

**PROJECT:**

42 Inch PCCP Raw Water  
Conveyance Pipeline and EDV  
Facility  
1515 Granville Road  
Westfield, MA 01085  
Project No. 24-01

**ADDENDUM NO. 3 03/28/2024**

Posted: 03/28/2024 at 1:36PM EDT

**Awarding Authority/Owner:**

Springfield Water and Sewer Commission  
250 M Street Extension  
Agawam, MA 01001

Reference Contract Documents (drawings and specifications) dated 02/21/2024

The attention of Bidders submitting proposals for the above subject project is called to the following addendum to the specifications and drawings. The items set forth herein, whether of omission, addition, substitution, or clarifications are all to be included in and form a part of the proposal submitted.

THE NUMBER OF THIS ADDENDUM (3) MUST BE ENTERED IN THE APPROPRIATE SPACE "B" PROVIDED AFTER THE WORD "NUMBERS" OF THE CONTRACT FORM ENTITLED "FORM FOR GENERAL BID," AND IN SPACE "B" OF THE "FORM FOR SUB-BID."

BID DOCUMENT MODIFICATIONS ARE AS FOLLOWS.

**Other Modifications / Attachments:**

The following attachment includes additional modifications, clarifications and/or provisions not included in the items above in this Addendum.  
See document at the end of document.

All other of the portions of the Contract Documents remain unchanged. Please be reminded to acknowledge this Addendum on the bid forms.

**ATTACHMENTS**

Addendum No. 3 IFB 24-01 42 Inch and EDV.pdf

--- End of Addendum No. 3 ---

**SPRINGFIELD WATER AND SEWER COMMISSION**

**ADDENDUM No. 3**

**TO  
CONTRACT DOCUMENTS FOR**

**IFB# 24-01 WEST PARISH FILTERS WATER TREATMENT PLANT 42 INCH  
RAW WATER CONVEYANCE REHABILITATION AND ENERGY  
DISSIPATION VALVE CHAMBER  
WESTFIELD, MASSACHUSETTS 01201**

Bidders are hereby notified of the following additions, deletions, and modifications to the Contract Documents for IFB# 24-01 42 Inch Raw Water Conveyance Rehabilitation and Energy Dissipation Valve Chamber.

Bidders shall acknowledge receipt of this Addendum in the space provided on the bid forms.

**A. ANNOUNCEMENTS**

The following changes have been made to the bid schedule:

Last day for submittal of written questions to CPO  
([theo.theocles@waterandsewer.org](mailto:theo.theocles@waterandsewer.org)) – Friday April 12, 2024

BIDS DUE TO SWSC and opened - Friday April 26, 2024

Another optional site visit is scheduled for April 5, 2024, at 10am at 1515 Granville Road, Westfield, MA.

**B. SPECIFICATIONS**

**Section 00300 Bid Form** – delete and replace with Attachment 1.

**Section 01500 Temporary Facilities – Paragraph 1.08** delete and replace with:

1.08 OFFICE FOR ENGINEER:

- A. Promptly after starting work at the site, the Contractor shall provide and equip a suitable office for the exclusive use of the Engineer, and the Contractor shall maintain this office thereafter until the completion of the work to be done under this contract. This office shall be a separate building located, as directed, where it will not interfere with the progress of the work. An approved, suitably constructed, and equipped trailer of adequate size and design for the purpose may be furnished as the Engineer's office. If a trailer is furnished, it shall have a minimum width of 12 feet, and a length as required to obtain the square footage specified below and an insulated floor. The office and furniture shall be relatively new and in good condition. The equipment, supplies, and services furnished shall be acceptable to the Engineer.
- B. The Contractor shall furnish insurance coverage of adequate amount to replace not only the Contractor's equipment, but all property belonging to the Engineer and the Engineer's staff, at replacement cost.
- C. The Office shall be of suitable height and of ample size to accommodate the furniture and equipment listed below, without crowding (at least 600 sq. ft. of floor area). It shall be weathertight and acceptably insulated and suitably ventilated; the floor shall be tight and of sufficient construction to withstand the loads imposed upon it. The office shall consist of separate space offices for the Owner's field engineers and separate space for meetings/conferences. Each room will have a door, with lock and key, and a minimum of two screened windows which can be both opened and locked shut. The office shall have two exterior doors, with cylinder locks and keys. The exterior doors shall also be provided with a hasp, for which the Engineer will furnish his own locks. The office shall contain separate and acceptable toilet facilities, to include a toilet, sink with hot and cold water, exhaust fan, and mirror. The Contractor shall make arrangements and pay all costs associated with tying the office sanitary system into an approved disposal system.
- D. The Contractor shall furnish a parking area large enough to accommodate a minimum of four cars adjacent to the office, for the exclusive use of the Engineer.
- E. The Contractor shall furnish the following furniture, equipment, supplies, and services:
  - 1. One plan table or sloping plan shelf, about 3 ft. by 6 ft., with a reasonably smooth top, and one suitable swivel stool.
  - 2. Eight additional folding chairs.
  - 3. Shelves, tables, and bookcases as directed by the Engineer.
  - 4. Electric lights, desk lamps and outlets as directed. The Contractor shall pay for installation and all charges for the energy used.

5. Broom and dustpan.
6. Two desks for general office use. Each about 3 ft. by 5 ft., all with a desk chair of the armchair swivel type.
7. Plan rack, as directed or approved by the Engineer.
8. Plan storage cabinet as approved by the Engineer.
9. Two four-drawer, legal size, metal filing cabinets each with locks. The Contractor shall furnish up to two additional filing cabinets if requested by the Engineer.
10. Coat rack and hooks
11. Provide telephone service to service voice grade lines with caller ID.
12. Provide a push button digital telephone for each of two desks.
13. Provide high speed internet access in the Engineer's field office for the Engineer's exclusive use. High speed internet access shall be capable of a minimum of 10 mbps upload and 100 mbps download speeds. High speed internet access for the Engineer's use shall be Cable, DSL, or T-1 type service.
14. Class ABC type fire extinguisher of at least 4-lb capacity.
15. Insulated waterproof chest for storage and moist curing of concrete cylinders; size and construction as directed with capability of maintaining required curing temp.
16. Supply of drinking water in a suitable dispenser, with hot and cold supply and refrigerator space.
17. Paper cups, paper towels, liquid soap, and toilet paper; each with suitable dispenser or holder.
18. A waste basket for each desk, and a supply of appropriately sized plastic trash bags.
19. Thermostatically controlled heating unit or system of adequate capacity to maintain a minimum temperature of not less than 68 deg. F. under all cold weather conditions. The Contractor shall provide all fuel used and service necessary.
18. Thermostatically controlled, refrigerant type, air conditioner of adequate capacity to maintain a maximum temperature of not more than 72 deg. F. under all hot weather conditions. The Contractor shall provide all service necessary and provide all power used.

19. Metal clothing locker, or closet, 36-in. wide by 18-in. deep by 72-in. high, minimum dimensions.
20. Metal storage cabinet 36-in. wide, by 18-in. deep by 72-in. high, with a minimum of five adjustable shelves, and a door lock.
21. The Contractor shall arrange for complete janitor service to be provided on a weekly basis.
22. One copying machine with supplies and service capable of scanning and faxing. Machine shall be capable of copying 8.5x11, 8.5x14 and 11x17 paper sizes. Copy rate shall be at least 20 copies per minute for 8.5x11 paper size.
23. Outdoor minimum-maximum thermometer with range of -40 deg. F to +120 deg. F and reset provisions.

**Section 02610 CFRP Repair** – delete and replace with attached revised specification provided as Attachment 2.

**Section 02612 Pipe Joint Pressure Testing** – Paragraphs 1.04 A delete and replace with:

- A. Submit the following after Award but prior to Mobilization upon request of the Engineer:

## **QUESTIONS**

**Addendum No. 2 Question 7:** Please provide design criteria for GFRP repair and confirm that a minimum of two layers is required.

**Addendum No. 3 Supplemental Response 7:** See modified Specification Section 02610 provided as Attachment 2.

**Addendum No. 2 Question 10:** Please confirm that submittals for Subsections 1.5A and 1.7A are required with bid for SECTION 02610 - CFRP TECHNICAL SPECIFICATION.

**Addendum No. 3 Supplemental Response 10:** See modified Specification Section 02610 provided as Attachment 2.

**Addendum No. 2 Question 22:** Please provide water quality information/ testing reports, velocity and confirm whether the flow media has presence of grit and solids to better confirm required topcoat system. Typical finish coat of thickened epoxy is suitable for potable water mains but may not be adequate for raw water systems.

**Addendum No. 3 Response 22:** The following Table 1-2 was included in the Springfield Water and Sewer Commission Phase II Facilities Plan for West Parish Filters Dated December 17, 2021.

Maximum flow velocity in the pipeline is limited to 10 ft/sec.

**Table 1-2. Raw Water Quality Statistical Summary for Years 2016 – 2020**

Parameter	Units	SMCL	Commission Raw Water Quality Data		
			Average	Min.	Max.
Raw Turbidity	NTU	None	0.54	0.30	5.57
pH	SU	6.5 – 8.5 <sup>(1)</sup>	6.93	6.10	7.90
Alkalinity	mg/L as CaCO <sub>3</sub>	None	8.82	5.00	20.00
Color	C.U.	15 <sup>(1)</sup>	21.39	11.00	42.00
Total Organic Carbon <sup>(2)</sup>	mg/L	None	2.82	2.10	4.04
Organics (UV-254)	cm <sup>-1</sup>	None	0.11	0.17	0.07
Chloride	mg/L	250 <sup>(1)</sup>	15.25	8.00	22.00
Iron	mg/L	0.30 <sup>(1)</sup>	0.11	0.01	0.32

Notes:

1. SMCL = Secondary Maximum Contaminant Level.
2. TOC data provided by the Commission for the period of 2/3/2016 through 11/12/2020

**Addendum No. 2 Question 27:** Please allow for letter from manufacturer of test equipment to be provided “After award and prior to mobilization.”

**Addendum No. 3 Supplemental Response 27:** See modified Specification Section 02612 Section 1.04 A under SPECIFICATIONS above.

**Addendum 2 Question 28:** Please allow for all qualified INSTALLERS of CFRP systems to be deemed acceptable and recognized for this particular scope item and for documentation to be provided “After award and prior to mobilization.”

**Addendum No. 3 Supplemental Response 28:** See modified Specification Section 02610 provided as Attachment 2.

**END OF ADDENDUM**

**Attachment 1 to Addendum No. 3**

**00300 Bid Form**

BID FORM

PLACE: \_\_\_\_\_

DATE: \_\_\_\_\_

Proposal of \_\_\_\_\_ (hereinafter called "BIDDER")\*  
(Name of Proposer)

A corporation organized and existing under the laws of the State of \_\_\_\_\_,\*  
a partnership, or an individual doing business as \_\_\_\_\_.

To the SPRINGFIELD WATER AND SEWER COMMISSION, hereinafter called the "Owner."

Bidders:

**Raw Water Conveyance Bypass Conveyance Rehabilitation and Energy Dissipation Valve Chamber**  
**SWSC Bid Number: 24-01**

The BIDDER, in compliance with your Invitation to Bid for the Springfield Water and Sewer Commission project entitled: **“42-Inch Raw Water Bypass Conveyance Pipeline Rehabilitation and Energy Dissipation Valve Chamber”**, Westfield, Massachusetts, having examined the Plans and Specifications with related documents and the site of the proposed Project and being familiar with all of the conditions surrounding the construction of the proposed project, including the availability of materials and labor, hereby proposes to furnish all labor, materials, and supplies and to construct the project in accordance with the Contract Documents within the time set forth therein, and at the prices stated below. These prices are to cover all expenses incurred in performing the work required under the Contract Documents of which this Proposal is a part.

BIDDER hereby agrees to commence work under this Contract on or before a date to be specified, in a written "Notice To Proceed", by the Owner, and to fully complete the project within 548 Calendar Days thereafter as stipulated in the Specifications. No work on holidays will be allowed. Work on Saturdays and/or Sundays will only be allowed with prior City of Springfield and Owner approval. Night work will only be allowed with prior City of Springfield and Owner approval. BIDDER further agrees to pay as liquidated damages the minimum sum of \$5,275.00 for each consecutive calendar day thereafter until the Project is Substantially Complete.

A Labor and Material or Payment Bond in the amount of 100% of the total Contract Price must be provided by the General Contractor.

A Performance Bond in the amount of 100% of the total Contract Price must be provided by the

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General Contractor.

Bidder acknowledges receipt of the following addenda:

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\*Insert corporation, partnership, or individual as applicable.

Unit and lump sum prices and extended amounts are to be shown in both words and figures. In case of discrepancy, the amount shown in words will govern.

BASE BID ITEMS

THIS NEEDS TO BE FILLED OUT WITH UNIT/LINE ITEMS

Total amount of Base Bid based on Engineer's estimate of quantities for Items 1 through 37 inclusive.

\_\_\_\_\_ \$ \_\_\_\_\_  
(Amount in Words) (Amount in Figures)

**BIDDER MUST FILL IN THE UNIT PRICES AND COMPUTE THE TOTALS**

(In case of error or discrepancies "UNIT PRICES Written Words" govern)

<b>Item No.</b>	<b>DESCRIPTION OF SCHEDULED ITEM</b>	<b>UNIT PRICES Dollar Figure UNIT PRICES Written Words</b>	<b>ESTIMATED QTY/ UNIT OF MEASURE</b>		<b>TOTAL PRICES Dollar figure</b>
1	Mobilization and Demobilization  *Not to exceed 5 percent of total Bid price		Lump sum		\$ _____
2	General Requirements		Lump Sum		\$ _____
3	Construction of Energy Dissipation Valve Chamber		Lump Sum		\$ _____
4	Procurement of Mokveld Energy Dissipation Valves		3	EA	\$ _____
5A	Block Retaining Walls – 2FT Height		60	LF	\$ _____

5B	Block Retaining Walls – 4FT Height		100	LF	\$ _____
5C	Block Retaining Walls – 6FT Height		95	LF	\$ _____
6	Internal Pipe Joint Testing		624	EA	\$ _____
7	Pre-Repair HD CCTV and LiDAR Defect Mapping Inspection		Lump Sum		\$ _____
8	PCCP Internal Joint Repair with Mortar, per pipe joint with designated repairs		70	EA	\$ _____
9	Install PCCP Internal Joint Compression Seal without Joint Repair		120 joint seals	EA	\$ _____

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10	Install PCCP Internal Joint Compression Seal with Joint Repair		55 joint seals with joint repair	EA	\$_____
11	Remove and Replace Manway		11 manways	EA	\$_____
12	Remove and Replace PCCP Pipe Segment [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		19 pipe segments	EA	\$_____
13	Install Internal Compression Pipe Seal		8 pipe seals	EA	\$_____
14	Repair Concrete Core Locally Along Pipe Barrel (Crown Region), per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		7 pipes	EA	\$_____
15	Repair Concrete Core Along Full Length of Pipe Barrel (Crown Region), per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		2 pipes	EA	\$_____

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16	Repair Concrete Core Along Full Length of Pipe Barrel (Invert Region), per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		140 pipes	EA	\$_____
17	Repair Concrete Cracks in Pipe Barrel, per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		5 pipes	EA	\$_____
18	Install Carbon Fiber Reinforced Polymeric (CFRP) Composites, per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		4 pipes	EA	\$_____
19	Install Glass Fiber Reinforced Polymeric (GFRP) Composites, per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		52 pipes	EA	\$_____
20	Repaint Steel access Ring and Lids in Old Manway		1 External, 1 Internal	EA	\$_____
21	Remove Pipe and Install New Manway		2	EA	\$_____

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22	Repair Steel Pipe Cement Mortar Lining (CML) Cracks, per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		6 pipes	EA	\$ _____
23	Repair Steel Pipe Cement Mortar Lining (CML), per pipe designated for repair [Standard Length of PCCP is 16 feet but varies, refer to Drawings]		2 pipes	EA	\$ _____
24	Install New Air Release Valves [42-Inch Pipe Only]		14 valves	EA	\$ _____
25	Install Vaults at Air Valves and Manways		15 vaults	EA	\$ _____
26	Furnish and Install Remote Transient Pressure Monitors		4	EA	\$ _____
27	Furnish and Install 12 inch Access/ Launch and Retrieval Locations		2	EA	\$ _____

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28	Post-Repair HD CCTV and LiDAR Defect Mapping Inspection		Lump Sum		\$ _____
29	Internal Free-Swimming Leak and Air Pocket Detection Inspection		Lump Sum		\$ _____
30	Erosion and Sediment Control		4100	LF	\$ _____
31	Rock Excavation and Disposal		1300	CY	\$ _____
32	Final Cleaning and Flushing		Lump Sum		\$ _____
33A	Temporary Pavement		6,200	SF	\$ _____



33B	Permanent Pavement		10,000	SF	\$ _____
34A	Upland Restoration [Buffer zone and lawn disturbances]		85,000	SF	\$ _____
34B	Wetland Restoration		4,400	SF	\$ _____
34C	Riverfront Restoration – Indigenous Shrubs		10	EA	\$ _____
35	Asphalt Price Adjustment	\$20,000	Allowance		\$ __20,000__
		Twenty Thousand Dollars			
36	Portland Cement Price Adjustment	\$20,000	Allowance		\$ __\$20,000__
		Twenty Thousand Dollars			

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37	Gasoline and Diesel Fuel Price Adjustment	\$20,000	Allowance	\$ 20,000 _____
		Twenty Thousand Dollars		

The above unit and lump sum prices shall include all labor, equipment, materials, overhead, profit, insurance, and other costs to cover the finished work of the several kinds called for.

NOTE: The award will be based upon the Proposed Contract Price and will be made in accordance with the provisions of MGL Chapter 30, Section 39M. The quantities designated throughout the Bid Schedule, however, are estimates only, and the Unit Price provided for a category of Work shall be the basis for the entire term of the Contract, for additions to or deletions from the Total Contract Price for Work of the category, so long as the number of units of work remains within fifteen percent (15%) of the estimated quantity or twenty five (25)% of the estimated quantity for items relating to soil management, handling, and/or disposal (Items 1 through 12).

This project is being bid under Chapter 30, Section 39M of the Massachusetts General Laws. The Bidder understands that the Owner reserves the right to reject any or all bids and to waive any informalities in the bidding. The Bidder understands that the Owner shall determine if this bid is responsible and eligible in accordance with M.G.L. c.30, s39M based in part on information contained in the Statement of Bidder's Qualifications submitted as part of this bid form.

The time period for holding bids, where Federal approval is not required is 30 days, Saturdays, Sundays and legal holidays excluded, after the opening of bids and where Federal approval is required, the time period for holding bids is 30 days, Saturdays, Sundays and holidays excluded after Federal approval. Upon receipt of written notice of the acceptance of this bid, Bidder shall execute the formal Contract attached within 10 calendar days and deliver a Performance and Payment Surety Bonds as required in the General Conditions. The Bid Security (5% of Bid) attached in the sum of \_\_\_\_\_ Dollars, (\$\_\_\_\_\_) is to become the property of the Owner in the event the Contract and Bond are not executed within the time above set forth as liquidated damages for the delay and additional expense to the Owner caused thereby.

The undersigned hereby declares that he has carefully examined the site of the proposed Work and fully informed and satisfied himself as to the conditions there existing, the character and requirements of the proposed Work, the difficulties attendant upon its execution and the accuracy of all estimated quantities stated in this BID FORM, and he has carefully read and examined the Drawings, the annexed proposed CONTRACT and the Specifications and other Contract Documents therein referred to and knows and understands the terms and provisions thereof.

The undersigned hereby declares that he understands that information relative to subsurface and other conditions, natural phenomena, existing pipes and other structures (surface and/or subsurface) has been furnished only for his information and convenience without any warranty or guarantee, expressed or implied, that the subsurface and/or other conditions, natural phenomena, existing pipes and other structures (surface and/or subsurface) actually encountered will be the same as those shown on the Drawings or in any of the other Contract Documents and he agrees that he shall not use or be entitled to use any such information made available to him through the Contract Documents or otherwise or obtained by him in his own examination of the site, as a basis of or ground for any claim against the Owner or the Engineer arising from or by reason of any variance which may exist between the aforesaid information made available to or acquired by him and the subsurface and/or other conditions, natural phenomena, existing pipes and other structures (surface and/or subsurface) actually encountered during the construction work, and he has made due allowance therefore in this Bid.

The undersigned hereby declares that he understands that the quantities of work tabulated in this Bid or indicated on the Drawings or in the Specifications or other Contract Documents are only approximate and are subject to increase or decrease as deemed necessary by the Engineer.

The undersigned agrees that, if this Bid is accepted he will contract with the Owner, as provided in the copy of the Contract Documents deposited in the office of the Engineer, this BID FORM being part of said Contract Documents, and that he will perform all the work and furnish all the materials and equipment, and provide all labor, services, plant, machinery, apparatus, appliances, tools, supplies and all other things required by the Contract Documents in the manner and within the time therein prescribed and according to the requirements of the Engineer as therein set forth, and that he will take in full payment therefore the lump sum or unit price applicable to each item of the Work as stated in the schedule below.

The undersigned certifies under penalties of perjury that no officer, agent, or employee of the Owner is directly or indirectly interested in this BID.

The undersigned certifies under penalties of perjury that this bid is in all respects bona fide, fair and made without collusion or fraud with any other person. As used in this paragraph the word "person" shall mean any natural person, joint venture, partnership, corporation or other business or legal entity.

The undersigned hereby certifies that he is able to furnish labor that can work in harmony with all other elements of labor employed or to be employed in the work.

Applicable provisions of Massachusetts General Laws and Regulations and/or the United States Code and Code of Federal Regulations govern this Contract, and any provision violation of the foregoing shall be deemed null, void and of no effect. Where conflict between Code of Federal Regulations and State Laws and Regulations exist, the more stringent requirement shall apply.

Pursuant to M.G.L.c.62C, s49A the undersigned certifies under the penalties of perjury that the Bidder, to the Bidder's best knowledge and belief, has filed all state tax returns and paid all State Taxes required under law.

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The undersigned bidder hereby certifies he/she will comply with the specific affirmative action steps contained in the EEO/AA provisions of this Contract, including compliance with the Disadvantaged Business Enterprise provisions as required under these contract provisions. The contractor receiving the award of the contract shall incorporate the EEO/AA provisions of this contract into all subcontracts and purchase orders so that such provisions will be binding upon each subcontractor or vendor.

The undersigned further certifies under penalty of perjury that the said undersigned is not presently debarred from doing public construction work in the Commonwealth under the provisions of Section Twenty-Nine F of Chapter Twenty-Nine, or any other applicable debarment provisions of any other Chapter of the General Laws or any rule or regulation promulgated thereunder; and is not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency.

Bidders must fully comply with Subpart C of 2 CFR Part 180 and 2 CFR Part 1532, entitled responsibilities of Participants Regarding transactions (Doing Business with Other Persons). Contractors, subcontractors, or suppliers that appear on the Excluded Parties List System at [www.usgovxml.com/dataservice.aspx?ds=EPLS](http://www.usgovxml.com/dataservice.aspx?ds=EPLS) are not eligible for award of any contracts funded by the Massachusetts State Revolving Fund. This project is funded by the Water Infrastructure Finance and Innovation Act (WIFIA), and potential bidder's attention should be drawn to the associated WIFIA requirements contained in the bidding documents.

The undersigned bidder agrees that the undersigned will fully comply with Subpart C of 2 CFR Part 180 and 2 CFR Part 1532, entitled Responsibilities of Participants Regarding Transactions (Doing Business with Other Persons). The undersigned shall not award any subcontracts or purchase any materials from suppliers that appear on the Excluded Parties List System. The undersigned shall include this requirement in each subcontract and require it to be included in all subcontracts regardless of tier. The undersigned shall maintain reasonable records to demonstrate compliance with these requirements.

Respectfully submitted,

Date: \_\_\_\_\_ Name of General Bidder: \_\_\_\_\_

Federal Employer Identification Number : \_\_\_\_\_

By (signature) : \_\_\_\_\_

Title and Name of Person Signing the Bid : \_\_\_\_\_

Business Address : \_\_\_\_\_

City, State, and Zip Code : \_\_\_\_\_

**CERTIFICATE OF AUTHORITY**

At a duly authorized meeting of the Board of Directors of the \_\_\_\_\_  
(name of corporation)

held on \_\_\_\_\_ Directors were present or waived notice, it was voted that \_\_\_\_\_  
(date)

\_\_\_\_\_ of this company be and hereby is authorized to execute contracts and bonds  
(name and title)

in the name and behalf of said company, and affix its Corporate Seal thereto, and such execution  
of any contract or bond of obligation in this company's name on its behalf of such \_\_\_\_\_  
(OFFICER)  
under seal of the company shall be valid and binding upon this company.

A TRUE COPY,

ATTEST: \_\_\_\_\_

Place of Business:

\_\_\_\_\_  
\_\_\_\_\_

I hereby certify that I am the \_\_\_\_\_ of the \_\_\_\_\_  
(Title) (Name of Corporation)

that \_\_\_\_\_ is the duly elected \_\_\_\_\_ of said  
(Name of Officer) (Title)

company, and the above vote has not been amended or rescinded and remains in full force and  
effect as of the date of this contract.

Signature: \_\_\_\_\_

(Corporate Seal)

Name/Title: \_\_\_\_\_

Date: \_\_\_\_\_

COMMONWEALTH OF MASSACHUSETTS, SS. \_\_\_\_\_, 2023

Then personally appeared the above named \_\_\_\_\_ and acknowledged the foregoing instrument to be his/her free act and deed before me.

NOTARY PUBLIC \_\_\_\_\_

My commission expires: \_\_\_\_\_

**THE BIDDER SHALL STATE THE NAMES OF ALL SUBCONTRACTORS THAT HE/SHE PROPOSES TO USE**

PROPOSED SUBCONTRACTORS

If none, write "none" \_\_\_\_\_.

\*Description of Work \_\_\_\_\_

Proposed Subcontractor  
Name \_\_\_\_\_

Address \_\_\_\_\_

\*Description of Work \_\_\_\_\_

Proposed Subcontractor  
Name \_\_\_\_\_

Address \_\_\_\_\_

\*Description of Work \_\_\_\_\_

Proposed Subcontractor  
Name \_\_\_\_\_

Address \_\_\_\_\_

\*Description of Work \_\_\_\_\_

Proposed Subcontractor  
Name \_\_\_\_\_

Address \_\_\_\_\_

\*Insert description of work and subcontractors' names as may be required.

This is to certify that the names of the above-mentioned subcontractors are submitted with full knowledge and consent of the respective parties. The Bidder warrants that none of the proposed subcontractors have any conflict of interest as respects this Contract.

Bidder \_\_\_\_\_  
(Name)

By \_\_\_\_\_  
(Signature and Title)



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**Attachment 2 to Addendum No. 3**

**Specification Section 02610 CFRP Repair**

## SECTION 02610

### CFRP TECHNICAL SPECIFICATION

#### PART 1 - GENERAL

##### 1.1 SUMMARY

- A. This Section covers the supply and installation of carbon fiber reinforced polymer (CFRP) and glass fiber reinforced polymer (GFRP) laminate repairs for the rehabilitation of select portions of the SWSC 42” diameter PCCP Raw Water line.
- B. This Section is applicable to the designated sections noted herein and on the Contract Drawings that contain existing 42-inch PCCP pipe “sticks” that will be rehabilitated using CFRP or GFRP laminates as defined herein.

##### 1.2 DEFINITIONS

- A. CFRP shall include either carbon fiber or glass reinforced polymer systems as defined in AWWA C305 in a prestressed concrete cylinder pipe (PCCP). When used with glass fiber reinforcing schema only, the repairs shall be designated as GFRP. When the term CFRP is used herein, it is understood that all technical and Contractual requirements apply to GFRP repairs as well. The use of CFRP shall be limited to wet lay-up application of CRFP and does not apply to pre-cured laminates adhered to the pipe wall, dry layup applications, nor robotic CFRP applications.
- B. Terms pertaining to CFRP shall be as defined in ASTM D883, Standard Terminology for Plastics; ASTM D3878 Standard Terminology for Composite Materials; ASTM D907 Standard Terminology of Adhesives, and the Standard Definitions noted herein and in AWWA C305. When definitions are in conflict, definitions noted in ASTM D3878 shall have precedence.
- C. Acceptance Test – A test or a series of tests conducted under actual or simulated field conditions to determine whether a material system or component conforms to specified requirements in a construction or procurement document.
- D. Type Tests – Tests carried out under controlled laboratory conditions to demonstrate representative short or long-term structural properties of a product or one of its components.
- E. Demonstration Test – A Type or Acceptance Test carried out to demonstrate cause and effect by specified methods; used to establish the relationship between a specific set of procedures to prepare and apply a product and a desired outcome in terms of achieving target mechanical or other properties. For example,

building a test panel to illustrate what combination of surface preparation and application technique/procedures are required to achieve target adhesion values.

- F. Material Resistance Adjustment Factor – Factors that define the expected end use condition in terms of the values obtained in Type Testing either due to the difference between controlled laboratory and actual or simulated field conditions or due to long term applied load effects where direct testing is not available.
- G. Maximum Allowable Pressure (MAP) – The maximum combination of internal pressures that a pipe or lining system is anticipated to be exposed to including sustained, occasional surge and/or test pressure.
- H. Maximum Allowable Operating Pressure (MAOP) – The maximum anticipated sustained internal operating pressure that a pipe system or liner is anticipated to be exposed to.
- I. Occasional Surge (emergency or transient) Pressure – Short-term internal pressure events usually caused by emergency operations of the pipe network system (e.g., a rapid valve closure) or malfunction (e.g., power failure, component failure, etc.).
- J. Recurring (cyclic) Surge Pressure – Internal surge pressures that occur frequently and are inherent to the design and operation of the pipe network system (such as normal pump start-up or shutdown and normal valve opening or closure). Recurring surge pressure may occur millions of times in a piping system’s lifetime.
- K. External Load –External loads due to earth pressure, static or fluctuating groundwater levels, or other non-dynamic loading sources.
- L. Live Load – Dynamic loads due to vehicles, railways, or airplanes.
- M. Loads Due to Thermal Effects – Load induced shear effects due to thermal expansion and contraction of the pipe lining system or bonded liner materials.

### 1.3 REFERENCE STANDARDS

- A. The following reference standards may be applicable to this specification:
  - 1. AWWA C305 CFRP RENEWAL AND STRENGTHENING OF PRESTRESSED CONCRETE CYLINDER PIPE (PCCP)
  - 2. AWWA Manual M11 – Steel Pipe
  - 3. ASTM D638 - Standard Test Methods for Tensile Properties of Plastics

4. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
  5. ASTM D3039 – Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials
  6. ASTM D3567 – Standard Practice for Determining Dimensions of “Fiberglass” (Glass-Fiber- Reinforced Thermosetting Resin) Pipe and Fittings
  7. ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
  8. NSF/ANSI Standard 61: Drinking Water System Components – Health Effects
  9. AWWA Committee Report “Structural Classifications of Pressure Pipe Linings – Suggested Protocol for Product Classification”
- B. All reference standards shall be inferred to be the latest revision of the specific reference standard unless a specific year is specified.

#### 1.4 DESCRIPTION

##### A. Pre-work Pipe Inspections

1. The CFRP Installer shall enter the pipe and shall positively mark each pipe requiring rehabilitation. Provide access to the Engineer to facilitate inspection and provide records of pre-work inspections.
2. The CFRP Installer shall examine the existing conditions to assess quality of substrate, document any damaged condition, ovality, or surface irregularities in the pipe, and identify any leaks near repair areas. The CFRP Installer shall be responsible to provide a substrate that is sound, visibly dry, and free of moisture.
3. The CFRP Installer shall correct all unsatisfactory conditions and obtain the Engineer’s approval prior to commencement of repairs.

##### B. Cleaning of PCCP Pipes Prior to Repairs

1. This Specification covers the cleaning of the pipelines to be rehabilitated under this Contract by CFRP methods.
2. As CFRP products require bond, cleaning of the host pipe requires surface preparation to assure long term bond to concrete and steel surfaces as noted herein and in AWWA C305.

C. CFRP Laminate Repairs

1. This specification covers the supply and installation of CFRP for repair of select areas. The use of CFRP shall be limited to wet lay-up application of CRFP and does not apply to pre-cured laminates adhered to the pipe wall, dry layup applications, nor robotic CFRP applications.

1.5 QUALIFICATIONS

A. CFRP Laminate Repairs

1. The CFRP INSTALLER must be certified by the MANUFACTURER and have completed a minimum of ten (10) independent installations of CFRP involving internal pipe rehabilitation projects in the past five years. For a project to be considered applicable, it must involve the following: internal application of CFRP on pipelines greater than 30 inch diameter, with pressures greater than 30 psi operating pressure, where the same CFRP system proposed for use on this project has been used as a stand-alone upgrade of the pipeline without reliance on the host pipe for structural integrity. The minimum project length shall be a single pipe stick of repair. Provide a list of project references meeting above requirement - with OWNER'S contact information for each project in accordance with Section 01300 Submittals after bid award.
2. The CFRP System MANUFACTURER shall specialize in the supply of the products specified with documented experience and written verification that the CFRP INSTALLER personnel are trained and certified in the use of the proposed CFRP system.
3. Certification that the foreman, head supervisor, and designated carbon fiber installation technicians who will perform the work for the OWNER have a minimum of 3 years of experience in man-entry pipe repair projects using CFRP, with a minimum of 5 internal pipe repair projects using CFRP per worker. A list of names, titles and projects shall be provided in accordance with Section 01300 Submittals after bid award.
4. CFRP INSTALLER workforce is to self-perform the CFRP installation and all associated work tasks as outlined in Division 1 General Requirements of the specification.
5. CFRP INSTALLER is to provide documentation confirming that they will provide ancillary equipment for the project including surface preparation equipment, ventilation, environmental controls units and generators. Include information on the equipment models for each typically utilized. Provide as a submittal in accordance with Section 01300 after bid award.

6. CFRP INSTALLER shall provide a letter from their surety company confirming that they can furnish a five-year warranty as described in section 3.09 of this specification. Provide as a submittal in accordance with Section 01300 Submittal after bid award.
7. CFRP INSTALLER shall provide, prior to formal award of the contract, a list of any projects where the installed CFRP system failed, did not perform as intended (leak, rupture, CFRP disbonded/had to be removed during or after installation, etc.), or where work was halted or abandoned prior to completion of the originally contracted scope of work. Provide owner contact information for any of the above referenced projects. If no projects occurred which meet these criteria, a letter stating such shall be provided. Failure to disclose or misrepresentation of this information shall be grounds for disqualification.
8. Safety: CFRP INSTALLER shall submit notarized documentation of the following in the name of the legal entity bidding, for the prequalified CFRP INSTALLER in accordance with Section 01300 Submittals after bid award:
  - a. Experience Modification Rates (EMR) for worker's compensation insurance for the last three (3) years with no year indicating an EMR above 1.5. A letter from company's surety must also be provided verifying this information and it must match the legal entity bidding the project.
  - b. OSHA TRIR for the last three (3) years with no year indicating a TRIR above 2.0 for the same legal entity bidding the project.

#### 1.6 QUALITY ASSURANCE

- A. The successful implementation of CFRP systems as repair of a steel host pipe is governed by the assurance of quality installation procedures and adherence to the approved specification and drawings. Thus, four components are interwoven to define quality CFRP system installations, and they are design, materials, installation, and quality control.
- B. The CFRP system design shall be completed in accordance with the AWWA C305 Standard by an experienced designer, familiar with both the behavior of steel pipe and the application of CFRP systems for pipeline repair and rehabilitation.
- C. The CFRP system materials shall meet the requirements as set forth in Sec. 3 of AWWA C305. Assurance that CFRP system materials will meet the design life expectancy is driven by the ability to provide material testing that justifies the service life desired in accordance with Sec. 3.3 of AWWA C305.

- D. Appropriate quality control measures shall be taken throughout the installation phase as detailed in this Section and in Section 4 of AWWA C305. This includes installation procedures (Sec. 4.4), effective testing (Sec. 4.5), and inspection (4.7). Testing, including material strength tests and bonding to the substrate tests, are detailed in Sec. 3.3 and Sec. 3.7.3. The CFRP system inspection requirements, as described in 4.7, place a high degree of responsibility for quality installation on the inspectors and best practices. In order to ensure that the inspection is performed by a qualified inspector who can verify that a quality installation takes place, the inspectors shall meet the requirements of Sec. 4.7 of AWWA C305.

## 1.7 SUBMITTALS

### A. CFRP Submittals

#### 1. CFRP Material Data – Prior to Design

- a. The Manufacturer shall provide the Engineer with product data sheets indicating physical, mechanical, and chemical characteristics of all materials used in the CFRP system. As a minimum, the Engineer shall be provided with the mechanical properties of the CFRP laminate, durability of the CFRP laminate based on the environmental conditions, and the physical properties of the resin.
- b. The test reports shall clearly indicate the commercial names of the products used, batch ID, sample dimensions, number of samples tested, number of fabric layers used, load and strain measurement techniques, failure modes, and obtained strength, modulus, and ultimate elongation for each sample tested.
- c. The Manufacturer shall provide documents indicating that all materials comply with the requirements of NSF 61 and NSF 61 Annex G. A printout from the NSF website, dated within one week of the due date, shall be submitted.
- d. The Manufacturer shall provide documents indicating that all materials meet OSHA, EPA, and local ordinances for health and safety including VOC compliance.
- e. Testing report demonstrating water tightness of the proposed CFRP system a minimum of twice the maximum design pressure of the pipeline. The testing report shall demonstrate that the proposed layup for the CFRP system does not leak when subject to twice the maximum design pressure of the pipeline.



- f. Written verification from the MANUFACTURER regarding acceptable cure temperatures and time as well as allowable time window between installation of different layers.
- 2. By the CFRP MANUFACTURER and CFRP INSTALLER – Prior to Construction
  - a. Document indicating agreement of the CFRP system manufacturer to have at least one field QA/QC personnel throughout the project execution.
  - b. Manufacturer's Material Safety Data Sheets (MSDS) for all materials to be used.
  - c. Application instructions, delivery, storage and handling instructions, and general recommendations regarding each material to be used.
  - d. General Confined Space Entry procedure. Upon award of assignment CFRP INSTALLER shall submit confined entry procedure specific to job.
  - e. CFRP INSTALLER shall submit a Job Hazard Analysis specific to job.
- 3. Working Drawings, Calculations and Methods Statements:
  - a. Working Drawings Shall Provide the Following:
    - (i) Type of Carbon Reinforcement Fabric Composite System.
    - (ii) Product Name of Reinforcing Fabric(s).
    - (iii) Product Name of Saturating Epoxy, the Primer Epoxy, and the Topcoat Epoxy.
    - (iv) Weight of fabric, number of layers and orientation.
    - (v) Minimum overlap circumferentially and longitudinally.
    - (vi) Repair procedures and details for damaged fabric layers.
    - (vii) Detail of proposed method of terminating carbon fiber-reinforced composite to provide a watertight seal that prevents any water from penetrating between the carbon fiber-reinforced composite layers and the end terminations of the existing pipe. At a minimum, stainless steel expansion

rings shall be included at each end termination for the CFRP system.

4. Working Calculations Shall Provide the Following:
  - a. Type of Carbon Reinforcement Fabric Composite System.
  - b. Product Name of Reinforcing Fabric(s).
  - c. Product Name of Saturating Epoxy.
  - d. The composite material properties used in the design calculations. The properties used shall be equal to or more conservative than the properties listed on the product data sheets for the materials used.
  - e. The design requirements utilized in the design calculations shall be equal to or greater than the design requirements provided by Engineer and shall incorporate details provided in Section 2.01 of this specification.
  - f. Calculations associated with each of the design limit states outlined in Section 2.1 of this specification.
  - g. Submit the design calculations in accordance with the specified requirements herein and sealed and signed by a Registered Professional Engineer licensed to practice in the Commonwealth of Massachusetts.
5. MANUFACTURER'S written installation procedures, maintenance instructions, and general recommendations regarding the overall system and each material to be used including:
  - a. Method for preparing surfaces to accept CFRP.
  - b. Method, equipment, and procedures to be used to apply CFRP.
  - c. Method and drawings detailing transition of new CFRP lining to existing pipe.
6. Implementation Plan
  - a. Submit an Implementation Plan describing the inspection of the installation. The submittal shall include the following:
    - (i) Names of key personnel (foreman, head supervisor and top three carbon fiber installation technicians) scheduled to perform the work. Documentation that all workers who plan to work on the pipeline have received annual first aid

training, confined space training and MANUFACTURER provided certified applicator training shall also be provided.

- (ii) Name of personnel responsible for quality assurance.
  - (iii) Testing program for CFRP system.
  - (iv) Surface evaluation procedure.
  - (v) Material testing of CFRP.
  - (vi) Method for ensuring that the adhesion of CFRP epoxy will conform to specified and indicated requirements.
  - (vii) Methods for repairing defective linings.
  - (viii) Contingency plan to meet specified requirements in the event of an interruption to the CFRP placement.
7. CFRP INSTALLER shall prepare and submit a detailed schedule describing the work to be accomplished prior to the start of the shutdown and work to be accomplished during each shift during the shutdown. Detail daily activities and manpower used at each site. If Engineer deems any schedule to be inadequate to secure the completion of work in the time submittal, correct and re-submit schedules to change the order of prosecution of work to ensure proper and timely execution.
8. Record Submittals
- a. Submit Quality Control Records, and Acceptance Test records in a report within 30 days of completion of each liner installation.
- B. Shop Drawings
- 1. Submit shop drawings for all CFRP Sections including termination details

## PART 2 PRODUCTS

### 2.1 CFRP DESIGN

#### A. Design Objectives

- 1. Class IV CFRP Liner: The CFRP Liner shall meet Class IV requirements for the stated design conditions in accordance with AWWA's Structural Classifications of Pressure Pipe Linings, Suggested Protocol for Product Classification. The design requirements of the liner system shall:
  - a. Provide an internal corrosion barrier for the host pipe.

- b. Have the ability to span holes, gaps, and defects in the host pipe.
- c. Have inherent ring stiffness such they do not collapse or appreciably change shape when dewatered.
- d. Have a long-term independent pressure rating greater than the specified MAOP for the system.
- e. Meet system identified constraints for Occasional and Recurrent Surge Pressures.
- f. Be able to survive a burst failure of the host pipe.
- g. Maximize the structural enhancement of the composite liner-host pipe by providing a close-fit with the host pipe.
- h. Eliminate leakage in the host pipe by providing a liner with adequate hydrostatic integrity and a liner system design that prevents migration of water between the liner and the host pipe emanating from reinstated service connections.
- i. Have a means of long-term restraint in the axial direction to preclude differential movement between the host pipe and the liner.
- j. Maximize hydraulic efficiency by providing a smooth flow channel and minimal reduction of bore in the rehabilitated system.
- k. Select a Class IV liner product and plan approach to rehabilitation toward maximizing the achievement of these design objectives.

B. Limit States Design Approach

- 1. The CFRP system shall be designed in accordance with AWWA C305 for each of the following potential limit states:
  - a. Rupture of CFRP laminate in the circumferential direction due to internal pressure.
  - b. Rupture of CFRP laminate in the circumferential direction due to bending of empty pipe.
  - c. Rupture of CFRP laminate in the circumferential direction due to combined pressure and bending due to gravity loads.
  - d. Buckling of the CFRP laminate in the circumferential direction due to external loads and pressures and internal negative pressure.

- e. Rupture of the CFRP laminate in the longitudinal direction due to pressure induced thrust, Poisson's effect of internal pressure, and temperature change.
- f. Interlaminar shear failure of CFRP at pipe ends.
- g. Buckling of the CFRP laminate in the longitudinal direction due to temperature change.

## C. Design Requirements

### 1. Project Specific Requirements:

- a. Design CFRP as detailed in AWWA C305, with the following minimum design assumptions applied:

#### (i) Circumferential Design Loads:

- Internal working pressure,  $P_w = 150$  psi
- Internal transient pressure (in excess of  $P_w$ ),  $P_t = 60$  psi
- Internal vacuum pressure,  $P_v = -14.7$  psi (full vacuum)
- Soil cover height,  $H = 4.5$  ft minimum per drawings,
- Height of groundwater,  $H_w =$  at ground surface
- Live load = HS-20 design truck
- Constrained soil modulus,  $M_s = 1,000$  psi
- Installation Temperature: 70°F
- Normal Operating Temperature: 40 - 90°F
- Load and resistance factors in accordance with AWWA C305.

#### (ii) Longitudinal Design Loads

- Internal pressure only (pressure-induced thrust force and Poisson's effect);
- Temperature difference,  $\Delta T$  (for empty pipe cooling or warming up, not less than  $\pm 40$ F°);
- Combined internal pressure and temperature.

#### (iii) End Termination

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- CFRP shall be terminated with end details that prevent water from getting behind the CFRP liner, including the use of steel expansion rings per Part 2.5.B. The end detail shall include a minimum of one layer of GFRP between the expansion ring and CFRP layers.

D. Existing System Design Conditions

1. Refer to the contract drawings for the location of the four pipes to be lined with CFRP. The four pipes are: 6-22, 9-15, 9-17 and 9-18.
2. Pipe 6-22 is a LCP150 and pipes 9-15, 9-17 and 9-18 are all ECP225.
3. None of the four pipes are reported to have any prestressing wire breaks based on recent electromagnetic inspection results. All four pipes exhibit longitudinal hairline cracks.
4. Refer to the Laying Schedules and Pipe Manufacturing Specifications included in the project specifications.
5. The CFRP liner shall be designed as a stand-alone buried flexible pipe (i.e., CFRP carrying 100% of the internal and external loads acting on the pipe).

E. Site Specific Design Requirements

1. Refer to Drawings and Contract documents for designated repair and pipe access locations.

## 2.2 CFRP SYSTEM

A. The CFRP system shall consist of epoxy primer, thickened epoxy (i.e., putty), unidirectional carbon fabric, impregnating epoxy resin, and topcoat. Other resin types (e.g., polyester, vinyl ester) shall not be used as any of these components.

B. Primer

1. The PCCP pipe substrate shall be primed with an epoxy material, which shall penetrate the pore structure of the substrate. The primer shall be 100% solids, low viscosity epoxy resin.
2. The primer shall have following minimum properties obtained according to ASTM D638 at 72°F and 40% relative humidity:
3. Tensile strength: 2,500 psi, minimum
4. Tensile modulus: 105 ksi, minimum

C. Thickened Epoxy

1. Thickened epoxy shall have a high enough viscosity to fill all voids in the PCCP substrate and provide a smooth base for the subsequent CFRP laminates.
  2. Thickened epoxy shall either be pre-formulated and brought to site in pre-proportioned containers or prepared on site by mixing the impregnating resin with Cab-O-Sil TS-720, or approved equal, treated fumed silica to achieve the required viscosity.
- D. Impregnating Resin
1. All fabrics shall be impregnated with 100% solids, low viscosity epoxy resin.
  2. The CFRP repair design shall use a two-component epoxy with the following mechanical properties obtained according to ASTM D638 at 72°F and 40% relative humidity and reported by the Manufacturer:
    - a. Maximum water absorption when tested in accordance with ASTM D570 (24 hours): 2 percent
    - b. Minimum compressive yield strength of 10,000 psi when tested in accordance with ASTM D695 (75F, 7-day cure)
    - c. Minimum tensile strength with an elongation of greater than 2 percent when tested in accordance with ASTM D638 (14-day cure): 6,000 psi
    - d. Tensile modulus: 300 ksi
    - e. Minimum flexural strength when tested in accordance with ASTM D790 (14-day cure): 7,500 psi
- E. Carbon Fiber-Epoxy Laminates
1. The CFRP rehabilitation design shall use carbon fiber composite laminates with the following mechanical and physical properties:
    - a. The tensile properties of the CFRP lamina shall be determined according to ASTM D3039 and statistically analyzed according to ASTM D7290 to determine the characteristic values.
    - b. Minimum tensile modulus of elasticity (ASTM D7290): 9,000 ksi
    - c. Minimum laminate thickness: 0.07 inch
    - d. Maximum laminate thickness: 0.10 inch
    - e. Minimum tensile strength (ASTM D7290): 100 ksi;

- f. Minimum flexural modulus of 350,000 psi
- g. Minimum flexural strength of 14,000 psi
- h. Minimum strain at CFRP rupture, when tested in accordance with ASTM D3039: 0.85 percent (obtained as the ratio of characteristic tensile strength and Weibull mean of the modulus)

## 2.3 STAND-ALONE GFRP DESIGN CRITERIA

### A. Design Objectives

1. Non-structural Class I Liner: The GFRP Liner shall meet Class I requirements for the stated design conditions in accordance with AWWA's Structural Classifications of Pressure Pipe Linings, Suggested Protocol for Product Classification. The design requirements of the liner system shall:
  - a. Protect the host pipe from internal erosion-corrosion and to resist any deleterious reaction with the fluid being conveyed for the stipulated design life.
2. Design Approach
  - a. The minimum number of GFRP layers and overall thickness required shall ensure that the lining has sufficient adhesion strength to resist negative pressures (vacuum), thermal stresses and shear stresses where relevant, and provide resistance to erosion-corrosion for the stipulated design life.
3. Design Requirements
  - a. Refer to the applicable portions of Section 2.1 C relating to the design of a non-structural Class I liner.
  - b. Design GFRP in conjunction with the host pipe with the following minimum design assumptions applied:
    - (i) Circumferential Design Loads:
      - Internal working pressure,  $P_w = 150$  psi
      - Internal transient pressure (in excess of  $P_w$ ),  $P_t = 60$  psi
      - Internal vacuum pressure,  $P_v = -14.7$  psi (full vacuum)
      - Installation Temperature: 70°F
      - Normal Operating Temperature: 40 - 90°F



(ii) Longitudinal Design Loads

- Internal pressure only (pressure-induced thrust force and Poisson's effect);
- Temperature difference,  $\Delta T$  (for empty pipe cooling or warming up, not less than  $\pm 40F^\circ$ );
- Combined internal pressure and temperature.

(iii) End Termination

- GFRP shall be terminated with end details that prevent water from getting behind the GFRP liner, including the use of steel expansion rings per Part 2.5.B.

4. Site Specific Design Requirements

- a. Refer to Drawings and Contract documents for designated repair and pipe access locations.

2.4 GFRP COMPOSITE SYSTEM

- A. A glass fiber reinforced polymer (GFRP) composite system shall be used as insulator between any steel components and CFRP to avoid possible galvanic corrosion and also shall be used as a watertightness layer.
- B. The GFRP composite system shall be a designed system consisting of all associated fiber reinforcement and polymer adhesives/resins. All components of the GFRP composite system shall be provided by the same Manufacturer of CFRP system. The GFRP composite laminates shall have the following mechanical and physical properties:
1. Minimum tensile modulus of elasticity: 2,000 ksi
  2. Minimum laminate thickness: 0.01 inch
  3. Maximum laminate thickness: 0.10 inch
  4. Minimum tensile strength: 30 ksi
  5. Minimum strain at GFRP rupture (ASTM D3039): 1.0 percent

2.5 PROTECTIVE COATINGS

- A. Topcoat

1. The CFRP system shall be top-coated with a coating recommended by the CFRP system Manufacturer and in conformance with the following:
  - a. The topcoat shall consist of the same thickened epoxy used between the CFRP layers or potable water coating, if needed.
  - b. Seams in fabric and edges shall be smoothed with thickened epoxy prior to application of the topcoat.
  - c. The topcoat material shall have been used successfully as a finished assembly on a minimum of five past documented pipe strengthening projects.
2. Topcoat shall be installed in accordance with the Manufacturer's published installation instructions. The duration elapsed between the application of the last CFRP layer and the topcoat shall not exceed the time specified by the Manufacturer.

## 2.6 OTHER MATERIALS

### A. Epoxy Mortar

1. Epoxy mortar shall consist of one-part mixed epoxy combined with five parts sand or equivalent demonstrated to have the ability to bond to concrete, steel, and CFRP in overhead and all other positions.

### B. Steel Expansion Ring

1. Internal Joint Seal stainless steel expansion ring (Weko Seal or equal) with a 1/4 in. rubber strip expanded against pipe wall to achieve minimum 100 psi interface pressure. All expansion rings, wedges, and shims shall conform to the grade recommended by the Manufacturer for the expected exposure condition and to ASTM A240.

## 2.7 DELIVERY, STORAGE AND HANDLING

### A. Delivery

1. The products shall be delivered in original, unopened containers. Containers shall be clearly marked with legible and intact labels listing the Manufacturer's name, brand name, product identification, batch number, storage conditions, mixing ratios, and shelf-life.

### B. Storage

1. Storage of all materials and equipment on site shall be in areas and using designated access locations.

2. Store materials in areas where temperatures conform to Manufacturer's written recommendations and instructions.
  3. Stored fiber reinforcement and resins shall be protected from dust, moisture, and chemical exposure.
  4. Resin components shall be stored separately and in tightly closed containers, away from direct sunlight, flame sources, or other hazards.
  5. Fiber reinforcement and resins shall not be exposed to freezing temperatures during transport, storage, preparation, installation or curing.
- C. Handling
1. The fabric reinforcement shall not be handled roughly. Care shall be taken not to damage the fibers.
  2. Fabric reinforcement may be stored either in rolls of 4 in. radius or greater or stacked after cutting.
  3. Consult the Manufacturer's MSDS for specific handling hazards of resin components.

## PART 3 EXECUTION

### 3.1 GENERAL PROCEDURES

- A. Work only in areas permitted by the Engineer.
- B. CFRP INSTALLER shall request approval to work outside of the standard work hours, if necessary, as outlined in Section 01046.
- C. Remove all tools, buckets, and materials from work areas and store neatly at a central location daily at the end of work. Clean work areas shall be maintained during construction activities.
- D. Protect adjacent areas from damage, stains, and spillage during delivery of material to repair areas. Repair any damage that occur as a result of this Work to pre-construction condition or an approved betterment at no cost to the Engineer.
- E. Protect the work from damage such as impact, marring of the surfaces, and other damage.
- F. Materials may be skin irritants or sensitizers. Accordingly, advise CFRP INSTALLER to avoid contact with eyes and skin, inhalation of vapors, and ingestion. Use protective and safety equipment on site. Heed all label warnings by manufacturers. Make application in accordance with applicable safety laws.

- G. Compliance with OSHA and other safety laws and regulations is the exclusive responsibility of the CFRP INSTALLER, his suppliers, consultants, and workers.
- H. Prevent hazardous accumulations of dusts, fumes, mists, vapors, or gases in areas occupied during construction. Provide local exhaust ventilation to prevent harmful dispersal of hazardous substances into atmosphere of occupied areas. Dispose in manner that will not result in harmful exposure to persons. Ventilate storage spaces containing hazardous or volatile materials. Provide dust and fume control, including, but not limited to, temporary protection and confinement barriers, ventilation equipment and procedures, and air-quality-monitoring equipment and procedures. Monitor air quality in the work area, and inside the pipeline. Comply with the requirements of all local governing regulatory agencies.
- I. Ventilation inside the pipeline shall be per all OSHA requirements, including but not limited to OSHA confined space entry and underground construction requirements.

### 3.2 PREPARATION

#### A. Environmental Conditions

1. Do not install CFRP when the ambient temperature is outside the range required by the Manufacturer, the relative humidity is outside the range required by the Manufacturer, and the pipe surface temperature is less than 5°F above the dewpoint. In cold conditions, auxiliary heat may be applied to raise the ambient temperature to a suitable level. If heating is used, direct-fired gas or kerosene “salamander” type heaters shall not be permitted. Only electric or indirect-fired heaters shall be permitted, to avoid contaminating the substrate with carbonation.
2. The presence of water inhibits the adhesion of epoxy to the substrate and may contribute to the formation of amine blush. Do not install CFRP when surface moisture is present. Use dehumidifiers to keep the relative humidity within the range required by the Manufacturer. There shall be no standing water in the pipe.
3. If water leakage exists through cracks or joints, water flow shall be stopped by the CFRP INSTALLER.

#### B. Site Conditions

1. The CFRP INSTALLER shall employ a confined space entry procedure which will require an entry permit according to OSHA regulations.

2. Maintain control of dust, and debris due to mortar lining repair or surface preparation in each area of work. Clean up and remove such material at the

### 3.3 INSTALLATION

#### A. Substrate Repair

1. All problems associated with the condition of the original substrate that can compromise the integrity of the CFRP system shall be addressed before surface preparation begins. The Manufacturer shall be consulted on the compatibility of the CFRP system with materials used for repairing the substrate.
2. Voids in the substrate shall be filled. Small voids no more than 0.50 in. in depth shall be filled with a thickened epoxy and larger voids with epoxy mortar.

#### B. Surface Preparation

1. All surfaces to receive CFRP shall be prepared. For the inner core concrete of PCCP, the concrete substrate shall be profiled using abrasive blasting to remove all contaminants (laitance, surface lubricants, broken mortar pieces, etc.) and to achieve a minimum profile of ICRI CSP 3 (refer to ICRI Guideline No. 03732).
2. For the end termination area, the steel cylinder shall be exposed, and the steel substrate shall be abrasively blasted to achieve SSPC SP-10 near white metal surface prior to installing the CFRP system.
3. Any holes or leaks in the pipelines shall be addressed as needed prior to application of the CFRP lining system.
4. The surfaces to which the CFRP system is to be applied shall be freshly exposed, free of loose or unsound materials, and shall be allowed to dry prior to CFRP installation.
5. Localized out-of-plane variations, such as form lines, sharp edges, and protrusions, shall not exceed ¼ in. Such out-of-plane variations can be removed by grinding, abrasive-blasting, or can be smoothed over using thickened epoxy if variations are very small.
6. All debris and dust generated during surface preparation shall be removed by air blasting or other approved means to achieve a dust free concrete surface.

#### C. Mixing of Resins

1. The resin and its catalyst shall be kept in tightly closed containers at all times except for the time of mixing to prevent absorption of carbon dioxide and moisture which could lead to amine blush. The mixing technique shall not cause air entrainment in the resin system.
2. All resins shall be mixed according to the Manufacturer's instructions. All resin components shall be at a proper temperature and mixed from pre-proportioned and pre-packaged containers until there is a uniform and complete mixing of components. On-site proportioning of resin components is not allowed. Resins shall be mixed for the Manufacturer's prescribed mixing time and visually inspected for uniformity of color.
3. Mixed resin that exceeds the pot life specified by the Manufacturer shall not be used.

D. Application of CFRP System by the Wet Lay-up Technique

1. The application of the CFRP system shall be performed in accordance with the Manufacturer's published installation instructions.
2. The CFRP system primer shall be applied to all areas on the existing pipe surface where the CFRP system is to be placed. The primer shall be placed uniformly on the prepared surface at the Manufacturer's specified rate of coverage. The primer shall be allowed to cure in accordance with the CFRP Manufacturer's installation instructions before applying subsequent materials.
3. Following the primer, all voids in the substrate shall be filled to achieve a smooth surface using thickened epoxy.
4. All fabrics shall be impregnated with epoxy using a mechanical saturation machine. Manual impregnation of fabrics is not allowed. Pre-cured laminates or the dry lay-up method are not permitted.
5. The impregnated fabric shall be pressed onto the substrate to achieve intimate contact. Entrapped air between layers shall be released or rolled out before the resin sets.
6. A thin layer of thickened epoxy shall be applied between all consecutive CFRP layers, over the entire surface.

E. Project Sequencing

1. All components of the lining system, including the primer, thickened epoxy, CFRP and GFRP layers, and topcoat, shall be applied within the allowable time windows recommended by the Manufacturer. If a project delay causes violation of the recommended allowable time windows, the previously

applied layer shall be scuff-sanded, all dust shall be removed by compressed air and/or vacuum, and the surface shall be wiped clean with a manufacturer-recommended material before resuming work with application of the subsequent materials and layers.

F. Preparation of Test Samples and Areas

1. The standard of workmanship shall be measured prior to construction through pull-off (bond) testing on representative mock-up areas, and after construction through tension tests performed on samples cut from witness panels.
  - a. Representative Mock-Ups for Pull-off (Bond) Testing Prior to Construction
    - (i) The CFRP INSTALLER shall install two layers of CFRP (oriented 0 and 90 degrees) in at least 2 ft by 2 ft areas in at least one representative location on a pipe adjacent to the repair scope to be used as mock-ups of the installed CFRP system.
    - (ii) The CFRP INSTALLER shall perform at least three pull-off tests in the presence of the Engineer in each mock-up area according to ASTM D4541 and using testers with documented calibration. The CFRP INSTALLER shall take precautions to ensure proper alignment and shimming of the test fixture to prevent non-perpendicular forces on the test specimen which can produce low bond strength results.
    - (iii) The Engineer shall evaluate the results as follows:
      - Failure within CFRP or at the CFRP- inner concrete interface with pull-off strength greater than 300 psi: Acceptable.
      - Failure at the inner concrete surface with pull-off strength less than 300 psi: Rejected. The CFRP INSTALLER shall improve the surface preparation and prepare and test new mock-up areas.
      - Failure within CFRP with pull-off strength less than 300 psi: Rejected. The CFRP INSTALLER shall improve the quality of construction and prepare and test new mock-up areas.

- (iv) Do not start work until the Engineer (with Owner's approval if necessary) has approved the mock-ups unless the Engineer allows commencement of work prior to testing of mock-ups.

b. Witness Panels for Tension Testing after Construction

- (i) The CFRP INSTALLER shall prepare at least two panels per work shift where CFRP installation is taking place made of one layer of CFRP using the same material and techniques used in the actual field installation.
- (ii) Place a plastic sheet on a smooth flat horizontal surface (a plastic plate on plywood). Cover the plastic plate with a thin plastic film as release agent. The fabric shall be epoxy coated on the plastic surface using the same amount of epoxy per unit area as would be applied in the actual installation. The samples shall be stored on a rigid level surface in the pipeline or in an area representative of the temperature and humidity conditions in the CFRP repair areas during the curing period or the end of the repair work.
- (iii) Label samples with time, date, sample number, fabric lot numbers, resin lot numbers and store in pipe section being repaired. Do not move for a minimum 48 hours after casting.
- (iv) Forward any test panels the Engineer intends to have tested to the Testing Agency/ Laboratory retained by the CFRP Installer. The cost of testing shall be incidental to CFRP installation.
- (v) Testing lab will prepare test specimens (coupons) from one CFRP witness test panel and test in accordance with ASTM D3039 using nominal material thickness. Each test specimen shall be tested for their material properties in the longitudinal (primary fiber) direction.
- (vi) Certified test results shall be provided to the Owner, CFRP INSTALLER and Engineer by the Test Lab within 20 business days of completion of the construction. The testing shall provide values for each specimen as follows:
  - Ultimate Tensile Strength
  - Tensile Modulus and Related Specimen Thickness
  - Percent Elongation



## G. Curing

1. All CFRP areas shall be cured using the curing schedule recommended by the Manufacturer in writing and approved by the Engineer prior to Construction.
2. The CFRP INSTALLER's work schedule shall allow sufficient time between completion of repairs and refilling of the pipeline so that all CFRP completes at least 85% cure before being exposed to water based on the cure temperature versus time relationship provided by the Manufacturer unless adequacy of lesser percent cure is proven by test data. The Engineer shall reject the work schedule if sufficient time for curing is not provided.
3. The Engineer may specify a revised curing schedule during construction, if needed, based on the cure progress reported by the Engineer.
4. Curing shall take place in a dry environment to prevent amine blush. If heating is used, direct-fired gas or kerosene "salamander" type heaters shall not be permitted. Only electric or indirect-fired heaters shall be permitted.
5. Curing at elevated temperatures is strongly encouraged. This not only minimizes the risk of amine blush but reduces the required curing time and increases the glass transition temperature of the epoxy. Satisfactory performance of the curing schedules used shall be proven by the Manufacturer with documentation of previous satisfactory applications or thermal test results indicating the curing behavior of the epoxy.
6. Exhaust fumes from vehicles or equipment shall be kept away from CFRP applied areas during curing.

## H. Installation of Joint Seals

1. A termination detail shall be provided to ensure durable water tightness and prevent water from getting behind the CFRP liner.
2. An epoxy mortar consisting of epoxy resin mixed with silica fume and sand shall be used in the joint region to create a smoothly tapered transition between the inner core substrate and the exposed steel substrate. To assure appropriate bond length, care shall be taken to avoid excess spread of the epoxy mortar onto prepared steel substrate. To prevent galvanic corrosion, a layer of epoxy saturated glass fiber reinforced polymer composite (GFRP) shall be applied in direct contact with the steel substrate prior to installation of the CFRP laminate. All layers of the CFRP liner system shall terminate into the joint region.

3. The CFRP liner applicator shall provide and install appropriately sized single band stainless steel expansion rings with ¼ in thick elastomeric rubber strips at the terminations between the CFRP liner and the host piping system. The stainless-steel expansion rings shall be installed in joints at each end of the CFRP upgrade after the CFRP materials have cured sufficiently to avoid damage during joint ring installation. The jacking pressure for the expansion ring shall be selected to achieve a minimum of 150 psi interface pressure in accordance with manufacturer's recommended procedures.
4. After the stainless-steel expansion rings have been installed, the remaining recess in joint region shall be filled back flush with the internal diameter of the adjacent CFRP lining system using epoxy mortar. The epoxy mortar shall be given sufficient time to cure prior to reinstating water into the pipeline.

#### I. INSPECTION DURING INSTALLATION

1. CFRP INSTALLER shall submit the Quality Assurance Program (QAP) covering the quality assurance measures imposed on the CFRP INSTALLER's work and imposed upon sub-Suppliers or subcontractors.
2. CFRP INSTALLER shall have at least one field QA/QC personnel throughout the project execution.
3. The Engineer may monitor and document all phases of the construction including material preparation, impregnation of all fabrics, application of all CFRP and GFRP layers, end termination details, curing, and the environmental conditions under which materials were stored and applied. Such inspections may be performed during all shifts of work.
4. The Engineer may inspect the fabric impregnation procedure periodically and observe the CFRP INSTALLER perform a "weight test" at random intervals during all shifts of work. A weight test consists of weighing an approximately 1 ft x 1 ft piece of fabric before and after impregnation in the impregnation machine and ensuring that the fabric-to-resin weight ratio is within the range recommended by the Manufacturer. The CFRP INSTALLER shall adjust the impregnation machine, as necessary.
5. The Engineer may witness preparation of all witness panels by the CFRP INSTALLER and monitor the conditions under which they are stored.
6. The CFRP INSTALLER shall specify corrective actions as necessary and reinspect all items to be corrected.
7. The Engineer may report to the Owner the results of all inspections required in this specification with traceable records, notes, measurements, and

photographs. Reported results of bond tests performed on mock-up areas shall indicate the location of test samples, pull-off test equipment used, and failure mode and test result for each sample tested.

J. POST-INSTALLATION INSPECTION AND REPAIR OF DAMAGED OR DEFECTIVE AREAS

1. Inspection for Voids and Delaminations

- a. Inspect each repair pipe after the CFRP liner has become tack free to identify imperfections such as voids, delaminations, wrinkles, and raised fabric edges, and to specify corrective actions to be taken by the CFRP INSTALLER, as necessary. Voids and delaminations shall be identified by dragging a coin or small piece of metal across the CFRP surface and tapping at areas of change in sound, or automated methods approved by the Engineer.
- b. Voids requiring corrective action shall be marked and repaired in accordance with paragraph 3.06.B.
- c. The Engineer shall also inspect all joints filled with epoxy mortar where CFRP is terminated and check for any sagging or hollow-sounding. If needed, the corrective action for hollow-sounding epoxy mortar shall be removal and replacement.

2. Repair of Delaminated Areas of Installed CFRP Reinforcement

- a. Small delaminations less than 2 sq in. each do not require corrective action, as long as the total delaminated area is less than 5% of the total laminate area and there are no more than ten such delaminations per 10 sq ft.
- b. Large delaminations, greater than 25 sq in., shall be repaired by selectively cutting away the affected laminate, abrading the surface and wiping the surface of the remaining layers with materials recommended by the Manufacturer and allowed by the Engineer, allowing the surface to dry, applying a coat of thickened epoxy, and applying an overlapping CFRP patch of equivalent layers and fiber orientations.
- c. Moderate delaminations less than 25 sq in. shall be repaired by filling the delamination by low-pressure injection of the epoxy resin or by the previous procedure specified for large delaminations.
- d. Repair procedures for conditions that are not specifically addressed in this Specification shall be approved by the Engineer.

- e. All areas of corrective actions shall be re-inspected.
- f. All repairs are to be performed at no cost to the Owner.

### 3.4 FIELD TESTING / QUALITY CONTROL

- A. Maintain the Quality Control records of the work and provide to the Engineer's after completion of the work in accordance with AWWA C305 protocol.
- B. Post Construction Design Review for Total Performance
  - 1. The Engineer will perform a post-construction design review to confirm that all completed repairs comply with the stated design life objectives for the Contract
  - 2. The Engineer will advise of any discrepancies between the constructed CFRP and the design requirements.
  - 3. The Contractor shall:
    - a. Perform necessary remedial measures to repair any sections noted as deficient
    - b. Review remedial action with the Engineer prior to implementation.
    - c. Perform further testing, monitoring and calculations and install structural enhancements at own cost.