Material Specification for Large Diameter Watermains

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TS 7.80.01 SCOPE

This specification covers materials for large diameter watermain piping ranging in size from 750 to 2300 mm nominal diameter.

TS 7.80.01.01 Application

Allowable piping systems and alternatives are selected by the City from the following list of materials:

- ductile iron (DI)
- high density polyethylene (HDPE)
- prestressed concrete cylinder pipe (PCCP)
- polyvinyl chloride (PVC)
- carbon steel and stainless steel: butt welded joints, welded lap joints and bell and spigot

TS 7.80.02 REFERENCES

This specification refers to the following standards, specifications or publications:

City of Toronto Standard Specifications

TS 7.10	Construction Specification for the Cleaning and Cement Mortar Lining of Cast and Ductile Iron Watermain
TS 7.22	Construction Specification for Cathodic Protection of New Watermains
TS 7.40	Construction Specification for Watermain and Water Service Tracer Wire
TS 415	Amendment to OPSS 415 (Nov 2008) – Construction Specification for Pipeline and Utility Installation by Tunnelling
TS 416	Amendment to OPSS 416 (Nov 2008) – Construction Specification for Pipeline and Utility Installation by Jacking and Boring
TS 441	Amendment to OPSS 441 (Nov 2012) – Construction Specification for Watermain Installation in Open Cut
TS 1802	Amendment to OPSS 1802 (Nov 2008) – Material Specification for Smooth Walled Steel Pipe

City of Toronto Manuals

Chapter 6 – Material Specifications	Design Criteria for Sewers and Watermains

Ontario Provincial Standard Specifications

OPSS 441	Construction Specification for Watermain Installation in Open Cut
OPSS 1842	Material Specification for Pressure Polyethylene Pressure Pipe Products

Canadian Standards Association

B137.3	Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications

American Society of Testing and Materials

A139	Standard Specification for Electric-Fusion (Arc) – Welded Steel Pipe (NPS 4 and Over)
A240	Stainless Steel Selection Guide
F2620	Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings

American Water Works Association

C104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
C105	Polyethylene Encasement for Ductile-Iron Pipe Systems
C110/A21.10	Ductile-Iron and Gray-Iron Fittings
C111/A21.11	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C150/A21.51	Thickness Design of Ductile-Iron Pipe
C151	Ductile-Iron Pipe, Centrifugally Cast
C153	Ductile-Iron Compact Fittings
C200	Steel Water Pipe – 6 In. (150 mm) and Larger
C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe – 4 in (100 mm) and Larger
C206	Field Welding of Steel Water Pipe
C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm Through 3600 mm)
C208	Dimensions for Fabricated Steel Water Pipe Fitting
C220	Stainless Steel Pipe, 1/2 in. (13 mm) and Larger
C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipe and Fittings
C226	Stainless-Steel Fittings for Waterworks Service, Sizes ½ In. Through 72 In. (13 mm Through 1800 mm)
C301	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
C304	Design of Pre-stressed Concrete Cylinder Pipe
C602	Cement-Mortar Lining of Water Pipelines in Place – 4 In. (100 mm) and Larger
C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1200 mm)
C906	Polyethylene Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1600 mm), for Water Distribution and Transmission
M9	Concrete Pressure Pipe
M11	Steel Pipe – A Guide for Design and Installation
M23	PVC Pipe Design and Installation
M41	Ductile Iron Pipe and Fittings
M55	PE Pipe Design and Installation Manual

American Society of Mechanical Engineers

B31.1	Power Piping

NSF International

NSF/ANSI Standard 61	Drinking Water System Components – Health Effects

TS 7.80.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

TS means Toronto Specification

Dimension Ratio (DR) means outside pipe diameter (inches) ÷ wall thickness (inches).

Working Pressure (WP) means maximum sustained operating pressure excluding transient surge pressures.

Surge Pressure (Ps) means transient surge pressure attributable to abrupt change in flow.

Pressure Class (PC) means numerical value assigned to standard manufactured pipe sizes reflecting their structural capacity for sustaining working and surge pressures with an appropriate factor of safety.

Design Guide means AWWA manuals M9, M11, M23, M41 or M55.

TS 7.80.04 DESIGN AND SUBMISSION REQUIREMENTS

TS 7.80.04.01 Design

Pipe design is governed by the appropriate Design Guide and the following criteria:

a)	Internal working pressure:	1100 kPa
b)	Additional allowance for surge pressure:	550 kPa
c)	Test pressure:	1200 kPa
d)	Trench supported full vacuum:	100 kPa
e)	Variable depth of cover to the top of the pipe:	1.0 to 3.5 m
f)	Live load:	HS-20
g)	Groundwater table:	1.0 m below finished grade

Pipe pressure class, wall thickness or dimension ratio shown on the Contract Drawings or in the Contract Documents take precedence and may vary from those determined through the application of Design Guide methodologies and procedures.

This does not relieve the pipe supplier from responsibility for conducting an independent analysis to confirm that dimensional information specified or shown elsewhere satisfies the design criteria. In the event that Design Guide procedures result in a wall section thicker than that shown or specified elsewhere, use the larger of the two values.

NSF/ANSI 61 compliant materials in contact with potable water.

Referenced pipe sizes are nominal based on a conversion factor of 25 mm equals one inch.

TS 7.80.04.02 Submissions

Submit Shop Drawings for review for all pipe, fittings, couplings and special fabrications based on field measurement as necessary.

Submit wall thickness design calculations for review bearing the seal and signature of an Engineer for all fabricated pipe and as specifically noted on the Contract Drawings.

TS 7.80.05 MATERIALS

TS 7.80.05.01 Ductile Iron Pipe

Wall thickness design according to AWWA C150/A21.50 and minimum Class 250.

Pipe manufactured to AWWA C151/A21.51 with push-on or mechanical joints.

Mechanical joint fittings to AWWA C110/A21.10 or AWWA C153/A21.53 and rubber gaskets to AWWA C111/A21.11.

Factory applied internal cement mortar lining for pipe and fittings to AWWA C104/A21.4 with NSF/ANSI 61 compliant seal coat.

External asphaltic coating for pipe and fittings.

All restrained pipe joints according to City approved manufacturers list:

- Clow Tyler Union – TUFGrip
- Ebba Iron – Megalug Series 1100 and 1700
- Uni-flange UFR1400-D and UFR1450-D

Copper bonding cables at all joints where electrical conductivity is not provided by restrained joint couplings.

Cathodic protection according to TS 7.22.

TS 7.80.05.02 High Density Polyethylene Pipe

Wall thickness design and manufacture for pipe and fittings shall be according to AWWA M55 and AWWA C906 to iron pipe size (IPS) or ductile iron pipe size (DIPS) dimensions as shown on the Contract Drawings.

Dimension ratio (DR) in accordance with AWWA C906 based on compound selection and a minimum of DR 11 for PE3608 and DR 13.5 for PE4710.

Continuous co-extruded blue stripe for potable water identification and markings according to AWWA C906.

All joints butt-end fusion-welded.

Corrosion-protected steel or ductile iron mechanical connections and transition couplings as shown on the Contract Drawings.

TS 7.80.05.03 Pre-stressed Concrete Cylinder Pipe

Design and manufacture for prestressed concrete pressure pipe and fittings—steel cylinder type—according to AWWA M9 and AWWA C304 and AWWA C301.

Lined cylinder pipe according to AWWA C301(L) for diameters from 750 to 1500 mm and embedded cylinder pipe according to AWWA C301(E) for larger diameters.

Minimum 30 MPa 28-day concrete mix design.

Type II (CSA A23.1 Type HS) sulphate resistant cement.

Silica fume admixture at 8 per cent by weight as a cement replacement to core concrete and mortar coating where specifically noted on the Contract Drawings.

All internally welded lap joints according to AWWA C206 or mechanical restrained gasketted joints where shown on the Contract Drawings, with internal and external grouted joint protection.

Urethane exterior coating where noted on the Contract Drawings.

Cathodic protection according to TS 7.22 electrically connected to the prestressing wires and steel cylinder where noted on the Contract Drawings.

TS 7.80.05.04 Polyvinyl Chloride Pipe

Wall thickness design and manufacture for pipe and fittings according to AWWA M23 and AWWA C905, certified to CSA B137.3, IPS or DIPS dimensions as shown on the Contract Drawings.

Dimension ratio (DR) according to AWWA C905 and a minimum of DR 25.

Blue pigmented resin for potable water identification and markings according to AWWA C905.

All restrained pipe and fitting joints according to City approved manufacturers list:

- Ebba Iron – Megalug Series 2500
- Uni-flange UFR1450-D

TS 7.80.05.05 Steel Pipe

Spiral or straight seam full penetration butt-welded carbon steel pipe fabrication according to TS 1802 and AWWA C200.

Fabricated fittings to AWWA C208.

Mill certified steel sheet ASTM A139 Grade C 290 MPa (42,000 psi) or higher.

Internal 19 mm cement mortar lining, factory applied to AWWA C205 or field applied to AWWA C602.

External coatings:

- Protective primer coating for encased pipe.
- Polyurethane coating according to AWWA C222 for direct buried pipe.

Cathodic protection according to TS 7.22 where specifically noted on the Contract Drawings.

TS 7.80.05.05.01 *Steel Pipe Joints*

Butt-joint end preparation for pipe continuously field welded according to AWWA C206 where noted on the Contract Drawings:

a) 30º bevel off vertical with 1.5 mm root face ground for top welding above the spring line and top welding below the spring line from inside the pipe.

b) Externally-welded back-up bars for joint alignment of same material as pipe, minimum 25 mm width, lower half of circumference below the spring line.

c) Externally-welded butt-strap joints for closure pieces only to take up minor field misalignment

d) Internal factory-applied cement mortar lining – and external coating where specified – cut back to prevent weld damage.

Lap joints for pipe continuously field welded according to AWWA C206 where noted on the Contract Drawings:

a) Square butt end for single fillet weld suitable top and bottom welding from inside the pipe.

b) Internal factory-applied cement mortar lining – and external coating where specified – cut back to prevent weld damage.

Bell and spigot joints according to AWWA C200 where noted on the Contract Drawings:

a) Rolled groove configuration and rubber gaskets according to AWWA C200.

b) Mechanical joint restraints in straight pipe runs designed for to working pressures according to TS 7.80.04, herein.

c) Mechanical harness joint restraints designed in accordance with AWWA M11 for thrust forces generated at changes in direction, based on a coefficient of friction between the pipe and soil of 0.25 or as may be determined by geotechnical testing.

TS 7.80.05.05.02 *Steel Pipe Wall Thickness*

Minimum steel pipe wall thicknesses based on the following design criteria and including an allowance for location risk:

a)	50% yield stress under design working pressure	
b)	75% yield stress under design working plus surge pressure	
c)	Deflection due to handling	diameter ÷ 240
d)	Soil modulus E’	6.9 MPa (1000 psi)
e)	Buoyancy factor R_w	1.0
f)	Factor of safety for buckling	2

Conduct site specific analysis according to AWWA M11 were criteria differ from design criteria contained in this specification to confirm that stated wall thicknesses are adequate.

Table 1: Steel pipe wall thickness

Nominal diameter	Minimum wall thickness	
mm	mm	inches
750 – 1100	6.35	1/4
1150 – 1500	7.94	5/16
1550 – 1900	9.53	3/8
1950 – 2250	11.11	7/16
2300	12.70	1/2

TS 7.80.05.06 Stainless Steel Pipe

Spiral or straight seam full penetration butt-welded stainless steel pipe fabrication according to TS 1802 and AWWA C220. Fabricated fittings according to AWWA C208.

Mill certified steel sheet Grade 316L 290 MPa (42,000 psi) or higher.

No internal lining or external coating unless specifically noted otherwise on the Contract Drawings.

TS 7.80.06 EQUIPMENT – Not Used

TS 7.80.07 PRODUCTION – Not Used

TS 7.80.08 QUALITY ASSURANCE

TS 7.80.08.01 Certification

Submit certified mill test reports for all pipe materials and factory testing.

As requested, provide copies of welder qualifications from a recognized regulatory authority for hand-welded fabrications.

TS 7.80.08.02 Inspection

The City has the right to inspect the fabrication and testing of pipe and fittings at the factory at any time having given prior notice and with the agreement of the supplier with respect to schedule and protocols.

Rectify materials and workmanship that fail to comply with these specifications and accepted industry practice as determined by the Contract Administrator.

TS 7.80.09 OWNER PURCHASE OF MATERIAL – Not Used