Product Submittal Document Information

CIPP Lateral Renewal Connection System

UV Cured Shorty™

Product Submittal Review

ITEM 1.

Manufacturer Company Name: LMK Technologies, LLC

Contact Individual(s) Steve Maszczak

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Telephone: 815.209.9262 ext. 254 Facsimile: 815.433.0107

Product Submittal: INSTALLATION PRACTICE FOR REHABILITATION OF A FULL-LENGTH SEWER SERVICE LATERAL USING A ONE-PIECE MAIN AND LATERAL CURED-IN-PLACE LINER ASSEMBLY INSTALLED BY MEANS OF AIR INVERSION

Only Certified Licensed Installers by LMK are authorized to install the LMK T-Liner or Shorty system.

ITEM 2.

INTENT:

This specification covers material requirements, installation practices, and test methods for the reconstruction of a sewer service lateral pipe and the main connection without excavation. The lateral pipe is remotely renovated from the main pipe to a specified distance ranging from 3-feet to 10-feet. The pipe renovation shall be accomplished by the inversion and inflation of a resin impregnated, single-piece lateral and main connection liner assembly. The liner assembly is pressed against the lined main pipe and lateral pipe by inflation of a bladder and held under pressure until the resin has cured. When cured, the liner extends over a predetermined length of the service lateral and the full circumference of the main pipe at the connection and forms a continuous, single-piece, tight fitting, corrosion resistant and verifiable non-leaking Main/Lateral cured in-place pipe (CIPP) outfitted with gasket seals. The Materials and Installation practices shall, at a minimum, adhere to the requirements of ASTM F2561-20 “Standard Practice for Rehabilitation of a Sewer Service Lateral and its Connection to the Main Using a One-Piece Main and Lateral Cured-in Place Liner”.

The T-Liner/Shorty Main-to-Lateral Connection System has been installed extensively throughout the United States, Canada, Mexico, Germany, Denmark and Singapore to effectively renew more than 100,000 Lateral Sewer Pipes.

LMK Technologies, LLC is the owner of Trademarks: T-Liner®, LMK® Shorty™.

ITEM 3.

References:

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ITEM 4.

4.0 The Technique	The UV Shorty repair structurally renews the entire main/lateral fitting and extends up into the lateral pipe. The repair consists of a one-piece, continuous main and lateral lining that is vacuum impregnated with UV initiated resins, air inverted from the main up into the lateral by the action of a translucent bladder assembly; hereby referred to as a "Liner/Bladder Assembly". See LMK's T-Liner or Shorty Installation Specification Sheet
4.1 A brief description of the operation and technique; including materials and methods of installation.	The reconstruction will be accomplished using woven fiberglass fabric tube of particular length and a UV initiated vinyl ester resin with physical and chemical properties appropriate for the application. The lateral tube within a translucent inversion bladder is vacuum impregnated with the resin and then placed inside a protective launching device. The main liner sheet is formed as a tube by wrapping around the main bladder. The launching device is winched into the existing sewer. When the launching device is properly positioned and aligned with the lateral connection, the main liner is inflated and the resin-saturated tube is inverted up through the old lateral pipe by the action of an inversion bladder. The resin saturated tube is UV light cured and the inversion bladder and launching device are removed. **The end result is a one-piece structural lateral lining and main pipe fitting that provides a verifiable non-leaking connection with all mainline pipe types by incorporating two hydrophilic O-rings at each side of the mainline connection or a compression connection gasket in lieu of the O-rings on the mainline and an O-ring at the upper terminal end of the lateral.** **The lateral tube length will be: UV Shorty – 10 ft. or less** The cured finished materials as described above will, upon installation inside the host pipe, exceed the minimum test standards specified by the American Society for Testing Methods F1216-16 and F2561-20. **Minimum Test Standards for CIPP ASTM F1216 Appendix X1** FLEXURAL STRENGTH - ASTM D-790 4,500 PSI FLEXURAL MODULUS - ASTM D-790 250,000 PSI
4.2 Intended use: Structural Repair Crack/Joint Sealing of Root Intrusion and Water Infiltration	The system is designed for fully deteriorated pipe conditions. Typical installations are a direct result of ground water infiltration, root intrusion and structural defects such as open joints, offset joints, broken or missing pipe sections and hammer taps. The new pipe exhibits a smoothbore interior that typically increases flow rates.
4.3 EXISTING SEWER **(Main and Lateral)**	**The system is compatible with all pipe materials due to the use of hydrophilic sealing O-rings embedded between the main pipe and lining at each terminal end of the Main/Lateral lining, or the use of the connection compression gasket in lieu of the O-rings on the mainline with an O-ring at the terminal end of the lateral tube.** The mainline portion is cylindrically shaped producing a structural Main/Lateral fitting.

4.4 Diameter Ranges	Lateral: 3 – 6 inch diameters. Main: 8,10,12 inch
4.5 Transitioning Diameters	The liner can transition from one pipe size to another ensuring adequate liner thickness throughout the lining.
4.6 Circular and/or Non-Circular Capability	The system can accommodate pipe ovality up to -10%.
4.7 Maximum Length Between Access Points	The system is capable of reaching a lateral that is 450 ft from the power system.
4.8 Material Limitations	This system is designed for gravity sewers and low pressure piping.
4.9 Lining Material Composition and Construction	Proprietary glass kitted tubes coated with a chemically resistant impervious film. The tube is air-tight and flexible in design to reduce inversion pressures. Minimum finished wall thickness: 3mm for 3 inch diameter pipe 3mm for 4 inch diameter pipe 3mm for 6 inch diameter pipe
4.10 Main/Lateral Jointing System	The lining material is constructed as a one-piece cylindrically shaped Main/Lateral fitting. Therefore, there is no joining of two separate liners during the installation process. The end product is a one-piece structural Main/Lateral cured-in place pipe.
4.11 Resin System	Resin System Vipel L040 UV initiated Aromatic Vinyl Ester Resin the comes to the installers pre-wet out from the factory to specification. 3-inch tube requires 0.43lbs of resin per lineal foot. 4-inch tube requires 0.63lbs of resin per lineal foot. 6-inch tube requires 0.94lbs of resin per lineal foot.
4.12 Mechanical Properties	Excess resin migrates into pipe defects allowing a mechanical anchoring.
4.13 Physical Properties	Flexural Strength 4,500 - PSI “Minimum” Test Method: ASTM 790 Flexural Modulus 250,000 - PSI “Minimum” Test Method: ASTM 790
4.14 Corrosion attack	Chemical Resistance Testing. Test Method: ASTM D5813 and F1216 See Independent Laboratory Testing:
4.15 Resin Saturation Method	The lining tube is pre-wet out at the factory by positioning within the translucent inversion bladder forming a liner/bladder assembly. The assembly is vacuum impregnated with the UV initiated resin and weighed for accuracy as a final quality control check. Additionally, the bladder is translucent, allowing for visual verification that the lining tube has 100% resin saturation.
4.16 Gasket Sealed End Seals	**The mainline connection** shall include a seamless molded flange shaped gasket attached to the main liner tube by use of stainless steel snaps. The gasket must be a minimum of 2.5mm and must retain this minimum

	thickness under installation pressures. Alternatively, the mainline liner tube shall include 4 hydrophilic O-rings (2 on each side of the service pipe). **The lateral tube** shall include a compression O-ring gasket attached six-inches from the terminating end of the lateral tube.
4.17 End Seal Test Data	The hydrophilic gasket seals shall include test data that supports substantial expansion properties so to form a watertight compression end seal at the terminating ends of the CIP-lateral liner. The test protocol shall simulate subterranean conditions and hydraulic loading at surface. Gasket seal submittals must include tests data simulating hydration/ dehydration conditions for a period of 10,000-hours and the test results must successfully demonstrate and document long-term performance without deterioration, loss of material, flexibility, and expansion of the gasket during repeated cycles of hydration and dehydration.
4.18 Installed at one-time	The system allows only one (1) lateral at a time to be renewed within a MH-MH reach. The UV curing system allows many laterals to be renewed in a day. Conditions and number of laterals within a manhole run greatly determine the number of laterals that can be renewed in one-day, though a typical number of laterals renewed in one-day is ten (10).
4.19 Missing Pipe Sections	The liner can span small missing sections of pipe.
4.20 Effects of Line and Grade	There are no effects caused by grade changes since air pressure is used to inflate the liner. The liner is flexible during insertion and can accommodate and negotiate 22, 45 and 90 degree bends.
4.21 Protruding Lateral Pipes	It is recommended protrusions into the main pipe are limited to ½-inch.
4.22 Reduction in Pipe Diameter, and its Effect	The liner exhibits a slick and typically smooth interior with a co-efficient that increases flow-rate. Minor wrinkling may occur at bends of 45-degrees and greater and some wrinkling may occur based on actual inner pipe diameter, inner surface, pipe configuration and conditions.
4.23 Homeowner Impact	Homeowners and building occupants at a minimum will receive a door knob notice bulletin 48 hours prior to the scheduled work and personal contact is attempted to be made the day of the scheduled work. The notice bulletin summarizes the scope of work, tentative time of service disruption and home/building owner cooperation for non-use of water/sewer for a 2-hour period or less. A brief explanation of “Dry Fixture Traps” is also included.

ITEM 5.

5.0 Sewer preparation involves cleaning and a flow stoppage or diversion period.	The main and the laterals are cleaned utilizing high-pressure water and mechanical cleaning tools. Pressures may range from 2,000 to 4,000 PSI removing all roots, debris and obstructions. Cleaning of the lateral is performed robotically from the main pipe. Any protruding service connections will be removed prior to liner insertion. The current condition of the pipe will be compared to the original designed condition to verify that design parameters have not changed. Normal mainline flows are plugged or by-passed during the process, depending on flow.
5.1 Mainline Service	Typical time for plugging the mainline is one-hour (1) or less.
5.2 Specific Requirements	Accesses to the upstream and downstream manholes are mandatory.
5.3 Cleanout System	Lateral lengths 10.0-feet and less are renewed without the need for a cleanout. For lengths greater than 10.0-feet a TEE shape, or back to back WYE shaped cleanout fittings located a minimum of two-feet (2') upstream from the terminal end of the lateral CIPP liner is suggested. Installation of cleanouts due to length and/ or lateral diameter transitions are to be made at the installer's discretion.
5.4 Installation Crew and Equipment	A typical crew consists of (3 to 4) technicians. Traffic disruption is minimal. The installation process is typically quick, efficient and non-disruptive when compared to open cut replacement methods.
5.5 Handling Sewer Access (i.e., existing manholes)	Certified and Licensed Technicians remotely carry out the installation. Internal pipe cleaning, inspection and insertion of the lining are typically performed without the need for confined space entry. Entry into a manhole may be required in order to insert a sewer plugs or to assist insertion of equipment in small diameter manholes or where drop inlets exist. If confined entry is required, Federal, State and local laws apply.
5.6 Inversion/Inflation Method	Air pressure is applied to launching device causing the Liner/Bladder Assembly to inflate the mainline portion and invert the lateral portion into the lateral pipe. The bladder extends past each terminal end of the lining assembly so the ends remain open and no cutting is necessary.
5.7 Maximum Length	Maximum length for a continuous lateral lining is three (3) feet for main to lateral connection where no cleanout exists.
5.8 Curing Method	The Resin and UV curing systems are proprietary to LMK Technologies. The resin systems are capable of curing 4" diameter liners in 8 minutes and 6" diameter lateral liners in 12 minutes
5.9 Removal of Inflation Device	The bladder is re-inverted peeling away from the new cured in-place pipe. During the removal process, the bladder is drawn back into the launching device.
5.10 Equipment Removal	Once cured, the equipment is removed from the mainline pipe.
5.11 Document Final Video and Testing Procedures	A final video inspection is performed from the main if the termination point of the liner can be seen with zoom cameras.

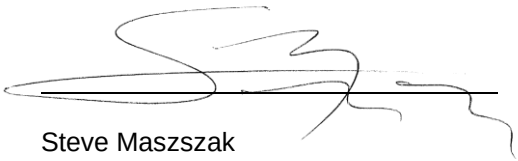
5.12 Design Life	50-Year Design Life based on assumption described in ASTM F1216 Appendix X1 and long-term creep as described in ASTM D2990.

ITEM 6.

Advanced Materials:

- **Translucent Inversion Bladder**
- **Liner/Bladder Assembly**
- **Vacuum Impregnation**
- **Installed from the main pipe up into the lateral**
- **Full circle one-piece Main/Lateral Lining**
- **Continuous lengths up to 10'**
- **Curing system as fast as 8 minutes**
- **Structural CIPP**
- **10,000 hour CIPP creep testing in accordance with ASTM D29990**
- **Flexible construction**
- **Remote installation where no excavation is required**
- **Gasket Sealing Technology (hydrophilic and/or compression gaskets)**
- **10,000 hour hydration/dehydration gasket sealing test**

Respectfully Submitted By:



Steve Maszszak
Director of Sales – LMK/APM

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Fax 713-692-8502
Toll Free 1-800-692-TEST

June 11, 2021

Water Renewal Technologies
25 Northwest Point, Suite 510
Elk Grove Village, IL 60007

Attn: Chris Ras

Re: 10,000 Hour Test Report
ASTM D 2990 Flexural Creep Test
50-Yr Linear Extrapolation
Sample ID. Light Ray UV
HTS Test Report No. 21-P-0261-01

Please find the enclosed 10,000 hour Flexural Creep test report and the 50-Yr Linear extrapolation of the test results.

Flexural Creep testing was performed in accordance with ASTM D2990-09 Section 6.3, Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics.

One (1) set of five (5) test specimens was conditioned in accordance with Procedure A of ASTM D618-13, prepared in accordance with ASTM D790, and placed on the test rack with the calculated amount of stress applied.

We greatly appreciate the opportunity to work with you and Reline America. Please let me know if you have any questions or comments.

Sincerely,
HTS Pipe Consultants

Rick Eastwood
Vice President

HTS Pipe Consultants, Inc.
420 Pickering, Houston, Texas 77091
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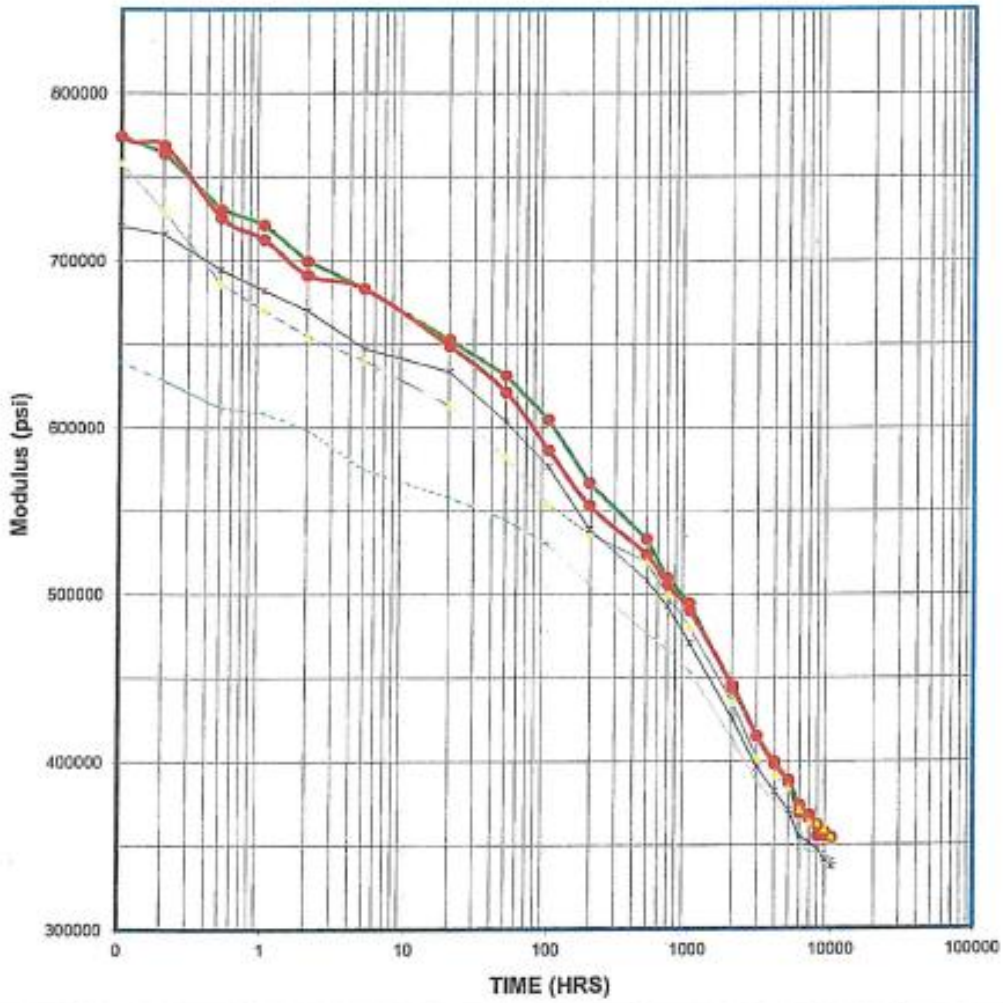
FLEXURAL CREEP
ASTM D2990



Project Name:
Project No.:
Sample ID No.: Light Ray UV
Test Started: 4/16/20
Test Ended: 6/07/21
HTS Report#: 21-P-0261-01

Tested Temperature: 71°F
Lab Humidity: 50%
Specimen Gage Length: 2.0"
Stress: 2369 PSI

Sample ID: Light Ray UV

Spec# 1	Stress: 2369 psi	Spec# 2	Stress: 2369 psi	Spec# 3	Stress: 2369 psi
Thickness: 0.136"	Width: 0.559"	Thickness: 0.136"	Width: 0.555"	Thickness: 0.137"	Width: 0.556"

TIME (HRS)	Strain (%)	TIME (HRS)	Strain (%)	TIME (HRS)	Strain (%)
0.02	0.2795	0.02	0.2856	0.02	0.3062
0.10	0.3060	0.10	0.3060	0.10	0.3124
0.20	0.3101	0.20	0.3080	0.20	0.3247
0.50	0.3244	0.50	0.3264	0.50	0.3452
1	0.3284	1	0.3325	1	0.3535
2	0.3386	2	0.3427	2	0.3617
5	0.3468	5	0.3468	5	0.3699
20	0.3631	20	0.3652	20	0.3863
50	0.3754	50	0.3815	50	0.4069
100	0.3917	100	0.4039	100	0.4274
196	0.4182	196	0.4284	196	0.4418
500	0.4447	500	0.4529	500	0.4562
700	0.4651	700	0.4692	700	0.4747
1004	0.4794	1004	0.4835	1004	0.4932
2012	0.5345	2012	0.5324	2012	0.5446
3000	0.5712	3000	0.5712	3000	0.5898
4004	0.5936	4004	0.5957	4004	0.6062
5013	0.6100	5013	0.612	5013	0.6165
6000	0.6344	6000	0.6426	6000	0.6391
7004	0.6446	7004	0.6487	7004	0.6514
7996	0.6671	7996	0.6548	7996	0.6535
9000	0.6671	9000	0.663	9000	0.6597
10005	0.6691	10005	0.6691	10005	0.6679

HTS
Pipe Consultants

Sample ID: Light Ray UV

Spec# 4 Stress: 2369 psi
Thickness: 0.138" Width: 0.559"

TIME (HRS)	Strain (%)
0.02	0.3519
0.10	0.3705
0.20	0.3767
0.50	0.3871
1	0.3892
2	0.3954
5	0.4119
20	0.4243
50	0.4347
100	0.4471
196	0.4678
500	0.4968
700	0.5071
1004	0.5216
2012	0.5734
3000	0.6106
4004	0.6313
5013	0.6438
6000	0.6728
7004	0.6872
7996	0.679
9000	0.6872
10005	0.6955

Spec# 5 Stress: 2369 psi
Thickness: 0.137" Width: 0.566"

TIME (HRS)	Strain (%)
0.02	0.3144
0.10	0.3288
0.20	0.3309
0.50	0.3411
1	0.3473
2	0.3535
5	0.3658
20	0.3740
50	0.3925
100	0.4110
196	0.4398
500	0.4665
700	0.4809
1004	0.5035
2012	0.5569
3000	0.598
4004	0.6206
5013	0.6391
6000	0.6679
7004	0.674
7996	0.6823
9000	0.6946
10005	0.7028

HTS Pipe Consultants

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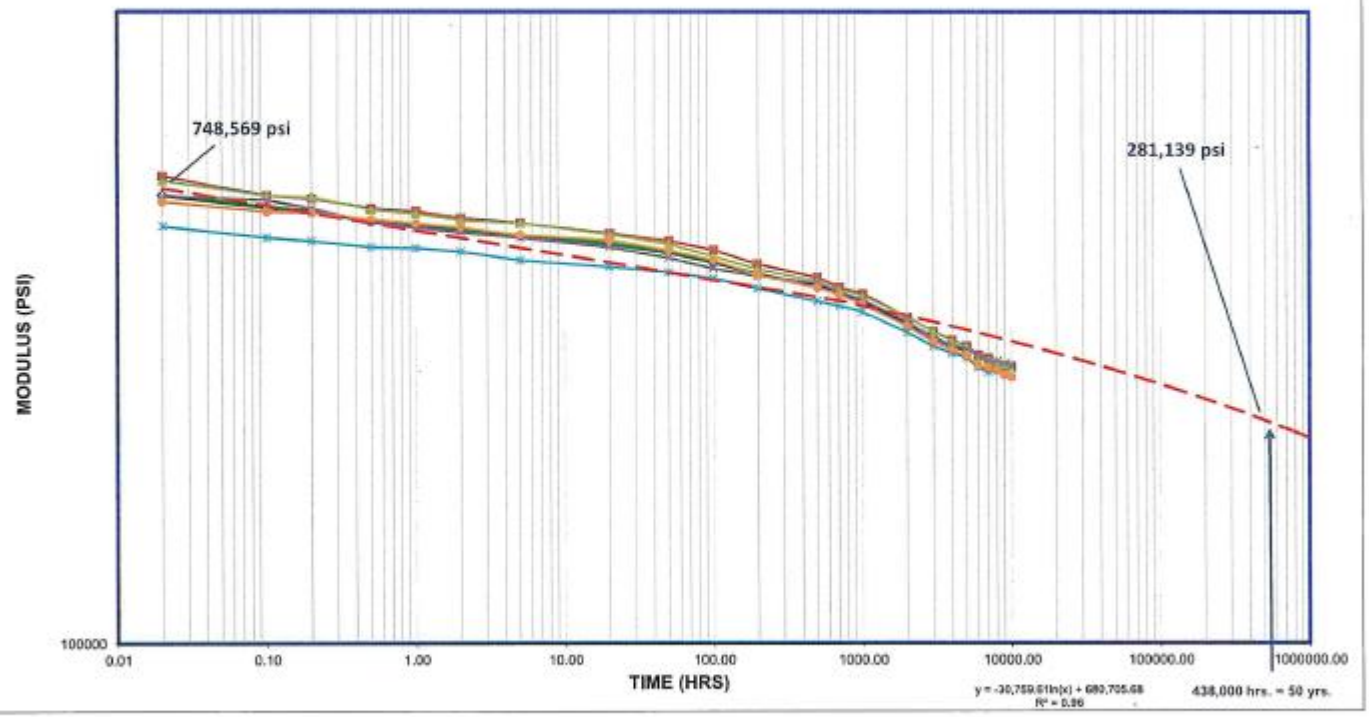
TENSILE CREEP
(ASTM D2990)



Project Name:	LMK	Modulus = 281,139 psi (extrapolated to 50 years)	Test Temperature : 71° F
Report Date :	June 11, 2021	% Retained = 36.3	Laboratory Humidity : 50%
Sample ID No.:	Light Ray UV	Line from Lab test data	Specimen Gage Length : 2.0"
HTS Report#:	21-P-0261-01	Line from linear extrapolation	Stress : 2369 psi

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www.crtlabs.com • e-mail: crtlabs@crtlabs.com
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ISO 9001 IAPMO R&T Certification No. ISO-09-23-12-11019

TEST REPORT

FOR: Perma-Liner Industries, LLC.
13000 Automobile Blvd., Suite-300
Clearwater, FL 33762
Tel: (727) 744-2594 / Fax: (727) 507-9849
ATTN: Mr. Rishi Vasudeva

LWR NO.: 21144 DATE: April 21, 2020

BACKGROUND: The client submitted two (2) samples of Drain Epoxy pipe for testing. The samples arrived on 03/27/2020 via customer-supplied courier. Visual inspection was performed on 03/27/2020 and no product defects were noted. Testing in accordance with customer PO #22364 and approved CRT quote received on 03/31/2020. The following additional information is provided:

CRT order entry log date: 03/31/2020 / **Report due date:** 04/30/2020

PRODUCT ID: Two (2) samples of Perma-Liner UV-LED PIPE, identified as;
1) LightRay UV-LED PIPE 3" Diameter Thickness 2.5mm
2) LightRay UV-LED PIPE 6" Diameter Thickness 3.0mm

PREPARATION: **Machining, CNC & Preparation** – ASTM D638-14 / CRT
Conditioning – ASTM D618-13, 40 h in a standard laboratory environment

SPECIFICATION: **ASTM F1743-17(Vol.: 8.04 2020) Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP):**

TEST PROCEDURES: **Resin properties (<82.2C) via Differential Thermal Analysis (DSC), N_2** – Section 5.2.3 (ASTM D3418-15)
Workmanship, Finish & Appearance – Section 6.8
7-day Chemical Resistance – Section 7.2.1
Type-I Tensile Properties @ 23°C (Psi) – ASTM D638-14
Flexural Properties @ 23°C (Psi) – ASTM D790-17
Dimensions and Tolerances, Wall Thickness @ 23°C (") – ASTM D5813-04

TEST RESULTS: The results of testing are reported in tables 1 thru 4, attached.

CONCLUSION: Based on the test results achieved, both samples meet the minimum requirements outlined in ASTM F1743-17(Vol.: 8.04 2020)…***Complies.***

Specimen Retain Bin: BB (30-day retain only unless otherwise specified)

Signed on behalf of;

CRT LABORATORIES, INC.

IAPMO R&T ANAB ISO 9001:15 Certified – Registered / ISO/IEC 17025:05 Recognized Co.

Ken A. Le Jeune
CEO / Laboratory Director

Raul Gonzalez
Laboratory Technician

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Geosynthetic Materials • Plumbing & Faucet Assemblies • Resin & Finished Product Testing

FOR: Perma-Liner Industries, LLC.
13000 Automobile Blvd., Suite-300
Clearwater, FL 33762
Tel: (727) 744-2594 / Fax: (727) 507-9849
ATTN: Mr. Rishi Vasudeva

LWR NO.: 21144 DATE: April 21, 2020

TABLE 1
SCOPE: Compliance with ASTM F1743-17 (Vol.: 8.04 2020)
SAMPLE ID: Sample - 1 LightRay UV-LED PIPE 3" Diameter Thickness 2.5mm

5.2.3 RESIN PROPERTIES (DSC)

	Value Obtained	Requirements	Results
Onset (°C)	66.48	<82.2	Pass
Midpoint (°C)	67.58	N/A	N/A
Contamination and/or copolymers	none detected	No contamination	Pass
Tech comments	See spectra	N/A	N/A

6.8 WORKMANSHIP FINISH & APPEARANCE

The finished CIPP is homogeneous throughout the entire length and free of dry spots, lifts and delamination(s)…***Complies***

7.2 CHEMICAL RESISTANCE / ASTM D790-17 (FLEXURAL PROPERTIES)

Test specimens were machined and immersed in chemicals solutions in Table 2 at a temperature of 23°C for 7 days. Flexural properties were determined per ASTM D790-17 before/after chemical exposure. The following results were obtained:

Control specimens								
Specimen #	**1**	**2**	**3**	**4**	**5**	**Average**	**% change**	**Results**
Flexural strength (psi)	11,448	11,458	11,154	10,799	11,212	11,214	N/A	N/A
Flexural modulus (psi)	419,649	441,056	413,237	443,610	448,272	433,163	N/A	N/A
Chemical: Nitric acid 1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	10,961	9,560	8,958	11,016	9,933	10,086	N/A	N/A
Flexural modulus (psi)	361,691	359,980	429,659	461,240	356,435	393,801	-9.09	Pass
Chemical: Sulfuric acid 5% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	9,689	10,681	8,738	9,932	10,909	9,991	N/A	N/A
Flexural modulus (psi)	390,116	360,730	411,888	395,484	397,737	391,191	-9.69	Pass
Chemical: ASTM Fuel C 100% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	9,032	9,859	10,572	9,268	9,586	9,664	N/A	N/A
Flexural modulus (psi)	369,720	345,621	394,941	355,531	381,949	369,552	-14.70	Pass
Chemical: Vegetable oil 100% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	11,932	10,937	10,994	11,068	10,915	11,169	N/A	N/A
Flexural modulus (psi)	368,174	394,195	350,067	370,350	350,092	368,375	-14.90	Pass
Chemical: Detergent 0.1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	8,828	8,155	10,294	9,874	10,064	9,443	N/A	N/A
Flexural modulus (psi)	441,364	423,051	355,009	381,956	443,793	409,034	-5.57	Pass
Chemical: Soap 0.1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	11,881	11,034	11,277	10,374	8,958	10,705	N/A	N/A
Flexural modulus (psi)	408,113	383,868	356,558	391,430	379,039	383,802	-11.40	Pass

…***Complies***

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LWR NO.: 21144 DATE: April 21, 2020

TABLE 1 continuation

SCOPE: Compliance with ASTM F1743-17 (Vol.: 8.04 2020)

SAMPLE ID: Sample - 1 LightRay UV-LED PIPE 3" Diameter Thickness 2.5mm

ASTM D 638-14 (TENSILE STRENGTH AT PEAK)

Tensile test specimens (type-I) were CNC machined and tensile properties were determined per ASTM D638-14. The following results were obtained:

Specimen #	1	2	3	4	5	Average	Requirements	Results
Peak strength (psi)	9,854	10,162	9,960	9,491	9,608	9,815	3,000 minimum	Pass

…Complies

5.2 DIMENSIONS & TOLERANCES

Dimensions were measured in accordance with ASTM D2122-16 using a digital caliper and micrometer as applicable. The following average results were obtained:

	Outside Diameter	Wall Thickness	Results
	3.503"	0.108"	N/A
Requirements	N/A	N/A	N/A

…for client information only

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TABLE 2
SCOPE: Compliance with ASTM F1743-17 (Vol.: 8.04 2020)
SAMPLE ID: Sample 2 - LightRay UV-LED PIPE 6" Diameter Thickness 3.0mm

5.2.3 RESIN PROPERTIES (DSC)

	Value Obtained	Requirements	Results
Onset (°C)	53.57	<82.2	Pass
Midpoint (°C)	59.01	N/A	N/A
Extrapolated Peak (°C)	68.27	N/A	
Contamination and/or copolymers	none detected	No contamination	Pass
Tech comments	See spectra	N/A	N/A

6.8 WORKMANSHIP FINISH & APPEARANCE

The finished CIPP is homogeneous throughout the entire length and free of dry spots, lifts and delamination(s)…***Complies***

7.2 CHEMICAL RESISTANCE / ASTM D790-17 (FLEXURAL PROPERTIES)

Test specimens were machined and immersed in chemicals solutions in Table 2 at a temperature of 23°C for 7 days. Flexural properties were determined per ASTM D790-17 before/after chemical exposure. The following results were obtained:

Control specimens								
Specimen #	1	2	3	4	5	Average	% change	Results
Flexural strength (psi)	6,900	6,829	7,012	6,311	6,464	6,703	N/A	N/A
Flexural modulus (psi)	417,523	419,129	410,733	437,347	438,221	424,589	N/A	N/A
Chemical: Nitric acid 1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	6,596	6,851	6,883	6,023	6,420	6,555	N/A	N/A
Flexural modulus (psi)	290,181	420,818	379,885	301,423	437,196	365,901	-13.8	Pass
Chemical: Sulfuric acid 5% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	4,709	8,292	6,190	6,810	4,656	6,132	N/A	N/A
Flexural modulus (psi)	337,219	385,195	396,357	346,831	347,620	362,644	-14.60	Pass
Chemical: ASTM Fuel C 100% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	5,748	5,899	7,753	6,817	5,373	6,318	N/A	N/A
Flexural modulus (psi)	362,806	346,203	351,547	455,791	363,533	373,976	-11.90	Pass
Chemical: Vegetable oil 100% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	8,304	8,499	8,756	6,911	5,882	7,670	N/A	N/A
Flexural modulus (psi)	363,142	378,404	412,797	349,833	348,072	370,450	-12.80	Pass
Chemical: Detergent 0.1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	7,575	5,792	6,773	6,945	7,463	6,910	N/A	N/A
Flexural modulus (psi)	361,584	358,501	441,945	414,826	407,688	396,909	-6.52	Pass
Chemical: Soap 0.1% (immersion: 7-days @ 23°C)								
Flexural strength (psi)	6,684	6,251	7,284	6,160	5,584	6,393	N/A	N/A
Flexural modulus (psi)	428,629	431,744	412,155	398,042	339,255	401,965	-5.33	Pass

…***Complies***