

**Specification for the  
Cured-In-Place Pipe Lining of Watermains**

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**TS 7.60.01                      Scope**

This specification is for Cured-in-Place Pipe (CIPP) lining of the various sizes of watermain pipes in the city of Toronto. The Work shall include performing the following operations: traffic control, temporary water lines and services, pavement cutting, excavation and access pits, cutting the watermain, dewatering, replacement of necessary valves or valve parts, replacement of hydrants, cleaning and preparing the watermain, grinding of service taps, disposal of water and waste products from cleaning operations, installing and curing the CIPP lining, liner samples and testing, reinstatement of all services, protection of the lining, CCTV inspections at various stages, chlorination and disinfection, cathodic protection, jumper and tracer wires, pressure testing, flushing, close-up of the watermain, back-filling of the excavation, restoration, repairs to pavement, repairs to the boulevard, clean-up of the site of the work, the guarantee and all other incidental work and services.

Where hydro pole support is required it shall be the responsibility of the Contractor. The Contractor shall make arrangements with Toronto Hydro. The Contract Administrator will assist in coordinating with Toronto Hydro if necessary.

The work involved requires special equipment to be handled by persons experienced in all phases of the work.

**TS 7.60.02                      Information to be Submitted with Bid**

The Tender Call requires the following information to be submitted with the Bid for the review and approval of the Contract Administrator. Further information could be required to be submitted elsewhere in the Tender Call other than in TS 7.60 herein.

Submit with Bid:

- 1) The name of a professional engineer licensed in the province of Ontario who will provide the CIPP liner engineering designs required according to the liner design requirements in TS 7.60 herein. The professional engineer shall be authorized to perform such work by Professional Engineers Ontario (PEO).
- 2) An engineered liner design for each watermain size to be lined that clearly shows the proposed liner thickness. The designs shall be according to TS 7.60 herein and shall identify all design parameters including the short-term and long-term CIPP properties used in the design. A one page designs summary shall be provided showing for each watermain size, the design liner thickness, the design pressure and the design watermain depth. The designs shall approved by an Engineer bearing the seal and signature of an Engineer.
- 3) Independent test data shall be provided to substantiate the CIPP material strength and modulus used in the design.
- 4) Approval certifications complete with supporting literature of NSF/ANSI Standard 61 for potable waters for the CIPP watermain liner to be used.
- 5) Material specifications and structural details of the proposed watermain liner in sufficient detail to enable confirmation by the Contract Administrator that the design and materials proposed will meet the design requirements in TS 7.60 herein.

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- 6) A summary of the Contractor's proposed installation procedure including an example of the design process wet-out plan and curing cycle summary sheet to be submitted for each liner diameter.
  - 7) A certified original copy complete with supporting literature from the resin manufacturer of the Infrared Spectrograph of the catalyzed resin mixture proposed for the Contract.

### **TS 7.60.03                      Operation of Valves and Hydrants**

In the event that in-service watermain valves require operation during the course of construction, Toronto Water staff will be the only individuals permitted to operate these valves. The operation of all live valves and hydrants, in connection with cleaning and lining watermains and disinfection shall be done by a the City's crew certified under Ontario Regulation 128/04 or under the direct supervision of a representative of the Contract Administrator.

In districts North York and Toronto /East York (former city of York, east of the Humber River) all valves supplied to these areas will open by operating in a clockwise direction.

In districts Etobicoke /York (former city of Etobicoke, west of the Humber River) and Scarborough all valves supplied to these areas will open by operating in a counter clockwise direction.

The Contractor will be required to keep and maintain a real time log book which logs the operation of any system valves—main line and bypass—found within the limits of the contract including valves on the temporary bypass system. Such a log book is to be presented daily for copy and signature to the on-site Inspector. The log book layout/format will be decided upon at pre-construction meeting. Primarily the Contractor will be asked to record the address of the valve, the date, time and reason for operation, time opened and/or closed as appropriate as well as the name of the individual operating the system valves.

### **TS 7.60.04                      Notification to Public and Log Record**

Unless otherwise required in the Special Specifications, three notices, as described below, shall be distributed to properties that will be affected by the work. Notice #1 shall be delivered by the City. Notices #2 and #3 shall be delivered by the Contractor. The Contractor shall maintain a log record of notices delivered by the Contractor and follow-up activities by the Contractor at each property throughout the contract work.

#### **Notice #1 (Initial Notice)**

A City notice, delivered by the City, that provides a brief introduction to the upcoming watermain CIPP lining construction contract, identifies the Contract Administrator and provides a contact phone number for the Contract Administrator. Notice #1 shall be delivered by the City to all properties in the contract area sometime well in advance of the start of onsite activities by the Contractor.

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## **Notice #2**

A City notice, delivered by the Contractor, that identifies the Contract Administrator and provides a detailed description of the up coming construction work, contact phone number for contractor, including periodic interruptions of water service and details of temporary water servicing etc. Notice #2 may include information sheet(s) from the City for the property resident. Notice #2 shall be delivered to all effected properties in the contract area one week before any temporary bypass lines, temporary water services or excavations take place. Delivery of Notice #2 should be zoned based on construction activities and therefore may be separately distributed for different construction zone areas. The Contractor shall produce the number of copies of the notices including any information sheets required for distribution.

## **Notice #3**

A Contractor notice, delivered by the Contractor that advises the property resident of the opportunity to obtain a price for replacement of the private side of the water service by the Contractor. Such work is between the Contractor and the property owner and is not related to the contract or the City. Notice #3 shall be delivered to all effected properties once the construction activities have commenced and may be delivered by construction work zones using separate delivery schedules. The Contractor shall produce the number of copies of the notices required for distribution.

## **Record Log of Notifications and Follow-up Work**

The Contractor shall make and maintain a log record. The log shall record the address where each notice was delivered, the date of delivery and any other information relevant to maintaining a record of notifications, such as follow-up telephone calls or property visits. The log shall also record date and description of any work performed at a property, such as installation of shut-off ball valves, disconnection of water meters and installation of hose bibs or other devices for temporary water service to the property, activation of temporary water service and deactivation of temporary water service. The log shall be maintained in a common electronic format, such as an MS Excel document. The log shall be provided to the Contract Administrator.

## **TS 7.60.05 Temporary Bypass Lines**

The Contractor shall supply, install temporary and maintain watermain bypass lines for watermains removed from service for CIPP lining operations. The work shall include the supply of all labour, Equipment and Material required for the following operations: installing the temporary line, temporary fire hydrants and connections, valves and check valves where required, supply connections, chlorination, protection of the installation from damage, temporary shut-off of private services by operation of curb-stops or such other means as required, removal of temporary service connections and bypass line and restoration of the site upon completion of the work. All bypass line materials shall conform to the NSF/ANSI Standard 61.

Temporary bypass lines shall be supplied by connections at each end of the line where practical. Where the ends are at different pressure districts, a check valve shall also be installed. Valves shall be installed in the bypass in the vicinity of existing main line valves on the line being cleaned and lined and also where 50 mm bypass line connects into 100 mm bypass line or at such other locations as the Contract Administrator may direct. The existing watermain shall not be removed from the service until the Contract Administrator has approved the installed bypass line.

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Progress payment(s) for the temporary bypass lines will be pro-rated based on the estimated quantity of watermain in the Pricing Form and length of existing watermain taken out of service and only paid when temporary bypass lines are placed in service.

The Contractor shall maintain temporary water service lines shall be maintained in a safe operative condition at all times and shall be responsible for the prevention of injury to persons and damage to property. The Contractor shall provide safeguards, but such provisions shall not relieve the Contractor of full responsibility for the adequacy of protection.

The Contractor must repair any leaks that are found or that may develop on any portion of the temporary bypass line. If a leak is not repaired, the Contract Administrator may deduct from the Contractor's progress payment the cost of the water lost as a result of the leak. Moreover, should it be necessary for City forces to repair any portion of the bypass system as a result of the Contractor not responding within a 2-hour period, any costs incurred by the City for such repairs will be deducted from the Contractor's progress payment.

### **TS 7.60.06            Temporary Service Connections**

The Contractor shall supply, install and maintain temporary water services where required to properties affected by CIPP watermain lining operations. All temporary service connection materials should conform to the NSF/ANSI Standard 61. All hose used for individual property connections, shall be minimum 20 mm internal diameter, designed for a working pressure of 860 kPa and be free from defects in material and workmanship. The pipe, hose and all other materials which are to be furnished by the Contractor for use in conjunction with the temporary service pipe and temporary connections to property services and branches shall be approved by the Contract Administrator, and shall be fully adequate to withstand the pressures and all other conditions of use and shall be of material which does not impart any taste or odour to the water in accordance with NSF/ANSI Standard 61.

Pipe and fittings shall provide adequate water tightness and care shall be exercised throughout the installation of any temporary pipe and service fittings to avoid the possible pollution of any City main or property services or contamination of the temporary service pipe proper. Flushing of the private service connections and chlorination of the bypass line prior to their use will be required.

The temporary service connections shall be valved near the point of connection to the bypass and also to the private plumbing system so that both the bypass line and private services may be chlorinated separately from the final connection.

During freezing, stormy or inclement weather, no work shall be done except that which is incidental to cleaning or lining, unless otherwise directed by the Contract Administrator.

No bypass service pipe or property service connections shall be installed during freezing or inclement weather and pipes already in use shall be removed or drained and services restored when so directed by the Contract Administrator.

Each home shall have its own temporary water service connection to the bypass pipe and a connection to the private plumbing via a wye at an outside tap. The branching of wyes from a single spigot shall not be permitted; nor will connecting homes in series.

It shall be the responsibility of the Contractor to ensure an adequate water supply at all times. During the construction process, the Contractor will be responsible to restore a customer's water supply within a two hour time period upon notification from the Contract Administrator.

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**TS 7.60.07 Temporary Hydrants**

The Contractor shall supply, install and maintain temporary fire hydrants and the necessary valves and fittings. These temporary hydrants shall be connected to 100 mm diameter bypass pipe and placed in locations as instructed by the Contract Administrator. The temporary hydrants shall be 62 mm nozzles with 5-threads per 25 mm. The operating nuts shall be 32 mm square.

The hydrants will be set in such a manner that the Toronto Fire Services will have no difficulty making a connection with a fire hose, and where they will cause least obstruction to vehicular and pedestrian traffic and will be least likely to be damaged. Temporary fabricated fire hydrants are acceptable.

A detailed sketch of the hydrant the Contractor proposes to use must be submitted prior to commencement of work.

All temporary hydrants, valves, fittings, and service pipe and all other material shall be adequate to withstand the pressures and conditions of use and shall provide adequate water-tightness. Before permanently shutting down the watermain that is to be cleaned and lined, the Contractor shall test all temporary hydrants and valves to be sure that they are in proper working order.

All temporary hydrants must have reflective tape on the barrel for increased visibility. The temporary hydrants must stand in an upright position at all times. Once put into use, the temporary hydrants shall be maintained until the existing hydrants are restored to service. The hydrants which are out of service during construction operations shall be bagged and clearly marked with a "Hydrant Out of Service" tag.

**TS 7.60.08 Burying Temporary Bypass Lines**

The Contractor shall cut and remove asphalt across streets to permit burying the bypass pipe without disturbing the concrete base, and shall replace the asphalt when the pipe is removed. Under no circumstance is a pipe road crossing to remain open and unprotected from vehicular and pedestrian traffic.

**TS 7.60.09 Connection to Hydrants**

All temporary bypass service attachments and any other attachments to fire hydrants shall be made with an approved backflow prevention device and shall be made in such a manner that if it becomes necessary they can be easily removed so that the hydrant can be used for fire fighting purposes.

**TS 7.60.10 Disinfection of Temporary Bypass Lines and Service Connections**

Disinfection shall be according to TS7.30 – *Procedure for Disinfecting Watermains*.

All temporary bypass lines and service connections shall be disinfected by the Contractor under the supervision of the Contract Administrator.

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The *Continuous Feed Method of Disinfection* can be used by adjusting the flow to a constant known rate and sufficient chlorine is added to completely fill the main with chlorinated potable water to produce a homogeneous chlorine solution as specified in TS 7.30, Table 1. Once this steady state is achieved the chlorinated water is left standing for a specified minimum contact time. For concentration and contact time, see Table 1 in TS 7.30.

To assure that the desired concentration is achieved, the disinfection crew shall measure the chlorine concentration at regular intervals at available ferrules using appropriate chlorine test kits. Chlorine application is to continue until the entire temporary service pipe is filled with heavily chlorinated water.

Where temporary service connections are disinfected in conjunction with the temporary bypass watermain no physical connections to hose bibs will be permitted until after successful disinfection.

Where temporary bypass service connections are disinfected offsite in a controlled environment one set of samples shall be collected from every 350 m of service hose connected in a series. One set of samples shall also be taken from the source and at each end of any hose group connected in series, regardless of total length. Where temporary bypass service connections are disinfected in conjunction with the temporary bypass watermain additional samples must be taken at the end of any two temporary bypass service connections for every 350 m of temporary bypass watermain disinfected.

Each sample taken shall be properly labeled and sealed as approved by the Contract Administrator.

The Contractor is responsible to arrange with the approved accredited laboratory to fax or e-mail all copies of water quality test results to the Contract Administrator or the City's representative where specified.

During the disinfection, an operator, certified under Ontario Regulation 128/04, shall be on site to operate hydrants and valves on the active distribution system. If no certified operator is available, the Contractor shall notify Toronto Water, Operations & Maintenance section at least 48 hours in advance to make arrangements for a certified operator.

All water sampling equipment for field-testing must be properly maintained and calibrated to factory specifications and be accurate within 5 per cent of the required water quality standards.

#### **TS 7.60.11                      Operation of Service Boxes**

The Contractor shall locate, inspect and ensure that all curb stops operate properly in advance of working on the street. During construction, if a curb box becomes inoperable, the Contractor may be required to repair the curb box by an approved method. The Contractor shall adjust curb boxes to grade where necessary.

Before carrying out the repair of curb boxes the Contractor shall submit a list, in a format approved by the Contract Administrator, of defective curb boxes for inspection and approval by the Contract Administrator's representative.

The defective curb boxes shall be repaired or excavated/replaced as required with new curb box and stainless steel rod, using a vacuum excavation method, connecting the rod to the curb stop with a cotter pin; adjustable ball bearings will not be permitted to make this connection.



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The replacement shall be complete up to and including 25 mm water services including restoration according to the Special Specifications and supply and installation of extensions fittings, if required, to raise new curb box to grade site restoration. Where required, the work shall include raising or chip out or both of existing curb boxes.

**TS 7.60.12                      Shut-Off of Water Services**

The Contractor shall make all shut-offs of property services and shall furnish water for the temporary bypass service from a hydrant or other temporary source.

**TS 7.60.13                      Protection of Public**

The Contractor shall be required, at no extra cost to the City, to mound over the bypass pipe with asphalt or other acceptable material, wherever it crosses a street, driveway or sidewalk in order to prevent injury to pedestrians or damage to vehicles. The use of a polyethylene sheet shall be required as a barrier on concrete or interlocking driveways or both. If the work performed or the material used is not to the satisfaction of the Contract Administrator, action will be taken to rectify the problem to ensure the safety of the public. All costs incurred in such rectification shall be deducted from the Contractor's payment.

Safety flashers and barricades as may be required shall be furnished and maintained by the Contractor. In general, the temporary service pipe shall be laid where it will cause the least obstruction and is least liable to get damaged.

**TS 7.60.14                      Access Pits**

The Contractor shall excavate pits for accessing the watermain for the CIPP lining process. The Contractor should use locations of existing tees, crosses, reducers and valves for access pits locations wherever this is feasible. When an access pit is excavated and a fitting is contained within it, the Contractor shall replace the fitting. The Contractor shall use existing valve, bend and tee locations as access pits as often as possible.

The Contractor shall note that the locations for all access pits shall be approved by the Contract Administrator prior to the beginning of construction. The work shall include all excavation, shoring, dewatering, bracing protection and restoration of access pits. Valves and fittings in close proximity to access pits shall be braced as required.

At the request of the Contract Administrator or due to unforeseen conditions, the Contractor shall excavate, supply and replace complete tees, bends including vertical bends, crosses, reducers and obstructions etc. including cathodic protection, jumper and tracer wire. The backfill and restoration shall be according to the Special Specifications.

When excavating bends/fittings/access points to watermains, and the access point requires the Contractor to remove water service connections, the Contractor shall be responsible to re-establish the water service connections to the watermain prior to backfill by re-tapping or relocating the service connection within the excavation.

Additional access pits may be required for the CIPP lining process due to unforeseen conditions. Such additional pits shall include all the work required for a regular pit. Payments for such additional pits shall be made at the Contract Price.

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### **TS 7.60.15                      Cathodic Protection, Jumper Wires and Tracer Wires**

At all locations where cast or ductile iron watermain have been exposed and accessed, including all pit locations, sacrificial anode shall be installed. The Contractor shall supply and install 14.5 kg magnesium anode and the lead thermite welded to the iron pipe or fitting in according to TS 7.20 – *Construction Specification for Cathodic Protection of Existing Iron Watermains*.

At all locations where the iron pipe has been accessed, the Contractor shall install jumper wires to create or maintain the electrical continuity of the iron watermain including for existing and new iron pipe and iron fittings. Jumper wire shall be RWU90, number 10 gauge, single strand, insulated copper wire with 60 mil of polyethylene insulation. Jumper wire shall be attached to all pipe and fittings by thermite welding.

Where plastic pipe has been installed between sections of iron pipe, a tracer wire shall be installed directly above the plastic pipe. The tracer wire shall be thermite welded to the adjacent iron pipe at each end of the plastic pipe section to maintain electrical continuity of the iron watermain. Tracer wire shall be RWU90, number 10 gauge, single strand, insulated copper wire with 60 mil of polyethylene insulation.

### **TS 7.60.16                      Cutting of Pipe**

Where reconnection is required, watermain pipe shall be cut with proper cutting devices such as power operated cut-off saws or other approved methods. Cuts shall be neat and square to the watermain and be free of jagged ends or lips. Watermain pipe shall not be broken apart unless all pieces with broken ends are to be discarded.

### **TS 7.60.17                      Capping Open Pipe Ends**

All watermain pipes shall be capped, plugged or bulk-headed using a mechanical joint plug/cap anytime there is no work being performed on the pipe. The bulkhead must be capable of preventing water from entering or exiting the watermain pipe, and should be equipped with a relief valve and be properly braced when the possibility exists that the capped section could be pressurized.

### **TS 7.60.18                      CCTV Inspections and Reports**

CCTV inspections for V1, V2 and V3 assessments shall follow the following:

- 1) The Contractor shall provide 48 hours notice prior to a required CCTV inspection in order that the Contract Administrator can arrange, if required, to be present for the CCTV inspection.
- 2) The camera equipment, the cable and any other related equipment that enters the watermain shall be doused with chlorine prior to insertion into the watermain. This step will be repeated for every section that is inspected. This is done to keep the equipment clean and operating in such a manner as to prevent any contamination of the watermain during use. The CCTV equipment shall be suitable for and allow viewing of the full perimeter of pipe for all watermain sizes included in the contract. The CCTV equipment shall employ a suitable colour camera with pan and tilt capability. The range of the camera equipment from one access shall allow single pass inspections of not less than 200 m of watermain length.

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- 3) The watermain shall be sufficiently dry so that any remaining water does not obscure any part of the interior of the watermain during the CCTV inspection. The inspection speed shall allow proper analysis of the watermain condition with a maximum travel speed of 5 metres/minute. The inspection must stop and view each service connection clearly and completely for at least 5 seconds. The camera shall provide sufficient light and proper focus to enable clear viewing of the pipe surface at all locations. The video inspection equipment shall be disinfected prior to insertion into the watermain and care shall be taken to avoid contamination of the main during inspection. If required by the Contract Administrator, the Contract Administrator shall be present to view the live CCTV inspection.
  - 4) Each individual CCTV inspection shall be continuous over the watermain section. The CCTV shall have on-screen identification of the location of the inspection including a start screen (or screens) that shown all the information necessary to describe and locate the CCTV inspection. During the inspection the screen shall continuously show a brief watermain section identification and the metered location of the camera within the watermain.
  - 5) Each individual watermain section CCTV inspection shall be recorded and the recording shall be the complete continuous CCTV inspection. The recorded CCTV inspection shall be provided to the Contract Administrator on digital video disc (DVD) or other approved media. The file name in the DVD shall clearly and concisely identify the CCTV inspection. A DVD may contain more than one CCTV inspection providing that the file name for each inspection properly identifies the CCTV inspection. Filenames that do not properly identify the inspection video will result in rejection of the DVD by the Contract Administrator. Video inspection file format shall be an MPEG-2 (or other Contract Administrator approved format) that is suitable for proper playback on commonly used video file playing software applications. The video files must play properly on correctly configured, up to date versions of Microsoft Windows Media Player, VideoLAN VLC Player and Apple QuickTime Player. Video files that do not play properly on all these three players will be rejected.
  - 6) The video inspection shall be accompanied by an inspection report in PDF format on the same DVD. The report shall list and locate all features noted in the CCTV inspection including service connections. The CCTV inspection file and the PDF report file shall be grouped together on the DVD along with any other information relevant to the specific CCTV inspection. The inspection report for each section of watermain inspected shall report as a minimum: contract number, street name, date of inspection, pipe type and size, start and end locations, length of pipe inspected, summary comments, disk, tape and file numbers. The summary comments should identify all distinguishing features of the watermain to include but not limited to service locations, condition of liner (or pre-lining condition of watermain), bends, valves, ponding water and poor visibility.
  - 7) CCTV inspections including reports shall be submitted to the Contract Administrator. These submissions will be used by the Contract Administrator to determine, in part, that the CIPP watermain lining work meets contract requirements and is acceptable to the Contract Administrator.

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**TS 7.60.19****Preliminary CCTV Inspection – V1**

When suitable access has been made to the interior of a section of watermain to be lined, a preliminary CCTV inspection—called the V1—shall be done and recorded. The V1 shall be used to determine that the inside condition of the watermain, including whether there are any existing coatings or linings, can be made suitable for CIPP lining and to locate any watermain configurations such as vertical bends, tees, diameter changes and so on that are not previously identified. The V1 shall also be used to determine location of further access pits that may be needed based on the findings in the V1. The V1 shall also be used to provide additional information for the Water Services Statement.

The V1 video and report shall be submitted to the Contract Administrator 48-hours prior to undertaking the cleaning and preparation of the watermain section unless the Contract Administrator waives this 48 hour requirement. For example, the Contract Administrator may waive the 48 hour requirement based on its live viewing of the inspection or when the CCTV was available for the Contract Administrator’s review prior to the formal submission. In the event that the Contract Administrator waives the 48-hour requirement, the V1 shall be submitted to the Contract Administrator at a later time.

Where the V1 inspection finds that the watermain section is in a condition that cannot be made suitable for lining by the cleaning and preparation process, the Contractor shall advise the Contract Administrator of this finding within 48-hours. In this situation, the Contractor shall wait for further instruction from the Contract Administrator before undertaking any further work on the watermain section. Further instruction may include deleting the section from lining, replacing part or all of the section with new watermain or some other appropriate action to be taken. In such a case, the V1 will be paid and any further work required that is outside of the contract will be negotiated with the Contractor.

CCTV inspection, report and submission shall be according to TS 7.60 herein.

**TS 7.60.20****Water Services Statement**

For each section of watermain to be lined, a *Water Services Statement* form shall be prepared by the Contractor. The form shall list all the service connections, including relevant street address, size, location and so forth. Information shall be started with known service connections from the drawings and curb stops. Additional service connections or service connection information determined from the V1 and V2 CCTV inspections shall be added to the form and include service connections that are to be abandoned and ground flush.

The format for the *Water Services Statement* form shall be an MS Excel spreadsheet or equivalent suitable for electronic information handling. As the information on the form will evolve during the course of the work on the watermain section to be lined, the form shall clearly identify by section of watermain lining and the current date of the form.

A *Water Services Statement* form, finalized for commencement of lining, shall be submitted to the Contract Administrator before start of liner installation. Liner installation shall not proceed without the *Water Services Statement* submission. Where possible the form should accompany the V2 CCTV submission.

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The *Water Services Statement* shall be used as a control document for reinstatement of service connections into the lined watermain. Once all service connections have been reinstated, the form shall be updated to identify the reinstatements.

A *Water Services Statement* finalized after lining to include a record of service reinstatements, shall be submitted to the Contract Administrator and accompany the V3 CCTV submission.

For a sample of the Water Services Statement form, see appendix herein.

### **TS 7.60.21                      Cleaning and Preparation of Watermain**

All rust, tuberculation, deposits, coatings, linings and any foreign materials shall be removed from the inside of the pipe and valves by a method approved by the Contract Administrator. Candidate methods include water-propelled cleaning devices and cable pulled scrapers and rack boring. The Contractor shall pass the cleaning device through the main as many times as is necessary and in each direction as necessary to obtain results satisfactory to the Contract Administrator.

The cleaned and prepared surface shall be suitable for CIPP liner installation and its long-term performance including the necessary bonding of the liner to the watermain surface. Where any small hard deposit cannot be removed by cleaning and preparation operations and that such deposit is of a size and in a location that will not negatively affect long-term liner performance then, at the discretion of the Contract Administrator lining shall be permitted.

In the event that any service taps protrude too far into the interior of the existing watermain resulting in interference with required cleaning and preparation, or protrude to the extent that they will have a negative effect on the liner including its long-term performance, the service taps shall be trimmed back to an acceptable protrusion length. The method of trimming shall not damage the service taps and the method must be approved by the Contract Administrator.

Cleaning and preparation operations shall be carried out in a manner that will avoid the application of vertical or horizontal loads on the pipe. Boxes of adequate size with compartments or other suitable and approved means shall be provided to function as settling tanks for the retention of solids removed during cleaning, flushing and pumping operations.

On total completion of the cleaning and preparation (including grinding of any service taps), the post cleaning and preparation V2 CCTV inspection shall be made.

### **TS 7.60.22                      Grinding Flush of Abandoned Service Taps**

Service connections that have been identified as no longer required, that is to say abandoned, shall be ground back flush with the inside surface of the watermain prior to the installation of the CIPP lining and prior to the V2 CCTV inspection. These service connections and their grind-off shall be identified on the Water Services Statement.

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**TS 7.60.23****Post Cleaning and Preparation CCTV Inspection – V2**

When the cleaning and preparation has been fully completed for a watermain section, a post preparation CCTV inspection including report—called the V2—shall be done and recorded. CCTV inspection and report shall be in accordance with the requirements in this specification. The V2 shall be used by the Contract Administrator and the Contactor to determine that the watermain cleaning and preparation is in accordance with requirements and that the watermain interior condition is suitable for lining. When required by the Contract Administrator, the Contractor shall notify the Contract Administrator 48 hours in advance of the CCTV inspection so that the Contract Administrator may be present for the live CCTV inspection.

The V2 shall be submitted to the Contract Administrator for its approval of the cleaning and preparation 48 hours prior to the start of lining of the watermain section. Lining shall not take place unless the Contract Administrator has approved the cleaning and preparation. In some circumstances, the Contract Administrator may waive the requirement for receiving and approving the V2 submission before lining – such as in the case of approving the cleaning and preparation during live viewing of the V2 CCTV inspection. However, even when the Contract Administrator waives the 48 hour prior to lining requirement, the V2 shall remain a required submission to be received no later than the V3 submission.

**TS 7.60.24****Materials and Standards**

The lining shall be cured-in-place-pipe (CIPP) according to ASTM F1216-09, ASTM F1743-08 or ASTM F2019-03(2009) with exceptions made for where the watermain liner is required to differ specifically from requirements in these standards. For CIPP liner design requirements refer to the section TS 7.60.26 herein.

The liner shall be approved for potable water use. Approval certifications, such as NSF/ANSI Standard 61 are to be provided with tender submission for approval by the Contract Administrator.

The liner potable water certification from various agencies must be submitted with Contract Documents for the Contract Administrator’s review. The Contract Administrator reserves the right to accept/reject these certifications. All materials must be delivered to the site in their appropriate containers that clearly show that the product has various agencies’ approvals.

The liner shall utilize a thermally cured epoxy type resin where the cure does not rely on ambient heat for curing. The liner shall be uniformly impregnated with the correct quantity of resin to produce a cured result that has homogeneous and uniform physical properties throughout the liner wall that meet or exceed the required physical properties premised in the liner design. In this context the liner wall does not include with the surface waterproof membrane layer. The correct quantity of resin shall be determined by the Contractor and be in accordance with the specifications of the liner manufacturer. The liner shall be provided with sufficient resin to effect the required bonding to the inside surface of the existing watermain including around the service connections.

The liner shall be capable of remote reinstatement of service connections from within the interior of the watermain and no further work shall be required to seal or otherwise connect the service connections for the liner to function for its design life.

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## **TS 7.60.25                      Diametric Sizing**

The Contractor shall confirm and record the internal diameters of each watermain section to be lined by measuring the watermain internal diameters. Measurements shall be taken for each individual liner installation. Internal diameter measurements shall be made at each end of a watermain section to be lined. Measurements shall be made with a suitably accurate device such as inside calipers. Measurement by tape measure is not acceptable. The internal diameter measurements made by the Contractor shall be available to the Contract Administrator for review if requested. The Contractor shall immediately notify the Contract Administrator of any step size discrepancy, for example nominal 300 mm instead of nominal 250 mm between any internal diameter measurement and the diameter identified in the Contract Documents.

The Contractor shall size the liner to be installed based on watermain section's inside diameter that will be in effect when the liner is installed, that is, the post cleaning and preparation size of the watermain. The Contractor shall be aware that measurements taken after cleaning and preparation may differ significantly—for the purpose of liner sizing—from measurements taken before cleaning and preparation.

To assure required tight fit and bonding to the watermain inside surface, it is acceptable that the Contractor over-size the liner by a small amount to assure that the required tight fit is achieved. This over-sizing may result in a small longitudinal ridge, typically called a fold, along the lined watermain. Due to existing small variations in the watermain's actual size along the section, correspondingly the size of the fold may also have variations along the watermain that are acceptable. Such folds along the lined watermain are acceptable providing they meet the requirements in section TS 7.60.27 herein.

## **TS 7.60.26                      Design Requirements**

The lining wall thickness shall be designed by the Contractor in accordance with ASTM F1216-07a, Appendix X1, Design Considerations, Section X1.3.2 (fully deteriorated design). The design method in later editions of the ASTM F1216 shall not be permitted. The design method and the design parameters for the liner are prescribed below. Engineering designs shall be approved by an Engineer bearing the seal and signature of an Engineer authorized to perform such work by PEO. The Contract Administrator reserves the right to reject the design, design method or design parameters should they differ from those prescribed in this section.

The thickness determined by the liner wall thickness design shall be the required wall thickness of the completed liner. The wall thickness shall be the wall thickness of the liner's structural zone only. Wall thickness measurements of the finished liner used to compare with design thickness shall not include such non-structural zones. If these zones have been included in the measurement, they shall be subtracted to determine the effective thickness of the liner. The determination of the actual thickness of the installed liner shall be in accordance with the method in ASTM D5813-04(2008). It is noted that among its provisions for measuring liner thickness and for calculating the effective thickness from these measurements, the ASTM 5813 requires that no thickness can be less than 87.5 per cent of the required thickness.

**Table 1: CIPP liner design parameters**

<b>Parameter</b>	<b>Requirement</b>
Design Method	ASTM F1216-07a, Appendix X1 for Fully Deteriorated Pressure Pipe. Design by later versions of the ASTM F1216 is not permitted.
Design Life	50 years or greater.
Safety Factors	External Loads: 2.0; Internal Pressure: 2.0; Vacuum: 2.0
Design Pressure	862 kPa (125 psi) internal pressure.
Vacuum	50 kPa below atmospheric pressure.
External Hydrostatic Pressure	Based on ground water table at 2.0 m below ground surface.
External Earth Load	For 2.0 m cover or the cover at the liner location, whichever is greater.
Live Load	AASHTO HS-20
Ovality	2 %
Soil Weight	1920 Kg per cubic metre
Soil Modulus	6.89 MPa
CIPP Liner Flexural Modulus	The flexural modulus for design equations X1.1, X1.3 and X1.4 shall be the long-term flexural modulus. The long-term flexural modulus used in design shall be the amount of short-term flexural modulus (according to ASTM D790) retained for the design life. The retention factor shall be derived from long-term testing and be appropriate for stress and stress duration in the installed liner. Independent third party test data is required (submit with tender) to substantiate the short-term and long-term values used in design. Minimum short-term value shall be in accordance with the minimum requirement in ASTM F1216-07a (1724 MPa).
CIPP Liner Tensile Strength	The liner tensile strength for design equation X1.7 shall be the long-term tensile strength. The long-term tensile strength to be used in design shall be the amount of short-term tensile strength (according to ASTM D638) retained for the design life. The retention factor shall be derived from long-term testing and be appropriate for stress and stress duration in the installed liner. Independent third party test data is required (submit with tender) to substantiate the short-term and long-term values used in design. Minimum short-term value shall be in accordance with the minimum requirement in ASTM F1216-07a (21 MPa).

### **Vacuum**

In accordance with the ASTM F1216 design method, vacuum is treated as an external pressure. For design purpose use of short-term liner flexural modulus is acceptable for vacuum resistance. Alternately, an equivalent vacuum may be used with long-term flexural modulus that has the same result as specified vacuum using short-term flexural modulus.

### **Short-term Flexural Modulus and Short-term Tensile Strength**

The short-term values of flexural modulus and tensile strength according to ASTM D790 and ASTM D638, respectively, used as the starting values from which the long-term design values are derived shall be values that will be reliably and repeatedly obtained in the installed liners as substantiated by testing samples from installed liners. These short-term values shall be identified in the liner design.



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### **Designs Correct for Field Conditions**

The Contractor shall check and determine that actual field conditions for any liner installation watermain section correspond with the liner design for that installation. The field conditions to be checked shall include deepest cover over top of the watermain and live load situation. Where the existing liner design is not appropriate for the field conditions, the Contractor shall adjust the liner design accordingly and the liner installed shall meet the requirements of the adjusted design. The adjusted liner design shall be submitted to the Contract Administrator for approval.

Where a liner design previously approved by the Contract Administrator is found needing adjustment due to determined actual field conditions, the Contractor shall advise the Contract Administrator within 48 hours and wait for the Contract Administrator's instructions. Where the adjusted design results in a thicker liner to be installed, any additional cost involved shall be determined according to the Contract Price where applicable, and if Contract Price are not applicable, then shall be negotiated with the Contract Administrator.

No liner shall be installed that does not meet the requirements for actual field conditions, including required liner thickness for actual field conditions.

### **TS 7.60.27                      Fit, Finish and Properties**

The cured liner within the watermain shall meet the following requirements for fit, finish and properties.

#### **Liner Fit and Finish to Existing Watermain**

The outside surface of the finished liner shall be in contact with and bonded to the inside surface of the existing watermain. The level of bonding shall correspond to the design and performance parameters for the liner. The inside surface of the existing watermain is the surface after the watermain has been prepared for lining in accordance with the cleaning and preparation requirements. Where any space or gap exists between the outside surface of the liner and the inside surface of the existing watermain the liner fit (and liner) will be considered deficient, subject to exceptions noted below. Should the lining be damaged as a direct result of the Contractor's operation or reveal evidence of defective work or materials prior to the completion of the contract, such damage or defective portions shall be removed and replaced.

#### **Exceptions to Liner Fit to Existing Watermain**

Existing watermain irregularities include joints, protrusions plugged main stops, bumps or other similar situations in the existing watermain that remain after the watermain has been cleaned and prepared in accordance with the requirements.

#### **Finished Liner Installation**

The liner shall be free of any interior bulges, ribs, ripples, or other irregularities except where these irregularities comply with the liner wall thickness tolerance, fit, shape and wall thickness given above or, in the case of over-sizing folds, comply with fold requirements.

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### **Liner Terminations at Ends of Liner Runs**

Liner terminations at the ends of liner runs shall be smooth, square and neatly cut. There shall be no separation from the inside surface of the existing watermain. The terminations shall be watertight to the requirements for external and internal hydrostatic pressure.

### **Liner Termination at Valves**

At valves, the interface between the exterior surface of the liner and the valve shall be watertight to the requirements for external and internal hydrostatic pressure. The finished ends of the liner shall be neat and smoothly cut.

### **Liner Fold**

A fold is defined as a longitudinal ridge in the liner that is due to the liner's circumference being in excess of the circumference of the post cleaning and preparation circumference of the watermain. Some types of liner tubes required sizing with an excess circumference to assure that the liner fully contacts and is bonded to 100 per cent of the circumference of the watermain. Such excess liner circumferential material shall result in a tight fold in the cured liner caused by the compression of the excess material from pressure used for inflating and curing the liner. Fold size may vary along the lined section in correspondence with variations in the watermain size along the same section.

Folds shall be tightly compressed, solid and without any space or voids within the fold. Folds shall be fully cured. A fold configuration shall not result in any annular space between the liner and the watermain. Folds shall not have any tube inner membrane material trapped within the fold.

Regardless of fold size and configuration, no fold shall be permitted that will negatively affect the long-term performance of the liner for its intended purpose including liner performance in accordance with design requirements.

### **Liner Wall Thickness and Tolerance**

The liner's finished wall thickness shall be as specified in the engineered design submitted with the Tender (or as submitted at a later date) meeting the requirements of the Contract and as approved by the Contract Administrator, subject to the following tolerances:

- Liner wall thickness minus tolerance: 0 %
- Liner wall thickness plus tolerance: 25 %

The thickness for comparison purposes shall be determined according to ASTM D5813-04(2008). The effective thickness for comparison to required thickness shall not include any non-structural layers or membranes.

### **Liner Physical Properties**

The final installed liner shall have the following required physical properties.

- Flexural modulus: Shall meet or exceed the short-term value used in the liner design or the minimum value in ASTM F1216, whichever is greater.

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- Tensile strength: Shall meet or exceed the short-term value used in the liner design or the minimum value in ASTM F1216, whichever is greater.

The final installed liner shall possess the required long-term retention characteristics such that the long-term values of flexural modulus and tensile strength used in design will be met by the liner over its design life.

## **TS 7.60.28                      Installation**

The installation of the liner into the watermain complete with curing is the responsibility of the Contractor. The Contractor shall follow the liner manufacturer's installation recommendations to the extent that they are appropriate for specific circumstances.

### **Installation Procedure**

The actual lining installation procedure shall be in accordance with the submission with Tender. Any proposed deviation from the submitted procedure shall be submitted, with explanation, to the Contract Administrator for approval and the submission shall include the approval of the lining manufacturer or senior licensor.

### **Equipment Ready for Lining**

The Contractor shall ensure that all required equipment (including as required by the Contract) is on site and in satisfactory working order prior to commencing the installation of a lining section.

### **Wet Out and Curing Requirements**

Prior to the lining of each watermain section the Contractor shall submit to the Contract Administrator a certificate of analysis, identifying the batch no. and product name and confirming that the liner to be installed complies with the product specification and tender design submissions. The Contractor shall also provide the Contract Administrator with copies of the wet out information sheet itemizing the dimensions of the liner and the quantity of each material to be used in the lining of the watermain section. Following installation of the liner the Contractor shall provide the Contract Administrator with copies of the boiler and thermocouple log in a format that will enable direct comparison with the process curing cycle submitted with the tender submission.

### **Quality Control and Assurance**

The Contractor shall have in place and follow a quality control and assurance program for the CIPP watermain liner that addresses: cleaning and preparation of the existing watermain, liner sizing, correct liner for the installation such as tube size, materials and design, liner thickness such as design and as cured, liner resin such as mix, impregnation and uniform distribution, liner fit and finish, liner service connection reinstatements and liner as cured physical properties. On the Contract Administrator's request, the Contractor shall provide full details of this program to the Contract Administrator. Where in the Contract Administrator's opinion, the program is not adequate, or not being followed, the Contract Administrator will require the Contractor to make rectification to the Contract Administrator's satisfaction.

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## **Records**

The Contractor shall keep detailed records that are sufficient to track the progress and parameters of each liner run installation. These records shall easily allow identification of individual liner runs and include, at a minimum: preliminary and final liner sizing, specifics of liner tube ordered, specifics of liner tube installed, location information independent of pit locations, number and size of services, GPS locating information (when required), installation dates, return to service dates and quality problems (if any). On the Contract Administrator's request, the Contractor shall show or provided these records. Where, in the Contract Administrator's opinion, the records are not adequate, the Contract Administrator will require the Contractor to make rectification to the Contract Administrator's satisfaction.

### **TS 7.60.29 Reinstatement of Service Connections**

The water service connections shall be reinstated from inside of the lined pipe, using a mechanical robot equipped with a camera and activated by an operator using a remote control and television unit. The robot shall be equipped with a drilling tool that allows the operator to drill a hole in the liner at the precise location of the connection. The service connection shall be opened to the full pre-existing flow opening size, including the removal of any resin slugging in or up the service connection that will impede flow. After opening the connections, the lined watermain shall be flushed clean, disinfected and restored to service.

The Contractor will be fully responsible to locate and successfully reinstate the existing service connection, without damaging the lining. Any damage to the service connection or the lining caused by the reinstatement process will require immediate corrective action by the Contractor.

If the Contractor is unable to reinstate a service connection from the inside, a suitable excavation will be required to access the main stop and to disconnect the existing copper pipe and reconnect the copper piping with the Contract Administrator's approved fittings.

If the Contractor is unable to effectively reconnect the service connection to the Contract Administrator's satisfaction, the Contractor shall be required to re-tap the watermain in accordance to the City's standards.

### **Clearing of Obstruction in Water Services**

Should any services be partially or fully obstructed due to the ingress of liner resin or other foreign materials it shall be the Contractor's responsibility to remove such obstructions in a manner approved by the Contract Administrator. Where an excavation of a water service is required and not caused by the negligence of the Contractor, payment will be made at the unit price under the applicable tender item. The work shall include all labour, Equipment, Material and tools for cutting pavement, excavating and removing restrictions in main stops or services or replacing the main stop as ordered by the Contract Administrator, reconnecting the service, backfilling and restoration.

### **Pay Limit on Clearing Water Services Plugged/Obstructed by Resin Using Excavation**

Payment by the City to clear water services plugged or obstructed with liner resin by excavating and clearing blockage via main stop shall be limited to six per cent of the total number of properties within the project limit. Contractor should take precaution to minimize the number of plugged services need to be cleared.

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**TS 7.60.30                      Field Lining Samples**

**Samples of Finished Liner**

At the request of the Contract Administrator, the Contractor shall furnish to the Contract Administrator a sample of the lining within the host watermain up to one metre in length at any location or time. A minimum of two one metre long pipe samples per kilometre of lined pipe shall be removed for inspection and for potential testing purposes. Immediately upon removal the Contractor shall give the samples into the custody of the Contract Administrator. Where samples have been removed, the watermain shall be closed up with new pipe and fittings in accordance with the specifications.

The Contractor shall provide for testing of the samples at a testing agency approved by the Contract Administrator. The Contractor shall authorize the testing agency to forward the test reports to the Contract Administrator and communicate with the Contract Administrator concerning the testing and results. The Contract Administrator will arrange for delivery of the samples to the testing agency.

**Samples of Resin**

The City with the Contractor's assistance, may from time to time sample resin from liners supplied for this Contract and may conduct Infrared Spectrophotometric analysis on each resin sample. The Spectrograph shall be generated by the same test method as employed by the supplier to generate the benchmark scan that shall include all components that will be incorporated into the final resin mix used with the liners. The certified copy of the IR Spectrograph provided by the Contractor shall be the reference IR Spectrograph used for comparison with IR spectrographs of field samples. All field samples supplied for this Contract shall produce IR Spectrographs that correspond to the reference IR Spectrograph when tested under the same conditions.

**TS 7.60.31                      Pressure Test**

The lined watermain shall be pressure tested before the reinstatement of the service connections. The test pressure shall be 120 per cent of the operating pressure for the watermain location being tested. The Contract Administrator will provide the operating pressure to the Contractor for the test section(s). The test pressure shall be maintained for a minimum of one hour during which time the maximum water loss shall not exceed 0.5 L/hour/100 m.

**TS 7.60.32                      CCTV Inspection of Completed Liner – V3**

On completion of the lining of a watermain section, including all reinstatements of services, a CCTV inspection—called the V3—shall be done and recorded. The CCTV recording and reports shall be submitted to the Contract Administrator for approval. The Contract Administrator shall use the V3 CCTV submission as part of its process for approving the watermain liner installation.

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**TS 7.60.33                    Close Up of Watermain after Lining Complete**

Upon completion of the CIPP liner, the openings in the watermain shall be closed as soon as possible using PVC watermain pipe and approved couplings. When using PVC pipe, approved restrainers shall be used to carry out the work. When PVC pipe used at fittings and change in direction of watermain shall be restrained with pipe restrainers according to Chapter 6, *Material Specifications* from the *Design Criteria for Sewers and Watermains* manual and installed in according to manufacturers instructions..

Cathodic protection, jumper wires and tracer wires shall be installed as required before back fill of the close up location.

Close up of the watermain shall be done within 24 hours following CIPP lining of the watermain.

**TS 7.60.34                    Disinfection**

Disinfection shall be according to TS 7.30 – *Procedure for Disinfecting Watermains*.

**TS 7.60.35                    Removal of Bypass and Temporary Services**

After the tests on all water samples have been approved, the watermain shall be flushed, water service connections restored, excavations backfilled, the watermain returned to service and the temporary service lines removed.

The Contractor will be permitted to reuse temporary bypass service connections previously disinfected without re-disinfecting provided that precautions are taken, to avoid the potential for contamination, that include: immediately capping each end of the temporary bypass service prior to storage and reuse; and storing the temporary service lines in a manner that will lessen the likelihood of contamination.

Prior to the reconnection of the previously disinfected temporary service connection, the connection ends of the service pipe must be submerged in a 5 per cent sodium hypochlorite solution. The service pipe must then be flushed, the outside hose bib and “Y” connector sprayed with a 5 per cent sodium hypochlorite solution before final hook up of the temporary service pipe to provide service.

The Contractor shall satisfactorily restore the permanent property connections and leave streets, sidewalks and adjacent property in a neat and orderly condition. Any valves, corporation stops or other appurtenances which have been damaged due to cleaning and lining operations shall be replaced by the Contractor.

**TS 7.60.36                    Payment**

Payment at the Contract Price shall be full compensation for all labour, Equipment and Material to do the Work.

**APPENDIX**

Appendix A: Water Services Statement

