

**CHAPTER 16.1
CURED-IN-PLACE PIPE LINING (CIPP) FOR MAIN SEWERS**

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1 **PART 1 - GENERAL**

2 **1.1 SCOPE**

3
4 A. Work under this section consists of furnishing all materials, labor, and equipment
5 required for the installation of cured-in-place pipe (CIPP) in main sewers.

6 **1.2 RELATED DOCUMENTS**

7
8 A. CHARLOTTE WATER Water and Sewer Design and Construction Standards and
9 Standard Details.

10 **1.3 DEFINITIONS AND ABBREVIATIONS**

11
12 A. See Sections iii and iv of the CHARLOTTE WATER Water and Sewer Design
13 and Construction Standards for common abbreviations and definitions.

14 **1.4 DESIGN AND PERFORMANCE REQUIREMENTS**

15
16 A. The CIPP shall be designed for a life of fifty (50) years or greater in accordance
17 with ASTM F1216, Appendix X.1, for “fully deteriorated gravity pipe conditions.”
18 The minimum installed, cured liner thickness shall be as listed below. The Bid
19 Form and/or Drawings may list alternate thicknesses for installation based on the
20 Engineer’s decision for specific installations and may list specific thicknesses for
21 larger diameter sewers.

22			
23	8” sewer:	6.0 mm	(0’ to 20’ deep)
24		7.5 mm	(20’ to 28’ deep)
25			
26	10” sewer:	6.0 mm	(0’ to 14’ deep)
27		7.5 mm	(14’ to 25’ deep)
28			
29	12” sewer:	7.5 mm	(0’ to 16’ deep)
30		9.0 mm	(16’ to 24’ deep)
31			
32	15” sewer:	7.5 mm	(0’ to 10’ deep)
33		9.0 mm	(10’ to 16’ deep)
34		10.5 mm	(16’ to 24’ deep)
35			
36	16” sewer:	7.5 mm	(0’ to 8’ deep)
37		9.0 mm	(8’ to 13’ deep)
38		10.5 mm	(13’ to 18’ deep)
39		12.0 mm	(18’ to 24’ deep)
40			
41	18” sewer:	9.0 mm	(0’ to 10’ deep)
42		10.5 mm	(10’ to 14’ deep)
43		12.0 mm	(14’ to 19’ deep)
44		13.5 mm	(19’ to 24’ deep)
45			

1	21" sewer:	10.5 mm	(0' to 10' deep)
2		12.0 mm	(10' to 13' deep)
3		13.5 mm	(13' to 17' deep)
4			
5	24" sewer:	12.0 mm	(0' to 10' deep)
6		13.5 mm	(10' to 13' deep)
7		15.0 mm	(13' to 16' deep)
8			
9	27" sewer:	13.5 mm	(0' to 10' deep)
10		15.0 mm	(10' to 12' deep)
11		16.5 mm	(12' to 15' deep)
12		18.0 mm	(15' to 18' deep)
13			
14	30" sewer:	15.0 mm	(0' to 10' deep)
15		16.5 mm	(10' to 12' deep)
16		18.0 mm	(12' to 14' deep)
17		19.5 mm	(14' to 17' deep)
18			
19	36" sewer:	18.0 mm	(0' to 10' deep)
20		19.5 mm	(10' to 12' deep)
21		21.0 mm	(12' to 14' deep)
22		22.5 mm	(14 to 16' deep)
23			

B. The cured liner shall have the following minimum structural properties:

- Flexural Strength of 4,500 psi in accordance with ASTM D 790
- Flexural Modulus of 250,000 psi in accordance with ASTM D 790
- Tensile Strength of 3,000 psi in accordance with ASTM D 638

C. The required structural CIPP wall thickness shall be based on the following design parameters:

Design Safety Factor	2.0
Short-Term Flexural Modulus	250,000 psi
Long-Term Flexural Modulus	125,000 psi
Flexural Strength	4,500 psi.
Creep Retention Factor	50%
Ovality	2%
Soil Modulus	1,000 psi
Soil Density	120 pounds per cubic foot
Soil Coefficient of Friction	0.130 r
Groundwater Depth	Ground Surface Elevation
Live Load	H20 Highway
Poisson's Ratio	0.3
Enhancement Factor, K	7
Service Temperature Range	40 to 140 degrees F
Maximum Long-Term Deflection	5 percent

1.5 SUBMITTALS

A. Submit a contractor statement of qualifications which identifies key personnel

1 and their specific CIPP experience, and recent projects listing the total length
2 installed by host pipe diameter. Work and personnel experience listed must
3 reference projects that used process method and materials to be used on this
4 project. Include project names, references/contacts and phone numbers.

5
6 B. Submit product data for the fabric tube, resin, catalysts, and waterstops
7 demonstrating conformance to the specifications.

8
9 C. Submit manufacturer material certifications for the fabric tube and resin that state
10 conformance to the specifications. The felt tube manufacturer shall provide in
11 their certification a statement identifying how many years they have produced the
12 felt tube. Material certifications shall be current and must reference the project.

13
14 D. Submit manufacturers' shipping, storage and handling recommendations for all
15 components of the CIPP system.

16
17 E. Submit CIPP wet-out information. Wet-out information shall include the
18 identification of the wet-out facility and process description and a sample wet-out
19 form. The wet-out forms shall document, at a minimum, the date and time of
20 wet-out, the wet-out supervisor, the wet-out facility address, the location where
21 the CIPP will be installed (by manhole numbers, and by pipe ID number), the
22 CIPP diameter, the length of wet-tube and dry-tube, the thickness of the CIPP,
23 the roller gap setting for establishing the liner thickness, the felt manufacturer,
24 the resin used (by product name and batch/shipment number) and quantity, the
25 catalyst(s) used (by product name) and quantity, any quality control samples
26 taken, and all else pertinent to the wet-out process.

27
28 F. Installation procedures and curing schedules shall be submitted. Installation
29 procedures shall include acceptable inversion heads and pressures, heating
30 ("cooking") and cool-down procedures and temperatures for varying sewer
31 diameters/lengths/depths, times for each stage of the process, and cure logs for
32 the resin/resin system used. Contractor shall provide this information without
33 delay or claim to any confidentiality. Testing procedures and quality control
34 procedures shall also be submitted.

35
36 G. Submit a sample CIPP installation report. The report shall include items such as
37 manhole numbers, and pipe ID numbers, location, project number, date, time,
38 temperature, curing temperature, curing time, and liner thickness.

39
40 H. With each shipment of CIPP delivered to the jobsite, submit certifications that the
41 CIPP lining was manufactured in accordance with these specifications and the
42 appropriate ASTM standards. The certifications shall include a signed statement
43 by the wet-out manager/supervisor that no fillers were added to the resin system
44 during manufacture of the CIPP. In addition, wet-out forms documenting the wet-
45 out shall be delivered with each section of CIPP manufactured and delivered to
46 the jobsite.

47
48 I. With each shipment of resin to the wet-out facility, submit certification that the
49 resin was manufactured under ISO 9002 certified procedures and meets these
50 specifications.
51

- 1 J. Submit a plan for bypassing sewage around the work area and facilities where
2 sewage flows must be interrupted to complete the work. The plan shall be
3 reviewed by Engineer and shall be acknowledged as acceptable before any work
4 is started. The bypass pumping plan, and requirements for bypass pumping,
5 shall be in accordance with Chapters 11 and 17 of CHARLOTTE WATER's
6 Water and Sewer Design and Construction Standards.

7 **1.6 DELIVERY, STORAGE, AND HANDLING**

- 8
9 A. Materials shall be shipped, stored, and handled in a manner consistent with
10 written recommendations of the CIPP system manufacturer to avoid damage.
11 Damage includes, but is not limited to, gouging, abrasion, flattening, cutting,
12 puncturing, premature curing, or ultra-violet (UV) degradation. The CIPP shall be
13 maintained at a proper temperature in refrigerated facilities prior to installation to
14 prevent premature curing. All damaged materials shall be promptly removed
15 from the project site at the Contractor's expense.

16 **1.7 QUALIFICATIONS**

- 17
18 A. Contractor performing the CIPP installation shall be fully qualified, experienced
19 and equipped to complete this work expeditiously and in a satisfactory manner
20 and shall be certified and/or licensed as an installer by the CIPP manufacturer.
21 Contractor must have successfully installed at least 1,000,000 feet of CIPP for a
22 minimum of ten (10) years in wastewater collection systems utilizing the products
23 and installation methods specified herein.

24
25 In addition, if steam cure is being proposed for the CIPP installation as specified
26 herein, Contractor must have successfully installed at least 500,000 feet of CIPP
27 via steam cure for at least five (5) years in wastewater collection systems utilizing
28 the products specified herein. If Contractor does not meet this experience
29 requirement, then water cure shall be used for all installations.

30
31 Contractor shall submit detailed references (project names, dates, owner contact
32 names and numbers, project descriptions with lengths installed, etc.) to Engineer
33 as requested to demonstrate compliance with the above experience
34 requirements. The Engineer's decision on whether Contractor meets the
35 experience requirements shall be final, and Contractor shall not be due any
36 additional money if the experience requirements are not met and water cure is
37 required.

- 38
39 B. The Contractor's personnel should have the following experience with the
40 products and installation method to be used on this project.

41
42 Project Manager – Should have a minimum of five (5) years managing
43 CIPP projects for wastewater collection systems.

44
45 Superintendent - Should have a minimum of five (5) years of on-site
46 supervision of CIPP projects for wastewater collection systems. The
47 superintendant shall have supervised a minimum of 300,000 feet of
48 installed CIPP in wastewater collection systems of the pipe diameters

1 included in the project.
2

3 C. The manufacturer of the felt tube shall have manufactured the product to be used
4 on this project for at least five (5) years. The felt material manufacturer and
5 facility shall not change throughout the duration of the contract unless approved
6 by Engineer in writing.
7

8 D. Approved CIPP products are listed in these specifications. Even though the
9 Contractor's product may be listed as approved, Contractor shall still meet the
10 experience requirements specified above, or Contractor will not be approved for
11 this work.

12 **1.8 ENVIRONMENTAL REQUIREMENTS**

13
14 A. The use of the product shall not result in the formation or production of any
15 detrimental compounds or by-products at the wastewater treatment plant.

16 **1.9 PROJECT ACCESS**

17
18 A. Contractor shall utilize existing road rights-of-way and sanitary sewer easements
19 to perform the work unless notified otherwise. Contractor shall coordinate with
20 and meet the requirements of North Carolina Department of Transportation,
21 Owner, or any other agency or municipality that may be impacted by the work.
22

23 B. The Contractor is required to obtain a written agreement from private property
24 owners granting them permission to perform work on private property. Copies of
25 any and all agreements between the Contractor and private property owners
26 granting temporary access by the Contractor for work on private property shall be
27 submitted to CHARLOTTE WATER.

28 **1.10 WARRANTY**

29
30 A. The materials used for the Assigned Project shall be certified by the
31 manufacturer for the specified purpose. The manufacturer shall warrant the liner
32 to be free from defects in raw materials for two (2) years from the date of final
33 acceptance by Owner. Contractor shall warrant the liner installation for a period
34 of two (2) years.

35 **1.11 REFERENCE SPECIFICATIONS, CODES AND STANDARDS**

36
37 A. Contractor shall ensure that the products and work comply with the current
38 version of the following American Society for Testing and Materials (ASTM)
39 standards:
40

41 1. ASTM D638 - Standard Test Method for Tensile Properties of Plastics
42

43 2. ASTM D790 - Standard Test Method for Flexural Properties of
44 Unreinforced and Reinforced Plastics and Electrical Insulating Materials
45

- 1 3. ASTM D2412 - Standard Test Method for Determination of External
2 Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
3
- 4 4. ASTM D5813 - Standard Specification for Cured-in-Place Thermosetting
5 Resin Sewer Pipe
6
- 7 5. ASTM F1216 - Standard Practice for Rehabilitation of Existing Pipelines
8 and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
9
- 10 6. ASTM F1743 – Standard Practice for Rehabilitation of Existing Pipelines
11 and Conduits by Pulled-in-Place Installation of Cured-in-Place
12 Thermosetting Resin Pipe (CIPP)
13

14 **PART 2 - PRODUCTS**

15 **2.1 CURED-IN-PLACE PIPE LINING**

- 16
- 17 A. Cured-In-Place-Pipe (CIPP) lining shall be one of the following products or
18 approved equal. The products below shall adhere to all requirements specified
19 herein and shall be modified as necessary to meet these requirements.
20

- 21 ▪ CIPP Corporation Liners
- 22 ▪ Invert-A-Pipe by IPR Southeast LLC
- 23 ▪ National Liner by National EnviroTech Group, LLC
- 24 ▪ Inliner by Inliner Technologies, Inc.
- 25 ▪ Insituform by Insituform Technologies, Inc.
- 26 ▪ Diamond Lining Systems by Daystar Composites LLC
- 27 ▪ Premier-Pipe USA by J.W.M. Environmental, Inc.
- 28 ▪ Pipenology CIPP for SAK Construction
29

- 30 B. The CIPP can be installed and cured using water or steam for sewers less than
31 18” in diameter. Only water cure shall be allowed for sewers 18” in diameter and
32 larger.
33

34 The curing method shall be appropriate for the pipe being lined and must be
35 ultimately approved by Engineer as stated below. For example, sewers with
36 heavy active leaks shall be lined using water cure unless Contractor can prove to
37 Engineer that the steam cure can overcome the heat sink and active water
38 stream.
39

40 Engineer will note any concerns with steam curing methods during review of the
41 pre-rehabilitation TV inspections. Those concerns will be in writing, and
42 Contractor shall fully address the concerns. If the Engineer’s concerns are not
43 fully addressed, Contractor shall install those specific sewers using water cure.
44

- 45 C. The liner shall be composed of tubing material consisting of one or more layers
46 of a flexible non-woven polyester felt with or without other additives such as
47 fiberglass or other reinforcing additives. The felt tubing shall be impregnated with
48 a thermosetting isothallic polyester resin and catalyst or vinyl ester and catalyst.
49 The liner material and resin shall be completely compatible. The inside and/or

1 outside layer of the tube shall be coated with an impermeable material
2 compatible with the resin and fabric. The inside layer of the tube shall be
3 resistant to blistering during the curing process. The liner shall cure in the
4 presence of water or steam at the required temperature for the resin system.
5

6 D. The felt material shall be manufactured by companies specializing in felt
7 production for CIPP. The felt manufacturer, references and location of the
8 manufacturing facility shall be submitted to Engineer for review and approval.
9 The felt material manufacturer and facility shall not change throughout the
10 duration of the Agreement unless specifically approved by Engineer in writing.
11

12 E. The polyester or vinyl ester resin shall be PREMIUM, NON-RECYCLED resin
13 only. PET (Polyethylene Terephthalate) resins, or those containing fillers,
14 additives or enhancement agents shall not be used. The resin manufacturer
15 shall not include any old resin or rework in the product shipped to the wet-out
16 facility. The resin shall be manufactured under ISO 9002 certified procedures.
17 Such certification shall be submitted to Engineer for each shipment of resin to the
18 wet-out facility. The proposed resin shall equal or exceed the published
19 properties of Reichhold PolyLite 33420 resin (for isothalic polyester resin) or
20 Reichhold Atlac 580-20 (for vinyl ester resin).
21

22 Engineer may consider strength enhancing fillers as an acceptable additive to the
23 resin if the fillers can be shown to be for the sole purpose of enhancing the
24 strength of the final CIPP product. The amount of strength enhancing fillers will
25 be limited to 26% by volume. The Engineer's decision on allowing strength-
26 enhancing resins shall be final. Any strength enhancing fillers added to the resin
27 shall be added by the resin manufacturer at the resin manufacturer's plant and
28 not at the wetout facility or any intermediate facility.
29

30 F. The exact makeup of the resin shall be submitted to Engineer including chemical
31 resistance information, cure logs and temperatures. Polyester resins shall have
32 a minimum Heat Distortion Temperature of 212 degrees Fahrenheit per ASTM
33 D648. Vinyl ester resins shall have a minimum Heat Distortion Temperature of
34 220 degrees Fahrenheit per ASTM D648.
35

36 G. The exact mixture ratio of resin and catalyst shall also be submitted. The
37 catalyst system shall be identified by product name. The resin/catalyst ratio shall
38 be approved by the resin manufacturer in writing. The catalyst system shall be
39 made up of a primary catalyst and a secondary catalyst. The primary catalyst
40 shall be Akzo Perkadox 16 or approved equal and shall be added at a maximum
41 of 1% of the resin volume by weight unless otherwise approved by Engineer.
42 The secondary catalyst shall be Akzo Trigonox or approved equal and shall be
43 added at a maximum of 0.5% of the resin volume by weight unless otherwise
44 approved by Engineer. The resin/catalyst system shall be formulated so that the
45 CIPP will cure as specified below. Resins, catalysts and resin/catalysts mixing
46 ratios shall not be changed during this Agreement unless specifically approved
47 by Engineer in writing.
48

49 H. The cure schedules for the CIPP shall be submitted to Engineer for review. The
50 curing process/schedules shall be approved by the resin manufacturer in writing.
51 The cure schedules shall include specific information on incremental temperature

1 stepping increases and decreases up to “cooking” temperatures, “cooking”
2 temperatures and durations, and cool-down procedures – all to be approved in
3 writing by the resin manufacturer. The CIPP shall cure in the presence of water
4 or steam. The minimum cure/”cook” time shall be as recommended by the resin
5 manufacturer. The cure time shall be increased as deemed necessary by the
6 Contractor/resin manufacturer, including but not limited to, longer CIPP
7 installations, active ground water infiltration into the existing sewers, pipe type,
8 pipe location, etc.
9

- 10 I. The resin shall be shipped directly from the resin manufacturer’s facility to the
11 CIPP wet-out facility. The resin shall not be sent to any intermediate mixing
12 facility. Copies of the shipment documents from the resin manufacturer shall be
13 submitted to Engineer showing dates of shipment, the originating location and
14 the receiving location.
15
16 J. The resin shall be used to manufacture the CIPP as shipped. No fillers or
17 additives shall be added at the wet-out facility except for the required catalyst as
18 recommended by the resin manufacturer. Contractor shall submit a Certificate of
19 Authenticity from the resin manufacturer for each shipment to the wet-out facility
20 (to include the date of manufacture and the Heat Distortion Temperature). This
21 information shall be submitted prior to manufacturing any CIPP.
22
23 K. Contractor shall identify the wet-out facility where all CIPP will be manufactured.
24 All CIPP shall be manufactured from this designated wet-out facility unless
25 specifically approved otherwise by Engineer in writing. Multiple wet-out facilities
26 shall not be allowed.
27
28 L. Engineer, Owner and/or an agent of the Owner may inspect the CIPP during
29 manufacturing (during “wet-out”). Contractor shall submit a schedule for
30 manufacturing the CIPP to Engineer. Engineer and Owner must be given an
31 opportunity to witness the manufacturing of all CIPP for this project. If the CIPP
32 is manufactured without providing the required notice to Engineer, the CIPP will
33 be marked as rejected prior to installation and will not be approved for installation
34 in this project.
35
36 M. If Engineer and/or Owner decide to inspect the manufacturing of the CIPP,
37 Contractor shall provide full access to witness the wet-out process and shall
38 provide any and all information related to the manufacturing as requested by
39 Engineer, Owner or Owner’s agent without delay and without claims of
40 confidentiality or product privacy.
41
42 N. Engineer or Owner may take samples of the resin from the wet-out facility for
43 infrared analyses (IR Scan). This standard analytical test involves shining a
44 beam of light in the infrared frequency region through a thin sample of the subject
45 resin. The frequency of light is then varied across the infrared spectrum.
46 Chemical functional groups present in the resin being analyzed will absorb
47 infrared light as specific frequencies and with characteristic absorption
48 intensities.

49
50 The Owner may request testing at their discretion at any time. Owner will pay for
51 all such infrared analyses and resin testing. To allow the resin samples to be

1 taken, Contractor shall place a sampling valve in-line at a point prior to the
2 resin/catalyst mixing stage and after the resin/catalyst mixing stage. These
3 sampling valves shall remain in place throughout the duration of the Agreement
4 and shall always be accessible to Engineer and Owner.
5

6 The infrared analyses will be used to verify that the resin and resin/catalyst
7 composition and mixture being used is the approved resin and resin/catalyst
8 system. Contractor shall submit results of infrared analyses of the proposed
9 resin and resin/catalyst mixture, performed and certified by the resin
10 manufacturer, prior to manufacturing any CIPP as a shop drawing. The results of
11 these analyses (the resin's chemical fingerprint) will be used as the standard for
12 verifying the resin and resin/catalyst mixture being used throughout the
13 Agreement.
14

15 Engineer will compare the submitted chemical fingerprint with the fingerprint of
16 Reichhold Polylyte 33420 resin (for isothalic polyester resin) or Reichhold Atlac
17 580-20 (for vinyl ester resin) for a baseline comparison. Contractor and the resin
18 manufacturer shall fully describe, explain and justify any differences between the
19 Reichhold and proposed resin fingerprints without delay or claim to
20 confidentiality.
21

- 22 O. When cured, the CIPP shall form a continuous, tight-fitting, hard, impermeable
23 liner which is chemically resistant to any chemicals normally found in domestic
24 sewage. The liner shall be chemically resistant to trace amounts of gasoline and
25 other oil products commonly found in municipal sewerage and soils adjacent to
26 the sewer pipe to be lined.
27
- 28 P. The CIPP shall be fabricated to a size that will tightly fit the sewer being
29 rehabilitated after being installed and cured. The liner shall be capable of fitting
30 into irregularly shaped pipe sections and through bends and dips within the
31 pipeline. Allowance for longitudinal and circumferential expansion shall be taken
32 into account when sizing and installing the liner. All dimensions shall be verified
33 in the field by Contractor prior to fabrication of the liner. Field measurements
34 shall be used to ensure maximum closure between the new liner and the existing
35 sewer pipe. There shall be no leakage of groundwater between the existing pipe
36 and the CIPP at the manhole connection or service lateral connections.
37
- 38 Q. The application of the resin to the felt tubing (wet-out) shall be conducted under
39 factory conditions and the materials shall be fully protected against UV light,
40 excessive heat and contamination at all times.
41
- 42 R. The length of the liner shall be the length deemed necessary by Contractor to
43 effectively carry out the insertion of the liner and sealing of the liner at the outlet
44 and inlet manholes. The required length of liner shall be verified in the field by
45 Contractor prior to fabrication of the liner.
46
- 47 S. Contractor shall submit Contractor's proposed plan for ensuring that the installed
48 CIPP meets the above minimum thickness requirements. The plan shall include
49 the proposed CIPP thickness to be installed (pre-installation thickness) and
50 detailed inversion or pull-in procedures to reduce stretching and to reduce
51 migration of resin.

1
2 **PART 3 - EXECUTION**

3 **3.1 INSTALLATION OF CURED-IN-PLACE PIPE LINING**

- 4
5 A. Care shall be taken in shipping, handling and laying to avoid damaging the CIPP.
6 Any CIPP damaged in shipment shall be replaced as directed by the Engineer.
7 Any CIPP showing a split or tear or has been mishandled shall be marked as
8 rejected and removed at once from the work. The liner shall be maintained at a
9 proper temperature in refrigerated facilities to prevent premature curing at all
10 times prior to installation. Any liner showing evidence of premature curing will be
11 rejected for use and will be removed from the site immediately.
12
13 B. Contractor shall continuously notify the public of the work being performed.
14 Owner will define the specific notification requirements, and Contractor shall
15 meet all of those requirements. At a minimum, Contractor shall distribute door
16 hangers to each property owner affected by the work seventy-two (72) hours
17 prior to performing any work. Contractor shall submit a sample door hanger to
18 Engineer and Owner for review and approval prior to distribution. The door
19 hangers shall include the specific work to be performed, start time and estimated
20 completion time for the work being conducted, impacts to the property owner,
21 contact names and local phone numbers for the Contractor's project manager,
22 superintendent, and the Engineer's on-site representative.
23
24 C. Contractor shall develop and submit to Engineer a protocol for addressing odor
25 complaints during the CIPP installation process (primarily styrene odor
26 complaints). The protocol shall include steps to be taken by on-site and
27 management personnel immediately when the complaint is received, including
28 discussing the odor with the property owners/residents to address their concerns
29 and alleviating the odor from the home/residence or business using fans or other
30 means as necessary. Contractor shall also maintain a calibrated portable
31 styrene test unit to immediately document the atmospheric concentrations of the
32 styrene on the site and in the house/residence/business when a complaint is
33 received. The styrene concentrations must be tested prior to exhausting the
34 odors from the house/residence/business. The Contractor shall also utilize an
35 exhaust system during the CIPP installation to exhaust odors from the sewers
36 and into the atmosphere during the installation as deemed necessary. The
37 exhaust system should pull air from the sewer instead of forcing air through the
38 sewer and sewer laterals. This will help to minimize the potential for odors to
39 travel up service laterals and into homes/businesses. The exhaust system(s)
40 shall be strategically placed to exhaust the concentrated odors in an isolated
41 location.
42
43 D. Contractor shall perform and provide all necessary traffic control measures to
44 complete the work. Warning signs, barricades and flagmen must be provided in
45 accordance with the NCDOT Transportation's "Manual on Uniform Traffic Control
46 Devices" at all times and places necessary. No roads shall be closed for
47 construction activities. At least one (1) lane of traffic will be safely maintained at
48 all times when construction is in progress. Access to businesses and residences

1 along the roads shall be maintained at all times. All lanes will be open when
2 work is suspended for one (1) hour or longer.
3

4 E. Contractor shall clean and televise each length of pipe to be lined as specified in
5 Chapter 16, Cleaning and Television Inspection, of CHARLOTTE WATER's
6 Water and Sewer Design and Construction Standards.
7

8 F. Water for use in the installation of cured-in-place-pipe lining for main sewers will
9 be available from approved fire hydrants owned and operated by CHARLOTTE
10 WATER only. Use of fire hydrants other than those approved by CHARLOTTE
11 WATER will not be allowed. The Contractor shall meet all Owner requirements
12 for connecting to fire hydrants and **will be charged** for water usage. Prior to
13 connection to, and use of any hydrant, the Contractor must apply for and
14 successfully obtain a temporary fire hydrant use permit (Vehicle Mounted
15 "Tanker Truck" Permit). All instructions and requirements for obtaining the permit
16 are listed under the **Fire Hydrant Program for Temporary Service** section of
17 CHARLOTTE WATER's website. The Contractor is responsible for meeting all
18 requirements whether listed herein or not.
19

20 The Contractor shall submit to the Engineer, a copy of the approved permit
21 number for each vehicle prior to connection to, and use of, any fire hydrant.
22

23 The Contractor shall be well versed in the proper operation of valves and
24 hydrants and will be responsible for any damage caused by improper operation
25 or usage of hydrants. All cure water must be discharged to the wastewater
26 collection system.
27

28 G. Contractor shall bypass pump sewage flows around the lining work while it is
29 being performed. Contractor is responsible for handling and accommodating all
30 existing wastewater flows during the work. Prior to performing the work,
31 Contractor shall submit, for approval by Engineer, a detailed plan of the method
32 Contractor proposes in order to maintain the existing flow during construction.
33 The plan must include a provision for handling the existing peak flow by pumping.
34 The peak flow shall be considered the existing pipe flowing full, which is highly
35 possible during rain events. When pumping is used, an identical standby
36 pump(s) shall be on site in the event of failure of the primary pump(s). Flows in
37 the lateral specified for lining will not require bypass pumping. Contractor shall
38 coordinate with the homeowner/business in advance of all work to ensure the
39 lateral will be inactive at the time of the CIPP installation. All bypass pumping
40 work shall be performed as specified in Chapters 11 and 17 of CHARLOTTE
41 WATER's Water and Sewer Design and Construction Standards.
42

43 H. Contractor shall take precautions to avoid damage or flooding to public or private
44 property being served by the line being cleaned. Contractor shall be responsible
45 for all flooding and pay for cleanup from flooding to the satisfaction of the
46 property owner. Contractor shall document all backups and submit
47 documentation to Engineer including the reason for the backup, the time and
48 date of the backup, the property owner's name, address and phone number, the
49 resolution to problem, the time and date the problem was resolved, and any
50 special cleanup work that had to be performed. This required documentation

1 shall be submitted for all backups regardless of when they occur. All cleanup
2 shall be completed within four (4) hours of the backup.
3

4 I. Contractor shall furnish and install the CIPP lining in the full length of sewer. The
5 installation of the CIPP shall be in complete accordance with the applicable
6 provisions of ASTM F1216 or ASTM F1743 except as modified herein, these
7 specifications and the manufacturers' specifications.
8

9 J. Water or air shall be used to invert CIPP installed via ASTM F1216 or to invert
10 the calibration hose through CIPP installed via ASTM F1743. The water
11 inversion of the CIPP and calibration hoses shall be accomplished by using
12 natural water pressure (head) achieved by erecting platforms or scaffolding to an
13 elevation determined by Contractor or by using CIPP installation vessels/units
14 that creates water pressure. Contractor shall determine the necessary inversion
15 heads (pressure) for each line segment. If an installation vessel/unit is used, a
16 pressure relief valve shall be installed on the vessel so that the necessary
17 pressure/inversion heads are not exceeded at any time during the inversion.
18 Water or air pressure shall not be varied by any means throughout the inversion
19 process except when approved by Engineer. Contractor shall submit required
20 inversion heads/inversion processes for each installation as a shop drawing
21 without delay and claim to confidentiality or product/installation privacy.
22

23 K. CIPP shall be cured with water or steam in strict accordance with the
24 manufacturer's recommendations. This shall include achieving cooking
25 temperatures, cooking times, and cool-down procedures. The Contractor shall
26 submit required curing schedules and procedures for each installation as a shop
27 drawing without delay and claim to confidentiality or product/installation privacy.
28

29 Cool down shall meet the minimum criteria established herein or the
30 manufacturer's recommendations, whichever is more stringent. The water
31 temperature inside the pipe shall be cooled at a maximum rate of 20 degrees per
32 hour until the water temperature is within 20 degrees of the ambient temperature.
33 Do not "shock" the liner with dramatically cooler water. Slowly introduce cooler
34 water into the cool down cycle. The cool down period cannot be less than 1 hour
35 even if the water temperature inside the pipe is within 20 degrees of the ambient
36 temperature.
37

38 L. The Contractor shall install and utilize the VeriCure process (or approved equal)
39 for monitoring the cure temperature of the CIPP. VeriCure shall be installed from
40 manhole to manhole under the bottom of the CIPP. The installation and use of
41 VeriCure shall be in strict accordance with the manufacturer's recommendations.
42 The cure temperature data shall be recorded electronically with the required
43 monitoring devices/computers/computer software. Printed color data reports
44 (hardcopies or pdf format) with detailed descriptions/summaries of the data along
45 with the digital data file shall be submitted to the Engineer for review prior to
46 requesting payment for the CIPP. All special software to review the data file shall
47 also be submitted.
48

49 M. In larger diameter sewers (30 inch or larger) and/or when the section being water
50 cured has a volume of 20,000 gallons or greater, the cure water shall be released
51 from the sewer being lined in a slow, methodical manner. A quick "batch"

1 release of the water shall not be allowed. The cure water shall be released by
2 cutting a small/narrow opening in the CIPP to allow the water to slowly drain
3 while the CIPP cool-down process is being implemented. This will serve to
4 slowly release the water and also allow some cool-down of the water prior
5 to/during the release. The entire release process shall occur over a minimum 6-
6 hour period unless approved otherwise by the Engineer. The Owner may also
7 sample the cure water during the release to test for chemical compounds that
8 may have a detrimental effect on the downstream water reclamation facility. The
9 Contractor shall accommodate all sampling efforts by the Owner. If damaging
10 chemical compounds (such as styrene or vinyl chloride) exist at high enough
11 levels that may impact treatment processes (as determined by the Owner), the
12 Contractor shall modify the cure water release time to further slow the release of
13 the water to allow additional time and dilution in the sewer system.
14

15 N. The CIPP shall be neatly cut two (2) inches from the manhole walls after
16 installation unless otherwise directed by Engineer. The CIPP shall be sealed at
17 the manholes to provide a watertight liner connection at the manhole. There
18 shall be no leakage of groundwater into the manhole between the CIPP and
19 existing sewer pipe and between the existing sewer pipe and manhole wall. A
20 hydrophilic waterstop (non-bentonite) comprised of modified chloroprene rubber
21 shall be installed around the liner six (6) inches from each manhole wall prior to
22 processing the liner to provide additional waterstop protection. As the CIPP is
23 expanded, the waterstop shall be pressed tightly against the existing sewer to
24 provide a leak-tight seal. The waterstop shall be Hydrotite as manufactured by
25 Greenstreak (St. Louis, Missouri) or equal. All CIPP connections to manholes
26 shall be further sealed with an approved non-shrink grout to completely cover the
27 CIPP/manhole connection point. CIPP lining shall be sealed to manhole linings
28 (where specified) in an acceptable manner as approved by Engineer. Further, all
29 invert channels shall be coated with an approved grout to match the CIPP
30 elevations in the manhole. Submit detailed drawings of the pipe-manhole
31 connections to Engineer for approval, including termination points in manholes
32 and transitions with manhole linings where installed.
33

34 O. Contractor shall fully reopen all of the existing active service connections in each
35 length of sewer following lining. The service connections shall be reopened from
36 inside the sewer by means of a closed-circuit television camera controlled cutting
37 device appropriate for the CIPP. All openings shall be clean and neatly cut and
38 shall be flush with the lateral pipe. The openings shall also be buffed with a wire
39 brush to remove rough edges and provide a smooth finish. The bottom of the
40 openings shall be flush with the bottom of the lateral pipe to remove any lip that
41 could catch debris. Openings shall be 100% of the service lateral pipe.
42 Contractor shall re-open any service lateral that does not meet this requirement
43 as evidenced by the post-rehabilitation inspections at no additional cost to
44 Owner. The Contractor shall be responsible for all costs associated with repairs
45 to improperly opened or damaged active service connections. See section 3.1.H
46 of this document.
47

48 P. Preliminary Post-CIPP TV Inspections: Immediately after the CIPP is installed
49 and the services connections are completely opened and brushed, the
50 Contractor shall televise the installed CIPP to verify and document that the CIPP
51 was properly installed and cured and that all service connections have been

1 opened as specified. The preliminary post-CIPP TV inspection videos shall be
2 submitted to the Engineer within 1 day of the CIPP being installed. This will allow
3 Engineer to confirm that there are no CIPP issues that need addressed on this
4 sewer and/or future installations and that the service laterals are properly
5 opened. The preliminary post-CIPP inspections shall clearly show the CIPP liner
6 and all service connections.
7

8 Contractor may submit these inspections as the final post-CIPP inspections if all
9 grout/concrete work is finalized in the connecting manholes (including grouting
10 the pipe connections, coating the invert channels, and performing the specified
11 manhole rehabilitation) and all specifications are met. Completing all of the
12 manhole work may be difficult to get finished so that the TV inspections can be
13 submitted within one (1) day as specified above.
14

15 Q. Installation reports shall be generated for each segment of liner installed. The
16 reports shall document installation, including manhole numbers, street
17 names/sewer location, project number, date, time, temperature, curing
18 temperature, curing time, liner thickness, etc. A sample report shall be submitted
19 to Engineer for approval prior to installing any lining.
20

21 R. For every sewer segment that is lined (sewer segment is defined as the sewer
22 between two manholes), Contractor shall remove one restrained sample of the
23 installed liner at least twelve (12) inches in length for testing of installed CIPP
24 flexural properties and thickness. The CIPP testing shall include determining
25 flexural strength, flexural modulus, tensile strength and thickness of each
26 sample. These four separate individual tests make up one completed CIPP test.
27

28 For sewers twelve (12) inches in diameter and smaller, the sample shall be
29 captured by installing the lining through a section of PVC pipe (same diameter as
30 the existing sewer diameter) within the most downstream manhole of the
31 installation and at all intermediate manholes if multiple sewer segments are lined
32 at the same time. For sewers fifteen (15) inches in diameter and larger, plate
33 samples shall be taken and cured in the same water as the installed CIPP.
34

35 Contractor shall be responsible for capturing the samples and preparing the
36 samples for testing (cutting the samples to the required dimensions, removing
37 the PVC pipe, etc.). The testing laboratory shall specify the dimensions for the
38 samples. In addition, Contractor shall cut a 1-inch wide representative sample
39 (taken at least 2 inches from the end of the specimen) for the Engineer's records.
40 Contractor shall label all samples including writing on the samples where they
41 were taken (manhole numbers and work orders) and the date they were taken.
42

43 Each day, Contractor shall submit the samples taken that day to Owner and/or
44 Owner representative. Owner will forward the samples to the testing laboratory.
45 Owner will copy Contractor on all submittals to the testing laboratory. The testing
46 laboratory shall submit all test results directly back to Owner with a copy to
47 Contractor. The test results should be returned to Owner within twenty-one (21)
48 days from the laboratory receiving the samples and should be available prior to
49 the following month's pay estimate. All testing shall be performed by an
50 independent, accredited, certified and experienced (minimum 5 years of
51 experience) testing laboratory.

1
2 The tests shall be used to verify that the installed CIPP meets these
3 specifications. CIPP thickness shall be measured in accordance with ASTM
4 D5813. Flexural properties shall be determined per ASTM D790. Tensile
5 strength shall be determined per ASTM D638.
6

7 The CIPP testing will include determining flexural strength, flexural modulus,
8 tensile strength and thickness of each sample to verify that the installed CIPP
9 meets the specifications. CIPP thickness shall be measured in accordance with
10 ASTM D5813. Flexural properties shall be determined per ASTM D790. Tensile
11 strength shall be determined per ASTM D638. Engineer will share the test
12 results with the Contractor as requested.
13

- 14 S. Any lining that does not meet the specified installed strength and/or thickness
15 requirements, regardless of the amount below the specified requirements, shall
16 be corrected by Contractor in a manner approved by Engineer at no additional
17 cost to Owner. The Engineer's decision on how to correct deficient CIPP
18 installations shall be final. Options for correcting deficient liner that will be
19 considered by Engineer include removing the liner, excavating and replacing the
20 sewer from manhole to manhole, pipe bursting the sewer from manhole to
21 manhole, or providing Owner with a substantial credit.
22

23 A standardized credit system has been established for CHARLOTTE WATER
24 funded contracts. Private work is not eligible for compensation under this
25 program. Credits will only be considered for lining that does not meet the
26 required thickness. CIPP lining thickness may be up to 5% below the specified
27 minimum installed thickness before the credit will be applied. For example, if the
28 minimum specified thickness is 6 mm, the credit will only apply if the CIPP is less
29 than 5.7 mm thick. There will be no "re-calculations" of required thicknesses
30 based on actual flexural test results for that sample. The minimum specified
31 thicknesses shall be required regardless of the final flexural properties of the
32 CIPP as installed. If a credit is acceptable to Engineer and Owner, the credit
33 shall be calculated by multiplying the bid price by the percent that the liner
34 thickness is below the minimum required installed thickness as follows:
35

36
$$\text{Credit} = (1 - (\text{installed CIPP thickness}/\text{min required thickness})) \times \text{Bid Price}$$

37

38 Contractor shall not assume that a credit will be acceptable to Engineer or Owner
39 or that the above formula will be used in all situations or for all installed CIPP
40 thicknesses. Liner thickness of less than 85% of the required minimum thickness
41 will not be eligible for any payment.
42

43 All credits shall be accounted for on the monthly pay estimates (each and every
44 month) as the failed test results are received by Engineer. Credits shall not
45 accumulate until the end of the Agreement. In addition, any other defective CIPP
46 shall be repaired within twenty-one (21) days of being identified or payment will
47 be withheld and work will not be allowed to continue.
48

- 49 T. Following installation of the CIPP, reopening and brushing of all active service
50 lateral connections, and completion of all manhole rehabilitation including
51 vacuum testing (where applicable), Contractor shall conduct a final post-

1 rehabilitation television inspection of the completed work to verify that the liner
2 installation is acceptable as defined herein. The sewers shall be thoroughly
3 cleaned prior to performing the television inspections. No cleaning equipment
4 shall be in the sewers during the post-rehabilitation inspections. The pipe shall
5 be dry so that the entire CIPP can be seen. This will require that temporary
6 plugging or bypass pumping be provided for all post-rehabilitation television
7 inspections.

8
9 The post-rehabilitation television inspections shall be in accordance with the
10 inspections specified in Chapter 16, Sewer Cleaning and Television Inspection,
11 of CHARLOTTE WATER's Water and Sewer Design and Construction
12 Standards. The post-rehabilitation television inspections shall be within 1.0
13 percent of the actual sewer length as measured above ground from center of
14 manhole to center of manhole. Any inspection that exceeds this limit shall be re-
15 performed and re-submitted to the Engineer prior to payment at no additional
16 cost to the Owner. One copy of the final post-rehabilitation inspections shall be
17 submitted to the Engineer for review and approval as specified. The inspections
18 must be in order, correct and complete or the Engineer will immediately return
19 the inspections to the Contractor for corrections.
20

- 21 U. The final CCTV inspection shall not be performed until all manhole rehabilitation
22 work is completed (including vacuum testing where applicable). Contractor shall
23 submit the required digital inspections within 30 calendar days after completion of
24 CIPP lining and/or manhole rehabilitation work, and/or as negotiated with the
25 Engineer.
26
- 27 V. There shall be no holes, dry spots, lifts, ribs, wrinkles, blisters, ridges, splits,
28 bulges, cracks, delaminations or other type defects in the CIPP lining. In
29 addition, there shall be no groundwater leakage through the CIPP or between the
30 liner and the existing pipes including at the connections to manholes. Defective
31 lining and groundwater leakage shall be repaired in a manner suitable to and
32 approved by Engineer at no additional cost to Owner.
33

34 The Engineer's decision on how to correct defective lining shall be final. Options
35 for repairing defective lining that will be considered by Engineer include removing
36 the liner and re-lining the sewer, excavating and replacing the sewer from
37 manhole to manhole, pipe bursting the sewer from manhole to manhole, or
38 installing a sectional CIPP patch to repair the defective area.
39

40 If a CIPP patch is approved as a repair method for manhole-to-manhole CIPP,
41 Owner will not pay the full bid price for that sewer segment (manhole to
42 manhole). The price reduction (credit) shall be negotiated with Contractor and
43 shall be acceptable to Owner. The credit shall be equal to at least 25% of the
44 unit price bid for the CIPP installation and shall apply to the entire CIPP lining
45 from manhole to manhole. Owner shall have the final decision on the amount of
46 the credit. Any such credits shall be accounted for on the pay estimates as the
47 defective CIPP is repaired. Credits shall not accumulate until the end of the
48 Agreement.
49

50
END OF SECTION

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