North Central Texas Public Works Construction Standards Revision Submissions Review

Thank you for taking the time to provide feedback on the Public Works Construction Standards specifications submissions. These submissions were received between June 2024 to January 31, 2026, through various methods, including the newly established Revisions and Comments Form. Each submission is titled by *Submission #,* with the following fields:

- **Form Submission**: The verbatim comment received on the Revisions and Comment Form, or other method of communication.
- **Current Version of the PW Construction Standards**: The current language in the *Fifth Edition PW Construction Standards, Amended August 2023*.
- **Recommended Revision**: Either the recommendation submitted on the Revisions and Comment Form, or NCTCOG staff's revision of the language to reflect the form input.
- **Attachments**: The attachments included on the Revisions and Comments Form to support the revision/recommendation. Any attachments that couldn't be linked are included in the immediate pages following the submission.
- **Reviewer Comments**: To help facilitate a dialogue and review of each submittal at the next Construction Standards Submissions Review meeting, please use this area to record any preliminary comments, questions, or thoughts you may have.

Submission 1: Inclusion of Product Specifications

Form Submission: "*3M EMS Path Marking Tapes are designed to make locating the underground infrastructure much more effective and efficient, saving our cities time and labor, as well as limiting exposure to liability on line strikes. Each of the existing methods of marking and locating have multiple issues each. This locatable caution tape eliminates all of those issues.*"

Current Version of PW Construction Standards:

Division 500 Underground Construction & Appurtenances, Item 502 Appurtenances, Connections to Conduit for Service

502.10.3.2. Services and Bullheads. The details on installation and materials required are shown in applicable Division 4000 Standard Drawings or on the appurtenance sheets attached to the plans.

The end of each water service connection shall be marked with heavy gauge polyethylene tape, 6-inches in width with a thickness of 0.004-inches. The tape should be blue in color on which has been printed "Caution Buried Water Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi lengthwise and 1200-psi crosswise.

Division 500 Underground Construction & Appurtenances, Item 502 Appurtenances, Wastewater Conduit Connections

502.10.4. Wastewater Conduit Connections. This section shall govern for the construction of connections to wastewater conduits. Connections of wastewater pipe to existing wastewater conduits or wastewater appurtenances shall be as shown on the plans or as directed by the Engineer. Details of construction shall be shown on the plans.

The end of each wastewater service connection shall be marked with heavy gauge polyethylene tape, 6-inches in width with a thickness of 0.004-inches unless a cleanout is present. The tape should be green in color on which has been printed "Caution Buried Wastewater Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi lengthwise and 1200-psi crosswise.

Recommended Revisions:

502.10.3.2. Services and Bullheads. The details on installation and materials required are shown in applicable Division 4000 Standard Drawings or on the appurtenance sheets attached to the plans.

The end of each water service connection shall be marked with heavy gauge polyethylene, locatable/traceable tape, 6-inches in width with a thickness of 0.004-inches. The tape should be blue in color on which has been printed "Caution Buried Water Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi lengthwise and 1200-psi crosswise.

502.10.4. Wastewater Conduit Connections. This section shall govern for the construction of connections to wastewater conduits. Connections of wastewater pipe to existing wastewater conduits or wastewater appurtenances shall be as shown on the plans or as directed by the Engineer. Details of construction shall be shown on the plans.

The end of each wastewater service connection shall be marked with heavy gauge polyethylene, locatable/traceable tape, 6-inches in width with a thickness of 0.004-inches unless a cleanout is present. The tape should be green in color on which has been printed "Caution Buried Wastewater Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi lengthwise and 1200-psi crosswise.

Attachments:

- 3M Locating and Marking System Brochure
- 3M EMS Path Marking Warning Tape Letter (attached)
- City of Austin Standard Products List for Tracer Tape
- City of Waxahachie Standard Construction Detail 3M Marker Tape Wastewater (Page S13 only)
- City of Waxahachie Standard Construction Detail 3M Marker Tape Water (Page W26 only)
- Generic RFID EMS Path Marking Tape Specification (attached)
- 3M EMS Warning Tape 7900 Series Data Sheet (attached)

Reviewer Comments for Submission #1

P.O. Box 1360 • Eustis, FL 32727
Phone (352) 589-5888
Fax (352) 589-5525
www.porterassociates.com

3M EMS Path Marking Warning Tape

The Future of Pipeline Marking, Protection and Location has Arrived

3M has revolutionized pipeline location and protection with its ***EMS Path Marking Warning Tape***. This 3M technology eliminates the ***many pitfalls*** of traditional tracer wire / warning tape systems.

From Point Marking to Pipeline Path Marking

Forty years ago, ***3M*** revolutionized the ability to ***Point Mark*** individual utility assets with their Electronic Marker (EMS) System (Marker Balls). By incorporating this same RFID technology into ***Warning Tape***, 3M now adds the ability to ***Path Mark*** municipal buried pipelines.

Intelligent Design

3M EMS Path Marking Warning Tapes feature internal RFID Markers at 8 foot intervals. These passive antenna markers are tuned to specific frequencies based on utility type. (Water, Sewer, Reclaim). While independent, these markers function together to create an uninterrupted pipeline "path" which is locatable from ground level. The ***independence*** of each RFID Tag, together with a ***Utility Specific Frequency***, allows this tape to eliminate the many pitfalls of traditional tracer wire / warning tape systems.

No Continuity or Grounding Required

And we're not kidding! Traditional locate methods require proper grounding and continuity to function. 3M Path Markers operate independently and ***do not require grounding or continuity to function.*** Even intentionally breaking / removing a section of ***3M EMS Part Marking Warning Tape*** will not affect the path marking ability of the remaining tape.

Pipeline Identification is Now Available

Because of differing frequencies, the RFID Markers inside the ***3M EMS Path Marking Warning Tapes*** allow you to differentiate between utilities from ground level. For example, Water Tape (Blue) utilizes a *different frequency* than Wastewater Tape (Green). While searching for a Water line, you will not accidentally locate a Force Main or Reclaim Main.

Pipeline Protection and Location in One Product

3M EMS Path Marking Warning Tapes also serve as a ***Visual Stop Sign*** for shovel and backhoe excavation, thus combining two individual systems (tracer wire / warning tape) into one.

Simplify your Locates

With ***3M EMS Path Marking Warning Tape*** simply turn your locator on and begin tracing your pipeline. And you will also know ***which utility*** (water, sewer, reclaim) you are tracing!

With 3M, there is no need to "Hook Up" or connect to anything. Additionally, you will no longer need a separate transmitter, access points / boxes, grounding rods, splice kits or isolating terminals. Because the locator acts as both a transmitter and receiver, you can begin your locate at any point along its installation.

RFID EMS Path Marking Warning Tape – Water, Wastewater, Reclaim

1. Specifications

   a. All underground pressure pipe shall have electronically detectable Path Marking Warning Tape installed above it.
   b. The Path Marking Warning Tape shall be made of polyethylene (or approved equivalent) material, 6-inches wide and a minimum of 11 millimeters thick.
   c. The Path Marking Warning Tape shall have detectable RFID Markers embedded in the tape every eight feet to provide a continuous path to allow for easy detection at any point along the pipe. The signal should be such that it will provide guidance on the direction of the tape.

      1. RFID Frequencies shall be as follows:
         1. Water: 73.5 kHZ
         2. Wastewater: 41.4 kHz
         3. Reclaim Water: 44.9 kHz

   d. The Path Marking Warning Tape shall be able to function and be detected without the need for a direct connection to an external power source (e.g. no access points needed), which will allow for a quicker detection at any point along the path.
   e. Each detectable RFID marker embedded in the Path Marking Warning Tape functions independently so that even if a section of tape is removed, the remaining marked sections will continue to function.
   f. Path Marking Warning Tape must be able to provide a depth measurement using an underground cable/pipe locator.
   g. The Path Marking Warning Tape will not require grounding.
   h. Path Marking Warning Tape shall be Blue, Green or Purple in color and shall be printed on one side in black letters (Typical for all lettering) and shall be as follows: “CAUTION WATER (or Sewer or Reclaim) LINE BURIED BELOW” (or an approved equivalent wording). The wording shall be repetitive along the full length of the tape.
   i. Path Marking Tape shall be detectable at a maximum of 48” below grade regardless of soil composition.

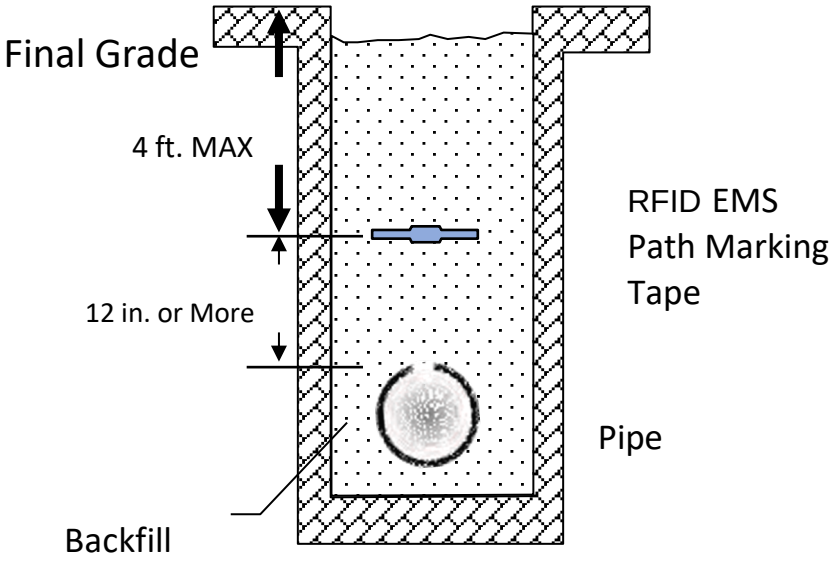
2. Installation

   a. Path Marking Warning Tape shall be installed continuously and longitudinally above and along all water, wastewater and reclaim pressure mains and services for new construction and for any repair or retrofit construction using open trench methods, for identification and detection purposes.

   b. For service connections, the Path Marking Warning Tape shall extend from the main line to the meter.

c. The Path Marking Warning Tape shall be installed directly above the center of the pipe and at least 16-inches deep from final grade to a maximum depth of 48-inches below final grade.

d. The contractor shall exercise care to prevent damage to the Path Marking Warning Tape when placing the remaining backfill.



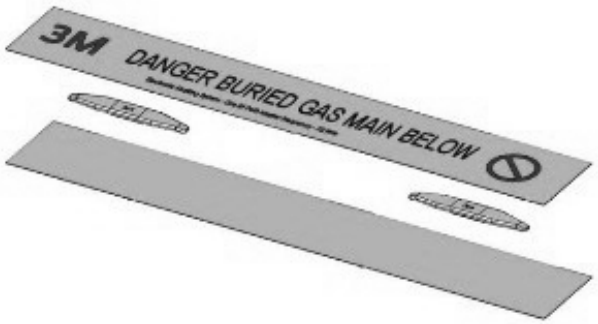
3M™ EMS Warning Tape 7900 Series

Data Sheet

The 7900 Series EMS Warning Tape is engineered to provide visual verification of underground utilities and can include the following additional features:

7900 EMS Warning Tape – Includes an EMS marker laminated between two pieces of film.

The RF technology does not require an electrically continuous path to provide detection in places where the tape has been damaged or detection where it is prohibitive to have an electrical path.

Agency Approvals & Self Certifications	For RoHS information, please visit www.3M.com/ROHS RoHS Compliant
Physical Specifications	
Models	**7900 EMS Warning Tape** 
Length	500ft (152m)
Tensile Strength	6”/360lb (15cm/1.6kN)
Elongation	20% at failure
Weight Mfg. Tested	6" (15cm) width - 18 LBS/500 ft (8.1 kg/150m)
Thickness (ASTM D2103)	11 MIL (.28mm) +Add 2 cm at RF marker
Printability PE Film (ASTM D2578)	34 dynes

Environmental Specifications	
Operating temperature	**-4° F to 122° F (-20° C to 50° C)**

Storage temperature	**-4° F to 140° F (-20° C to 60° C)**	
Environmental Standard	**IP68**	
Impact Rating of Marker	**IK-9 (Tag)**	
Chemical Resistance	**Excellent resistance to acids. Good resistance to alkalis.**	
Electrical Specifications		
Marker Detection Depth	**4’ (1.2 m) for 3M Dynatel™ Locators 7420, 7550 and 7573. 3' (.9 m) for 3M Dynatel Locator 1420-iD, 2250MiD,2273M-iD, 2550-iD and 2573-iD (for units with compatible hardware)**	
Nominal Distance Between Markers	**8ft. (2.4m)**	
Minimum Separation from Metallic Facilities	**4 in (10 cm)**	
Utility	**Color**	**Frequency**
Gas	**Yellow**	**53.9 kHz**
Telecom	**Orange**	**48.8 kHz**
Power	**Red**	**34.9 kHz**
Water Part Number 7903	**Blue**	**73.5 kHz**
Wastewater Part Number 7904	**Green**	**41.4 kHz**
Reclaimed Water Part Number 7908	**Purple**	**44.9 kHz**

***APWA Guidelines. Check local reference as some exceptions may apply.**

Submission 2: Revision to 303.2.1 – 303.2.12.1

Form Submission: "*Below is the recommended verbiage for this necessary update to 251D. I have also attached five documents regarding environmental/green building certifications. All of these documents and many more are always accessible at Product Resources (prowoodlumber.com). Let me know if there is any information you need that isn't available here. Regarding next steps with this update to 251D. I believe a simple review of the Redwood Lumber Grades and Uses guide (attached) makes the need for this update very obvious. It is important for me to mention that even these "all heartwood species" of redwood are recommended by the Redwood Inspection Service for "above ground" or "on or near soil." As we all know, every piece of expansion joint is installed in ground contact applications throughout North Texas and must be required to perform in those applications."*

Current Version of PW Construction Standards:

Division 300 Roadway Construction, Item 303 Portland Cement Concrete Pavement, Materials

303.2.12. Joint Filler. Joint filler is the material placed in concrete pavement and concrete structures to allow for the expansion and contraction of the concrete.

303.2.12.1. Material. Expansion joint materials shall consist of boards or a premolded asphalt board tested in accordance with ASTM D545 Test Methods for Preformed Expansion Joint Fillers for Concrete Construction (Nonextruding and Resilient Types).

Boards for expansion joint filler shall be of the required size, shape and type indicated on the plans or required in the specifications. Boards shall be of selected stock of redwood, cypress, gum, southern yellow pine, or Douglas fir timber. The boards shall be sound heartwood and shall be free from sapwood, knots, clustered birdseyes, checks and splits. Occasional sound or hollow birdseyes, when not in clusters, shall be permitted, provided the board is free from any other effects that shall impair its usefulness as a joint filler. With the exception of redwood and cypress, all boards shall be preservative treated according to American Wood-Preservers' Association (AWPA) Standards.

Asphalt boards for expansion joint filler shall be of the required size and uniform thickness and, when used in transverse joints, they shall conform approximately to the shape of the pavement crown shown on the plans and details. Asphalt boards shall consist of two liners of 0.016 asphalt impregnated kraft paper filled with a mastic mixture of asphalt and vegetable fiber and/or mineral filler. Boards shall be smooth, flat and straight throughout, and shall be sufficiently rigid to permit ease of installation. Boards shall be furnished in lengths equal to the width between longitudinal joints, and may be furnished in strips or scored sheet of the required shape.

Asphalt boards, when tested in accordance with the following described methods, shall not deflect from the horizontal more than ¾-inches in 3½-inches. A sample of the board, 2-in. wide and 6-in. long, flat, straight and cut with its length parallel to the lay of the fiber, shall be clamped between two blocks in the direction of its thickness in such manner that 3½-in. length of the sample shall extend unsupported and at right angles from the common plane of the block faces. The samples and clamp so assembled shall be maintained at a temperature of 180°F for 2-hours, with the length and width of the clamped portion of the sample horizontal after which the deflection from the horizontal of the unclamped portion shall be immediately measured.

303.2.12.2. Dimensions. The thickness of the expansion joint filler shall be shown on the plans; the width shall be not less than that shown on the plans, providing for the top seal space.

303.2.12.3. Rejection. Expansion joint filler may be rejected for failure to meet any of the requirements of this specification.

Recommended Revision: Wood used as expansion joint must conform to the following properties and be suitable for use in contact with ground, fresh water, concrete or other situations favorable to deterioration.

- **Southern Yellow Pine (SYP)** lumber must be grade #2 or better in accordance with American Lumber Standard Committee (ALSC) grading rules and preserved with Micronized Copper Azole (MCA) to AWPA (American Wood Protection Association) Use Category 4A for ground, fresh water and concrete contact. SYP lumber that is MCA treated to UC4A standards must also be color-treated with a micronized iron-based pigment.
- **Redwood** must be an All-Heartwood grade as outlined by the Redwood Inspection Service and the California Redwood Association's Grade and Uses guide. Acceptable grades of redwood are Clear All Heart, Heart B, Construction Heart or Merchantable Heart. No grades containing sapwood or open hole are permitted.

Attachments:

- Redwood Grade Descriptions
- ProWood XJ Sell Sheet (attached)
- ProWood 2024 NGBS Green Certified
- ProWood 2026 GreenGuard Gold
- ProWood 2024 Environmentally Preferable Treated Wood Process

Review Comments for Submission #2

prowood XJ
EXPANSION JOINT

READY FOR A BETTER ALTERNATIVE?

NEVER SETTLE.

THE PROBLEM WITH REDWOOD

Why is Merch Redwood still being used for Expansion Joint applications in Texas?

No expansion joint specification exists that allows for sapwood. The quality of redwood used as expansion joint in Texas has continued to decline and no longer meets the spec for which it was originally intended.

THE SOLUTION IS ▶ PROWOOD COLOR TREATED EXPANSION JOINT

- ProWood XJ is subject to 3rd Party Treatment Quality Auditing by Timber Products Inspection and shall be labeled as such with a designation end tag
- Monitored internally not only by the plant treater and QC operator, but by a team of wood scientists and engineers with over 65 years of combined wood preservation experience and know how
- Treated with micronized copper azole preservative system to **AWPA U-1 Standard for Ground Contact Applications (UC4A)** for use in ground contact, fresh water and situations favorable to deterioration and meets the IBC and IRC current building codes
- Micronized copper azole preservative system listed in **AASHTO M-133 12** Standard Specifications for Preservatives and Pressure Treatment Process for Timber
- **TXDOT-approved DMS-6310 "Joint Sealants and Fillers"**

SEE HOW WE STACK UP
PROWOODLUMBER.COM/COLORTREATED

PROWOOD COLOR TREATED EXPANSION JOINT LUMBER IS BUILT TO LAST.

	ProWood Color Treated Expansion Joint	Merchantable Heart "All Heart Merch" Redwood	Merchantable "Merch" Redwood
TXDOT DMS-6310 Approved	✓	✓	✗
Resistance to Rot/ Decay/Deterioration	✓	✓	✗
Suitable for Permanent Ground Contact	✓	✗	✗
OK for contact with fresh water	✓	✗	✗
Meets All ICC Major Building Codes	✓	✗	✗
Environmental and Green Certifications	✓	✗	✗
Made In Texas	✓	✗	✗

LOCAL SUPPLY AND EASY TO ORDER

- Harvested from responsibly-managed timberland, treated in Texas and distributed throughout the state
- Abundant supply and multiple wood treatment locations in Texas make ordering specific tallies and large volumes with quick lead times possible and cost effective

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OUR WORD IS CONCRETE

THE ONLY TREATED WOOD PRESERVATIVE SYSTEM WITH ALL OF THESE THIRD-PARTY ENVIRONMENTAL AND GREEN CERTIFICATIONS:

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Submission 3: Revision to 501.7.3

Form Submission: *"Recommend the removal of the requirement of Asphaltic coating on the cement mortar of Ductile Iron pipe. It is a singular, minor request, and the proposed revision would update the spec to no longer be out of conformance with AWWA Standards. Further comment and explanation are in the PDF document attached below in detail, along with an exact copy of the proposed changes being shown in the attached word document. Thank you in advance for your consideration."*

Current Version of PW Construction Standards:

Division 500 Underground Construction and Appurtenances, Item 501 Underground Conduit Materials, Ductile-Iron Pressure Pipe and Fittings, Coating and Lining

501.7.3. Coating and Lining. All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside. The cement mortar lining shall be seal coated in accordance with the latest revision of ANSI / AWWA C104 / A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. All ductile iron pipe shall require an exterior polywrap corrosion protection system as defined in the latest version of ANSI / AWWA C105 / A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems. In the event of tears, pinches, breaches, or other damage to the initial external polywrap protection layer, the use of dual layer external polywrap protection meeting the above standards shall be required. If this specification conflicts with manufacturer's installation recommendations, follow manufacturer's recommendations for ductile iron pipe installation.

Recommended Revision:

501.7.3. Coating and Lining. All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside. The cement mortar lining shall be ~~seal coated~~ in accordance with the latest revision of ANSI / AWWA C104 / A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. All ductile iron pipe shall require an exterior polywrap corrosion protection system as defined in the latest version of ANSI / AWWA C105 / A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems. In the event of tears, pinches, breaches, or other damage to the initial external polywrap protection layer, the use of dual layer external polywrap protection meeting the above standards shall be required. If this specification conflicts with manufacturer's installation recommendations, follow manufacturer's recommendations for ductile iron pipe installation.

Attachment:

- Letter (attached)

Review Comments for Submission #3

AMERICAN
DUCTILE IRON PIPE
SPIRALWELD PIPE

THE RIGHT WAY

Public Works Construction Standards Committee
North Central Texas Council of Governments
616 Six Flags Dr
Arlington, TX 76011

August 22nd, 2025

Re: NCTCOG- Public Works Construction Standard- Section 501.7.3- Ductile Iron Pipe Coating and Linings

To Whom it may concern:

Thank you for allowing me the opportunity to discuss and review the North Central Texas Public Works Construction Standard. This request is in reference to Section 501.7.3- Ductile Iron Pipe Coatings and linings. Currently, the criteria of the specification are not in alignment with current American Water Works Association (AWWA) C104 standard entitled "Cement-Mortar Lining for Ductile-Iron Pipe and Fittings." This is a formal request to consider revising Section 501.7.3 which has a mandatory requirement for asphaltic seal coat being applied to the cement mortar lining. Currently, AWWA C104, Section 4.12.1, provides manufacturers with the option to apply an asphaltic seal coat and is written as follows:

Sec 4.12 Seal Coat

"4.12.1 General. Unless otherwise specified, the manufacturer shall have the option of providing the cement-mortar lining with or without a seal coat."

Please accept this letter as a formal request to enact the requested change outlined in the information below along with further supporting information. We appreciate your time and consideration and please let me know if we need to provide any additional information or be of any further assistance.

Best Regards,

Jake Phillips

Jake Phillips
Senior Sales Representative

jakephillips@american-usa.com
P: (913)-704-8209
Dallas, TX

All references herein are to the NCTCOG- Public Works Construction Standard. Individually, applicable referenced Section is indicated in bold.

501.7 Ductile-Iron Pressure Pipe and Fittings- Section 501.7.3

Original: All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside. The ***cement mortar lining shall be seal coated in accordance with the latest revision of ANSI/AWWA C104 / A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.***

Proposed: All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside. The ***cement mortar lining shall be in accordance with the latest revision of ANSI/AWWA C104 / A21.4 American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.***

Why should we make this change?

The requirement of seal coat is an artifact of a previous revision of AWWA C104, and the seal coat provides no measurable performance advantages to the pipe. Additional supporting facts and benefits for making this modification:

- AWWA C104 "Cement-Mortar Lining for Ductile-Iron Pipe and Fittings", originally adopted in 1939, was revised in 1953 to include the use of a seal coat to provide controlled hydration/curing of CML. With significant advancements in cement mortar application equipment and techniques, the seal coat is no longer needed to properly cure CML

- The 1995 edition of the standard was revised to allow the manufacturer the option of providing the cement-mortar lining with or without a seal-coat. One of the primary reasons for the change was to minimize the use of the seal-coat and thereby help reduce VOC (volatile organic compound) emissions.

- The seal-coat material used on AMERICAN Ductile iron pipe and fittings is a solvent-based paint that contains VOCs. The Clean Air Act placed strict restrictions on emissions of numerous air pollutants, including VOCs. Manufacturers are continually researching alternative coatings that contain little or no VOCs

- The change does not eliminate nor exclude any other Ductile Iron Pipe manufacturers from competing or providing pipe on projects.

- It provides flexibility to the manufacturer to utilize seal coat on cement mortar lining or not based on equipment technology present in each plant facility.

- Seal coated CML is primarily unique to the domestic market. DIP and fittings manufactured elsewhere in the world have been successfully furnished without sealcoat for decades.

- Cement mortar lining per AWWA C205 being used for AWWA C200 steel pipe does not require a seal coat; and operation of these pipelines has not caused any measurable water quality issues.

- Cement mortar lining for AWWA C301/C303 Concrete Pressure Pipe does not require a seal coat; and operation of these pipelines has not caused any measurable water quality issues.

- The City of Austin; one of the largest Ductile Iron pipe users in the State of Texas, has accepted this proposed change.

- Any alkalinity, hardness, taste/odor issues experienced upon initial filling of newly installed Ductile Iron Pipe with fresh CML will quickly subside with flushing.

Submission 4: Revision to PP Pipe Specification

Form Submission: *"Our PP pipe is listed in the specifications currently, however I would like to suggest a change in the language to make it accurate as the ASTM specification mentioned is outdated."*

Current Version of PW Construction Standards:

Division 500 Underground Construction and Appurtenances, Item 501 Underground Conduit Materials

501.23. THERMOPLASTIC CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS

501.23.1. General. High Density Corrugated and Corrugated Smooth Lined Thermoplastic storm water tube/pipe and fittings shall conform to Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Pipe Material	Topic	Standard
Polyvinyl Chloride (PVC)	PVC Corrugated Storm Water Pipe With A Smooth Interior	ASTM F949 (4"-36")
Polyethylene (PE)	PE Corrugated Pipe With A Smooth Interior	AASHTO M294 (12"-60") AASHTO M252 (3"-10")
Polypropylene (PP)	PP Corrugated Pipe With A Smooth Interior	ASTM F2736 (6"-30")

501.23.2. Materials.

501.23.2.1. PVC. The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

501.23.2.2. PE. The tube/pipe and fittings shall be made of virgin polyethylene which conforms with the requirements of cell class 335400C as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials.

501.23.2.3. PP. Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2736, Section 4 for the respective diameters. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM F2736, Section 6.2.6 Pipe Stiffness.

501.23.3. Stiffness.

501.23.3.1. PVC. Constant minimum pipe stiffness at five-percent deflection shall be 46-psi for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.23.3.2. PE. Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi for 3-in. through 10-in. diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters.

501.23.3.3. PP. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM F2736, Section 6.2.6 Pipe Stiffness.

501.23.4. Joints.

501.23.4.1. PVC. Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2-psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8-psi

test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

501.23.4.2. PE. Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24" or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.23.4.3. PP. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2736 for the respected diameters (12"-30"), and shall be watertight according to the requirements of ASTM D3212. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. 12"-30" diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

501.23.5. Testing.

501.23.5.1. PVC. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.23.5.2. PE. All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F2648, as applicable.

501.23.5.3. PP. All polypropylene piping shall be tested as per ASTM F2736, Section 8 as applicable.

Division 500 Underground Construction and Appurtenances, Item 501 Underground Conduit Materials, Corrugated Thermoplastic Pipe, Excavation and Backfilling

508.6.5.2. Backfilling. Backfill from the pipe bedding up to 1 ft. above the top of the pipe to provide necessary structural support to the pipe and control pipe deflection. Take special precautions when placing and compacting backfill material. Place special emphasis obtaining uniform compacted density throughout the length of the pipe, to avoid unequal pressure. Use extreme care to ensure proper backfill under the pipe, in the haunch zone.

Provide backfill material meeting the following specifications:

(1) Type I- Provide backfill consisting of flowable fill in accordance with Item 504.2.3.4 Flowable Backfill. Place the flowable backfill across the entire width of the trench and maintain a minimum depth of 12 in. above the pipe. Wait a minimum of 24 hours before backfilling the remaining portion of the trench with other backfill material in accordance with Item 504.2.3. Final Backfill.

(2) Type II- Provide backfill consisting of cement stabilized backfill in accordance with Item 504.2.3.5. Modified Flowable Backfill. Place and compact cement stabilized backfill to completely fill any voids.

(3) Type III- Provide backfill consisting of hard, durable, clean granular material that is free of organic matter, clay lumps, and other deleterious matter. Provide backfill meeting the gradation requirement shown in Table 508.6.5.2.(a). Place the backfill material along both sides of the completed structure to a depth of 12 in. above the pipe. Place the backfill in uniform layers a minimum of 6 in. deep (loose measurement), wet if required and thoroughly compacted between adjacent structures and between the structure and the sides of the trench. Until a minimum cover of 12 in. is obtained, only hand-operated tamping equipment will be allowed within vertical planes 2 ft. beyond the horizontal projection of the outside surfaces of the structure. If using Type III backfill,

Recommended Revisions:

501.23. THERMOPLASTIC CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS

501.23.1. General. High Density Corrugated and Corrugated Smooth Lined Thermoplastic storm water tube/pipe and fittings shall conform to Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Pipe Material	Topic	Standard
Polyvinyl Chloride (PVC)	PVC Corrugated Storm Water Pipe With A Smooth Interior	ASTM F949 (4"-36")
Polyethylene (PE)	PE Corrugated Pipe With A Smooth Interior	AASHTO M294 (12"-60") AASHTO M252 (3"-10")
Polypropylene (PP)	PP Corrugated Pipe With A Smooth Interior	~~ASTM F2736 (6"-30")~~ ASTM F2881 (12"-60")

501.23.2. Materials.

501.23.2.1. PVC. The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

501.23.2.2. PE. The tube/pipe and fittings shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4" - 10" diameters and 435400C for 12" - 60" diameters as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials. The 12" - 60" pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294.

501.23.2.3. PP. Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM F2881, Section 4 for the respective diameters. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM F2881, Section 6.2.6 Pipe Stiffness.

501.23.3. Stiffness.

501.23.3.1. PVC. Constant minimum pipe stiffness at five-percent deflection shall be 46-psi for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.23.3.2. PE. Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi for 3-in. through 10-in. diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters.

501.23.3.3. PP. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM F2881, Section 6.2.6 Pipe Stiffness.

test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

501.23.4.2. PE. Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24" or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.23.4.3. PP. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM F2736 for the respected diameters (12"-30"), and shall be watertight according to the requirements of ASTM F2881. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. 12"-30" diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

501.23.5. Testing.

501.23.5.1. PVC. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.23.5.2. PE. All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F2648, as applicable.

501.23.5.3. PP. All polypropylene piping shall be tested as per ASTM F2881, Section 8 as applicable.

508.6.5.2. Backfilling. Backfill from the pipe bedding at minimum to the crown of the pipe to provide necessary structural support to the pipe and control pipe deflection. If migration of fines is a concern, geotextile fabric can be used between initial and final backfill. Initial backfill should extend 6" above crown of pipe if final backfill has particles greater than 1 1/2 in. in size. Take special precautions when placing and compacting backfill material. Place special emphasis obtaining uniform compacted density throughout the length of the pipe, to avoid unequal pressure. Use extreme care to ensure proper backfill under the pipe, in the haunch zone.

Attachment:

- NCTCOG Recommended Revisions – ADS (attached)

Review Comments for Submission #4

501.22.2. Materials. The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials with a minimum cell classification of 345444C.

501.22.3. Stiffness. Minimum pipe stiffness at five-percent deflection shall be 10-psi for wastewater as specified for all sizes when calculated according to Appendix XI, "Relation of RSC To Pipe Properties and Pipe Stiffness" of ASTM F894.

501.22.4. Joints. Joint tightness shall be tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.22.5. Testing. Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designations.

501.23. THERMOPLASTIC CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS

501.23.1. General. High Density Corrugated and Corrugated Smooth Lined Thermoplastic storm water tube/pipe and fittings shall conform to Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Table 501.23.1.(a) Thermoplastic Storm Water Pipe and Fittings.

Pipe Material	Topic	Standard
Polyvinyl Chloride (PVC)	PVC Corrugated Storm Water Pipe With A Smooth Interior	ASTM F949 (4"-36")
Polyethylene (PE)	PE Corrugated Pipe With A Smooth Interior	AASHTO M294 (12"-60") AASHTO M252 (3"-10")
Polypropylene (PP)	PP Corrugated Pipe With A Smooth Interior	~~ASTM F2736 (6"-30")~~

501.23.2. Materials.

501.23.2.1. PVC. The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

501.23.2.2. PE. The tube/pipe and fittings shall be made of virgin polyethylene which conforms with the requirements of cell class 335400C as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials.

501.23.2.3. PP. Polypropylene compound for pipe and fitting production shall be impact modified copolymer meeting the material requirements of ASTM ~~F2736~~, Section 4 for the respective diameters. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM ~~F2736~~, Section 6.2.6 Pipe Stiffness.

501.23.3. Stiffness.

501.23.3.1. PVC. Constant minimum pipe stiffness at five-percent deflection shall be 46-psi for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.23.3.2. PE. Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi for 3-in. through 10-in. diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters.

501.23.3.3. PP. Minimum pipe stiffnesses at 5% deflection shall meet or exceed ASTM ~~F2736~~, Section 6.2.6 Pipe Stiffness.

501.23.4. Joints.

501.23.4.1. PVC. Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2-psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8-psi

F2881

F2881

F2881

Our recommendation is to change this to ASTM F2881 (12" - 60")and remove ASTM F2736. ASTM F2736 is an older spec for small diameter polypropylene (PP) and includes single wall pipe, which would not have a smooth interior. The industry standard for dual wall, smooth interior polypropylene (PP) pipe is ASTM F2881, which is for 12" - 60" pipe. This recommended change would also align with Table 508.6.3.(a), shown below for reference, where trench widths are only provided for 12" - 60" pipe diameter. Pipes smaller than 12" would usually by polyethylene (PE). This recommendation would include only calling out ASTM F2881 for polypropylene (PP) and replace any reference to ASTM F2736 under item 501.23.

Table 508.6.3.(a) Minimum Trench Widths for the Installation of Corrugated Thermoplastic Pipe

Nominal Inside Pipe Diameter (Inches)	Typical Outside Pipe Diameter (inches)			Minimum Trench Width[1] (Inches)
	HDPE	PP	PVC	
4	4.9	NA	4.3	21
6	6.9	NA	6.4	23
8	9.1	NA	8.6	25
10	11.2	NA	10.8	27
12	14.3	14.5	12.8	30
15	17.5	17.6	15.7	33
18	21.5	21.2	19.2	38
24	28.0	28.0	25.6	46
30	35.5	35.4	32.2	55
36	42.0	41.1	38.7	63
42	47.5	47.2	NA	71
48	54.0	53.8	NA	79
54	61.0	NA	NA	88
60	67.0	66.5	NA	95

Our recommendation is to update the verbiage under 501.23.2.2 PE. to "The tube/pipe and fittings shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4" - 10" diameters and 435400C for 12" - 60" diameters as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials. The 12" - 60" pipe material shall comply with the notched constant ligament- stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294."

The reasoning for this recommendation is to align with AASHTO. AASHTO M292 covers cell classification 424420C and AASHTO M294 covers cell classification 435400C. AASHTO M294 also changed in 2018 to allow for recycled resin in HDPE pipe, as long as the pipe met the NCLS test to ensure proper performance. Because of this, our recommendation is to remove the word virgin. This will decrease cost of all HDPE pipe and save money for respective owners/developers, which ensuring the same performance is upheld.

test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

501.23.4.2. PE. Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24" or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

F2881

501.23.4.3. PP. Pipe shall be joined with a gasketed integral bell & spigot joint meeting the requirements of ASTM ~~F2736~~ for the respected diameters (12”-30”), and shall be watertight according to the requirements of ASTM D3212. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. 12”-30” diameters shall have a reinforced bell with a polymer composite band installed by the manufacturer.

501.23.5. Testing.

501.23.5.1. PVC. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.23.5.2. PE. All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F2648, as applicable.

501.23.5.3. PP. All polypropylene piping shall be tested as per ASTM ~~F2736~~, Section 8 as applicable.

F2881

at minimum to the crown

508.6.5.2. Backfilling. Backfill from the pipe bedding ~~up to 1 ft. above the top~~ of the pipe to provide necessary structural support to the pipe and control pipe deflection. Take special precautions when placing and compacting backfill material. Place special emphasis obtaining uniform compacted density throughout the length of the pipe, to avoid unequal pressure. Use extreme care to ensure proper backfill under the pipe, in the haunch zone.

Provide backfill material meeting the following specifications:

(1) Type I- Provide backfill consisting of flowable fill in accordance with Item 504.2.3.4 Flowable Backfill. Place the flowable backfill across the entire width of the trench and maintain a minimum depth of 12 in. above the pipe. Wait a minimum of 24 hours before backfilling the remaining portion of the trench with other backfill material in accordance with Item 504.2.3. Final Backfill.

(2) Type II- Provide backfill consisting of cement stabilized backfill in accordance with Item 504.2.3.5. Modified Flowable Backfill. Place and compact cement stabilized backfill to completely fill any voids.

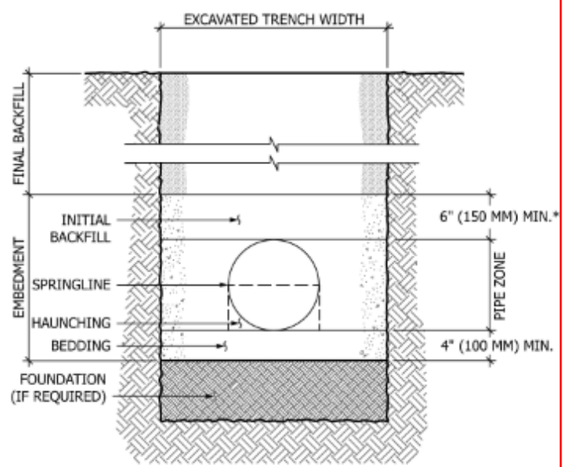
(3) Type III- Provide backfill consisting of hard, durable, clean granular material that is free of organic matter, clay lumps, and other deleterious matter. Provide backfill meeting the gradation requirement shown in Table 508.6.5.2.(a). Place the backfill material along both sides of the completed structure to a depth of 12 in. above the pipe. Place the backfill in uniform layers a minimum of 6 in. deep (loose measurement), wet if required and thoroughly compacted between adjacent structures and between the structure and the sides of the trench. Until a minimum cover of 12 in. is obtained, only hand-operated tamping equipment will be allowed within vertical planes 2 ft. beyond the horizontal projection of the outside surfaces of the structure. If using Type III backfill,

If migration of fines is a concern, getotextile fabric can be used between initial and final backfill. Initial backfill should extend 6" above crown of pipe if final backfill has particles greater than 1 1/2 in. in size.

Extra initial backfill above the crown of pipe is not structural, and only for protection from larger rocks and cobbles in final backfill material. See reference from ASTM D2321 to the right. We recommend removing the requirement of 1 ft above the top of pipe for initial backfill and updating the language to the above markup.

5.4 *Maximum Particle Size*—Maximum particle size for embedment is limited to material passing a 1½ in. (37.5 mm) sieve (see Table 2). To enhance placement around small diameter pipe and to prevent damage to the pipe wall, a smaller maximum size may be required (see X1.9). The final backfill material may extend down to the top of the pipe as long as the material is less than 1 ½ in. (37.5 mm) in size. When final backfill contains rocks, cobbles, etc., the engineer may require greater initial backfill cover levels (see Fig. 1) if damage to the pipe is of a concern.

NOTE 7—While the main purpose of the initial backfill material is to protect the pipe from impact from larger rocks or cobbles, it is still the responsibility of the engineer to determine the appropriate thickness of this layer based on field conditions and construction practices at the site.



* See 7.6 Minimum Cover

FIG. 1 Trench Cross Section

DIVISION 3000 GENERAL UNDERGROUND CONDUIT

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508.6. CORRUGATED THERMOPLASTIC PIPE

This item shall govern and control the furnishing and placing of corrugated thermoplastic pipe to be used in storm water collection systems.

508.6.1. Pipe Materials. Unless otherwise specified on the plans or as required herein, corrugated thermoplastic pipe shall meet the requirements of Item 501.23. Thermoplastic Corrugated Drainage Tubing and Corrugated Smooth Lined Storm Water Pipe and Fittings. Pipe shall be full circle as shown on the plans. Damage to the materials incurred prior to backfilling shall be removed and replaced.

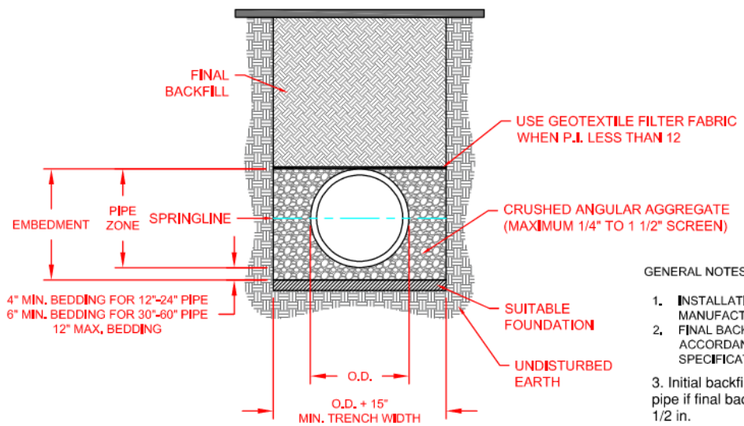
508.6.2. Couplings. Materials shall conform to the requirements of Item 501.23.4. Joints shall prevent infiltration of side material during the life of the installation. Soil-tight Joints shall be bell and spigot or utilize couplings that engage at least two full corrugations on each pipe section in accordance with AASHTO M330.

508.6.3. Installation of Pipe. The CONTRACTOR shall furnish, at its own expense, and place in position as directed by the OWNER all necessary batter boards, string lines, plummets, graduated poles, lasers, etc., required in establishing and maintaining the lines and grades. The batter boards and all location stakes must be protected from possible damage or change of location. The cost of replacement of location stakes shall be at no additional cost to the OWNER.

All pipe and fittings shall be laid and jointed in a dry trench of a minimum width as shown in Table 508.6.3.(a) Minimum Trench Widths for the Installation of Corrugated Thermoplastic Pipe.

The minimum depth of cover and trench width should be established by the OWNER based on evaluation of specific project conditions or ASTM D2321.

There is not a standard trench detail in division 3000 for thermoplastic pipe installation for section 508.6 in the underground conduit standard details. We'd recommend adding a generic detail for clarity. Similar to below could be an example and we'd be happy to create a generic detail for this section if needed.



STORM DRAIN POLYPROPYLENE (PP) PIPE (MEETS ASTM F2881) EMBEDMENT

Submission 5: Addition of SPRE Pipe

Form Submission: "*We are recommending revisions to Section I, Division 500, to allow the use of Steel Reinforced Polyethylene (SRPE) pipe, for storm drainage, sanitary sewer applications, and rehabilitation of existing aged pipelines.*

We are proposing that SRPE pipe be added as an approved pipe material within Section I, Division 500 for the applications noted above. The purpose of this revision is to provide the City with an additional pipe option that combines the structural capacity of steel reinforcement with the corrosion resistance, abrasion resistance, and hydraulic efficiency of polyethylene. SRPE pipe is designed using applicable AASHTO LRFD methodologies and has been successfully implemented on municipal and DOT projects nationwide for both new construction and rehabilitation applications."

Current Version of PW Construction Standards:

Recommended Revisions:

501.XX. STEEL REINFORCED POLYETHYLENE (SRPE) LARGE DIAMETER WASTEWATER AND STORM PIPE

501.XX.1. General.

Steel Reinforced Polyethylene (SRPE) gravity wastewater and storm drainage pipe and fittings in nominal sizes 30-in. through 120-in. shall conform to current ASTM F2562 Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage.

501.XX.2. Materials.

The pipe shall be manufactured from high density polyethylene (HDPE) resin with a minimum cell classification of 345464C as defined in ASTM D3350 *Polyethylene Plastics Pipe and Fittings Materials*. The pipe profile shall be reinforced with high strength galvanized steel ribs (80,000 psi minimum yield strength) fully encased within the polyethylene material.

501.XX.3. Stiffness.

Structural design shall consider soil loads, live loads, hydrostatic loads, and installation conditions in accordance with AASHTO LRFD Section 12. The pipe shall be designed to limit deflection to acceptable industry standards for thermoplastic pipe systems.

501.XX.4. Joints.

Pipe joints shall be watertight and shall utilize a double-gasketed bell-and-spigot joint system. Joint performance shall meet the requirements of ASTM D3212, “Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.XX.5. Testing.

(A) Field Joint Testing: Field testing shall be performed on every installed joint to verify watertight performance. Joint testing shall be conducted in accordance with ASTM D3212 or approved project-specific low-pressure air or hydrostatic testing procedures.

(B) Pipe Testing. Pipe shall be tested for flattening, quality as specified in ASTM F2562.

Attachments:

- DuroMaxx SRPE Product Brochure and Technical Data
- Product Specifications and Applicable Standards References

- Case Studies in Texas (attached)

Review Comments for Submission #5

DFW International Airport – Aircraft Hardstand Ramp Expansion

Dallas, Texas

Glycol Storage Containment

Owner:
Dallas/Fort Worth International Airport

Engineer:
ATKINS

Contractor:
Renaissance Contractors, Inc.

Installation:
2017

In the spring of 2016, the Dallas/Fort Worth (DFW) International Airport opened a bid for an aircraft hardstand ramp expansion. Part of these improvements included several new aircraft fueling locations as well as additional hardstand space for deicing planes prior to take off, driving the need for a new storm drain and collection system.

Consequently, the DFW International Airport needed a cost-effective solution to properly store storm water contaminated with deicing fluid prior to being treated. The system needed to have a small footprint that would allow them to maximize the available land space. It must also meet the heavy live-loading design specification to accommodate an Airbus A380 - the world's largest passenger airliner. The airports at which the A380 operates must have upgraded facilities to accommodate it.

DFW International Airport worked closely with their consulting engineer, ATKINS, to choose an optimum collection, storage and treatment system. Ultimately, they selected a solution by Contech Engineered Solutions LLC which utilized DuroMaxx® steel reinforced polyethylene (SRPE) pipe and met AASHTO MP20 standard specification. This system would serve as an underground storage chamber from

Technical Description:

- Product: DuroMaxx® Steel Reinforced Polyethylene (SRPE) with WC Joints (30 psi)
- Length: Two runs of 134 LF of 96" dia.
- Storage: 13,053 CF of volume storage

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DFW International Airport – Aircraft Hardstand Ramp Expansion

Dallas, Texas

which the runoff would be pumped to a treatment system constructed above. The complete system consisted of 268 LF of 96-inch diameter pipe resulting in 13,053 CF storage volume. DuroMaxx is a reinforced polyethylene pipe with a smooth waterway wall and exterior profile that is reinforced with high strength galvanized steel ribs. While DuroMaxx provides a completely structural solution, it is also lightweight and installation was quick, which meant less expense and fewer dewatering issues. Given the sensitivity of the chemicals being stored here, it was also crucial that the joints be leak-free. The DuroMaxx system was designed with welded coupler (WC) joints capable of a 30 psi, watertight connection conforming with the ASTM D3212 joint requirements. Lastly, both bulkheads and risers for the DuroMaxx SRPE glycol storage system were custom-designed to handle the heavy live-loading from an Airbus A380.

There was some concern on the ease of maintaining a glycol storage system after installation. Fortunately, DuroMaxx SRPE glycol storage systems include manhole risers allowing easy access and maintenance. Because the pipe is round (as opposed to a concrete vault or box) and the polyethylene material is smooth and has a very low coefficient of friction, it is much easier to flush silt and debris from one end of the system to the other where, once accumulated, it can be removed with a vacuum truck from that one end of the system.

Chad Richards, P.E., Senior Project Manager at ATKINS, commented, "We were challenged to provide storage from pretreatment runoff from airfield operations and required a product that was cost-effective but met the stringent loading and life cycle design requirements required by the airport. Under a strict timeline, Contech provided a solution that satisfied our Engineering team, addressed client concerns, and provided responsive, technically capable staff to assist with a fully integrated final product."

DFW International Airport was extremely satisfied with the selected DuroMaxx SRPE system which exceeded the design requirements, was easy to install and easy to maintain.

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Lick Creek Wastewater Treatment Plant Expansion

College Station, Texas

Sanitary Outfall

Owner:
City of College Station

Engineer:
Freese and Nichols, Inc.

Contractor:
CSA Construction

Installation:
Summer 2020

The City of College Station, Texas, home of Texas A&M University, desired to expand the Lick Creek Wastewater Treatment Plant (WWTP) from its current permitted capacity of 2 MGD to a new rated capacity of 5 MGD. There were several major enhancements to the plant structure these included the expansion of the pump station, a grit wastewater facility, and an expanded return and waste activated pump station.

Technical Description:

- Product: DuroMaxx® SRPE with HP joints
- Diameter(s): 54-inch
- Length: 924 LF

The project was designed to accommodate projected growth rate in the area based on Land Use Plan through the installation of large interceptors, added capacity to the WWTP and replacement of aging infrastructure. The design was completed and opened to bid at the end of 2018. Due in part to the labor cost increases with Hurricane Harvey projects also bidding and an increase in material costs, the bids were much higher than anticipated. The City worked to reduce costs with CSA Construction and Freese and Nichols (Freese), the selected contractor and engineer.

In order to address the project design requirements while finding a cost-efficient solution, the engineer specified a DuroMaxx® SRPE sanitary outfall line as one of the allowable materials from the WWTP to aid in the expansion of the pump station. The general contractor chose DuroMaxx. This provided significant cost reductions in comparison to the fiberglass reinforced pipe (FRP) gravity sewer pipe originally specified on the plans. After review of the system requirements, a 54-inch diameter, 924 LF with 10.8 psi HP joints meeting the performance requirements of ASTM D3212, DuroMaxx® SPRE system. Additionally, a short run of 54-inch DuroMaxx that

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Lick Creek Wastewater Treatment Plant Expansion

College Station, Texas

included a removable plug was added to allow for a future connection to a 54-inch sanitary trunkline coming into the WWTP.

DuroMaxx® SRPE was a viable solution because it was able to handle all of the necessary design requirements and had the lowest installed estimate of all the reviewed pipe materials. The 54-inch DuroMaxx passed a low-pressure air test after it was installed. Additionally, the area where this pipe was installed was very tight and no trees were allowed to be removed, so the lightweight DuroMaxx pipe was easier for the contractor to handle versus other pipe materials.

In a growing city, new and expanded sewer lines are a necessity. Unfortunately, the work involved also created inconveniences and other changes to the nearby Lick Creek Park. According to the College Station Parks & Recreation Department, Lick Creek Park's beautiful trails exist because of the treatment plant, which began operating in 1987. Sewer lines were trenched toward the plant before the city developed the trail system years later. While a temporary inconvenience during the expansion phase, the added benefits of the enhanced Lick Creek WWTP system far outweighed the intermittent closures. The new trunk line will run through the established public utility corridor from Fitch Parkway to the treatment plant.

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Lochwood Court Drainage Project

Fort Worth, Texas

Storm Sewer

Owner:
City of Fort Worth

Engineer:
Wade Trim, Inc.

Contractor:
Jackson Construction Ltd.

Installation:
March 2014

Located in the suburbs of Fort Worth, Texas, the Lochwood Court offers beautiful, residential housing with landscaped lawns and spacious living areas. However, when replacing a water main and storm sewer system located between houses, the spacing can be quite tight and determining how best to handle the project with minimal impact is crucial.

Technical Description:

- Product: DuroMaxx® Steel Reinforced Polyethylene (SRPE) with HP Joints (15 psi)
- Diameter: 72"
- Length: 378 LF

This was certainly no exception when deciding the ideal product to use for a recently awarded project by the City of Fort Worth to replace a storm sewer system in Lochwood Court. Wade Trim, Inc. specified that Contech Engineered Solution's DuroMaxx® steel reinforced polyethylene (SRPE) be used for the project with concrete pipe as an alternate choice. The selection of DuroMaxx was quickly approved by the City of Fort Worth, Texas to complete the project. Not only is DuroMaxx lightweight, but its longer 24' joints allowed for a quicker installation of the required 378 LF. Given these attributes, the pipe could be installed utilizing small equipment providing additional cost-savings. The High Performance (HP) joints also provided a watertight joint capable of up to 15 psi while the unique profile of DuroMaxx would provide the durability of plastic with the strength of steel. Jackson Construction was extremely pleased when the pipe was quickly installed with minimal impact to the surrounding neighborhood.

The nearby homeowners were also very pleased as the installation was kept to a very constrained site that avoided wrecking landscaping and encroaching upon surrounding lawns.The project engineer, David Speicher of Wade Trim, Inc. stated, "The product was delivered on time, easy to install, and is functioning as designed. The use of this product expedited our project construction time, and made it much easier to work between two homes. I'd

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strongly recommend this product for use in similar areas."

Click here to view on Google maps.

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Owens-Illinois Waco Drainage Improvements

Waco, Texas

Drainage

Owner:
O-I Waco

Engineer:
CDS Muery

Contractor:
Shallow Ford Construction

Installation:
December 2017

Owens-Illinois, more commonly known as O-I, is the world's largest glassmaker, manufacturing glass containers and packaging for many of the world's leading food and beverage brands. Their heritage of glass making runs deep as one of the founders was also the first to design a fully automated bottle-making machine. In fact, one of every two glass containers is made by O-I.

With constant improvements and expansions to their existing facilities, O-I actively addresses quality at each of their manufacturing locations. One such facility, located in Waco, Texas (O-I Waco), needed an improved drainage system for their glass container landfill situated nearby the manufacturing facility. The consulting engineer, Mark Roetzel, worked closely with Shallow Ford Construction, to design a system that would address the needs of this particular site. Because of the location and soil conditions, the project required a watertight joint pipe that was capable of conveying storm water efficiently with minimal leakage.

With that in mind, DuroMaxx® steel reinforced polyethylene (SRPE) was selected to address the project design requirements along with A-2000™ PVC for a complete drainage system solution. The steel reinforcing ribs of the DuroMaxx pipe provided

Technical Description:

- Product: DuroMaxx® Steel Reinforced Polyethylene (SRPE) with WC Joints (30 psi)
- Diameter: 48-in.
- Length: 624 LF
- Additional Product: A-2000™ PVC, 506 LF of 18-in. to 24-in. diameter

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Owens-Illinois Waco Drainage Improvements

Waco, Texas

the strength while the polyethylene provided the durability. The smooth interior met the hydraulic needs of the system with a Manning's "n" value of 0.011 while the welded coupler joint ensured a watertight connection throughout the drainage system.

Initially, the engineer considered the use of HDPE throughout the entire drainage system, but considering the somewhat inefficient watertight joints and potential buckling conditions, they determined that DuroMaxx would be more than capable to address these design concerns.

Because the project was located inside of a glass container landfill, a special approval letter from the city was required by the general contractor to install the 48-inch DuroMaxx and A-2000™ drainage system. This additional approval process increased the project timeframe by another two months but was unavoidable. Ultimately, the complete drainage system was installed successfully. The contractor was very satisfied with the product and the ease of installation.

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Submission 6: Revision to Asphalt Specification

Form Submission: *"Asphalt specification - item 302, is out of date. TXAPA has authored a local agency asphalt specification that incorporates to latest (2024) TxDOT language into a simple, ready to use specification. The NCTCOG can use all or part of the proposed spec, or simply use it as a template to create their own."*

Current Version of PW Construction Standards:

Division 300 Roadway Construction, Item 302 Asphalt Pavement

Recommended Revisions:

See NCTCOG Spec Review Comment Document

Attachments:

- Item 341M Municipal Dense-Graded Hot-Mix Asphalt.
- NCTCOG Spec Review Comments Document (attached)
- TxDOT Item 300 Asphalts, Oils, and Emulsions
- TxDOT Item 344 Superpave Mixtures
- TxDOT Item 342 Permeable Friction Course
- TxDOT Item 346 Stone-Matrix Asphalt

Review Comments for Submission #6

NCTCOG – Item 302 Asphalt Pavement

Spec review comments

- 302.2 Aggregates
  - Cumbersome to read through – entirety of page 1 doesn't really say anything
  - No mention / limitations of RAP
  - No mention / limitations / restriction of field sand / manufactured sand
- 302.3 Bituminous Materials
  - 12 ½ pages that can be summed up by saying:
    Asphalt Binder. Furnish the type and grade of performance-graded (PG) asphalt binder shown on the plans that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions."
- 302.4 – Blank, should be removed
- 302.5 – Storage of Bituminous Materials
  - May be removed as this is covered in TxDOT 300
- 302.6 – Emulsified Asphalt Treatment
  - Again, material is covered in TxDOT 300
  - This should be combined with 302.7 Prime Coat
- 302.7 – Prime Coat – see comments for 302.6 – these should be combined to a single section
- 302.8 – Asphalt Base Course
  - 302.8.2 – Materials
    - This should already be covered by 302.2 and 302.3
    - Stabilometer test (Hveem stability) is outdated and should be removed from chart 302.8.3(a)
  - 302.8.3 – Construction Methods
    - This entire section is confusing and I'm not sure what it's trying to govern – possibly mix design?
- 302.9 – Hot-Mix Asphalt Pavement
  - 302.9.2 – materials
    - Should already be covered by 302.2 and 302.3
  - 302.9.2.2.1 – Paving mixture – should be removed – no new information here
  - 302.9.3(b) – Superpave Grading Chart
    - Lots of gaps in sieves
  - 302.9.3(c) – Superpave mix requirements
    - VFA is outdated and not necessary with VMA and should be removed
    - I would simply state material must conform to TxDOT 344 (Superpave) rather than trying to cover it under this spec with a chart

- 302.9.3(d) and (e) – Cellulose modified mixes
    - As with Superpave mix, I would ask for material conforming to TxDOT 346 (SMA) or 342 (PFC) rather than trying to cover it under this spec with a couple of charts
- 302.9.3.1
    - This is a test to determine liquid asphalt content of the mix – throughout the document, we are going back and forth between TxDot (Tex) test procedures, AASHTO and ASTM – this should all be standardized to TxDOT. The TxDOT test procedure for this is Tex-236-F "Determining Asphalt Content from Asphalt Paving Mixtures by the Ignition Method"
- 302.9.3.2
    - As above, the Hveem stability was a test used in design to establish the optimum asphalt content of the mix. Current design practices that target a specific density (96%) make this test obsolete
- 302.9.4 and 302.9.5 in their entirety
    - I question why most if not all of this spec is necessary, and there's a lot that is antiquated and out of date.
    - 302.9.4 states that "All equipment … shall be on the project…" and then lists of several pieces that are plant related, so they will never be on the project.
    - 302.9.5 goes through about 3 pages of different plant types – not necessary and not enforceable
- 302.9.6 Construction Methods
    - Much of what's here is redundant and already listed in other sections

- Overall, the specification references TxDOT, ASTM and AASHTO test procedures, but doesn't stipulate that technicians are certified. We would suggest standardizing all testing to follow TxDOT's test procedures and require anyone conducting those tests to be certified.

The attached Item 341M Municipal Dense-Graded Hot-Mix Asphalt was developed by the Texas Asphalt Pavement Association (TXAPA) in conjunction with the AGC of Texas to provide a standardized, current and streamlined specification that follows the general layout of TxDOT's 341 Dense Graded Hot Mix Asphalt specification. It places much of the quality control / quality acceptance burden on the asphalt producer to ensure local agencies aren't overly taxed with additional duties, but ensures they get a high quality asphalt product.

Submission 7: Revision to 303.5.6.2

Form Submission: *"Class C 3600 PSI has a minimum of 564 lbs but the Class P1 Machine finish 4000 PSI has a min of 517 lbs, a ½ sack less than what's required for the lesser min compressive strength at 28 days. Also Class P2 hand finish has a min of 564 lbs and 4500 PSI at 28 days and is only a ½ sack more than the P1 machine requirements. IN 303.5.6.2 Hand, the specification states "an addition of one-sack of cement per cubic yards shall be required for all hand." This contradicts P1 and P2 (only ½ sack added) and if Class C is required for hand design the full sack is more than the min in P2 of a higher required strength. Also, Class C 3600 PSI Min Cementitious of 564 is more than the minimums in P1 and P2 that have higher minimum compressive strengths.*

- *What is Class C purpose?*
- *Can minimum sack requirement be decreased? 517?"*

Current Version of PW Construction Standards:

Division 300 Roadway Construction, Item 303 Portland Cement Concrete Pavement, Construction Methods, Finishing, Hand

303.5.6.2. Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. The addition of one-sack of cement per cubic-yard shall be required for all hand finish concrete.

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation the strike template shall be moved forward with a combined longitudinal and transverse motion and so manipulated that neither end of the template is raised from the forms during the striking-off process. A slight excess of material shall be kept in front of the cutting edge at all times.

The straightedge and joint finishing shall be as hereinabove prescribed.

Table 303.3.4.2.(a) Standard Classes of Pavement Concrete.

Class of Concrete[1]	Minimum Cementitious Lb./CY	28 Day Min. Compressive Strength[2] psi	28 Day Min. Beam Strength[2,3] psi	Maximum Water/ Cementitious Ratio	Coarse Aggregate Maximum Size[4]
A[5]	470	3000	500	0.58	1½"
C	564	3600	600	0.53	1½"
P1[6]	517	4000	N/A	0.49	1½"
P2[7]	564	4500	N/A	0.45	1½"
M	As directed by the OWNER or as shown on the plans				

1. All exposed horizontal concrete shall have entrained – air.
2. Minimum Strength Required by OWNER [Compressive or Flexural]
3. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is Used
4. Smaller nominal maximum size aggregate may be used if strength requirement is satisfied
5. Sidewalks, separate curb and gutter, and 4-inch thick median pavement
6. Machine Finished
7. Hand Finished

Recommended Revision:

303.5.6.2. Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. ~~The addition of one-sack of cement per cubic-yard shall be required for all hand finish concrete.~~

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation the strike template shall be moved forward with a combined longitudinal and transverse motion and so manipulated that neither end of the template is raised from the forms during the striking-off process. A slight excess of material shall be kept in front of the cutting edge at all times.

Attachment:

- COG-Min Sack Req 1-23-26 (attached)

Review Comments for Submission #7

As stated in my original email the contradiction occurs in 303.5.6.2 stating an addition of one-sack cement per CY is required for hand but per table 303.3.4.2 the minimum in hand P2 is only one – half sack more than machine placement in P1.

- To avoid contradiction, I suggest striking the sentence in 303.5.6.2 requiring addition of one -sack and directing to Table 303.3.4.2 (a) for minimum hand finishing sack requirement in P2.

Also, Class C 3600 PSI Min Cementitious of 564 is more than the minimums in P1 and P2 that have higher minimum compressive strengths.

- What is Class C purpose?
- Can minimum sack requirement be decreased? 517?

Table 303.3.4.2.(a) Standard Classes of Pavement Concrete.

Class of Concrete[1]	Minimum Cementitious Lb./CY	28 Day Min. Compressive Strength[2] psi	28 Day Min. Beam Strength[2,3] psi	Maximum Water/ Cementitious Ratio	Coarse Aggregate Maximum Size[4]
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P2[7]	564	4500	N/A	0.45	1½"
M	As directed by the OWNER or as shown on the plans				

1. All exposed horizontal concrete shall have entrained – air.
2. Minimum Strength Required by OWNER [Compressive or Flexural]
3. ASTM C78 (Third-Point); Reduce by 10% when Type II Cement is Used
4. Smaller nominal maximum size aggregate may be used if strength requirement is satisfied
5. Sidewalks, separate curb and gutter, and 4-inch thick median pavement
6. Machine Finished
7. Hand Finished

303.5.6.2. Hand. Hand finishing shall be permitted only in intersections and areas inaccessible to a finishing machine. The addition of one-sack of cement per cubic-yard shall be required for all hand finish concrete.

When the hand method of striking off and consolidating is permitted, the concrete, as soon as placed, shall be approximately leveled and then struck off and screeded to such elevation above grade that, when consolidated and finished, the surface of the pavement shall be at the grade elevation shown on the plans. The entire surface shall then be tamped and the concrete consolidated so as to insure maximum compaction and a minimum of voids. For the strike off and consolidation, both a strike template and tamping template shall be provided on the work. In operation the strike template shall be moved forward with a combined longitudinal and transverse motion and so manipulated that neither end of the template is raised from the forms during the striking-off process. A slight excess of material shall be kept in front of the cutting edge at all times.

The straightedge and joint finishing shall be as hereinabove prescribed.

Submission 8: Revision to Section 1, Division 100, Item 109.3

Form Submission: "*Sub-item 1 of Paragraph 109.3.2 has two sentences. One addresses payment on a unit price basis, while the other addresses payment on a lump sum basis. It appears that there should have been a hard return prior to the second sentence, placing the lump sum basis as the second option for compensating a contractor for Extra Work. (And then existing sub-items 2 and 3 would be re-numbered to become 3 and 4.)*"

Current Version of PW Construction Standards:

Division 100 General Provisions, Item 109 Measurement and Payment, Payment for Extra Work

109.3.2. Method of Determination. The method of determination and payment of cost, or credit to the OWNER, for any Extra Work shall be one of the following:

(1) Unit prices agreed on in writing, approved by the OWNER and executed by the OWNER and CONTRACTOR before the Extra Work is commenced, or unit prices already included in the Contract documents, subject to all other conditions of the Contract. Mutual acceptance of a not-to-exceed lump sum properly itemized and supported by sufficient substantiating data to permit evaluation before the Extra Work is commenced, subject to all other conditions of the Contract.

(2) A not-to-exceed cost to be determined in a manner agreed upon by the parties plus a mutually acceptable fixed or percentage fee, agreed upon before the Extra Work is commenced and subject to all other conditions of the Contract.

(3) The force account method provided in Item 109.3.3. Force Account Work.

Recommended Revision:

109.3.2. Method of Determination. The method of determination and payment of cost, or credit to the OWNER, for any Extra Work shall be one of the following:

(1) Unit prices agreed on in writing, approved by the OWNER and executed by the OWNER and CONTRACTOR before the Extra Work is commenced, or unit prices already included in the Contract documents, subject to all other conditions of the Contract.

(2) Mutual acceptance of a not-to-exceed lump sum properly itemized and supported by sufficient substantiating data to permit evaluation before the Extra Work is commenced, subject to all other conditions of the Contract.

(3) A not-to-exceed cost to be determined in a manner agreed upon by the parties plus a mutually acceptable fixed or percentage fee, agreed upon before the Extra Work is commenced and subject to all other conditions of the Contract.

(4) The force account method provided in Item 109.3.3. Force Account Work.

Attachment:

- Pages from NCTCOG Amended 5th Edition (attached)

Review Comments for Submission #8

included under this paragraph, disallowed costs or other future additional money or time shall be accepted; each change order shall be specific and final as described in Item 104.2.4 Finality of Change Orders.

109.3.2. Method of Determination. The method of determination and payment of cost, or credit to the OWNER, for any Extra Work shall be one of the following:

(1) Unit prices agreed on in writing, approved by the OWNER and executed by the OWNER and CONTRACTOR before the Extra Work is commenced, or unit prices already included in the Contract documents, subject to all other conditions of the Contract. Mutual acceptance of a not-to-exceed lump sum properly itemized and supported by sufficient substantiating data to permit evaluation before the Extra Work is commenced, subject to all other conditions of the Contract.

(2) A not-to-exceed cost to be determined in a manner agreed upon by the parties plus a mutually acceptable fixed or percentage fee, agreed upon before the Extra Work is commenced and subject to all other conditions of the Contract.

(3) The force account method provided in Item 109.3.3. Force Account Work.

109.3.3. Force Account Work. If the CONTRACTOR and the OWNER cannot agree to one of the methods of calculating cost provided in Item 109.3.2. Method of Determination above, or if the parties agree to a method er reason fails or refuses to sign the n order signed by the OWNER, shall be construed to relieve the of Item 104.3. Disputed Work and tra or Disputed Work, and where well as this Item 109.3.3. Force a force account basis, on the basis s, plus a reasonable allowance for overhead, profit, markups of other SUBCONTRACTORS and suppliers, general supervision, field office expense and other elements of cost not embraced within the actual field cost as specified herein, such allowance in any case never to exceed 15%. In such case, the CONTRACTOR shall keep a detailed itemized account of the work involved and the actual field cost incurred, in a format acceptable to the OWNER and with such appropriate supporting data as the OWNER may prescribe. Sworn copies of the itemized accounting shall be directed to the OWNER each day during the performance of the force account work. Failure of the CONTRACTOR to submit the sworn-to itemized accounting daily as required herein shall constitute a waiver by the CONTRACTOR of any right to dispute the OWNER'S determination of the amount due the CONTRACTOR for force account work.

It appears that the highlighted statement should have been its own, numbered item, which would result in these compensation options:
(1) = unit price
(2) = lump sum
(3) = NTE + a fee
(4) = force account

Actual, reasonable field cost of the work to be charged under this Item 109.3.3. Force Account Work for force account work is limited to the following:

(1) The reasonable wages of all workers, foremen, timekeepers, mechanics and laborers, plus costs of social security, old age and unemployment insurance, fringe benefits required by agreement or custom (excluding employee or executive bonuses), and worker's compensation insurance, for the time such labor is actually employed or used on force account work.

(2) Reasonable costs of materials, tools, supplies and equipment (but not to include off-site storage unless so approved and directed in writing by the OWNER), whether incorporated or consumed into the force account work.

(3) Reasonable rental costs of machinery and equipment, exclusive of hand tools, only for the time actually employed or used on force account work, whether rented from the CONTRACTOR or others.

(4) A pro rata portion of premium expenses for all bonds and insurance to the extent force account work would cause an increase in such bond or insurance premiums.

Pending final determination of the cost to the OWNER, payment of undisputed amounts on force account shall be included on the monthly estimate as work is completed unless otherwise expressly provided in the written order signed by the OWNER to perform the work. Nothing in this Item 109.3.3. Force Account Work shall be construed as directing the CONTRACTOR'S means and methods of performing the work in question.

109.3.4. Distinguishing Extra Work. For purposes of this Item or any other provision of the Contract documents that allows a claim for Extra Work, the term "Extra Work" means work that is not reasonably within the scope of the Contract Documents or not otherwise incidental or necessary to performance of the