

PART E
SPECIFICATIONS

PART E - SPECIFICATIONS

GENERAL

E1. APPLICABLE SPECIFICATIONS, STANDARD DETAILS AND DRAWINGS

- E1.1 *The City of Winnipeg Standard Construction Specifications* in its entirety, whether or not specifically listed on Form B: Prices, shall apply to the Work.
- E1.1.1 *The City of Winnipeg Standard Construction Specifications* is available in Adobe Acrobat (.pdf) format on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Division internet site at <http://www.winnipeg.ca/matmgt>.
- E1.1.2 The version in effect three (3) Business Days before the Submission Deadline shall apply.
- E1.1.3 Further to GC:2.4(d), Specifications included in the Bid Opportunity shall govern over *The City of Winnipeg Standard Construction Specifications*.
- E1.2 The following Drawings are applicable to the Work:

<u>Drawing No.</u>	<u>Drawing</u>
05480	Archibald Street – 60m N. of Giroux Street to 75m N. of Kavanagh Street
05481	Burnell Street – Ellice Avenue to 100m N. of Ellice Avenue
05482	De La Morenie Street – 51m N. of Yelle Street to 63m S. of Hamel Avenue
05483	Polson Avenue – 63m E. of Airlies Street to 150m W. of Sinclair Street
05484	Polson Avenue – 280m E. of Airlies Street to Sinclair Street

E2. APPROVED CONSTRUCTION METHODS

- E2.1 The sewer rehabilitation on all streets may be undertaken by CIPP lining or GRP Segmental lining methods with the exception of the sewer rehabilitation on Burnell Street, which shall only be undertaken by GRP Segmental lining methods.

E3. CURED-IN-PLACE-PIPE (CIPP)

- E3.1 Description
- E3.1.1 This specification covers the supply and installation of full segment sewer rehabilitation on non-circular sewer using cured-in-place pipe (CIPP) rehabilitation methods.
- E3.2 Definitions
- E3.2.1 Cured-in-place-pipe (CIPP) means trenchless sewer rehabilitation by installing a resin-felt composite structure which when cured will form a continuous-close fit liner within an existing sewer.
- E3.2.2 Approved CIPP Suppliers and Installers means suppliers and installers pre-approved under City of Winnipeg "Request for Qualifications for the Supply and Installation of Cured in Pipe (CIPP)". A list of pre-approved CIPP suppliers and installers for 2004 is included in the Specifications.
- E3.2.3 Full segment CIPP means CIPP extending from manhole to manhole or manhole to node (wye or tee connection to another sewer).
- E3.2.4 Minimum material requirements for CIPP shall conform to ASTM D5813 "Standard Specification for Cured-In-Place Thermosetting Resin Sewer Pipe" and the supplemental requirements noted herein.

E3.3 Materials

E3.3.1 Pre-Approved CIPP Suppliers and Installers and Materials

- (a) The following is a list of sewer lining systems – suppliers and installers and materials that have been pre-approved under the City of Winnipeg “Request for Qualifications for the Supply and Installation of Cured in Pipe (CIPP) Bid Opportunity No. 82-2004” for 2004 City of Winnipeg sewer rehabilitation projects with non-circular sewers.

Table E3.3.1a): Pre-Approved CIPP Suppliers and Installers for Non-Circular Sewers

<i>Applicant</i>	<i>Insituform Technologies Limited</i>	<i>Capital Commercial Pipe Services</i>	<i>Nelson River Construction Inc.</i>
Contact	Ken Foster 780-413-0200	Brian Ratchford 905-522-0522	Gordon Lee 204-949-8700
Supplier	Insituform Technologies Inc.	Capital Commercial Pipe Services	C.I.P.P. Corporation
Installer	Insituform Technologies Limited	Capital Commercial Pipe Services	Municipal Pipe Tool Inc.
Liner Name	Standard Insituform® CIPP	Capital Lining System	C.I.P.P. Corp Liner

E3.3.2 CIPP Design Objectives

- (a) Design objectives for CIPP include:
- (i) Maximizing the structural enhancement of the sewer by installing a close-fit CIPP.
 - (ii) Providing no impact or increasing the hydraulic capacity of the rehabilitated sewer.
 - (iii) Reducing infiltration and exfiltration.
 - (iv) Preventing root intrusion.
 - (v) Providing sufficient chemical resistance to prevent further sewer pipe degradation related to the conveyance of sewage.
 - (vi) Minimizing sewer service disruption during rehabilitation.
 - (vii) Minimizing the time required to complete the sewer rehabilitation.
 - (viii) Minimizing disturbance to pavements and boulevards.
 - (ix) Minimizing disruption to vehicular and pedestrian traffic.
 - (x) Minimizing the impact of construction on commercial, industrial, and institutional facilities.
- (b) Select CIPP and plan approach to rehabilitation toward maximizing the achievement of these design objectives.

E3.3.3 CIPP Non-circular Design Requirements – General

- (a) Design full segment CIPP as a Type II lining system in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and these specifications as a gravity pipe in a partially or fully deteriorated pipe condition in accordance with design conditions noted in the Drawings and Specifications.
- (b) Size CIPP in accordance with the design objectives to provide a close-fit to the host pipe with no annulus except for the maximum allowable diametric shrinkage due to curing permitted in ASTM D5813.

- (c) Perform a design check to confirm the full flow hydraulic capacity of the CIPP will be equal to or greater than the existing sewer. Use “Manning’s” formula with assumed ‘n’ value of 0.010 for the CIPP and an “n” value for the existing section estimated on the observed condition of the pipeline from the Sewer Maintenance Inspection and the general guidelines presented in Appendix C of Volume I – Rehabilitation Planning, WRc Sewerage Rehabilitation Manual, 4th Edition.

E3.3.4 CIPP Type II Design - Partially Deteriorated Condition

- (a) Where partially deteriorated design conditions are indicated design CIPP as a Type II non-circular liner in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks:
 - (i) Short term buckling/deformation checks (only required if secondary grouting is contemplated);
 - (ii) Long term check buckling/deformation checks due to hydrostatic pressure;
 - (iii) No allowance required for earth and superimposed loading.
- (b) Use the following minimum design assumptions:
 - (i) Flexible liner, no bond with host pipe;
 - (ii) Groundwater table is 2.0 m below the existing ground surface;
 - (iii) Long-term values for flexural modulus of elasticity and flexural strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific resin and felt composite approved for use in the pre-qualification process;
 - (iv) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressure.

E3.3.5 CIPP Type II Design - Fully Deteriorated Condition

- (a) Where fully deteriorated design conditions are indicated design CIPP as a Type II non-circular liner in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks:
 - (i) Short term buckling/deformation checks (only required if secondary grouting is contemplated);
 - (ii) Long term check buckling/deformation checks due to hydrostatic pressure;
 - (iii) Provide allowance for full earth and superimposed loading as noted below.
- (b) Use the following minimum design assumptions:
 - (i) Flexible liner, no bond with host pipe;
 - (ii) Groundwater table is 2.0 m below the existing ground surface;
 - (iii) Long-term values for flexural modulus of elasticity and flexural strength will be considered to be the projected value at 50 years of a continuous application of the design load based on the specific resin and felt composite approved for use in the pre-qualification process;
 - (iv) Calculate dead load based on soil density of 1920 kg/m³ and assumption of prism loading on host pipe. Modulus of soil reaction (E’s) will be assumed to be 6900 kPa unless a higher or lower value is indicated in the contract specifications;
 - (v) Include an allowance for an AASHTO HSS25 concentrated live load in the total external pressure on the pipe. Calculate minimum live load surcharge based on Cooper E80 distributed load for portions of CIPP installed under railway lines;
 - (vi) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressure.

E3.3.6 Existing Sewer Design Conditions

- (a) The assessment of liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed in 2000 – 2003 as part of the City of Winnipeg’s Sewer Cleaning and Inspection Programs. Copies of these video inspections are available to the Contractor in digital format on CDs.
- (b) The Contractor shall be aware the video inspections provided were completed immediately after sewer cleaning and the amount of sediment and debris present at the time of this Bid Opportunity may not be the same. The Contractor shall be responsible to determine the actual amount of sediment and debris in the sewers included in this Work.
- (c) The following specific design conditions and site specific repair requirements apply to the Work.

Table E3.3.6: Specific Design Conditions and Site Specific Repairs

Archibald St. (Sewer ID 7351)		From MH (ID 7350) at Kavanagh St. to 1st MH (ID 7352) North of Kavanagh St.	
Rehabilitation Type	Full Segment Lining		
Size/Shape	1200mm x 900mm Egg		
Material	Concrete		
Total Length	76.1m		
Sewer Depth to Invert – maximum	5.5 m		
Design Condition	Partially deteriorated		
MH 7350 to MH 7352			
Lining	MH to MH		
Site Specific Repairs			
Location - Defect (clock reference)	Required Action		
From MH 7350 to MH 7352	none		
Manhole Defect Location/Type	Required Action		
MH 7350	Replace manhole.		

Burnell St. (Sewer ID 26019)		From 1st MH (ID 26020) North of Ellice Ave. to 1st MH (ID 26021) South of Ellice Ave.	
Rehabilitation Type	Partial Full Segment Lining		
Size/Shape	2591mm Circular		
Material	Concrete		
Total Length	117.3		
Sewer Depth to Invert – maximum	9.7m		
Design Condition	Partially deteriorated		
MH 26020 to MH 26021			
Lining	65.0-95.0		
Site Specific Repairs			
Location - Defect (clock reference)	Required Action		
From MH 26020 to MH 26021	none		
Manhole Defect Location/Type	Required Action		
MH 26020	Replace manhole riser.		

De La Morenie St. (Sewer ID 19261) From 1st MH (ID 19260) South of Hamel Ave. to 2nd MH (ID 19262) South of Hamel Ave.	
Rehabilitation Type	Full Segment Lining
Size/Shape	1200mm x 750mm Egg
Material	Concrete
Total Length	106.4m
Sewer Depth to Invert – maximum	5.5m
Design Condition	Partially deteriorated
MH 19260 to MH 19262	
Lining	MH to MH
Site Specific Repairs	
Location - Defect (clock reference)	Required Action
From MH 19260 to MH 19262	
2.5 CXI (11)	Remove Intruding Sewer Service.
2.5 SSM (09-01)	Internal Sewer Repairs.
13.8 CNI (01)	Remove Intruding Sewer Service.
19.7 CN (10)	Sewer Service Grouting.
26.2 RM	Solid Debris Cutting.
29.2 CN (11)	Sewer Service Grouting.
38.5 SSM (02-03)	Internal Sewer Repairs.
52.2-55.2 SSM (06-10)	Internal Sewer Repairs.
54.0 RF (10)	Solid Debris Cutting.
55.7 CX (12)	Sewer Service Grouting.
57.3-58.3 SSM (07-10)	Internal Sewer Repairs.
67.5 CN (10)	Sewer Service Grouting.
68.0-70.0 SSM (05-07)	Internal Sewer Repairs.
71.5 SSM (01-03)	Internal Sewer Repairs.
73.7 SSM (06-08)	Internal Sewer Repairs.
74.4 CN (11)	Sewer Service Grouting.
78.6-79.6 SSL (03-09)	Internal Sewer Repairs.
83.4 CN (01)	Sewer Service Grouting.
85.0-86.0 SSL (04-07)	Internal Sewer Repairs.
94.3-95.3 SSM (04-10)	Internal Sewer Repairs.
95.1 CN (11)	Sewer Service Grouting.
96.0-99.0 - H	3.0m Sewer repair including 1 sewer service reconnection (By Others).
101.8-103.3 SSM (12-12)	Internal Sewer Repairs.
105.4 SSM (05-07)	Internal Sewer Repairs.
Manhole Defect Location/Type	Required Action
MH 19260	Replace manhole.
CB Defect Location/Type	Required Action
CB 01	Inspect CB lead.
CB 02	Inspect CB lead.

Polson Ave. (Sewer ID 16757)		1st MH (ID 16756) East of Airlies St. to 2nd MH (ID 16758) East of Airlies St.	
Rehabilitation Type		Full Segment Lining	
Size/Shape	1550mm x 1200mm Egg		
Material	Concrete		
Total Length	100.4m		
Sewer Depth to Invert – maximum	6.4m		
Design Condition	Partially deteriorated		
MH 16756 to MH 16758			
Lining	MH to MH		
Site Specific Repairs			
Location - Defect (clock reference)		Required Action	
From MH 16756 to MH 16758			
4.9 EL (07-11)		Solid Debris Cutting.	
5.6 EM (02-05)		Solid Debris Cutting.	
6.2 EL (08-11)		Solid Debris Cutting.	
9.7 CN (01)		Sewer Service Grouting.	
15.5 EL (07-10)		Solid Debris Cutting.	
16.0 EL (02)		Solid Debris Cutting.	
38.0-39.0 SSM (05-07)		Internal Sewer Repairs.	
43.9-44.9 SSL (07)		Internal Sewer Repairs.	
45.8-46.8 SSM (04-06)		Internal Sewer Repairs.	
48.8 SSS (02-04, 08-10)		Internal Sewer Repairs.	
50.3-51.3 SSL (07)		Internal Sewer Repairs.	
52.5-55.8 SSM (03-09)		Internal Sewer Repairs.	
71.5-74.0 SSL (03-06)		Remove pieces of pipe. Internal Sewer Repairs.	
75.5-82.5 SSM (12-12)		Internal Sewer Repairs.	
87.5-88.5 SSM (05-07)		Internal Sewer Repairs.	
Manhole Defect Location/Type		Required Action	
MH 16756		Replace manhole riser.	
MH 16758		Patch 4780-6380 and 250-550 of manhole.	
CB Defect Location/Type		Required Action	
CB 07		Inspect CB lead.	
CB 08		Inspect CB lead.	
CB 09		Inspect CB lead.	

Polson Ave. (Sewer ID 16768)		3rd MH (ID 16767) East of Airlies St. to MH (ID 16769) at Sinclair St. (E PL)	
Rehabilitation Type		Full Segment Lining	
Size/Shape	1550mm x 1200mm Egg		
Material	Concrete		
Total Length	100.6m		
Sewer Depth to Invert – maximum	7.4m		
Design Condition	Partially deteriorated		
MH 16767 to MH 16769			
Lining	MH to MH		
Site Specific Repairs			
Location - Defect (clock reference)		Required Action	
From MH 16767 to MH 16769			
6.0-7.0 SSL (03-05)		Internal Sewer Repairs.	
15.7 SSM (03)		Internal Sewer Repairs.	
65.3 EL (01-03)		Solid Debris Cutting	
66.6 SSM (07)		Internal Sewer Repairs.	
70.0-74.0 SSM (07-10)		Internal Sewer Repairs.	
78.5-81.0 B (05-09)		Remove pieces of pipe. Internal Sewer Repairs.	
81.8 EL (01-04)		Solid Debris Cutting	
88.8 EM (08-11)		Solid Debris Cutting	
94.5 EL (08-12)		Solid Debris Cutting	
95.8 EL (03-05)		Solid Debris Cutting	
96.8 EM (07-05)		Solid Debris Cutting	
Manhole Defect Location/Type		Required Action	
MH 16767		Replace manhole riser.	
MH 16769		Replace 250-950 of manhole riser.	
CB Defect Location/Type		Required Action	
CB 10		Inspect CB lead.	
CB 11		Inspect CB lead.	

E3.3.7 Submittals Before Starting Work

- (a) Provide the required submittals to the Contract Administrator a minimum of 10 days before starting the lining.
- (b) Submit the CIPP design Shop Drawings in accordance with CW1110 and sealed and signed by a Professional Engineer licensed to practice in the Province of Manitoba. Include the following information.
 - (i) CIPP thickness computations including all specified design checks. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions.
 - (ii) Calculations showing the hydraulic capacity of the CIPP sewer will be equal to or greater than the existing sewer.
 - (iii) Name and manufacturer of the resin and tube proposed for each CIPP.
 - (iv) CIPP curing schedule provided by the resin supplier indicating the temperature, staging, duration and pressure required to achieve a proper cure of the resin and fabric tube composite.
 - (v) Other information that may reasonably be required by the Contract Administrator to confirm the CIPP design proposed conforms to the specified requirements and design intent.
- (c) Resin Samples
 - (i) Arrange for the manufacturer of the resin to forward a reference sample of each resin proposed for use on the Works to a test laboratory designated by the Contract Administrator to be used as a comparative reference sample for infrared spectrum testing.
 - (ii) Deliver a representative sample of each resin to be used on the project before adding the catalyst from the wet-out facility to a test laboratory designated by the Contract Administrator.
 - (iii) The Contract Administrator will arrange and pay for an infrared analysis of the samples.
- (d) Submit an operations protocol that provides information on the following.
 - (i) Resin impregnation method.
 - (ii) Designated location of the wet out facility.
 - (iii) Documentation the resin to be used has not exceeded its shelf life as recommended by the manufacturer of the resin.
 - (iv) Volume of resin to be impregnated into each liner and repair section including the proposed excess allowance for polymerization and migration (typically 7%) into cracks and joints of the host pipe.
 - (v) Roller gap setting required to provide the final installed CIPP thickness based on the proposed volume of resin.
 - (vi) Details of the wet-out procedure for internal point repair CIPP.
- (e) Submit a construction protocol that provides information on the following.
 - (i) Proposed main line and sewer service flow control arrangements.
 - (ii) Details of template establishment and inspection protocol to confirm the size of liner required, the need for secondary grouting, and to be used post-installation to confirm liner fit and secondary grouting requirements.
 - (iii) Minimum pressure to hold the tube tight against the existing sewer and the maximum pressure to not damage the sewer or uncured liner.
 - (iv) Provide the maximum allowable axial and longitudinal tensile stress for the fabric tube and the arrangement for monitoring pull-in forces during installation if liner insertion is to be by pull-in methods.

- (v) Number and location of heat source monitor gauges.
- (vi) Minimum and maximum allowable temperature during each phase of the cure period as measured at the heat source return line.
- (vii) Number of stages and anticipated time for each stage of the curing period based on resin supplier's recommendations.
- (viii) Estimated length of time required to reinstate the main line sewer and sewer services.

E3.4 Construction Methods

E3.4.1 Verification of Existing Sewer Dimensions

- (a) Verify dimensional requirements of each sewer to be rehabilitated prior to manufacture of the CIPP tube by passing a template of sufficient size, rigidity, length, and cross section to determine liner dimensional requirements and the potential need for secondary grouting.

E3.4.2 Sewer Cleaning

- (a) Remove loose and solid debris and intruding connections in accordance with CW 2140 to adequately prepare the sewer for lining.

E3.4.3 Sewer Inspections

- (a) Perform the following sewer inspections in accordance with CW 2145 in the presence of the Contract Administrator.
 - (i) Pre-Sewer Repair Inspection, where required, before starting any excavation. No coding submission will be required.
 - (ii) Pre-Lining Inspection after sewer cleaning and preparation. No coding of the submission will be required.
 - (iii) Post-Lining Inspection subsequent to installing the CIPP and sewer service reinstatement. Full coding required.
 - (iv) Warranty Inspection before expiration of the warranty period and acceptance. Full coding required.
- (b) Review the Pre-Sewer Repair Inspection video with the Contract Administrator before starting the repair work to confirm the extent and precise location of internal sewer repairs. All external sewer repairs will be undertaken by others.
- (c) Review the Pre-Lining Inspection videotape with the Contract Administrator at least 24 hours before installing the CIPP and obtain approval to install the CIPP. The Pre-Lining Inspection shall confirm:
 - (i) Necessary cleaning and pipe preparation work, including internal and external sewer repairs, have been satisfactorily completed.
 - (ii) Condition of the sewer pipe is consistent with the design conditions and the Specifications. Advise the Contract Administrator of any condition that is contrary to the design conditions or assumptions made that may affect either long or short term performance of the CIPP prior to commencing lining.
 - (iii) Location, condition and operational status of all sewer services.
 - (iv) The limit and precise location for each internal point repair.
 - (v) Review Sewer Service Reports while reviewing the Pre-Lining Inspection.
- (d) Post-Lining Inspection is to confirm the adequacy of sewer service reinstatements and the fit and finish of the CIPP including continuous measurement of the height and width of non-circular sewers along the entire length of the sewer or confirmation of same by the use of an approved template. The actual measurements and distance of the measurements from the upstream manhole are to be visible and recorded on the Post Lining Inspection. Where an approved template is utilized, variances shall be measured and coded in an approved manner.

- (e) Warranty Inspection to confirm the fit and finish of the CIPP, need for any remedial work and acceptance of any repair work performed during the warranty period. Sewer cleaning in accordance with CW 2140 is required to obtain a satisfactory inspection.

E3.4.4 Sewer Service Report

- (a) Confirm exact location of all sewer services connected to the sewer being lined by dye testing methods.
- (b) Submit a written Sewer Service Report for each CIPP location to the Contract Administrator providing the following information for each sewer service.
 - (i) Operational status of each sewer service (live or out of service). For live services indicate the property address of structure serviced.
 - (ii) Distance from the upstream manhole in metres and clock reference of the connection position to the sewer.
 - (iii) Diameter in millimetres.
 - (iv) Material type.
 - (v) Observed condition of the sewer service.

E3.4.5 Flow Control

- (a) Provide necessary flow control measures for the main line sewer and sewer services required to perform the Work. Diversion of wastewater flow directly or indirectly to the environment, Land Drainage Sewers, or Storm Relief sewers will not be allowed.
- (b) Maintain existing sewer flows from upstream sewers during construction around the sewers being lined.
- (c) Provide adequate temporary bypass pumping for live sewer services connected to the sewer being lined from when the service is blocked off until it is reinstated.
- (d) Provide temporary indoor portable toilets for residential homes and for each apartment in small apartment buildings instead of temporary sewer service bypass pumping where feasible and approved by the building owner and the Contract Administrator. Provide necessary supplies for portable toilets and clean as often as required while in use. Remove portable toilets promptly once sewer service is reinstated.
- (e) Expose sewer services for facilities with a high volume of effluent discharge that have no feasible means of intercepting the flow within the building or at a location outside the building agreed upon by the Contract Administrator and drain or pump the sewer service from that location until the sewer service is reinstated.
- (f) Excavate for sewer service exposure in accordance with CW 2030. Repair and backfill exposed sewer services in accordance with CW 2130.
- (g) Restore the surface in accordance with CW 2130 and the following specifications:
 - (i) Boulevard areas in accordance with CW 3510.
 - (ii) Concrete pavement in accordance with CW 3230.
 - (iii) Asphaltic pavement in accordance with CW 3410.
 - (iv) Concrete sidewalk and interlocking paving stone in accordance with CW 3325 and CW 3330.

E3.4.6 Sewer Preparation and Repairs Prior to Lining

- (a) Perform sewer preparation and repairs as indicated in the specification and drawings.
- (b) Complete the following internal host pipe repairs in accordance with E5 of this specification.
 - (i) Fill holes in and patch deteriorated sections of the host sewer pipe wall.
 - (ii) Fill voids in the surrounding backfill flush with the inside surface of the sewer pipe.

(iii) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.

(c) Removal of Intruding Sewer Services and Solid Debris Cutting

(i) Remove intruding sewer services and solid debris in accordance with CW 2140.

(d) Sewer Service Grouting

(i) Fill voids around sewer services with a non-shrink, watertight cement grout, an appropriate polyurethane grout compound, or other approved grouting product to form a smooth watertight connection.

E3.4.7 External Sewer Repairs

(a) External sewer repairs as indicated in the Specifications and on the Drawings will be completed where noted. Where external sewer repairs are required in conjunction with manhole modifications carry out Work in accordance with CW 2130, SD-022A and SD-022B.

E3.4.8 Manhole and Catch Basin Repairs

(a) Complete manhole and catch basin repairs as indicated in the Specifications and Drawings in accordance with CW 2130.

(b) Remove and replace manhole frames, covers, rungs and risers required to facilitate the CIPP installation in accordance with CW 2130.

E3.4.9 Weather

(a) Review the Environment Canada weather forecast with the Contract Administrator before starting CIPP lining installation.

(b) Delay installation of CIPP when the anticipated weather conditions are such that anticipated sewer flow will exceed the flow control measures provided.

E3.4.10 Installation of CIPP

(a) Install liners by inversion methods in accordance with ASTM F1216 or by pull-in methods in accordance with ASTM F1743.

(i) Full segment and partial full segment CIPP shall be cured by hot water or steam.

(ii) Internal point repair CIPP shall be ambient, hot water or steam cured.

(b) Carry out workmanship in accordance with ASTM D5813.

(c) Trim ends of CIPP neatly to fit flush with interior vertical surface and manhole benching and seal to make watertight.

(d) Fill annular spaces where the CIPP does not make an adequate seal with the host pipe at manholes, termination points and sewer services due to broken or misaligned pipe with a resin mixture compatible with the CIPP.

E3.4.11 Reinstatement of Sewer Services

(a) Reinststate live sewer services to 100% of the original cross sectional area.

(b) Cut out openings for sewer services from inside the lined sewer by manual means or with a television camera and a remote controlled cutting device.

(c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.

(d) Sewer Service Grouting

(i) Fill voids between the CIPP and the host pipe at sewer service openings with a non-shrink, watertight cement grout or an appropriate polyurethane grout compatible with the liner system, or other approved grouting product to form a smooth watertight connection.

- (ii) Locations for sewer service grouting shall be identified by the Contract Administrator during review of Post Lining Video Inspection.
- (iii) If the voids are due to the condition of the existing sewer service and host pipe, sewer service grouting shall be measured and paid for under sewer service grouting – after lining. If the voids are due to the Contractor's method of reinstatement, deficiencies in the CIPP installation, or any other reason related to the Contractor's workmanship or method of operations, they shall be filled at the Contractor's expense.
- (iv) Repair of defective or incomplete sewer service grouting shall be at the Contractor's own expense.

E3.4.12 Sewer Inspection Reports

- (a) Provide the Contract Administrator with the following sewer inspection reports prepared in accordance with CW 2145.
 - (i) Submit pre-sewer repair inspection and pre and post-lining inspection and reports before Total Performance of Work.
 - (ii) Submit a warranty inspection report before Final Acceptance of Work.

E3.4.13 Quality Control Records

- (a) Maintain the following Quality Control records of the Work and provide to the Contract Administrator after completion of the Work.
 - (i) Summary of the resin impregnation process including:
 - Volume of resin supplied.
 - Excess quantity of resin added during the wet out to account for polymerization and migration into the host pipe.
 - Roller gap setting.
 - Resin catalyst(s) used.
 - Time and location of the wet out.
 - Means taken to store and transport the resin impregnated CIPP from the wet out facility to the job site.
 - Means of curing internal point repair liners.
 - (ii) Continuous log of pressure maintained in the liner during the curing period.
 - (iii) Pulling force used to pull or winch CIPP into place in the host sewer and measured liner elongation.
 - (iv) Continuous log of temperature at boiler in and out and at all thermistors placed between the host pipe and the liner at all manholes during the initial cure, cure, and cool down periods.

E3.4.14 Test Plate Samples

- (a) Obtain and provide the Contract Administrator with test plate samples of each CIPP.
- (b) Prepare test plate samples on-site from the actual CIPP and cure in a clamped mold placed in the downtube or manhole.
- (c) The Contract Administrator will coordinate and pay for test plate sample testing to confirm the flexural strength, flexural modulus and thickness in accordance with the requirements of ASTM D5813, D790, and D3567.
- (d) Flexural strength and flexural modulus results obtained from test plates will be reduced by the observed correlation between confined pipe and test plate samples secured in the City of Winnipeg over the past three construction seasons. The factors used to convert the samples shall be derived from the 90% lower confidence limit established by type testing.

- (e) Obtain and provide the Contract Administrator with pre and post lining measurements taken in accordance with Clause E3.4.1 of this specification to confirm in-place liner thickness.
- (f) The Contract Administrator will review liner thickness results taken from test plates or unconfined samples on a case-by-case basis.

E3.4.15 Infrared Spectroscopy

- (a) The Contract Administrator will arrange and pay for testing to compare the infrared spectrum of the resin field samples supplied from the wet-out to the reference spectrum generated from the resin sample provided by the resin manufacturer to verify installed material acceptability.

E3.4.16 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to ensure that the completed CIPP meets the 50 year design life structural requirements prior to Total Performance. The design review will utilize the measured values for flexural strength, flexural modulus, and CIPP thickness from the confined pipe sample testing or the reduced strength/modulus values obtained from the test plate testing in circumstances where confined pipe samples are not able to be secured.
- (b) CIPP strength values will be further reduced to account for creep based on the creep reduction values recommended in the pre-qualification submissions to assess the suitability of the liner to meet the 50 year design life requirement. The use of full enhancement factors in this analysis will be limited to liners that are confirmed by visual classification to be close-fit liners based on the post-lining sewer inspection.
- (c) The Contract Administrator will advise of any discrepancies between the constructed CIPP and the design requirements.
- (d) Perform necessary remedial measures to confirm that a CIPP deemed as structurally deficient will comply with the 50 year design life requirement such as determination of a more representative groundwater elevation locally through monitoring, and supplemental strength testing and thickness measurements.
- (e) Repair sections of CIPP removed for supplemental testing by placing a full circumference internal point repair of the same thickness as the full segment liner over and extending 300 millimetres beyond each side of the cut section.
- (f) Install a supplemental CIPP of the required thickness to structurally enhance the installed CIPP if supplemental testing fails to confirm the CIPP will meet the 50 year design life requirement.
- (g) Review remedial action with the Contract Administrator prior to implementation.
- (h) Perform further testing, monitoring and calculations and install structural enhancements at own cost.

E3.5 Measurement and Payment

E3.5.1 Mobilization and Demobilization

- (a) Mobilization and demobilization will be measured on a unit basis and paid for at the Contract Unit Price for "Mobilization and Demobilization". Number of units to be paid for will be the total number of units of equipment set-up and removed, personnel, office and storage facilities to the job site and site clean up supplied and delivered in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) 50% of the Mobilization and Demobilization unit price will be paid on the first progress payment.
- (c) The remaining 50% of the Mobilization and Demobilization unit price will be paid subsequent to the completion of the CIPP installation and site clean up.

- E3.5.2 Verification of Existing Sewer Dimensions
- (a) Verification of existing sewer dimensions including the pre-design inspection will not be measured for separate payment and will be included with CIPP installation.
- E3.5.3 Submittals Before Starting Work
- (a) Submittals required before starting Work including CIPP design, resin samples, operations protocol and construction protocol will not be measured for separate payment and will be included with CIPP installation.
- E3.5.4 Sewer Cleaning
- (a) Sewer cleaning will be measured and paid for in accordance with CW 2140.
- E3.5.5 Sewer Inspections
- (a) Sewer inspections will be measured and paid for in accordance with CW 2145.
- E3.5.6 Sewer Service Reports
- (a) Sewer service reports will not be measured for separate payment and will be included with CIPP installation.
- E3.5.7 Flow Control
- (a) Flow control measures necessary for mainline and all sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Flow Control". Number of units to be paid for will be the total number of units supplied in accordance with this specification, accepted and measured by the Contract Administrator.
 - (b) Only one unit of flow control will be paid for each sewer segment and will include all mainline and sewer service flow control requirements.
 - (c) Where no flow control measures are undertaken, no payment will be made for this item of Work.
- E3.5.8 Sewer Preparation and Repairs Prior to Lining
- (a) Internal sewer pipe repairs will be measured and paid for in accordance with E5.
 - (b) Removal of intruding sewer services and solid debris cutting will be measured and paid for in accordance with CW 2140.
 - (c) Sewer service grouting will be measured on a unit basis and paid for at the Contract Unit Price for "Sewer Service Grouting – Prior to Lining". Number of units to be paid for will be the total number of units grouted in accordance with this specification, accepted and measured by the Contract Administrator.
- E3.5.9 CIPP Installation
- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Full Segment Sewer Lining", Length to be paid for will be the total length of CIPP supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
 - (b) Full segment CIPP measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes.
 - (c) Eighty (80) percent of the payment will be made upon satisfactory completion of the CIPP installation work. The remaining twenty (20) percent of the payment will be made upon confirmation of the CIPP strength and delivery and acceptance of all required submissions, shop drawings, and reports.
- E3.5.10 Reinstatement of Sewer Services
- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid

for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.

- (b) Where additional payment is to be made for sewer service grouting it shall be measured and paid as "Sewer Service Grouting – After Lining".

E3.5.11 Sewer Service Grouting After Lining

- (a) Sewer service grouting will be measured on a unit basis and paid for at the Contract Unit Price for "Sewer Service Grouting – After Lining". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.

E3.5.12 Sewer Inspection Reports

- (a) Sewer inspection reports measured and paid for in accordance with CW 2145.

E3.5.13 Quality Control Records

- (a) Quality control records will not be measured for separate payment and will be included with payment for CIPP installation.

E3.5.14 Test Samples

- (a) CIPP test samples will not be measured for separate payment and will be included with payment for CIPP installation.

E3.5.15 Manhole Repairs

- (a) Manhole frames, covers, rungs and risers removed and replaced to facilitate the CIPP installation will not be measured for separate payment and will be included with payment for CIPP installation.

E4. SEWER REHABILITATION BY INSTALLATION OF GROUTED-IN-PLACE GRP SEGMENTAL LINERS

E4.1 Description

- E4.1.1 This specification covers the rehabilitation of circular or non-circular sewers by the installation of grouted-in-place GRP segmental liners

E4.2 Relevant References

- E4.2.1 WRC Sewerage Rehabilitation Manual – Volume II – Fourth Edition.

- E4.2.2 WRC Information and Guidance Note IGN 4-34-02: Specification for Glassfibre Reinforced Plastic (GRP) Sewer Linings

- (a) Appendix A: Sewer / Lining dimensions and design method.
- (b) Appendix B: Methods of manufacture of GRP sewer liners.
- (c) Appendix C: Short term flexural (bending) modulus method.
- (d) Appendix C: Long term flexural (bending) modulus method.
- (e) Appendix D: Method of determination of Shear bond strength.
- (f) Appendix E: Method for the analysis of construction (loss of ignition).
- (g) Appendix F: Sampling frequency for QC tests.

- E4.2.3 ASTM D3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe

- E4.2.4 BS 5480: Standard Specification for Reinforced plastic (GRP) pipes and fittings for water supply and sewerage

- E4.2.5 ASTM D638 Standard Test Method for Tensile Properties of Plastics

- E4.2.6 ASTM D790 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- E4.2.7 ASTM D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- E4.2.8 ASTM D2583 (2001) e1 Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor
- E4.2.9 ASTM D2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins
- E4.2.10 ASTM D3567 Standard Practice for Determining Dimensions of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
- E4.2.11 ASTM D3681 Standard Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition
- E4.2.12 BS 2782 / ISO 527: Standard method for testing plastics
 - (a) Method 1003 Determination of tensile properties.
 - (b) Method 1005 Determination of flexural properties.
 - (c) Method 1001 Measure of hardness by Barcol Impressor.
 - (d) Method 930A Preparation of test specimens
- E4.3 Materials
 - E4.3.1 GRP Segmental Panels
 - (a) Constituent materials for GRP segments shall conform to Section 3 of IGN 4-34-02.
 - E4.3.2 GRP Segmental Lining Design Objectives
 - (a) Design objectives for GRP Segmental Lining include.
 - (i) Maximizing the structural enhancement of the sewer by installing a structural section of sufficient quality and sufficient strength to address all relevant loading conditions and preclude further sewer deterioration.
 - (ii) Providing minimal to no reductions in hydraulic capacity of the rehabilitated sewer.
 - (iii) Reducing infiltration and exfiltration.
 - (iv) Preventing root intrusion.
 - (v) Providing sufficient chemical resistance to prevent further sewer pipe degradation related to the conveyance of sewage.
 - (vi) Minimizing sewer service disruption during rehabilitation.
 - (vii) Minimizing the time required to complete the sewer rehabilitation.
 - (viii) Minimizing disturbance to pavements and boulevards.
 - (ix) Minimizing disruption to vehicular and pedestrian traffic.
 - (x) Minimizing the impact of construction on commercial, industrial, and institutional facilities.
 - (b) Select GRP product and plan approach to rehabilitation toward maximizing the achievement of these design objectives.
 - E4.3.3 GRP Circular and Non-circular Design Requirements – General
 - (a) Design full or partial segment GRP Segmental lining as either a Type I or Type II lining system in accordance with Section 4 or 5, respectively of Volume II – Sewer Renovation, WRC Sewerage Rehabilitation Manual, 4th Edition and these specifications as a gravity pipe in a partially or fully deteriorated pipe condition in accordance with design conditions noted in the Drawings and Specifications.

- (b) Size GRP Segments in accordance with the design objectives to minimize annulus size and maximize hydraulic capacity.
- (c) Perform a design check to confirm the full flow hydraulic capacity of the CIPP will be comparable to the existing sewer. Use "Manning's" formula with assumed 'n' value of 0.010 for the GRP and an "n" value for the existing section estimated on the observed condition of the pipeline from the Sewer Maintenance Inspection and the general guidelines presented in Appendix C of Volume I – Rehabilitation Planning, WRc Sewerage Rehabilitation Manual, 4th Edition.

E4.3.4 GRP Type I Design

- (a) Where Type I Design contemplated design as a Type II non-circular liner in accordance with Section 4 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks.
 - (i) Short term buckling/strength/deformation checks against external pressure due to grouting operations. Short term checks to address both external pressure and flotation.
 - (ii) Long term tensile capacity check due to earth and superimposed loading as noted below
 - (iii) Long term buckling/deformation checks due to hydrostatic pressure;
- (b) Use the following minimum design assumptions.
 - (i) Rigid composite section, bond with host pipe required.
 - (ii) External pressures due to grouting based on Installers proposed construction protocol/method statement.
 - (iii) Groundwater table is 2.0 m below the existing ground surface.
 - (iv) Third party verified values for short term flexural modulus, long term flexural modulus, long term permissible flexural strain (measured in the hoop direction), long term tensile strength, and shear bond strength all measured in accordance with Section 8 of IGN 4-34-02
 - (v) Calculate dead load based on soil density of 1920 kg/m³ and assumption of prism loading on host pipe.
 - (vi) Include an allowance for an AASHTO HSS25 concentrated live load in the total external pressure on the pipe. Calculate minimum live load surcharge based on Cooper E80 distributed load for portions of GRP installed under railway lines.
 - (vii) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressure.

E4.3.5 GRP Type II Design - Partially Deteriorated Condition

- (a) Where partially deteriorated design conditions are indicated design GRP as a Type II circular or non-circular liner, as the case may be, in accordance with Section 5 of Volume II – Sewer Renovation, WRc Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks.
 - (i) Short term buckling/deformation checks against external pressure due to grouting operations. Short term checks to address both external pressure and flotation.
 - (ii) Long term check buckling/deformation checks due to hydrostatic pressure;
 - (iii) No allowance required for earth and superimposed loading.
- (b) Use the following minimum design assumptions.
 - (i) Flexible liner, no bond with host pipe.
 - (ii) External pressures due to grouting based on Installers proposed construction protocol/method statement.
 - (iii) Groundwater table is 2.0 m below the existing ground surface.

- (iv) Third party verified values for short term flexural modulus, long term flexural modulus, long term permissible flexural strain (measured in the hoop direction), and long term tensile strength all measured in accordance with Section 8 of IGN 4-34-02
- (v) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressure.

E4.3.6 GRP Type II Design - Fully Deteriorated Condition

- (a) Where fully deteriorated design conditions are indicated design GRP as a Type II circular or non-circular liner, as the case may be, in accordance with Section 5 of Volume II – Sewer Renovation, WRC Sewerage Rehabilitation Manual, 4th Edition and the following minimum design checks.
 - (i) Short term buckling/deformation checks against external pressure due to grouting operations. Short term checks to address both external pressure and flotation.
 - (ii) Long term check buckling/deformation checks due to hydrostatic pressure;
 - (iii) Provide allowance for full earth and superimposed loading as noted below.
- (b) Use the following minimum design assumptions.
 - (i) Flexible liner, no bond with host pipe.
 - (ii) Groundwater table is 2.0 m below the existing ground surface.
 - (iii) Third party verified values for short term flexural modulus, long term flexural modulus, long term permissible flexural strain (measured in the hoop direction), and long term tensile strength all measured in accordance with Section 8 of IGN 4-34-02
 - (iv) Calculate dead load based on soil density of 1920 kg/m³ and assumption of prism loading on host pipe. Modulus of soil reaction (E's) will be assumed to be 6900 kPa unless a higher or lower value is indicated in the contract specifications.
 - (v) Include an allowance for an AASHTO HSS25 concentrated live load in the total external pressure on the pipe. Calculate minimum live load surcharge based on Cooper E80 distributed load for portions of CIPP installed under railway lines.
 - (vi) Minimum factor of safety (N) of 2 against failure in determination of maximum permissible external pressure.

E4.3.7 Existing Sewer Design Conditions

- (a) The assessment of liner system design conditions and site-specific repairs required to accommodate lining were based on the conditions observed from sewer inspections that were performed in 2000 – 2003 as part of the City of Winnipeg's Sewer Cleaning and Inspection Programs. Copies of these video inspections are available to the Contractor in digital format on CDs.
- (b) The Contractor shall be aware the video inspections provided were completed immediately after sewer cleaning and the amount of sediment and debris present at the time of this Bid Opportunity may not be the same. The Contractor shall be responsible to determine the actual amount of sediment and debris in the sewers included in this Work.
- (c) The site specific design conditions identified in **Table E3.3.6** apply to the Work.

E4.3.8 Submittals Before Starting Work

- (a) Provide the required submittals to the Contract Administrator a minimum of 10 days before starting the lining.

- (b) Submit the GRP design Shop Drawings in accordance with CW1110 and sealed and signed by a Professional Engineer licensed to practice in the Province of Manitoba. Include the following information.
 - (i) GRP thickness computations including all specified design checks. Identify design assumptions based on a review of the Sewer Maintenance Inspection that differ from the information provided in the Specifications for the existing sewer design conditions.
 - (ii) Calculations showing the hydraulic capacity of the GRP sewer will be comparable to the existing sewer.
 - (iii) Details of the GRP composite proposed and verification of all short and long term material properties.
 - (iv) Design mix and relevant constituent properties for the grout mixture.
 - (v) Other information that may reasonably be required by the Contract Administrator to confirm the GRP Segmental design proposed conforms to the specified requirements and design intent.
- (c) Submit a construction protocol that provides information on the following.
 - (i) Confined entry and safety protocol.
 - (ii) Proposed main line and sewer service flow control arrangements.
 - (iii) Details of template establishment and inspection protocol to confirm the size of liner required, the need for secondary grouting, and to be used post-installation to confirm liner fit and secondary grouting requirements.
 - (iv) Pipe assembly details including joint assembly requirements, temporary support of segmental panels to facilitate construction and grouting operations.
 - (v) Detailed grouting protocol including minimum and maximum grouting pressures, maximum allowable liner deflection/deformation, and quality assurance and quality control program to verify grout physical characteristics and annulus filling verification.
 - (vi) Method proposed for temporary groundwater control on Burnell Street to ensure that groundwater infiltration does not compromise annulus grouting operations.
 - (vii) Detailed implementation schedule for panel assembly, annulus grouting, service reinstatement, and terminations.

E4.4 Construction Methods

E4.4.1 Verification of Existing Sewer Dimensions

- (a) Verify dimensional of each sewer to be rehabilitated prior to manufacture of the GRP segments by passing a template of sufficient size, rigidity, length, and cross section to determine liner dimensional and grouting requirements.

E4.4.2 Sewer Cleaning

- (a) Remove loose and solid debris and intruding connections in accordance with CW 2140 to adequately prepare the sewer for lining.

E4.4.3 Sewer Inspections

- (a) Perform the following sewer inspections in accordance with CW 2145 in the presence of the Contract Administrator.
 - (i) Pre-Sewer Repair Inspection, where required, before starting any excavation. No coding submission will be required.
 - (ii) Pre-Lining Inspection after sewer cleaning and preparation. No coding of the submission will be required.
 - (iii) Post-Lining Inspection subsequent to installing the GRP and sewer service reinstatement. Full coding required.

- (iv) Warranty Inspection before expiration of the warranty period and acceptance. Full coding required.
- (b) Review the Pre-Sewer Repair Inspection video with the Contract Administrator before starting the repair work to confirm the extent and precise location of internal sewer repairs. All external sewer repairs will be undertaken by others.
- (c) Review the Pre-Lining Inspection videotape with the Contract Administrator at least 24 hours before installing the GRP liner and obtain approval to GRP lining operations.

The Pre-Lining Inspection shall confirm:

- (i) Necessary cleaning and pipe preparation work, including internal and external sewer repairs, have been satisfactorily completed.
- (ii) Condition of the sewer pipe is consistent with the design conditions and the Specifications. Advise the Contract Administrator of any condition that is contrary to the design conditions or assumptions made that may affect either long or short term performance of the GRP liner prior to commencing lining.
- (iii) Location, condition and operational status of all sewer services.
- (iv) The limit and precise location for each internal point repair.
- (v) Review Sewer Service Reports while reviewing the Pre-Lining Inspection.
- (d) Post-Lining Inspection is to confirm the adequacy of sewer service reinstatements and the fit and finish of the GRP.
- (e) Warranty Inspection to confirm the fit and finish of the GRP, need for any remedial work and acceptance of any repair work performed during the warranty period. Sewer cleaning in accordance with CW 2140 is required to obtain a satisfactory inspection.

E4.4.4 Sewer Service Report

- (a) Confirm exact location of all sewer services connected to the sewer being lined by dye testing methods.
- (b) Submit a written Sewer Service Report for each site to the Contract Administrator providing the following information for each sewer service.
 - (i) Operational status of each sewer service (live or out of service). For live services indicate the property address of structure serviced.
 - (ii) Distance from the upstream manhole in metres and clock reference of the connection position to the sewer.
 - (iii) Diameter in millimetres.
 - (iv) Material type.
 - (v) Observed condition of the sewer service.

E4.4.5 Flow Control

- (a) Provide necessary flow control measures for the main line sewer and sewer services required to perform the Work. Diversion of wastewater flow directly or indirectly to the environment, Land Drainage Sewers, or Storm Relief sewers will not be allowed.
- (b) Maintain existing sewer flows from upstream sewers during construction around the sewers being lined.
- (c) Provide adequate temporary bypass pumping for live sewer services connected to the sewer being lined from when the service is blocked off until it is reinstated.
- (d) Provide temporary indoor portable toilets for residential homes and for each apartment in small apartment buildings instead of temporary sewer service bypass pumping where feasible and approved by the building owner and the Contract Administrator. Provide necessary supplies for portable toilets and clean as often as

required while in use. Remove portable toilets promptly once sewer service is reinstated.

- (e) Expose sewer services for facilities with a high volume of effluent discharge that have no feasible means of intercepting the flow within the building or at a location outside the building agreed upon by the Contract Administrator and drain or pump the sewer service from that location until the sewer service is reinstated.
- (f) Excavate for sewer service exposure in accordance with CW 2030. Repair and backfill exposed sewer services in accordance with CW 2130.
- (g) Restore the surface in accordance with CW 2130 and the following specifications:
 - (i) Boulevard areas in accordance with CW 3510.
 - (ii) Concrete pavement in accordance with CW 3230.
 - (iii) Asphaltic pavement in accordance with CW 3410.
 - (iv) Concrete sidewalk and interlocking paving stone in accordance with CW 3325 and CW 3330.

E4.4.6 Sewer Preparation and Repairs Prior to Lining

- (a) Perform sewer preparation and repairs as indicated in the specification and drawings.
- (b) Complete the following internal host pipe repairs in accordance with E5 of this specification.
 - (i) Fill holes in and patch deteriorated sections of the host sewer pipe wall.
 - (ii) Fill voids in the surrounding backfill flush with the inside surface of the sewer pipe.
 - (iii) Reshape host sewer pipe invert to the original dimension and cross section at locations where the invert has completely deteriorated.
 - (iv) Provide means of temporary groundwater control in accordance with approved method statement to facilitate lining operations on Burnell Street.
- (c) Removal of Intruding Sewer Services and Solid Debris Cutting
 - (i) Remove intruding sewer services and solid debris in accordance with CW 2140.
- (d) Sewer Service Grouting
 - (i) Fill voids around sewer services with a non-shrink, watertight cement grout, an appropriate polyurethane grout compound, or other approved grouting product to form a smooth watertight connection.

E4.4.7 External Sewer Repairs

- (a) External sewer repairs as indicated in the Specifications and on the Drawings will be completed where noted. Where external sewer repairs are required in conjunction with manhole modifications carry out Work in accordance with CW 2130, SD-022A and SD-022B.

E4.4.8 Manhole and Catch Basin Repairs

- (a) Complete manhole and catch basin repairs as indicated in the Specifications and Drawings in accordance with CW 2130.
- (b) Remove and replace manhole frames, covers, rungs and risers required to facilitate the CIPP installation in accordance with CW 2130.

E4.4.9 Weather

- (a) Review the Environment Canada weather forecast with the Contract Administrator before starting CIPP lining installation.

- (b) Delay installation of GRP and/or temporarily secure Works when the anticipated weather conditions are such that anticipated sewer flow will exceed the flow control measures provided.

E4.4.10 Installation of GRP Segmental Liners

(a) GRP Panel Installation

- (i) Assemble GRP panels in accordance with approved installation protocol submission.
- (ii) Profile of alignment shall be offset to invert of pipe to as great a degree as possible leaving largest annulus at crown.
- (iii) Securely fasten panels in-place to facilitate construction and sufficiently to assure that panels are not displaced during grouting operations. Ensure that temporary support system minimizes point loads and other features that may cause damage to GRP liner during grouting operations.

(b) Annulus Grouting

- (i) Carry out annulus grouting in accordance with approved grouting protocol submission. Monitor liner during grouting operations to ensure short-term deflections do not exceed maximum allowable and that liner is not displaced during grouting operations. Confirm that annulus is fully grouted.
- (ii) Grout holes to be pre-drilled. Temporary wooden plugs may be used during grouting. On completion, the holes should be made good with appropriate preparation and filler materials.
- (iii) General rules that apply to grouting include:
 - .1 Estimate the volume of grout required (include overfill allowance based on grout properties, sewer geometry and condition, and previous experience with grout mixture);
 - .2 By-pass or pump through any sewer flows that occur during grouting operations;
 - .3 Minimize infiltration (or its effects);
 - .4 Inject from the downstream end of the renovated section;
 - .5 Inject from the invert towards the crown;
 - .6 Provide air vents at the high points;
 - .7 Monitor and record the injection pressures;
 - .8 Inspect the lining for signs of distortion or flotation;
 - .9 Monitor and record the volume of grout injected and compare with the estimate (with due consideration of overfill allowance); and
 - .10 Regularly monitor for grout leaks in sections of sewer upstream and downstream, drain connections (via inspection chambers), particularly if the volume of grout injected exceeds the estimated grout take.
- (iv) The volume to be grouted at any one time can be varied to suit the various constraints such as the workability of the grout, design of the lining (including flotation), capacity of the mixing and pumping equipment, rate of installation of the lining, and the necessity for overpumping.
- (v) Sections should be grouted during the shift immediately following their installation provided that the stop ends and any lateral connections have attained sufficient strength.
- (vi) Grout should either be injected through a minimum of three preformed holes (nominally 50 mm diameter) located in the haunches and crown of the lining or through pipes cast into the crown and invert of the stop ends. The former method is preferable because, in the event of a blockage, grouting can recommence at the adjacent panel. The grout should be injected from the lowest vent hole and successive holes plugged as air free grout is seen to issue

from them. If the major dimension of the lining exceeds 1000 mm consideration should be given to the provision of more grout holes.

(c) Manhole and Transition Terminations

- (i) At manhole entrances and exits and transition terminations, the interface between the exterior surface of the liner and the manhole shall be made watertight. The ends of the liner shall be neatly trimmed so the liner fits flush with the manhole interior surface. Where required, the benching of the manhole shall be restored to conform to the liner shape and the standard requirements for manhole benching.
- (ii) Sealing at manholes and terminations shall be with a resin mixture compatible with the GRP liner.

E4.4.11 Reinstatement of Sewer Services

- (a) Reinstatement of live sewer services to 100% of the original cross sectional area.
- (b) Cut out openings for sewer services from inside the lined sewer by manual means or with a television camera and a remote controlled cutting device.
- (c) Remove sharp edges from opening cut outs and provide a smooth rounded lip.
- (d) Sewer Service Grouting
 - (i) Fill voids between the GRP liner and the host pipe at sewer service openings with a non-shrink, watertight cement grout or an appropriate polyurethane grout compatible with the liner system, or other approved grouting product to form a smooth watertight connection.
 - (ii) Locations for sewer service grouting shall be identified by the Contract Administrator during review of Post Lining Video Inspection.
 - (iii) If the voids are due to the condition of the existing sewer service and host pipe, sewer service grouting shall be measured and paid for under sewer service grouting – after lining. If the voids are due to the Contractor's method of reinstatement, deficiencies in the GRP installation, or any other reason related to the Contractor's workmanship or method of operations, they shall be filled at the Contractor's expense.
 - (iv) Repair of defective or incomplete sewer service grouting shall be at the Contractor's own expense.

E4.4.12 Sewer Inspection Reports

- (a) Provide the Contract Administrator with the following sewer inspection reports prepared in accordance with CW 2145.
 - (i) Submit pre-sewer repair inspection and pre and post-lining inspection and reports before Total Performance of Work.
 - (ii) Submit a warranty inspection report before Final Acceptance of Work.

E4.4.13 Quality Control Records

- (a) Maintain the following Quality Control records of the Work and provide to the Contract Administrator after completion of the Work.
 - (i) Summary of the GRP Segment manufacturing records, including
 - All Qa/Qc testing carried out in accordance with IGN 4-34-02.
 - A certificate of compliance in accordance with Appendix H of IGN 4-34-02 for each GRP liner design.
 - (ii) A grouting summary.

E4.4.14 Test Plate Samples

- (a) In addition to the normal Qa/Qc associated with GRP production, the Contract Administrator will select at least one panel from each production run for each site to

secure test plate samples for thickness measurements and the determination of relevant short term flexural modulus values.

- (b) The Contract Administrator will coordinate and pay for test plate sample testing to confirm the flexural strength, flexural modulus and thickness in accordance with the requirements of ASTM D790.

E4.4.15 Appearance Criteria

- (a) Each panel shall be reviewed relative to Table 3 of Appendix G of IGN 4-34-02 for confirmation that all external and internal surfaces are within final allowable defect limits.

E4.4.16 Post Construction Design Review for Total Performance

- (a) The Contract Administrator will perform a post-construction design review to ensure that the completed GRP meets the design objectives relative to structural requirements prior to Total Performance. The design review will utilize the measured values for flexural strength, flexural modulus, and GRP thickness.
- (b) The Contract Administrator will advise of any discrepancies between the constructed CIPP and the design requirements.
- (c) Perform necessary remedial measures to confirm that any GRP liner deemed as structurally deficient will comply with the design life objectives such as determination of a more representative groundwater elevation locally through monitoring, and supplemental strength testing and thickness measurements.
- (d) Repair sections of GRP removed for supplemental testing by placing an approved internal point repair of the same thickness and strength as the full segment liner.
- (e) Review remedial action with the Contract Administrator prior to implementation.
- (f) Perform further testing, monitoring and calculations and install structural enhancements at own cost.

E4.5 Measurement and Payment

E4.5.1 Mobilization and Demobilization

- (a) Mobilization and demobilization will be measured on a unit basis and paid for at the Contract Unit Price for "Mobilization and Demobilization". Number of units to be paid for will be the total number of units of equipment set-up and removed, personnel, office and storage facilities to the job site and site clean up supplied and delivered in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) 50% of the Mobilization and Demobilization unit price will be paid on the first progress payment.
- (c) The remaining 50% of the Mobilization and Demobilization unit price will be paid subsequent to the completion of the GRP installation and site clean up.

E4.5.2 Verification of Existing Sewer Dimensions

- (a) Verification of existing sewer dimensions including the pre-design inspection will not be measured for separate payment and will be included with GRP installation.

E4.5.3 Submittals Before Starting Work

- (a) Submittals required before starting Work will not be measured for separate payment and will be included with GRP installation.

E4.5.4 Sewer Cleaning

- (a) Sewer cleaning will be measured and paid for in accordance with CW 2140.

- E4.5.5 Sewer Inspections
- (a) Sewer inspections will be measured and paid for in accordance with CW 2145.
- E4.5.6 Sewer Service Reports
- (a) Sewer service reports will not be measured for separate payment and will be included with GRP installation.
- E4.5.7 Flow Control
- (a) Flow control measures necessary for mainline and all sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Flow Control". Number of units to be paid for will be the total number of units supplied in accordance with this specification, accepted and measured by the Contract Administrator.
 - (b) Only one unit of flow control will be paid for each sewer segment and will include all mainline and sewer service flow control requirements.
 - (c) Where no flow control measures are undertaken, no payment will be made for this item of Work.
- E4.5.8 Sewer Preparation and Repairs Prior to Lining
- (a) Internal sewer pipe repairs will be measured and paid for in accordance with E5.
 - (b) Removal of intruding sewer services and solid debris cutting will be measured and paid for in accordance with CW 2140.
 - (c) Sewer service grouting will be measured on a unit basis and paid for at the Contract Unit Price for "Sewer Service Grouting – Prior to Lining". Number of units to be paid for will be the total number of units grouted in accordance with this specification, accepted and measured by the Contract Administrator.
- E4.5.9 GRP Installation
- (a) Liner installation will be measured on a length basis for each size and paid for at the Contract Unit Price for "Full Segment Sewer Lining". Length to be paid for will be the total length of GRP supplied and installed in accordance with this specification, accepted and measured by the Contract Administrator.
 - (b) Full segment GRP measurement will be made horizontally at grade, above the centreline of the pipe from centre to centre of manholes.
 - (c) Partial full segment GRP measurement will be made along the invert of the pipe from the lining commencement point to its termination point as measured by the Contract Administrator.
 - (d) Eighty (80) percent of the payment will be made upon satisfactory completion of the GRP installation work. The remaining twenty (20) percent of the payment will be made upon confirmation of the GRP strength and delivery and acceptance of all required submissions, shop drawings, and reports.
- E4.5.10 Reinstatement of Sewer Services
- (a) Reinstatement of sewer services will be measured on a unit basis and paid for at the Contract Unit Price for "Reinstatement of Sewer Services". Number of units to be paid for will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.
 - (b) Where additional payment is to be made for sewer service grouting it shall be measured and paid as "Sewer Service Grouting – After Lining".
- E4.5.11 Sewer Service Grouting After Lining
- (a) Sewer service grouting will be measured on a unit basis and paid for at the Contract Unit Price for "Sewer Service Grouting – After Lining". Number of units to be paid for

will be the total number of units reinstated in accordance with this specification, accepted and measured by the Contract Administrator.

E4.5.12 Sewer Inspection Reports

- (a) Sewer inspection reports measured and paid for in accordance with CW 2145.

E4.5.13 Quality Control Records

- (a) Quality control records will not be measured for separate payment and will be included with payment for GRP installation.

E4.5.14 Test Samples

- (a) GRP test samples will not be measured for separate payment and will be included with payment for GRP installation.

E4.5.15 Manhole Repairs

- (a) Manhole frames, covers, rungs and risers removed and replaced to facilitate the GRP installation will not be measured for separate payment and will be included with payment for GRP installation.

E5. SEWER STABILIZATION

E5.1 Description

E5.1.1 Sewer stabilization shall mean the internal repair of sewers and manholes by man entry techniques. Repairs are varied and may consist of holes in sewers with voids, missing bricks in sewers, obstructions and manhole base or riser repairs. Sewer stabilization repairs shall be carried out at the locations noted in Table E3.3.6 prior to performing sewer lining.

E5.1.2 The scope of Work involved in sewer stabilization is as follows:

- (a) Secure the site and provide temporary traffic control;
- (b) Obtain all necessary underground clearances
- (c) Conduct a hazard assessment, including identification and evaluation;
- (d) Develop a safe work plan;
- (e) Implement the necessary procedures and controls to control hazards and maintain a safe working environment
- (f) Enter the manhole/sewer and perform the required repairs.
- (g) Clean-up the site.

E5.2 Materials

E5.2.1 Concrete

- (a) Concrete for large internal repairs to concrete and brick sewers and manholes and internal void filling shall be in conformance with Table CW 2160.1, Type B.
- (b) Patching and grouting of repairs to concrete and brick sewers and manholes shall be with a fast hardening high strength concrete repairing compound designed for underwater use, Duro-Crete by C C Chemicals or approved equal.
- (c) Flowable cement-stabilized fill for external void filling from the ground surface shall be in conformance with Table CW 2160.1, Type D.

E5.3 Construction Methods

E5.3.1 Hazard Assessment

- (a) In conjunction with securing the site and obtaining underground clearances, the Contractor shall conduct a hazard assessment for each site requiring a stabilization repair. The assessment shall identify and evaluate the hazards, including but not be limited to review of the following as it pertains to the Work to be performed:
 - (i) nature of the defect;
 - (ii) location of the defect in the sewer/manhole;
 - (iii) structural condition and amount of debris in the remaining sewer/manhole;
 - (iv) condition of the manholes up and downstream of the required repair;
 - (v) atmospheric conditions in the manholes up and downstream of the required repair;
 - (vi) condition of adjacent downstream sewers;
 - (vii) flow in the sewer.
- (b) The hazard assessment shall be based on the Contractor's review of video for the sewer(s) and site inspection of the manholes, sewers and external conditions. Prior to the inspection, the Contractor shall conduct the necessary atmospheric monitoring of the affected manholes and sewers to establish acceptable entry conditions.
- (c) Based on the results of the hazard assessment the Contractor shall determine if they can perform the stabilization repairs in a safe manner. If the Contractor decides to proceed with the internal repairs they shall prepare a Safe Work Plan in accordance with E5.3.2 complete with the necessary controls and procedures required to maintain a safe working environment for the repair. Otherwise they shall notify the Contract Administrator and jointly the Contractor and the Contract Administrator shall review the nature of the defect and determine if an external point repair shall be performed in accordance with CW2130.

E5.3.2 Safe Work Plan

- (a) Subsequent to performing a hazard assessment the Contractor shall develop a safe work plan to address the potential hazards associated with each site. In addition to addressing the potential hazards the safe work plan shall address but not be limited to the following:
 - (i) guidelines for confined space entry work established by The Manitoba Workplace Safety and Health Act;
 - (ii) provision for emergency response;
 - (iii) training and duties for entry personnel;
 - (iv) rescue and emergency services;
 - (v) requirement for purging, ingesting, flushing and/or continuous ventilation to eliminate or control atmospheric hazards;
 - (vi) requirement for and provision of supplied air;
 - (vii) communication between members of the repair crew in the pipe and on the ground's surface;
 - (viii) current and forecasted weather conditions;
 - (ix) isolating the workspace by plugging of upstream sewers and monitoring of upstream flow levels;
 - (x) provision of back-up equipment;
 - (xi) method of ingress into the sewer;
 - (xii) method of egress out of the sewer – forward and backwards.
- (b) The Contractor shall not enter the sewer or manholes to begin the Work until they have completed a hazard assessment and safe work plan for the specific repair and

reviewed the plans with their designated safety officer for acceptance. The safe work plan procedures and practices shall conform to all federal, provincial and municipal codes, regulations and guidelines including Manitoba Labour "Guidelines for Confined Space Entry".

E5.3.3 Equipment Set Up

- (a) In accordance with the safe work plan for the repair, the Contractor shall set up the required safety equipment and controls to safely perform the Work.
- (b) Specialized equipment to perform the repair work, such as lights, pressure washers, drills and chipping hammers shall in no way adversely affect the operation of the safety equipment required to perform the Work.
- (c) Subsequent to completion of the repairs the Contractor shall remove all equipment from the sewers and manholes.

E5.3.4 Enter the Manhole and Sewer

- (a) The Contractor shall enter the manhole/sewer and complete the Work in accordance with their safe work plan and requirements for the repair contained herein.
- (b) If at any time during the repair the attendant and/or Contractor believes he cannot safely perform the Work they shall immediately stop the Work and evacuate the sewer and manholes. The Contractor shall re-assess their safe work plan considering the reason for the Work stoppage. The Work shall only be resumed when the Contractor has deemed it safe to return by completing a re-assessment and safe work plan revision, where necessary.
- (c) If the Contractor deems the Work cannot be safely completed by internal stabilization they shall notify the Contract Administrator and jointly the Contractor and the Contract Administrator shall review the nature of the defect and determine if an external point repair shall be performed in accordance with CW 2130.

E5.3.5 Internal Sewer Repairs

- (a) The Contractor shall repair the sewer fabric to restore the structural integrity of the sewer and provide a smooth flow surface conforming to the adjacent sewer/manhole cross-section and materials.
- (b) Large concrete repairs shall include a reasonable and limited level of surface preparation, including removal of unsound material and cleaning of the edges of the repair area, and setting of the required formwork and bracing. Concrete placement and finishing shall be done in accordance with CW 2160. All formwork and bracing shall be removed from the sewer/manhole at the completion of the Work.
- (c) Concrete patching shall include a reasonable and limited level of surface preparation, including removal of unsound material and cleaning of the edges of the repair area. The Contractor shall apply the patching material in accordance with the manufacturer's printed instructions.
- (d) Small voids in the backfill shall be filled with concrete or other approved material from the inside of the sewer prior to repairing the sewer fabric or by pressure grouting after completion of the repairs. The void shall be completely filled to prevent settlement of the backfill and provide a solid backing for the liner.
- (e) Pressure grouting shall be done in accordance with the manufacturer's printed instructions.
- (f) Large voids shall be filled from the ground surface after completion of the repairs. Holes shall be cored in the pavement or the pavement shall be saw cut and removed to permit vacuum excavation from the underside of the pavement to the void. The void shall then be completely filled with flowable cement-stabilized fill. Pavement removal and restoration shall be in accordance with CW 2130.

E5.3.6 Internal Manhole Repairs

- (a) Complete manhole repairs identified in the Specifications or on the Drawings in accordance with CW 2130.

E5.4 Quality Control

E5.4.1 Repair Acceptance

- (a) Upon completion of the designated repair the Contractor shall clean and perform the pre-lining inspection.
- (b) The Contractor shall not be responsible for defects in existing un-repaired sewer lines unless those defects are a direct result of the Contractor's operation.

E5.4.2 Correction of Deficiencies

- (a) The Contractor shall correct deficiencies found in the sewer repair at their own cost including the cost of re-cleaning and re-inspection to confirm that the deficiencies are rectified in accordance with these specifications.

E5.5 Measurement and Payment

E5.5.1 Internal Sewer Repairs

- (a) Large concrete repairs requiring formwork will be measured on a unit basis and paid for at the Contract Unit Price for "Large Concrete Repairs". Number of units to be paid for will be the total number of large concrete repairs made in accordance with this specification, accepted and measured by the Contract Administrator.
- (b) Concrete patching of sewer walls and invert up to 1.0 metre in length will be measured and paid for on a unit basis and paid for at the Contract Unit Price for "Concrete Patching – Up to 1.0 metre long". Number of units to be to be paid for will be total number of concrete patch repairs up to 1.0 metre long completed in accordance with this specification, accepted and measured by the Contract Administrator.
- (c) Concrete patching of sewer walls and inverts in excess of 1.0 metre in length will be measured and paid for on a length basis for "Concrete Patching – In Excess of 1.0 metre long". Length to be paid for will be total linear metres of concrete patch repairs completed in accordance with this specification, accepted and measured by the Contract Administrator.
- (d) Filling small voids internally will be measured and paid for on a unit basis and paid for at the Contract Unit Price for "Filling Small Voids Internally". Number of units to be to be paid for will be total number of small voids filled internally in accordance with this specification, accepted and measured by the Contract Administrator.
- (e) Filling large voids externally with flowable cement-stabilized fill will be measured and paid for on a volume basis and paid for at the Contract Unit Price for "Filling Large Voids Externally – With Cement-Stabilized Fill". Volume to be to be paid for will be total number of cubic metres of void filled externally in accordance with this specification, accepted and measured by the Contract Administrator.

E5.5.2 Internal Manhole Repairs

- (a) Internal manhole repairs will be measured and paid for in accordance with CW 2130.

E6. CATCH BASIN INSPECTIONS

E6.1 Description

- E6.1.1 This specification shall cover the cleaning and inspection of all catch basin leads connected to sewers included in this contract to be lined with a CIPP for the purposes of determining whether the catch basin lead requires repair work.

E6.2 Construction Methods

E6.2.1 Cleaning

- (a) Clean catch basin leads in accordance with CW 2140.

E6.2.2 Video Inspections and Inspection Reports

- (a) Perform video inspection from catch basin to mainline sewer and provide inspection reports in accordance with CW2145.

E6.2.3 Repair Work

- (a) The Contract Administrator will review the video inspections of the catch basin leads to determine if repair work is required.
- (b) Catch basin leads determined to require full segment, partial full segment or internal point repair CIPP lining shall be done in accordance with E3 of this specification.
- (c) Catch basin leads determined to require replacement or external point repairs will be done by others outside of this Contract.

E6.3 Measurement and Payment

E6.3.1 Cleaning

- (a) Cleaning of catch basin leads shall be measured and paid for in accordance with CW 2140.

E6.3.2 Video Inspection

- (a) Video inspection of catch basin leads shall be measured and paid for in accordance with CW 2145.

E6.3.3 CIPP Lining

- (a) Full segment, partial full segment and internal point repair CIPP lining of catch basin leads shall be measured and paid for in accordance with E3.