnish Sign with Reflective Sheeting:** Signs will be measured to the nearest 0.1 foot and the area computed to the nearest 0.1 square foot of the sign face for each sign furnished. Deduction will not be made for rounded corners. Sheet aluminum signs will be paid for at the contract unit price per square foot of the type of sign furnished. Payment will be full compensation for furnishing materials, including borders, legend, and edge trim.
- D. Install Traffic Signs:** Install signs will be measured per each sign installed including Contractor furnished signs, salvaged signs, and City-furnished signs based upon their type of installation location. Multiple signs placed on the same post will be measured separately. Install signs will be paid at the contract unit price per each for the respective type of installation location. Payment will be full compensation for all labor, materials including mounting hardware, and incidentals. Separate measurement and payment will be made for perforated tube posts and flange channel posts.
- E. Object Markers:** Object markers quantities will be determined by count of each type. Object markers will be paid for at the contract unit price per each. Payment will be full compensation for furnishing and installing materials, including posts, reflective panels, and hardware.
- F. Delineators:** Delineator quantities will be determined by count of each type. Delineators will be paid for at the contract unit price per each. Payment will be full compensation for furnishing and installing materials, including posts, reflectors, and hardware.
- G. Perforated Tube Posts and Flange Channel Posts:** Post quantities for steel posts, other than those used for delineators and object markers, will be measured to the nearest 0.1 foot. Perforated tube posts and flange channel posts will be paid for at the contract unit price per foot. Payment will be full compensation for all labor, materials, and incidentals including post anchors, anchor sleeves, mounting hardware, telescoped inner post sections, and anchor plates.

City of Canton
Standard Specifications
for
Pavement Marking
Section 633

Adopted: _____

633.1 DESCRIPTION

This work consists of furnishing and applying pavement marking materials and surface grooving of Portland cement concrete pavement or asphalt concrete pavement.

633.2 MATERIALS

Materials shall conform to the following:

A. Traffic Paint

The finished paint shall be smooth and homogeneous, free of coarse particles, skins, or any other foreign materials that are detrimental to its use or appearance.

The vehicle shall be composed of a 100 percent acrylic polymer such as Rohm and Haas Rhoplex Fastrack 3427, Dow DT-250, or an approved equal.

1. **Accepted Brands of Paint:** Acceptable brands of traffic paint known to meet the quantitative and qualitative requirements outlined below are Sherwin Williams and Diamond Vogel. Alternate brands will only be allowed if they are tested by an independent facility to verify conformity to the specifications. All costs for testing shall be the responsibility of the Contractor.
2. **Manufactured Date:** The paint supplied shall be manufactured during the same calendar year that the contract work is done.
3. **Quantitative Requirements:** The finished paint shall meet the following quantitative requirements:

	White	Yellow
<i>Lead</i> , parts per million max. ASTM D 3335 or X-ray fluorescence	100	100
<i>Pigment</i> , percent by weight	60.0–62.5	58.5–61.0
<i>Pigment</i> , percent by weight; when tested in accordance with ASTM D 3723 (See Note 1)	60.0–62.5	56.1–58.6

Note 1: The residual extracted pigment upon analysis shall conform to the following quantitative compositional requirements when tested in accordance with ASTM D 1394 or ASTM D 4764.

Titanium Dioxide ASTM D 476 Type II Rutile 92% min. TiO ₂ tested in accordance with ASTM D 1394 or ASTM D 4764	1.00 lb/gal min.	0.20 lb/gal min.
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PAVEMENT MARKING

633

<i>Total Solids</i> , percent by weight; min. when tested in accordance with ASTM D 3723	77.0	76.1
<i>Non-volatile Vehicle</i> , percent by weight vehicle; min. when tested in accordance with FTMS 141c (Method 4051.1)	42.5	42.5
<i>Consistency</i> . Krebs-Stormer Shearing rate 200 r.p.m. Grams	190 to 300	190 to 300
Equivalent K.U. when tested in accordance with ASTM D 562 (See Note 2)	80 to 95	80 to 95

Note 2: The consistency of the paint shall be within the stated specification when determined a minimum 48 hours after packaging the material.

<i>Weight per Gallon</i> , pounds minimum when tested in accordance with ASTM D 1475 (See Note 3)	13.90	13.35
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Note 3: In addition to compliance with the minimum, the weight per gallon shall not vary more than ± 0.3 lbs / gal. between batches.

<i>Fineness of Dispersion</i> Hegman Scale, min. when tested in accordance with ASTM D 1210	2 min. "B" Cleanliness	2 min "B" Cleanliness
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<i>Drying Time</i> , No Pick-Up, Minutes, max. when tested in accordance with ASTM D711, except the wet film thickness shall be 12.5 ± 0.5 mils. The applied film shall be immediately placed in a laboratory drying chamber maintaining the relative humidity of $65 \pm 3\%$, the temperature $73.5 \pm 3.5^{\circ}\text{F}$, and airflow less than one foot (1') per minute.	12 max.	12 max.
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<i>Drying Time</i> , Dry-through, Minutes max., when tested in accordance with ASTM 1640, except the wet film thickness shall be 12.5 ± 0.5 mils. The applied film shall be immediately placed in a laboratory drying chamber maintaining the relative humidity at $90 \pm 3\%$, and the temperature $23 \pm 2^{\circ}\text{C}$. The pressure exerted will be the minimum needed to maintain contact between the thumb and	120 max.	120 max.
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film. A reference-control paint will be run in conjunction with the candidate paint. Rohm and Haas formulation will be referenced-control paint.

Note 4: If either the candidate or reference-control paint exceeds the 120-minute maximum, then the candidate paint shall not exceed the dry time of the reference-control paint by more than 15 minutes.

<i>Field Drying Time, Track-Free, Minutes max.</i>	2	2
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When applied under the following conditions, the line shall show no visual tracking when viewed from 50 feet after driving a passenger vehicle over the line at a speed of 25-35 mph:

- Fifteen mils wet film thickness
- Six lbs. of glass beads per gal. of paint
- Paint temperature at nozzle between 70 to 120°F
- Pavement dry, pavement temperature 50 to 120°F
- Relative humidity of 85% maximum

<i>Directional Reflectance, minimum., when applied at a wet film thickness of 15 mils and when tested in accordance with ASTM E 1347 (Illuminate C 2°)</i>	85	50
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<i>pH, minimum when tested in accordance with ASTM E70</i>	9.80	9.80
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<i>Dry Opacity, Contrast ratio, min., when applied at a wet film thickness of 6 to 7 mils and when tested in accordance with FTMS 141c (Method 4121 Illuminate C 2°)</i>	0.955	0.880
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<i>Volatile Organic Content (VOC), max. in accordance with ASTM D 3960</i>	115 g/liter	115 g/liter
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<i>Flash Point, closed cup, min.</i>	115°F	115°F
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Color: The paint shall meet the color specification limits and luminance factors listed in Tables 1 and 2 when tested in accordance with ASTM E1347 or ASTM E1349. The paint shall not discolor in sunlight and shall maintain the colors and luminance factors throughout the life of the paint. No Bayferrox 3950, iron oxides, or other color enhancers will be permitted to achieve the color chromaticity coordinates.

Table 1*

Color	Chromaticity Coordinates (corner points)								Min. Luminance Factor (Y %)
	X	Y	X	Y	X	Y	X	Y	
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25

* Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2**

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

** Nighttime Color Specification Limits for Pavement Marking Retroreflective Material With CIE 2° Standard Observer, Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A.

4. **Qualitative Requirements:** The finished paint shall meet the following qualitative requirements:

Condition in Container—Storage Stability. Within a period of twelve (12) months from the time of delivery and when examined in accordance with FTMS 141C (Method 3011.2), the paint shall not show excessive settling in a freshly opened full can and shall be easily redispersed with a paddle to a smooth homogeneous state. The paint shall show no undesirable characteristics to include curdling, livering, caking, gelling, or thixotropic properties, lumps, skins, or color separation. The consistency shall not change more than 5 Krieb Units from that of the original sample, the degree of settling shall have a rating of six (6) or better, and the drying time shall be as specified.

Skimming. The paint shall not skin within 48 hours in a three-quarter filled, tightly closed container when examined in accordance with FTS 141C (Method 3021.1).

Flexibility and Adhesion. The paint shall show no cracking, flaking, or loss of adhesion when tested as specified. Apply a wet film thickness of 0.005 inches with a film applicator to a 3- x 5-inch tin panel weighing 0.39 to 0.51 lbs. per sq. foot, previously cleaned with benzene and lightly buffed with steel wool. Dry the paint film at 70 to 80°F in a horizontal position for 18 hours, then bake in an oven at 122 ± 4°F (47.8 to 52.2°C) for two hours, and cool to room temperature for at least one-half hour. Bend over a 1/2-inch diameter rod and

examine, without magnification, in accordance with FMST 141C (Method 6221).

Water Resistance. The paint shall show no softening, blistering, loss of adhesion, or other evidence of deterioration, other than a slight loss in gloss when tested as specified. Apply a wet film thickness of 0.015 inches with a film applicator to a clean glass plate. Dry the paint film at 70 to 80°F in a horizontal position for 72 hours. Immerse one-half of the painted plate in distilled water in a vertical position at room temperature (70 to 80°F) for 18 hours in accordance with FTS 141C (Method 6011). Remove the painted plate from the immersion liquid, allow to air dry for two hours, and then examine.

Dilution Stability. The paint shall be capable of dilution with water with no separation, curdling, or precipitation observed when examined in accordance with FTS 141C (Method 4203.1), such that the wet paint can be readily cleanable with only water.

Spraying Properties. The paint as received shall have satisfactory spraying and hiding properties when applied by either airless or air-assisted type traffic stripers to glass or metal plates at a wet film thickness of 0.015 inches.

Bleeding. The paint shall have a minimum bleeding ratio of 0.97 when tested in accordance with Federal Specification TT-P-1952 B. The asphalt-saturated felt shall conform to ASTM D 226 (Type I).

Freeze-Thaw Stability. The paint shall show no coagulation or change in consistency greater than 5 Krieb Units when tested in accordance with TT-P-1952 B.

Heat Stability. The paint shall show no coagulation, discoloration, or change in consistency greater than 5 Krieb Units when tested in accordance with TT-P-1952 B. The degree of settling shall have a rating of six (6) or better when evaluated in accordance with ASTM D 869.

Abrasion Resistance. No less than 190 liters of sand shall be required for removal of the paint film when tested in accordance with TT-P-1952 B.

The manufacturer shall submit a "Certificate of Compliance" for each batch of paint produced for use under this specification. The certification shall contain the manufacturer's code number and batch number along with the test results of each batch for weight per gallon, viscosity, drying time, percent pigment, percent vehicle, and fineness of grind.

B. Epoxy Pavement Marking Paint

1. **General:** This specification provides for the classification of epoxy pavement marking systems by type. The plans will specify the type epoxy paint to be used.

Type I: A fast-cure material suitable for line applications but may require coning.

Type II: A slow-cure material suitable for all applications of pavement markings performed under controlled traffic conditions requiring coning.

2. **Certifications:** The manufacturer shall certify that the components meet the following requirements and shall furnish certified test results for each batch. The Contractor shall provide the Engineer with a copy of the manufacturer's product data sheet, instructions for surface preparation and material application at least one week before application work begins. Whenever the manufacturer's recommendations are more stringent than these provisions, the manufacturer's recommendations shall apply.

3. **Epoxy Material:** Furnish a two-component 100 percent solids epoxy material containing no fillers or pigment extenders. Follow the manufacturer's mixing ratio when mixing the two components. Mix the components within plus or minus 2 1/2 percent of the manufacturer's recommended mix ratio. No solvents are to be given off to the environment upon application to a pavement surface. The components, when combined, shall not contain or produce volatile solvents. Type II material shall be completely free of TMPTA (Tri-Methylol Propane Tri-Acrylate) and other multi-functional monomers. All materials shall be free of lead, cadmium, mercury, hexavalent chromium, and other toxic heavy metals as defined by the United States Environmental Protection Agency.

The Resin/Pigment component shall meet the following percentages by weight:

Pigment	White	Yellow
TiO ₂ , meeting ASTM D-476, Type II	18–25	12–17
Organic Yellow		7–9
Epoxy Resin	75–82	74–82

Test the epoxy content of the epoxy resin in accordance with ASTM D 1652 and calculate as the Weight per Epoxy Equivalent (WPE) for both white and yellow. Determine the epoxy content on a pigment-free basis. The accepted epoxy content range (WPE) is ±50 of the manufacturer's target value.

Ensure the Activator/Curing Agent meets the following requirements:

Test the amine value in accordance with ASTM D 2074. Ensure the total amine value meets the manufacturer’s target value with the acceptance range being ±50 of the target value.

a. Color:

White: The color shall be within the Chromaticity coordinates listed in Tables 1 and 2 when tested in accordance with ASTM E-1347 or ASTM E-1349

Yellow: The color shall match Federal Test Standard Number 595a, Color 13538, or shall be within the Chromaticity coordinates listed in Tables 1 and 2 when tested in accordance with ASTM E-1347 or ASTM E-1349.

TABLE 1

Color	Chromaticity coordinates (corner points)							
	x	Y	x	y	x	y	x	y
White	.355	.355	.305	.305	.285	.325	.335	.375
Yellow w	.560	.440	.490	.510	.420	.440	.460	.400
Color	Y values %							
	With Glass Beads		Without Glass Beads					
	Min	Max	Min	Max				
White	60	--	70	--				
Yellow w	30	--	35	--				

Table 1: Daytime Color Specification Limits for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE D65 Standard Illuminant

TABLE 2

Color	Chromaticity coordinates (corner points)							
	1		2		3		4	
	x	y	x	y	x	y	x	y
White	.480	.410	.430	.380	.405	.405	.455	.435
Yellow	.575	.425	.508	.415	.473	.453	.510	.490

Table 2: Nighttime Color Specification Limits for Pavement Marking Retroreflective Material With CIE 2° Standard Observer and Observation

Angle = 1.05° , Entrance Angle = 88.76° (beta angle 2 and epsilon = 0°) and CIE Standard Illuminant A

- b. **Shelf Life:** The individual components shall not require mixing prior to use when stored for a period of 12 months or less.
- c. **Adhesion Capabilities:** When the adhesion of the material to Portland cement concrete (the concrete shall have a minimum of 300 psi. tensile strength (2,070 kPa)) is tested in accordance with the American Concrete Institute Committee 503 testing procedure, the failure of the system must take place in the concrete. The concrete shall be a minimum of 90°F (32°C) when the material is applied, after which the material shall be allowed to cure for 72 hours at $73^\circ\text{F} \pm 5^\circ\text{F}$ ($23^\circ\text{C} \pm 2^\circ\text{C}$).
- d. **Abrasion Resistance:** When the abrasion resistance of the material is tested in accordance with ASTM C 501 with a CS-17 wheel under a load of 1,000 grams for 1,000 cycles, the wear index shall be no greater than 82. (The wear index is the weight in milligrams that is abraded from the sample under the test conditions.)
- e. **Hardness:** The Type D durometer hardness of the material shall not be less than 75 nor more than 90 when tested in accordance with ASTM D 2240 after the material has cured for 72 hours at $73^\circ\text{F} \pm 5^\circ\text{F}$ ($23^\circ\text{C} \pm 2^\circ\text{C}$).
- f. **Tensile Strength:** The tensile strength of the material, when tested in accordance with ASTM D 638, shall not be less than 6,000 psi. (42 MPa) after 72 hours cure at $73^\circ\text{F} \pm 5^\circ\text{F}$ ($23^\circ\text{C} \pm 2^\circ\text{C}$).
- g. **Compressive Strength:** The compressive strength of the material, when tested in accordance with ASTM D 695, shall not be less than 12,000 psi (83 MPa) after 72 hours cure at $73^\circ\text{F} \pm 5^\circ\text{F}$ ($23^\circ\text{C} \pm 2^\circ\text{C}$). The rate of compression of these samples shall be no more than 1/4 inch (6 mm) per minute.
- h. **Weather Resistance:** Apply the mixed epoxy, both white and yellow, at 15 mils ± 1 mil thick to 3- x 6-inch (75 mm x 150 mm) aluminum panels. Do not apply beads to the epoxy sample. Expose the cured sample in an Environmental Test Chamber meeting the requirements of ASTM G 53. Conduct the test for 80 hours at 122°F (50°C), alternating four-hour cycles of condensation and ultraviolet light.

C. Glass Beads

Glass beads for use with pavement marking paint shall be moisture resistant and shall meet the requirements of AASHTO M 247, Type I. The glass beads shall be without floatation properties. The glass beads shall have dual surface treatment

consisting of a moisture resistant silicone treatment, and silane adherence surface treatment. The glass beads shall have a minimum of 80 percent true spheres. Roundness shall be tested in accordance with SD 510.

D. Cold Applied Plastic Pavement Markings and Legends

This material shall consist of a homogeneous mixture of resins, plasticizers, fillers, pigments, and glass beads. The marking material shall be designed to adhere to bituminous and Portland cement concrete pavements. All cold-applied plastic pavement markings and legends shall be Type A unless otherwise specified.

Type A reflectorized plastic pavement marking shall consist of a homogeneous, extruded, prefabricated, pliant polymer material of specified thickness and width, which shall contain abrasion-resistant ceramic or ceramic coated beads bonded in a highly durable polyurethane topcoat. The material shall be fabricated with a patterned surface that presents a near vertical face to traffic to maximize retroreflectance. The pavement marking material shall be capable of being affixed to the pavement surface by means of a precoated, pressure-sensitive adhesive.

An adhesive activator supplied by the manufacturer shall be utilized on applications of this material when required by the product specification, except on newly installed asphalt when the surface temperature is 80°F or above, or when the material is inlaid at the time asphalt is being installed.

An acceptable brand of Cold-Applied Plastic Pavement Marking material known to meet the specific requirements outlined below is 3M Series 380I ES. Alternate brands will only be allowed if they are tested by an independent facility to verify conformity to the specifications. All costs for testing shall be the responsibility of the Contractor.

Type A Specific Requirements:

- 1. Reseal Test:** The plastic marking material shall reseal to itself when tested. Cut two 1" x 3" pieces of plastic. Overlap these pieces face-to-face for an area of 1 square inch on a flat steel plate with the adhesive backing material remaining in place. Center a 2.2 lb weight over the 1 square inch overlap area and place in an oven at 190°F for one hour. After cooling to 77°F, the pieces shall be inseparable without tearing.
- 2. Pull Test:** The plastic shall require a pull of 8 to 20 pounds to break. The elongation shall be no greater than 50 percent. The specimens for this test shall be Type 1 prepared in accordance with ASTM D 638. One-inch square pieces of carborundum extra coarse emery cloth, or its equivalent, may be applied at each end of the test specimens to prevent the plastic adhesive from adhering to the test equipment. The break resistance shall be based on an average of at least three samples, and the rate of pull shall be 1/4 inch per minute. This test shall be conducted at a temperature of 70°F to 80°F.

- 3. **Support Test:** A test specimen cut to dimension of 1 inch by 6 inches shall support a dead load of 6 pounds for 30 minutes. This test shall be conducted at a temperature of 70°F to 80°F.
- 4. **Color:** The plastic marking material shall meet the color specification limits and luminance factors listed in Tables 1 and 2 when tested in accordance with ASTM E1347 or ASTM E1349. The plastic marking material shall maintain the color and luminance factors provided in the following tables throughout its service life.

Table 1

Color	Chromaticity Coordinates (corner points)								Luminance Factor (Y %)	
	X	Y	X	Y	X	Y	X	Y	Minimum	Maximum
White	0.355	0.355	0.305	0.305	0.285	0.325	0.335	0.375	35	
Yellow	0.560	0.440	0.490	0.510	0.420	0.440	0.460	0.400	25	
Red	0.480	0.300	0.690	0.315	0.620	0.380	0.480	0.360	6	15
Blue	0.105	0.100	0.220	0.180	0.200	0.260	0.060	0.220	5	14

Daytime Color Specification Limits and Luminance Factors for Pavement Markings Material with CIE 2° Standard Observer and 45/0 (0/45) Geometry and CIE Standard Illuminant D65

Table 2

Color	Chromaticity Coordinates (corner points)							
	1		2		3		4	
	X	Y	X	Y	X	Y	X	Y
White	0.480	0.410	0.430	0.380	0.405	0.405	0.455	0.435
Yellow	0.575	0.425	0.508	0.415	0.473	0.453	0.510	0.490

Nighttime Color Specification Limits for Pavement Marking Retroreflective Material with CIE 2° Standard Observer and Observation Angle = 1.05°, Entrance Angle + 88.76° and CIE Standard Illuminant A

633.3 CONSTRUCTION REQUIREMENTS

- A. **General:** Traffic control for the pavement marking operations shall be in conformance with the MUTCD. Unless otherwise specified, all costs for traffic control shall be considered incidental to the various pavement marking bid items.

Any pavement markings not conforming to the specifications shall be removed. The removal shall be accomplished using suitable sand blasting, water blasting, or grinding equipment unless the Engineer authorizes other means. The removal process shall remove at least 90 percent of the deficient line with no excessive scarring of the existing pavement. The removal width shall be 1 inch wider all around the nominal width of the pavement marking to be removed. Removal shall be at Contractor’s expense with no cost incurred by the City.

B. Cold-Applied Plastic Pavement Marking and Legends:

1. **Width Tolerance:** Width shall be as specified with a tolerance of $\pm 1/8$ inch.
2. **Surface and Air Temperature:** The surface and air temperature shall meet the requirements of the manufacturer's specifications.
3. **Bonding:** To ensure a uniform bond of material to asphalt or concrete surfaces after initial laydown, rolling of the material with a truck wheel, car wheel, or heavy hand roller is required.
4. **Pavement Condition:** Pavement must be dry, free of dirt, dust, and oily substances.
5. **Lane Lines:** Lane lines shall not be placed over a longitudinal pavement joint and shall not be installed closer than 1/2 inch or more than 1 1/2 inches away from the joint. Lane lines shall not deviate more than 1 inch per 200 feet, nor shall any deviations be abrupt.
6. **Waste Disposal:** It shall be the responsibility of the Contractor to provide for disposal of empty material cartons, liner papers, etc.
7. **Molding and Sealing:** The material shall mold to the pavement contours, breaks, and faults by the action of traffic. The material shall have resealing characteristics, which enable the material to fuse with itself and with previously applied marking materials of the same composition without externally applied tackifiers or adhesives.
8. **Prefabrication:** Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD.
9. **Application Instructions:** The manufacturer shall supply proper application instructions and shall identify activators and adhesives which are to be used. A copy of the application instructions shall be provided to the Engineer prior to use. The plastic markings shall be manufactured and packaged in a manner which will permit storage at normal temperatures for up to one year after purchase.
10. **Uniformity:** The material shall have a uniform cross section and be free of air inclusions and other film abnormalities.
11. **Thickness:** The material shall be a minimum of 0.060 inch thick when measured without the precoated adhesive.
12. **Deterioration:** Material must exhibit no significant deterioration due to exposure to climatic conditions, sunlight, water, oil, gasoline, or salt.

- 13. Serviceability:** Material must be free of ragged edges, die line, cracks, discolorations, and other defects, which would affect serviceability.

C. Inlay on Asphalt Surface Installation Requirements:

- 1. Surface Temperature:** Surface temperature of the asphalt shall not be less than 120°F or more than 150°F.
- 2. Application:** Plastic pavement marking shall not be applied until compaction of the asphaltic mixture has been completed and all residual moisture has evaporated.
- 3. Initial Contact:** Pressure by foot or light hand roller shall be applied to ensure initial contact with the surface.
- 4. Final Rolling:** Final inlay shall be accomplished with the use of a 5- to 10-ton tandem roller.
- 5. Rolling Procedure:** The roller motion shall be slow at all times, and shall not be reversed when wheels are on the marking material. The roller shall run straight at all times. Turning or twisting of roller wheels on the material shall not be permitted.
- 6. Use of Water:** Water shall be shut off or reduced to a minimum on roller wheels when rolling in pavement marking material.

D. Pavement Marking Paint and Beads: Pavement marking paint shall be applied by machine. On special areas and markings that are not adaptable to machine application, hand application will be permitted.

The paint shall be used as furnished by the manufacturer. Thinner or diluent shall not be added. Filling tanks, pouring paint, or cleaning of equipment shall not be allowed on the pavement.

The pavement marking shall be applied during daylight hours when the ambient air temperature is above 45°F and the road surface is dry. The pavement shall be cleaned of dirt, loose stones, and other foreign material before the paint is applied.

The paint applicator shall be a self-propelled spraying machine with nozzles capable of applying a minimum of three lines at one time, each gun applying 4 to 8 inches wide.

During pavement marking operations on sections of roadway open to traffic, the Contractor shall protect the markings from tracking either by placing suitable traffic control devices or by utilizing a shadow vehicle. The work shall be arranged such that half of the traveled roadway will be open to traffic at all times.

The Contractor shall take the steps necessary to assure that the permanent pavement markings will match the markings on the existing surface.

The Contractor shall sweep the street within 24 hours prior to the application of the paint.

Tolerances:

1. The length of the painted stripe shall not vary more than plus or minus 3 inches from the plans requirement.
2. The width of the painted stripe shall not vary more than plus or minus 1/2 inch from the plans requirement.
3. The length of a 40-foot cycle length (stripe and gap) shall not vary more than 3 inches.
4. The alignment from the plans requirement or existing markings shall not vary more than plus or minus 2 inches.
5. The maximum longitudinal deviation from the existing markings at either end of the painted roadway segment shall not vary more than plus or minus 6 inches.
6. Lane lines shall not deviate more than 1 inch per 200 feet, nor shall any deviations be abrupt.

Any markings that deviate outside these tolerances will be removed and replaced by the Contractor at no cost to the City. Removal shall be performed utilizing equipment that is not detrimental to the final surface, as required by the Engineer.

The pavement marking paint shall be applied at a minimum wet thickness of 15 mils, equivalent to a dry thickness of 7 to 8 mils (A 4 inch wide stripe 320 feet long equals 1 gallon of paint at 15 mils thick or 105 square feet equals 1 gallon of paint at 15 mils thick). Glass beads shall be applied on the wet paint line at a minimum of 6 pounds of glass beads per gallon of paint. Restriping of pavement markings to meet this requirement and to provide a quality retroreflective line shall be at the expense of the Contractor with no additional cost to the City. Sections to be restriped shall be determined by the Engineer.

The paint shall be capable of being applied at paint temperature up to 160°F. When applied with glass beads at pavement temperatures above 45°F and at relative humidities of up to 75 percent, the paint shall dry to a no-track condition within three minutes.

- E. Groove Pavement for Pavement Marking:** Grooving will only be required for longitudinal pavement marking tape. Grooving will not be required for transverse pavement markings such as stop bars or crosswalks, arrows, or words. The

equipment shall be capable of performing uniform grinding for alignment and depth.

The grooving shall be performed by a self-propelled machine equipped with gang-mounted blades on a turning head. The equipment shall be capable of grooving the total width of the groove in one pass or be capable of grooving uniform depths with multiple passes. The equipment shall be capable of grooving double lines simultaneously or parallel lines to a uniform depth with two passes.

The grooving shall be performed within the following tolerances:

	Minimum Dimension	Allowable Variation
Depth of Groove	Material Thickness	+10 mils
Width of 4" Groove	4 1/2"	± 1/8"
Width of 6" Groove	6 1/2"	± 1/8"
Width of 8" Groove	8 1/2"	±1/8"
Width of 12" Groove	12 1/2"	±1/8"
Width of 24" Groove	24 1/2"	± 1/8"
Length of Skip Lines	10'6"	± 3"
Tapers at Ends of Lines	6" to 9"	
Between Double Lines	4"	± 1/2"

Lane lines shall not be placed over a longitudinal pavement joint and shall not be installed closer than 1/2 inch or more than 1 1/2 inches away from the joint. Lane lines shall not deviate more than 1 inch per 200 feet, nor shall any deviations be abrupt.

Priming and tape application shall only be performed on dry clean pavement in weather conditions acceptable to the Engineer and according to the pavement marking tape manufacturer recommendations. If the groove is exposed to traffic or adverse weather conditions overnight, the Contractor shall sand blast the groove prior to priming and applying tape.

F. Epoxy Pavement Marking Paint

- 1. Equipment:** Equipment furnished shall be designed to apply an epoxy pavement marking material and glass reflectorizing beads in a continuous or intermittent line pattern. The equipment shall be capable of placing stripes on the left and right sides. The left carriage shall be capable of placing two lines simultaneously with either line in a solid or intermittent pattern in yellow or white. The equipment shall be capable of accumulating the footage of paint applied per gun, individually, each day; and the gallons of paint applied each day. Only material application shall activate the footage accumulators. The readout shall be digital and shall not be adjustable. The equipment shall accurately meter the two components. The equipment shall produce and maintain the mixing head temperature meeting the manufacturer's

specifications. The equipment shall be equipped with a high-pressure air blast device that cleans the surface immediately ahead of the epoxy application.

The equipment shall be capable of applying glass beads in a pressurized system at a rate of at least 25 lb./gal synchronized with the spray guns. A greater bead application rate may be necessary to meet minimum levels of retroreflectivity. All guns on the spray carriages shall be in full view of the operator(s) during operation.

The equipment in the striping train shall have permanently mounted Type C flashing arrow boards. All vehicles shall be visible to oncoming or following traffic. All traffic control items that are mounted on the equipment shall be incidental to the other contract items. No separate payment will be made.

2. **Surface Preparation for Pavement Marking:** When specified in the plans, all pavement surfaces shall be ground lightly prior to the air blast and epoxy application. Light grinding is defined as surface abrasion 15 mils to 20 mils deep to establish a roughened surface free of surface treatments, laitance, loose paint chips, loose seal aggregate, and surface impurities. If the light grinding does not remove all of the existing or temporary pavement markings, the Contractor shall increase the grinding depth sufficient to remove the existing pavement marking material. Removal depth is measured vertically from the bottom of a 3-foot or longer straight edge placed on the roadway surface to the ground surface.

Meet the following removal limits:

- a. Grind not more than 2 inches wider than the stripe.
- b. Grind no more than 4 inches from the beginning or end of the stripe.
- c. Remove the remains of existing pavement marking.

Immediately following the surface preparation grinding, the Contractor shall broom the surface and vacuum up the removed residue with a vacuum truck or pickup broom.

3. **Application:** Pavement markings shall be placed in accordance with the details shown in the plans. When the epoxy pavement marking paint is to be placed over existing pavement markings, the surface preparation and the placement of the pavement markings shall be directly over the existing pavement marking patterns on the street. This requirement supersedes the 40-foot cycle standard. Markings shall not be applied when the wind or other conditions cause a film of dust to be deposited on the pavement surface before the material can be applied.

The Contractor shall place necessary control points for striping and to indicate necessary starting and cutoff points.

The epoxy material application shall be preceded by an air blast, minimum pressure of 100 psi, and shall immediately follow the pavement grinding. Placement of epoxy materials shall be only on clean, dry pavement with air and pavement temperatures at least 50°F and rising.

The Engineer may require brooming to ensure a clean, dry pavement surface free of deleterious material. All costs of brooming shall be incidental to the other contract items. No separate payment will be made.

Tracking of applied pavement marking will not be allowed. The Contractor shall adjust the pavement marking operation to prevent tracking. The “no-tracking” time shall be determined by passing over the line with a passenger car or pickup truck at a speed of 25 to 30 mph in a simulated passing maneuver. A line showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing “no-tracking” and conforming to the requirement for time to “no-track.”

All material heated over 140°F shall be discarded.

Glass beads shall be applied immediately after the placement of the epoxy.

The Contractor shall complete the painting application on all areas that have had the existing pavement marking removed by the end of each workday.

4. Minimum Application Rates and Retro-reflective Values

- a. **Epoxy Application Thickness:** 20 mils \pm 2 mils wet film thickness.
- b. **Glass Beads:** Glass beads shall be applied at a rate of at least 25 lb./gal. A greater bead application rate may be necessary for meeting minimum levels of retro-reflectivity.
- c. **Retro-reflective Values:** Ensure the pavement markings have the following minimum retro-reflective values (measured using a 30-meter geometry unit) once the loose beads are removed from the line:

White: 310 mcd/m²/lux

Yellow: 190 mcd/m²/lux

5. Application Tolerances:

The length of the painted stripe shall not vary more than plus or minus 3 inches from the plans requirement.

The minimum width of the painted stripe shall be its nominal width as required in the plans with 1/2 inch greater than nominal width allowed

provided the variation is gradual and does not detract from the general appearance.

The alignment from the plans requirement or existing markings shall not vary more than plus or minus 2 inches in 80 feet.

The maximum longitudinal deviation from the existing markings at either end of the painted roadway segment shall not vary more than plus or minus 6 inches.

- 6. Retro Reflective Testing:** The Contractor will be required to furnish a portable or mobile retroreflectometer conforming to 30-meter geometry to take retro-reflectivity readings on the pavement marking lines. The Contractor will be required to coordinate this testing with the Engineer and City personnel. City personnel will accompany the Contractor and will randomly select a minimum of two test locations per quarter mile from each of the street segments painted. The Engineer may order additional testing. Retro-reflectivity readings will be taken on each line at each test location. Segments not meeting the minimum requirements will be required to be corrected by the Contractor. No additional payment will be made for this testing and the costs to perform this work shall be considered incidental to the epoxy paint installation.

633.4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- A. Cold-Applied Plastic Pavement Marking:** Cold-applied plastic pavement marking of the width and color specified will be measured by the foot. Pavement marking of each width specified will be paid for at the contract unit price per foot. Payment will be full compensation for all material, labor, equipment, and incidentals necessary.

Measurement and payment for cold applied plastic pavement marking arrows and messages will be per each type specified. Payment will be full compensation for all material, labor, equipment, and incidentals necessary.

Measurement and payment for cold-applied plastic pavement marking used for areas shall be to the nearest square foot. Payment will be full compensation for all material, labor, equipment, and incidentals necessary.

- B. Pavement Marking Paint and Beads:** Measurement and payment for pavement marking paint will be as specified in the plans. Paint and beads will be measured to the nearest one-half gallon of paint or to the nearest foot of the width and color of paint specified. Paint and beads will be paid for at the contract unit price per gallon for each color of pavement marking paint or to the nearest foot of the width and color of paint. Payment will be full compensation for furnishing paint and beads and for labor, equipment, and incidentals necessary.

Measurement and payment for pavement marking paint and beads used for arrows and words will be per each type specified. Payment will be full compensation for furnishing paint and beads and for labor, equipment, and incidentals necessary.

Measurement and payment for pavement marking paint and beads used for areas shall be to the nearest square foot. Payment will be full compensation for furnishing paint and beads and for labor, equipment, and incidentals necessary.

- C. Groove Pavement for Pavement Marking:** Groove pavement for pavement marking will be measured to the nearest foot, along the length of the groove for the width of grooving specified in the plans. Grooving will be paid for at the contract unit price per foot for the width of groove specified. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

- D. Epoxy Pavement Marking Material:** Measurement and payment for epoxy pavement marking material will be as specified in the plans. Epoxy paint and beads will be measured to the nearest one-half gallon of paint or to the nearest foot of the width and color of paint specified. Epoxy paint and beads will be paid for at the contract unit price per gallon for each color of epoxy pavement marking paint or to the nearest foot of the width and color of paint. Payment will be full compensation for furnishing the epoxy paint and beads and for labor, equipment, and incidentals necessary.

Measurement and payment for epoxy pavement marking material and beads used for arrows and messages will be per each type specified. Payment will be full compensation for furnishing the epoxy paint and beads and for labor, equipment, and incidentals necessary.

Measurement and payment for epoxy pavement marking material and beads used for areas shall be to the nearest square foot. Payment will be full compensation for furnishing the epoxy paint and beads and for labor, equipment, and incidentals necessary.

- E. Surface Preparation for Pavement Marking:** Surface preparation for pavement marking will be measured to the nearest foot, along the length of the groove for the width of grooving specified in the plans. Surface preparation for pavement marking will be paid for at the contract unit price per foot for the width of surface preparation. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

Measurement and payment for surface preparation for pavement marking used for arrows and messages will be per each type specified. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

Measurement and payment for surface preparation used for areas shall be to the nearest square foot. Payment will be full compensation for equipment, labor, materials, and all incidentals required.

City of Canton
Standard Specifications
for
Traffic Signals
Section 635A

Revised: _____

635A.1 DESCRIPTION

This work consists of furnishing and installing materials and equipment necessary for the operation of traffic signals.

635A.2 MATERIALS**A. Electrical Grounding and Bonding:**

1. **Grounding Wire:** Grounding wire from power feed equipment to the ground rod shall be bare, soft drawn copper, size per NEC. Grounding wire from pole to ground rod shall be bare, soft drawn copper, minimum size No. 6 AWG.
2. **Bonding Conductors:** Bonding conductors shall be of the same size and insulation grade as the associated circuit conductors. Load size bonding jumpers shall not be smaller than the applicable size listed by the NEC, Table 250-95.
3. **Ground Rods:** Ground rods shall be copper-coated electrodes in accordance with Underwriters Laboratory (UL). The size and length shall conform to NEC requirements.

B. Electrical Conduit:

1. **Rigid Steel Conduit:** Conduit and fittings shall meet the requirements of UL 6 and 514 and shall be hot dip galvanized. Each section of conduit shall bear the UL label.
2. **Rigid Nonmetallic Conduit:** Conduit and fittings shall be polyvinyl chloride heavy wall meeting the requirements of UL 651 and 514. Use and installation of PVC Schedule 40 and 80 shall be in accordance with NEC Article 347 and each section shall bear the UL label. When nonmetallic conduit is to be used in areas subject to vehicular traffic, it shall be Schedule 80.
3. **Innerduct:** Innerduct conduit shall be SDR 13.5 polyethylene. The nominal duct size shall be as indicated in the plans.

C. Junction Boxes: Shall meet the following requirements:

Corrugated metal pipe shall conform to the requirements of AASHTO M 36.

Lid and cover assemblies for corrugated metal junction boxes shall be cast iron Neenah Foundry Co. R5900A Series or an Engineer approved equal. The word TRAFFIC shall be cast into the top of the cover.

All conduits, other than innerduct, coming into and leaving the junction box shall be rigid steel for at least 5 feet outside of the junction box. These conduits will

have a grounding bushing attached and a grounding wire installed to bond all conduits to the junction box using an appropriately sized terminal lug bolted to the wall of the junction box.

- D. Concrete Footings:** Concrete for traffic signal pole and controller cabinet footings shall meet the requirements for Class M6 concrete. Cement shall be Type II. Vertical reinforcement shall be deformed unless otherwise noted and shall conform to the requirements of ASTM A 615/AASHTO M31 Grade 40. Spiral reinforcing may also be fabricated from cold drawn wire conforming to ASTM A 82 or hot rolled plain bars conforming to ASTM A 651/AASHTO M31 Grade 40.
- E. Anchor Bolts:** The Contractor is responsible to contact the pole manufacturer and receive the manufacturer's recommendation on the proper anchor bolt selection meeting the specifications listed below.

Bolts conforming to ASTM A307, A449, and F1554 are allowed to be used for anchor bolts. Other materials may be submitted for approval providing the following information is submitted:

1. The allowable stresses that are to be used for design based on the proposed material.
2. Minimum average Charpy V-Notch impact values for 15 ft-lb at -20 degrees F in accordance with ASTM A370.
3. Ultimate wedge tensile strength in accordance with ASTM A370.
4. Yield strength reports in accordance with ASTM A370.

Anchor bolts shall be either threaded full length or equipped with a satisfactory mechanical end anchorage. Details for any mechanical end anchorage shall be included in the shop plans submittal for prior approval. Swaged anchor bolts and anchor bolts with hooked end anchorage are not allowed.

The anchor bolt threads shall be 3 inches plus the projection. At least 3 inches of threads shall be below the top of the concrete. Rolled UNC threads are required for all bolts.

Nuts shall conform to ASTM A194, 2H or ASTM A563, DH. All nuts are to be heavy hex.

Washers shall conform to ASTM F436 or ASTM F959.

Bolts, nuts, and washers shall be galvanized in accordance with ASTM A153 or B695, Class 50. The minimum length of galvanizing shall be the bolt projection plus 3 inches.

Bolt Testing: Bolt testing shall conform to the following:

When bolts conforming to ASTM A325, A449, A307, F1554, or others are designated for use in the plans and/or shop drawings, a Certified Mill Test Report for each type designated shall be submitted for approval to the Engineer a minimum of 14 days prior to incorporating these bolts into the work. Certified Mill Test Reports for nuts, washers, direct tension indicators, and other required hardware shall be included.

The Certified Mill Test Reports for the bolts shall include test results, tested in accordance with the applicable ASTM Specifications, for the following:

Test	A325	A449	A307	F1554	Others
Chemical Analysis	X	X	X	X	X
Hardness Test	X	X	X		X
* Tensile Strength (By Wedge Test Method)	X	X	X	X	X
** Proof Load Test	X	X	X	X	X
*** Rotational Capacity Test	X				
**** Charpy V-Notch				X	X

* Certified Mill Test Report shall state that Wedge Test Method was used. For ASTM A307 and A449 bolts, the Wedge Test Method is required only for square and hexagon head bolts. The Wedge Test Method is not required for ASTM F1554 bolts. See appropriate specifications.

** Proof Load Test and/or Yield Test as allowed or specified by the applicable ASTM Specification.

*** Rotational Capacity Test required for Zinc Coated (Galvanized) bolts only. This test shall be conducted using the actual nuts that are used on the project.

**** Anchor bolts conforming to ASTM F1554 Grade 36 and 55 shall satisfy Supplemental Requirement S4. Anchor bolts conforming to ASTM F1554 Grade 105 shall satisfy Supplemental Requirement S5.

Note: The requirements set forth in this table are to alert the Contractor to the requirements for testing and certification as specified in the applicable ASTM Specifications and are not intended to alter the requirements of the ASTM Specifications

Proof load tests on bolts (ASTM F606 Method 1) are required. Wedge testing of full size bolts is required in accordance with AASHTO M164 (ASTM A325). Galvanized bolts shall be wedge tested after galvanizing. Proof load tests (AASHTO M291) are required for the nuts and shall be performed after galvanizing, overtapping, and lubricating.

F. Electrical Power Cable: Electrical cables shall be type THW, THWN, or XHHW rated for 600 volts AC and be clearly and durably marked with the UL label, type of insulation, number of conductors, and the AWG size.

G. Traffic Signal Control Cable:

1. **Conductors:** Shall meet either of the two specifications below.
 - a. General Purpose Control Cable with stranded copper conductors, ICEA S-61-402, PE-PV Insulated (20-10), 600 volts.
 - b. General Purpose Control Cable, with stranded copper conductors, Aerial and Duct, IMSA 20-1, 600 volts.
2. **Colors:** Conductor insulation shall be colored in accordance with ICEA S-61-402, Appendix K, Table K-1 or IMSA 19-1 Table II.
3. **Markings:** The cable shall be marked with the name of the manufacturer, rated voltage, UL label, AWG size, and number of conductors.

H. Power Feed Equipment:

Meter Pedestal shall be Milbank U4322-0-5T95 Terminal, Single Meter Pedestal or approved equal.

Meter Pedestal shall be Milbank U4323-0-5T95 Terminal, Double Meter Pedestal or approved equal.

Shall meet NEMA standard for rain tight.

Size shall be as required to house required

components. Shall be rated for service entrance

equipment.

Required components:

1. A copper bus rated for the voltage, current, and phases required by the plans.
2. Branch circuit breakers meeting plan requirements for amps, voltage, and phases. Minimum A.I.C. shall be 10,000.

I. Preformed Detector Loops: The preformed detector loops shall be any one of the following three models: Patriot-Detection LLC Model CG16MMC, De-Tech Manufacturing Model HDR, and Never-Fail Model LS. All preformed detector loop shall be 6 feet x 6 feet square unless shown differently on the plans. All loops shall be constructed with four (4) turns of wire. The lead-in lengths shall be as specified

on the plans.

- J. Traffic Counter Surface Utility Box:** The Traffic Counter Surface Utility box shall be an Emerson Network Power model number UPCBD2. The terminal strip shall be as detailed on the standard plate.
- K. Emergency Vehicle Preemption (EVP) Equipment:** EVP detector cable shall be as approved by the manufacture. The plans shall indicate the manufacture of the EVP equipment.

Mounting hardware shall consist of 3/4-inch NPT electrical pipe materials including a malleable Iron "T" approved for rain tight locations, threaded nipples, and single lamp holder approved for outdoor use. The use of a PELCO AB-0155-42 Band Mount Mini-Brac, or approved, equal shall be used where no integrated threaded outlet exists on the mast arm. The confirmation lamp shall be a 90-watt flood lamp rated for outdoor use.

Confirmation lights shall be wired with IMSA 19-1, 2, or 3 - #14 AWG stranded wire cable for single direction indication and IMSA 19-1, 3 - #14 AWG stranded wire cable for dual direction indications.

635A.3 CONSTRUCTION REQUIREMENTS

A. General

Installations shall comply with applicable sections of the NEC, state regulations, and local ordinances. Licenses or permits required shall be obtained by and at the expense of the Contractor.

The Contractor shall be responsible for the locating of all traffic signal infrastructure from the start of the project until the traffic signal work has been accepted and the as-built information has been provided to the City.

Equipment and materials furnished shall be new.

The Contractor shall arrange for necessary electrical services at locations specified, which have previously been agreed to by the City and the utility company.

All cables shall be permanently identified in hand holes, junction boxes, pedestal bases, and controller cabinets. Labels to identify cables shall be plastic adhesive tape which is clearly and legibly embossed or printed with numerals and letters and permanently attached to the cable.

- B. Final Inspection:** Upon completion of the traffic signal installation or associated work, the Contractor (and electrical subcontractor if applicable) shall complete a Traffic Signal Inspection with the Engineer and City to assure that all installation items are completed. The Engineer will provide a punch list of traffic signal items

requiring Contractor's completion prior to final acceptance.

- C. Warranties and Maintenance:** The Contractor is responsible for routine maintenance including providing emergency power to the traffic signal until the signal system has been accepted by the City. Upon acceptance, the Contractor shall be relieved of routine maintenance responsibility.

The Contractor must provide a one-year warranty on the traffic signal system from the time the system is accepted. The Contractor is not responsible for providing a one-year warranty on City-furnished materials, except they shall be responsible for the replacement or repair of City-furnished materials damaged due to poor workmanship or negligence.

Warranties and guarantees offered by electrical and mechanical equipment manufacturers on Contractor-furnished materials shall be turned over to the City and the City shall be named as the obligee.

- D. Removal Signal Pole Footings and Controller Cabinet Footings:** The Contractor is to completely remove all signal pole and controller cabinet footings when specified. When field conditions prevent a signal pole footing from being completely removed, the footing, anchor bolts, and all pipes shall be removed to a depth of 2 feet below the final grade.
- E. Salvage Signal Equipment:** The Contractor shall be responsible to salvage all signal equipment specified including signal poles, mast arms, traffic signal heads, controller cabinets including controller, signal and power cables, and junction box frame and lids. This equipment will be removed and returned to the Canton Shop in the same condition in which it was found at the beginning of the project. Any salvaged equipment damaged during removal or transportation will be replaced at the expense of the Contractor. Electrical cables shall not be cut further than 4 inches from the terminations and be neatly coiled.
- F. Electrical Grounding and Bonding:** Grounding and bonding of electrical power feeds shall be in strict compliance with the National Electrical Code (NEC), local ordinances, and local utility company rules.
- G. Electrical Conduit:** Unless otherwise specified, the electrical conduit will be furnished and installed by the Contractor.

Unless otherwise specified in the plans or required by the NEC, the type of conduit shall be:

RGSC shall be used to connect all junction boxes, traffic signal footings, and controller cabinets at a signalized intersection.

Innerduct shall be used on all fiber optic cable runs between junction boxes away from signalized intersections. RGSC shall be used to sleeve innerduct conduit under roadways. RGSC shall be used in the short segments between

the junction box and controller cabinet or between junction boxes at the signalized intersections for fiber optic cable. All innerduct conduits shall include a 1c #12 trace wire. The trace wire shall be continuous from junction box to junction box. The trace wire shall be spliced using a Buchanon crimp sleeve and left bare (insinuated). The trace wire shall be considered incidental to the cost of the conduit.

All innerduct conduits shall be sealed using TDUX Inflatable Sealing System manufactured by Tyco Electronics.

Use and installation shall conform to NEC and the following requirements:

1. The size of the conduits installed shall not be less than the electrical trade size specified.
2. The location and direction of conduit runs is diagrammatic and may be shifted to meet field conditions.
3. The minimum depth for all RGSC and Rigid Nonmetallic Conduit is 24" The minimum depth for all Innerduct is 36".
4. Underground conduit shall be placed by trenching, jacking, or drilling methods. The use of the trenching method for placement under existing roadway pavements will be permitted only after jacking or drilling attempts have failed. The Contractor shall not use a machine requiring flowing water for installation of conduit under streets or roadways unless approved by the Engineer.

Trenches shall be backfilled and compacted to the same density as the adjoining ground. Roadway surfaces, sidewalks, curb and gutters, sod, etc., which are removed by trenching operations shall be replaced. The cost of removing and replacing these materials shall be incidental to the bid price for the conduit.

5. Where trenching operations require the removal of concrete pavement or sidewalk, the concrete shall be sawed full depth along the removal lines or the concrete shall be removed to existing joints.
6. Metal conduit open ends in junction boxes or above concrete foundations shall be provided with an approved threaded conduit grounding bushing.

Nonmetallic conduit open ends shall have an approved bell end or bushing installed to prevent damage to cable or conductors.

7. Metal conduit ends shall be reamed to remove sharp edges and burrs. Couplings shall be tightened until the ends of the conduit are brought together.

- H. Tie to Existing Conduit, Signal Footing, or Junction Box:** When specified, the Contractor shall tie the proposed conduit to or into an existing conduit, signal footing, or junction box. The Contractor shall furnish all materials to properly tie into the specified location.
- I. Junction Boxes:** Unless otherwise specified, the junction boxes will be furnished and installed by the Contractor.

The top of the junction box cover shall be flush with final surfaced areas. The top of the junction box must match the grade of the surrounding surface.

The diameter of the holes in the junction or pull box walls shall be no more than 1/4 inch larger than the diameter of the conduit. The area around the conduit shall be sealed with a material that will prevent dirt intrusion into the junction box.

- J. Concrete Footings:** The bottom of concrete footings shall rest on firm ground. The sides of the footings shall be formed by using an auger and then placing the concrete against the natural soil. A suitable form shall be used above existing ground line and all exposed portions shall be formed to present a neat appearance. An acceptable form shall be used if the excavation is larger than the standard footing dimensions. Backfill must be replaced to a density equal to or greater than adjacent undisturbed natural soil. Finished base shall be level and have steel trowel finish.
- K. Anchor Bolts:** Anchor bolts shall be installed as specified in the plans or by the manufacturer.
- L. Electrical Power Cables:** Unless otherwise specified, the electrical power cables will be furnished and installed by the Contractor.

Cables shall be installed using methods that will not injure the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer recommendations and the use shall not injure the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

The Contractor may provide power feed cables with conductor AWG size larger than specified where conduit fill requirements are not exceeded. All power feed cables must extend from terminal to terminal for circuits used with no splices allowed.

- M. Traffic Signal Control Cables:** Unless otherwise specified, the traffic signal control cables will be furnished and installed by the Contractor.

Traffic signal conductors shall be continuous from the controller cabinets to the pole bases. Splices from the signal control cables to the signal head cables shall only be done in the signal pole bases. All traffic signal heads shall be wired with IMSA multi-conductor cables.

Cables shall be installed using methods that will not injure the jacket, insulation, or conductors. All cables within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer recommendations and the use shall not injure the cable.

The Contractor may substitute a multiple conductor cable having more conductors than specified if conduit fill requirements are not exceeded, subject to approval by the Engineer.

The Contractor shall leave no more than 6 feet of excess cable in the cabinet.

The Contractor shall use Buchanan crimp connectors and insulating caps on all wire terminations in the signal bases. All cable splices shall be suspended off the signal pole footing surface with capped end up to shed water.

The Contractor shall furnish and install approved strain relief devices on all cables exiting the mast arm.

N. Power Feed: The power feed shall be furnished and installed by the Contractor.

Power feed equipment shall be installed in accordance with the plans and the manufacturer's recommendations. The power feed shall be exclusively for traffic signals and shall be permanently marked on the exterior with the address of the location and the word "TRAFFIC."

O. Signal Poles: The signal poles will be furnished and installed by the Contractor.

The following shall apply to traffic signal poles:

1. Poles shall be plumb after the bracket arms, signal heads, fittings, and fixtures have been installed and connections have been made. Nuts shall be firmly tightened as per manufacturer's recommendations. Signal heads shall be mounted plumb.
2. Field repair of damaged galvanizing shall be done in accordance with AASHTO M36.
3. If the gap between the concrete footing and the signal pole base is greater than 1/4 inch, it shall be sealed and provide an approved drain hole.
4. When a luminaire arm is specified to be installed as part of the signal pole the

luminaire arm shall be considered part of the signal pole installation and will include furnishing and installing the UF wire, luminaire arm, luminaire, bulb, and photo eye.

P. Controller Cabinet:

1. The controller cabinet will be furnished and installed by the Contractor.
2. The controller cabinet shall be installed according to the directions supplied by the manufacturer. A 100% silicone caulk shall be used to seal the cabinet flange to the concrete footing to prevent the incursion of water and shall be placed the total distance of the flange.
3. Wiring and connections in the controller cabinet shall be neat, firm, and in accordance with industry standards.
4. Two sets of wiring diagrams and one maintenance and operation manual shall be supplied for each controller that is required. The Contractor shall place all diagrams and manuals in the controller cabinet.
5. If the controller cabinet base is not located next to a sidewalk, the Contractor shall provide a 3-foot by 4-foot, 4-inch-thick concrete pad in front of the controller base. The cost shall be considered incidental to the controller cabinet footing unless there are other sidewalk bid items included in the contract.

Q. Controller: The controller and all other cabinet components will be furnished and installed by the Contractor.

The installation of controller and all other cabinet components and location in the cabinet shall be accordance with directions supplied by the manufacturer.

R. Battery Backup System: The Contractor shall furnish and install battery backup equipment, consisting of the batteries and the control unit. The Contractor shall follow the manufacturer's installation instructions.

When the battery backup equipment is installed in a new traffic signal cabinet, the automatic transfer switch is already wired into the cabinet. If installed in an existing cabinet, the Contactor shall furnish and install an automatic transfer switch according to manufacturer's instructions. If this installation of the automatic transfer switch is required, it shall be noted on the plan sheet.

If the existing traffic signal cabinet does not have room to store the battery backup equipment, the Contractor shall furnish and install either a NS-Riser unit for a

Type P signal cabinet or an Alpha BSM-4 Battery Side Module enclosure to be mounted on the existing cabinet. The plans will note if this is required and what type to furnish.

S. Detector Loops:

Unless otherwise specified, the preformed detector loops and sawed-in detector loops will be furnished and installed by the Contractor.

1. Clearance Between Loops and Metallic Objects: The Contractor shall provide sufficient clearance between detector loops and metallic objects such as manhole covers, drop inlets, etc., to avoid interference with the operation of the loop.

2. Sawed-in Detector Loops:

Lead-in saw cuts shall clear each other by a minimum of 1 foot.

Backer rod material (if needed) shall be cut into 1-inch by 2-inch lengths and spaced not farther apart than 2 feet.

Saw slots in the pavement shall be blown out with compressed air and shall be clean and free of loose grit and moisture when wires are placed and sealer is applied.

The flexible imbedding loop sealer shall be placed into the bottom of the saw cut to allow the loop sealer to get under the loop wire (or lead-in wire) during installation. The loop wires shall be pushed into the sawed slots with a blunt wood stick (not with a screwdriver). The wires shall be laid in the slots so there are no kinks or curls and without straining or stretching the insulation.

The flexible embedding sealer shall completely surround the 1/4-inch tube, displace all the air within the sawed slot, and fill the area of the sawed slot except for that area which is taken up by the backer rod and the wires.

Conductor size for loops and leads shall not be smaller than 14 AWG stranded copper meeting IMSA Spec. 51-5, Type XHHW, with Polyethylene tube jacket.

Lead-ins shall be twisted at least five (5) turns per foot.

Splices shall not be made in the loop or lead-in conductors, except in the junction box. All splices are to be done in the field where the installation of the loop takes place.

Lead-in conductors shall be permanently labeled in the junction box. Each lead-in conductor shall extend into the junction box a minimum of 6 feet. The home-run cable shall also extend a minimum of 6 feet into the junction box.

3. Preformed Loops:

Preformed loops are to be placed in the surface of the base course prior to placement of proposed pavement.

Preformed loops are to be centered under each proposed driving lane. The exact location of the loop will be determined in the field by Traffic Engineering personnel.

All conductors leading from each loop to the junction box or surface utility box may be placed in the same trench.

- 4. Lead-ins:** Lead-in conductors shall be twisted at least one turn per foot. Splices shall not be made in the loop or lead-in conductors except in the junction box. Lead-in conductors shall be permanently labeled in the junction box. Each lead-in conductor shall extend into the junction box a minimum of 6 feet. The home-run cable shall also extend a minimum of 6 feet into the junction box.

5. Splices in Junction Boxes: Splices shall be as follows:

Crimping bare connectors with a non-insulated butt connector and soldering with a soldering iron (not a torch) with sufficient heat applied to the splice. Cold soldered joints are not acceptable.

Splices shall be insulated to prevent electrical shorting and encapsulated with an epoxy encapsulating kit.

The bare drain wire from the home-run cable shall be cut at the jacket and insulated with electrical tape.

- 6. Loop Connections in the Controller Cabinet:** Terminal board screws shall be turned down tightly on the lug. Shielding shall be grounded at the controller only.

- 7. Loop Testing:** After installation, each loop shall be tested by the Contractor. Necessary test equipment shall be furnished by the Contractor and test results recorded and furnished to the Engineer. Each detector loop shall conform to the following:

Continuity:	5 ohms maximum
Resistance, loop to ground:	100 megaohms minimum
Inductance:	100–500 micro henries

Ground resistance reading shall read greater than 100 megaohms to ground, measured on a 500-volt DC megger or larger.

T. Traffic Counter Surface Utility Box: The Contractor will be required to furnish and install the traffic counter surface utility box, one 8-foot-long by 2-inch-square telspar post, and two 4- by 8-inch white delineators at each specified location.

U. Vehicular and Pedestrian Traffic Signal Heads:

1. The vehicular and pedestrian traffic signal heads will be furnished and installed by the Contractor.
2. Signal heads are to be rigidly attached to signal poles and shall be vertical from the street approach, which they control. All heads shall be level and plumb. All signal heads mounted on the same mast arm shall be level across the bottom of the back plates. Side of pole signal heads shall be mounted on the side of the pole away from the street.
3. Signals heads, which are mounted in place, but are not in operation, shall be hooded, have the lenses blocked, or positioned so the lenses are not visible to any approach.
4. Backplates for three and five-section signal heads shall be attached using zinc plated #10x1/2" hex head tapping screws and zinc plated 3/16"x3/4" fender washers. These screws and washers shall be considered incidental to the cost of mounting the signal head.

V. Pedestrian Push Buttons, Pedestrian Crossing Signs, and Pedestrian Push Button Pole:

1. The pedestrian push buttons will be furnished and installed by the Contractor. All other materials including push button pole, pedestrian crossing signs, and conduit shall be furnished and installed by the Contractor.
2. Pedestrian push buttons shall be accessible a maximum horizontal distance of 10 inches from an asphalt or concrete surface that does not exceed a 2 percent slope in any direction and is at least 36 inches by 48 inches.
3. Pedestrian push buttons shall be mounted at a nominal height of 42 inches above the surface the button is accessible from. All pedestrian push buttons shall be mounted using 1/4-inch – 20 bolts, stainless or zinc coated.
4. Pedestrian push buttons shall be mounted on the traffic signal pole whenever possible. If necessary to meet ADA requirements, the Contractor must mount the pedestrian push button on a push button pole(telspar post) as specified.
5. The Contractor shall furnish and install the appropriate pedestrian crossing sign at each location a push button is installed.

- W. Emergency Vehicle Preemption (EVP) Equipment:** The Contractor shall furnish and install EVP detector heads and the EVP controller unit. The Contractor shall furnish and install the approved EVP detector cable, confirmation lights, sockets, and confirmation light cable. The Contractor shall also be responsible to furnish and install all mounting hardware for both the detector heads and confirmation lights.

The EVP detector cable and the confirmation light cable shall be a continuous section from termination point in traffic signal cabinet to the EVP detector and confirmation light terminals.

EVP detector heads and confirmation lights shall be mounted to the signal mast arm approximately 6 feet from the tip of the mast arm using 3/4-inch NPT electrical pipe materials including a malleable Iron "T" approved for rain-tight locations, threaded nipples, and single lamp holder approved for outdoor use. The use of a PELCO AB-0155-42 Band Mount Mini-Brac, or approved, equal shall be used where no integrated threaded outlet exists on the mast arm. All equipment shall be securely mounted to be level/plumb and retain its alignment.

Confirmation lights shall be wired with IMSA 19-1, 2, or 3 - #14 AWG stranded wire cable for single direction indication and IMSA 19-1, 3 - #14 AWG stranded wire cable for dual direction indications.

635A.4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- A. Tax on City-Furnished Traffic Materials:** Measurement and payment for tax on City-furnished material will be on a lump sum basis. The estimated amount of tax will be listed in the contract documents and final payment will be adjusted based on the final value of the City-furnished material.
- B. Remove Signal Pole Footing and Remove Controller Cabinet Footing:** Measurement will be per actual number of signal pole or controller cabinet footings removed. Payment will be at the contract unit price per each and shall be full compensation for all labor, equipment, and incidentals.
- C. Salvage Signal Equipment:** Measurement and payment for salvaging traffic signal equipment will be on a lump sum basis. Payment will be full compensation for all labor, equipment, and incidentals.
- D. Electrical Grounding and Bonding:** No field measurement will be made. The cost of furnishing and installing conduits for grounding will be incidental to the cost of footing, power feed equipment, junction box, or controller cabinet to be grounded.
- E. Electrical Conduit:** The plan shown quantity of each type and size specified will be the measured quantity unless changes are ordered by the Engineer. Conduit of each type and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.

- F. Tie to Existing Conduit, Signal Footing, or Junction Box:** Measurement will be by actual count of the various types of connections made. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- G. Junction Boxes:** Measurement will be by actual count of the various types and sizes of junction boxes furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- H. Concrete Footings:** Concrete footings of the various diameters will be measured to the nearest vertical foot furnished and installed. Payment for concrete footings of the various diameters will be at their respective contract unit prices per foot. Payment will be full compensation for all materials, labor, and incidentals necessary to furnish and install the footings.
- I. Controller Cabinet Footing:** Measurement will be by the actual count of controller cabinet footings furnished and installed for each type and size specified. Controller cabinet footings will be paid for at the contract price per each. Payment will be full compensation for all required materials, labor, and incidentals to furnish and install the controller cabinet footings including the ground rod, 3/4 PVC conduit, and anchors
- J. Anchor Bolts:** Measurement will be by actual count of anchor bolts furnished and installed in each footing. Cost for anchor bolts will be at the contract unit price per each.
- K. Electrical Power Cable:** The plan shown quantity of each type, number of conductors, and size specified will be the method of measurement unless changes are ordered by the Engineer. Electrical power cable of each type, number of conductors, and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- L. Traffic Signal Control Cable:** The plan shown quantity of each type, number of conductors, and size specified will be the method of measurement unless changes are ordered by the Engineer. Traffic signal control cable of each type, number of conductors, and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- M. Power Feed Equipment:** Measurement will be by actual count of the type of power feed locations furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing power feed equipment including meter panel and base, circuit breakers, fuses, contactor, manual on/off switch, power cables and conduit between the transformer and meter pedestal, and other materials and fixtures

required. Any fees charged by the power company associated with the power feed hookup will be the responsibility of the City.

- N. Install Signal Poles:** Measurement will be by actual count of the various types and sizes furnished and installed. Payment for furnishing and installing signal poles of the various types will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- O. Install Signal Heads:** Measurement will be by actual count of the various types and sizes of signal heads furnished and installed. Payment for this item for the various sizes will be at the contract unit price per each. Payment will be full compensation for furnishing, installing and wiring signal heads including mounting hardware, brackets, and back plates.
- P. Install Controller Cabinet:** Measurement will be by actual number of controller cabinets furnished and installed. Payment for furnishing and installing controller cabinets will be at the contract unit price per each. Payment will be full compensation for materials, required labor, equipment, and incidentals.
- Q. Install Traffic Signal Controller and Cabinet Wiring:** No field measurement will be made. Costs for furnishing and installing the traffic signal controller, cabinet components, and all cabinet wiring will be included in the contract unit price for the controller cabinet.
- R. Install Battery Backup System:** Measurement will be actual count of battery backup systems furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- S. Preformed Detector Loops:** Measurement will be actual count of preformed detector furnished and installed at traffic signals or permanent traffic counter locations. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- T. Sawed-in Detector Loops:** Measurement will be actual count of sawed-in detector loops furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required labor, material, equipment, and incidentals.
- U. Traffic Counter Surface Utility Box:** Measurement will be actual count of traffic counter surface utility boxes furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals. Materials include the box, terminal strip, 8-foot-long by 2-inch-square telspar post, and delineators. Payment also includes costs for wiring the loops into the box.
- V. Install Pedestrian Push Buttons:** Measurement will be by the actual count of pedestrian push buttons furnished and installed based on their respective

installation type. Payment for this item will be at the contract unit price per each. Payment will be full compensation for all materials, labor, equipment, and incidentals..

- W. Pedestrian Crossing Sign and Pedestrian Push Button Pole:** Measurement will be by the actual count of pedestrian signs and push button poles(telspar posts) furnished and installed. Payment for these items will be at the contract unit price per each. Payment will be full compensation for all materials, labor, equipment, and incidentals.
- X. Emergency Vehicle Preemption (EVP) Unit:** Measurement will be per each type of EVP detector head and EVP controller unit. Measurement for EVP cable and confirmation light cable will be measured to the nearest foot. Payment for EVP detector heads and controller units will be at the contract unit price per each. Payment for EVP cable and confirmation light cable will be at the contract price per foot. Payment will be full compensation for all materials, labor, equipment and incidentals. The confirmation socket and bulb are considered incidental to the detector heads.

City of Canton
Standard Specifications
for
Roadway Lighting
Section 635B

Adopted: _____

635B.1 DESCRIPTION

This work consists of furnishing and installing materials and equipment necessary for the operation of roadway lighting.

635B.2 MATERIALS**A. Electrical Grounding and Bonding**

1. **Grounding Wire:** Grounding wire from power feed equipment to the ground rod shall be bare, soft drawn copper, size per NEC.
2. **Bonding Conductors:** Bonding conductors shall be of the same size and insulation grade as the associated circuit conductors. Load size bonding jumpers shall not be smaller than the applicable size listed by the NEC, Table 250-66.
3. **Ground Rods:** Ground rods shall be copper coated electrodes in accordance with Underwriters Laboratory (UL). The size and length shall conform to NEC requirements.

B. Electrical Conduit

1. **Rigid Steel Conduit:** Conduit and fittings shall meet the requirements of UL 6 and 514 and shall be hot dip galvanized. Each section of conduit shall bear the UL label.
2. **Rigid Nonmetallic Conduit:** Conduit and fittings shall be polyvinyl chloride heavy wall meeting the requirements of UL 651 and 514. Use and installation of PVC Schedule 40 and 80 shall be in accordance with NEC Article 347 and each section shall bear the UL label.

3. **Innerduct:** Innerduct shall be Schedule 40 high density polyethylene and shall bear the UL label. The nominal innerduct size shall be as indicated in the plans and the innerduct shall be red in color.

C. Junction Boxes: Shall meet the following requirements:

Corrugated metal pipe shall conform to the requirements of AASHTO M 36.

Lid and cover assemblies for corrugated metal junction boxes shall be cast iron Neenah Foundry Co. R5900A Series or an Engineer approved equal. The word "ELECTRIC" shall be cast into the top of the cover.

- D. Concrete Footings:** Concrete for traffic signal pole and controller cabinet footings shall meet the requirements for Class M6 concrete. Cement shall be Type II. Vertical reinforcement shall be deformed unless otherwise noted and shall conform to the requirements of ASTM A 615/AASHTO M31 Grade 40. Spiral reinforcing may also be fabricated from cold drawn wire conforming to ASTM A 82 or hot rolled plain bars conforming to ASTM A 651/AASHTO M31 Grade 40.

- E. Electrical Power Cable:** Electrical cables shall be type THW, THWN, or XHHW rated for 600 volts AC and be clearly and durably marked with the UL label, type of insulation, number of conductors, and the AWG size.

F. Power Feed Equipment

Meter Pedestal shall be Milbank U4322-0-5T95 Terminal, Single Meter Pedestal, or approved equal.

Meter Pedestal shall be Milbank U4323-0-5T95 Terminal, Double Meter Pedestal, or approved equal.

Shall meet NEMA standard for rain tight.

Size shall be as required to house required components.

Shall be rated for service entrance equipment.

Required components:

1. A copper bus rated for the voltage, current, and phases required by the plans.
2. Branch circuit breakers meeting plan requirements for amps, voltage, and phases. Minimum A.I.C. shall be 10,000.

635B.3 CONSTRUCTION REQUIREMENTS**A. General**

Installations shall comply with applicable sections of the NEC, state regulations, and local ordinances. Licenses or permits required shall be obtained by and at the expense of the Contractor.

The Contractor shall be responsible for the locating of all roadway lighting infrastructure from the start of the project until the roadway lighting work has been accepted and the as-built information has been provided to the City.

Equipment and materials furnished by the Contractor shall be new.

The Contractor shall arrange for necessary electrical services at locations specified, which have previously been agreed to by the City and the utility company.

The Contractor will make all line to line connections in all light bases, junction boxes, and meter locations. It will be the responsibility of the Contractor to contact the City when the system is ready to be hooked up.

- B. Remove Luminaire Pole Footing:** The Contractor is to completely remove the luminaire footings when specified. When field conditions prevent a luminaire pole footing from being completely removed, the footing shall be removed to a depth of 2 feet below the final grade.
- C. Salvage Luminaire Pole:** The Contractor is responsible to salvage luminaire poles as specified. The base, pole or shaft, luminaire arm, and luminaire are all considered part of the luminaire pole. The luminaire pole will be removed undamaged and returned to the City Shop. The base, luminaire arm, and luminaire shall be removed from the pole or shaft prior to delivery to the Light Department. Any salvaged poles damaged during removal or transportation will be replaced at the expense of the Contractor.
- D. Remove Street Light Wire:** The Contractor is responsible to remove all electrical wire within electrical conduits on the project limits.
- E. Electrical Grounding and Bonding:** Grounding and bonding of electrical power feeds shall be in strict compliance with the National Electrical Code (NEC), local ordinances, and local utility company rules.

- F. Electrical Conduit:** Unless otherwise specified, the electrical conduit will be furnished and installed by the Contractor.

Use and installation shall conform to NEC and the following requirements:

1. Unless otherwise specified or required, all PVC conduits shall be schedule 40.
2. When PVC conduit is specified, the Contractor has the option to install innerduct in lieu of PVC conduit. When innerduct is used, PVC conduit will still be required to be used entering and within the footings and junction boxes. The Contractor must use the proper PVC/innerduct connections at these locations.
3. The size of the conduits installed shall not be less than the electrical trade size specified.
4. The location and direction of conduit runs is diagrammatic and may be shifted to meet field conditions.
5. The minimum depth of conduit installation is 24 inches.
6. Underground conduit shall be placed by trenching, jacking, or drilling methods. The use of the trenching method for placement under existing roadway pavements will be permitted only after jacking or drilling attempts have failed. The Contractor shall not use a machine requiring flowing water for installation of conduit under streets or roadways unless approved by the Engineer.

Trenches shall be backfilled and compacted to the same density as the adjoining ground. Roadway surfaces, sidewalks, curb and gutters, sod, etc., which are removed by trenching operations shall be replaced. The cost of removing and replacing these materials shall be incidental to the bid price for the conduit.

7. Where trenching operations require the removal of concrete pavement or sidewalk, the concrete shall be sawed full depth along the removal lines or the concrete shall be removed to existing joints.
8. Metal conduit open ends in junction boxes or above concrete foundations shall be provided with an approved threaded conduit grounding bushing.

Nonmetallic conduit open ends shall have an approved bell end or bushing installed to prevent damage to cable or conductors.

9. Metal conduit ends shall be reamed to remove sharp edges and burrs. Threads on threaded conduit shall be painted with a good quality lead or rust preventive paint as the couplings are made up. Couplings shall be tightened until the ends of the conduit are brought together.

10. Stubbed ends shall be capped.

G. Tie to Existing Conduit, Light Base, Junction Box, or Power Source: When specified, the Contractor shall tie the proposed conduit into an existing conduit, light base, junction box, or power source. The Contractor shall furnish all materials to properly tie into the specified location. The power feed shall be furnished and installed by the Contractor including the electrical power cables between the transformer and meter pedestal.

H. Junction Boxes: Unless otherwise specified, the junction boxes will be furnished and installed by the Contractor.

The top of the junction box cover shall be flush with final surfaced areas. The top of the junction box must match the grade of the surrounding surface.

The diameter of the holes in the junction or pull box walls shall be no more than 1/4 inch larger than the diameter of the conduit. The area around the conduit shall be sealed with a waterproof silicon sealant.

I. Concrete Footings: The bottom of concrete footings shall rest on firm ground. The sides of the footings shall be formed by using an auger and then placing the concrete against the natural soil. A suitable form shall be used above existing ground line and all exposed portions shall be formed to present a neat appearance. An acceptable form shall be used if the excavation is larger than the standard footing dimensions. Backfill must be replaced to a density equal to or greater than adjacent undisturbed natural soil. Finished base will be level and have steel trowel finish.

The Contractor will be responsible to install anchor bolts into the concrete footing.

J. Install Street Light Wire: Unless otherwise specified, the electrical power cables will be furnished by the Contractor and installed by the Contractor.

Wire shall be installed using methods that will not injure the jacket, insulation, or conductors. All wire within a single conduit shall be placed at the same time. When powder or compound is required to ease pulling, the powder or compound shall be used according to manufacturer recommendations and the use shall not injure the cable.

K. Power Feed: The power feed shall be furnished and installed by the Contractor including the electrical power cables and conduit between the transformer and meter pedestal.

Power feed equipment shall be installed in accordance with the plans and the manufacturer's recommendations. The power feed shall be exclusively for roadway lighting and shall be permanently marked on the exterior with the address of the location and the word "ELECTRICAL."

- L. Roadway Lighting Poles:** Unless otherwise specified, the roadway lighting poles (aka luminaire poles) will be furnished by the Contractor and installed by the Contractor. The light pole includes the base, pole or shaft, UF wire, luminaire arm, luminaire, bulb, and photo eye.

When a luminaire arm is specified to be installed as part of the signal pole, the luminaire arm shall be considered part of the signal pole installation and will include installing the UF wire, luminaire arm, luminaire, bulb, and photo eye.

The following shall apply to roadway lighting poles:

1. Poles shall be plumb when the installation is complete and nuts are firmly tightened as per manufacturer's recommendations.
2. The luminaire's arm shall be set perpendicular to the project centerline.
3. Field repair of damaged galvanizing shall be done in accordance with AASHTO M36.

- M. Install Wood Utility Pole:** The Contractor shall furnish and install wood utility pole at specified locations.

- N. Install Locator Ball and Tracer Wire:** The Contractor shall furnish and install a Locator Ball and furnish and install 14 AWG THWN or THHN solid strand copper wire on all empty conduits 10' and longer in length.

635B.4 METHOD OF MEASUREMENT AND BASIS OF PAYMENT

- A. Tax on City Furnished Roadway Lighting Material:** Measurement and payment for tax on City furnished material will be on a lump sum basis. The estimated amount of tax will be listed in the contract documents and final payment will be adjusted based on the final value of the City furnished material.
- B. Remove Luminaire Pole Footing:** Measurement will be per actual number of luminaire pole footings removed. Payment will be at the contract unit price per each and shall be full compensation for all labor, equipment, and incidentals.
- C. Salvage Luminaire Pole:** Measurement will be per actual number of luminaire poles salvaged. Payment will be full compensation for all labor, equipment, and incidentals.

- D. Remove Street Light Wire:** No measurement or payment will be made. The costs to remove the wire shall be considered incidental to the other roadway lighting items on the project.
- E. Electrical Grounding and Bonding:** No field measurement will be made. The cost of furnishing and installing conduits for grounding will be incidental to the cost of footing, power feed equipment, junction box, or controller cabinet to be grounded.
- F. Electrical Conduit:** The plan shown quantity of each type and size specified will be the measured quantity unless changes are ordered by the Engineer. Measurement will be from center to center of the footing or junction box and will not include the elbows or risers within the footing or junction box. Conduit of each type and size specified will be paid for at the contract unit price per foot. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- G. Tie To Existing Conduit, Light Base, Junction Box, or Power Source:** Measurement will be by actual count of the various types of connections made. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- H. Junction Boxes:** Measurement will be by actual count of the various types and sizes of junction boxes furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- I. Concrete Footings:** Concrete footings of the various diameters will be measured to the nearest vertical foot furnished and installed. Spread footings will be measured per each footing furnished and installed. Payment for concrete footings of the various diameters will be at their respective contract unit prices per foot. Payment for spread footings will be at their respective contract unit price per each. Payment will be full compensation for all materials, labor, and incidentals necessary to furnish and install the footings.
- J. Install Street Light Wire:** Measurement will be by actual amount of wire installed. Measurement will be from center to center of the footing or junction box and will include an additional 5' of length for each run of wire installed into the footing or junction box. The wire will be paid for at the contract unit price per foot. Payment for furnishing and installing street light wire will be full compensation for required materials, labor, equipment, and incidentals.
- K. Power Feed Equipment:** Measurement will be by actual count of the type of power feed locations furnished and installed. Payment for this item will be at the contract unit price per each. Payment will be full compensation for furnishing and installing power feed equipment including meter panel and base, circuit breakers, fuses, contactor, manual on/off switch, power cables and conduit between the transformer and meter pedestal, and other materials and fixtures required. Any fees charged by

the power company associated with the power feed hookup will be the responsibility of the City.

- L. Install Luminaire Pole:** Measurement will be by actual count of the various types and sizes of luminaire poles furnished and installed. The base, pole or shaft, UF wire, luminaire arm, luminaire, bulb, and photo eye are all considered part of the pole and will be measured as one unit unless otherwise specified. Payment for furnishing and installing luminaire poles of the various types will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- M. Install Wood Utility Pole:** Measurement will be by actual count of wood utility poles furnished and installed. Payment will be full compensation for required materials, labor, equipment, and incidentals.
- N. Install Locator Ball and Tracer Wire:** Measurement will be by the actual count of power balls furnished and installed. Payment will be at the contract unit price per each. Payment will be full compensation for required materials, labor, equipment, and incidentals.