Ordinance No. 129 – **2020**

Accepting The Bid Of Performance Pipelining, Inc., 1551 W. Norris Drive, Ottawa, Illinois 61350 For Furnishing Labor, Materials And Equipment For The Sanitary Sewer Rehabilitation Project, Phase 5, Part A; Authorizing The Mayor, Director of Public Service And Finance Director To Enter Into A Contract With Said Contractor; And Declaring An Emergency

Summary And Background

Ordinance No. 1-2020 passed by Oregon City Council on January 13, 2020, the Director of Public Service was authorized to take bids for projects, such as the Sanitary Sewer Rehabilitation Project, Phase 5 – Part A.

Bids were advertised in accordance with law and were received and opened on October 21, 2020 and October 27, 2020.

The project will be financed with a low interest loan through the OEPA Water Pollution Control Loan Fund, and the City also received a $450,000 grant and $450,000 loan through the Ohio Public Works Commission (OPWC) for the construction of this project.

The said project is included in the approved 2020 CIP Budget under 340.3150.57739. **Now, Therefore,**

Be It Ordained By The Council Of The City Of Oregon, Ohio, That:

Section 1. The bid of Performance Pipelining, Inc., 1551 W. Norris Drive, Ottawa, Illinois 61350 for the Sanitary Sewer Rehabilitation Project, Phase 5 – Part A in a total amount of One Million Six Hundred Eighty-Seven Thousand Eight Hundred Fifty-Four and 29/100 Dollars ($1,687,854.29) be in the same is hereby accepted as the lowest and best bid in accordance with prices as set forth in Exhibit A, attached hereto and made a part hereof.

Section 2. The Mayor, Director of Public Service and Finance Director are hereby authorized to enter into a contract with Performance Pipelining, Inc. in an amount not to exceed $1,687,854.29 for the Sanitary Sewer Rehabilitation Project, Phase 5- Part A.

Section 3. It is hereby found and determined that all formal actions of this Council concerning and relating to the passage of this Ordinance were adopted in an open meeting of this Council and that all deliberations of this Council and any of its committees that resulted in such formal actions were in meetings open to the public in compliance with all legal requirements, including Section 121.22 of the Ohio Revised Code and that the consideration, reading and adoption of this Ordinance has been in accordance with Article III, Section 9 of the City Charter as amended.

Section 4. This Ordinance is hereby declared to be an emergency measure and shall take effect upon its passage and signature by the Mayor. The reason for the emergency lies in the fact that this Ordinance is necessary to let the construction contracts and begin construction in a timely manner.

Vote on passage as an emergency: Yeas 6 Nays 0 Abs. 0

Passed as an emergency measure: December 21, 2020

President of Council

Attest:

Clerk of Council

Approved:

Mayor

"Exhibit A"

City of OREGON Ohio

interoffice

MEMORANDUM

Department of Public Service

From: Don Nelson
Environmental Specialist

Date: October 30, 2020

To: Michael J. Seferian, Mayor
Michael Beazley, City Administrator
Oregon City Council Members

cc: File

Through: Paul Roman, P.E. - Director of Public Service

Subject: Project Award Recommendation

Project: Sanitary Sewer Rehabilitation Project, Phase 5, Part A

On Wednesday, October 21, 2020 bids for the Sanitary Sewer Rehabilitation Project, Phase 5, Part A were opened by the Department of Public Service (See the attached Bid Tabulation). There were five (5) bidders on the project and the two lowest bids received were from BLD Services, LLC, 2424 Tyler Street, Kenner, LA 70062 at a price of $1,670,932.00. and from Performance Pipelining Inc., 1551 W. Norris Drive, Ottawa, IL 61350, at a price of $1,687,854.29. This work includes the trenchless rehabilitation of sanitary sewers, sanitary sewer service laterals, and sanitary sewer manholes in the South Shore Park subdivision of the City. This work also includes sewer spot repairs within the project area. These sanitary sewers were constructed in the mid - late 1960's and are made of vitrified clay sewer pipe. For specific roads within the project area, see the attached project map.

While reviewing the two companies, their methods, and their products, it was determined that BLD Services, LLC (BLD) is proposing to use a lateral lining product that does not meet the City's engineering specification for lateral lining. Specifically, the product does not meet ASTM F2561-20, which requires the use of a molded expandable neoprene gasket at the mainline / lateral sanitary sewer connection. In lieu of this gasket, BLD's product uses a paste like material that is placed by caulk gun on the liner at this connection. As noted on City CCTV sewer inspection video in this project area as well as many others, the mainline to lateral connection is a major source of Inflow/Infiltration, as these connections fail over time especially in vitrified clay sewer pipe. Though BLD is stating that the watertightness with their product is the same as the ASTM F2561-20 specification, it is our opinion that the molded gasket is a more permanent and watertight connection. We also question the consistency in the volume of material applied to for each and every lateral in the field versus the factory-made molded neoprene gasket.

While doing research on the two products, a report that was presented at the 2018 North American Society for Trenchless Technology (NASTT) No-Dig show entitled "Best Value Engineered Design for a Sealed CIPP Collection System," Paper Number TA-T3-04, was found. In this report it is noted that, over time, all Cured in Place Pipe (CIPP) liners under hydrostatic pressure (groundwater pressure) will undergo pressure creep (shrink in circumference) (Beaudet, P.E. et. al., 2018). This will cause an annular space to form between the installed liner and the

original host pipe. This space is large enough to allow groundwater to migrate along the pipe liner and into the sewer via nearby sewer tap connections. In this situation an expandable gasket will prevent this water from infiltrating into the sewer pipe. Though both the BLD paste material and the ASTM F2561-20 molded gaskets are expandable, the F2561-20 molded gasket has the capability to expand 190% or 0.3"; while the BLD paste has the capability to expand 100% or 0.012" (Beaudet, P.E., et. al., 2018). Beaudet, P.E., et. al., 2018 concluded that after eight (8) years, the annular space between the host pipe and the liner would be greater than the BLD paste's ability to expand. This would allow groundwater infiltration passed the seal and into the sewer.

Based on the above information, the BLD product is not an approved equal to the City's lateral lining specification. See the attached images for comparison of the two different lateral lining systems and the attached excerpt from the report cited above.

The 2nd low bidder, Performance Pipelining, Inc. (PPI), is planning to use a lateral lining system (LMK T-Liner) that does meet the City's Lateral Lining Specification and ASTM F2561-20. This system does include the molded expandable gaskets. To date, the City has installed six hundred and sixty (660) ASTM F2561-20 lateral liners since the Sanitary Sewer Rehabilitation Project Phase 3 in 2015. The City has followed up with CCTV inspections of these liners and have found very few issues. Any issues that were found were corrected by the contractor at no cost to the City.

PPI has a good track record of successful projects with the City of Oregon. In 2015 – 2016, PPI completed the Sanitary Sewer Rehabilitation Project, Phase 3 project and was on time and under budget (contract award: $1,929,000.00, final construction cost: $1,776,066.53). Also, in 2018 – 2019, PPI completed the Sanitary Sewer Rehabilitation Project, Phase 4, Part C for the City of Oregon. This project was in the Moundview Subdivision where sewers are located in tight backyard easements. This made for a difficult project and working conditions, yet PPI was able to complete the project on time and under budget (contract award: $2,438,000.00, final construction cost: $1,957,182.30). PPI has also completed similar projects for the Northwestern Water and Sewer District in Walbridge, Ohio as well as, multiple other cities across Ohio and the Midwest.

Based on the review of the best bid criteria including the proposed products and methods, project references, and PPI's work experience in Cured in Place sewer lining, PPI is hereby the lowest and best bid and is recommended for contract award in the amount of $1,687,854.29.

Since the project is contingent upon the City of Oregon securing funding from the Ohio EPA Water Pollution Control Loan Fund (WPCLF), the following information must be submitted to the Ohio EPA, Division of Environmental and Financial Assistance (DEFA), for contract endorsement:

1. Copy of Addendum #1
2. Copy of successful bidder's proposal
3. Bid tabulation
4. Copy of this correspondence
5. Signed copy of the Contractor's Equal Employment Opportunity Certification
6. Signed copy of the Certification Regarding Debarment, Suspension, and other Responsibility Matters
7. DBE Form 6100-4 completed by the bidder and alternate Good Faith Efforts documentation

8. Signed copy of the American Iron and Steel Acknowledgement Form
9. Resolution from the City of Oregon tentatively awarding the contract to the successful bidder
10. Copy of the attorney site title opinion that all sites, easements / and or right-of-way necessary to construct the project have been acquired

These items are planned to be submitted to Mr. Samih Al-Jamal, P.E., of Ohio EPA – DEFA on Monday, November 2, 2020.

Should you have any questions concerning this project please feel free to contact the Department of Public Service to discuss further.

Don Nelson
Environmental Specialist

Attachment

References Cited

Beaudet, P.E., B., Kampbell, P.E., N., Muenchmeyer, P.E., G., Back, P.E., T., 2018: "Best Value Engineered Design for a Sealed CIPP Collection System", *NASTT 2018 No Dig Show Palm Springs, California: Paper TA-T3-04*

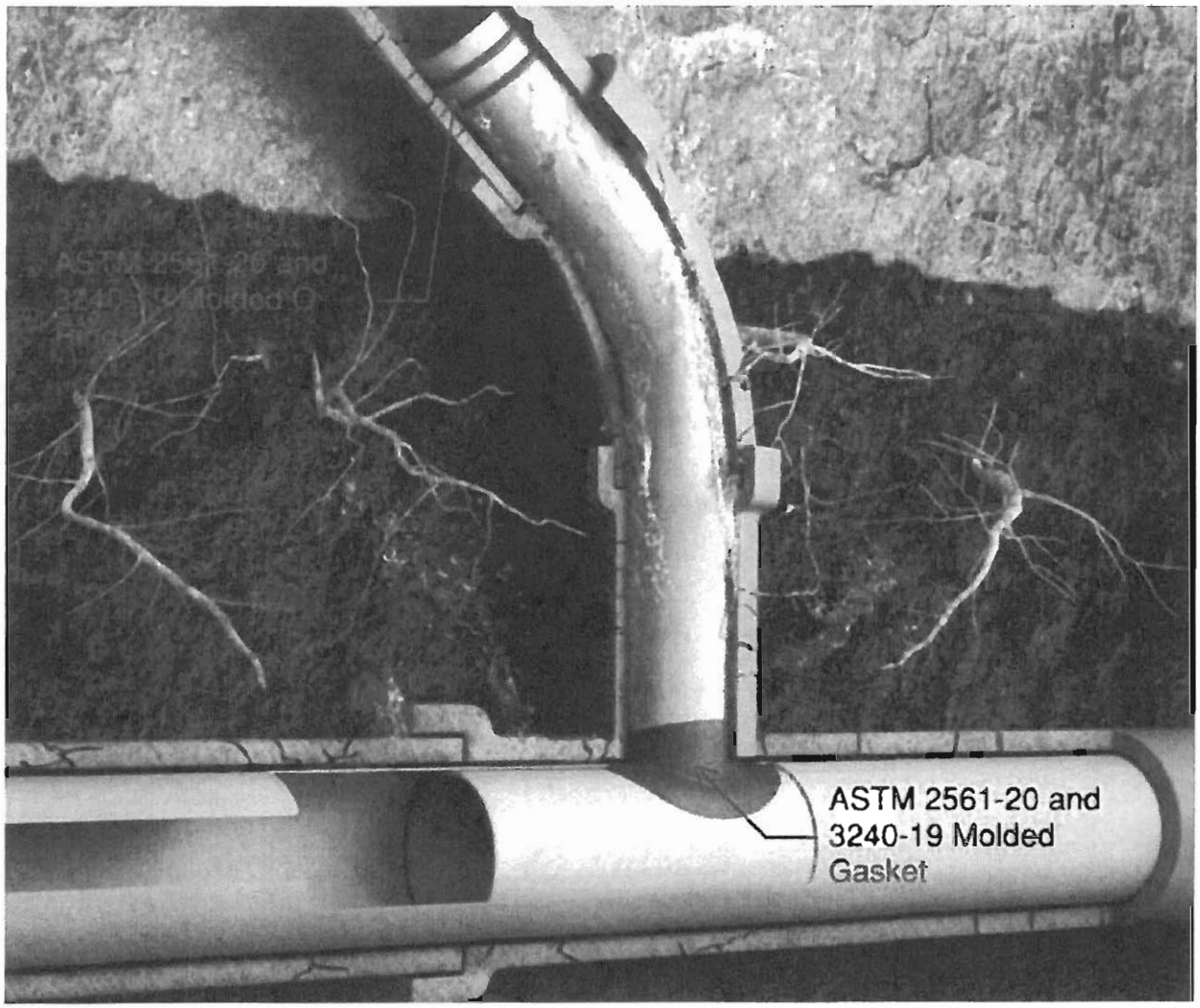

Figure 1: ASTM 2561-20 and 3240-19 Lateral Liner showing molded gasket at mainline / lateral connection

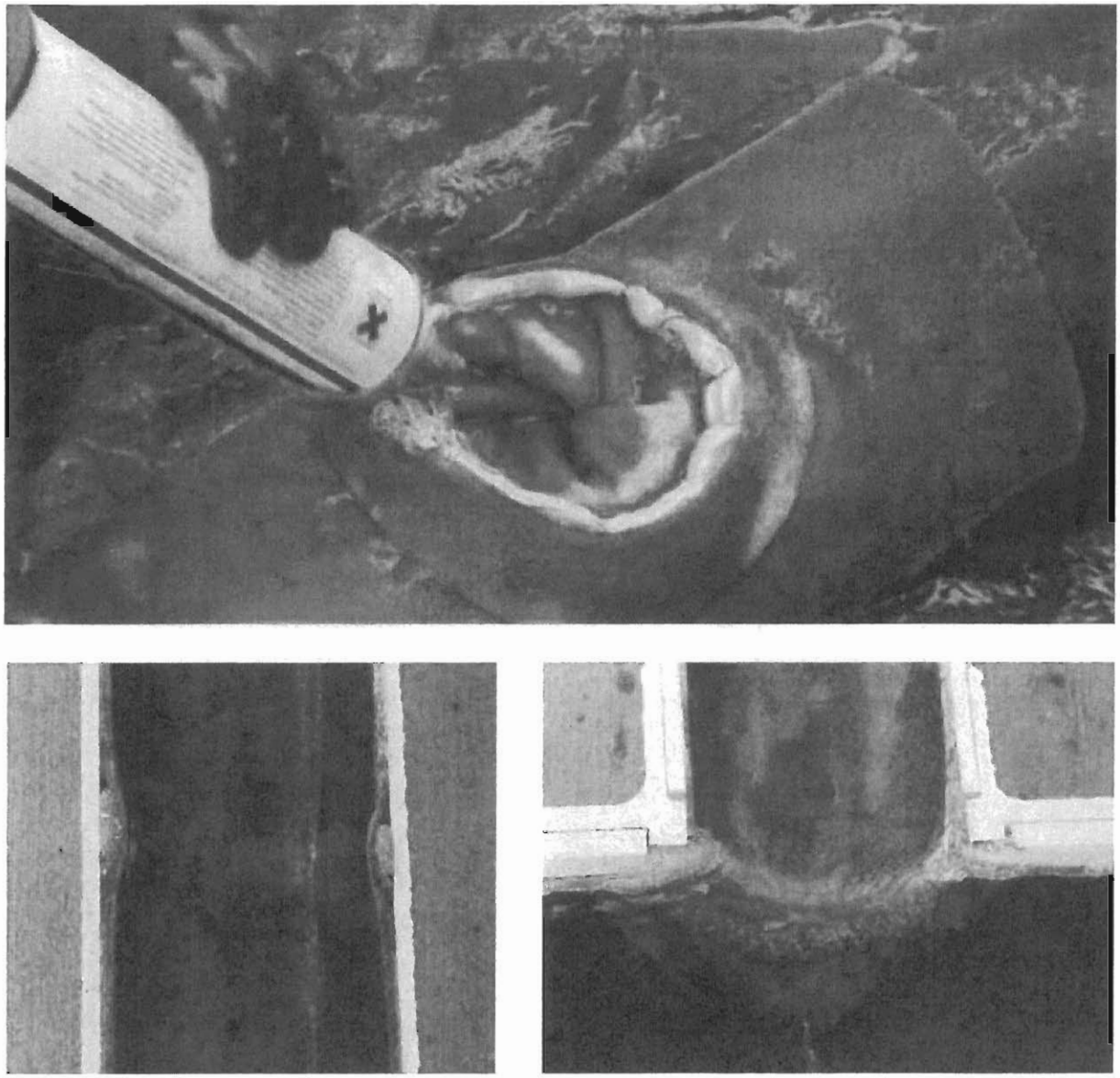

Figure 2: Gunable paste used in BLD Services, LLC Liner at mainline / lateral connection (image source: Adeka P-201 fact sheet)

City of Oregon, Ohio

Sanitary Sewer Rehabilitation Project Phase 5, Part A

Bid Tabulation

Eng. Estimate: $2,200,000.00

Date: 10/21/2020

Time: 2:00 P.M.

Opened by: Paul Roman, P.E.

Witness: D. Nelson, K. Wolfe, R Shultz, P.E.

Bid Tab: D. Nelson

Bid Item	Item Description	Quantity	Unit	Performance Pipelining, Inc. 1551 W. Norris Drive Ottawa, IL 61350		Speer Bros, Inc 3812 Old Railroad Street Sandusky, OH 44870		Musson Bros, Inc 1522 Pearl Street Waukesha, WI 53186		United Survey, Inc 25145 Broadway Oakwood Village, OH 44146		BLD Services, LLC 2424 Tyler Street Kenner, LA 70062	
			Bid Bond:	Penal Sum		Penal Sum		10% Bid Bond		10% Bid Bond		10% Bid Bond	
				Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price
	General Requirements												
1	Mobilization	1	LS	$35,000.00	$35,000.00	$60,000.00	$60,000.00	$150,000.00	$150,000.00	$77,000.00	$77,000.00	$80,000.00	$80,000.00
2	Maintenance of Traffic (ODOT 614)	1	LS	$150.00	$150.00	$10,000.00	$10,000.00	$25,000.00	$25,000.00	$7,500.00	$7,500.00	$10,000.00	$10,000.00
3	Flow Diversion and By-Pass Pumping	1	LS	$150.00	$150.00	$10,000.00	$10,000.00	$10,000.00	$10,000.00	$2,500.00	$2,500.00	$10,000.00	$10,000.00
4	Restoration of Right-of-Way	1	LS	$150.00	$150.00	$20,000.00	$20,000.00	$30,000.00	$30,000.00	$20,000.00	$20,000.00	$2,500.00	$2,500.00
5	Performance Bond	1	LS	$18,500.00	$18,500.00	$50,000.00	$50,000.00	$25,000.00	$25,000.00	$45,000.00	$45,000.00	$50,000.00	$50,000.00
	Sanitary Sewer Mainline - Sewer Cleaning, T.V. Inspection, and Lining of Pipe Sewers												
6	Pre-Rehabilitation Cleaning and Television Inspection of 8-Inch Sanitary Sewer Pipe	9,823	LF	$3.36	$33,005.28	$5.00	$49,115.00	$2.60	$25,539.80	$6.00	$58,938.00	$3.50	$34,380.50
7	Pre-Rehabilitation Cleaning and Television Inspection of 6-Inch Sanitary Sewer Pipe	84	LF	$3.36	$282.24	$5.00	$420.00	$2.60	$218.40	$6.00	$504.00	$3.50	$294.00
8	Post-Rehabilitation Cleaning and Television Inspection of 8-Inch Sanitary Sewer Pipe	9,823	LF	$0.35	$3,438.05	$3.00	$29,469.00	$0.52	$5,107.96	$0.50	$4,911.50	$0.50	$4,911.50
9	Post-Rehabilitation Cleaning and Television Inspection of 8-Inch Sanitary Sewer Pipe	84	LF	$0.35	$29.40	$3.00	$252.00	$0.52	$43.68	$0.50	$42.00	$0.50	$42.00
10	Trimming of Protruding Connections	5	EA	$132.00	$660.00	$300.00	$1,500.00	$130.00	$650.00	$150.00	$750.00	$125.00	$625.00
11	Install Cured-in-Place Pipe Liner in Existing 8-Inch Sanitary Sewer Pipe (6 mm min. thickness)	9,823	LF	$22.44	$220,428.12	$25.00	$245,575.00	$21.84	$214,534.32	$28.50	$279,955.50	$22.00	$216,106.00
12	Install Cured-in-Place Pipe Liner in Existing 6-Inch Sanitary Sewer Pipe (4.5 mm min. thickness)	84	LF	$74.80	$6,283.20	$63.00	$5,292.00	$106.40	$8,937.60	$50.00	$4,200.00	$72.00	$6,048.00
13	Reconnecting Service Connections	210	EA	$110.00	$23,100.00	$130.00	$27,300.00	$104.00	$21,840.00	$130.00	$27,300.00	$125.00	$26,250.00
14	Mainline Liner End Seals	91	EA	$110.00	$10,010.00	$125.00	$11,375.00	$135.20	$12,303.20	$325.00	$29,575.00	$125.00	$11,375.00
15	Sectional Liner: 8" Mainline Part Segment Liner - LMK or Approved Equal Sectional Liner (5' Min.)	30	LF	$700.00	$21,000.00	$500.00	$15,000.00	$580.00	$17,400.00	$489.00	$14,670.00	$500.00	$15,000.00
16	Grouting: Grouting of Mainline Sanitary Sewer prior to lining	50	GAL	$114.00	$5,700.00	$300.00	$15,000.00	$125.00	$6,250.00	$15.00	$750.00	$100.00	$5,000.00
	Sanitary Sewer Laterals - Rehabilitation of Laterals												
17a	Installation of 6" Cleanout through sod, if required, and if residential cleanout does not exist outside of home, complete, brought to 4" below grade with watertight cleanout cap.	72	EA	$1,900.00	$136,800.00	$2,500.00	$180,000.00	$1,000.00	$72,000.00	$1,550.00	$111,600.00	$1,400.00	$100,800.00

City of Oregon, Ohio

Sanitary Sewer Rehabilitation Project Phase 5, Part A

Bid Tabulation

Eng. Estimate: $2,200,000.00

Date: 10/21/2020

Time: 2:00 P.M.

Opened by: Paul Roman, P.E.

Witness: D. Nelson, K. Wolfe, R Shultz, P.E.

Bid Tab: D. Nelson

					Performance Pipelining, Inc.		Speer Bros, Inc		Musson Bros, Inc		United Survey, Inc		BLD Services, LLC	
					1551 W. Norris Drive Ottawa, IL 61350		3812 Old Railroad Street Sandusky, OH 44870		1522 Pearl Street Waukesha, WI 53186		25145 Broadway Oakwood Village, OH 44146		2424 Tyler Street Kenner, LA 70062	
				Bid Bond:	Penal Sum		Penal Sum		10% Bid Bond		10% Bid Bond		10% Bid Bond	
Bid Item	Item Description	Quantity	Unit		Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price
17b	Installation of 6" Cleanout in pavement or stoned park areas, if required, and if residential cleanout does not exist outside of home, complete, brought to 4" below grade with watertight cleanout cap.	10	EA		$2,750.00	$27,500.00	$3,500.00	$35,000.00	$1,250.00	$12,500.00	$1,700.00	$17,000.00	$2,200.00	$22,000.00
18	SHORT LATERAL LINER: One piece short mainline / lateral connection liner system with Lateral Main Connection (LMC) seal in active laterals, no cleanout to be used, complete, 0' – 9.99' in length	24	EA		$3,550.00	$85,200.00	$4,500.00	$108,000.00	$3,400.00	$81,600.00	$2,700.00	$64,800.00	$3,250.00	$78,000.00
19	SHORT LATERAL LINER: One piece short mainline / lateral connection liner system with Lateral Main Connection (LMC) seal in active laterals, no cleanout to be used, complete, 10' – 20' in length	65	EA		$3,600.00	$234,000.00	$4,700.00	$305,500.00	$3,625.00	$235,625.00	$3,100.00	$201,500.00	$3,450.00	$224,250.00
20	FULL LENGTH LATERAL LINER – One piece lateral lining system with Lateral Main Connection (LMC) seal in active laterals cleanout to be used, complete, 10 ' – 19.99' in length	10	LF		$3,800.00	$38,000.00	$4,700.00	$47,000.00	$3,625.00	$36,250.00	$3,300.00	$33,000.00	$3,450.00	$34,500.00
21	FULL LENGTH LATERAL LINER – One piece lateral lining system with Lateral Main Connection (LMC) seal in active laterals cleanout to be used, complete, 20 ' – 29.99' in length	36	EA		$3,900.00	$140,400.00	$4,800.00	$172,800.00*	$3,900.00	$140,400.00	$3,985.00	$143,460.00	$3,850.00	$138,600.00
22	FULL LENGTH LATERAL LINER – One piece lateral lining system with Lateral Main Connection (LMC) seal in active laterals cleanout to be used, complete, 30 ' – 39.99' in length	51	EA		$4,000.00	$204,000.00	$5,000.00	$255,000.00	$4,100.00	$209,100.00	$4,700.00	$239,700.00	$4,250.00	$216,750.00
23	FULL LENGTH LATERAL LINER – One piece lateral lining system with Lateral Main Connection (LMC) seal in active laterals cleanout to be used, complete, 40 ' – 49.99' in length	24	EA		$4,200.00	$100,800.00	$5,100.00	$122,400.00	$4,550.00	$109,200.00	$5,800.00	$139,200.00	$5,250.00	$126,000.00
24	FULL LENGTH LATERAL LINER – One piece lateral lining system with Lateral Main Connection (LMC) seal in active laterals cleanout to be used, complete, 50' and greater in length	4	EA		$4,500.00	$18,000.00	$5,600.00	$22,400.00	$4,850.00	$19,400.00	$5,900.09	$23,600.36	$5,850.00	$23,400.00
25	LATERAL LINING THROUGH EXISTING LATERAL WYES -providing labor, method, and all materials necessary to line through existing sanitary sewer lateral single and double wyes, lining past branches that are capped	19	EA		$3,000.00	$57,000.00	$3,500.00	$66,500.00	$2,000.00	$38,000.00	$1,000.00	$19,000.00	$250.00	$4,750.00
26	GROUTING: Grouting of sanitary sewer laterals prior to lining	50	GAL		$114.00	$5,700.00	$300.00	$15,000.00	$125.00	$6,250.00	$15.00	$750.00	$100.00	$5,000.00
27	LATERAL LINING - Misc. 6" lateral lining per linear foot as needed	100	LF		$65.00	$6,500.00	$110.00	$11,000.00	$30.00	$3,000.00	$113.00	$11,300.00	$20.00	$2,000.00
28	MANHOLE OUTSIDE DROP CONNECTION LINING - 8" drop connection lining per vertical linear foot	59	VLF		$550.00	$32,450.00	$750.00	$44,250.00	$560.00	$33,040.00	$1,119.00	$66,021.00	$550.00	$32,450.00

City of Oregon, Ohio

Sanitary Sewer Rehabilitation Project Phase 5, Part A

Bid Tabulation

Eng. Estimate: $2,200,000.00

Date: 10/21/2020

Time: 2:00 P.M.

Opened by: Paul Roman, P.E.

Witness: D. Nelson, K. Wolfe, R Shultz, P.E.

Bid Tab: D. Nelson

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				Bid Bond:	Penal Sum		Penal Sum		10% Bid Bond		10% Bid Bond		10% Bid Bond	
Bid Item	Item Description	Quantity	Unit		Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price	Unit Price	Total Price
	Sanitary Sewer Mainline and Sanitary Sewer Lateral - Pipe Sewer Repair													
29	MAINLINE - PIPE SEWER POINT REPAIR - 8" Pipe Sewer Point Repair (Min 5' Repair) 5' – 15' Est. Excavation Depth	10	LF		$2,145.00	$21,450.00	$1,000.00	$10,000.00	$2,640.00	$26,400.00	$1,950.00	$19,500.00	$1,450.00	$14,500.00
30	MAINLINE – WYE POINT REPAIR - 8" x 8" x 6" Wye excavation and Replacement, including up to 5' of PVC for each wye branch, 5' – 15' Est. Excavation Depth	2	EA		$13,200.00	$26,400.00	$2,000.00	$4,000.00	$14,000.00	$28,000.00	$12,000.00	$24,000.00	$5,250.00	$10,500.00
31	LATERAL - PIPE SEWER POINT REPAIR – 6" pipe sewer point repair (Min 5' Repair) 5' – 15' Est. Excavation Depth	10	LF		$1,100.00	$11,000.00	$500.00	$5,000.00	$2,640.00	$26,400.00	$1,000.00	$10,000.00	$1,250.00	$12,500.00
32	LATERAL – WYE POINT REPAIR – 6" x 6" x 6" Wye Excavation and Replacement, including up to 5' of PVC pipe sewer for each wye branch, 5' – 15' Est. Excavation Depth	8	EA		$5,500.00	$44,000.00	$2,000.00	$16,000.00	$14,000.00	$112,000.00	$5,000.00	$40,000.00	$4,250.00	$34,000.00
	Sanitary Sewer Manholes - Manhole Rehabilitation and Installation													
33	Sanitary Sewer Manhole Lining - (Precast Manhole)	592	VLF		$204.00	$120,768.00	$200.00	$118,400.00	$200.00	$118,400.00	$190.00	$112,480.00	$200.00	$118,400.00
	* Denotes Corrected Number	**TOTAL PROJECT BASE BID:**			**$1,687,854.29**		**$2,088,548.00***		**$1,860,389.96**		**$1,850,507.36**		**$1,670,932.00**	

Note: BLD Services, LLC's bid was opened on 10/27/2020 at 4:00 p.m. due to bid being received by City Security and inadvertantly sent to City mailroom instead of Public Service Dept. prior to original bid opening on 10/21/2020.

Best Value Engineered Design for a Sealed CIPP Collection System

Description

Best Value Engineered Design for a Sealed CIPP Collection System

Authors:
Bevin A. Beaudet, P.E., Bevin A. Beaudet, P.E., LLC
Norman E. "Ed" Kampbell, P.E., Rehabilitation Solutions LLC
Gerhard Muenchmeyer, P.E., Muenchmeyer Associates LLC
Tim Back, P.E., Back Municipal Consulting

Abstract: A major challenge faced by utilities in North America is rehabilitation of aging sewer collection systems. Failure of collection systems causes increased water infiltration, overloading pipes, pumps and wastewater treatment plants, at great public expense. Too often such projects are ineffective. Defects reappear and infiltration continues, resulting in wasted money. There are several requirements for a successful rehabilitation project. First the entire collection system must be sealed. Experience has shown that rehabilitation of main lines only results in infiltration reduction of less than 50%. Manholes and sewer laterals also need rehabilitation. Second, the system needs to be sealed as watertight as possible. Third, the project must be sustainable, capable of performing over the long term, 50-100 years. Cured-In-Place-Pipe (CIPP) lining is the most often used method of trenchless rehabilitation today. Long-term, sustainable sealing of CIPP rehabilitation systems is thus of utmost importance to understand and apply in the field. This paper is focused primarily on trenchless sewer lateral lining and covers:

- Theoretical technical discussion comparing the effectiveness and sustainability of molded rubber compression gaskets, as required by most utilities for new pipe installations, with adhesive-based sealing methods.
- Challenges faced in obtaining a tight seal under typical pipe conditions in the field.
- Independent laboratory testing data of ASTM 2561-compliant neoprene hydrophilic gasket sealing systems.

Publication Date: 2018

Presented at:
NASTT's 2018 No-Dig Show Palm Springs, California
March 25-29, 2018 | Paper Number: TA-T3-04

Non-Member Price: $10.00

Discounted Member Price: $0.00

Your Price: $10.00

Qty 1

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Annual Report (https://www.nastt.org/membership/annual-report/)
Strategic Plan (https://www.nastt.org/membership/strategic-plan/)
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Books (http://www.nastt.org/resources/bookstore/)

Glossary of Microtunneling Terms (https://www.nastt.org/resources/glossary-of-microtunneling-terms/)

Background

A major challenge faced by nearly every utility is how they will address their aging underground infrastructure. Failure over time of sewer collection systems can lead to increased water infiltration which can overload pipes, pumps and wastewater treatment plants, at great public expense. Wastewater leaking from the collection system can also lead to pollution of surrounding soils, groundwater, and waterways. Wastewater utilities in North America spend billions of dollars annually to rehabilitate their aging sewer collection systems. Too often, however, rehabilitation projects do not fix the problem: defects reappear and sometimes become worse, infiltration continues, and the money spent to fix the pipelines is wasted. In some cases, the work must be done a second time, resulting in avoidable expenditures of ratepayer revenues and State Revolving Fund (SRF) loans.

There are several requirements for a successful system renewal project. First it is necessary to seal the entire collection system. Case study after case study has shown that replacement or rehabilitation of only main lines results in less than 50% of the infiltration removal. Manholes, and most importantly sewer laterals that connect businesses and homes to the main pipes, also need to be rehabilitated. Second, the collection system needs to be sealed and as watertight as possible. Third, the project must be sustainable, capable of performing over the long term, for the next 50-100 years.

There are typically two options from which a utility owner can choose to achieve a renewed collection system:

1. Dig and replace thereby installing new pipe, manholes and similar structures, and cleanouts
2. Trenchless rehabilitation

The choice of either should produce the same result: a new or a restored collection system that is "as good as new."

- The first is to dig up the old pipe and replace it with a new one. Dig and replace results in a leak-free line when each segment, including the main, the lateral pipes and manholes, are connected as a watertight system by using an engineered compression gasket. The use of gasket sealing technology provides repeatable performance ensuring a watertight sealed system by when the design adheres to proven engineering principles for pipeline construction. The engineered seal provides repeatable results whereby a sustainable service life can match the 50-year Design Life for a watertight system. The cost and disruption of the dig and replace method should make it a sound choice only when trenchless methods are not suitable due to pipe conditions or other special circumstances.
- The second is to employ a trenchless technology solution, most commonly cured-in-place pipe (CIPP) to accomplish system rehabilitation, repairing the sewer system from within. This solution is generally preferable due to its speed of installation, lower cost, efficiency and minimal social impact when compared to dig and replace. As with the first option, however, an engineered pre-molded gasket must be used to ensure a leak-free system. Many utility owners are experiencing 'good as new results' on their projects when the same "gasket seal design" for new pipe construction is commissioned for CIPP rehabilitation. In other words, they are receiving performance comparable to new pipe construction without the cost, time, and disruption commonly associated with dig and replace.

The use of trenchless technology, however, must also be accompanied by a commitment to sound science and adherence to established engineering standards. For the utility manager to achieve "as good as new pipe" performance from a trenchless CIPP rehabilitation project, the same standards of quality used for new construction must also be practiced and adhered to. ASTM, the international standards setting organization which is relied upon by utility owners and their engineers to develop specifications for trenchless technology, currently publishes several standards for trenchless CIPP sewer rehabilitation.

However, there is only one published ASTM standard that relates to *service lateral renovation using CIPP*. ASTM F2561, **(attachment 1)** defines this industry standard. The purpose of this report is to present comprehensive technical data to support the fact that CIPP "end seals" and ASTM F2561-compliant lateral liners, which use molded hydrophilic gaskets, provide the highest quality, longest lasting and most sustainable solution for any utility seeking to develop and maintain a watertight collection system.

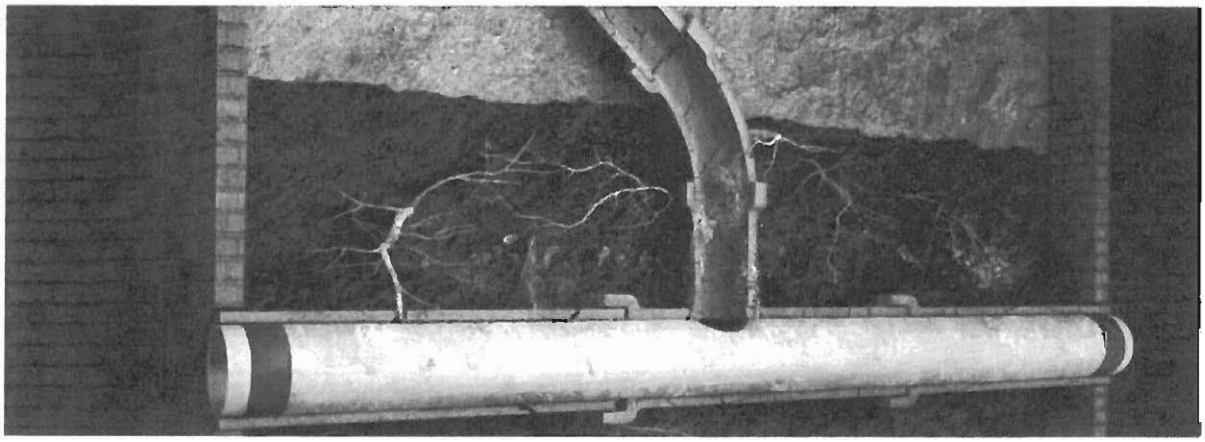


Figure 1 Provides Illustrations of Gaskets for Sealing Manhole Connections.

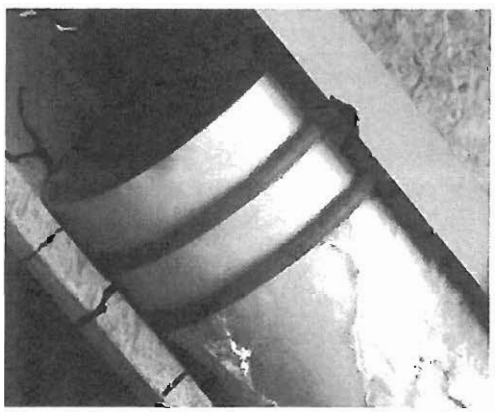


Figure 2 Hydrophilic O-rings at terminating end of CIPP lateral liner

Figure 2 provides illustration of sealing upper terminating end of lateral CIPP. Figure 3 below provides illustrations of gaskets for sealing lateral connections. The use of molded end seal gaskets provides for a watertight CIPP collection system. It is important to note that the gaskets used in creating F2561-compliant systems also comply with ASTM F477, the Standard Specification for Elastomeric Seals (Gaskets). It is common industry practice for utilities to only use rubber gaskets that meet the F477 standard in all new pipe installation. It stands to reason that those utilities should remain consistent requiring a minimum level of quality for the materials used to ensure a watertight seal for at least fifty (50) years. Molded gaskets provide a watertight seal for each end of a mainline CIPP and service lateral connections.

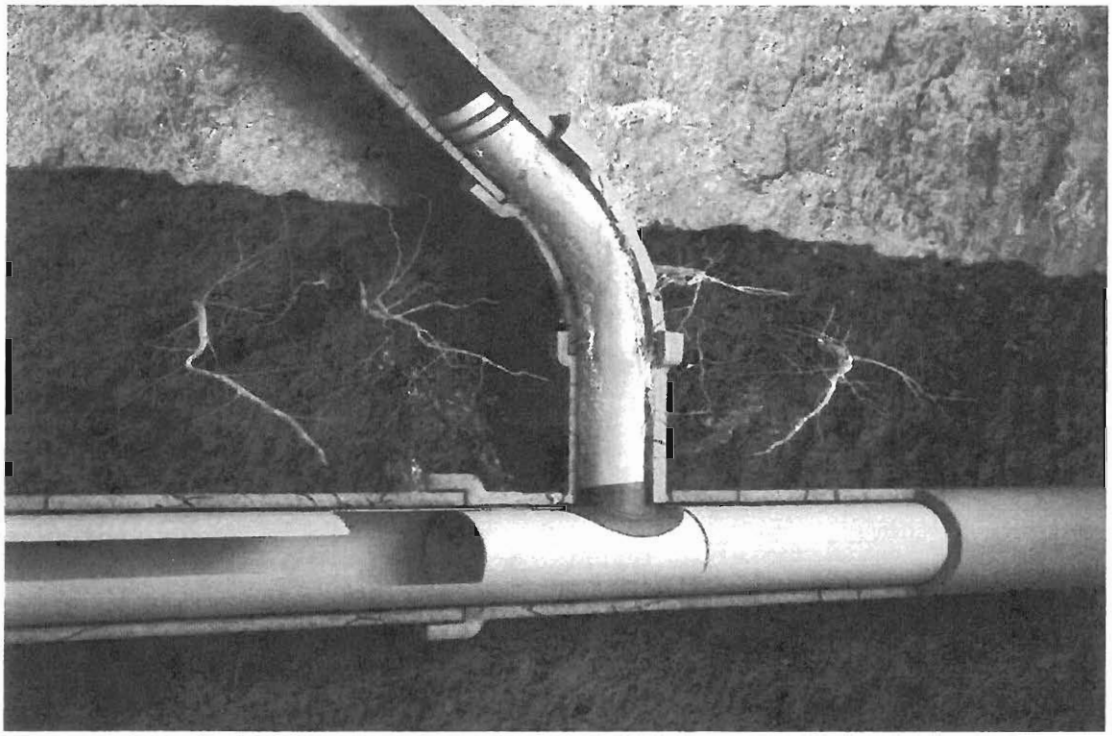


Figure 3 Flange Shaped Gasket for Sealing a Service Lateral Connection

The points that are covered in this report include:

- The technical discussion will clearly point out that all CIPP thermo-set resin systems including epoxy, silicate, polyester, and vinyl-ester are subject to creep and shrinkage and fail to provide long-term sustainability for a watertight collection system.
- A technical discussion as to why molded rubber pipe seals (expansive gaskets), as required and used by many utilities for all new pipe installations, provide a consistent and long-lasting pipe seal for CIPP regardless of the resin system used.
- Test data on both the Insignia™ Neoprene hydrophilic molded gasket sealing system and on the Adeka hydrophilic paste system used by *contractors* when the specification fails to require molded gaskets. This data demonstrates the superiority of the hydrophilic gasket seals and casts doubt on the potential performance and service life of the gunable hydrophilic Adeka paste when used in an uncured state in conjunction with CIPP.
- Four case studies, two of which focus on successful installation of pre-engineered, neoprene hydrophilic lateral liners in areas of high groundwater levels that are also challenged by sea level rise. One study, published and peer-reviewed by the North American Society of Trenchless Technology (NASTT), concerns Coral Gables, Florida; it demonstrates the city's sustained success in reducing infiltration and pump run times. The second case study, from the North Coral Springs Improvement District, also in Florida, clearly shows a significant return on investment based on the long lasting, tight sealing properties of ASTM-compliant lateral liners. A third case study, from Naperville, Illinois, also NASTT peer-reviewed, is the most detailed in presenting the economic benefits of using neoprene hydrophilic gaskets to

seal the end connections of the mainline pipe and the service laterals: Naperville realized an estimated savings of $1.25 million per year and has been able to defer a $6 million treatment plant expansion. The final case study, from Portland, Oregon, presents its unique approach to meeting the CMOM requirements of that City's Consent Order.

- A discussion on the point that ASTM F2561 lateral lining technology can be used to perform difficult tasks that others cannot accomplish with their non-compliant industry standard methods. These include the lining of opposing laterals (double stack and Siamese twin laterals) as well as difficult spot repairs near the old lateral.
- A discussion of structural CIPP failures when the contractor short changes the utility on resin, and the value of clean-outs which includes a sample cost comparison of operating with and without cleanouts.
- A brief discussion of the procurement issues and traps which a utility can face when specifying and bidding lateral liners.
- A partial list of Florida and North American utilities which specify and install ASTM F2561-compliant lateral liners.

Comparison of Sealing Systems

Designing long-lasting seals for CIPP for both main line linings and lateral linings starts with the recognition that all buried pipes are meant to provide a long-lasting water-tight service performance. The primary design elements are to assure the pipe's owner that the *seal made on day one will be there throughout the life of this buried structure*. These elements are: 1) a flexible, preformed gasket of a material that is durable for the service environment for the desired service life, 2) a groove or channel for holding the gasket in place as the pipes are joined together and afterward to facilitate the in-service performance requirements of the sealing function(s), and 3) the right cross-sectional geometry to stand up to the needed operational performance under a constant loading (refer to figures 4 and 5).

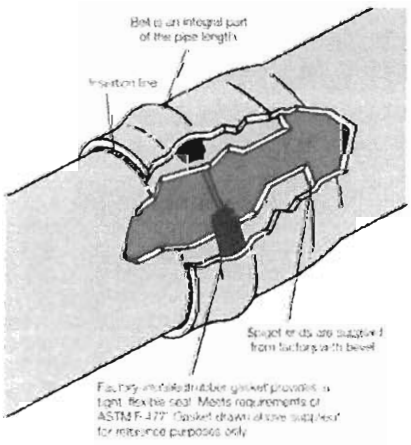


Figure 4 Comparison of Sealing Systems - Groove Contains Molded Gasket

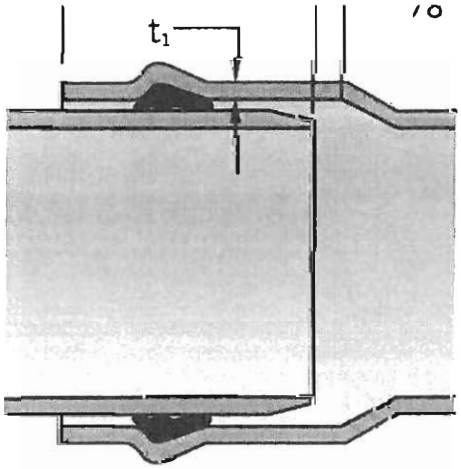


Figure 5 Comparison of Sealing Systems - Gasket Compressed in Groove

Gaskets come in many geometries reflecting whether the need is simply to stop soil and migrating groundwater (rainfall) from intruding into the pipeline, to stop external groundwater (i.e. external hydrostatic pressure) from entering the pipeline such as when the pipeline is below the water table, to hold pressurized fluid inside of the pipeline, or a combination of these functions. The effort required to join the two components of a pipe joint and the allowable misalignment both horizontally and vertically also comes into play because it is a well-established fact that *pipes move with the ground surrounding them over their lifetime*. Further, the gasket must have the ability to press tightly enough (i.e. trying to expand) to seal out the pressure of the intruding fluid (refer to figure 6).

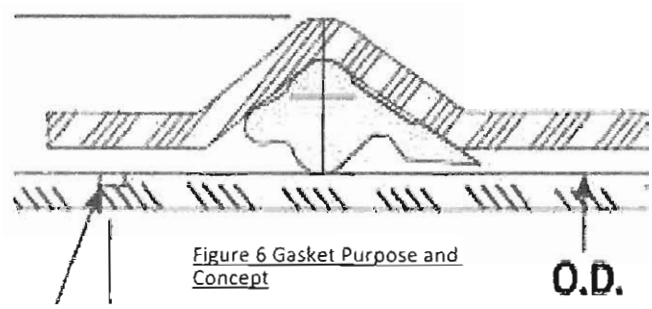
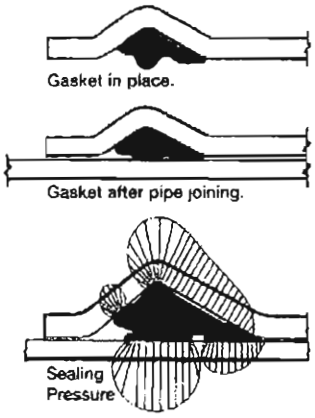


Figure 6 Gasket Purpose and Concept

Also, the groove or channel that holds the gasket in place must also be carefully designed to accommodate the shape of the gasket; holding it in place to properly perform its function (see figure 7).



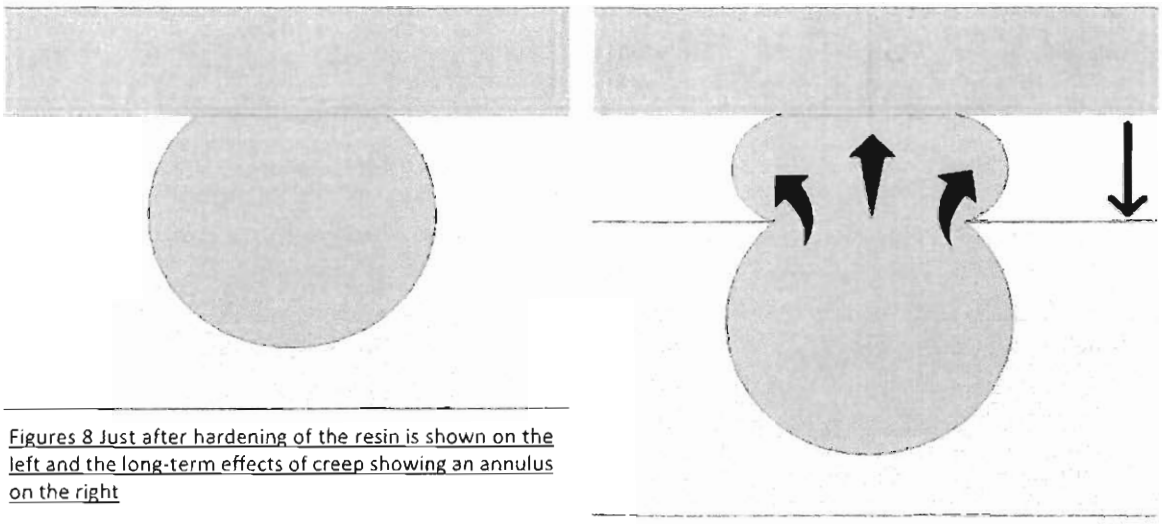
Figures 7 Gasket Design

In CIPP it is a scientific fact that with the resin hardening process comes shrinkage. Standard polyester resins used in lining typically shrink 7-10 % by volume. Recognizing this given parameter, CIPP installers must hold the liner during the hardening process tightly against the host pipe until the hardening is completed and the new CIPP is cooled down to a point that it becomes dimensionally stable. Thus, the inherent volumetric shrinkage occurs in the thickness of the finished liner which can be accounted for in the wall thickness design process. If this controlled cool-down process is not properly executed during the liner's installation, the liner will typically retreat (shrink) inward, leaving a gap between the host pipe and the new liner. The amount of gap formed is directly related to how much the installer has short-changed the installation process.

Additionally, liners under sustained external groundwater pressure creep (i.e. shrink in circumference), which is another form of shrinkage. This means that the gap the gasket needs to fill to make the seal will in fact get larger with time under external hydrostatic pressure, which means that the gasket must be capable of "growing" to continue to fill the space tightly to maintain its sealing capabilities for its intended service life *(refer to figures 8 below)*.

Since the name of the game in the trenchless sewer renewal business is to stop groundwater intrusion, one easy way to give the gasket an ability to grow larger is to chemically modify the rubber used in the gasket's manufacture with a hydrophilic material that will prompt the seal to undergo a "controlled expansion" when in the presence of water so that any voids within the

limits of the gasket's volumetric expansion capability (or coefficient) will be filled by the expansion of the seal. The amount of external hydrostatic head, or groundwater pressure, further requires that the expansion be significant enough to firmly press the gasket against the two mating surfaces at a level that exceeds the groundwater pressure's ability to breach the seal being made.



Figures 8 Just after hardening of the resin is shown on the left and the long-term effects of creep showing an annulus on the right

It would be very easy, and much less costly, if one could simply employ a gun-able caulking material like the ones used in concrete construction for making a seal at a cold joint rather than having to fabricate preformed gaskets that are location specific and capable of addressing the movement of the various building materials with respect to one another over the life of the sealing requirement.

Unfortunately, gun-able caulking materials (i.e. pastes) have the least amount of volumetric expansion, typically on the order of 100%. Further, the installation pressures required during the lateral lining's installation are between 15 and 30 psi. It has been shown that under these pressures a paste material that is not allowed to pre-harden (i.e. cure) prior to its use in the lining process will be reduced to a thickness of 0.008 to 0.0125 inches in thickness (a standard business card has a thickness of between 0.014 and 0.016 inches). At this thickness and its corresponding area spread there is little usable expansive capacity for a "squashed paste" to provide any long-term sealing. Further, it needs to have a channel of some sort to direct or control the expansion process which would not have been created by such a compressible material.

Even in a best case, when the installers faithfully adhere to the controlled cool-down process which keeps the full wrap liner barrel of the lateral lining system tight to the host's wall surface, there remains to be considered the issue of dimensional shrinkage caused from long-term creep. The gap formed after analyzing a standard barrel wrap under just 5.0 feet of groundwater after 7.5 years is approximately .012 inches, equivalent to what has been proposed to be the maximum swelling capability of the paste. The gap over a normal design life of 50-years is approximately 0.050 inches (a U.S. quarter is 0.07 inches thick). This gap is well beyond the capabilities of the "squashed paste" at its thickest if one makes the assumption that it still possesses the ability to grow 100% volumetrically in its thin form without dimensional controls.

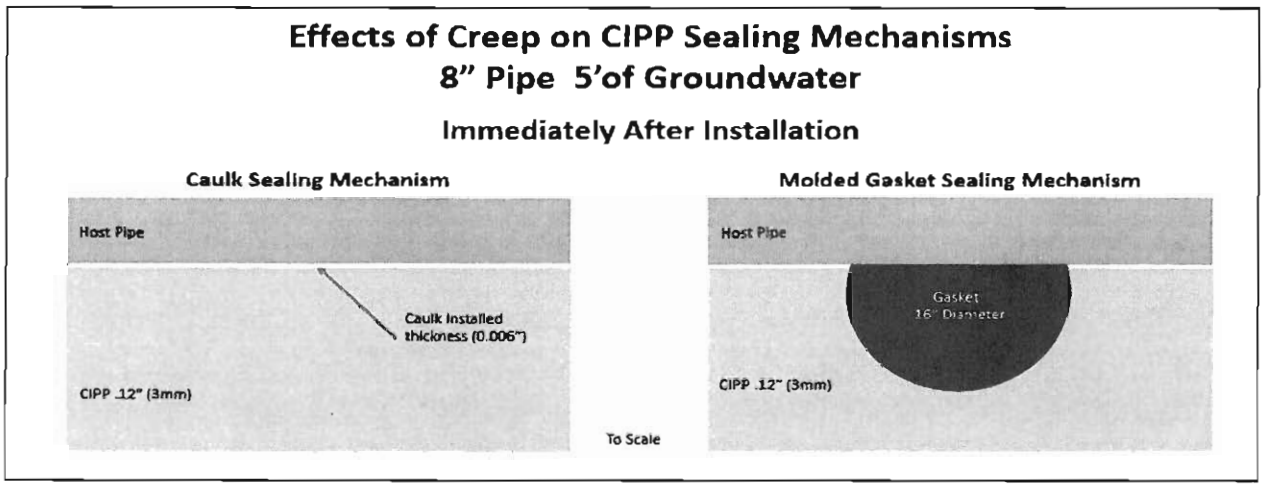


Figure 9a Comparison of Paste and Molded Gasket Immediately After Installation

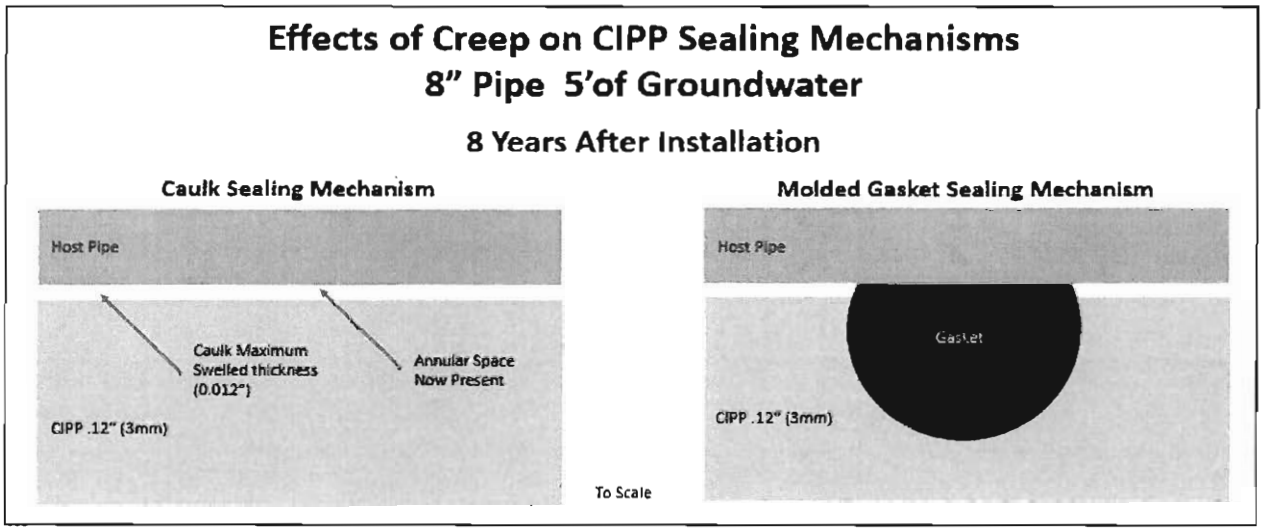


Figure 9b Comparison of Paste and Molded Gasket through time lapse year 8

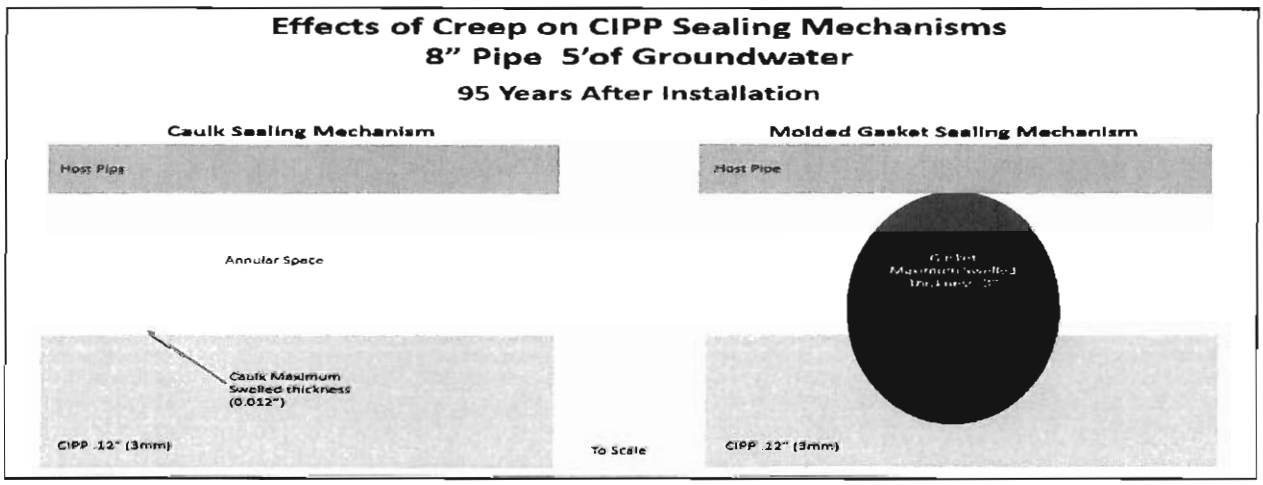


Figure 9c Comparison of Paste and Molded Gasket through time lapse year 95

Such a configuration produces a controlled expansion of the gasket. A conservative increase in thickness of 190% results in maximum thickness of 0.3 inches. An analysis under the same 5.0 feet of ground water shows the O-ring gasket capable of providing a seal for approximately 95 years.

Figure 9A above shows a comparison of the paste and the molded gasket immediately after installation, figure 9b at year 8, and figure 9c at year 95.

The formulation of the preformed gasket material has an engineered minimum volumetric expansion coefficient of 190% assuring a compression seal capable of external hydrostatic head pressures far beyond what will be seen by the in service lateral connection. This makes for a water-tight performance of the system that is on a par with brand new pipe installations.

Specifically, what are the differences between the Adeka paste system used by *contractors* when the specification fails to require molded gaskets? BLD Service, LLC is a *contractor* that advertises Adeka Ultra Seal P-201A as the principle sealing mechanism in their CIPP lateral lining product. The Adeka Ultra Seal P-201A is a Hydrophilic paste substance (gunable material like bathtub caulk) that is manufactured in Japan. When CIPP specifications require gasket seals, contractors install Seamless Hydrophilic Neoprene Molded Gaskets that are manufactured in the United States. Permaliner, LLC and LMK Technologies, LLC are both CIPP producers that provide contractors lateral connection liners that are compliant with ASTM F2561. Both the paste and the Neoprene molded gaskets are hydrophilic; however, there are significant differences in their construction and performance.

Both sealing mechanisms are positioned between the newly installed Cured-in-Place Pipe and the Host pipe. They both rely on their ability to swell to provide the sealing needed to stop water in the annular space that exists with all Cured-in-Place Pipe. As time goes by the annular space can continue to get larger and larger due to movement and creep of the plastic liner. Therefore, the performance of the sealing mechanism is related to its ability to swell repeatedly and the amount that it swells.

The *contractor that* advertises and promotes the use of Adeka Ultra Seal P201A specifies the application of a ½" bead around the circumference of a lateral connection pipe, with installation and inflation pressing the liner/paste against the host pipe occurring with the paste in an uncured state. That *contractor*'s specifications call for installation pressures that range from 15-30 psi depending upon the lateral diameter. Recent testing on those installation pressures by an independent third-party laboratory concluded that the finished thickness of the Adeka paste averaged .006 inches.

According to the Adeka Ultra Seal P201A data sheet, the volume expansion is 100%. To calculate the maximum swelling thickness, a *paste-favorable* approach would be to assume that all the expansion will occur in the thickness dimension. By this approach, the maximum expanded thickness of the paste as applied in the field will be .012" which is less than 1/64". In the real world, the thinness of the seal and the lack of

a groove or channel to control the expansion would mean that no meaningful expansion would occur thus breaking the seal there on day one for the remaining life of the lateral liner. The molded Neoprene gasket that is installed with the ASTM F2561 compliant products has been tested to expand 190% in thickness when exposed to water. The gasket is molded to be .16" thick and so will expand to .3". Therefore, the molded gasket will expand in thickness 25 times greater than paste (taken at the most paste-favorable performance estimate. *see figure 10*).

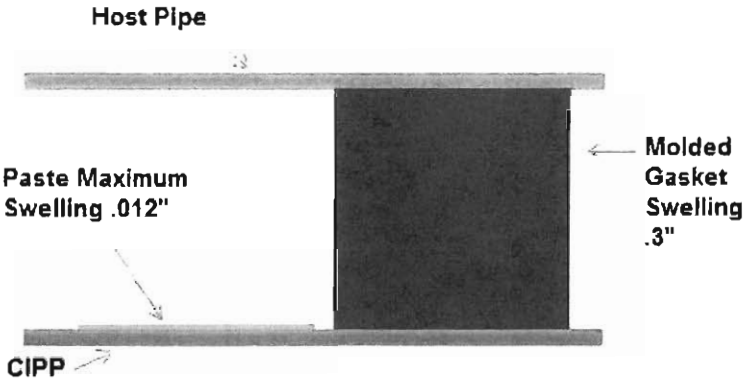


Figure 10 Expansive Properties of Paste versus Molded Neoprene Gasket

This is significant when considering the expected service life (amount of time the CIPP will not leak) of each sealing mechanism. The paste (if applied perfectly and not wiped off which is unlikely) may provide immediate relief but for only a short period of time, whereas the molded Neoprene gasket will provide immediate relief and continue to expand long after the capabilities of the paste have been exceeded. The amount of infiltration that the gasket will keep out over its lifetime versus the paste over its lifetime is quite significant.

Test Data

Two laboratory tests are presented in this report. The first test report is a 10,000-hour hydration/dehydration test run conducted on the Insignia neoprene hydrophilic gasket material. The second test is a short-term test run on the Adeka hydrophilic Paste material in an uncured state.

10,000-Hour Hydration/Dehydration Test

The CIPP gasket sealing system is an engineered solution to the problem of water tracking in the annular space that exists between a CIPP liner and the host pipe. This space exists due to the shrinkage of resins as they undergo polymerization during the process of curing. This water drains back into the sewer collection system affecting the capacity of the sewer system and consequently the capacity of any waste treatment services that the collection system utilizes.

The Insignia™ CIPP Sealing System consists of three construction types of Gasket Seals: O-Rings, Lateral (flanged shape) Connection Hats, and Mainline End Seals for eliminating infiltration from the known sources in a collection system. Neoprene, formerly known as Duprene, is the backbone of the chemical makeup of the Insignia™ Seals. Neoprene is known for its properties

of chemical inertness and maintaining flexibility over a wide range of temperatures. The proprietary neoprene compound further has hydrophilic properties that allow it to absorb water and expand up to190% in volume when left unconstrained. In a pipe, when the seal is constrained between the host pipe and the CIPP liner, the seal swells to close the annular gap between the liner and the pipe preventing extraneous water from infiltrating the CIPP collection system.

Since the Insignia™ Seals are hydrophilic; a concern by the engineering and design team was the long-term performance of the seals when dehydrated or deprived of water. It was this concern that led to the development of the 10,000-hour alternating hydration/dehydration testing of the Neoprene gasket seals. The test comprised of six samples of the gasket seals subjected to various cycles of hydration and dehydration ranging from 48 hours to 10,000 hours. The seals were tested for gain in weight and size when hydrated and the subsequent loss in weight and thickness when dehydrated.

The tests show the gasket seals expand and gain about 800% of their original weight when hydrated for prolonged periods of time. When the seals were dehydrated, they did not exhibit any degradation or loss of materials and maintained their original surface properties, which is a significant find for long-term sealing. The seals maintained their flexibility and expansion properties during continuous hydration and dehydration cycles. The seals also continued to exhibit their expansion properties when subjected to long term dehydration. After numerous hydration and dehydration cycles, the gasket seals were able to retain almost up to 75% of their expansion when dehydrated.

The test results establish (**Attachment 2: 10,000-hour test**) that the Insignia™ Gasket Seals can maintain their water sealing properties when subjected to simulated sewer and ground water conditions of hydration and dehydration. Further, the results establish that the Gasket Seals remained smooth and malleable after multiple cycles of hydration/dehydration providing ideal surface properties for pipe sealing.

Adeka Paste Short-term Test

This short-term test was performed to further understand the characteristics and compressibility of the Adeka P-201A caulk material prior to designing a 10,000-hour hydration/dehydration test to compare with the Insignia™ products. Testing involved utilizing a Universal Testing Machine compress freshly extruded P-201A material to 15 and 30 psi. Several methods were used to cure the paste and release it from two different types of release paper. After seven to ten days of curing, the thickness of the compressed caulk was measured using digital microscopy. The appearance of the P-201A caulk was documented before and after compression and curing. While the product did appear to have both sealing and adhesive properties, it required significant exposure to air to cure, and in some cases, it did not cure at all. It is not yet clear what the mechanism for curing is for this material when it is applied in a relatively air tight environment such as a pipe section buried underground. At 15-30 psi of pressure, the thickness

of P-201A was less than 0.01 inch. At this thickness level, a significant amount of shrinkage voids was observed in areas where curing was complete (see figure 11). These preliminary results do not look promising for use of this material as a long-term sealing mechanism for a lateral liner. The full preliminary report, including many more photos, is included as **Attachment 3.**

Adeka Paste Limitations

According to the paste material manufacturer, the material is not recommended for use with CIPP technology in an uncured state. In order to use the paste sealant material correctly in a CIPP as a leak prevention application, certain requirements must be fulfilled before the liner is installed, as per the product manufacturer.

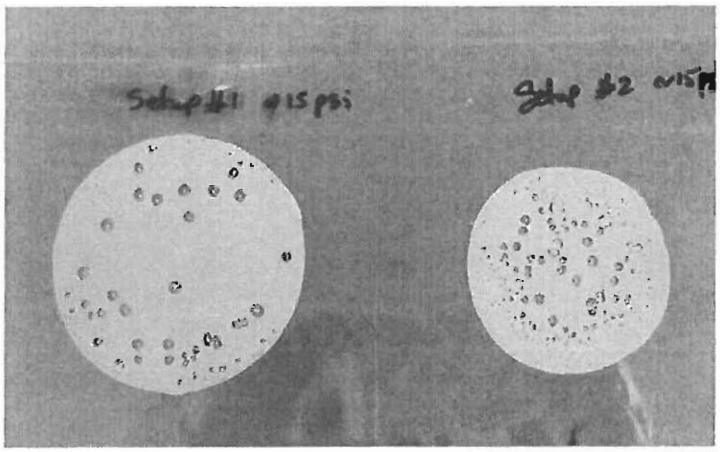


Figure 11 Voids in Curing Paste

The product should only be applied in a clean environment free of oil and grease. In addition, the material should not be exposed to a wet environment until it has an opportunity to cure.
The manufacturer's literature also includes a disclaimer which states as follow:

NOTE: The information contained herein is based on our present state of knowledge and is intended to provide general notes on Adeka Waterstops and their uses. Any recommendations or suggestions, which may be made, are without guarantee, since the conditions of use are beyond our control. Furthermore, nothing contained in this publication shall be construed as a recommendation for any use that may infringe patent rights. Readers are cautioned to satisfy themselves as to the suitability of such goods for the purposes intended prior to use.

This disclaimer is reinforced by the printed Application Instructions which come with the paste. A copy of these instructions are shown below (see figure 12). It is difficult to see how an old, slime coated wet sewer pipe, often leaking due to hydrostatic pressure, can meet these requirements.

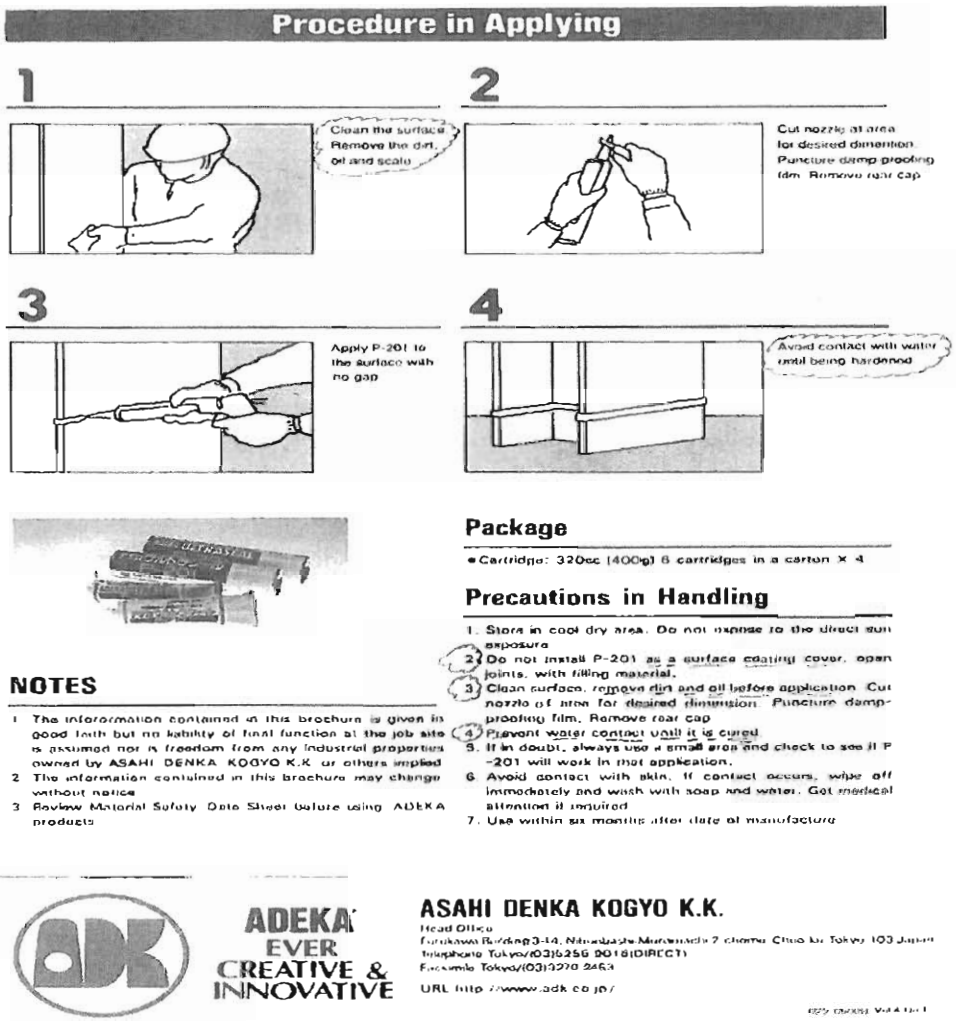


Figure 12 Adeka Paste Technical Data Sheet

No Pipe Seals

Some CIPP suppliers if allowed will provide a CIPP liner without any sort of pipe seal. Most often due to low bid environment, some contractors look for ways to cut costs, and if the specification does not require pre-molded gaskets, the liner goes in without a gasket seal. In some cases, they argue a pipe seal is not necessary because they claim to use a minimal shrink resin and the resin itself makes a seal. The F2561 standard practice describes four (4) approved resin systems: polyester, vinyl-ester, silicate, and epoxy. Regardless of the resin system utilized, the standard requires gasket seals for the reasons explained previously in this document including but not limited to sustained external groundwater pressure creep. The notion of installing PVC pipe, Concrete pipe, or Ductile Iron Pipe without a gasket and expecting long-term watertight performance would never be an option to consider for a pipe design engineer, even if the pipe joints are tight fitting.

The most difficult challenge utility owners must overcome is the sales pitch for low cost short-lived solutions by many CIPP suppliers and contractors alike. The argument for CIPP liners bonding in a wet sewer pipe for at least 50-years has led to millions of dollars going down the drain.

Most everyone understands that butter in a frying pan is used for two reasons....it makes food taste good and it prevents the egg from sticking to the pan. Fats, oils, and grease (FOG) are prevalent in all sewer pipes and the cleaning method described in ASTM F1216 simply reference the NASSCO recommended specifications which calls for removing any debris in the pipe. There is no mention of using hot water or detergents and the presence of FOG ensures no chemical bonding can occur just as with butter in the frying pan.

Let's take another look at the F1216 standard, specifically section 7.5 Lubricant. In this section, lubricant is described as an oil based product applied to the coated surface of the liner tube for purposes of reducing friction during inversion of the resin saturated liner tube. The inversion process for installing a mainline CIPP ensures by design an oily substance is present on the interior surface of the new CIPP. The concept of bonding a connection lateral liner to a mainline liner with the inner surface purposely greased up as prescribed in F1216 is just not practical.

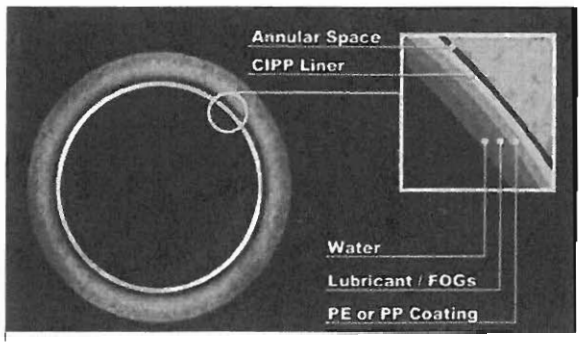


Figure 13 Illustration of CIPP Critical Layers

Another misconception of bonding a lateral liner to a mainline liner is the incompatible substrate materials. The coated surface of an inverted mainline CIPP as described in F1216 is made from polyethylene (PE), polypropylene (PP), or thermal plastic urethane (TPU). The PP and PE coatings are olefin based plastics that are well known to be non-stick materials, and TPU is not a water stable material. For the reasons explained in this document, bonding CIPP in a sewer is not practical.

Long-term adhesion or mechanical bonding with either the wall surface of the host pipe and/or the main line liner were soundly rejected by engineers in the sanitary sewer industry years ago. This was because in order to obtain a long-lasting mechanical bond as claimed requires a thorough cleaning of the wall surface and development of a surface profile (i.e. a roughened texture to the surface area) with which the epoxy resin can lock on to. This is not practical to do inside a non-man-entry size sewer main; and is certainly impossible to do inside of a lateral sewer service pipe. Further, pipes will move in the ground over their service life and whatever semblance of a mechanical bond was obtained with the host pipe initially will easily be broken within a few years.

As discussed earlier, the significant gap that can form between the liner and the host pipe is due to creep. Epoxy resin systems are subject to creep just like polyester and vinyl ester resin systems. Creep is the mechanism whereby the gap widens over time when the CIPP is subjected to an external hydrostatic head. The amount of creep that will occur is tied to the stiffness of the material; or its modulus of elasticity. The modulus of elasticity for epoxy resin systems are quite

like that of the polyester and vinyl ester resins; and thus, the amount of creep under which the gap forms will be similar as well. That means that minimal shrink resins like epoxy and silicate that report having less initial shrinkage as the resin cures offers no real protection over the polyester and vinyl ester resins when it comes to the long-term formation of a gap and the resultant groundwater leakage that will occur. One fact to be certain of: the silicate resin produces the lowest stiffness of the four (4) approved resins described in ASTMF2561.

Therefore, the only reliable way of sealing the interface between an epoxy lateral liner and the mainline liner is using a robust gasket seal that can adapt to the movements within the buried pipeline and expand as needed to address the ever-increasing gap that will form when there is a significant external hydrostatic pressure (i.e. groundwater) acting on the lateral lining system. As stated earlier, a mere 5.0-foot head of groundwater on an 8-inch dimeter liner will see a gap of 0.01 inches in just 7.5 years; and over 0.05 inches in the normally requested 50-year design life (again, a quarter is approximately 0.07 inches thick). As the size of the main line grows in diameter so does the magnitude of the gap that is formed under creep. Therefore, all CIPP resin systems will require a preformed hydrophilic gasket if the expected performance of the pipe owner is at least 50-years of watertight service.

Case Studies

Four case studies are presented in **Attachment 4**. They explore the technical challenges which Coral Gables, Florida, Coral Springs Improvement District, Florida, Naperville, Illinois and the City of Portland, Oregon each confronted and the solutions which they implemented.

The Coral Gables case study is a peer-reviewed paper of a city adjacent to Miami with the same challenges of needing resiliency to sea level rise, coastal flooding and high groundwater conditions throughout its collection system. The primary goal of their collection system rehabilitation project was to mitigate the serious amount of seawater infiltrating their system during high tides, to reduce their lift station pump run times and to use trenchless technology as much as possible to reduce costs and disruption to the public. Coral Gables used a folded PVC mainline pipe liner, and used ASTM F2561-compliant lateral liner technology. They achieved dramatic results, which continue unabated seven (7) years later. In the basin that was the subject of the paper, pump run times were reduced from a high of 30.81 hours in October 2011, to an average of 4.23 hours in August 2013, post rehabilitation – an 86% reduction in pump run time. Average daily flows from the basin were correspondingly reduced from an Average Daily Flow of 65 gpm to 13 gpm.

The Naperville, Illinois case study is significant because it provides a data-driven basis to calculate the annual dollar value of its system-wide program of lining their main lines with CIPP, sealing the ends of the main line installation with neoprene hydrophilic sealing gaskets, and using ASTM F2561-compliant lateral liners. The result of its program is that, even with a 10.5% population growth in its service area, the City was able to defer a previously planned multi-million expansion of its wastewater treatment plant. Naperville's annual savings in avoided treatment costs and

debt service, as well as the additional revenue of the added customers it was able to connect to its renewed collection system due to this project, is approximately $1.25 million.

The Coral Springs Improvement District was experiencing significant infiltration even though it had previously lined much of its main line pipes with CIPP. This effort was not successful in achieving significant reduction in infiltration as they learned that most of the leakage was from the system's laterals that had not been renewed. Furthermore, the mainline CIPP was installed without gaskets and leakage was also evident at the manhole connections. Key lift stations often operated in surcharge conditions during rain events. The utility owner had a financial interest in mitigating I&I.

The result of the District's lateral lining using ASTM F2561-compliant specifications was a conservation of groundwater resources, protection of the environment, and a good return on investment. The District invested $1 million for this rehabilitation project, which was completed over a 10-month period. The District reports reduction of infiltration into its system by 232 million gallons annually, with average savings of $365,000 yearly.

Even though years earlier a large part of the system had the mains lined, it was not until the laterals were lined that the hidden value in the previous lining project was revealed. The payback for the entire project is just 2.6 years, but going forward the District's investment is expected to continue to save or earn CSID $365,000 each year for the life of the repairs.

The Portland, Oregon case study is presented as a unique approach to repair and rehabilitation of a gravity collection system in a large city. The City's Bureau of Maintenance has been installing CIPP mainline and lateral lining since 1998 using in-house crews. The City partnered with LMK to provide the lining equipment, materials and training for these in-house crews. The City has been so successful with this approach they have increased the number of dedicated CIPP crews and trained their traditional line crews to perform lining work.

All work done by the City trained crews is compliant with ASTM standards and the lateral lining is done in accordance with ASTM F2561.

Life Cycle Cost Considerations

If a utility wants to use State Revolving Loan Funds to pay for its sewer rehabilitation project, the design must be justified based on life cycle cost (LCC) analysis. This requirement is imposed by legislation passed by the US Congress in 2014 known as the Water Resource Reform and Development ACT (WRRDA). The days of ground water infiltrating and overloading pipes, pumps and wastewater treatment plants, at public expense is now a priority to correct.

All projected future costs must be included in the LCC, including expected service life, replacement costs, costs of transporting and treating I/I, and routine maintenance costs. The WRRDA standard sanctions a broad range of evidence in the analysis, including job site tests,

published reports, manufacturer product data, anecdotal local experience, as well as projected future operating and maintenance, rehabilitation and replacement costs. This WRRDA standard closely tracks ASTM F1675, "Standard Practice for Life-Cycle Cost Analysis of Plastic Pipe Used for Culverts, Storm Sewers, and Other Buried Conduits."

An LCC analysis is highly site specific and cannot be performed based only on the technical data discussed in this report or that contained in the above case studies. But important lessons flow from the case studies: for example, Coral Springs Improvement District reported a "positive" return on investment based on their three-year operating experience using ASTM F2561-compliant lateral liners.

Additionally, the data presented in this report clearly demonstrates a strong technical case for longer-term service by using the ASTM F2561 standard versus non-compliant paste-based or minimal shrink resin lateral lining systems. The case studies presented herein add an additional level of credence to a strong inference that adoption of ASTM F2561-compliant lateral liners would lead to a lower Life Cycle Cost to a utility's collection system's rehabilitation program. Lastly, a utility should recognize that it only increases the GASB34 valuation of its capital assets by including the clean-out and gasket features that come with ASTM F2561 compliant lining as substantiated by these LCC indicators. These are not merely added costs; they represent investments.

Difficult-to-Perform Lateral Lining Tasks

CIPP lateral products that adhere to the requirements of ASTM F2561 have pre-engineered design capability that allow for the rehabilitation of difficult to perform lining tasks, including;

- The lining of shared service lines such as double stack laterals using a single-piece CIPP
- Siamese (opposing) laterals typically located at 3:00 and 9:00

Figures 14a, 14b and 14c demonstrating these capabilities are shown below. **Attachment 5** provides further insight into the intricacies to these types of repairs which frequently occur in many sewer systems.

Double Stack (Shared Service Laterals)

Concerns:

- Typically installed in high ground water table
- Normally requires a three step process
- The bull headed tee is not rehabilitated
- Three liners with cold joints that leak

Solution: Install from Main with One Installation

- Produces a one-step monolithic main multiple lateral lining where all ends are sealed with gaskets
- No excavation required whatsoever

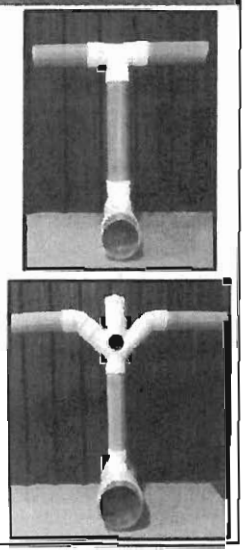


Figure 14a Double Stack Service Lateral Pipes

Siamese (Opposing Laterals)

Concerns:

- Normally requires a three step process
- Line the first connection
- Cutting the first connection, causing a leak
- Line the second connection
- Three liners with cold joints that leak

Solution: Multi-Lateral Lining System

- Section of main is rehabilitated
- Both opposing laterals are rehabilitated
- Produces a one-step monolithic main multiple lateral lining where all ends are sealed with gaskets
- No excavation required whatsoever

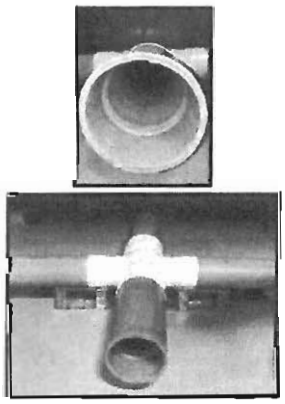
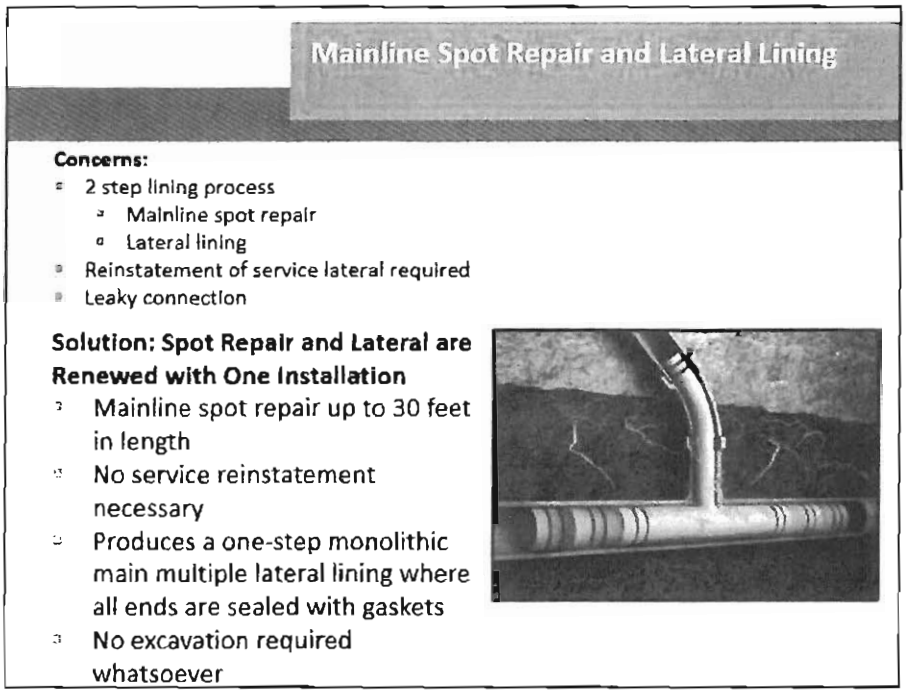


Figure 14b Siamese (opposing) Laterals



14c Spot repairs near the lateral to be lined

Clean-Outs

Clean-outs are required for a fully compliant ASTM F2561 installation. One method for installation of clean-outs, as shown in Figure 14, is to use a vacuum excavation method known as Vac-A-Tee. This method, described in ASTM Standard F3097 (see **Attachment 6**) and the subject of an in-depth peer-reviewed paper which is attached as **Attachment 7**, is much less expensive and disruptive than the installation of a clean-out through regular excavation.

There are many benefits to installing a clean-out during lateral lining:

- Quality of New Pipe: CIPP is a process whereby a new pipe is formed within the existing pipe. The manufacturing of the new CIPP takes place in two specific locations.

1. Under a strict quality control process, the US manufacturing facility produces the liner tube and the thermoset resin kits for the contractors.
2. Independent contractors who are trained in the skillset necessary to install the liner produce the new CIPP pipe within a pipe as the liner is inserted, inflated and cured.

Figure 14 Shows the Minimally Disruptive Vacuum Excavation Process

This manufacturing process needs to be conducted to achieve the full high-quality potential of this new pipe and its promise of long-term performance. The CIPP industry relies on ASTM F1216 as a minimum level of quality for physical property requirements such as flexural strength, flexural modulus, and chemical resistance. It is imperative that the new CIPP at least meets the minimum test requirements.

That is why the clean-out is important: it allows the lateral pipe to be temporarily taken out of service so the new CIPP can be installed meeting the anticipated 50-year design life. When a service lateral is renewed by the CIPP method and a clean-out is not installed and the homeowner discharges sewage, the sewage becomes part of the new pipe, which clearly undermines the integrity and diminishes the design and service life of the new pipe. Just as drivers cannot use a road while it is being repaved, homeowners cannot use the sewer as it is being lined.

Furthermore, both ASTM F2561 and ASTM F1216 require 5-10% excess resin is added to the liner tube to account for resin consumed in open joints and pipe defects. When a lateral liner is installed from the main pipe and no clean-out exists the resin saturation process requiring excess resin cannot be achieved without causing a resin slug (partial blockage) at the upper end of the liner. This results in contractors short changing the utility owner on the amount of thermoset resin in the liner tube as it incentivizes the contractors to install resin shy liners which again does not meet the industry standard requirements.

- Protect Public Health: A clean-out allows the service lateral to be temporarily taken out of service that not only prevents the homeowner from discharging during installation of the liner but also prevents any odors from entering homes through dry plumbing fixture traps. The owner should not take the risk that it will be liable for the damages sustained by a homeowner who is needlessly exposed to potentially harmful chemical odors.

- Plumbing Codes: The International Plumbing Code requires cleanouts to be installed for all new drain pipes and sewer pipes. The renewal of a sewer service lateral using CIPP effectively constitutes a new stand-alone pipe within a pipe.

- Future Access for the Utility: The line between public and private is a serious issue and too often the Utility Owner is blamed for sewer backups that occur post rehabilitation of the lateral located in the public right of way. In this case, the Utility Owner is challenged to determine if the blockage is the result of the rehabilitation or if the blockage is on private property. A clean-out allows the Utility Owner to quickly determine whether the blockage is related to the rehabilitation work in the public right of way by simply lamping a clean-out.

- Future Access for Homeowner: A clean-out not only guarantees the highest quality new pipe, protects public health, conforms to plumbing codes, provides future access to the county, but also provides future access to the homeowner should their private sewer lateral need maintained in the future. Furthermore, a clean-out located at the property line provides access for homeowner's private lateral to be rehabilitated anytime in the future through the clean-out where no excavation is required.

Following lateral lining, the clean-out becomes a major asset to the utility. Routine inspection, cleaning, clearing of blocked laterals and main lines and diagnosis of whether the blockage is on the utility's side or the customer's side can be performed more easily and at less cost. Maintenance staff responsible for the gravity collection system can readily attest to this value.

One example speaks powerfully to this point. In a February 2017 meeting, staff from the Miami-Dade County Water and Sewer Department estimated that they responded to approximately 250 calls per month from customers relating to blocked service. **Attachment 8** presents a cost analysis of the yearly savings in operational costs to the utility based on this number of calls and estimates of servicing these calls based on assumptions of the cost of operational effort required for response. While precise elements of the estimate may be debated, the savings to the utility on an annual basis, which are estimated at over $1.5 million dollars per year, are clearly substantial. Moreover, this estimated cost reduction due to having clean-outs does not address the savings that accrue to customers if they are responsible for clearing the blockage on their side of the lateral.

An additional but important note on cleanouts: some utility owners are concerned about the possible legal issues of performing rehabilitation work on a customer's property, including the installation of cleanouts. Many utilities have confronted this problem successfully. The Water Environment Federation has compiled a *Private Property Virtual Library* which is a growing library of case studies from private property-related programs at wastewater utilities. It is intended to be a resource for other utilities seeking information or advice about private property programs. This library can be accessed by using the following link: http://www.wefppvl.org/WEF-PPVL-library/.

Procurement Issues

Three procurement issues often arise when a utility specifies a lateral lining technology. The first is whether an ASTM F2561-compliant specification is sole source. ASTM F2561 specifications are not sole source!

LMK, is a technology provider (not a contractor) that has hundreds of licensed installers, and it has licensed another manufacturer, Perma-Liner Industries, to manufacture and sell its CIPP lateral liner products that also comply with the ASTM F2561 standards.

Furthermore, the projects are bid by independently owned, licensed contractors. The cost of the manufactured lining materials is no more than 25% of the contractor's total installed cost of a lateral lining project. Therefore, bids for ASTM F2561 specifications draw participation from numerous bidders, thereby keeping the cost to the client competitive.

The second issue arises from bidding the ASTM F2561 standard directly against an adhesive based sealing technology system for which there is no standard. Allowing an adhesive based technology to be considered "as equal" to ASTM F2561 is a trap to the owner. ASTM F2561-compliant systems are marginally more expensive than lower quality adhesive based systems; therefore, this practice allows the adhesive based bidders to increase their bid prices and still win an award. This practice has been seen repeatedly in many marketplaces and essentially robs the utility and its customers from money that could be used in other parts of their capital plan. This extra money flows into the contractor's pocket.

Utilities That Have Adopted the ASTM F2561 Industry Standard

Many utilities have adopted ASTM F2561 as their primary standard for lateral lining or have installed many these lateral lining systems. **Attachment 9** includes a partial list of these utilities. **Attachment 10** provides the example of one major municipal utility's F2561-compliant specifications as well as industry model specifications for CIPP lateral connections and end seals.

Conclusions

The technical material presented in this report clearly supports previous assertions that:

- Insignia hydrophilic neoprene CIPP gasket seals that are compliant with ASTM F2561 sealing gaskets provide a watertight, long-lasting seal for mainline CIPP and lateral CIPP liners similar to that routinely used in new pipe installations.
- Paste-based systems have significant limitations and cannot provide the water tightness nor long term sustainability of the hydrophilic neoprene seals.
- Long-term hydration/dehydration studies clearly demonstrate the sustainability of LMK's sealing technology, while preliminary studies of paste-based systems have demonstrated significant potential limitations. This conclusion is applicable to all adhesive based systems, including silicate-epoxy based systems due to their inability to sufficiently expand like hydrophilic neoprene seals to fill the annular space created by long-term creep of the liner.
- Case studies demonstrate the success, value and client satisfaction of ASTM F2561 installations.

- LMK's ASTM 2561-compliant pre-engineered liners can be used to perform difficult lining tasks that others cannot perform.
- LMK's ASTM 2561-compliant liners and hydrophilic seals are factory manufactured to standard size and tolerances, whereas paste sealants are subject to field variations from different installing technicians.
- Clean-outs which are required for complete compliance to ASTM F2561, provide significant advantages to the installation and quality of the installed lateral liner, and are a significant asset to the future operation and maintenance of the gravity sewer system. Clean-outs can also provide significant long-term O&M cost savings to the utility as well as to the utility customer.
- Owners who are concerned about the installation of clean-outs due to private property concerns can access the Water Environment's Private Property Virtual Library to learn how scores of other utilities in the US have solved this problem to the benefit of their rehabilitation projects and to their customers.
- Owners not wishing to use clean-outs can still get the benefits of LMK's superior gasket sealing system.
- Purchasing documents need to be clearly thought out when bidding ASTM F2561 systems, which are not sole source, in order that the owner does not get into the trap of ending up with lower quality lateral lining systems at high prices.