ITB 201915 – NEIGHBORHOOD UTILITY REINVESTMENT – PROJECT 1

THE VILLAGE OF WELLINGTON,
CLERK'S OFFICE,
12300 FOREST HILL BLVD,
WELLINGTON, FL 33414

LANZO TRENCHLESS
TECHNOLOGIES INC SOUTH
125 SE 5TH COURT
DEERFIELD BEACH, FLORIDA 33441

CONTACT: JAMES M. TILLI,
ASSISTANT SECRETARY
PHONE: 954-979-0802
EMAIL: ESTIMATING@LANZO.ORG

THE VILLAGE OF WELLINGTON

LANZO TRENCHLESS TECHNOLOGIES SOUTH

LANZO
TRENCHLESS TECHNOLOGIES

125 SE 5th Court
Deerfield Beach, FL 33441
Office: (954) 973-9700
Fax: (954) 974-3894
www.lanzo.net

The Village of Wellington

Clerk's Office

12300 Forest Hill Blvd,

Wellington, FL 33414

Re: Neighborhood Utility Reinvestment – Project 1; ITB No. 201915

Lanzo Trenchless Technologies Inc South is pleased to submit to you for review the following proposal to perform cleaning, televising and sewer rehabilitation services as needed for the Village of Wellington, FL.

What makes our proposal unique is that it brings together three (3) companies under one roof; those being Lanzo Trenchless Technologies, Lanzo Construction, and Lanzo Materials; all firms qualified and experienced within scope of services required by this request for qualifications document.

The services of each of these companies, while proposed within this Lanzo Trenchless Technologies submittal; offer all services as a sole source without additional markup for subcontractors.

Lanzo Trenchless Technologies is a Florida based Sewer & Water Rehabilitation company. Lanzo Trenchless Technologies is a part of the D'Alessandro family of construction companies established over fifty (50) years ago is deeply rooted in construction tradition. Lanzo Trenchless Technologies was founded in 1993 to serve the Municipal needs for infrastructure cleaning, inspection and rehabilitation services. We specialize in all types of Water, Wastewater & Specialty Lining Operations. Our staff of engineers, project managers, health & safety professionals share and facilitate the company passion for excellence and are committed to the safe & timely completion of all projects. Our team of skilled equipment operators, experienced labor workforce, and highly qualified internal support staff has responded quickly to perform some of the most complex projects in the industry with an unwavering commitment to quality and customer satisfaction. Our company offers a wide range of services designed to upgrade America's infrastructure, improve energy efficiency, reduce operating costs, and protect the environment. Their abilities include a full range of pipeline services such as:

- Pipeline Cleaning
- CCTV Inspection
- CIPP Manhole-to-Manhole Lining
- CIPP Sectional Lining
- CIPP Service Lateral Lining
- Mechanical Joint Sealing
- NSF 61 certified CIPP Water Main Lining
- GRP/Segmented Panel Lining
- Slip lining (HDPE, Hobas, GRP)
- Carbon Fiber Reinforced Plastic (CFRP)
- Manhole Lining
- Joint Sealing via Chemical Grout Injection

LANZO TRENCHLESS TECHNOLOGIES

125 SE 5th Court
Deerfield Beach, FL 33441
Office: (954) 973-9700
Fax: (954) 974-3894
www.lanzo.net

On this project, Lanzo Trenchless Technologies proposes to perform work in the following categories:

- CIPP Reconstruction
- Maintenance of Traffic (MOT)
- Isolation and by-pass pumping
- Erosion and Sediment Control
- Site Restoration
- Lateral Reinstatement,
- Manhole Repairs.
- Manhole Rehabilitation

Attached are the resumes and certifications of our key personnel who will be supervising the projects in all categories that we are proposing to perform work.

Also attached are current equipment lists to assist in demonstrating our ability to meet the needs of the Village of Wellington, FL. This equipment is available for use in all categories of work which we are proposing to perform work. Along with our installation equipment I would like to note our wet-out facility capabilities both permanent and temporary for over the hole wet out applications for weight prohibitive installations. Our permanent facility is located at 4260 NW 19th Ave., Pompano Beach, Florida, 33064.

Thank you for considering Lanzo Trenchless Technologies Inc South to work with the Village of Wellington, FL. If you have any questions or need further information concerning our proposal, please feel free to contact me at 954-979-0802.

Respectfully submitted;

James M. Tilli

Assistant Secretary

Lanzo Trenchless Technologies

Table of Contents

LANZO TRENCHLESS TECHNOLOGIES

Bid Proposal

BID PROPOSAL CHECKLIST

Please submit your proposal in this order

YES_X_ NO___ 1. Bid submittal – one (1) original and one (1) PDF (CD) Copy

YES_X_ NO___ 2. Bid Form signed by authorized representative

YES_X_ NO___ 3. Acknowledgment of addendums

YES_X_ NO___ 4. Bid Bond/Security or Cashier's Check

YES_X_ NO___ 5. Schedule of Value

YES___ NO___ 6. Schedule of Subcontractor/Supplies

YES___ NO___ 7. Schedule of Equipment and Materials

YES_X_ NO___ 8. Sworn Statement under Section 287.133(3) (a)

YES_X_ NO___ 9. Drug Free Workplace

YES_X_ NO___ 10. Trench Safety Affidavit

YES_X_ NO___ 11. Questionnaire

YES_X_ NO___ 12. Insurance Certificates

YES_X_ NO___ 13. Copy of Appropriate Licenses

YES_X_ NO___ 14. Proof of Workers Compensation Insurance/Workers Compensation Exemption

YES___ NO_X_ 15. Local Preference Affidavit

YES_X_ NO___ 16. Conflict of Interest Statement

YES_X_ NO___ 17. Non-Collusion Affidavit

YES_X_ NO___ 18. References and Prior Experience Form

YES_X_ NO___ 19. Certification Pursuant To Florida Statute § 215.4725

BID BOND/SECURITY

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

KNOW ALL MEN BY THESE PRESENTS, that we Lanzo Trenchless Technologies, Inc.- South

125 SE 5th Court, Deerfield Beach, FL 33441

as Principal, hereinafter called the Principal, and North American Specialty Insurance Company

1450 American Lane, Suite 1100, Schaumburg, IL 60173

a corporation duly organized under the laws of the State of New Hampshire as Surety, hereinafter called the Surety, are held and firmly bound unto Wellington, Purchasing Dept., 12300 Forest Hill Boulevard, Wellington, FL 33414

as Obligee, hereinafter called the Obligee, in the sum of Ten Percent (10%) of amount bid for the payment of which sum well and truly to be made, the said Principal and the said Surety, bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the said Principal has submitted a bid for ITB 201915 - Neighborhood Utility Reinvestment – Project 1.

NOW, THEREFORE, if the Obligee shall accept the bid of the Principal and the Principal shall enter into a Contract with the Obligee in accordance with the terms of such bid, and give such bond or bonds as may be specified in the bidding or Contract Documents with good and sufficient surety for the faithful performance of such Contract and for the prompt payment of labor and material furnished in the prosecution thereof, or in the event of the failure of the Principal to enter such Contract and give such bond or bonds, if the Principal shall pay to the Obligee the difference not to exceed the penalty hereof between the amount specified in said bid and such larger amount for which the Obligee may in good faith contract with another party to perform the Work covered by said bid, then this obligation shall be null and void, otherwise to remain in full force and effect.

Signed and sealed September 11, 2019

Witnesses:

Ram Vithal Chilakdazalli

Charlene Vaughn, Surety Administrator

Lanzo Trenchless Technologies, Inc.- South

Seal

By: ____________________

James M. Tolli, Asst. Secretary

North American Specialty Insurance Company

Seal

By: ____________________

Alan P. Chandler, Attorney-in-Fact

SWISS RE CORPORATE SOLUTIONS

NORTH AMERICAN SPECIALTY INSURANCE COMPANY
WASHINGTON INTERNATIONAL INSURANCE COMPANY
WESTPORT INSURANCE CORPORATION

GENERAL POWER OF ATTORNEY

KNOW ALL MEN BY THESE PRESENTS, THAT North American Specialty Insurance Company, a corporation duly organized and existing under laws of the State of New Hampshire, and having its principal office in the City of Overland Park, Kansas and Washington International Insurance Company a corporation organized and existing under the laws of the State of New Hampshire and having its principal office in the City of Overland Park, Kansas, and Westport Insurance Corporation, organized under the laws of the State of Missouri, and having its principal office in the City of Overland Park, Kansas each does hereby make, constitute and appoint:

ROBERT TROBEC, KATHLEEN M. IRELAN, IAN J. DONALD, JEFFREY A. CHANDLER, ALAN P. CHANDLER, SUSAN L. SMALL, T.J. GRIFFIN, JOHN L. BUDDE,

STEVEN K. BRANDON, TERENCE J. GRIFFIN, WILLIAM A. PIRRET, TERRI L. YOUNG and PATRICK E. WILLIAMS

Its true and lawful Attorney(s)-in-Fact, to make, execute, seal and deliver, for and on its behalf and as its act and deed, bonds or other writings obligatory in the nature of a bond on behalf of each of said Companies, as surety, on contracts of suretyship as are or may be required or permitted by law, regulation, contract or otherwise, provided that no bond or undertaking or contract or suretyship executed under this authority shall exceed the amount of: ONE HUNDRED TWENTY FIVE MILLION ($125,000,000.00) DOLLARS

This Power of Attorney is granted and is signed by facsimile under and by the authority of the following Resolutions adopted by the Boards of Directors of North American Specialty Insurance Company and Washington International Insurance Company at meetings duly called and held on March 24, 2000 and Westport Insurance Corporation by written consent of its Executive Committee dated July 18, 2011.

"RESOLVED, that any two of the President, any Senior Vice President, any Vice President, any Assistant Vice President, the Secretary or any Assistant Secretary be, and each or any of them hereby is authorized to execute a Power of Attorney qualifying the attorney named in the given Power of Attorney to execute on behalf of the Company bonds, undertakings and all contracts of surety, and that each or any of them hereby is authorized to attest to the execution of any such Power of Attorney and to attach therein the seal of the Company; and it is

FURTHER RESOLVED, that the signature of such officers and the seal of the Company may be affixed to any such Power of Attorney or to any certificate relating thereto by facsimile, and any such Power of Attorney or certificate bearing such facsimile signatures or facsimile seal shall be binding upon the Company when so affixed and in the future with regard to any bond, undertaking or contract of surety to which it is attached."

NORTH AMERICAN SPECIALTY INSURANCE COMPANY CORPORATE SEAL 1973 NEW HAMPSHIRE

WASHINGTON INTERNATIONAL INSURANCE COMPANY CORPORATE SEAL NEW HAMPSHIRE

By ______
Steven P. Anderson, Senior Vice President of Washington International Insurance Company
& Senior Vice President of North American Specialty Insurance Company
& Senior Vice President of Westport Insurance Corporation

By ______
Mike A. Ito, Senior Vice President of Washington International Insurance Company
& Senior Vice President of North American Specialty Insurance Company
& Senior Vice President of Westport Insurance Corporation

WESTPORT INSURANCE CORPORATION CORPORATE SEAL

IN WITNESS WHEREOF, North American Specialty Insurance Company, Washington International Insurance Company and Westport Insurance Corporation have caused their official seals to be hereunto affixed, and these presents to be signed by their authorized officers this this 29TH day of March, 20 18.

North American Specialty Insurance Company
Washington International Insurance Company
Westport Insurance Corporation

State of Illinois
County of Cook ss:

On this 29THday of March, 20 18, before me, a Notary Public personally appeared Steven P. Anderson, Senior Vice President of Washington International Insurance Company and Senior Vice President of North American Specialty Insurance Company and Senior Vice President of Westport Insurance Corporation and Michael A. Ito Senior Vice President of Washington International Insurance Company and Senior Vice President of North American Specialty Insurance Company and Senior Vice President of Westport Insurance Corporation, personally known to me, who being by me duly sworn, acknowledged that they signed the above Power of Attorney as officers of and acknowledged said instrument to be the voluntary act and deed of their respective companies.

OFFICIAL SEAL M. KENNY Notary Public - State of Illinois

M. Kenny, Notary Public

I, Jeffrey Goldberg, the duly elected Vice President and Assistant Secretary of North American Specialty Insurance Company, Washington International Insurance Company and Westport Insurance Corporation do hereby certify that the above and foregoing is a true and correct copy of a Power of Attorney given by said North American Specialty Insurance Company, Washington International Insurance Company and Westport Insurance Corporation which is still in full force and effect.

IN WITNESS WHEREOF, I have set my hand and affixed the seals of the Companies this 11th day of September, 2019.

______
Jeffrey Goldberg, Vice President & Assistant Secretary of Washington International Insurance Company &
North American Specialty Insurance Company & Vice President & Assistant Secretary of Westport Insurance Corporation

BID FORM

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

PROJECT: Neighborhood Utility Reinvestment – Project 1 Date: 10/03/2019

BIDDER: LANZO TRENCHLESS TECHNOLOGIES INC., SOUTH

THIS BID IS SUBMITTED TO:

Wellington
Clerk's Office
12300 Forest Hill Boulevard
Wellington, FL 33414

1. The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.

2. BIDDER accepts all of the terms and conditions of the Advertisement or Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 180 days after the posting of the recommended award. BIDDER will sign and submit the Agreement with the Bonds and other documents required by the Bidding Requirements within 15 days after the date of OWNER'S Notice of Award.

3. In submitting this Bid, BIDDER represents, as more fully set forth in the Agreement, that:

(a) BIDDER has examined copies of all the Bidding Documents and of the following Addenda (receipt of all which is hereby acknowledged):

Date 08/06/2019	Addenda Number 1
Date 08/30/2019	Addenda Number 2
Date	Addenda Number

(b) BIDDER has familiarized itself with the nature and extent of the Contract Documents, Work, Site, locality, and all local conditions, Laws, and Regulations that in any manner may affect cost, progress, performance, or furnishing of the Work.

(c) BIDDER has studied carefully all reports and drawings of subsurface conditions and drawings of physical conditions which, if any, are attached to the Contract Documents, and accepts the determination as set forth in the Bidding Documents of the extent of the technical data contained in such reports and drawings upon which BIDDER is entitled to rely.

(d) BIDDER has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests and studies (in addition to or to supplement those referred to in (c) above) which pertain to the subsurface or physical conditions at the site or otherwise may affect the cost, progress, performance or furnishing of the Work as BIDDER considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents, and no additional examinations, investigations, explorations, tests, reports or similar information or data are or will be required by BIDDER for such purposes.

(e) BIDDER has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports or similar information or data in respect of said Underground Facilities are or will be required by BIDDER in order to perform and furnish the Work at the Contract price, within the Contract Time and in accordance with the other terms and conditions of the Contract Documents.

(f) BIDDER has correlated the results of all such observations, examinations, investigations, explorations, tests, reports, and studies with the terms and conditions of the Contract Documents.

THE VILLAGE OF WELLINGTON

A GREAT HOMETOWN

ITB 201915
Title: Neighborhood Utility Reinvestment – Project 1
Opening Date: September 11, 2019 at 2:00pm
Addendum Date: August 6, 2019

ADDENDUM NO. ONE

PURPOSE: The purpose of this Addendum/NOTICE is to make changes, additions, deletions, revisions, and clarifications to the (ITB) Invitation to Bid documents for Neighborhood Utility Reinvestment – Project 1. Bidder shall review the Addendum/NOTICE work and requirements in detail and incorporate any effects the Addendum/NOTICE may have in their proposal price.

1. **The mandatory pre-bid meeting date for this bid has been changed. The pre-bid meeting will now be held on August 14, 2019 at 9:00am.**

ACKNOWLEDGEMENT: Bidder must acknowledge receipt of any and all Addenda in the space provided on the Bidder Submittal Form. Failure to do so may result in rejection of the Proposal. All requirements of the proposal documents remain unchanged except as cited herein.

Signature of Bidder Acknowledging Receipt of
Addendum No. (1) One to be attached in front of Bid
SIGNED BY: JAMES M. TILLI, ASSISTANT SECRETARY

ITB 201915
Title: Neighborhood Utility Reinvestment – Project 1
Opening Date: October 3, 2019 at 2:00pm
Addendum Date: August 30, 2019

ADDENDUM NO. TWO

PURPOSE: The purpose of this Addendum/NOTICE is to make changes, additions, deletions, revisions, and clarifications to the (ITB) Invitation to Bid documents for Neighborhood Utility Reinvestment – Project 1. Bidder shall review the Addendum/NOTICE work and requirements in detail and incorporate any effects the Addendum/NOTICE may have in their proposal price.

1. **The bid opening date for this bid has changed. Bids are now due October 3, 2019 at 2:00pm.**

2. **Question: For Line Item P1 – 8" PVC Replacement, the quantity provided is 120 LF. This appears to line up with the length for the 5 "Point Repairs" on pages 32 and 33 and it appears there is a 20 LF Minimum repair length, will that be the case if additional point repairs are found to be needed as we clean and tv the lines? Obviously the length of repair will affect the per LF pricing.**

   Response: The minimum repair length is 10 feet.

3. **Question: Line Item P2 – 8" PVC manhole connection, references using boots at the manholes which requires coring. Would sand collars be an acceptable alternative for connecting pipe to manholes?**

   Response: No, sand collars will not be acceptable.

4. **Question: Line Item P3 – 8" PVC Wye at Sewer Main – Will this only be used in conjunction with point repairs or pipe replacement? Or will we be required in some locations to dig down to the main and just replace a Wye on the main if one is found to be broken?**

5. **Response:** This bid item is intended for the replacement of the Wye at the main during pipe replacements or during lateral service replacement, if needed. This line item will not be used as a standalone repair, therefore excavation and backfill top expose the wye at the main should be included in other bid items.

6. **Question: Line Item P5-P6 – Cured in Place Pipe Lining – The measurement and payment says "grouting to prevent infiltration at service connections and liner ends" please confirm if grouting will only be required in laterals which have active or if all reinstated laterals are required to be grouted.**

   Response: All reinstated laterals shall be sealed in accordance with Section 33 01 30.72 – Relining Gravity Mains, CIPP of the specifications.

7. **Question: Line Item L3 – Lateral Replacement – does this line item include the Wye on the main or is that to be billed under Line Item P3 Separately?**

   Response: Bid item L3 – Lateral Replacement does not include the replacement of the Wye at the main. If the Village determines it is necessary to replace the Wye at the main, then it should be billed under bid item P3 separately.

8. **Question: When does the Village anticipate awarding this contract and issuing an NTP?**

   Response: Anticipated Notice to Proceed is November 15.

9. **Question: Who will be responsible for the construction coordination on the project? Will the Village handle directly or will it be through the EOR?**

   Response: The Village of Wellington will administer the Construction Contract.

10. **Question: SECTION 33 01 30.73 – SEWER SERVICE LATERAL LINING, PART 1 – GENERAL, 1.2 REFERENCE SPECIFICATIONS, CODES AND STANDARDS, A., 3. ASTM F2561**

    When ASTM F2561 is added to the specification, this section becomes a defacto sole source bid. ASTM F2561 contains proprietary hydrophilic O-Ring gaskets, and only ONE product, LMK T-Liner meets that ASTM. Furthermore, only one contractor in Florida meets the qualifications, LMK Pipe Renewal. You can only get one bidder on this section.

    In section; 1.4 QUALITY ASSURANCE – The use of both ASTM F1216 and ASTM F2561 are mentioned in the product qualifications. This has been used in bids so the owner knows what ASTM the contractor is bidding under (there are several lateral lining contractors that meet ASTM F1216, that use hydrophilic products that meet the intent of ASTM F2561 – a structural watertight lateral lining).

    PART 2 – PRODUCTS – 2.1 MATERIALS, L. Component CIPP Properties, 4. Hydrophilic Rubber End Seal. Again, this makes this a sole source section. As stated, the rubber (Neoprene) rubber and hydrophilic product mentioned is proprietary to ONE product, LMK "T-Liner". There are other proven hydrophilic materials, that have passed a 10,000 hour hydration, dehydration under pressure test, which will provide a watertight lateral liner.

    To have a competitive bid so the City gets the best prices, we recommend in the Lateral Lining section of this specification a contractor can bid either ASTM F1216 or, ASTM F2561 that can meet the existing qualifications.

    Response: The Contractor shall prepare his/her bid based the products specified. The Village of Wellington will consider "or equal" products after the bid is awarded.

11. **Question: If we are submitting our proposal online, do we also have to submit the one original and copy in mail or can we just do online? The wording was a little confusing at parts.**

    Response: If your firm submits online, you can just submit your bid in our bid portal.

ACKNOWLEDGEMENT: Bidder must acknowledge receipt of any and all Addenda in the space provided on the Bidder Submittal Form. Failure to do so may result in rejection of the Proposal. All requirements of the proposal documents remain unchanged except as cited herein.

Signature of Bidder Acknowledging Receipt of
Addendum No. (2) One to be attached in front of Bid
SIGNED BY: JAMES M. TILLI, ASSISTANT SECRETARY

(g) BIDDER has given OWNER written notice of all conflicts, errors or discrepancies that it has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to BIDDER.

(h) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm, or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; BIDDER has not solicited or induced any person, firm or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other Bidder or over OWNER.

4. BIDDER agrees to perform all the Work described in Contract Documents, subject to adjustments as provided therein, for the Prices BIDDER provides on the Schedule of Values.

5. BIDDER declares it understands that the unit quantities shown on the Bid Form Unit Price Schedule are approximate only and not guaranteed and are subject to either increase or decrease; and that should the quantities of any of the items of Work be increased, the BIDDER agrees to do the additional Work at the unit prices set out herein, and should the quantities be decreased, BIDDER also understands that final payment shall be made on actual quantities completed at the unit prices, and shall make no claims for anticipated profits for any decrease in the quantities.

6. The BIDDER further declares its understands the OWNER may elect to construct only a portion of the Work covered by these Documents and BIDDER agrees to perform that portion of the Work for which BIDDER is awarded a Contract at the unit prices quoted herein.

7. BIDDER agrees that the Work:

   Neighborhood Utility Reinvestment – Project 1 shall be Substantially Complete within 210 days of Notice to Proceed and Finally Complete within 245 days of Notice to Proceed. Work hours 7:00am to 7:00pm Monday – Friday, excluding holidays.

   BIDDER accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work on time.

8. The following documents are attached to and made a condition of this Bid:

   (a) Required Bid security in the form of Bid Bond.
   (b) Schedule of Values.
   (c) List other documents as pertinent.

9. Communications concerning this Bid shall be telephoned or addressed to:

   Name: JAMES M. TILLI, ASSISTANT SECRETARY
   Address: 125 SE 5TH COURT, DEERFIELD BEACH, FL 33441

   Phone No.: (954) 979-0802 Fax: (954) 979-9897

10. BIDDER'S Florida Contractor's License No. CUC053346; CGC050862

11. BIDDER covenants that it is qualified to do business in the State of Florida and has attached evidence of BIDDER'S qualification to do business in the State of Florida, or if not attached, BIDDER covenants to obtain such evidence within five days of request by OWNER to provide evidence.

If BIDDER is

An Individual

Name____________________(SEAL)

Signature:____________________

Doing business as ____________________

Business Address:____________________

RICK SCOTT, GOVERNOR

JONATHAN ZACHEM, SECRETARY

Florida dbpr

STATE OF FLORIDA

DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION

CONSTRUCTION INDUSTRY LICENSING BOARD

THE UNDERGROUND UTILITY & EXCAVATION CO HEREIN IS CERTIFIED UNDER THE PROVISIONS OF CHAPTER 489, FLORIDA STATUTES

BEATY, ROBERT WILLIAM III

LANZO TRENCHLESS TECHNOLOGIES-SOUTH
1864 GOLFVIEW BLVD
SOUTH DAYTONA FL 32119

LICENSE NUMBER: CUC053346

EXPIRATION DATE: AUGUST 31, 2020

Always verify licenses online at MyFloridaLicense.com

Do not alter this document in any form.

This is your license. It is unlawful for anyone other than the licensee to use this document.

RICK SCOTT, GOVERNOR

JONATHAN ZACHEM, SECRETARY

Florida dbpr

STATE OF FLORIDA
DEPARTMENT OF BUSINESS AND PROFESSIONAL REGULATION

CONSTRUCTION INDUSTRY LICENSING BOARD

THE GENERAL CONTRACTOR HEREIN IS CERTIFIED UNDER THE PROVISIONS OF CHAPTER 489, FLORIDA STATUTES

BEATY, ROBERT WILLIAM III

LANZO TRENCHLESS TECHNOLOGIES-SOUTH
1864 GOLFVIEW BLVD
SOUTH DAYTONA FL 32119

LICENSE NUMBER: CGC050862

EXPIRATION DATE: AUGUST 31, 2020

Always verify licenses online at MyFloridaLicense.com

Do not alter this document in any form.

This is your license. It is unlawful for anyone other than the licensee to use this document.

Phone Number:____________________ Fax Number____________________

A Partnership

Firm's Name ____ (SEAL)

General Partner Signature:____________________________________

Business Address:____

Phone Number:____________________ Fax Number____________________

A Corporation

Corporation's Name LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH (SEAL)

State of Incorporation FLORIDA

Authorized Person: JAMES M. TILLI

Title: ASSISTANT SECRETARY

Signature:____

Attest:____ (Assistant Secretary)

KEVIN PAWLOWSKI

Signature:____

Business Address: 125 SE 5TH COURT, DEERFIELD BEACH, FL 33441

Phone Number: (954) 979-0802 Fax Number (954) 979-9897

SCHEDULE OF VALUES

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

Item No.	Item	Quantity	Units	Unit Price	Amount
General					
G1	1.Mobilization/Demobilization/General Conditions	1	LS	$25,000.00	$25,000.00
G2	2. Bonds and Insurance	1	LS	$20,000.00	$20,000.00
G3	3. Laboratory Testing Services (Concrete Cylinders, Proctors, Density Tests)	1	LS	$10,900.00	$10,900.00
G4	4. Pre-Construction Video Taping	1	LS	$8,600.00	$8,600.00
G5	5. Record Drawings	1	LS	$10,350.00	$10,350.00
G6	6. Public Outreach - Scheduling/Notifications	1	LS	$32,300.00	$32,300.00
Pipe Repairs					
P1	7. 8" PVC C-900 Pipe Replacement	120	LF	$305.00	$36,600.00
P2	8. Core Manhole, 8" PVC Connection and Reconstruct Manhole Bench	2	EA	$1,975.00	$3,950.00
P3	9. 8" PVC Wye at Sewer Main (Including Connection to Lateral)	4	EA	$4,400.00	$17,600.00
P4	10. Gravity Sewer Main Cleaning and TV Inspection	22,210	LF	$3.50	$77,735.00
P5	11. Cured in Place Pipe Lining, 8" Pipe	22,000	LF	$30.00	$660,000.00
P6	12. Cured in Place Pipe Lining, 15" Pipe	210	LF	$52.00	$10,920.00
P7	13. Mechanical Root or Grease Removal (8" or smaller)	250	LF	$8.00	$2,000.00
P8	14. Mechanical Tuberculation/Concrete Removal (8" & smaller)	3,000	LF	$13.00	$39,000.00
Lateral Repairs					
L1	15. Lateral Repair No. 1, Clean and Televise Lateral, Install Double Cleanout	11	EA	$290.00	$3,190.00
L2	16. Lateral Repair No. 2, Clean Wye Remove Obstructions, Install Double Cleanout	2	EA	$1,450.00	$2,900.00
L3	17. Lateral Repair No. 3, 6" PVC SDR 26 Sewer Service Lateral Replacement (Up to 30' Long)	10	EA	$2,650.00	$26,500.00
L4	18. Lateral Repair No. 4, Adjust Service Connections, Private Side	5	EA	$1,350.00	$6,750.00
L5	19. Lateral Repair No. 5, Replace Wye at Property Line, includes up to 5' of Lateral Replacement, Install Double Cleanout	34	EA	$2,650.00	$90,100.00
L6	20. Lateral Repair No. 6, Cured in Place Pipe Lining 6" Sewer Service Lateral (Up to 30' Long), Install Double Cleanout	23	EA	$4,500.00	$103,500.00
L7	21. Lateral Repair No. 7, Abandon Lateral, Cap at Main, Remove Lateral from Roadway, Grout Service Lateral to Property Line/Easement	24	EA	$2,900.00	$69,600.00

L8	22. 6" PVC SDR 26 Sewer Lateral Replacement (Beyond 30' Long)	30	LF	$60.00	$1,800.00
L9	23. Cured in Place Pipe Lining, 6" Sewer Lateral Replacement (Beyond 30' Long)	100	LF	$97.00	$9,700.00
L10	24. Sewer Lateral Spot Replacement beyond 5' (associated with Bid Item L5)	15	LF	$103.00	$1,545.00
Miscellaneous Repairs					
MR1	25. Asphalt Replacement (Including Base and Subgrade)	1,800	SY	$25.00	$45,000.00
MR2	26. 1 1/2" Mill and Overlay	6,400	SY	$17.00	$108,800.00
MR3	27. Concrete Driveway Replacement 6" Minimum Thickness	1,400	SY	$46.00	$64,400.00
MR4	28. Concrete Sidewalk Replacement 4" Minimum Thickness	450	SY	$31.00	$13,950.00
MR5	29. Concrete Curb Replacement (all types)	25	LF	$51.00	$1,275.00
MR6	30. Sod Replacement	2,000	SY	$4.00	$8,000.00
MR7	31. Install Root Barrier	20	LF	$17.00	$340.00
MR8	32. Replace Outside Drop with Inside Drop MH	1	EA	$4,900.00	$4,900.00
MR9	33. Water Treatment Plan Discharge Bypass (from MH0493 to MH0219)	1	LS	$5,900.00	$5,900.00
Owner Allowances					
A1	34. Coventry Green	1	Allow	$200,000.00	$200,000.00
A2	35. Contingencies	1	Allow	$100,000.00	$100,000.00
				Grand Total	$1,823,105.00

BIDDER/CONTRACTOR understands and agrees that this is Unit Price Contract and that contractor will be paid based upon items and quantities actually performed and accepted by Owner. The Schedule of Values is provided for the purpose of Bid Evaluation and when initiated by Wellington, the pricing of change orders. Contractor's price will not be adjusted to reflect any deviation from the Schedule of Values, except to the extent that Wellington changes the scope of Project after the Contract Date.

Quantities listed on the Schedule of Values are estimates only and are not to be construed as guaranteed work quantities. Bids will be evaluated based upon the total contract price. Balance of pricing shall be considered by OWNER in determining lowest, responsive, responsible bidder. CONTRACTORS/BIDDERS shall submit balanced bids.

SCHEDULE OF SUBCONTRACTORS

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

Discipline	Subcontractor	Address City, ST, Zip	License Number
CIPP Lining/Underground	(SELF-PERFORM)		
Paving (SELF- PERFORM)			
MAINTENANCE OF TRAFFIC;	BONS BARRICADES;	5001 NW 13TH AVENUE, POMPANO BEACH, FL 33064	
PUBLIC OUTREACH;	QUEST CORPORATION OF AMERICA;	17220 CAMELOT CT, LAND O LAKS, FL 34638	

Address of Subcontractor may be considered in accordance with Wellington's Local Preference Policy

SCHEDULE OF EQUIPMENT AND MATERIALS

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

Item	Manufacturer	Description
PVC PIPE AND FITTINGS		PIPE & SUPPLIES
(FERGUSON)		

SWORN STATEMENT UNDER SECTION 287.133(3)(a), FLORIDA STATUTES, ON PUBLIC ENTITY CRIMES

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

THIS FORM MUST BE SIGNED IN THE PRESENCE OF A NOTARY PUBLIC OR OTHER OFFICER AUTHORIZED TO ADMINISTER OATHS.

1. This sworn statement is submitted to VILLAGE OF WELLINGTON, FL
   [print name of the public entity]
   by JAMES M. TILLI, ASSISTANT SECRETARY
   [print individual's name and title]
   for LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH
   [print name of entity submitting sworn statement]

   whose business address is 125 SE 5TH COURT, DEERFIELD BEACH, FL 33441

   ____

   and (if applicable) its Federal Employer Identification Number (FEIN) is 65-0414559

   (If the entity has no FEIN, include the Social Security Number of the individual signing this sworn statement: ______________________________.)

2. I understand that a "public entity crime" as defined in Paragraph 287.133(1)(g), Florida Statutes, means a violation of any state or federal law by a person with respect to and directly related to the transaction of business with any public entity or with an agency or political subdivision of any other state or of the United States, including, but not limited to, any bid or contract for goods or services or any contract for the construction or repair of a public building or public work, to be provided to any public entity or an agency or political subdivision of any other state or of the United States and involving antitrust, fraud, theft, bribery, collusion, racketeering, conspiracy, or material misrepresentation.

3. I understand that "convicted" or "conviction" as defined in Paragraph 287.133(1)(b), Florida Statutes, means a finding of guilt or a conviction of a public entity crime, with or without an adjudication of guilt, in any federal or state trial court of record relating to charges brought by indictment or information after July 1, 1989, as a result of jury verdict, nonjury trial, or entry of a plea of guilty or nolo contendere.

4. I understand that an "affiliate" as defined in Paragraph 287.133(1)(a), Florida Statutes, means:

   1. A predecessor or successor of a person convicted of a public entity crime; or
   2. An entity under the control of any natural person who is active in the management of the entity and who has been convicted of a public entity crime. The term "affiliate" includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in the management of an affiliate. The ownership by one person of shares constituting a controlling interest in another person, or a pooling of equipment or income among persons when not for fair market value under an arm's length agreement, shall be a prima facie case that one person controls another person. A person who knowingly enters into a joint venture with a person who has been convicted of a public entity crime in Florida during the preceding 36 months shall be considered an affiliate.

5. I understand that a "person" as defined in Paragraph 287.133(1)(c), Florida Statutes, means any natural person or entity organized under the laws of any state or of the United States with the legal power to enter into a binding contract and which bids or applies to bid on contracts for the provision of goods or services let by a public entity, or which otherwise transacts or applies to transact business with a public entity. The term "person" includes those officers, directors, executives, partners, shareholders, employees, members, and agents who are active in management of an entity.

6. Based on information and belief, the statement which I have marked below is true in relation to the entity submitting this sworn statement. [Please indicate which statement applies.]

   XXX Neither the entity submitting this sworn statement, nor any officers, directors, executives, partners, shareholders, employees, members, or agents who are active in management of the entity, nor any affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989.

   _____ The entity submitting this sworn statement, or one or more of the officers, directors, executives, partners, shareholders, employees, members, or agents who are active in management of the entity, or an affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989.

   _____ The entity submitting this sworn statement, or one or more of its officers, directors, executives, partners, shareholders, employees, members, or agents who are active in the management of the entity, or an affiliate of the entity has been charged with and convicted of a public entity crime subsequent to July 1, 1989. However, there has been a subsequent proceeding before a Hearing Officer of the State of Florida, Division of Administrative Hearings and the Final Order entered by the Hearing Officer determined that it was not in the public interest to place the entity submitting this sworn statement on the convicted vendor list. [attach a copy of the final order]

I UNDERSTAND THAT THE SUBMISSION OF THIS FORM TO THE CONTRACTING OFFICER FOR THE PUBLIC ENTITY IDENTIFIED IN PARAGRAPH 1 (ONE) ABOVE IS FOR THAT PUBLIC ENTITY ONLY AND, THAT THIS FORM IS VALID THROUGH DECEMBER 31 OF THE CALENDAR YEAR IN WHICH IT IS FILED. I ALSO UNDERSTAND THAT I AM REQUIRED TO INFORM THE PUBLIC ENTITY PRIOR TO ENTERING INTO A CONTRACT IN EXCESS OF THE THRESHOLD AMOUNT PROVIDED IN SECTION 287.017, FLORIDA STATUTES FOR CATEGORY TWO OF ANY CHANGE IN THE INFORMATION CONTAINED IN THIS FORM.

[signature] JAMES M. TILLI, ASSISTANT SECRETARY

10/03/2019
[date]

STATE OF FLORIDA

COUNTY OF BROWARD

Subscribed and Sworn to (or affirmed) before me on 10/03/2019 by
[date]
JAMES M. TILLI, ASSISTANT SECRETARY. He/she is personally known to me or has presented
[name]
PERSONALLY KNOWN TO ME as identification.
[type of identification]

[Notary's Signature and Seal]

SUSAN MARKS
Print Notary Name and Commission No.

SUSAN MCMAHON MARKS
Notary Public - State of Florida
Commission # FF979930
My Comm. Expires Apr 7, 2020
Bonded through National Notary Assn.

DRUG FREE WORKPLACE

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

Preference may be given to businesses with drug-free workplace programs. Whenever two or more Bids which are equal with respect to price, quality, and service are received by the Owner for the procurement of commodities or contractual services, a Bid received from a business that certifies that it has implemented a drug-free workplace program may be given preference in the award process. Established procedures for processing tie Bids will be followed if none of the tied vendors have a drug-free workplace program. In order to have a drug-free workplace program, a business must attest to the following:

1. We publish a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the workplace and specifying the actions that will be taken against employees for violations of such prohibition.

2. We inform employees about the dangers of drug abuse in the workplace, the business's policy of maintaining a drug-free workplace, any available drug counseling, rehabilitation, and employee assistance programs, and the penalties that may be imposed upon employees for drug abuse violations.

3. We give each employee engaged in providing the commodities or contractual services that are under Bid a copy of the statement specified in subsection (1).

4. We, in the statement specified in subsection (1), notify the employees that, as a condition of working on the commodities or contractual services that are under Bid, the employee will abide by the terms of the statement and will notify the employer of any conviction of, or plea of guilty or nolo contendere to, any violation of Chapter 893 or of any controlled substance law of the United States or any state, for a violation occurring in the workplace no later than five (5) days after such conviction.

5. We impose a sanction on, or require the satisfactory participation in a drug abuse assistance or rehabilitation program if such is available in the employee's community, by any employee who is so convicted.

6. We make a good faith effort to continue to maintain a drug-free workplace through implementation of this section.

As the person authorized to sign the statement, I certify that this firm complies fully with the above requirements.

____

Contractor's Signature JAMES M. TILLI, ASSISTANT SECRETARY

TRENCH SAFETY AFFIDAVIT

(FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE)

LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH (NAME OF FIRM) hereby provides written assurance that compliance with applicable Trench Safety Standards identified in the Occupational Safety and Health Administration's Excavation Safety Standards, (OSHA) 29 C.F.R.S. 1926.650 Subpart P will be adhered to during trench excavation in accordance with Florida Statutes 553.60 through 533.64 inclusive (1990), "Trench Safety Act".

The undersigned acknowledges that included in the various items of the proposal and in the Total Proposal Price are costs for complying with the Florida "Trench Safety Act" as summarized below: (Attach additional sheets as necessary).

LF= LINEAR FEET

Schedule Item	Trench Safety Measure (Slope, Trench Shield, etc.)	Cost
P1, L8 & L9	SLOPE / BOX METHOD	$1.50 / LF
	Total	$375.00

10/03/2019

(Signature) JAMES M. TILLI, ASSISTANT SECRETARY (Date)

STATE OF FLORIDA

COUNTY OF BROWARD

Subscribed and Sworn to (or affirmed) before me on 10/03/2019 by

JAMES M. TILLI, ASSISTANT SECRETARY. He/she is personally known to me or has presented

PERSONALLY KNOWN TO ME (type of i.d.) as identification.

Notary Public Signature and Seal

Susan Marks

Print Notary Name and Commission No.

SUSAN MCMAHON MARKS
Notary Public - State of Florida
Commission # FF979930
My Comm. Expires Apr 7, 2020
Bonded through National Notary Assn.

NOTARY PUBLIC STATE OF FLORIDA

QUESTIONNAIRE

The following Questionnaire shall be completed and submitted in Envelope with the Bid. By submission of this Bid, Bidder guarantees the truth and accuracy of all statements and answers herein contained.

1. How many years has your organization been in business? 26 YEARS

2. Have you ever failed to complete work awarded to you? If so, where and why? NO

3. Has the bidder or his or her representative inspected the proposed project and does the Bidder have a complete plan for its performance?

YES

4. Will you subcontract any part of this work? If so, give details including a list of each subcontractor(s) that will perform work in excess of the percent (10%) of the contract amount and the work that will be performed by each subcontractor(s).

Subcontractor	Work to be Performed
BONS BARRICADES	MAINTENANCE OF TRAFFIC
QUEST CORPORATION OF AMERICA	PUBLIC OUTREACH

5. What equipment do you own that is available for the work? *** PLEASE SEE ATTACHED FOR RESUME OF QUALIFICATIONS; EQUIPMENT LIST***

6. What equipment will you purchase for the proposed work? NONE

7. What equipment will you rent for the proposed work? NONE

8. State the name of your proposed project manager and give details of his or her qualifications and experience in managing similar jobs.

*** PLEASE SEE ATTACHED FOR RESUME OF QUALIFICATIONS; KEY PERSONNEL RESUMES ***

9. State the true, exact, correct and complete name of the partnership, corporation, or trade name under which you do business and the address of the place of business. (If a corporation, state the name of the president and secretary. If a partnership, state the names of all partners. If a trade name, state the names of the individuals who do businesses under the trade name.

10. The correct name of the Bidder is LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH

11. The partnership is a ☐ Sole Proprietorship, ☐ Partnership, or ☒ Corporation or ☐ Other Type of Entity ____________ (Fill In).

12. The address of principal place of business is 125 SE 5TH COURT, DEERFIELD BEACH, FL 33441

13. The names of the Corporate Officers, or Partners, or Individuals doing business under a trade name, are as follows:

*** PLEASE SEE ATTACHED FOR CORPORATE RESOLUTION AND SUNBIZ REPORT ***

14. List all organizations which were predecessors to Bidder or in which the principals or officers of the Bidder were principals or officers.

LANZO CONSTRUCTION CO., FLORIDA; LANZO TRENCHLESS TECHNOLOGIES INC. NORTH, LANZO COMPANIES, INC.

15. List and describe all bankruptcy petitions (Voluntary or Involuntary) which have been filed by or against the Bidder, its parent or subsidiaries or predecessor organizations during the past five (5) years. Include in the description the disposition of each such petition.

NONE

16. List and describe all successful Performance or Payment Bond claims made to your surety(ies) during the last five (5) years. The list and descriptions should include claims against the bond of the Bidder and its predecessor organization(s).

NONE

17. List all claims, arbitrations, administrative hearings and lawsuits brought by or against the Bidder or its predecessor organization(s) during the last five (5) years. The list shall include all case names; case, arbitration, or hearing identification numbers; the name of the project over which the dispute arose; and a description of the subject matter of the dispute.

*** PLEASE SEE ATTACHED FOR LITIGATION HISTORY (5) YEARS ***

18. List and describe all criminal proceedings or hearings concerning business related offenses in which the Bidder, its principals or officers or predecessor organization (s) were defendants.

NONE

19. Has the Bidder, its principals, officers, or predecessor organization(s) been debarred or suspended from bidding by any government during the last five (5) years? If yes, provide details.

NONE

20. List and disclose any and all business relations with any members of Wellington Council.

NONE

2019 FLORIDA PROFIT CORPORATION AMENDED ANNUAL REPORT

DOCUMENT# P93000026586

Entity Name: LANZO TRENCHLESS TECHNOLOGIES, INC.-SOUTH

FILED
May 31, 2019
Secretary of State
5989430142CC

Current Principal Place of Business:

125 SE 5TH COURT
DEERFIELD BEACH, FL 33441

Current Mailing Address:

125 SE 5TH COURT
DEERFIELD BEACH, FL 33441 US

FEI Number: 65-0414559

Certificate of Status Desired: No

Name and Address of Current Registered Agent:

D'ALESSANDRO, ANTONIO CARLO
125 SE 5TH COURT
DEERFIELD BEACH, FL 33441 US

The above named entity submits this statement for the purpose of changing its registered office or registered agent, or both, in the State of Florida.

SIGNATURE: ANTONIO D'ALESSANDRO — 05/31/2019

Electronic Signature of Registered Agent — Date

Officer/Director Detail :

Title	AS
Name	TILLI, MATTHEW P
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

Title	COO
Name	TINGBERG, FREDERICK JR.
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

Title	SECRETARY, TREASURER
Name	TORRES, ROSAMARIA
Address	37230 WILLOW LANE
City-State-Zip:	CLINTON TWP MI 48036

Title	ASST. SECRETARY
Name	BEATY, ROBERT
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

Title	AS
Name	PAWLOWSKI, KEVIN P
Address	2734 NE 27TH COURT
City-State-Zip:	LIGHTHOUSE PT. FL 33064

Title	VP
Name	D'ALESSANDRO, ANTONIO
Address	21788 REFLECTIONLANE
City-State-Zip:	BOCA RATON FL

Title	VP
Name	D'ALESSANDRO, QUIRINO JR.
Address	4611 NORTH FEDERAL HWY 520
City-State-Zip:	POMPANO BEACH FL 33064

Title	CHAIRMAN
Name	D'ALESSANDRO, QUIRINO SR.
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

Continues on page 2

I hereby certify that the information indicated on this report or supplemental report is true and accurate and that my electronic signature shall have the same legal effect as if made under oath; that I am an officer or director of the corporation or the receiver or trustee empowered to execute this report as required by Chapter 607, Florida Statutes; and that my name appears above, or on an attachment with all other like empowered.

SIGNATURE: KEVIN PAWLOWSKI — ASST SECRETARY — 05/31/2019

Electronic Signature of Signing Officer/Director Detail — Date

Officer/Director Detail Continued :

Title	ASST. SECRETARY
Name	TILLI, JAMES
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

LANZO TRENCHLESS TECHNOLOGIES SOUTH

Delivering innovative trenchless technology solutions to rehabilitate the world's diverse infrastructure

125 S.E. 5th Court
Deerfield Beach, FL 33441-4749
Office: (954) 973-9700
Fax: (954) 974-3894
www.lanzo.net

RESOLUTION OF CORPORATION

I HEREBY certify that I am the duly elected and qualified Secretary of Lanzo Trenchless Technologies Inc. South, a Florida Corporation and that the following is a true and complete copy of a Resolution duly adopted at a meeting of the Board of Directors of said Corporation, held on the 20th of May 2019 and that such resolution is still in full force and effect.

RESOLUTION, that the officers listed below are authorized to sign Contracts, Bids and any other documents to carry out the business of the Corporation.

Name	Title	Signature
Quirino D'Alessandro, Sr.	Chairman	
Fredrick Tingberg, Jr.	Chief Operating Officer	
Rosemarie Torres	Secretary / Treasurer	
Quirino D'Alessandro, Jr.	Executive Vice President	
Antonio D'Alessandro	Executive Vice President	
Kevin Pawlowski	Assistant Secretary	
Matthew P. Tilli	Assistant Secretary	Matthew P. Tilli
Robert Beaty, III	Assistant Secretary	
James M. Tilli	Assistant Secretary	

IN WITNESS WHEREOF, I have hereunto set my hand as Secretary of said Corporation and affix the Corporate Seal on the 20th of May 2019.

By ______________________
Rosemarie Torres, Secretary

Attest:
____
Fredrick Tingberg, Jr., Chief Operating Officer

Lanzo Trenchless Technologies, Inc. South f/k/a Lanzo Lining Services, Inc.

All of the lawsuits that have been filed against that entity, its directors, partners, principals, and/or board members, based on breach of contract by that entity in the five years prior to bid or proposal submittal, including the case number and the disposition of the case

Case Name:	*Lanzo Lining Services, Inc. v. Proshot Concrete, Inc., et al.*
Case Number:	U.S. District Court, District of Columbia Case No.: 1:2013-cv-01382
Disposition:	Settled
Date Filed:	09/11/2013

REQUEST FOR PROOF OF WORKERS COMPENSATION INSURANCE OR EXEMPTION

Dear Provider of Services or Goods:

In order to provide services or goods to Wellington, we require that you provide us either proof of workers compensation coverage or proof of exemption.

Employers conducting work in the State of Florida are required to provide workers' compensation insurance for their employees. Specific employer coverage requirements are based on the type of industry, number of employees and entity organization. To determine coverage requirements for a specific employer, the following information is provided by the Bureau of Compliance.

Construction Industry - One (1) or more employees, including the owner of the business who are corporate officers or Limited Liability Company (LLC) members. For a list of the trades considered to be in the construction industry see 69L-6.021 Florida Administrative Code.

Non-Construction Industry - Four (4) or more employees, including business owners who are corporate officers or Limited Liability Company (LLC) members.

Please note: Non-construction industry Sole Proprietors or partners in a Partnership are not employees unless they want to be included on the business' Workers' Compensation Insurance policy and file a form DWC 251 with the Division of Workers' Compensation.

Agricultural Industry - Six (6) regular employees and/or twelve (12) seasonal workers who work more than 30 days during a season but no more than a total of 45 days in a calendar year.

Out of State Employers must notify their insurance carrier that they are working in Florida. If there is no insurance, the out of state employer is required to obtain a Florida Workers' Compensation Insurance policy with a Florida approved insurance carrier which meets the requirements of Florida law and the Florida Insurance Code. This means that "Florida" must be specifically listed in Section 3A of the policy (on the Information Page).

An Extraterritorial Reciprocity clause in the home state's statute allows some out of state Employers to work in Florida temporarily using their home state's Workers' Compensation insurance policy.

Contractors are required to make certain that all sub-contractors have the required Workers' Compensation Insurance **before** they begin work on a project. To see the documentation that is required from a sub-contractor, see 69L-6.032 Florida Administrative Code.

If the sub-contractor does not have Workers' Compensation Insurance for its employees, those workers become the employees of the contractor. If an injury occurs, the contractor is responsible for paying the benefits for the work related injury, illness or fatality.

If you meet the above criteria to be exempt, you MUST provide us with one of the following:

- If your business is a sole proprietorship or unincorporated business: provide us a Verification of Automatic Exempt Certificate. This verification is a letter that is issued by the State of Florida Department of Financial Services. To receive a letter from the State, complete the following directions: 1) Call the National Council of Compensation Insurance 1-800-622-4123, Option 5, and ask them for the class code for your type of business. 2) Once you have received this code, call the Department of Financial Services at 1-850-413-1601 and provide them your business name, class code, mailing address, and contact phone number. They will send you the Verification of Automatic Exempt Certificate. 3) Provide us a copy of the Verification of Automatic Exempt Certificate.
- If your business is a corporation (including a professional association or limited liability company), and you are not required to have workers compensation insurance as per the requirements as outlined above, you must provide the Village with a copy of your Florida Division of Workers' Compensation Certificate of Election to be Exempt.

If you are an employer that meets the requirements of workers compensation and needs to obtain coverage, contact your current business insurance agent, or you may use the following resources to locate an agent: www.faia.com., www.piafl.org/wc-info.pdf , or call (850) 893-8245.

Please be reminded that the furnishing of this information to Wellington is a non-negotiable requirement to perform services for us. Failure to provide this timely may result in either termination of your services or delay of payment for services. Your workers compensation Certificate of Coverage, of Workers' Compensation Certificate of Election to be Exempt, or Verification of Automatic Exempt Certificate must be delivered or mailed to the Purchasing Department located at 12300 Forest Hill Boulevard, Wellington, Florida, 33414.

*** PLEASE SEE ATTACHED FOR EVIDENCE OF COVERAGE ***

CERTIFICATE OF LIABILITY INSURANCE

DATE (MM/DD/YYYY): 2/28/2019

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AFFIRMATIVELY OR NEGATIVELY AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW. THIS CERTIFICATE OF INSURANCE DOES NOT CONSTITUTE A CONTRACT BETWEEN THE ISSUING INSURER(S), AUTHORIZED REPRESENTATIVE OR PRODUCER, AND THE CERTIFICATE HOLDER.

IMPORTANT: If the certificate holder is an ADDITIONAL INSURED, the policy(ies) must be endorsed. If SUBROGATION IS WAIVED, subject to the terms and conditions of the policy, certain policies may require an endorsement. A statement on this certificate does not confer rights to the certificate holder in lieu of such endorsement(s).

PRODUCER VTC Insurance Group Troy Office 1175 W. Long Lake Ste. 200 Troy MI 48098-4960	CONTACT NAME: LeAnne Bushong PHONE (A/C, No, Ext): (248)828-3377 FAX (A/C, No): (248)828-3741 E-MAIL ADDRESS: lbushong@vtcins.com
INSURED Lanzo Companies Inc 125 S.E. 5th Court Deerfield Beach FL 33441	

INSURER(S) AFFORDING COVERAGE	NAIC #
INSURER A: Zurich American Ins. Co.	16535
INSURER B: American Guarantee & Liability	26247
INSURER C:	
INSURER D:	
INSURER E:	
INSURER F:	

COVERAGES CERTIFICATE NUMBER: 19/20 Master REVISION NUMBER:

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED. NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

INSR LTR	TYPE OF INSURANCE	ADDL INSD	SUBR WVD	POLICY NUMBER	POLICY EFF (MM/DD/YYYY)	POLICY EXP (MM/DD/YYYY)	LIMITS	
A	X COMMERCIAL GENERAL LIABILITY CLAIMS-MADE [X] OCCUR X XCU Included GEN'L AGGREGATE LIMIT APPLIES PER: POLICY [X] PRO-JECT [ ] LOC OTHER:			GL03067667	3/1/2019	3/1/2020	EACH OCCURRENCE	$ 1,000,000
							DAMAGE TO RENTED PREMISES (Ea occurrence)	$ 100,000
							MED EXP (Any one person)	$ 10,000
							PERSONAL & ADV INJURY	$ 1,000,000
							GENERAL AGGREGATE	$ 2,000,000
							PRODUCTS - COMP/OP AGG	$ 2,000,000
								$
A	AUTOMOBILE LIABILITY X ANY AUTO ALL OWNED AUTOS SCHEDULED AUTOS X HIRED AUTOS X NON-OWNED AUTOS			BAP3067670	3/1/2019	3/1/2020	COMBINED SINGLE LIMIT (Ea accident)	$ 1,000,000
							BODILY INJURY (Per person)	$
							BODILY INJURY (Per accident)	$
							PROPERTY DAMAGE (Per accident)	$
								$
B	X UMBRELLA LIAB X OCCUR EXCESS LIAB CLAIMS-MADE DED RETENTION $			AUC3231759	3/1/2019	3/1/2020	EACH OCCURRENCE	$ 5,000,000
							AGGREGATE	$ 5,000,000
								$
A	WORKERS COMPENSATION AND EMPLOYERS' LIABILITY Y/N ANY PROPRIETOR/PARTNER/EXECUTIVE OFFICER/MEMBER EXCLUDED? (Mandatory in NH) If yes, describe under DESCRIPTION OF OPERATIONS below	N/A		WC3067669	3/1/2019	3/1/2020	PER STATUTE / OTH-ER	
							E.L. EACH ACCIDENT	$ 1,000,000
							E.L. DISEASE - EA EMPLOYEE	$ 1,000,000
							E.L. DISEASE - POLICY LIMIT	$ 1,000,000
A	Installation Floater Leased & Rented Equipment			CPP3216321	3/1/2019	3/1/2020	Limit $4,500,000. Ded. $5,000. Limit $640,000. Ded $5,000.	

DESCRIPTION OF OPERATIONS / LOCATIONS / VEHICLES (ACORD 101, Additional Remarks Schedule, may be attached if more space is required)

All operations of the named insured.

CERTIFICATE HOLDER	CANCELLATION
Evidence of Coverage ***	SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, NOTICE WILL BE DELIVERED IN ACCORDANCE WITH THE POLICY PROVISIONS. AUTHORIZED REPRESENTATIVE Alan Chandler/SZEBRO *Alan P. Chandler*

WELLINGTON LOCAL PREFERENCE

APPLICATION TO BE CONSIDERED A LOCAL BUSINESS IN ACCORDANCE WITH VILLAGE OF WELLINGTON FLORIDA'S LOCAL PREFERENCE POLICY

Wellington gives preference to local businesses in certain purchasing situations as set forth in Chapter 9 of Wellington's Purchasing and Procurement Manual. In order to be considered a local business, entitled to be given preference, the business must make application with Wellington and meet one of the following criteria as such is more fully set forth in Chapter 9, of Wellington's Purchasing and Procurement Manual:

Chapter 9, LOCAL PREFERENCE
Western Communities Local Business - For the purpose of determining a "Western Communities local business" a vendor must have a principal permanent business location and headquarters within Wellington of Wellington, Florida or west of the Florida Turnpike to the Palm Beach County western boundary line. This applies to all entity formations, including, but not limited to, limited liability companies, partnerships, limited partnerships and the like or sole proprietors. Further, the entity or sole proprietor must provide that it, he or she has been domiciled and headquartered in the jurisdictional boundaries of the Western Communities for at least six months prior to the solicitation. Post Office boxes will not be considered a permanent business location within the Western Communities. Home business offices shall be considered as a business location if it otherwise meets the requirements herein. In order to be eligible for such local preference the vendor shall have a local business tax receipt pursuant to the County's and/or municipalities' Code of Ordinances, having jurisdiction over the location of the business, unless otherwise exempt therefrom. Further, the vendor must be properly licensed and authorized by law to provide the goods, services or professional services to the extent applicable and the location of the business must be properly zoned in order for the vendor to conduct its business.

Palm Beach County local business - For the purpose of determining a "Palm Beach County local business" a vendor must have a principal permanent business location and headquarters within Palm Beach County, Florida. This applies to all entity formations, including, but not limited to, limited liability companies, partnerships, limited partnerships and the like or sole proprietors. Further, the entity or sole proprietor must provide that it, he or she has been headquartered and domiciled in the jurisdictional boundaries of Palm Beach County, Florida for at least six months prior to the solicitation. Post Office boxes will not be considered a permanent business location within Palm Beach County, Florida. Home business offices shall be considered as a business location if it otherwise meets the requirements herein. In order to be eligible for such local preference the vendor shall have a local business tax receipt pursuant to the Palm Beach County Code of Ordinances as amended from time to time, unless otherwise exempt there from. Further, the vendor must be properly licensed and authorized by law to provide the goods, services or professional services to the extent applicable and the location of the business must be properly zoned in order for the vendor to conduct its business.

Subcontractor utilization - In competitive bid situations, a business may also qualify as either a Palm Beach County or Western Community local business if they are utilizing subcontractors to perform the work or materialmen to supply the job and more than fifty (50%) percent of their proposed bid price will be paid to subcontractors and/or materialmen who qualify, under the above standards, as Palm Beach County and/or Western Community local businesses.

Please check the box below indicating which preference category your business is applying for:

☐ Western Communities Local Business

☐ Palm Beach County Local Business *** NOT APPLICABLE ***

☐ Subcontractor Utilization

1. The name of the business is: ______________________________

2. The address of the business is: ______________________________

3. How long has the business been located at its current address: __________

4. If the business has relocated within the last six months, please provide the answers to questions 1-3 for the previous location:

5. The previous name of the business is: ______________________________

6. The previous address of the business is: ______________________________

7. How long was this business at the previous location: __________

8. If the business is attempting to qualify under the subcontractor utilization provision, please provide a breakdown of the subcontractors who would qualify for either the Palm Beach County or Western Community, business classification, the requisite information, provide their responses to the above 1 - 7 questions and for each of the subcontractors, indicate the amount that they are proposed to be compensated at under the bid price.

9. The business as a local business tax receipt from: (1) Palm Beach County ☐ (2) the following municipality: ____________________ (3) located in unincorporated Palm Beach County: ☐

10. Please provide a copy of Local Business Tax Receipts from Palm Beach County and the applicable municipality are attached.

11. Please provide a Certificate of Good Standing indicating the formation or domestication of the entity in and for the State of Florida is attached.

12. Please provide copies of licenses if applicable from the State of Florida authorizing the business to provide the good services or professional services contemplated in the bid documents.

By signing below, I hereby certify that under penalty of perjury I believe my business qualifies as a Palm Beach County, Western Community or subcontractor utilization business in accordance with Wellington's Local Preference Policy and that I have submitted current and accurate information and documents relating to my qualifications. I further acknowledge and agree that any fraudulent or duplicitous information submitted in furtherance of this application will be grounds for disqualification from bidding on this project and doing business with Wellington in the future.

Applicants Federal Tax ID Number - ________________ Applicants Business Address ________________

____

*** NOT APPLICABLE ***

Signature of Authorized Representative of Corporation, Partnership, or other business entity:

*** NOT APPLICABLE ***
____

Print Name: ________________________________

Title: __________________________

Date: _____________________

CITY OF: ______________________

COUNTY OF: ______________________

SUBSCRIBED AND SWORN TO (or affirmed) before me on this ____ day of ________________, 201__, by _______________________________________. He/She is personally known to me or has presented

_______________________ as identification.

____
(Signature of Notary)

____
(Print or Stamp Name of Notary)

Notary Public ____________________________ (State)

Notary Seal

Signature of Individual if Sole Proprietor:

____

Print Name: ________________________________

Date: _____________________

CITY OF: ______________________

COUNTY OF: ______________________

SUBSCRIBED AND SWORN TO (or affirmed) before me on this ____ day of ________________, 201__, by _______________________________________. He/She is personally known to me or has presented

_______________________ as identification.

____
(Signature of Notary)

____
(Print or Stamp Name of Notary)

Notary Public ____________________________ (State)

Notary Seal

CONFLICT OF INTEREST STATEMENT

This Proposal/Agreement (whichever is applicable) is subject to the conflict of interest provisions of the policies and Code of Ordinances of WELLINGTON, the Palm Beach County Code of Ethics, and the Florida Statutes. During the term of this Agreement and any renewals or extensions thereof, the VENDOR shall disclose to WELLINGTON any possible conflicts of interests. The VENDOR's duty to disclose is of a continuing nature and any conflict of interest shall be immediately brought to the attention of WELLINGTON. The terms below shall be defined in accordance with the policies and Code of Ordinances of WELLINGTON, the Palm Beach County Code of Ethics, and Ch. 112, Part III, Florida Statutes.

CHECK ALL THAT APPLY.

[X] To the best of our knowledge, the undersigned business has no potential conflict of interest for this Agreement due to any other clients, contracts, or property interests.

[X] To the best of our knowledge, the undersigned business has no employment or other contractual relationship with any WELLINGTON employee, elected official or appointed official.

[X] To the best of our knowledge, the undersigned business has no officer, director, partner or proprietor that is a WELLINGTON purchasing agent, other employee, elected official or appointed official. The term "purchasing agent", "elected official" or "appointed official", as used in this paragraph, shall include the respective individual's spouse or child, as defined in Ch. 112, Part III, Florida Statutes.

[X] To the best of our knowledge, no WELLINGTON employee, elected official or appointed official has a material or ownership interest (5% ownership) in our business. The term "employee", "elected official" and "appointed official", as used in this paragraph, shall include such respective individual's relatives and household members as described and defined in the Palm Beach County Code of Ethics.

[X] To the best of our knowledge, the undersigned business has no current clients that are presently subject to the jurisdiction of WELLINGTON's Planning, Zoning and Building Department.

CONFLICT:

[ ] **The undersigned business, by attachment to this form, submits information which may be a potential conflict of interest due to any of the above listed reasons or otherwise.**

THE UNDERSIGNED UNDERSTANDS AND AGREES THAT THE FAILURE TO CHECK THE APPROPRIATE BLOCKS ABOVE OR TO ATTACH THE DOCUMENTATION OF ANY POSSIBLE CONFLICTS OF INTEREST MAY RESULT IN DISQUALIFICATION OF YOUR BID/PROPOSAL OR IN THE IMMEDIATE CANCELLATION OF YOUR AGREEMENT, WHICHEVER IS APPLICABLE.

LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH
COMPANY NAME

[signature]
AUTHORIZED SIGNATURE

JAMES M. TILLI
NAME (PRINT OR TYPE)

ASSISTANT SECRETARY
TITLE

NON-COLLUSION AFFIDAVIT

State of FLORIDA

County of BROWARD

Being duly sworn deposes and says:

That he/she is an officer of the parties making the forgoing bid submittal, that the bid is made without prior understanding, agreement, or connection with any individual, firm, partnership, corporation or other entity submitting a bid for the same materials, services, supplies or equipment, either directly or indirectly, and is in all respects fair and without collusion or fraud. No premiums, rebates, or gratuities are permitted with, prior to, or after any delivery of material or provision of services. Any violation of this provision may result in disqualification, contract cancellation, return of materials or discontinuation of services, and the possible removal of Bidder from the vendor Bid lists.

LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH
Name of Bidder

JAMES M. TILLI
Print name of designated signatory

[signature]
Signature

ASSISTANT SECRETARY
Title

On this 3rd day of OCTOBER, 20 19, before me appeared JAMES M. TILLI, ASSISTANT SECRETARY personally known to me to be the person described in and who executed this NON-COLLUSION AFFIDAVIT and acknowledged that (she/he) signed the name freely and voluntarily for the uses and purposes therein described.

In witness thereof, I have hereunto set my hand and affixed seal the day and year last written above.

[signature]
Signature

(Affix Seal Here)

SUSAN MCMAHON MARKS
Notary Public - State of Florida
Commission # FF979930
My Comm. Expires Apr 7, 2020
Bonded through National Notary Assn.

Notary Public in and for the State of FL

SUSAN MARKS
(Name Printed)

Residing at BROWARD CTY

My commission expires ______

REFERENCES AND PRIOR EXPERIENCE (PRIME CONTRACTOR)

Bidder Company Name: LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH

Bidder shall provide detailed summary of prior experience evidencing successful completion of five (5) Similar projects over the last five (5) years (in scope and complexity). Include information on construction methodology, project budget versus completed cost, project change orders with associated justification, project schedule versus actual completion time, and project litigation if encountered. The Bidder shall provide current names and telephone numbers of agency references for each project provided.

PROJECT NAME: *** PLEASE SEE ATTACHED FOR DETAILED JOB DESCRIPTIONS ***

Owner/Reference Name: ______________________________

Owner/Reference Contact: ______________________________

Name Title

____

Phone Email

Project Location: ______________________________

Project Description: ______________________________

Was the Bidder Prime Contractor or Subcontractor? ______________________________

List project scope similarities: ______________________________

Project Cost: Initial Contract Value $__________

Change Orders $__________

Final Contract Price $__________

Explain Reason(s) for Change Orders: ______________________________

Project Timeline: Start Date __________

Contract Time Extension __________

Completion Date __________

Explain Reason(s) for Time Extension:____

____

____

____

NOTE: Include additional pages with the same format to list other projects as proof of prior experience. List a minimum of five (5) similar projects.

FAILURE TO COMPLETE THIS FORM MAY RESULT IN THE BID BEING DECLARED NON-RESPONSIVE

CERTIFICATION PURSUANT TO FLORIDA STATUTE § 215.4725

I, JAMES M. TILLI, ASSISTANT SECRETARY, on behalf of LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH certifies
Print Name — Company Name

that LANZO TRENCHLESS TECHNOLOGIES INC. SOUTH does not:
Company Name

1. Participate in a boycott of Israel; and
2. Is not on the Scrutinized Companies that Boycott Israel list; and
3. Is not on the Scrutinized Companies with Activities in Sudan List; and
4. Is not on the Scrutinized Companies with Activities in the Iran Petroleum Energy Sector List; and
5. Has not engaged in business operations in Cuba or Syria.

Signature JAMES M. TILLI

ASSISTANT SECRETARY
Title

10/03/2019
Date

Contractor Qualifications

LANZO TRENCHLESS TECHNOLOGIES

Village of Wellington, FL

INSTALLER:

Lanzo Trenchless Technologies Inc South is pleased to following table that we believe illustrates that our organization is more than capable of performing the scope of work described in Neighborhood Utility Reinvestment – Project 1. Lanzo Trenchless Technologies Inc South certifies that the installation of Commercially Acceptable Product will be done in accordance with Manufacturer's recommended procedures. The Manufacture's letter has been attached to this table. We are always available if you have any questions regarding these projects.

DESCRIPTION	YES	NO	REMARKS
Contractor to have minimum of 5 years of experience.	X		Lanzo has been in business and doing similar work since 1996.
Contractor to have a minimum of five (5) years of previous experience and 75,000 LF of successfully completed CIPP lining installation for sanitary sewer gravity mains size 6" and larger.	X		Lanzo has installed over 1 Million feet of Cured-in-place-pipe liner in Sanitary Sewer Gravity Mains with sizes varying 6-inch or larger since 1996.
A minimum of two (2) years of previous experience and 15,000 LF of successfully completed CIPP lining installation for sanitary sewer service laterals	X		Lanzo has installed Hundreds of Thousands of feet of Cured-In-Place Pipe Liner in Sanitary Sewer Service Laterals Since 1996.

LL654 Taft Street 60-inch Sanitary Sewer
Cured-In-Place Pipe Rehabilitation

LANZO TRENCHLESS TECHNOLOGIES

City of Hollywood

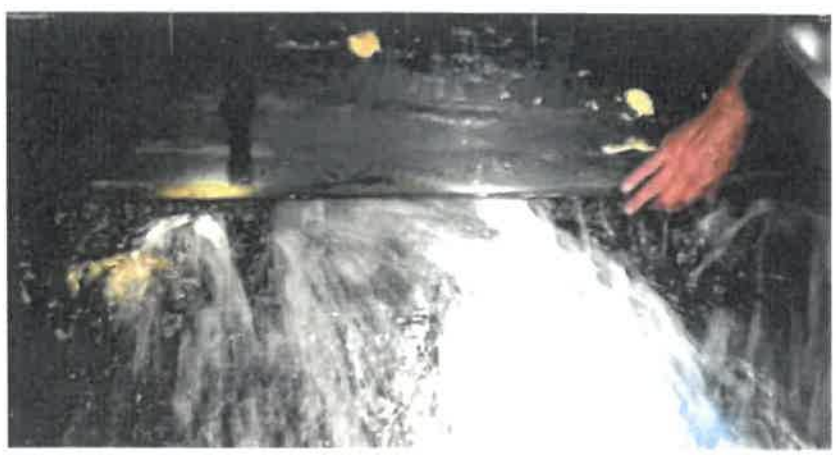
Owner
City of Hollywood
2600 Hollywood Boulevard
Hollywood, FL 33020

Owner Contact
Jose Polanco
(954) 921-3930
jpolanco@hollywoodfl.org

Final Project Amount:
$2,484,295.35

Start Date: May 2014
Completion Date: Nov 2014

Lanzo Lining Services was the prime contractor for this project and self-performed all of the work associated. The project included any permits associated with the project, traffic control and cleaning and CCTV investigation of the sewers. After review of the videos, Lanzo designed the liner tubes per ASTM specifications and installed the liners. Many of the sewers on this project posed a difficult challenge due to the amount of ground water infiltration. Lanzo also engineered and installed a new 48" X 60" eccentric reducer. Lanzo also corrected multiple infiltration points in the line,caused by ground getting into the line. The size of these points ranged from pinholes to gushers like the one illustrated to the right.



LL 703 48-inch Force Main Cure-In-Place Pipe Lining
Phase 2 Contract No. 17673

City of West Palm Beach

Owner
City of West Palm Beach
401 Clematis Street, 5th Floor
West Palm Beach, FL 33401

Owner Contact
Rudy Fernandez
(561) 882-5004
Rudy.Fernandez@jacobs.com

Engineer:

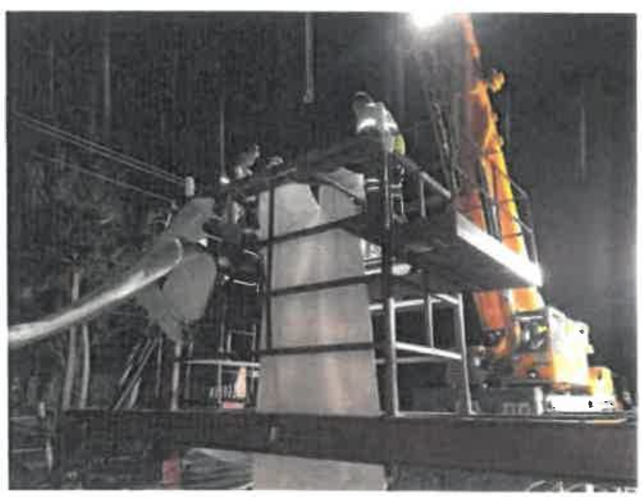
Jacobs Engineering Group, Inc.
800 Fairway Dr. Suite #190
Deerfield Beach, FL 33441

Start Date: November 2, 2016
Completion Date: March 2018

Final Project Amount:
$7,450,242.90

Contract Amount:
$7,089,516.28

This project was located from North Military Trail and Roebuck Road to Haverhill Road and Roebuck Road in West Palm Beach, Florida. An extensive bypass was needed to re-route the Force Main, using directional boring to partially bored under Military Trail. Four access pits were needed to being the installation of the Cured-In-Place pipe liner. These access pits measured 20 foot by 20 foot and were 20' deep. The CIPP installation could not be completed without installing the liner using the Wet Out over the Hole operation. Wet Over the Hole is a method used to impregnate the liner with chemicals on site, The liner was impregnated on site due to the weigh constrictions that the liner has if shipped from the manufactures. The 48-inch liner was inverted using water and cured using hot water that was circulated through each liner installation.



LN 2050 OAKLAND - MACOMB INTERCEPTOR DRAIN (OMID)
SEGMENT 4 REPAIR PROGRAM CONTRACT 5

OMID

LANZO TRENCHLESS TECHNOLOGIES

Owner:
OCWRC
Building 95 West
One Public Works Drive
Waterford, Michigan 48328

Owner Contact:
Lawrence Gilbert
(586) 469-5100

Final Project Amount
$9,303,900

Engineer:
Anderson Eckstein, and
Westrick, Inc.
51301 Schoenherr Rd.
Shelby Charter Township, MI
48315

Start Date: April 2015
Completion: December 2017

Contract 5 repair work is located along the Oakland Arm Interceptor in PCI-9 and PCI-10A/B extending mostly along Utica Road in the cities of Sterling Heights and Utica and the Township of Shelby. PCI-10A/B reaches of sewer extend through the southern and northern parts (respectively) of a nature preserve, now comprised of River bends Park and Holland Ponds Park.

The scope of work included the construction of 2 access shafts on each end of the project approximately 8 miles apart to afford access for the main equipment used for the rehabilitation project. These shafts were dropped over the pipe and the pipe was cut away for this purpose. Structural repairs to the tunnel included patching a breach in the wall located in the PCI-9 interceptor and repair of visible reinforcement and where reinforcement outline is visible. Also included in the scope of work is the injection of cementitious grout from within the tunnel in areas with suspected voids surrounding the interceptor, seal running and gushing leaks with chemical grout. Existing access manholes required modification and restoration. Repair of localized cracks and fractures using chemical grout, interceptor lining of selected locations and CCTV inspection after completion of repairs.

LN 2046 OAKLAND-MACOMB INTERCEPTOR DRAIN (OMID)
SEGMENT 4 REPAIR PROGRAM CONTRACT 6

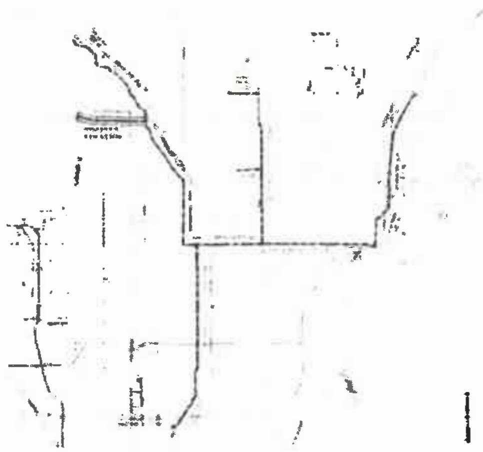
LANZO
TRENCHLESS TECHNOLOGIES

Oakland - Macomb

Owner
Oakland-Macomb Interceptor
Drain Drainage District
Building 95 West- One Public
Works Drive
Waterford, Michigan 48328-1907

Owner Contact
George P. Nichols
(248) 975-9571
nicholsg@oakgov.com

Final Project Amount:
$3,172,793.60



Engineer:
NTH Consultants, Ltd.
2000 Brush Street
Detroit, Michigan 48226

Start Date: December 2014
Completion Date: December 2017

Contract 6 repair work is located along the Avon Arm Interceptor in PCI-11A extending mostly along Dobry Drive. Work included the installation of 5,400 LF of Cured In Place Liner of 36" to 48" interceptor, 14,100LF of Cleaning & TV. The scope of work included gaining access for Structural repairs to the interceptor included patching a breach in the wall & repair of visible reinforcement.Also included in the scope of work is the injection of cementitious grout from within the pipe in areas with suspected voids surrounding the interceptor, seal running and gushing leaks with chemical grout. Existing access manholes required modification and restoration. Repair of localized cracks and fractures using chemical grout, interceptor lining of selected locations and CCTV inspection after completion of repairs.

LL683 Gravity Sewer System Condition Assessment & Renewal & Replacement (I/I) Program Level 2

LANZO TRENCHLESS TECHNOLOGIES

City of Hollywood

Owner
City of Hollywood
2600 Hollywood Boulevard
Hollywood, FL 33020

City of HOLLYWOOD FLORIDA

Start Date: April 2015
Completion Date: Sept 2017

Owner Contact
Jose Polanco
(754) 208-9443
jpolanco@hollywoodfl.org

Final Project Amount:
$7,757,350.00

Lanzo Trenchless Technologies was the prime contractor for this project and self-performed most of the work associated. The project included obtaining permits associated with the project, traffic control and cleaning and CCTV investigation of the sewers, Cured-In-Place Pipe rehabilitation, point repairs, grouting & other incidental work. After review of the videos, Lanzo designed the liner tubes per ASTM specifications and installed the liners. Rehabilitation included 110,834LF of 8" to 48" Gravity Mains at varying depths. Many of the sewers on this project posed a difficult challenge due to the amount of ground water infiltration.

LANZO TRENCHLESS TECHNOLOGIES

LL 684 FDOT Contract E5T27 Lining and Cleaning Various Sections of Storm Drains

FDOT

Owner:
FDOT
719 South Woodland
Boulevard
Deland, Florida 32720

Owner Contact:
Michael Raney
(386) 740-3522
Michael.Raney@dot.state.fl.us

Final Project Amount
$1,468,776.50

Engineer:
FDOT
719 South Woodland
Boulevard
Deland, Florida 32720

Start Date: April 2015
Completion: September 2015

Lanzo Trenchless Technologies was the prime contractor for this project and self-performed 90% of the project. The project consisted of approx. 12,895LF of 15" to 48" diameter storm sewers, inclusive of any permits associated with the project, traffic control and cleaning and CCTV investigation of the sewers. After review of the videos, Lanzo designed the liner tubes per ASTM specifications and installed the liners. Many of the Sewers on this project posed a difficult challenge due to the amount of ground water infiltration. Lanzo also exposed and installed three (3) Manhole cover and frames to accommodate the lining of newly discovered conflict sewers.

Experience

Experience

Company Background

Lanzo Trenchless Technologies is a Florida Based general contractor and engineering company specializing in infrastructure, construction, and rehabilitation services.
Lanzo Trenchless Technologies is a part of the D'Alessandro family of construction companies which are deeply rooted in the history of Florida's construction tradition and was established over fifty (50) years ago. Lanzo encompasses a dynamic group of individuals that have come together to form one of the most progressive construction companies in the industry. Lanzo has formed alliances based on quality and integrity with customers throughout the country. Lanzo employs a highly diversified staff of over 160 people and provides a full range of construction services and contracting capabilities.

Lanzo has demonstrated the ability and the resources required for the construction management and successful completion of a variety of construction services including:

- Water Transmission and Wastewater Collection Systems
- Water and Wastewater Treatment Plant Construction
- Roads & Highway Construction
- Site work & Civil Construction
- Marine Construction
- Utility Construction
- Demolition
- Sewer/Watermain Rehabilitation
- HOBAS and HDPE Discrete Slip-lining
- Point Repairs, Emergency Repair Services, and Open-cut Excavation
- Pipe Bursting using fusion weld HDPE or fusion weld PVC liners
- Fully Deteriorated "Stand Alone" Rehabilitation of Pipes using the full range of Trenchless Technologies

Lanzo's staff of experienced professionals and skilled trade people has performed many annual and emergency projects with similar requirements contained within this RFP in various regions throughout the United States. With hundreds of small and large projects successfully completed, Lanzo uses its capabilities and experience to provide innovative solutions for the most complicated projects, and ensures that each project is completed on time, under budget, and built safely to the quality expectations of the customer. Lanzo delivers a multitude of self-perform capabilities, maintains its own local fleet of equipment.

Since 1993 Lanzo Trenchless Technologies has provided a cost-effective, less invasive alternative to replacing failing underground infrastructure through a multitude of trenchless methods. They were one of the first companies worldwide to use trenchless methodologies and they continue to lead the industry with innovation in design, expertise, and experience. Lanzo maintains that spirit of innovation by constantly expanding its services, equipment, and methods to deliver high quality and long-term solutions to private and public-sector clients. Time-tested and proven experience in all forms of cured-in-place pipe lining methodologies (CIPP) has established Lanzo as one of the premier lining contractors in the U.S. with a reputation for completing difficult work which has grown worldwide.

Experience

To date, Lanzo Trenchless Technologies has installed over fifteen million (15,000,000) lineal feet of sanitary sewer, force main, storm drain, NSF 61 potable water transmission, large diameter and non-circular CIPP applications throughout North America including over 4,000,000LF in wastewater collection systems within the past 5 years.

With its local presence, which includes a fully integrated state of the art wet out facility; Lanzo stands ready to meet the challenges posed by any municipality's rehabilitation initiative. Since 1993 this company has been the most responsive rehabilitation contractor capable of reacting in the shortest time to a myriad of needs including sewer breaks, collapses, watermain emergencies, and issues requiring an imminent response.

Lanzo has been instrumental throughout the US with many complex design build and emergency repairs one example of unique work is the rehabilitation of 22 outfalls in the City of Detroit. These combined sanitary and storm sewer outfalls ranged in size from 36" to 84" diameters that were fully deteriorated and some over 100 years old. This work uniquely demonstrates the complexity and diversity of Lanzo's capabilities with over 20,000 linear feet of lining on this project alone.

Lanzo Trenchless Technologies owes its success to an emphasis on safety, consideration of the community, and quality installation by experienced crews. Based upon our conservative design and superior resins utilized; we provide third party testing as well as an unprecedented unconditional five (5) year warranty on all technologies provided for herein.

Lanzo Trenchless Technologies delivers a multitude of self-perform capabilities, maintains its own local fleet of equipment. Lanzo provides to its customers a distinct advantage through operating two state of the art wet out facilities both in Michigan and Florida. The Florida and Michigan facilities have produced over ten million (10,000,000) Lineal feet of CIPP meeting ASTM F-1216 and ASTM F-1743 without failure during these past twenty (24) years.

- **Cured-In-Place Pipe Lining (CIPP):** Lanzo Trenchless Technologies is uniquely positioned as one of the most experienced cured-in-place installers in the world. Considered 'pioneers' in the industry, our initial introduction to the trenchless technology industry was during a time when direct inversion methods, as described in the ASTM F-1216, were not "public domain". As one of the industry's original in-liner licensees, Lanzo was actively engaged in the creation and ratification of ASTM F-1743 that describes the pull and invert method. At that time, the pull and invert method was considered an alternate. It has since been specified and utilized successfully by Lanzo Trenchless Technologies as well as other contractors in what are now tens of millions of feet of installations.

  Today we offer both direct inversion and pull and invert technologies depending on which is best suited for the application. We also offer remote impregnated epoxy, UV light, steam and ambient cured methods. With millions of feet installation experience in all technologies, Lanzo can offer valuable insight and comparisons while providing solution scenarios to meet your community's environmental, timing, and budget objectives.

Experience

- **Large Bore Sewer, Storm Drain & Non-Circular Pipeline Repair:** Lanzo Trenchless Technologies has a reputation for taking on and successfully completing the most challenging underground renovation applications like those found in large bore, sewer, and storm drain applications. Large diameter and non-circular installations of CIPP, Carbon Fiber, and Structural Foam materials require a more thorough understanding of project specifics as well as design and application

- **NSF 61 Water Main Rehab:** All potable water main repairs must be NSF 61 certified to insure all products compliance with recognized safety measures. Due to the potential impact to the community, water main rehabilitation projects demand the most experienced installers. Lanzo Trenchless Technologies offers several CIPP repair methods that are certified, fully structural, and proven in stand-alone applications for water main renewal or catastrophic repair and rehabilitation.

- **Carbon Fiber:** The most significant advancement in the field of CIPP within the past decade has been the implementation of a space aged technology known as sequential carbon fiber epoxy or "Carbon Fiber Rehabilitation". This method has been implemented to preempt catastrophic line breaks in PCCP large diameter water and pressure mains throughout the United States. Lanzo remains one (1) of only two (2) companies nationally qualified, licensed, and certified to provide this preemptive rehabilitation method.

- **Segmental and Glass Panel Liners:** Lanzo has extensive experience with both segmental, as well as, glass panel liners which allow our CIPP technology to be adapted to applications requiring bends, transitions, and non-circular installation. Our product options include GRP, Cellular Foam, as well as Polymer Concrete. Be assured that we are staffed and ready to provide the turnkey services required on any of the most challenging combinations of shapes and configurations of your fully structural "stand alone" requirements.

- **Slip Lining:** Lanzo Trenchless Technologies proudly received an award from for installation of the worlds "Largest application" of HDPE in its eight thousand (8,000) linear foot singular Fusion Weld seventy-two (72") project for Miami Dade Water and Sewer Department (WASD). Lanzo has enjoyed decades of success including miles of Large Bore HDPE, Hobas, and Fusion Weld products including several projects for DWSD. We remain a licensed installer of Sekisui SPR (spiral wound) PVC, Sekisui Norditube, RS Technic Citiliner and have proprietary access to breaking products such as Fusion Weld PVC among others.

- **Pipe Bursting:** Lanzo has installed over a quarter million (250,000') linear feet of various Pipe Bursting applications including Sanitary Sewer Laterals, Mainlines, and Watermains.

- **Manhole & Tunnel Renovation:** With over 100 alternative manhole rehabilitation methods available, the common denominators in determining a successful manhole or tunnel rehabilitation include experience and careful analysis of the site-specific criteria. While many materials may prove to be suitable solutions "in a lab", for the harsh sulfide gas, industrial chemical, and adverse temperature environments, the real test comes in the field where materials, along with Lanzo expertise, and workmanship come together for long term solutions.

- **Pipeline Cleaning & CCTV Video Inspection:** With the advent of the Pipeline Assessment and Certification Program (PACP), along with the established defect classification protocol, we have entered a new era of pipeline inspection. However, before lines can be televised for inspection, they must be properly cleaned. Lanzo Trenchless Technologies has been directly involved in the preparation of over 8 million feet of pipeline ranging in size from 4" through 144" in gravity, pressure, municipal, and industrial applications. Whether we are desilting a vitrified clay sewer pipe or detuberculating a cast iron water main, the pipe must be made ready for accurate documentation of all defects, anomalies, and services encountered. Lanzo Trenchless Technologies is certified and qualified to perform cleaning and PACP certified CCTV-Video inspection services on all infrastructure rehabilitation applications.

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Large Bore Rectangular Box Culvert and Non Circular Rehabilitation with CIPP

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Abstract: This paper addresses the site specific challenges that lie inherent in rehabilitating large diameter non circular pipe and concrete box culverts using the cured in place pipe methods described in ASTM F 1216, as well as ASTM F 1743. This paper details the pipe preparation requirements including corner grouting to allow for fully deteriorated design modeling as a large bore non circular case. It focuses on several case histories detailing the design thru installation including a triple barrel renovation of a 8'-8" x 6'-0" rectangular box culvert. At the time of its installation, the triple barrel box was the largest cured in place installation of this kind in the world. This direct inversion installation using methods described in ASTM F 1216 utilized over one million pounds of isophtallic polyester resin. Due to the tubes being too large to transport over the highway; three (3) tubes, each measuring twelve hundred foot, were installed in a period of less than one month using the "over the hole" method of field wet out and inversion.

INTRODUCTION

There are many benefits available when considering cured in place pipe in non circular application. This rehabilitation method not only offers maximum retention of hydraulic storage potential, but it has been proven to increase flow capacity by reducing the systems Manning's coefficient. The unique ability of this rehabilitation method to take the shape of its container most often precludes the need to bridge problematic gaps or annular spaces (post rehabilitation) with substances such as grout.

Generally speaking, the risk associated with relying on post applied grout materials regard unfilled spaces between the liner and host. These types of voids not only make the resultant structure suspect, but offer capacity for the storage and flow of unwanted or detrimental contaminants. In many rehab methods, the regulation of grout pressures and a continuous flow of grout material between the profile of a rough liner exterior and a host pipe is far from an exact science. An example of an undesirable condition which may occur should a gap remain between the rehabilitation and the host pipe is the infamous "annular space". The detrimental effects of this phenomenon include a condition known as "piping" where flow may continue within the utility after rehabilitation between the liner and the host pipe. Although an internal video inspection may seem to reveal all is well, external to the liner pipe; water, silt, and other effluents may continue to flow while eroding the host pipeline and potentially undermining the soil envelope. Given the objective in trenchless rehabilitation to renew the host pipe to a full service life expectation of fifty (50) years or more; it is important to disallow such phenomenon.

A tremendous advantage afforded the designer of CIPP rehabilitations is the ability to rely on this method to accommodate inline diameter and directional changes efficiently and economically. This paper shall document the successful fully deteriorated structural rehabilitation of large bore non circular pipeline and box culvert installations with both transitions and directional changes using cured in place pipe methods described in ASTM F 1216 and F 1743. Reliable grout methods for disallowing gaps, voids, and annular spaces shall be presented.

F 1216 vs. F 1743

With direct inversion becoming "public domain" in 1995, several experienced contractors were afforded the opportunity to obtain large bore experience with either method. There are some significant observations which should be noted as to where there may lie advantage in quality and/or installation efficiency when comparing these technologies.

ASTM F 1743 describes the pull in place of an impregnated tube followed by the inversion of a secondary constituent known as a calibration hose. ASTM F 1216 describes the direct inversion of an impregnated tube into the host pipe to be rehabilitated. Although, either method has been put to task in many large bore applications; the success of the repair invariably mirrors the experience of the installation crew, the quality of data extracted during the pre lining pipeline survey, pre lining pipeline preparation, and testing. This being stated, we point to Black Point WWTP, a Miami Dade Treatment Facility which was rehabilitated over ten (10) years ago using methods described in ASTM F 1743 (Figure 1). The failure mode in this 96" to 72" to 48" three tiered reducing concrete pipe oxygenation train was classic sulfide attack of the crown, "the father" of sanitary sewer pipe failures. This four hundred fifty (450) foot rehabilitation was allowed by staging a seven (7) day shutdown for each of the three critical treatment plants influent lines. Each pipe to be rehabilitated had three inline eccentric reducers, one ninety (90) degree, and two (2) forty five (45) degree bends. Further complicating matters was that each single shot transitioned from 44mm to 37.5mm to 24.0mm material containing approximately one hundred thousand (100,000) pounds of epoxy vinyl ester resin. Sufficed to say that attempting this rehabilitation with methods described in ASTM F 1216 could be compared to an Olympic gymnast coming off the uneven bars and "sticking the landing" after a routine with a difficulty factor of ten (10)!

After thorough cleaning and debris removal; pipeline preparation consisted of trowel filling all voids, cracks, and fissures with calcium aluminate cement. Although the structural properties of grout or cements utilized is not factored into the CIP tube design; it is important to achieve a continuous bearing surface insuring contact between the liner and host pipe at all places. The goal is to utilize a material which insures attaining the commonly achievable densities of compacted granular backfill or concrete.
The ASTM F 1743 installation method allowed for the liner to be winched into place while a careful comparison could be made, in the pipe, between the position of the different material stages and the pipeline anomalies themselves. Once the tube was properly positioned; the inversion of a calibration hose ensued and a precise rehabilitation product was assured.

Conversely, in an outfall installation called B 29 on the Detroit River we encountered a 72" x 54" x60" three tiered transition over a one thousand (1000') foot distance rehabilitated using methods described in ASTM F 1216. A post rehabilitation inspection using both non destructive, as well as core sampling revealed the liner to be fully in contact with the host pipe throughout the length of the rehabilitation. The Judges.....9.9, 9.9, 10.0!

The parameters affecting successful inversion of a large bore rectangular box culvert or transitional CIPP installation include:

- Experience of the installation crew
- Pre inversion pipeline preparation
- Accurate survey data
- Testing

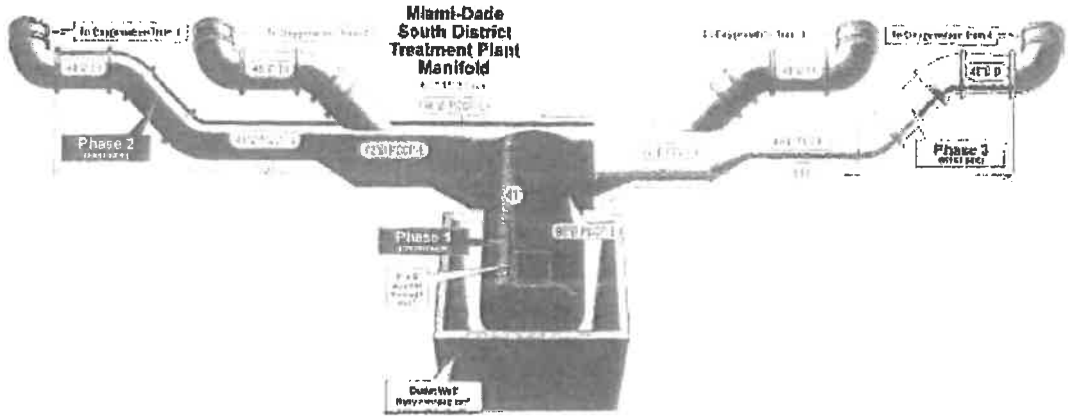

Figure 1 Transitional 96"x72"x48" Cured in Place Rehab favoring methods listed in ASTM F 1743

DESIGN CONSIDERATIONS

It is not the intent of this paper to spend a great deal of time rehashing the design methods stated in ASTM F 1216, ASTM F 1743, or the WRc Design Types 1 thru 3. Rather it is recommended that these designs be compared for applicability to the conditions encountered. There are many installations of CIP technology that have been in place for adequate duration to demonstrate the viability of this methodology in fully structural application meeting the criteria set forth in each of the afore mentioned design approaches.

In the rectangular shapes encountered during the box culvert rehabilitations presented it was extremely significant that full contact between the host pipe and liner was assured. This was achieved by installing fillets in each of the corners allowing the tube to take on an elliptical configuration. Validation of the fully deteriorated structural design could then proceed by considering the liner as an ovalized non circular application, as opposed to a rectangle. Fillet dimensions were calculated after a comparison of the areas between the rectangle to be rehabilitated and the circular tube to be utilized which, when inverted into a box culvert, took on the shape of an ellipse.

In all cases the loss of area did not exceed 12% which was then regained hydraulically due to the intrinsic efficiencies of flow characteristics in cured in place pipe. Ovality generally ranged in the 8% to 14% range which caused substantial wall thickness increases when compared with comparable circular rehabilitations; but none that proved prohibitive in handling or tube inversion ability. No rectangular box rehabilitated exceeded a span to rise ratio of 2:1.

Key design parameters

- Design Method ASTM F 1216 /1743 vs. WRc Type I, II, or III
- Span to rise ratio
- Ovality of the resultant Non circular Liner
- Capacity change and tolerance for area reduction
- Fillet design and dimensions
- Inversion length
- Wall thickness

- Weight of materials being installed
- Over the hole vs. factory impregnated

INSTALLATION

There can not be enough emphasis placed on pipe preparation prior to installation of any trenchless rehabilitation. The properties, quality, and life expectancy achieved are always dependant upon the clean and televise protocol adopted by the installer. Not only are these efforts the eyes and ears of the operation on a production basis, but they set the stage for the installation's ultimate efficiency and technical success. In the cases of rectangular box culvert, large bore, and transitional liner application; not only are the cleaning crews making the pipeline available for the critical survey step, but they prepare the pipe for placement of the fillets and tube installation.

During the pre installation survey; defects and dimensions catalogued are compared with visual and CCTV data collected. Prior to tube fabrication, analysis of the design dimensions and pipeline configuration must take place. With critical lead times as long as three (3) weeks in mammoth tube fabrication, the urge to rush the pre installation survey must be resisted.

The fillets are placed with a gravity fed trowel methodology at the inverts, while a mesh coping may be used to keep material at the crown locations. Since the tube will expand upwardly as it is being installed it may not be necessary to grout the crown prior to inversion. Alternatively, crown material may be either pumped from the inside of the tube at fifty (50) foot intervals, pumped from above ground through placement tubes (if access exists), or through placement tubes longitudinally which are extracted as pumping proceeds. Excessive grout pressures must be avoided since this may cause undue pressures on the liner application. Optimum results, however, are assured through gravity or mechanical pre inversion grout placement methods.

Once the host pipe is fully prepared and geometrically modified the stage is set for the non circular CIPP inversion. The installation may commence over the hole in cases where installation quantities exceed those which can be transported, or conventionally, out of a reefer trailer or low boy hauled "cool box".

An additional factor of safety may be implemented by increasing the anticipated resin consumption by a sacrificial quantity of between 5% and 15%. This additional material insures intimate contact between the liner and host pipe, while enhancing structural characteristics in the finished product and filling all cracks and voids.

In transitional liner applications (concentric diameter changes or eccentric increaser/reducer applications) it should also be noted that it takes a distance of approximately three times the largest diameter over a longitudinal distance within the host pipe to make the transition desired. In other words in a five (5') foot diameter equivalent round pipe it may take as much as fifteen (15') of longitudinal distance to make a diameter change. This is also significant when performing pre installation grout preparation on the host pipe.

The tube should generally be installed such as to overlap the smaller diameter liner into the larger diameter host. In this case the effects of grout and sacrificial resin may be counted on for support in order to avoid or minimize the phenomenon of fins. Fins occur when there is plainly more material than can be distributed over the hydraulic radius. Cut away investigation of fining has demonstrated that this is not a defect but rather the manifestation of excess material. This material may be cut, ground out or sanded if there remains concern that a hydraulic inefficiency or debris flow blockage might ensue.

Table 1 Boxes rehabilitated by methods described

	METHOD	WALL THICKNESS/LENGTH	FILLET DIMENSIONS	ROUND EQUIVALENT
72" X 48"	OVER THE HOLE	38.5MM / 1605LF	18"X12"	60"
84" X 60"	FACTORY IMPREGNATED	38.5MM / 910LF	18"X18"	72"
72" X 104"	OVER THE HOLE	47.5MM / 3600 LF	18"X24"	89"
63" X 72"	FACTORY INPREGNATED	36MM / 700LF	NONE REQUIRED	66"
78" TRAPEZOIDAL	OVER THE HOLE	42MM / 3525LF	18"X18"	72"

TESTING

The benefits of third party testing have been well documented and utilized over millions of feet of CIPP installation. The ability to demonstrate properties achieved in the field by flexural modulus and flexural strength testing of a composite resin/felt coupon not only validates the preliminary design basis but additionally:

- Proves the wet out phase was adequate
- Insures that the prescribed cure / cool cycle was thorough
- Serves as a secondary check of design wall thickness
- May be utilized for resin verification

Upon conclusion of a large bore non circular or rectangular box culvert installation it may also be advisable to do some internal pipeline verification of the corners using either destructive or non destructive means. The simplest is a core sample where a small tap is drilled to insure that there is an intimate contact between the host pipe and liner. A batch of ambient cure resin or epoxy and hardener may be utilized to fill these taps upon conclusion of the verification. Where tapping a good liner is not desired; a "sounding" of the area with a rubber mallet may be performed. Voids behind the liner will sound hollow when struck. Should voids be detected there are several methods which can be utilized to insure a suitable end result ranging from resin injection to cutting out the suspect area and performing a "hand lay up" or sectional repair. For comparison purposes, consider that in the over ten thousand (10,000') lineal feet of large bore non circular and box culvert rehabilitation documented in this paper the need to perform this type of repair occurred twice while impacting only some forty (40') feet of pipe.

CONCLUSIONS

In this paper we have documented the rehabilitation of over two (2) miles of non circular, transitional, and rectangular box culverts which were successfully renovated to fully deteriorated model stand alone structures with a renewed full service life expectancy using cured in place pipe methods described in ASTM F 1216 and ASTM F 1743. The successes were attributable to contractor experience, superior pre installation pipe preparation, accurate dimensional survey, and post installation testing. The pre lining grouting methods successfully utilized were explained while alternative methods were presented for consideration.

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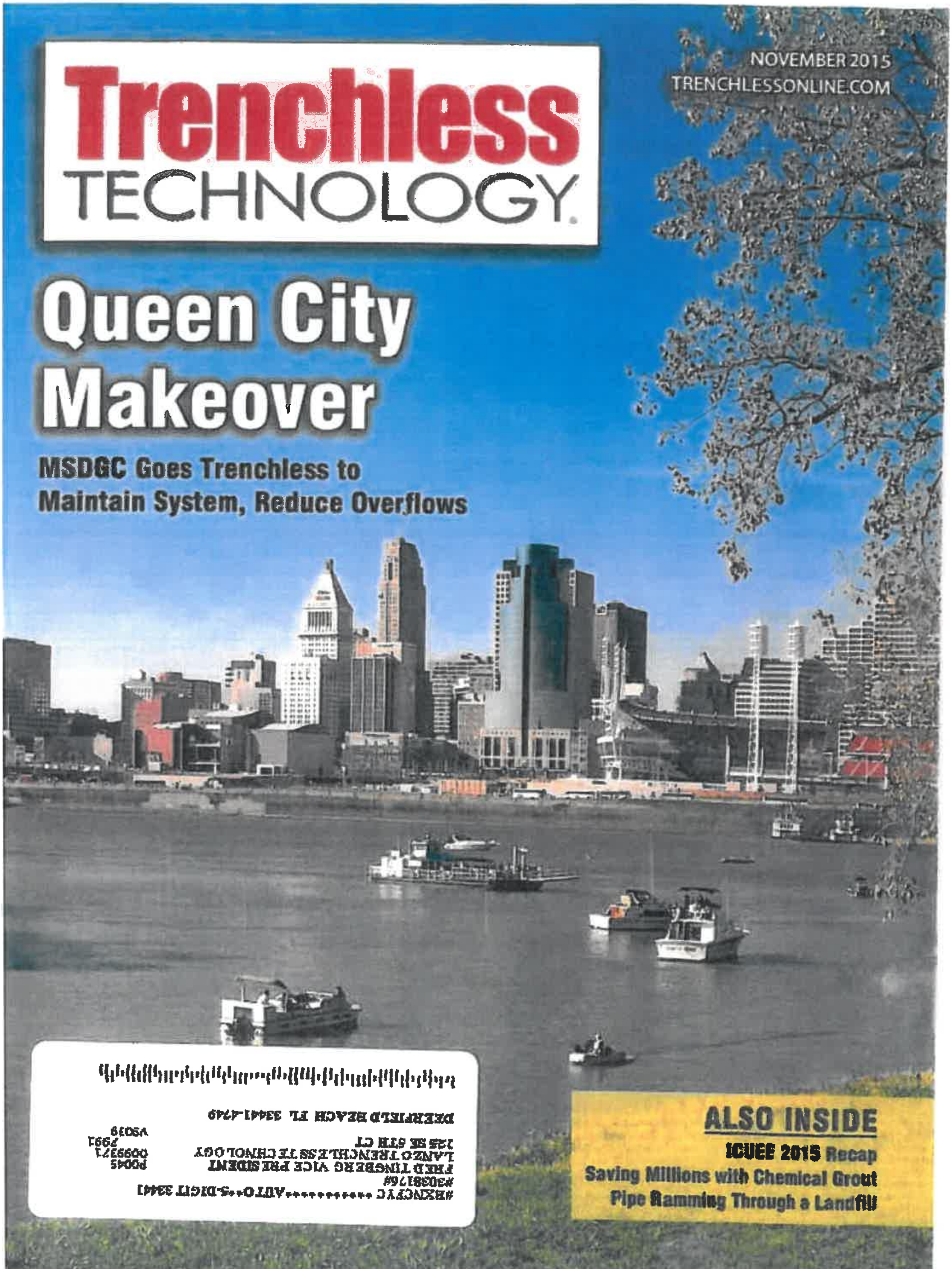

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CAPACITY TO BE DIVERSE

Combination of Trenchless Methods Applied to Michigan Interceptor Project

By Fred Tingberg

In late 2014, Lanzo Trenchless Technologies received a call from NTH Consulting and Drain Commission officials asking if there was interest to competitively bid on the latest contracts in a series of projects called the Oakland-Macomb Interceptor Drain (OMID). The tasks to be performed included deep interceptor pipeline and structure rehabilitation on problematic segments of sewer straddling Oakland and Macomb Counties in southeast Michigan. This 50-year-old concrete system ran adjacent to a crucial roadway (M 59) connecting the east and west sides of heavily populated suburban Metro Detroit.

There was concern as to competitive market interest on a project that would be mixing several different trenchless technologies in one or two construction packages valued in the $20 million range.

THE PROBLEM

Engineers had identified that the system was succumbing to sulfide attack of reinforced concrete pipe and manholes that were installed during the late 1970s. As part of Segment 4 Repairs, it was deemed a priority to evaluate and repair more than seven miles of large diameter interceptor sewers some 40 ft beneath the active county thoroughfare to preempt any "catastrophic" failures.

The successful contractor would need to provide a suite of services, including permanent access road construction, high volume sewage control management, cementitious grout in place liners, fully deteriorated model CIPP, large bore spot repairs, cementitious grouting of voids, access manhole restoration, localized crack/failure repairs using chemical grout and CCTV.

Sealed proposals were reviewed by a board overseen by Oakland County Water Commissioner Jim Nash, Macomb County Public Works Commissioner Anthony V Marrocco, and State of Michigan Department of Agriculture and Rural Development's Michael Gregg. Under an MDEQ permit using State "SAW" Loan and EPA funded money; the board solicited to contract work in both the Oakland Arm (PCI-9 / PCI 10), as well as the Avon Arm (PCI 11) Interceptors. NTH served as lead consultant while a local engineering firm, FKE was similarly retained with intimate knowledge of the system, prevailing defects and the pipeline's potential for trenchless rehabilitation.

Pre-qualified contractors were required to "self-perform" much of the construction trade work by dollar volume. This provision added quality to the specification, minimized risk and insured that the general contractor selected would perform the work as specified while providing first quality materials and workmanship.

Contractors performing the lining work had to demonstrate a proven record of performance in pipeline rehabilitation with minimum lineal footage and minimum successful years of experience for each of applications specified. Additionally, like conditions and necessary skill set for projects of this scale were considered.

Having experience in all of the proposed technologies, Lanzo tendered bids on both projects and was selected with an overall price of under $16 million. Additionally, Lanzo offered a five-year warranty on all materials and workmanship associated with the contracts.

George Nichols, P.E. Oakland County drain commission civil engineer III, would oversee the OMID Segment 4 Repair Program, specifically Contracts 5 and 6, serving as project manager. "Our objective was to reduce system inflow and infiltration (I&I) while structurally stabilizing the Interceptors being investigated," he said.

Work was difficult and dangerous, requiring the utmost care in safety consideration, monitoring and management. The initial phase of the contract included constructing permanent gravel roads for access and to insure constructability of the project.

The grout-in-place liners was comprised of a Permacast product, which was selected for its corrosion resistance and structural properties. The Permacast pipelining material product was specially designed for dry shot application and is fully compatible with Conshield, which was specified to prevent Microbially Induced Corrosion (MIC) while resisting the attack of sewer gases.

The Permacast material also contained a Crystal X additive which creates a crystalline waterproofing membrane to auto heal any cracks which might develop. This material may be put on in multiple lifts without cold joints.

For the chemical portion, a premixed liquid acrylamide grout was formulated and shipped by Avanti International for ease of application and to facilitate a high rate of installation.

Lanzo also used "Fully Deteriorated Design Model" cured-in-place (CIPP) liners, which would offer stand alone structural characteristics while meeting the demands of a 50-year service life expectancy.

High-quality isophthalic polyester resin manufactured by Interplastic was used in tubes weighing as much as 40,000 lbs each.

One of the early tasks was to tunnel a 16-ft diameter shaft down to the 96-in. diameter sewer crown, create access and build a platform for staging of both the chemical and cementitious grouting activities within the pipeline.

Challenges included working in and around flow that could not be disrupted during the construction process. Much of the work was conducted above existing flow lines by holding cementitious delivery hoses at elevations above the hydraulic grade line. A cabled Hammerhead Winch System was erected to pull construction carts between access points as far as 1,200 ft apart. Specially fabricated platforms and this mobile carriage delivery system insured the transport of materials to respective rehabilitation sites within the pipeline.

As part of the Segment 4 repairs, a suite of trenchless methods were used, including CIPP, cementitious Centripipe and grout-in-place liners.

As part of the inspection process, any reinforcing steel that was identified as suspect was slated to be replaced as directed by the engineer.

The owner's objective was to perform as many repairs possible given this unique opportunity to have total access to this critical trunk sewer interceptor during the project.

Lanzo Trenchless North principal Angelo D'Alessandro was involved in periodic evaluation meetings where additional rehabilitation of lines already under bypass was considered.

"The cost to bypass, access and enter these sewers is high. It's in everyone's best interest to make hay while the sun is shining," said D'Alessandro. An opportunity was identified given a window of time to provide expanded services, while already under bypass, in order to minimize future risk while conserving cost moving forward.

Anticipation of repairs as specified, while thorough, did not cover every inch of pipeline. The cost to return vs. the cost of making additional repairs while in the pipeline was considered. Engineers discussed the ability to anticipate areas which would be the next in line to undergo attack. Work in additional "areas of concern" was then added and performed concurrent with the specified schedule of services.

It was decided to perform additional CIPP lining which would offer a "one and done" approach to select line segments. This would effectively take these lines out of any future consideration for maintenance or ongoing evaluation. Given a CIPP service life expectation of at least 50 years, the cost of evaluating the sewers every eight years or so affords diminished returns when major flow control management (bypass), maintenance of traffic and social cost of disruption is considered.

On a grand scale, the OMID projects represented an overall $160 million effort by the board which has been under construction since about 2009. Segment 4 activities are ongoing with an anticipated completion date of spring 2016.

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Contractor Savings

As the water crisis continues to challenge businesses in California and elsewhere, many businesses are looking to relieve environmental pressures through sustainable practices. Nevertheless, decreased water consumption and recycling efforts can also retain profits for many contractors — a win-win for contractors and the environment. While fluid recycling is becoming increasingly common due to advances in HDD technology, contractors are pursuing the process for a variety of reasons.

Cost is one key driver. The cost of additives and disposal fees for 1,000 gals of drilling fluid can range from up to $600 or more — and this does not include water and transportation costs.

Also, because drilling fluid is being recycled during the pumping process, lower fluid volumes mean fewer additives and less water consumption. For example, an operation with a 30,000-lb pullback drill unit may pump 20,000 gals of fluid throughout the project. Yet, when a micro recycling system is used, the actual fluid loss may only be 1,500 gals of drilling fluids throughout the entire operation. And because reduced drilling fluid lowers the number of vac systems and trucks needed for mud extraction, it can also lower fuel costs substantially.

Using fewer additives, water and transportation resources can save contractors hundreds to thousands of dollars throughout the drilling process.

Additionally, most HDD projects use a stand-alone mud-mixing system, employing more machines throughout the operation. Mud-recycling systems, however, can also mix fluids and reduce the need for a vacuum trailer or truck, requiring fewer machines and operators.

Environmental Relief

Emissions, drilling fluids and water consumption are diminished during the

> And although HDD fluid recycling still requires a skilled operator for maximum efficiency, the benefits of increased hole velocity include increased production, improved tooling life and reduced risk of inadvertent returns. For utility contractors, this means fewer trips to haul water supplies and dispose of fluids. For the environment, this means less water consumption and additive and landfill use after the process is complete.

"Green" Cured in Place Pipe Utilization, Styrene Free Emerging Methods and Resin Systems

Fred Tingberg Jr.

Business Development Manager Lanzo Lining Services Deerfield Beach, Fl

ABSTRACT: This paper compares Non Styrenated, UV Light, Remote Epoxy CIPP, and Sequential Wrapped Carbon Fiber/ Epoxy technology in applications where the presence of VOC's, fumes, vapors, is unacceptable, undesirable or impractical. Several recent case histories of successfully installed CIPP applications are presented where the application did not allow for Styrene emissions either in the Vapor Phase during Cure or during the release of liquid Styrene laden process water during commissioning of the pipeline. UV cure technology is also compared which, while styrenated, requires no process water resulting in styrene concentrations well below those realized during typical CIPP installation. Finally in NSF 61 Certified Application there is no room for introduction of solvents, reagents, and residuals into the distribution side of the municipal water stream.

The practical limits of Styrene usage in the trenchless industry has become controversial citing environmental, exposure, and safety issues. The use of non-styrenated, UV Cure, and Remote Impregnated Epoxy Resins in CIPP installation sidesteps this debate while offering the benefits of close fit, full structural, and pressure rated cured in place pipe.

Issues associated with styrene usage, such as cycle water contamination and airborne odor concentration has been largely eliminated in Europe through the evolution of UV, as well as, Remote impregnated epoxy technologies. While it remains to be seen as to the timing of this change within the US; both sides along with the economics of this issue will be presented within this paper.

The movement towards more "Green" materials in construction has been largely accepted in concept while the Owner/End users must weigh the economic impact of such materials as compared with alternative means of using styrenated products and more common technologies. While styrene utilization remains commonplace within our industry; Green or sensitive application requires containment, absorption, and/or shielding methodologies. This paper shall demonstrate the successful installation of CIPP without Styrene in applications where Odors, Exposures, or Contamination could not be tolerated.

INTRODUCTION

The issue of styrene utilization in CIPP installation is recently become controversial within the United States stirring debate within and outside of the Trenchless Construction Industry [1]. Experts point to the five year lag in technology implementation between Europe and the United States arguing that today's snapshot overseas would demonstrate less usage of styrenated resins in favor of UV and Remote Impregnated Epoxy Technologies. In this country the increasing use of CIPP has been an adaptive process while solving the gamut of trenchless application ranges from small to large and non-circular diameter, pressure rated, storm drain, industrial sewer and process pipes has largely been accomplished with little or no effect being attributed to the use of a common, inexpensive, and in CIPP, practical solvent known as styrene.

On the other hand; as we strive to become more environmentally responsible; what were once novel process are coming under increased scrutiny for the monitoring, exposure to, installation and transport of VOC laden constituents.

Additionally; the need to contain, shield, absorb or eliminate solvents needs to compare with cost to provide the user with an end result that is both cost effective and practical.

Exhibit #1: Non Styrenated Gravity Sewer Rehabilitation at Indoor Casino:

(Figure#1 Trappers Alley, Detroit Michigan)

Greek town was selected for downtown survival and revival in the seventies. Part of this effort was the development of Trappers Alley as a brick mall encasing of a street whose history dated back to the fur trading days of the eighteenth century.

Seemingly unconsidered in this development was the existence of a one hundred (100) year old 18" to 15" transition sewer some twenty feet below the surface of what was now a full service gaming casino and restaurant complex.

When numerous complaints emanating from ongoing backups, odor issues, and flow restrictions failed to be satiated with routine and ongoing cleaning and plumbing efforts; CIPP became the solution of choice.

One of the parameters made necessary was the zero tolerance for Casino Closing during the rehabilitation effort. Additionally, the two hundred plus foot installation with an inline transition and multiple service reinstatements would require an around the clock installation schedule. The issue of styrene emissions were discussed and deemed by the management company to be unacceptable.

A styrene free resin was selected and approved based on its property where during exotherm it remained virtually odor free. Fully deteriorated structural properties along with common cycle times and installation method made the selection an easy one to make.

Exhibit 2: Non Styrenated Pressure Pipe in Water Fountain Application at Detroit's Renaissance Center:

(Figure #2 Renaissance Center Fountain overlooking the Detroit River)

At the same time the Casino Project was being constructed a call came in from the Management Company responsible for the Renaissance Center in Downtown Detroit. A pressure pipe beneath the plaza facing the Detroit River had become deteriorated causing shutdown of a critical and decorative centerpiece of the complex also the focal point of each summer's Downtown Detroit's multi heritage festival schedule.

While there was no declaration of NSF 61 water main requirement; the fact that children commonly come in contact with this water during the summer festivities gave the owner cause to seek a "green resin". In fact, the styrene free resin used at the Greek town Casino project had recently been submitted to NSF 61 for leach testing in accordance with the UL/NSF 61 certification process. This rendered substantial chemical analysis available for submission to Engineers reviewing the project offering comfort with regard to the fountain application.

The project required CIPP lining of twin twelve (12") inch water transmission lines rated at 100 psi. The ASTM F 1743 (pull and invert) method implemented during installation allowed for a successful installation, pressure test and return to service within one week of project commencement.

Exhibit 3: UV Cured Trunk and Collection Sewer Interceptor:

(Figure #3 Light Train inserted into a 30" Trunk Sewer on Division Street)

UV cured CIPP utilizes resin which while styrenated allows only minimal emissions since:

- There is no Process Water release upon conclusion of the lining process
- The tube is encapsulated in a protective black plastic which acts as a UV shield
- Fully deteriorated design relies more heavily on Tube Reinforcement than resin during wall selection [2]

During installation of the Division Street Interceptor Project for the City of Dover over five (5,000') thousand feet of trunk transmission and residential collection sewers were lined on an extremely tight schedule within and around the Downtown area. Cycle time to install was significantly reduced in that the typical inflate/ cure/cool/ process water release was sidestepped in favor of the Air inflate/UV Cure steps used with UV methodology. Additionally; there were no residential complaints or calls from residents concerning the matter of Styrene Odors which may be ordinarily be expected during the implementation of standard styrenated polyesters and vinyl esters.

Exhibit # 4: Remote Impregnated NSF 61 Certified Epoxy Water main:

Remote Impregnated Epoxy looms as a highly desirable CIPP methodology. This method allows for the transport of the entire wet out procedure to the respective jobsite; while using the beneficial properties of 100% solids, 0 VOC's, structural epoxy which has tremendous structural, adhesion, and life span benefits. The process is applicable to Gravity, Pressure, High Corrosion, and NSF 61 Potable Water application. This process enjoys widespread acceptance within Europe and has proven to be an Engineers favorite since it is so repeatable, recordable, and controllable.

A 3,000 lf NSF 61 Residential Distribution Water main of 8" through 12" was installed tested at 100 psi on Theodore in Clinton Township, Michigan and using this technology [3]. Remote Impregnated Epoxy methods include products such as Norditube, Aquapipe, and Blue Line Citi Liner by RS Tecknik.

Exhibit #5: Non Styrenated Gravity Storm Sewer Culverts in Environmentally Sensetive Wetlands:

A styrene free resin was selected and approved based on its property that no styrene could be released into the environment which might pose a risk to Fish and Wildlife. Fully deteriorated structural properties and a fifty (50) year service life expectation were desired using the direct inversion methods described in ASTM F 1216. No styrene was released since none existed in the products delivered to this environmentally sensitive Wetland application. On another note in the wetland application thermal shock must also be considered prior to process water release. While ASTM F 1216 discusses cooling to 100'F prior to release, process water might be cooled further, transported out, or pumped onto adjacent ground in an effort to eliminate any chance for Fish kills or other undesirable environmental effect. Several installations of 36" & 48" Non Sytrenated CIPP were installed in culverts throughout the Loxahatchee Water Reclamation District during this project

Exhibit #6: NSF 61 Certified Carbon Fiber/ Epoxy Matrix Sectional Lining in Cylinder Pipe Watermains:

In the late Seventies (70's) and Early Eighties (80's) a large quantity of defective Prestressed Concrete Cylinder Pipe became distributed to major municipalities throughout North America. This pipeline product became depended on for Potable Water distribution in High Pressure Transmission Mains. Only recently have these utilities become "condition assessed" for potential to allow catastrophic line break and failure. The utilization of a space age process involving sequential Carbon Fiber wrapping technology allows for the implementation of NSF 61 certified internal sleeving to preempt line breaks given pressure ratings of 150psi or more. One such installation of this technology was a 54" 150 psi Water Transmission Line in Metro Dade County. The strict UL certified NSF guidelines allow for no harmful solvents to remain residual in what will become the rehabilitated water supply. This technology shows great promise for growth as the Nation prepares to forge forward with new Federal mandates for Water Infrastructure Rehab and Renovation.

Other means and methods:

A reagent known as "Sty Redux" has also been utilized on certain projects where strict limits have been placed on concentrations of styrene in the process water released. This compound, when added to the process water within a water cured inversion column, causes the styrene present to polymerize for easy collection upon release of the cooling water that was utilized. The implementation of a Pre Liner should be added if the concerns include Styrene emissions in a gas phase up through the lateral stacks of the sanitary applications being rehabilitated.

Frac Tank water collection, Pre liner utilization, and closed system containment are all ways which can be utilized to diminish any levels of styrene which ultimately become released into the environment.

The Numbers:

Regarding Styrene; the author of this paper has been associated with over eight Million (8,000,000) lineal feet of CIPP installation using styrenated resins during which time we are not aware of one individual whose health has been directly impacted by exposure to the styrene emissions prevalent using conventional methods described in ASTM F 1216 or F 1743. Styrene concentrations as they pertain to recognized levels are:

Human recognition	2ppm
Monitored during Wet out	17ppm
TWA (NIOSH)	50ppm [4]
IDLH (NIOSH)	5000ppm

Putting this in perspective then; the Human Nose can detect 2 parts per million of styrene while in accordance with OSHA guidelines the "Time Weighted Average" for exposure is 50 parts per million during a forty (40) hour workweek. The Immediately Dangerous to Life and Health exposure limit tops 5000 parts per million. While in the mixing room within a CIPP wet out facility it is uncommon to monitor concentrations greater than 17 parts per million. Given this insight; it is safe to say that odors associated with styrene in and around the CIPP process as we presently know it; may represent more nuisance than hazard. However; certain individuals may possess sensitivities to this or any other solvent which is perhaps why the potential for eliminating its use is compelling. Additionally, the implementation of Styrene laden resins in wetlands and waterways may pose risk to wildlife if one or more of the methods listed in this paper are not utilized.

Cost:

The bottom line is that what we as a society are willing to pay to "go green", eliminate solvents, or minimize sensitivities. When so many millions of feet have been successfully installed within The United States and elsewhere; using an efficient, cheap, and proven styrene based material such as iso polyester and vinyl ester resins; those leading us into the next generation of Rehab methodology or toward the European Model will need to provide persuasive guidance.

Estimate Cost of comparative technologies eliminating or minimizing Styrene Exposure

Conventional Styrenated Resin Application	\$ 4 - \$ 8 per diameter inch [5]
Non Styrenated Resin Application	\$ 6 - \$10 per diameter inch
Remote Epoxy Impregnated Application	\$ 8 - \$12 per diameter inch
UV Light Cured Application	\$10 - \$16 per diameter inch
Sequential Wraped Carbon Fiber / Epoxy Matrix	\$75-\$100 per diameter inch

Many factors must be weighed along with these crude estimates such as site specific information, access, cycle time allowable and others.

Conclusions:

The intent of this paper was to discuss and compare methods where the use of styrene emissions needed to be sidestepped, minimized or eliminated. The use of styrene continues in the face of Federal initiative suggesting against its use along with the persistent nuisance represented by emissions of odors and release of chemicals within our environment and at the home sites of the unsuspecting public at large.

For purposes of this presentation the facts surrounding the applications listed; made selection a non styrenated or a reduced emission styrenated product, as opposed to solvent styrene based product forthright and justifiable.

Simply adding these products to the specifications will no more insure their utilization than the specification of "silver plating" as an equal alternate to "galvanized" in storm drain culvert manufacture.

Objectives such as the removal of styrene, elimination of the nuisance and risks associated with solvents, or the desire for properties such as reduced cycle time and higher physical properties; will only be achieved by direct specification of the Owner/Engineer.

References:

[1] Guideline for the Use and Handling of Styrenated Resins in Cured in place Pipe NASSCO CIPP Committee September 2008

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[3] Tingberg, Fred. "Trenchless Cured in Place Watermain Rehabilitation meeting NSF 61."
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NIOSH pocket guide to chemical Hazards: Cincinnati, 1990. Print.

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LANZO
Lining Services, Inc.

ENGINEERING DESIGN GUIDE FOR REHABILITATION WITH CURED-IN-PLACE PIPE

Second Edition

LANZO COMPANY HISTORY

Lanzo has been a leading competitor in the construction industry for over 45 years. Lanzo was founded in Roseville, Michigan with offices presently in Detroit, Michigan, Atlanta, Georgia and Deerfield Beach, Florida. Lanzo employs a highly diversified staff of over 400 people providing a full range of construction services with contracting capabilities including:

Professional Services

- Construction Management
- Engineering Design/Build

Trenchless Technologies

- Cured-in-Place Pipe Lining
- "Over the hole" Application
- Noncircular, Box Culvert and Large Bore CIPP
- NSF61 Certified Waterline Rehabilitation
- Air Duct/Plenum Reconstruction
- Lateral Rehabilitation
- Interface seal technology

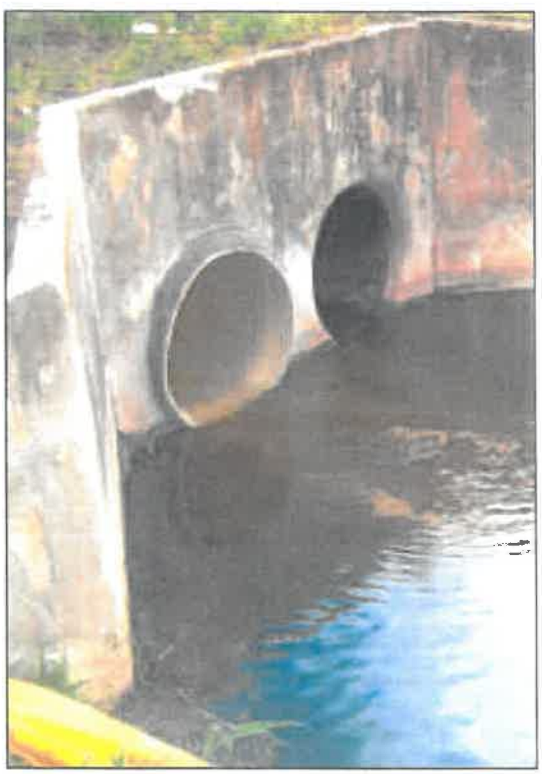
Heavy Construction

- Road & Highway Construction
- Site Work/Civil Construction
- Water Transmission
- Wastewater Collection Systems
- Water/Wastewater Treatment Facilities
- Marine Construction
- Demolition

Land Development

- Acquisitions
- Design Build

At Lanzo, we value our employees and the residents of the communities within which we serve. Our mission at Lanzo is to provide safe, high quality, cost-effective and on-time construction. Lanzo is an equal opportunity employer meeting all Federal, State and Municipal health & safety regulations. We hold the highest level of ethics and are committed to ensuring the safety of our employees along with both the convenience and safety of the residents of the communities we service.



Trenchless renovation in storm drain application

Environmentally friendly "Green Resin Formulations"

FORWARD

At the time of this publication, Lanzo Lining Services marks seventeen years serving the municipal, industrial, and public works rehabilitation marketplaces with a quality cured-in-place pipe (CIPP) liner. Having installed over 6,000,000 linear feet of sanitary sewer, force main, storm drain, NSF 61 potable water transmission, large diameter, and non-circular CIPP, we offer this newly revised second edition of the Lanzo Lining Services Design Guide as continued confirmation of our experience with design and application.

With millions of feet of CIPP in service throughout the world, it is not necessary to state the applicability or validity of CIPP as a proven rehabilitation technology. Over the years the industry has witnessed the introduction of many new products competing for a portion of the pipeline rehabilitation market. Several seemingly logical technologies have dissipated due to a number of reasons that include short term failure, lack of marketplace support, poor installation practices, and inexperienced contractors. Some products have failed in aggressive environments unanticipated by the designer or installer.

Lanzo Lining Services success can be attributed to five primary directives:

1. An emphasis on safety
2. Consideration of the community.
3. Quality installation by experienced crews.
4. A conservative design approach and superior resins.
5. Third party testing of each liner run.

DAILY THIRD PARTY TESTING vs. CATEGORIC LONG-TERM TESTING

The mere use of long-term testing for product selection is inadequate. The participation in a long-term testing program, while notable, does not insulate the customer from workmanship flaws, inferior resin or batch irregularities, or day-to-day jobsite fluctuations. There is no better way to prove quality and product reliability than to take a test specimen from the actual installation being lined and have it tested by a third party laboratory. For instance, the ability to retrieve samples from CIPP installations with properties in excess of 350,000 psi flexural modulus demonstrates that the submitted design basis has been validated. This additionally proves out the quality of the liner wet out, the adherence by the installer to ASTM installation practices, and the quality of the resin actually used on the day of the installation. The existence of over six million feet of Lanzo installed CIPP in service throughout the United States and Canada may serve to qualify our technology as viable, conservative, and safe.

INNOVATION

Our service is the daily solution of problems and pursuit of a quality installation. This is not simply the installation of a product, but rather the accomplishment of a complete sequence of events ranging from resin preparation and wet out to installation, utility reinstatement and jobsite cleanup with minimal disruption to the surrounding community. In the evolution of our company, many new product developments, installation tools, and refined practices have combined to make the use of our service a practical occurrence. Our conservative use of the highest design standards and field proven methods have been applied to diameters as large as 120", circular and non-circular storm drain applications, pressure rated force main and NSF 61 certified water main "stand alone" pipe liner installations.

CONTENTS

INTRODUCTION

OBJECTIVE OF THE MANUAL

This manual is intended to serve both as a general reference as well as an educational tool for the owner or project engineer designing infrastructure rehabilitation projects. The technology presented includes cured-in-place pipe, NSF61 certified water main transmission and potable water distribution pipeline rehabilitation, lateral lining, large diameter circular and non circular structural pipeline repair as installed by Lanzo Lining Services.

Cured-in-place pipe is prepared and installed by first saturating a specially fabricated tube with a thermosetting resin. The flexible, resin-saturated tube is installed by pulling it in place or inverting the liner into itself directly through the host pipe using either an existing or constructed access point. With the use of a static head of water, steam pressure, or pressurized air; the resin-saturated tube is pressed tightly against the existing "host" pipe. The water or steam is then continuously circulated through a heater in order to quickly polymerize the thermoset resin which forms a new pipe within the existing "host" pipe. Lateral connections are easily identified where the liner dimples and may quickly be reinstated robotically. All of these steps are typically accomplished without the need to excavate demonstrating truly trenchless technology.

Members of both the public and private sectors are finding the benefits of cured-in-place pipelining immeasurable. This trenchless rehabilitation technology allows placement of pipe within a pipe with "stand alone" structural characteristics while eliminating infiltration and exfiltration at a lower cost, in less time, and with fewer inconveniences to the owners and the communities served.

LANZO LINING SERVICES CONSTRUCTION EXPERIENCE

Lanzo Lining Services is among a handful of companies proven competent in the use of a wide array of cured in place pipelining technologies to rehabilitate deteriorated water, sewer, and drainage pipelines.

Lanzo Lining has successfully installed over six million (6,000,000) linear feet of cured-in-place pipe throughout the United States and Canada, in pipe sizes ranging from 6" to 144". Our specialties include large diameter, non-circular, pressure, high temperature, and corrosive environments in collection, transmission, treatment plant, industrial, NSF 61 potable water main, environmentally sensitive," green" and storm drain applications. [1,2].

Lanzo Lining Services has installed over 1,000,000 feet of large bore CIPP, of which over 250,000 feet has been placed using "over the hole" wet out/installation technology; where factory liner preparation or transport to the remote jobsite location was not possible. We have installed non-styrenated polyester, non-styrenated vinyl ester, and epoxy resin impregnated tubes where environmentally sensitive, potable water transmission or air plenum ventilation application prohibits the use of styrene or other VOC's.

"Over the hole" wet out and installation of large bore circular, non-circular, and box culvert applications

THE CORROSIVE PIPELINE ENVIRONMENT

Accelerated aging caused by hydrogen sulfide-related corrosion has generally caused premature failure of our nation's sanitary sewer infrastructure. Awareness of the existence of corrosion and concern about its effect on the sewer system has been an issue since concrete and ductile iron first started displacing clay and brick as the primary materials in sanitary sewer construction. Even though it was known that some corrosion would take place, precautions taken in the sewer design and pipe thickness were intended to produce the 100+ year life expectancy of the sewer system [3]. However, within the last 25 years, hydrogen sulfide-related corrosion has accelerated at an alarming rate throughout the U.S. and has been documented by the Environmental Protection Agency (EPA) in a number of studies [3,4,5,6]. The primary cause of the accelerated corrosion has been attributed to the proliferation of several strains of Desulfiobrio bacteria in response to the reduction of cyanide and other heavy metal pollutants regulated by the EPA [3,4]. An anaerobic bacteria living in the slime layer on the lower hemisphere of the pipe reduces sulfur-containing compounds to hydrogen sulfide (H2S). An aerobic strain living in the slime on the crown of the pipe oxidizes hydrogen sulfide to sulfuric acid (H2SO4). Routine wastewater pH measurements often indicate the effluent to remain in a range of pH 5-8, which would not ordinarily be of concern. However, the area of most concern with materials having low acid resistance is in the slime layer itself where the aerobic bacteria live. The aerobic bacteria have been observed to produce sulfuric acid up to 5% by weight (i.e., pH ~ 0.28) and remains viable in concentrations as high as 7% (i.e., pH < 0.15) [4,7]. At these acid concentrations unprotected concrete or ferrous metals are readily decomposed, producing holes in the top of the pipe commonly found during inspection.

ADMINISTRATIVE ORDER/CONSENT DECREE

Sewage overflow restrictions, overflow monitoring, and stiff penalties for non-compliance imposed by the EPA and state water agencies have motivated municipal sanitation departments to develop aggressive programs to maintain and/or rehabilitate their systems [4]. These programs have fostered the growth and acceptance of number of trenchless pipe rehabilitation techniques, as well as creative maintenance solutions [4,6,8]. The most popular current ongoing maintenance program utilized by many sanitation districts is the development of chemical treatment protocols and inventive application techniques to control hydrogen sulfide corrosion [4,6,8]. Depending on the program objectives, regular addition of one or more chemicals can reduce existing hydrogen sulfide, neutralize the acids, temporarily shock the bacteria, or accomplish all three. Chemicals commonly used for this purpose includes strong oxidizing agents (i.e., hydrogen peroxide, sodium hypochlorite (active ingredient in bleach), chlorine, potassium permanganate), weak oxidizing agents (i.e., oxygen and air injection), acid neutralizing bases (i.e., sodium hydroxide), and iron salts [4,6]. Use of magnesium hydroxide has been utilized as a thick alkaline chemical coating on the crown of cementitious pipe in order to neutralize the acid gases and kill the acid forming bacteria.

In general, this nation's sanitation system has changed dramatically within the last several decades and will continue to evolve. Studies demonstrate that decreased flows related to water conservation efforts increase the corrosive environment in sewer systems [9]. It is suggested that municipal efforts to reduce inflow and infiltration (I/I) through rehabilitation will also increase hydrogen sulfide-related corrosion and concentrate all other chemical agents present [10]. These and other unpredictable changes may necessitate lining to fortify existing pipelines against an increasingly aggressive corrosion environment [11].

Finally as the nation's infrastructure becomes tighter and additionally rehabilitated; the concentration of the many chemicals contributing to system deterioration will naturally increase. This will further emphasize the need to completely renovate our systems and finish the job started.

ALLOWABLE LEAKAGE BY SPECIFICATION

Infiltration & Inflow reduction

Maximum flow capacity

As a continuous and joint free pipe material, CIPP has been part of a "Green Revolution" even before the environmental community first coined this phrase. The evolution of specified materials has allowed the Engineering Community to reduce the allowable passage of effluent through the joints of newly installed or rehabilitated pipelines, thus improving the overall environment. As late as the 1980's a leakage level of 200 gallons per inch-mile-day was commonly found in new vitrified clay pipe installations and this has now been reduced to a level of 50 gallons per inch-mile-day available with Unibell installations of PVC pipe today. The impact of a zero leakage system such as CIPP should prove instrumental as efforts to move towards a "greener" society remain emphasized. CIPP offers the luxury of a "pressure rated" sewer pipe where leakage either in or out of the system was previously commonplace in new installations.

CIPP BACKGROUND AND APPLICATION

NSF 61 Certified water main rehabilitation

ASTM F1743 Pull & Invert technology

The full technology development of cured-in-place pipe as an industry is attributed to Insituform Technologies back in the early 70's in the United Kingdom. As the technology grew, installation techniques, materials advancements and product marketing were all combined to spawn the international multibillion-dollar business it is today. Recent estimates place the total number of cured in place pipe feet installed at over 100 million feet worldwide. At the present time the North American market has become the largest in the world for CIPP as for many other trenchless technologies.

Cured-in-place pipe has achieved wide popularity and acceptance because it is one of the most versatile methods of trenchless pipeline renewal that exists today. Many of the key features of CIPP are summarized as follows:

1. CIPP is able to span a diameter range of 4 inches to over 120 inches.
2. CIPP has been used to rehabilitate sections of pipe over 3000 feet in length.
3. CIPP can rehabilitate non circular pipe configurations such as ovals, boxes, bends and transitional diameters without digging.
4. Used to rehabilitate partially, as well as, fully deteriorated pipe.
5. Used for gravity, internal pressure and vacuum applications.
6. CIPP is used in extremes of temperature and pH.
7. Specialized products meet NSF61 certification for potable water pipe distribution, green resin applications in sensitive environmental areas, and ventilation applications where styrene use is prohibited
8. CIPP eliminates inflow and infiltration, as well as exfiltration.
9. The smooth inner surface of CIPP increases the flow capacity of the existing pipe.
10. CIPP has ASTM F1216 [12] and ASTM F1743 [13] installation specifications.
11. CIPP tube and resin materials are specified by ASTM D5813 [14].

CIPP INSTALLATION DETAILS

In this section of the manual a general description of the various installation techniques will be described for both the direct inversion and pulled-in-place installation techniques. The descriptions and figures detailed are not intended to encompass all aspects of any given installation. Variable job site, underground piping, and climatic conditions may necessitate a variety of modifications to these descriptions that are intended to produce the same installed product. The basic categories involved with CIPP installation involve the following steps:

1. Inspection
2. Pipe and job site preparation
3. Tube preparation
4. Tube installation
5. Tube curing and cool down
6. Lateral reinstatement and finishing steps

Inspection - Initially before any lining tubes are prepared the existing pipe must be CCTV inspected for debris, roots, damage, offset joints or any other anomaly that does not allow for proper CIPP installation. Inspection also involves measurement of the pipe diameter, pipe length, manhole depths and records of pipe location and other job site conditions (i.e. overhead power lines, or railway, backyard easement, excessive sewerage flows, etc.) that can be properly planned for to help the project proceed efficiently. CIPP can easily be installed over dirt and debris, through severely offset joints or around protruding laterals, and in multiple bends as severe as 90°. CIPP will not eliminate existing pipe defects, but rather will contour the configuration of the host pipe being lined. It must be determined that later inspection with CCTV or water jet cleaning may occur and that bumps or fins in the liner will not disallow equipment from passing through the rehabilitated pipeline.

Pipe Preparation - Preparation for lining may involve internal mechanical cleaning and grinding to remove roots, protruding laterals, or other obstructions in the pipe. Collapsed pipe or severely offset joints (i.e. 40% of the diameter) typically require point excavations at those locations. Loose dirt, debris, or tuberculation may require high pressure water or mechanical cleaning with a final pre-lining inspection showing the full circumference of the pipe.

Tube Preparation - After the engineered tube of proper diameter and thickness for the pipe being rehabilitated has been matched to the host pipe length; it is ready for resin-impregnation. Most liner preparation and resin saturation takes place in the controlled environment of a workshop where the resin and tube temperatures are controlled to desired conditions. The resin and resin-saturated tube may be refrigerated to slow the chemical reaction and provide an additional factor of safety during the transportation and installation of the liner. The tube is prepared by first evacuating the air from it to create a condition for vacuum impregnation. Secondly, the catalyzed resin is introduced into the tube under vacuum so that air is completely displaced with resin while saturating the fabric. The tube is moved through pinch rollers calibrated to the proper thickness so that a controlled amount of resin is introduced into the tube. The tube is then loaded into a refrigerated truck for transportation to the job site. For projects where either the diameter is large and/or the length of the liner is long, this process will take place at the construction site and the liner will go from wet out directly into the pipe being rehabilitated. When properly handled and stored, resin-saturated tubes can be stable for up to a week or more.

Tube Installation - The following installation descriptions are intended to be a generalized overview of common direct inversion and pulled-in-place installations. Since there are so many variables associated with each project and the job site conditions on projects, an overview is provided here to familiarize the reader with general knowledge of this technology. While direct inversion and pulled-in-place installations are performed in a different manner and require different equipment, the decision to choose one installation method over another is related to the project, job site and piping conditions. On a single project it may be advantageous to use both techniques, as well as variations of each to maximize quality and efficiency of the installed product. Both techniques have been used successfully for pipe diameters from 4 inch to greater than 120 inch. The installation techniques described below use water as the installation and curing media since it is by far the most common and reliable method of installing CIPP. However, steam and air pressure may also be used as job conditions dictate. Each technique can be considered a tool in the toolbox of a CIPP installer. As such, each one has its place at the appropriate time to successfully complete a project safely, on time and within budget.

Direct inversion of CIPP is installed to meet or exceed the requirements of specification ASTM F1216 . Initially the tube is attached to a top ring or pulled through a column and turned inside out and attached to an elbow. In both cases, the tube is turned inside out with the use of a hydrostatic head of water as shown in Figure 1. As the water is carefully introduced into a column, the resin-saturated tube is allowed to invert upon itself and progress longitudinally through the pipe in a continuous and controlled manner.

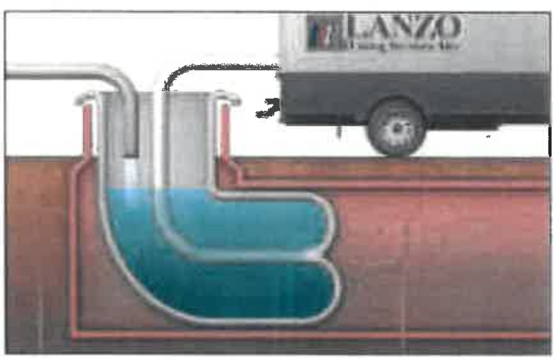


figure1: Direct inversion installation per ASTM F1216

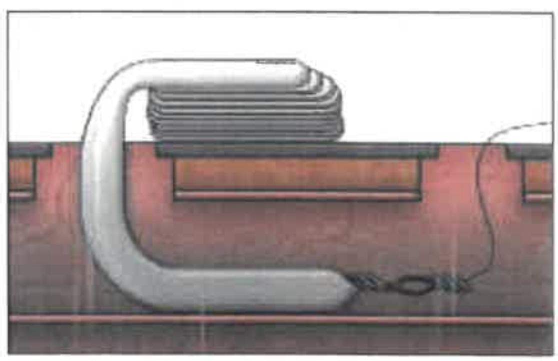


figure 2: Liner pulled-in-place per ASTM F1743

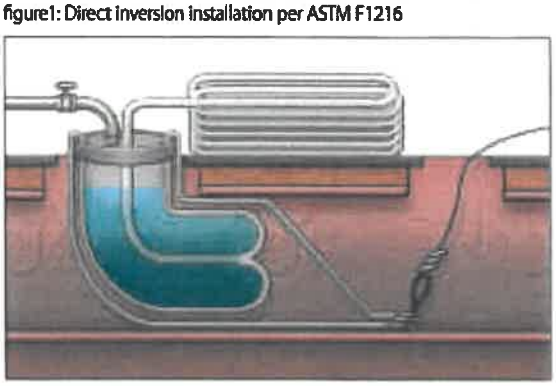


figure 3: Calibration hose or pre liner utilization

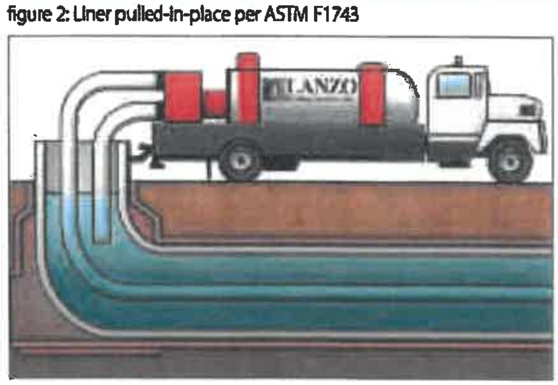


figure 4: Curing liner with hot water or steam

The direct inversion method is the most popular method, available in virtually all sizes, and especially suited to the "over the hole" technique.

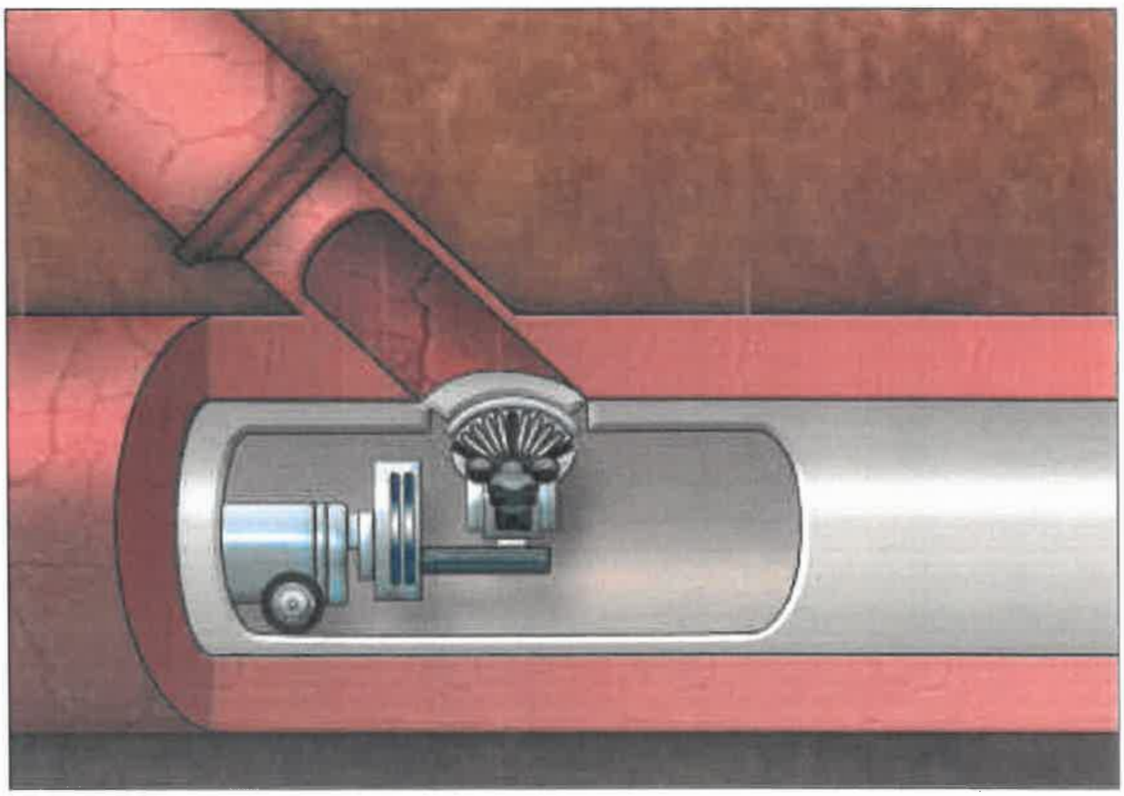
Pulled-in-place CIPP installation is installed to meet or exceed the requirements of specification ASTM F 1743. For this technique a cable is strung through the existing pipe and attached to the tube. Once attached, the tube is carefully pulled into position as shown in Figure 2. In order to reduce potential friction between the pipe and the liner, hydrant water may be introduced into the pipe through the manhole, allowing the tube to easily slide down the pipe. Through the choice of tube materials and careful pulling techniques, pulling forces rarely exceed 10-20% of the maximum tensile properties of the fabric tube. Tube stretch is less than the maximum 5% specified in ASTM F1743, but is usually less than half that value. For a more detailed estimation of maximum tensile strength of a tube and estimated pulling forces, contact Lanzo Lining Services.

Pull in place employs a second installation step. A calibration or retractable hose is inverted into the center of the resin-saturated tube by a hydrostatic head of water. This hose sequentially inflates the resin-saturated tube from one access point to another and holds it tight against the existing pipe as shown in Figure 3. Any residual water trapped in the pipe is directed downstream as the calibration hose inflates and longitudinally progresses within the tube sequentially from one end of the pipe to the other.

Pull in place is extremely instrumental in the many special applications such as Pressure pipe, transitional sizes, NSF 61 water main, ventilation plenum rehabilitation, and large diameter applications where particular placement challenges exist.

CIPP Curing and Cool Down - Once installed by direct inversion or pulled-in-place the tube is cured through the use of circulating heated water, introduction of steam, or the use of an ultraviolet (UV) light.

When water is used, it is taken into the water heater from the column and discharged out into the center of the installed tube at the downstream end. The heated water circulates back to the column at the upstream end where the cycle in



Robotic reinstatement of house connection or "lateral" sewer continued throughout the curing process as shown in Figure 4.

When steam is used as a heat source, the steam is typically introduced at one end and flows through the length of the liner and out the downstream end through a specialized manifold that helps control temperature and internal pressure. New innovations in steam generation technology allow for dryer steam and can also allow the installer to cure at much higher temperatures than circulating hot water.

UV light is a third method of curing CIPP and requires specialized resins and photo sensitive initiators. UV light curing technology is relatively new in North America, but has been used for many years overseas and is proving to have advantages for many different applications. Liners can be stored and transported without refrigeration and still be viable months. When the lights are turned on, curing takes place within minutes.

Whether cured with water or steam, the process must be carried out in a controlled manner with the temperature monitored at both ends of the tube with thermocouples placed between the liner and the host pipe. In addition, the water/steam temperature is monitored at the heater and may also be monitored at the downstream end of the liner. Where intermediate access points exist, the curing process of the tube may also be monitored at those locations also.

Most often the tube is cured in a two-staged heating process and cooled down in a controlled manner to a temperature below 100F. The times and temperatures of these different stages are highly variable based on tube diameter, length, thickness, resin type, catalyst formulation, size of the water heater, environmental and job site conditions. In general, thick tubes require extended curing and cooling times, while thinner tubes may be cured more rapidly. The variable cure times and tube thickness relate to the slow heat transfer into and out of the tube, as well as the requirement to control the exothermic (i.e. heat producing) reaction that occurs when the thermoset resin in the tube polymerizes.

Lateral Reinstatement and Finishing Steps - Once installed, cured and cooled down the CIPP is fully opened on both ends while any lateral connections leading to the pipe are then reinstated. When the pipe is too small for a man entry, CCTV is used to re-locate lateral connections and remotely operated cutting machines are used to re-open the lateral connection. At the manhole connections an end sealing procedure may be utilized which helps eliminate infiltrating water from tracking down or around the host pipe and/or CIPP and re-entering the collection system at the manhole. Where there is heavy groundwater some type of lateral sealing technology is recommended where the lateral connects to the main line. Top hats or interface seals may be applied remotely from inside the liner using a robot without the need to introduce a cleanout or other above ground access. Other trenchless sealing techniques include chemical grouting, lateral lining at the connection and/or up the entire lateral, or robotic placement of polymer putty. Alternatively, laterals may be opened and sealed by making a point excavation to place a new saddle connection at each lateral.

Final Inspection - As with any project, final CCTV inspection provides the documentation for the project engineer that the CIPP was properly installed. Ideally CIPP is smooth and wrinkle free throughout the length of the installation. However, CIPP cannot eliminate piping irregularities and will mirror pre-existing problems in a defective pipe being lined to eliminate I/I, exfiltration, or improve structural integrity. In addition, fins in the CIPP can occur when the pipe diameter decreases to less than the nominal diameter of the existing pipe. During the engineering and design phase of a contract, tubes are commonly specified with an undersized diameter (i.e. 4-8% undersized) to anticipate host pipe diameter changes and moderate bends. When encountering crushed pipe, PVC pipe used for point repairs, and clay pipe the host pipe diameter can decrease to the point where these measures cannot prevent fins. Fins are also unavoidable in sharp bends where the inner radius bunches going around the bend. Wrinkles such as these are cosmetic defects in an otherwise defective host pipe and prevalent in all CIPP construction. Since most all fins run along the length of the pipe they typically increase the physical properties like that of a built-in I-beam and do not affect flow. Typically fins in the CIPP are of little concern to the overall performance objectives of the rehabilitation project.

CIPP PROJECT SPECIFICATION

To insure the desired results from a CIPP rehabilitation project, proper specifications must clearly outline the objectives. With any rehabilitation project it is recommended that the collection system be evaluated as a whole and pipeline sections be segregated for repair using the appropriate rehabilitation technology(s) most suited for the stated project objectives. A project may be put out to bid with multiple technologies (i.e. CIPP, sliplining, open cut replacement, lateral lining) to achieve the desired end result. Exclusive rehabilitation with CIPP is recommended in areas where any or a combination of the following conditions may exist:

1. Suspect structural characteristics in the host pipe are manifested in the form of radial or longitudinal cracks, offset and/or displaced joints.
2. Ovality sufficient to preclude sliplining or folded and re-formed products from reaching a full round configuration consistent with ring compression support theory (see Design Section).
3. Pipes where sections are completely missing.
4. Pipe subject to highway loading in shallow or live loads.
5. Deeply buried pipe where high external hydrostatic pressure may exist.
6. Pipe with line and/or grade differentials (i.e. existing bellies in the pipe run) that may produce friction for sliplining and/or not allow folded products to reach their fully rounded state after installation.

Once it has been determined that CIPP is the proper choice for pipeline rehabilitation there are many aspects of specification that will determine the success and quality of the completed project. Prequalification factors such as threshold contractor experience, minimum installed footage, same liner size or larger, key employee resumes and local wet out facility are significant items that may be taken into account prior to bid. Contact Lanzo Lining Services for a sample specification that can be used as a template for your specific CIPP project.

ASTM SPECIFICATION

ASTM standardization is extremely important to insure consistency in materials and installation practices, while minimizing owner liability in ongoing construction work. It may take as long as five (5) years to obtain a ratified specification. After initial publication ASTM standards are kept current through a mandatory review process that is required every seven years. If there is no interest to review a standard it is dropped from publication. Standards exist for virtually every pipe rehabilitation product, including CIPP. ASTM does not purport to cover all the details of every project or installation, but does provide a valuable framework and set of guidelines that are absolutely necessary for the underground rehabilitation industry in general.

ASTM D5813 "Specification for Cured-In-Place Thermosetting Resin Sewer Pipe" covers material requirements for the resins and fabric tube materials used for CIPP. ASTM D5813 also outlines test methods for evaluating installed CIPP.

ASTM F1216 "Practice for the Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube" provides guidelines for the installation of CIPP with the direct inversion method.

ASTM F1743 "Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)" is an installation standard practice for the pulled-in-place method of installation. ASTM F1743 references both ASTM F1216 and ASTM D5813 for designing and specifying CIPP.

As with any technology there are critics within and outside the CIPP industry regarding the validity of the aforementioned standard practices. Two areas that have come under extreme scrutiny are the design criteria and pre-qualifying materials for chemical resistance testing. CIPP gravity sewer design is divided into "Partially and Fully" deteriorated existing piping criteria. Based on the pipe classification, the CIPP is designed to either withstand hydrostatic loading only, or all possible external loads that the CIPP may be exposed to. In addition, some municipalities have developed their own chemical resistance and design criteria, which is much more severe than that specified in ASTM (i.e. The California Green Book [15]). Proponents and supporters of these specifications argue that CIPP has performed admirably in the U.S. for over 40 years and has not failed as a technology because the approach taken has been conservative and aimed at long term performance for the product(s).

Lanzo Lining Services supports the more conservative approach to specification selection. With over six million (6,000,000) feet of failure free installation, primarily in fully deteriorated design basis, serves as testimony to the confidence attainable in a conservative approach.

CIPP APPLICATION GUIDELINES

Since the publication of our premier Design Guide ten (10) years ago there has been an absolute transformation within the CIPP marketplace with respect to comfort with this technology and a relative boom in the range of application for composite felt/resin liner systems.

Lanzo has remained an innovator and pioneer installer of CIPP in many cutting edge applications such as:

- I/I reduction in sanitary collection systems
- Large Diameter and Non Circular sewers, storm drains, and box culverts
- "Over the Hole" wetout and installation
- High temperature chemical concentrations and industrial sewers
- Pressure rated force main sanitary sewer transmission
- NSF 61 certified water main rehabilitation
- Green resin utilization in wetland or environmentally sensitive areas
- Air duct ventilation repair and vacuum pressure line
- Contaminated soil remediation prevention
- Flood control structure rehab
- Submerged or canal enclosure pipeline rehabilitation

CIPP has been installed by Lanzo in diameters ranging from 6" through 144".

The utilization of direct inversion, pull in place, and hand lay-up methods are application dependant but generic in terms of the design parameters presented in this guide. Additionally, both gravity and pressure rated design is presented herein, while an abundance of information has been accumulated on each of these methods available for informational or specification writing purposes by contacting Lanzo.

COMPETING TRENCHLESS PIPELINE REHABILITATION TECHNOLOGIES

In general, trenchless pipeline rehabilitation technologies have proliferated and gained extraordinary acceptance because of the changing chemical environment previously described, enforcement of the clean water regulations, inadequacies of traditional piping materials, and the rising social costs of traditional dig and replace methods. Social costs include the direct and indirect costs that will impact the community surrounding the project. These costs might include destruction of old trees, disturbance of a wetland habitat, disruption to businesses, and impact of traffic congestion on side streets as people are forced to take alternative routes. A number of experts and engineering firms have studied this more closely to develop generalized costs [16]. Pipe repair alternatives include chemical grouting, point repairs/excavation, internal robotic repairs, sectional liners, sliplining, CIPP liners, fold and form liners, and pipe bursting. Acceptance of new technologies has increased competition and pushed the cost down to the point where the cost of a trenchless repair is generally less costly than trenching, even without taking social costs into consideration.

Table 1. Generic costs of Pipeline Construction and Repair Methods [16].

Method	Cost/Inch Diameter/Foot	Type of Installation
Sliplining	$4-$6	Rehab
Grouting	$4-$6	Rehab
Cured-In-Place Pipe	$4-$8	Rehab
Pipe Bursting	$8-$10	Rehab
Over the Hole large diameter CIPP	$10-$28	Rehab
Trenching	$15-$30	Rehab or New
NSF 61 Water main CIPP rehab	$20-$30	Rehab
Sectional CIPP Liner	$50-$85	Rehab

Each method of repair has a niche where it is most applicable. These technologies are briefly reviewed with the understanding that the included summary cannot encompass the full scope of each technology.

Chemical Grouting - Chemical grouting is a technique primarily used to seal leaks in pipes or lateral connections in pipe diameters typically in the range of 6 inch to 24 inch. It has been used for years and includes material selection options such as acrylamide gel, acrylic additives, urethane gels or foam. These products are typically injected under pressure with a specialized packer that forces the liquid grout through the hole in the pipe into the surrounding soil envelope. There it polymerizes to form a solid or semi-solid gel that pervades the soil envelope serving to non-structurally seal the pipe. Grouting is economical and effective but temporary in sealing leaks and not a structural repair to a damaged pipe. The estimated effective lifetime of various grouts is an ongoing point of debate which points to a range from 3 to 7 years.

Sectional or Part Liner – Developed as a repair technique for CIPP defects, this method has seen expanded application and is perhaps "over used" to repair damaged pipe. It can be designed as a structural repair to a fully deteriorated host pipe. This method is essentially a short CIPP repair that may be furnished in lengths ranging from 3 feet to as long as necessary, depending on diameter and location of the repair. The primary issue in electing to utilize this technology is the selection of an adequate repair length. Pre video inspection reports revealing target defects do not offer insight into the underlying cause of the failure or extent of soil envelope deterioration. Consequently, a seemingly adequate repair may not prevent crack propagation outside of the limits of the sectional repair after a relatively short time. It is judicious to select a sectional repair length which takes this phenomenon into account by extending the repair to several joints in either direction beyond the target defect. Additionally, a maintenance program should exist to monitor these repairs over time as post cure shrinkage as well as other effects may cause movement of the short liner.

This method is most typically used for pipes 8 inch to 24 inch in diameter, but is available in diameters as large as 120". Fabric tubes constructed of woven and/or non-woven materials (i.e. polyester felt and/or fiberglass) are manufactured for the project and saturated with a variety of resins which have been modified for a reactive cure with low heat or UV light. The sectional liner is typically pulled into position on a carrier or packer which is then pressurized causing the short CIPP segment to expand tightly against the host pipe then allowed to cure in place.

A practical alternative to this method is an installation technique called a "blind shot" or a sectional CIPP liner section which only requires access to the pipe at one end for a starting point. Although Part Liners typically do not run manhole to manhole, this variety of sectional pipe repair offers the additional benefits of:

-
- a solid connection to a manhole-pipe interface
- a repair which is readily visible from the manhole
- the ability to line past the defect by several joints thus clearing the suspect soil envelope by a more conservative distance

Service Connection Reinstatement, Repair, Interface Seal and Lateral Lining Lanzo has become proficient in providing several technologies to repair lateral connections and lateral pipes both remotely from within the mainline, as well as, from a cleanout located at the property line. These repair technologies require specialized liner materials and equipment, but can successfully seal the lateral-mainline connection and rehabilitate the smaller lateral pipe up to the house or business. These methods require experienced field technicians with an understanding of varying host pipe materials, resin cure, remote camera and robotic equipment operation, variable temperature, flow and piping conditions to complete a successful time sensitive repair.

Different technologies exist in the marketplace which utilizes either water or air as placement media with either water, steam, or UV light for curing the resin systems. There exist several proprietary technological approaches while the end user should be cautious to insulate themselves from sole source specification which may drive cost unduly higher as they become embroiled in trade issues such as full wrap vs. lateral region adhesion, or minimum length of interface seal dimension.

An interface seal is intended to eliminate annular space or shear condition, while lateral lining serves to seal and structurally repair the lead to a determined length within the service. Although certain lateral lining technologies may be remotely launched from within the main, a cleanout is routinely necessary to insure the removal of root manifestation and mineral deposits while visually inspecting defects within the lateral to be rehabilitated. The notion that a lateral may be routinely lined without a cleanout is therefore flawed.

Robotic Repairs - This is a highly specialized technology that can also be used as a trenchless point repair method to seal cracks and leaking lateral connections. Through the use of grinding tools and epoxy resins or chemical grouts a wide variety of pipe defects can be repaired. Widespread use of this method has been hampered by the initial purchase and maintenance expense of the robotic equipment employed which also requires highly trained personnel for a small portion of the repairs typically being addressed in a comprehensive system rehabilitation project.

Repairs consist of employing a remote cutter head to ream, gouge, or machine a channel into an existing defect which then is more receptive to an epoxy which may be robotically troweled or pumped into place. Typical repairs apply to pipes in the 8-inch to 24 inch robotic equipment are repaired with these techniques.

Point Excavation for Repair - When a pipe is severely damaged or crushed it may be most cost effective to dig at that location to repair the section of pipe. This method is often used in conjunction with trenchless lining techniques to replace collapsed sections so the existing pipe may then be inspected, cleaned and subsequently lined from manhole to manhole. All sizes, shapes, and varieties of pipe have been repaired with this method to effect a conventional open cut repair.

Sliplining and Segmental Sliplining - These methods can be used to either pull or push new plastic or composite system into the existing host pipe. Traditional or "discrete" sliplining typically either pulls a high-density polyethylene (HDPE) pipe or pushes a reinforced thermoset resin (RTR) or reinforced plastic mortar (RPM) through one access pit to another. Depending on site conditions, sections of pipe of 1000 feet or more may be pulled or pushed at one time. The pull method of pipe repair is most typically used on pipe 8 inch to 24 inch in diameter, but larger sizes have been installed. In 48 inch and larger applications, segmental sliplining with thermoplastic or composite pipe can become more cost effective depending on site conditions at the entry and receiving pit along with the costs associated with bypass pumping.

Segmental sliplining is performed by lowering individual sections of pipe into an access pit and hydraulically jacking each into the host pipe towards a receiving pit while maintaining pipe flow.

Hard pipe material slipline methods are limited by the frictional forces of the slipline material against the host pipe, which will determine the shot length or allowable distance between pits.

Sliplining reduces the overall hydraulic radius significantly and may reduce the capacity of the pipe rehabilitated. Factors such as pipe joint articulation , mineral deposits, bends and line obstructions must be thoroughly investigated prior to method selection. Reinstatement of lateral connections requires external point excavations.

Pipe Bursting - Pipe bursting is a technology where the existing pipe is sheared or cracked while a new pipe is pulled behind (sliplining) a specialized bursting tool. Many types of tools have been developed with hydraulic or pneumatic bursting capability and include pulling only, pulling and pushing, and so on. This method enables the owner to actually increase the size of the existing pipe by one or more diameters and actually increase the hydraulic radius. Pipe bursting has been used to up-size 8 inch to 10 inch or 12 inch and has been used to increase pipe up to 36 inch or larger, from smaller diameters. The technique works most efficiently on brittle host pipe materials, such as clay, concrete, asbestos cement and "pit" cast iron. HDPE is most often used as the replacement pipe, but PVC, composite pipe, and even clay have been used. The limitations to this technology involve use of the bursting tools when the pipe is close to structures such as foundations or utilities that cross the line being burst. Where these structures can be point excavated, bursting can proceed without incident. Reinstatement of lateral connections requires external point excavations.

Fold and Form Lining - This process uses plastic pipe that has been folded into a "U" shape allowing it to be steam softened then pulled into the existing pipe. Using steam heat and internal pressure the liner is reshaped to meet the existing pipe. Fold and form has been attempted in diameters ranging from 6 inch to 24 inch, but is most applicable in the range of 8 inch to12 inch. HDPE and modified PVC are the piping products used for fold and form. This method is a low cost rehabilitation technology that is used where the existing pipe can provide structural support to the liner for gravity flow applications. Potential problems exist where the liner does not fully unfold, making it susceptible to collapse under external groundwater pressure. For some products the modified PVC materials are often experimental in nature without extensive long-term property research behind them. Therefore, prior to use the owner should review all products carefully. In most cases lateral connections can be reinstated by remote cutting tools, but may require point excavation and typically require grouting to guard against flow tracking through an annular space. There is no reliable "adhesion" or "mechanical bond" between a thermoplastic material and a host pipe.

Pipe Preparation - Most of the technologies listed have the common need for pre-installation inspection, cleaning, and other forms of preliminary pipe preparation. For most applications by pass pumping is of minor concern in diameters up to 15 inch. In the range of 18 inch and above by pass pumping can become a significant portion of project planning and cost. Depending on site conditions pipes greater than 48 inches may be rehabilitated during flow diversions and using techniques that minimize the reliance on by pass pumping.

Lanzo Lining Services brings experience with dig and replace, new pipe construction and multiple rehabilitation technologies while adding value to the project. The Lanzo Companies can combine construction capabilities to optimize the allocation of municipal dollars while streamlining coordination efforts on any given project.

CIPP ENGINEERING AND COMPOSITE MATERIAL PROPERTIES

Since 1993, Lanzo Lining Services representatives have actively participated in national organizations such as ASTM, NASTT, AWWA, APWA and NASSCO in an effort to assist owners, municipal and plant engineers maintain the most current material specifications. Lanzo Lining Services' objective is to provide a competitive CIPP product that will meet or exceed the EPA mandated fifty-year design life. To satisfy ASTM and municipal/industrial specifications it is critical to select tubes, resin, and catalyst products from qualified suppliers providing the highest quality materials and services. Lanzo Lining Services only uses the finest quality manufactured products and supplies from ISO 9000 certified sources. In the following sections, minimum and typical property values for the fabric and resin products are provided. In order to remain competitive while providing the highest quality CIPP; Lanzo Lining has continued to review and update the following published criteria, as the industry and job conditions necessitate.

FABRIC TUBE MATERIALS

The flexible fabric tube is one of several key elements of the CIPP process. The materials used to construct tubes must possess chemical resistance, flexibility, an ability to stretch and conform to irregular piping, and be durable to withstand the rigors of underground construction. Currently, the most commonly used fabric tube material in North America is composed of thermoplastic polyester fibers needled into a dense felt. However fabric tubes made of combinations of needled polyester and polypropylene fibers and needled polyester with various fiber reinforcements are also available. Depending on fiber orientation, liners constructed of fiberglass tubes can easily produce a flexural modulus that would exceed 1,000,000psi and flexural strength values over 15,000psi. At the time this criteria was placed in the referenced ASTM specifications the targeted material(s) were needled polyester felt and coated polyester felt. Many coatings may actually enhance the properties of a tube. Table 2 includes typical values for plain polyester felt and coated polyester felt.

Table 2. Typical tensile properties for polyester felt and plastic coated felt.

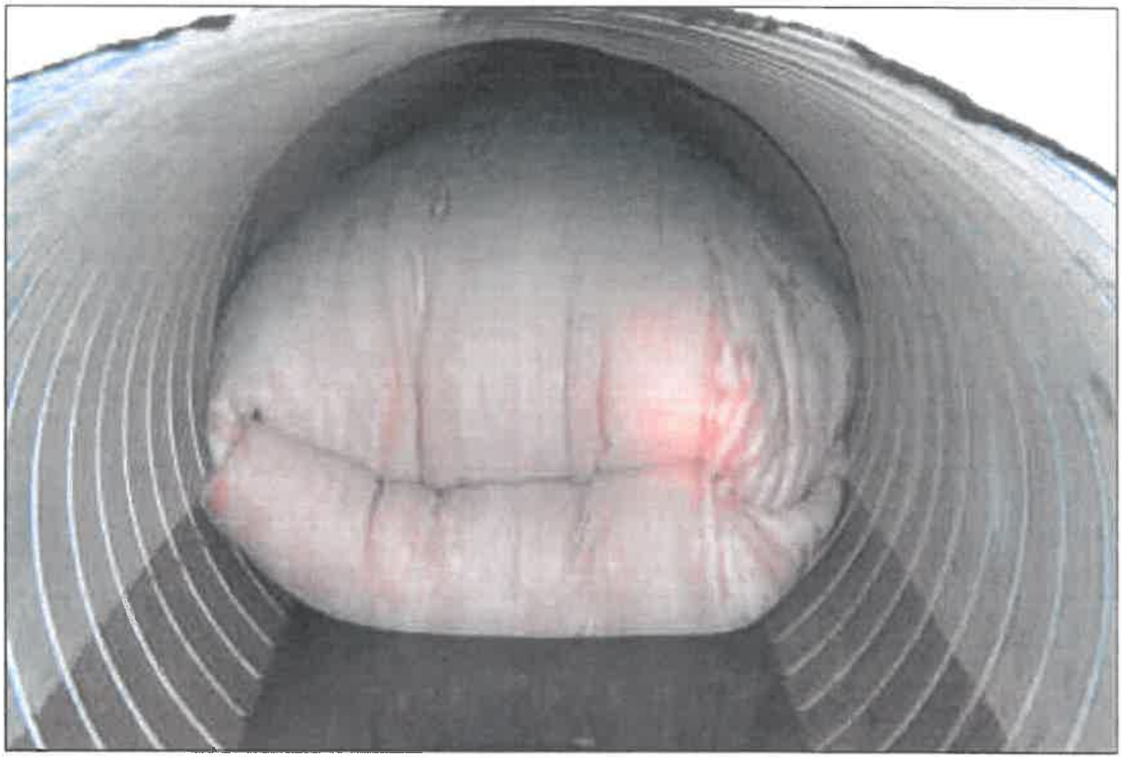
Material	% Elongation at Failure	Ultimate Tensile Strength
Felt	85-95	800-1000 psi
Plastic coated felt	70-75	1200-1500 psi

THERMOSET RESINS

Resins Overview and Properties

The thermosetting resins used for CIPP are the most important component to the short- and long-term performance of the product. First, there is a distinction between initial or short-term properties and the long-term performance that dictates the life span of a product. Short-term properties include parameters such as flexural, tensile, and compressive properties. Long-term properties include parameters such as chemical resistance, creep, and strain corrosion. Most all these parameters are important for the qualification, design, and performance of CIPP.

There are three main groups of thermoset resins used for CIPP and they consist of polyester, vinyl ester and epoxy resins. Within each of these three categories exist hundreds of combinations of products with their own characteristics that distinguish their performance. A number of papers have been published that generally review the short- and long-term performance of these three classifications of thermoset resins. In general epoxy and vinyl ester resins are higher performance products compared to polyester resins. They have higher strength, elongation, elevated thermal and chemical resistance compared to polyesters. However, not all pipe rehabilitation applications require the elevated performance of a vinyl ester or epoxy resin. The vast majority of standard gravity flow sewer pipe rehabilitated has been accomplished with polyester resins. However, since there are so many types of products within each category typical properties provided are given as a range of values that could be expected. Table 3 provides some typical properties of neat resins formulated for CIPP that have 'not' been combined with any fabrics or specialty fillers.



Frontal view of 60 inch diameter direct inversion

Finished outfall product at the headwall

Table 3. Typical neat physical properties.

Test Property	Epoxy Resin	Epoxy Vinyl Ester	Isophthalic Polyester
Flexural Modulus[1], psi	500,000-550,000	500,000-570,000	500,000-570,000
Flexural Strength, psi	15,000-25,000	15,000-25,000	10,000-18,000
Maximum Strain, %	4-7%	4-7%	3-5%
Tensile Modulus[2], psi	490,000-540,000	490,000-560,000	490,000-560,000
Tensile Strength, psi	8,000-10,000	8,000-10,000	5,000-8,000
Tensile Elongation, %	4-7%	4-7%	2-5%

1 Flexural properties determined by ASTM D790

2 Tensile properties determined by ASTM D638

Resin/Felt and Resin/Fiber Composite Properties

When the aforementioned thermoset resins are combined with the flexible fabric of a tube, material properties can be dramatically changed, as previously overviewed in the FABRIC TUBE MATERIALS section. The following discussion will focus primarily on the effects of needled polyester felt tubes on the material properties of a thermoset composite. There are several reasons for the observed effect on physical properties. First, the randomly oriented needled fibers of a felt tube are not oriented in a manner that can become load bearing. Therefore, modulus or stiffness and strength values are often reduced 30-50% compared to the neat resin properties. However, it is not as simple as it appears, since fiber types, sizes, orientation, and felt density can also affect material properties. In addition, felts made of combinations of polyester, polypropylene, and/or polyethylene fibers have varying performance due to the level of resin adhesion to the fiber(s). Polyester fibers tend to slightly solvate when exposed to styrene based resins (i.e. polyester and vinyl ester) and bond extremely well. Tubes made with a combination of polyester felt and fiberglass fibers or entirely with fiberglass can produce extremely high physical properties. By so doing, the designer can produce CIPP with a reduced wall thickness, but still perform extremely well for either external hydrostatic pressure or internal pressure applications.

The resin component of the resin/felt or resin/fiberglass composite can also be modified with fillers to effect the processing parameters and the mechanical properties of the composite. The viscosity of thermoset resins developed for CIPP are modified with specialty fillers called thixotropes. Thixotropic fillers are added at small levels (i.e. 1-3%) to increase the viscosity of the resins so that they stay in the tube fabric during processing and installation and do not drain out of the tube and into the host pipe, ground, lateral connections, etc. Thixotropes typically do not effect physical properties since they are added at such low quantities.

Other mineral fillers such as aluminum trihydrate (ATH) are also added to resin to enhance the overall material properties. Newer formulations with calcium carbonate and calcium carbonate/ATH combinations have been developed and have recently been introduced to the market. ATH and other fillers are added to significantly increase the modulus (i.e. stiffness) of the overall composite without diminishing the resins' processability, or decreasing the strength or the chemical resistance of the CIPP. Increasing the modulus of the composite can provide some cost advantages when designing CIPP and this is reviewed in the ENGINEERING DESIGN section of the manual. In addition to design advantages, resins with fillers have an increased thermal conductivity and therefore heat up more uniformly through the entire thickness of the tube which is especially helpful when working in cold climates. Fillers reduce resin and tube shrinkage during curing and cool down, which provides a tighter fit to the host pipe after the CIPP is installed. To illustrate the effects of resin/felt composite properties in Table 4 is provided with typical properties. As consistent with Table 3, these properties are generated from experimental panels made in laboratory conditions and should not be misconstrued to be typical of all installed CIPP.

Table 4. Typical property ranges for resin/felt composites consistent with CIPP construction.

Test Property	Epoxy Resin Data	Epoxy Vinyl Ester Data	Isophthalic Polyester Data	Filled Isophthalic Polyester Data
Flexural Modulus, psi	480,000-550,000	480,000-570,000	480,000-570,000	550,000-750,000
Flexural Strength, psi	10,000-12,000	10,000-12,000	7,000-9,000	7,000-8,500
Maximum Strain, %	3-5%	3-5%	2-4%	2-4%
Tensile Modulus, psi	490,000-540,000	490,000-560,000	490,000-560,000	550,000-750,000
Tensile Strength, psi	7,000-10,000	7,000-10,000	6,000-9,000	5,000-8,000
Tensile Elongation, %	2-4%	2-4%	1-3%	1-3%

Minimum Recommended Design Properties

Typical properties of neat and resin/felt composites produced in the laboratory are not typical of the product produced in the field. When all the parameters of the preparation, installation, curing, and sampling are carefully monitored and controlled the properties of installed CIPP fall within the median range of data provided in Table 4. However, there are many uncontrollable variables of an underground construction project that can negatively affect the end product. The net overall result is that variability is increased and the variability in the test data also increases. Therefore, minimum property values have been established within the industry to provide a conservative minimum value for flexural and tensile properties of installed CIPP. Table 5 provides recommended minimum design values for standard CIPP. The values in Table 5 are relatively low compared to the values of Table 4, but the median value of installed CIPP is typically 15-25% higher than minimums. However, cold weather, high groundwater, poor water or steam circulation and/or equipment failure can produce reduced properties just above the minimum standards. In effect, the majority of all CIPP installed essentially has an additional factor of safety due to the conservative design practices that have been adopted in ASTM standards. Minimum properties are given for both flexural and tensile properties, but it should be pointed out that tensile properties are only used in the design of fully deteriorated (stand-alone) internal pressure pipe.

Although not emphasized in this design guide, minimum properties using fiberglass reinforced liners might be specified with a flexural modulus that would exceed 1,000,000psi and strengths that would exceed 10,000psi for gravity flow applications. With proper fiber orientation, tensile properties can also be greatly enhanced for internal pressure applications like NSF 61 potable water pipe rehabilitation and/or sewer force mains.

Table 5. Minimum recommended design properties for CIPP.

Test Property	Epoxy Resin Data	Epoxy Vinyl Ester Data	Isophthalic Polyester Data	Filled Isophthalic Polyester Data
Flexural Modulus, psi	250,000-300,000	350,000-450,000	250,000-350,000	400,000
Flexural Strength, psi	5,500	5,500	5,500	5,500
Tensile Strength, psi	3,000-5,000	3,000-5,000	3,000-5,000	3,000-5,000

Creep Properties of Thermosetting Resins

Engineering materials of all kinds deform when placed under a load and this is a basis for careful engineering and design for any structural application. When materials such as thermoset and thermoplastic resins are subjected to low loads relative to their ultimate breaking point they will experience incremental deformation occurring over a period of time. These deformations occurring over the design life of a product is referred to as creep. Creep is affected by many factors that include the type of material being analyzed, the degree of cure (for thermoset resins), environmental conditions (temperature, chemical agents), and the amount of load applied. For the thermoset resins used for CIPP creep is an important design parameter that must be taken into account to provide an adequate factor of safety over the design life of the pipe. Loading on CIPP occurs when it is installed under the water table and uniform hydrostatic pressure pushes uniformly around the circumference of the CIPP. Additional forces can occur where CIPP is installed in unstable soil conditions and/or live loads act on the pipe. In these cases the loads may not be uniform, but would push down on the upper half of the CIPP creating a combination of complex loading conditions.

In order to understand long-term creep performance of common resin/felt composites mechanical tests have been developed to characterize the performance of CIPP. The typical expected design life of CIPP is fifty (50) years so testing is performed in a way to estimate long-term performance and produce a safety factor that can be applied to the design of CIPP. Tests include hydrostatic buckling and three point bend tests performed under constant loading conditions. Tests are typically performed over a time period of 10,000 hours. The data is statistically fit to a line and extrapolated out to fifty (50) years for the design life of the CIPP. The reduction of stiffness due to creep is applied to the short-term flexural modulus (as given in Table 5) to estimate a long-term modulus (EL). Many confidential research projects have been conducted without publication until Louisiana Tech University carried out a research program to evaluate the long-term performance of a number of pipe lining products [17]. The results of this study have been highly controversial due to criticism over uncontrolled variables and statistical data treatment. However, this research created a basis for additional analysis and comparison between hydrostatic testing and three-point bend testing as specified in ASTM D2990 [18].

Published results of the aforementioned testing indicate factors like degree of cure, loading level, thermal and chemical environment, and type of resin and/or reinforcement will affect the amount of creep that may be experienced over the life of installed CIPP. Therefore, test results have been analyzed to develop a conservative recommendation for creep. When all conditions are set equal it is generally understood that there are differences between resin types. Therefore, the minimum recommendations in Table 6 given for the different resin categories used for CIPP are multiplied times the short-term modulus or strength to obtain the estimated EL (long-term modulus), sL (long-term flexural strength), or stL (long-term tensile strength) used for long-term CIPP design. For special applications such as pressure pipe, industrial chemical exposure, and/or elevated temperature consult Lanzo Lining for creep recommendations.

Table 6. Recommended minimum factors for creep

	Epoxy* Resin	**Epoxy Vinyl Ester**	**Isophthalic Polyester**	**Filled Isophthalic Polyester**
Creep Factor	0.25 - 0.6	0.5 - 0.6	0.4 - 0.5	0.4 - 0.5

*The creep factor of epoxy resins is quite variable depending on the curing agent chosen. Consult Lanzo Lining technical services for proper recommendations.

Thermal Properties of Thermoset Resins

The thermal properties of thermoset resins are measured by the heat distortion temperature (HDT). The HDT is not the only method of determining the performance of resins at elevated temperature, but is a commonly used indicator. Thermoset resins have what is called a glass transition temperature (Tg) where their properties changing from a glassy or rigid state to a softer or rubbery state. When the temperature reaches and goes beyond the Tg of a particular resin its physical properties diminish significantly. However, as temperatures approach the HDT physical properties remain fairly constant. The Tg and HDT of resins are determined by the inherent chemistry of the resin and the degree of cure. Typical HDT values are provided for the different categories of thermoset resins in Table 7. When pipe rehabilitation products will be required to perform continuously at elevated temperatures alternative resins and/or additional factors of safety may be required to compensate for the resulting reduction of stiffness and/or strength.

Table 7. Typical heat distortion temperatures (HDT) for thermoset resins used for CIPP.

	Epoxy Resin	**Epoxy Vinyl Ester**	**Isophthalic Polyester**	**Filled Isophthalic Polyester**
HDT	150-225F	200-245F	190-225F	190-225F

Chemical Resistance Properties of Thermosetting Resins

By the nature of the application, most CIPP will be exposed to some type of chemical environment. Since most applications involve a combination of chemicals at varying concentrations it is difficult to evaluate all the possibilities that may be necessary to define the exact performance. To simplify this analysis standard chemicals are chosen at higher than normal concentrations. Testing can also be done at elevated temperatures to accelerate the effects of these chemicals on the resin/felt composites. To date there is no defined test method for specifically evaluating CIPP composites. The standard practice currently used is to adopt a modified version of ASTM C581, which was developed for fiberglass/resin composites. By so doing, four resin/felt coupons are submerged into the chemical of interest. At intervals of 30, 90, 180 and 360 days a coupon is removed from the chemical, weighed, measured, and tested for flexural properties. At the end of one year these separate evaluations are compared to a control coupon that was not exposed to the chemical. The one aspect of this test method that can create anomalies arises when the test coupons are not uniform. In other words, all five coupons should initially have identical physical properties before the testing starts. If one or several coupons had significantly higher or lower physical properties initially, this may adversely effect of the outcome of the protocol with an anomalous data point(s). For such cases it is common to eliminate that data point from the data set and use the remaining data as an indication of the overall performance.

Table 8 provides a set of chemical resistance performance for the different types of thermoset resins used for CIPP in a number of different chemicals. This set of chemical data was performed at an elevated temperature of 120F. The one-year data was statistically fit and extrapolated out to obtain a prediction of performance at 25 years. From the data it is clear that different resin categories perform differently in groups of chemicals. Isophthalic polyester resins generally perform extremely well in acidic chemicals (i.e. sulfuric, nitric, hydrochloric acids), but perform moderately in oxidizing agents (i.e. sodium hypochlorite, potassium permanganate, hydrogen peroxide), and poorly in basic chemicals (i.e. ammonium hydroxide, sodium hydroxide). Epoxy resins generally perform extremely well in basic chemicals, but also can withstand acidic and oxidizing chemicals. Epoxy vinyl ester resins have excellent overall chemical resistance to all three categories of chemicals.

Table 9 provides and estimate of the retention of physical properties of resin/felt composites using the chemical agents specified in ASTM F1216. The data obtained in Table 9 was run at room temperature and evaluated for a period of one (1) year. Several different resin types were tested and the 1, 3, 6 and 12 month data was averaged to obtain an overall estimate of the one-year retention of physical properties. This set of tests indicates a high level of chemical resistance to all the chemicals when evaluated at the aforementioned conditions. There also appears to be no significant difference between the standard polyester and the filled polyester resins.

When specifying a resin for CIPP it is obvious one must consider the chemical environment of the application. Since most sewerage applications are acidic in nature, isophthalic polyester resins typically are adequate and work well in this environment. However, it is often difficult to predict what may be introduced into a municipal sewer or industrial piping system. For example, odor-reducing chemicals commonly used in municipal sewers could be potentially damaging to polyester resins, while not effecting epoxy or epoxy vinyl ester resins. As the environment and managing personnel change over years, common practices also change, thereby changing the requirements of the CIPP.

Large bore trenchless renovation in "tight quarters"

Table 8. Chemical Resistance of Thermoset Resins Used for CIPP. Estimated Percent Retention of Flexural Properties.

		Percent Retention of Flexural Properties					
		Epoxy Vinyl Ester		Epoxy		Isophthalic Polyester	
Chemical Tested	Flexural Property	1 Year Actual	25 Years Estimated	1 Year Actual	25 Years Estimated	1 Year Actual	25 Years Estimated
2.5% Sodium	Modulus	100	99	30	42	0	0
Hypochlorite	Strength	100+	100+	42	45	0	0
5%Hydrogen	Modulus	96	94	76	84	75	65
Peroxide	Strength	100	100	66	84	83	76
5% Potassium	Modulus	100+	100+	90	83	84	77
Permanganate	Strength	98	97	83	60	62	49
5% Sodium	Modulus	74	65	78	88	0	0
Hydroxide	Strength	79	71	75	72	0	0
5% Ammonium	Modulus	76	65	66	65	35	22
Hydroxide	Strength	72	61	64	54	38	25
25% Sulfuric	Modulus	100+	100+	93	93	92	89
Acid	Strength	97	95	90	100+	93	91
20% Hydrochloric	Modulus	100+	100+	93	89	84	78
Acid	Strength	100+	100+	99	95	79	70
5% Nitric	Modulus	100+	100+	91	85	86	79
Acid	Strength	100+	100+	100+	82	82	75

Note: 100+ indicates the curve fit would predict physical property retention greater than 100%.

Table 9. Average Chemical Resistance of Typical Thermoset Resins Evaluated for One Year Using Chemicals Specified in ASTM F1216.

		Percent Retention of Flexural Properties		
Chemical Tested	Physical Property	Epoxy Vinyl Ester	Isophthalic polyester	Filled Isophthalic Polyester
10% Sulfuric	Modulus	92	98	90
Acid	Strength	90	87	94
5% Nitric	Modulus	98	95	86
Acid	Strength	93	87	99
10% Phosphoric	Modulus	87	94	87
Acid	Strength	89	90	99
100% Gasoline	Modulus	101	98	90
	Strength	94	94	95
100% Vegetable	Modulus	102	99	95
Oil	Strength	100	94	100
Tap Water	Modulus	92	95	85
	Strength	90	85	99
0.1% Detergent	Modulus	110	94	90
	Strength	108	90	94
0.1% Soap	Modulus	99	93	85
	Strength	95	89	98

CIPP installation at Joe Louis Arena – Home of the Detroit Red Wings

Rehabilitation of 900 feet of 72-inch sanitary trunk sewer at "The Joe"

STRUCTURAL DESIGN OF CIPP

In the previous sections of this Engineering Design Manual ASTM specifications F1216 and F1743 have been reviewed and the design equations utilized in this manual will conform to the requirements of these specifications. Alternative designs for CIPP have merits and potentially offer more accurate predictions of performance. However, it is not the purpose of this Design Manual to advocate or implement the use of these alternative design equations until they have been accepted and adopted by specifying organizations such as ASTM. In order to provide a basis for theses design models a review of the development of the design theory used in the ASTM standards will be discussed. To put these theories into perspective an overview of some recently introduced modeling alternatives will also be discussed in this manual.

DESIGN BACKGROUND

The objective of buried pipe design evolves around the ability to develop a set of equations that can take forces of ground water, soil loading and other pressures such as live loads into consideration. Through practical experience and scientific study it was determined that cylindrical structures such as tubes or pipe failed by buckling when exposed to an external load. Some of the earliest proven buckling theories published were carried out by Timoshenko and others in the early 1900's [19]. This work focused on buckling behavior of thin wall tubes. These equations were subsequently modified to take into account long tubes having a practical thickness consistent with the building materials available at the time. One of the first practical applications of this work was the successful development of the first submarines. The unrestrained buckling equation that was developed for long thin tubes is given as follows:

$$Pw = \frac{2 E t^3}{(1 - v^2) D_m^3} \quad (1)$$

where,

Pw	=	**Hydrostatic water pressure**
E	=	**Modulus of elasticity of the pipe**
t	=	**Pipe wall thickness**
v	=	**Poisson's ratio, typically = 0.3**
D_m	=	**Mean pipe diameter (Do - t)**
Do	=	**Mean outer CIPP diameter**

In the 1940's Spangler published work that was conducted on flexible piping systems[20]. This work was the basis by which pipe stiffness of flexible pipes was derived. The measurement of pipe stiffness has been standardized with ASTM D2412[21] and is determined at a pipe deflection of 5%. This is a relatively simple test and is performed on free standing, unsupported pipe placed between two parallel plates that are pressed towards each other at a controlled rate. Spangler's also developed a model for the deflection of buried flexible pipe that took into account factors such as dead load forces, pipe bedding, and soil modulus[20].

Work by these early pioneering engineers was extremely important in laying the foundation that is the basis of the design equations used for CIPP. However, it is important to understand that there is very little similarity between the loading experienced by installed CIPP and that of buried rigid or flexible pipe. CIPP is installed into existing pipe that has typically been buried for many years. As such, the soil has long since consolidated and the soil pipe system is typically very stable. Therefore, installed CIPP is supported by the soil pipe system and subsequent pipe deflections can be expected to be minimal. When CIPP is installed into an existing pipe the surrounding pipe provides constrained ring support to the CIPP under the influence of uniform hydrostatic water pressure. When CIPP is exposed to this type of loading the CIPP is under compression. If the load increases to a critical level the CIPP will eventually deform and fail by buckling. Hydrostatic buckling experiments carried out by Aggerwal and Cooper[22], Lo and Zhang[23], and Kleweno[24] have clearly demonstrated practical ranges of the enhancement that can be obtained by the support provided by the host pipe. These studies demonstrated that supported CIPP can buckle at pressures that are seven to fifteen times greater than that of unrestrained CIPP. In order to account for this support in the development of buckling equations used in the design of CIPP this phenomenon was characterized as an enhancement factor and assigned the variable "K". The enhancement factor is the ratio between the restrained buckling pressure and the unrestrained buckling pressure. By applying a statistical treatment of the data generated by Aggerwal and Cooper the value of K was assigned a value of seven (7). In other words, there is high statistical confidence that the restrained buckling pressure will be at least seven times greater than the unrestrained buckling pressure. By applying the enhancement factor and appropriate safety factors to the buckling equation attributed to Timeshenko, CIPP can be designed to easily withstand the hydrostatic forces that are prevalent around the pipe. In most practical applications, CIPP is installed in conditions where the hydrostatic pressure is significantly less than the critical buckling pressure. As such CIPP failure may still occur, but would occur over a very long period of time. This type of long-term buckling.failure occurs as a result of plastic creep deformation. Materials such as thermoset and thermoplastic resins will undergo slight deformations over time when exposed to a constant load, such as hydrostatic water pressure. Given enough pressure and a long enough period of time, the CIPP can deform to the extent that it will produce catastrophic failure by buckling. In order to take the long term effects of creep into account the modulus of elasticity in the buckling equation attributed to Timeshenko was modified to a long-term modulus. In addition, a safety factor and correction for pipe ovality was also added to obtain the restrained buckling equation. By substituting the dimension ratio (DR) for the mean diameter and rearranging, the equation reduces as given below:

$$Pw = \frac{2KE_L}{(1 - v^2)} \frac{1}{(DR - 1)^3} \frac{C}{N} \quad (2)$$

where,

E_L	=	Long-term modulus of elasticity of the pipe material
K	=	Enhancement factor, typically K = 7
DR	=	Do/t, Do = mean outside diameter of the CIPP
N	=	Safety factor
C	=	Ovality correction factor (See Appendix Table 12)

$$C = [Domin/(Domax)^2]^3 = [(1 - q/100) / (1 + q/100)^2]^3 = (r/re)^3 \quad (3)$$

$$q = 100 \times \frac{(D - Dmin)}{D}, \text{ or } 100 \times \frac{(Dmax - D)}{D} \quad (4)$$

where,

C	=	Ovality reduction factor
q	=	Percentage of ovality of the original pipe
D	=	Inside diameter of the original pipe
Dmin	=	Minimum inside diameter of the original pipe
Dmax	=	Maximum inside diameter of the original pipe

The effects of long-term hydrostatic buckling of installed CIPP was studied by the Trenchless Technology Center (TTC) at Louisiana Tech University by Guice in 1994[17]. The study carried out by the TTC was an investigation into the long-term structural performance comparing the critical buckling behavior of several pipe rehabilitation systems (i.e. five cured-in-place pipe (CIPP) and one PVC fold and form (FNF)) from a number of commercial product manufacturers. These pipe rehabilitation products were installed in sections of round steel pipe that were sealed with gaskets on the ends.. The annular space between the steel pipe and the liner were pressurized with water at a number of different pressures and monitored over time as the products creeped, deformed, and eventually failed by buckling. Although the report was extensive the data produced had significant scatter and has been the subject of many subsequent papers that questioned the inability to control experimental variables. Subsequent reports and presentations (McAlpine, 1996[25], 1996[26]) have pointed out the flaws of the testing program. These flaws include: 1) testing carried out in perfectly round steel pipe, 2) the CIPP was manufactured above ground under highly controlled conditions, 3) tested under controlled temperature and humidity conditions, 4) no influence of chemicals typically found in sanitary sewer conditions, and 5) lack of detailed statistical analysis. In recent years long-term tests have been extensively analyzed in an attempt to develop experimental protocols that can carefully control variables for long- and short-term hydrostatic buckling. In addition, there has been considerable research to define the relationship between EL and K, and/or to develop alternative buckling models that correlate more closely with data. The model developed by Glock[27] has gained considerable support (Guice & Li, [28], Schrock & Gumbel, [29]) as a more accurately representing existing data. New models being proposed are refinements that can represent pipe imperfections (Moore[30]) and ovality (Omara[31])) more accurately. With all the potential problems pointed out by a number of authors regarding the modified buckling equation that is currently used in ASTM F1216 and ASTM F1743, this equation appears to be providing a conservative design basis for pipe lining systems as evidenced by the lack of failures over the 30+ years of its use.

Since there is currently no single design equation that can be used for all the different conditions that must be taken into account for the proper design of CIPP it is necessary to divide these conditions into different groups. For both gravity flow and internal pressure design equations have been divided into categories of "partially deteriorated" and "fully deteriorated" conditions of the existing pipe to be rehabilitated. These piping conditions are defined as follows:

Partially Deteriorated Piping Condition

A partially deteriorated gravity flow pipe is one in which the existing pipe may have displaced joints, cracks or corrosion, but is structurally able to support all soil and surface loads. In this case the existing pipe is intended to provide structural support over the full circumference of the CIPP. When assuming a pipe is partially deteriorated, the CIPP will be designed to withstand uniform hydrostatic pressure over the full circumference of the CIPP. In addition, as a conservative approach, this design does not assume that the CIPP is attached to the existing pipe in any way.

A partially deteriorated pressure pipe is one in which the existing pipe may also have minor corrosion, leaking joints, and/or small holes, and should be free of any longitudinal cracks. In this case the existing pipe is assumed to be able to withstand the specified internal design pressure over the expected lifetime of the pipe. When assuming a pressure pipe is partially deteriorated, it is assumed that the CIPP will conform tightly against the host pipe everywhere (i.e. in bends or diameter changes, etc.) and uses the strength of the existing pipe to support the stresses. The thickness of the CIPP can be compensated to span small holes or leaking joints, but will not be of sufficient thickness to withstand design pressures. In addition, if the partially deteriorated pressure pipe is assumed to be leaking the designer must also be aware of external hydrostatic pressure to insure that the minimum CIPP thickness is sufficient to withstand these forces over the design life of the product.

Fully Deteriorated Piping Condition

A fully deteriorated gravity flow pipe is one in which the existing pipe has insufficient strength to support all soil and surface loads. A fully deteriorated pipe is characterized by severe corrosion, missing pipe, crushed pipe, longitudinal cracks, and severely deformed pipe. When assuming a pipe is fully deteriorated, the CIPP is designed as a pipe able to withstand all hydrostatic, soil, and live loads that may exist in the CIPP-soil system with adequate soil support.

An alternative strategy for fully deteriorated gravity flow pipes is available to the designer in areas where there are isolated sections of missing or severely offset pipe that would otherwise cause it to be classified as fully deteriorated. In these areas it may be possible to carry out point repairs, and rehabilitate the pipe as a partially deteriorated classification. However, each situation must be considered separately.

A fully deteriorated pressure pipe is one in which the existing pipe has failed and/or has insufficient strength to operate at specified design pressures. A pipe may also be classified as fully deteriorated if it is determined that it will not be able to withstand design pressures at some point during the expected lifetime. A fully deteriorated pressure pipe is characterized by significant loss of wall thickness due to severe corrosion, large holes, missing sections of pipe, and leaking longitudinal cracks. When assuming a pipe is fully deteriorated, the CIPP is designed as a stand alone pipe able to withstand all internal pressure. In addition, the designer must also be aware that fully deteriorated CIPP pressure pipe must be capable of withstanding external hydrostatic pressure.

PARTIALLY DETERIORATED GRAVITY FLOW CIPP DESIGN

When rehabilitating existing pipe that has been classified as partially deteriorated in a gravity flow condition the restrained buckling condition applies. In this case the classical buckling equation that has been described previously is re-arranged to solve for CIPP thickness as follows:

$$t = \frac{Do}{\left(\frac{2KE_LC}{PwN(1-v^2)}\right)^{1/3} + 1} \qquad (5)$$

where,	Do	=	Mean outer CIPP diameter, inches
	K	=	Enhancement factor, typically K = 7
	E_L	=	Long-term modulus of elasticity of the pipe material
	C	=	Ovality correction factor (See Appendix Table 12)
	Pw	=	External water pressure measured above the pipe invert (See Appendix Table 13)
	N	=	Safety factor, typically N = 1.5 - 2.0
	v	=	Poisson's ratio, typically v = 0.3

For partially deteriorated design conditions where the groundwater is below the invert of the pipe the hydrostatic pressure is equal to zero and the restrained buckling equation cannot be used to calculate CIPP thickness. For this special design case the calculated thickness of the CIPP must be equal to or greater than that which will produce a maximum dimension ratio of DR = 100. When this special design condition exists, CIPP thickness is determined by the following equation:

$$t = Do/100 \qquad (6)$$

When designing for circular partially deteriorated pipe the CIPP is under constant compressive hoop stresses. If the existing pipe is out of round or has localized ovalization, bending moment forces may predominate on the CIPP. For this special case the CIPP must be checked to insure that the bending forces do not exceed the long-term flexural strength of the CIPP. To make this determination the bending stresses on the CIPP are determined by the following equation:

$$\frac{S}{PwN} = [1.5q/100\,(1 + q/100)DR^2] - [0.5(1 + q/100)DR] \qquad (7)$$

where q is defined by Equation 4 and the other parameters have been defined previously.

Partially Deteriorated Design Example

Determine the minimum wall thickness required of the following piping condition:

1) Existing pipe classification = Partially deteriorated

2) Mean outer CIPP diameter (Do) = 24 inches

3) Minimum pipe diameter (Dmin) = 23.1 inches
4) External water above invert = 8 feet
5) Minimum CIPP modulus (E) = 350,000 psi
6) Minimum CIPP strength (s) = 5,500 psi
7) Long-term modulus (E_L) = 175,000 psi
8) Long-term strength (s_L) = 2750 psi

A. Determine hydrostatic pressure acting on CIPP

P = 8 ft x 0.433 psi/ft water = 3.46 psi

B. Calculate the pipe ovality

Determine q using Equation 4.

q = 100(24 - 23.1)/24 = 3.75%

Determine ovality reduction factor using Equation 3

$C = [(1 - 3.75/100)/(1 + 3.75/100)^2]^3 = 0.715$

C. Determine minimum CIPP design thickness using buckling Equation 5

$$t = \frac{24}{\left(\frac{2(7)175{,}000(.715)}{(3.46)2(1-.32)}\right)^{1/3} + 1} = 0.36 \text{ inches}$$

D. Because the pipe is out of round, bending stresses must be calculated to insure they do not exceed the long-term flexural strength of the CIPP

Determine S using Equation 7

DR = Do/t = 24/0.36 = 66.6

$S/(3.46)2 = [1.5(3.75/100)(1 + 3.75/100)66.6^2] - [0.5(1 + 3.75/100)66.6]$

S = 1552.2 psi

E. The minimum CIPP design thickness is 0.36 inches because the bending stresses are less than the long-term CIPP flexural strength. However, if the bending stresses had exceeded the long-term flexural strength then this equation would control the design. In this case solving for the proper thickness can be accomplished by trial and error. Start by choosing dimension ratios (DR) that are smaller than previously used until the bending stress is less than the long-term flexural strength of the CIPP.

FULLY DETERIORATED GRAVITY FLOW CIPP DESIGN

When rehabilitating existing pipe that has been classified as fully deteriorated in a gravity flow condition ASTM F1216 and ASTM F1743 specifies the use of a design equation from AWWA C950 that has been modified by adding the ovality reduction factor, and the consideration of long-term effects due to creep. In this case the modified AWWA C950 equation from ASTM F1216 has been re-arranged to solve for CIPP thickness as follows:

$$t = .721\,Do\left(\frac{(NP_t)^2}{CE_L R_w B'E'}\right)^{1/3} \qquad (8)$$

where,
P_t = Total pressure due to water, soil and live load acting on pipe, psi
Rw = Buoyancy factor, dimensionless
B' = Empirical coefficient of elastic support, dimensionless
E' = Modulus of elasticity of adjacent soils or soil reaction, psi

The CIPP designed by the modified AWWA C950 formula is required to have a minimum stiffness (EI/Do3) which is 50% of the specification. The AWWA C950 specification calls for EI/Do3 to be equal to 0.186 and 50% of this value is 0.093. In the following equation this means that pipe designed with a flexural modulus of elasticity E = 350,000 psi would have a dimension ratio equal to 67 for fully deteriorated pipe. If the CIPP stiffness is too low, the wall thickness must be increased accordingly to insure that the following design condition is met:

$$EI/Do^3 = E/12(DR)^3 \geq 0.093 \qquad (9)$$

where, E = Flexural modulus of elasticity of the CIPP, psi

I = Moment of inertia, in^4,In = $t^3/12$

When designing fully deteriorated CIPP where the existing pipe is out of round or the CIPP may have localized ovalization, bending moment forces may predominate on the CIPP. For this special case of the fully deteriorated design the CIPP must be checked to insure that the bending forces do not exceed the long-term flexural strength of the CIPP. To make this determination the bending stresses on the CIPP are determined by modifying Equation 7 and substituting total pressure (Pt) to produce the following equation:

$$\frac{S_L}{P_t N} = [1.5q/100\ (1 + q/100)DR^2] - [0.5(1 + q/100)DR] \qquad (10)$$

where q is defined by Equation 4 and the other parameters have been defined previously.

Total External Pressure on CIPP

Several new parameters are introduced for the design of fully deteriorated gravity flow pipe. This manual is intended to provide simplistic explanations of these design parameters that have not been provided in ASTM F1216 or other design guides currently available. When determining fully deteriorated designs all loads acting on the CIPP must be estimated to determine the total pressure (Pt). This is accomplished by estimating the contribution of each individual load and adding them together. The total load is typically made up of hydrostatic water pressure (Pw'), buoyancy corrected soil load (Ps), superimposed or live loads (PL), and other loads such a vacuum (Pv). Loading due to vacuum is a special case and will not be handled here. Consult Lanzo Lining Services for recommendations related to vacuum loading. The total pressure acting on the pipe can be represented as follows:

$$P = Pw' + Ps + P_L + Pv \qquad (11)$$

Hydrostatic Water and Soil Loads

Initially, groundwater and soil heights must be determined or estimated to begin the design process. For the fully deteriorated design condition be careful to note that groundwater and soil heights are determined from the top of the pipe and not the invert. The hydrostatic pressure is determined as follows:

$$Pw' = Hw\ (.433psi/ft\ water) \qquad (12)$$

where, Hw = Water height above the top of the pipe, ft

The contribution related to soil loading involves many different parameters. The soil prism loading pressure is determined as follows:

$$Ps = wHsRw/144in^2/ft^2 \quad (13)$$

where, w = Soil density, lb/ft^3 (See Table 14 for soil types and densities)
Hs = Soil height above top of pipe, ft.
Rw = Water buoyancy factor, dimensionless

$$Rw = 1 - 0.33(Hw/Hs) \geq 0.67 \quad (14)$$

Other related design parameters are the modulus of soil reaction or elastic support (E') and the coefficient of elastic support (B'). The modulus of soil reaction values used for CIPP design should typically represent stable undisturbed soils that would have E' values in the range of 700 to 3000 psi. Most typically a value of 700 psi is recommended for unknown soil conditions. Where the pipe is buried deep and the soil condition is stable values of 1000 to 1500 psi may be applicable. In areas known to have weak and unstable native soils a value of 200 psi may be appropriate. The coefficient of elastic support (B') is determined with the following relationship:

$$B' = 1/(1 + 4e^{-0.065Hs}) \quad (15)$$

Superimposed or Live Loads

For the fully deteriorated design condition dynamic live load pressures occur frequently and are a standard design condition for the parameter PL. Live loads may be classified as either concentrated or distributed, depending on the soil pipe conditions and the depth the pipe is buried. In some cases the live load may be characterized by impact factors. Impact loading is generally only applicable for pipes that are relatively shallow (i.e. 2-5 ft). A number of maximum live load conditions have bee studied and recommended for pipe buried beneath highways, railways, and airport runways. The generally accepted guidelines for determining these live loading conditions are provided by the ASSHTO Standard Specifications for Highway Bridges[32], HS-20-44 highway loading, American Railway Engineers Association (AREA) Cooper E-80 loading, and the Federal Aviation Agency criteria. The most frequently encountered design condition is that for pipes buried under active roads or highways. For highway HS-20 loading the live load becomes insignificant beyond seven feet of soil height cover over the top of the pipe. Live load pressures (PL) associated with the aforementioned piping conditions are given in Table 18.

Fully Deteriorated Design Example

Determine the minimum wall thickness required of the following piping condition:

1) Existing pipe classification	=	Fully deteriorated
2) Mean outer CIPP diameter (Do)	=	48 inches
3) Minimum pipe diameter (Dmin)	=	47.04 inches
4) External water above pipe (Hw)	=	8 feet
5) Depth of soil cover above pipe (Hs)	=	15 feet
6) Type of soil	=	Ordinary Clay (120lb/ft^3)
7) Soil Modulus (E's)	=	700 psi
8) Live load	=	Live load HS-20
9) Minimum CIPP flexural modulus (E)	=	350,000 psi
10) Minimum CIPP flexural strength (s)	=	5,500 psi
11) Long-term modulus (E_L)	=	175,000 psi
12) Long-term strength (S_L)	=	2750 psi

A. Determine the total load

Hydrostatic water pressure

$Pw = 0.433(Hw) = .433psi/ft(8ft) = 3.46$ psi

Soil load

$Ps = wHsRw/144in^2/ft^2$

$Rw = 1 - 0.33(Hw/Hs) \geq 0.67 = 1 - 0.33(8ft/15ft) = 0.824$ which is > 0.67

Ordinary clay soil density = $120lb/ft^3$

$Ps = 120lb/ft^3(15ft)0.824/144in^2/ft^2 = 10.3$ psi

The soil pressure can also be determined by multiplying the Buoyancy Correction Factor (Rw) times the Soil Prism Pressure give in Table 17.

$Ps = 0.824(12.5) = 10.3$ psi

Live load (P_L) (Table 18) ~ 0 psi

Total pressure load applied to the CIPP

$P_t = 3.46$ psi + 10.3 psi = 13.76

B. Calculate coefficient of elastic support

$B' = 1/(1 + 4e^{-0.065Hs})$

$B' = 1/(1 + 4e^{-0.065}(15ft)) = 0.40$ (Table 16)

C. Calculate pipe ovality using Equation 4

$q = 100(48 - 47.04)/48 = 2.0\%$

Determine ovality reduction factor using Equation 3

$C = [(1 - 2.29/100)/(1 + 2.29/100)^2]^3 = 0.84$ (Table 12)

D. Determine the minimum CIPP thickness for buckling

$$t = .721\ Do\left(\frac{(NP_t)^2}{CE_L RwB'E'}\right)^{1/3} = .721(48)\left(\frac{(2.0(13.76))^2}{(.84)(175{,}000)(.824)(.4)(700)}\right)^{1/3}$$

t = 0.975 inch

E. Check for minimum pipe stiffness

$DR = 48/0.975 = 49.2$

$350{,}000/12(49.2)^3 = .26 \geq 0.093$

F. Check for pressure limited due to bending stresses (Equation 10)

$S_L = 13.76(2)[1.5(2)/100(1 + 2.0/100)48^2] - [0.5(1 + 2/100)48]]$

$S_L = 1920$ psi

G. The calculated bending stress (i.e. 1,920psi) is less than the estimated long-term bending strength of the resin (i.e. 2,750psi) so bending stress does not control the design thickness for this example.

Therefore, the final design thickness for the CIPP is:

t = .975 inch

PARTIALLY DETERIORATED INTERNAL PRESSURE PIPE

When designing for internal pressure, it is critical to obtain a proper evaluation of the condition of the pipe being evaluated. Secondary to this is the requirement to understand the proper operating pressure. The third consideration for the design of pressure pipe is an understanding of test pressures, surge pressures and/or water hammer that may significantly exceed the standard operating or test pressures of the pipe. In addition, the project engineer and contractor must be aware that pipe requiring heavy cleaning may change the condition of the pipe from a partially to a fully deteriorated condition. After cleaning it is recommended that pipe classified as partially deteriorated be tested for the operating or test pressure to verify the condition of the pipe prior to lining. If the pipe is able to maintain the specified pressure then it can be classified as partially deteriorated without question. However, this may not always be possible due to the presence of small holes in the pipe that will not allow it to maintain pressure. When the condition of the pipe and/or the operating parameter is not well defined, it is recommended that the pipe be classified as fully deteriorated. Pressure pipe presents a higher risk application of CIPP and it is recommended that the contractor have experience in this area of technology to insure success[33].

The partially deteriorated design equation for internal pressure pipe given in ASTM F1216 was derived with the assumption that the CIPP acts like a uniformly pressurized round flat plate with fixed edges covering an existing hole in the pipe. The CIPP is designed with the assumption that the aforementioned condition prevails and that bending stresses at and around the hole (if one exists) control the design thickness. This design assumption is more conservative than that of a square or rectangular plate.

The equation given in ASTM F1216 has been incorrectly derived with the term DR-1 in the derivation instead of the correct term DR. Although it may be argued that the difference is negligible to the outcome of the calculated thickness, the technically correct derivation will be advocated for use in this engineering design guide. The technically correct derivation for pressure acting on a flat circular plate covering a hole is given below. This equation has been rearranged to solve for CIPP thickness:

$$t = \frac{Do}{[5.33/Pi\,(Do/Dh)^2(S_L/N)]^{0.5} + 1} \qquad (16)$$

where,

Do	=	Mean outer CIPP diameter, inches
Pi	=	Internal pipe pressure, psi
Dh	=	Hole diameter in the pipe, inches
S_L	=	Long-term flexural bending strength for the CIPP, psi
N	=	Safety factor, N = 2 minimum

In order for the circular flat plate design condition to be valid the following criteria must be met. If this condition is not met then the CIPP cannot be considered a circular flat plate and ring tension or hoop stress will dominate. For this condition the internal pressure condition is designed as a fully deteriorated internal pressure pipe.

$$Dh/Do \leq 1.83(t/Do)^{0.5} \qquad (17)$$

The variables used in Equation 17 have been previously defined.

Once the CIPP thickness has been calculated this value must be compared with the thickness calculated from Equation 5 to confirm that external hydrostatic water pressure does not dominate the design condition. The larger thickness is then selected for the design. Since design Equation 17 is conservative it may at times lead to a greater CIPP thickness than if the CIPP is evaluated in ring tension as an unrestrained, stand-alone pipe. Any internal pressure pipe application is higher risk so it is recommended that a Lanzo Lining Services representative be contacted for assistance in pressure pipe design assistance.

Partially Deteriorated Internal Pressure Pipe Design Example

1) Determine the CIPP thickness for the following piping conditions:

2) Existing pipe classification	=	Partially deteriorated
3) Existing pipe inner diameter (D)	=	15 inches
4) Existing pipe maximum diameter (Dmax)	=	15.2 inches
5) Internal pressure (Pi)	=	80 psi
6) External water (Hw)	=	5 ft above top of pipe
7) Maximum pipe hole diameter (Dh)	=	1 inch
8) Minimum CIPP flexural modulus (E)	=	350,000 psi
9) Minimum CIPP flexural strength (s)	=	5,500 psi
10) Minimum long-term modulus (E_L)	=	175,000 psi
11) Minimum long-term strength (S_L)	=	2,750 psi
12) Minimum long-term tensile strength (S_{tL})	=	1,750 psi

A. Determine the pressure pipe thickness using Equation 16.

$$Do = \frac{D + Dmax}{2} = \frac{15.0 + 15.2}{2}$$

Do = 15.1 inches

$$t = \frac{15.1}{[5.33/80(15.1/1.0)^2(2{,}750/2.0)]^{1/2} + 1}$$

t = 0.10 inches

B. Check thickness with Equation 17.

$1/15.1 \leq 1.83(0.1/15.1)^{1/2}$

$0.066 \leq 0.149$

The condition of Equation 17 is met

C. Check the thickness for external pressure using Equation 5.

q = 100(15.2 – 15.0)/15.0 = 1.33%

$C = [(1 - 1.33/100)/(1 + 1.33/100)^2]^3 = 0.89$

Pw = 5(.433) = 2.2psi

t = 0.18 inches

The thickness for external pressure is greater than that required for internal pressure and the DR = 84, which is less than 100, as specified in Equation 6.

D. Since the pipe is slightly out of round, the bending stresses must be checked using Equation 7.

$S_L = 2.2(2.0)[[1.5(.0133)(1 + .0133)84^2] - [0.5(1 + .0133)84]]$

S_L = 440, which is less than the long-term flexural strength of the CIPP. Therefore, the final CIPP thickness is t = 0.18 inches.

FULLY DETERIORATED INTERNAL PRESSURE PIPE

As discussed previously, it is critical to understand the physical conditions of the pipe and the operating parameters of the system when designing for the fully deteriorated pressure condition. This pipe classification assumes the existing pipe has no capability to hold any of the pressure and the CIPP must be designed of a proper thickness to hold all internal and external pressure.

For the design of pressure pipes it may assumed that pipes are either thick or thin walled cylinders with uniform pipe wall thickness. Internal pressure produces an internal ring tension loading condition and tensile strength of the resin/fabric matrix used to construct the CIPP is important to the design. As reviewed in the Materials section of the Engineering Design Guide, high performance resins such as vinyl esters and epoxy resins are recommended for pressure applications due to their high tensile strength and elongation properties. Contact Lanzo Lining technical services for recommendations concerning the design and materials selection for pressure pipe.

The design equation for fully deteriorated pressure pipe given in ASTM F1216 assumes pressure pipe is a thick walled cylinder as given below:

$$Pi = \frac{2s_a}{(DR-2)\,N} \qquad (18)$$

The equation for a thin walled cylinder is given as follows:

$$Pi = \frac{2s_a}{(DR-1)\,N} \qquad (19)$$

When rearranged to solve for thickness Equation 19 becomes:

$$t = \frac{Do}{[(2s_a/PiN)+1]} \qquad (20)$$

The variables used in Equation 20 have previously been defined.

Although the differences are relatively small, the solution for a thin walled cylinder is a more conservative approach than ASTM F1216. Therefore, design Equation 20 for a thin walled pressure cylinder will be used for fully deteriorated pressure pipe. When the pressure pipe is underground the CIPP thickness for internal pressure should be checked against Equations 8 and 9 for fully deteriorated gravity flow pipe. The greatest thickness is chosen for the pressure pipe.

Fully Deteriorated Internal Pressure Pipe Design Example

Determine the CIPP thickness for the following pipe design conditions:

1) Existing pipe classification	=	Fully deteriorated
2) Existing pipe inner diameter (D)	=	15 inches
3) Existing pipe maximum diameter (Dmax)	=	15.2 inches
4) Internal pressure (Pi)	=	80 psi
5) External water (Hw)	=	8 ft above top of pipe
6) Soil height (Hs)	=	15 ft above top of pipe
7) Soil type	=	Ordinary Clay (120lb/ft3)
8) Soil modulus (E')	=	700 psi
9) Minimum CIPP flexural modulus (E)	=	350,000 psi
10) Minimum CIPP flexural strength (s)	=	5,500 psi
11) Minimum long-term modulus (EL)	=	175,000 psi
12) Minimum long-term strength (sL)	=	2,750 psi
13) Minimum long-term tensile strength (stL)	=	1,750 psi

A. Determine the CIPP thickness using Equation 20.

Do = 15.1 (From previous example)

t = 15.1/[(2(1750)/80(2)) + 1] = 0.66 inches

B. Check the CIPP thickness against the fully deteriorated gravity flow design condition for external buckling (Equation 8).

Determine the total pressure

Pt = Pw + Ps + PL = 3.46 + 10.3 + 0 (see previous Fully Deteriorated example)

Pt = 13.76

Determine pipe ovality (see previous example)

q = 1.33% (Equation 4)

C = 0.89 (Equation 3, Table 12)

Determine CIPP thickness using Equation 8.

Rw = 0.824 (Table 15, see previous example)

B' = 0.40 (Table 16)

$$t = .721 D_o \left(\frac{[(NP_t)^2]}{C E_L R_w B' E'} \right)^{1/3} = .721(15.1) \left(\frac{((2.0)(13.76))^2}{(.89)(175{,}000)(.824)(.4)(700)} \right)^{1/3}$$

t = 0.30 inch

Since 0.30 in ≤ 0.66 inch internal pressure dominates the design.

C. Check the CIPP thickness for minimum pipe stiffness using Equation 9.

DR = 15.1/0.66 = 22.9

$350{,}000/12(22.9)^3 \geq 0.093$

$2.43 \geq 0.093$

D. Since the pipe is slightly out of round, the bending stresses must be checked using Equation 10.

$S_L = 13.76(2.0)[[1.5(1.33)/100(1+1.33/100)22.9^2] + [0.5(1+1.33/100)22.9]]$

S_L = 612 psi, which is less than 2750psi

E. All checks indicate that internal pressure dominates the design of this fully deteriorated pressure pipe and the specified thickness is t = 0.66 inches.

HYDRAULIC DESIGN OF CIPP

GRAVITY FLOW

The installation of CIPP typically improves the flow characteristics of the pipe being rehabilitated. Flow is improved because the inner surface of CIPP is extremely smooth and continuous, without any joints or discontinuities that create friction to flow. Typically the Manning equation is used to predict flow in gravity or open channel piping conditions as follows:

$$Q = VA = \frac{1.486\, AR^{2/3}\, S^{1/2}}{n} \tag{21}$$

where,	Q	=	Flow rate, cfs
	V	=	Velocity, fps
	A	=	Flow Area
	n	=	Manning coefficient of roughness (see Table 10)
	R	=	Hydraulic radius, ft = A/P
	P	=	Wetted perimeter of flow, ft
	S	=	Slope of grade line, ft(slope)/ft(pipe)

When the pipe is circular and the flow is full as in a surcharged situation the Manning equation may be modified to the following form:

$$Q = \frac{0.463\, D^{8/3}\, S^{1/2}}{n} \tag{22}$$

where, D = pipe internal diameter, ft.

For circular pipe flowing full the Manning equation can be abbreviated to produce an easy comparison of flow capacity between CIPP and different piping materials as given below:

$$\%\ \text{Flow Capacity} = \frac{Q_{CIPP} \times 100}{Q_{exist}} = \frac{n_{exist}}{n_{CIPP}} \left(\frac{D_{CIPP}}{D_{exist}}\right)^{8/3} \times 100 \tag{23}$$

Manning coefficients provide a relative comparison of the resistance to flow for different types of pipe and coefficients for several piping materials have been provided in Table 10. There is a large variation in the coefficients for different materials and even variation for the same piping product because these coefficients are dependent on the condition of the pipe evaluated. A conservative average Manning coefficient for CIPP in relatively smooth concrete, clay, or steel pipe is an 'n' of 0.010. However, this coefficient might be subject to change over time as slime and/or debris build up in uncleaned pipe over time.

Gravity Flow Design Example

Problem: Determine the change in flow capacity when a circular 24 inch concrete pipe is flowing full and is lined with a 12 mm thick CIPP.

1. Select Manning coefficients for the piping materials (Table 10).
   a) n' for CIPP = 0.010
   b) 'n' for concrete = 0.015
2. Determine inside pipe diameters.
   a) Existing concrete pipe D = 24 inches
   b) New CIPP D = 24 - 2(12/25.4) = 23.1 inches
3. Determine increased flow capacity using Equation 23.

$$\% \text{ Flow Capacity} = \frac{0.015}{0.10}\left(\frac{23.1}{24.0}\right)^{8/3} \times 100 = 135\%$$

Therefore, it was determined that the CIPP increased the flow of the pipe approximately 135% compared to the existing concrete pipe. This increase in flow was realized even though the inside diameter of the CIPP was slightly smaller than the existing concrete pipe.

PRESSURE FLOW

For pressure flow the Hazen-Williams equation is commonly utilized for determining the flow rate of the pipe. For pressure flow CIPP also increases the flow capacity of a pipe because of the inherent smoothness of the inner surface. The Hazen-Williams equation is given as follows:

$$Q = 1.318\, C\, R^{0.63}\, S^{0.54}\, A \quad (24)$$

where,

Q	=	Flow rate, cfs
C	=	Hazen-Williams coefficient (see Table 11)
R	=	Hydraulic radius, ft = A/P
A	=	Flow area, ft^2
P	=	Wetted perimeter of flow, ft
S	=	Slope of grade line, ft(slope)/ft(pipe)

As shown previously, the Hazen-Williams equation can be simplified to provide a comparison of flow capacity between CIPP and the existing pipe as follows:

$$\% \text{ Flow Capacity} = \frac{Q_{CIPP}}{Q_{exist}} \times 100 = \frac{C_{CIPP}}{C_{exist}} \left(\frac{D_{CIPP}}{D_{exist}}\right)^{8/3} \times 100 \quad (25)$$

The Hazen-Williams coefficients for different piping materials, or age of materials are provided in Table 11. Determination of flow capacities of CIPP in a pressure application relative to other existing piping materials is calculated in the same manner as given in the gravity flow design example.

APPENDIX

Table 10. Manning Coefficients for Typical Piping Materials.

Pipe Material	Manning 'n' Coefficient	Recommended Manning 'n'
Cured-In-Place Pipe	0.009 - 0.012	0.010
Vitrified Clay	0.013 - 0.017	0.013
Concrete	0.013 - 0.017	0.015
Corrugated Metal	0.019 - 0.030	0.025
Brick	0.015 - 0.017	0.016

Table 11. Hazen-Williams Coefficients for Typical Piping Materials.

Pipe Material/Condition	Recommended Hazen-Williams 'C' Coefficient
Cured-In-Place Pipe	140
New steel or ductile iron (less than 1 year old)	120
Cement lined new steel or ductile iron	140
Steel (2 years old)	120
Steel (10 years old)	100
Cast Iron (5 years old)	120
Cast Iron (18 years old)	100
Tuberculated Steel or Cast Iron	80

Table 12. Ovality reduction factor, C.

$C = [Domin/(Domax)^2]^3$

Percent Ovality	1	2	3	4	5	6	7	8	9	10
Reduction Factor, C	0.91	0.84	0.76	0.70	0.64	0.59	0.54	0.49	0.45	0.41

Easement installation of subdivision sewer rehab

Subaqueous installation of CIPP into storm drain

Table 13. Partially Deteriorated Gravity Flow CIPP Design Thickness.

CIPP Thickness (mm) for each Pipe Diameter (Inches) at the given Depth (feet)

Water Depth	Water Pressure	6	8	10	12	15	18	21	24	27	30	36	42	48	54	60	66	72
1	**0.44**	1.1	1.5	1.8	2.2	2.8	3.3	3.9	4.4	5.0	5.5	6.6	7.7	8.8	9.9	11.0	12.1	13.2
2	**0.87**	1.4	1.8	2.3	2.8	3.5	4.2	4.8	5.5	6.2	6.9	8.3	9.7	11.1	12.5	13.8	15.2	16.6
3	**1.30**	1.6	2.1	2.6	3.2	3.9	4.7	5.5	6.3	7.1	7.9	9.5	11.1	12.6	14.2	15.8	17.4	19.0
4	**1.73**	1.7	2.3	2.9	3.5	4.3	5.2	6.1	6.9	7.8	8.7	10.4	12.2	13.9	15.6	17.4	19.1	20.8
5	**2.17**	1.9	2.5	3.1	3.7	4.7	5.6	6.5	7.5	8.4	9.4	11.2	13.1	15.0	16.8	18.7	20.6	22.4
6	**2.60**	2.0	2.6	3.3	4.0	5.0	6.0	6.9	7.9	8.9	9.9	11.9	13.9	15.9	17.9	19.9	21.8	23.8
7	**3.03**	2.1	2.8	3.5	4.2	5.2	6.3	7.3	8.4	9.4	10.4	12.5	14.6	16.7	18.8	20.9	23.0	25.1
8	**3.46**	2.2	2.9	3.6	4.4	5.5	6.5	7.6	8.7	9.8	10.9	13.1	15.3	17.4	19.6	21.8	24.0	26.2
9	**3.90**	2.3	3.0	3.8	4.5	5.7	6.8	7.9	9.1	10.2	11.3	13.6	15.9	18.1	20.4	22.7	25.0	27.2
10	**4.33**	2.3	3.1	3.9	4.7	5.9	7.0	8.2	9.4	10.6	11.7	14.1	16.4	18.8	21.1	23.5	25.8	28.2
11	**4.76**	2.4	3.2	4.0	4.8	6.1	7.3	8.5	9.7	10.9	12.1	14.5	17.0	19.4	21.8	24.2	26.6	29.1
12	**5.20**	2.5	3.3	4.2	5.0	6.2	7.5	8.7	10.0	11.2	12.5	15.0	17.5	19.9	22.4	24.9	27.4	29.9
13	**5.63**	2.6	3.4	4.3	5.1	6.4	7.7	9.0	10.2	11.5	12.8	15.4	17.9	20.5	23.0	25.6	28.1	30.7
14	**6.06**	2.6	3.5	4.4	5.2	6.6	7.9	9.2	10.5	11.8	13.1	15.7	18.3	21.0	23.6	26.2	28.8	31.5
15	**6.50**	2.7	3.6	4.5	5.4	6.7	8.0	9.4	10.7	12.1	13.4	16.1	18.8	21.5	24.1	26.8	29.5	32.2
16	**6.93**	2.7	3.7	4.6	5.5	6.8	8.2	9.6	11.0	12.3	13.7	16.4	19.2	21.9	24.6	27.4	30.1	32.9
17	**7.36**	2.8	3.7	4.7	5.6	7.0	8.4	9.8	11.2	12.6	14.0	16.8	19.6	22.3	25.1	27.9	30.7	33.5
18	**7.79**	2.8	3.8	4.7	5.7	7.1	8.5	10.0	11.4	12.8	14.2	17.1	19.9	22.8	25.6	28.5	31.3	34.1
19	**8.23**	2.9	3.9	4.8	5.8	7.2	8.7	10.1	11.6	13.0	14.5	17.4	20.3	23.2	26.1	29.0	31.9	34.8
20	**8.66**	2.9	3.9	4.9	5.9	7.4	8.8	10.3	11.8	13.3	14.7	17.7	20.6	23.6	26.5	29.5	32.4	35.4
Minimum Practical Thickness		4.5	6.0	6.0	7.5	9.0	10.5	10.5	12.0	12.0	13.5	15.0	16.5	18.0	21.0	24.0	27.0	28.5

For determining the CIPP thickness in Table 13 the following variables were utilized in the calculations: E_L = 175,000 psi, S_L = 2750 psi, 2% Ovality, Safety Factor = 2.0, Enhancement Factor K = 7.0, Poisson's Ratio = 0.3

Table 14. Soil Types and Densities.

Soil Type	**Density, w (lb/ft3)**
Sand & Gravel	110
Saturated Topsoil	115
Ordinary Clay	120
Saturated Clay	130

Table 15. Water Buoyancy Factor, Rw.

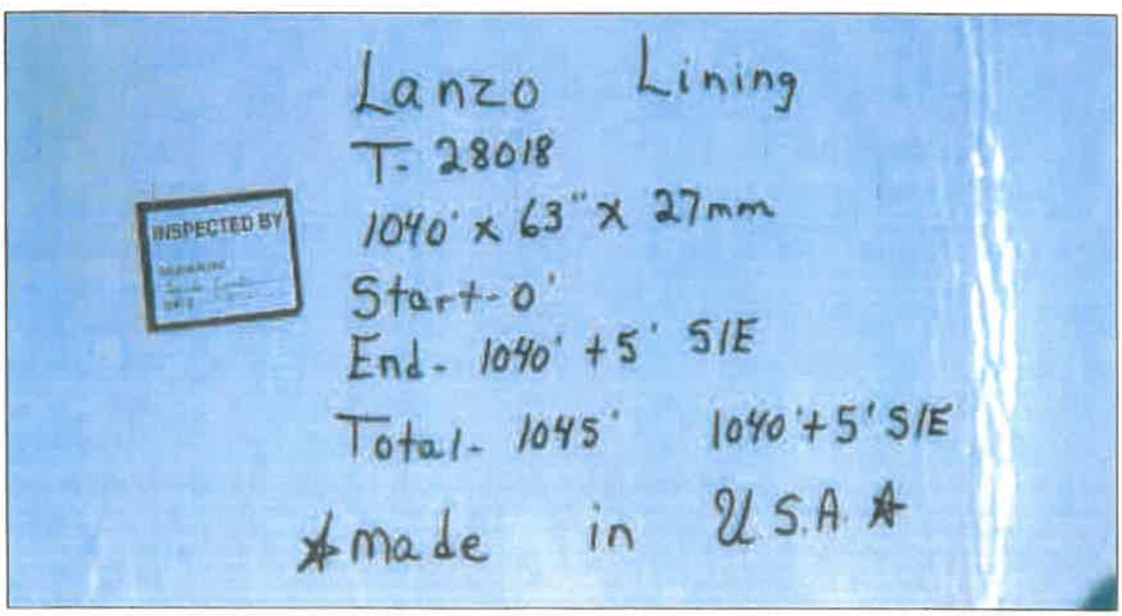
$Rw = 1 - 0.33(Hw/Hs) \geq 0.67$

Ratio Hw/Hs	Factor Rw
0	1.00
0.05	0.98
0.1	0.97
0.15	0.95
0.20	0.93
0.25	0.92
0.30	0.90
0.35	0.88
0.40	0.87
0.45	0.85
0.50	0.84
0.55	0.82
0.60	0.80
0.65	0.79
0.70	0.77
0.75	0.75
0.80	0.74
0.85	0.72
0.90	0.70
0.95	0.69
1.00	0.67

Table 16. Coefficient of Elastic Support, B'

$B' = 1/(1 + 4e^{-0.065Hs})$

Soil Height Hs, ft	Elastic Support B'
0	0.2
1	0.21
2	0.22
3	0.23
4	0.24
5	0.26
6	0.27
7	0.28
8	0.30
9	0.31
10	0.32
11	0.34
12	0.35
13	0.37
14	0.38
15	0.40
16	0.41
17	0.43
18	0.45
19	0.46
20	0.48
22	0.51
24	0.54
26	0.58
28	0.61
30	0.64



All materials are rigorously inspected for quality while Lanzo Lining Services emphasizes materials "Made in America"

Table 17. Soil Prism Pressure as a Function of Water or Soil Height and Soil Density.

Height of Water, Hw or Soil, Hs, ft	Hydrostatic Pressure Pw', psi	Soil Prism Pressure, psi Soil Density, w, lbs/ft³ 100 lbs/ft³	110 lbs/ft³	115 lbs/ft³	120 lbs/ft³	130 lbs/ft³
1	0.43	0.7	0.8	0.8	0.8	0.9
2	0.87	1.4	1.5	1.6	1.7	1.8
3	1.30	2.1	2.3	2.4	2.5	2.7
4	1.73	2.8	3.1	3.2	3.3	3.6
5	2.17	3.5	3.8	4.0	4.2	4.5
6	2.60	4.2	4.6	4.8	5.0	5.4
7	3.03	4.9	5.3	5.4	5.8	6.3
8	3.46	5.6	6.1	6.4	6.7	7.2
9	3.90	6.3	6.9	7.2	7.5	8.1
10	4.33	6.9	7.6	8.0	8.3	9.0
11	4.76	7.6	8.4	8.8	9.2	9.9
12	5.20	8.3	9.2	9.6	10.0	10.8
13	5.63	9.0	9.9	10.4	10.8	11.7
14	6.06	9.7	10.7	11.2	11.7	12.6
15	6.50	10.4	11.5	12.0	12.5	13.5
16	6.93	11.1	12.2	12.7	13.3	14.4
17	7.37	11.8	13.0	13.6	14.2	15.3
18	7.79	12.5	13.8	14.4	15.0	16.3
19	8.23	13.2	14.5	15.1	15.8	17.2
20	8.66	13.9	15.3	16.0	16.7	18.1
22	9.53	15.3	16.8	17.5	18.3	19.9
24	10.4	16.7	18.3	19.2	20.0	21.7
26	11.3	18.1	19.9	20.8	21.7	23.5
28	12.1	19.4	21.4	22.3	23.3	25.3
30	13.0	20.8	22.9	24.0	25.0	27.1

Trenchless CIPP rehabilitation of a pipe running under a busy highway during rush hour traffic

Table 18. Live load Pressure and Impact Factors for Surface Load Impact.

Soil Height	Highway HS-20		Railway E-80		Airport	
Hs	Load, psi	Impact	Load, psi	Impact	Load, psi	Impact
0-1	>15.1	0.3	N/A	0.4	N/A	0.5
1	15.1	0.3	N/A	0.4	N/A	0.5
2	10.9	0.2	26.4	0.36	13.2	**
3	5.3	0	23.6	0.28	12.3	**
4	2.2	0	18.4	0.24	11.3	**
5	1.7	0	16.7	0.2	10.1	**
6	1.3	0	15.6	0.16	8.8	**
7	1.1	0	12.2	0.12	7.9	**
8	1.0	0	11.1	0.08	6.9	**
9	*	0	9.4	0.04	6.5	**
10	*	0	7.6	0	6.1	**
12	*	0	5.6	0	4.7	
15	*	0	4.2	0	2.5	

*Insignificant, less that 1.0psi

**Consult FAA requirements for ground conditions

Table 19. Fully Deteriorated Gravity Flow Condition for High Groundwater at Grade.

CIPP Thickness (mm) for each Pipe Diameter (Inches) at the given Depth (feet)

Soil Depth	Water Depth	6	8	10	12	15	18	21	24	27	30	36	42	48	54	60	66	72
6	6	2.5	3.0	3.7	4.5	5.6	6.7	7.9	9.0	10.1	11.2	13.5	15.7	17.9	20.2	22.4	24.7	26.9
8	8	2.5	3.2	4.0	4.7	5.9	7.0	8.1	9.2	10.2	11.3	13.5	15.7	17.9	20.2	22.4	24.7	26.9
10	10	2.5	3.3	4.1	5.0	6.1	7.7	8.8	10.0	11.3	12.4	14.6	16.9	19.0	21.2	23.5	25.9	28.2
12	12	2.8	3.7	4.6	5.5	7.1	8.4	9.7	11.0	12.3	13.7	16.1	18.5	21.1	23.4	25.8	28.0	30.2
16	16	3.2	4.2	5.3	6.3	8.0	9.6	11.1	12.6	14.1	15.6	18.5	21.4	24.3	27.1	29.9	32.6	35.2
20	20	3.5	4.7	5.8	7.0	8.9	10.6	12.3	14.0	15.6	17.3	20.6	23.8	27.0	30.3	33.4	36.5	39.5
25	25	3.9	5.2	6.4	7.7	9.8	11.7	13.6	15.4	17.3	19.1	22.8	26.5	30.1	33.6	37.2	40.7	44.2
30	30	4.2	5.6	7.0	8.4	10.6	12.6	14.7	16.7	18.7	20.8	24.8	28.8	32.7	36.6	40.5	44.3	48.2
Minimum Practical Thickness		4.5	6.0	6.0	7.5	9.0	10.5	10.5	12.0	12.0	13.5	15.0	16.5	18.0	21.0	24.0	27.0	28.5

For determining the thickness of the CIPP in Table 19 the following variables were used: E_L = 175,000 psi, S_L = 2750 psi, 2% Ovality, Safety Factor = 2.0, Soil Density = 120 lb/ft^3, Soil Modulus = 1000 psi, HS-20 Highway Loading at shallow depths

APPENDIX

Table 20. Fully Deteriorated Gravity Flow Condition for Groundwater at 50% of Soil Depth.

CIPP Thickness (mm) for each Pipe Diameter (Inches) at the given Depth (feet)

Soil Depth	Water Depth	6	8	10	12	15	18	21	24	27	30	36	42	48	54	60	66	72
6	3	2.5	3.0	3.7	4.5	5.6	6.7	7.9	9.0	10.1	11.2	13.5	15.7	17.9	20.2	22.4	24.7	26.9
8	4	2.5	3.1	3.7	4.5	5.6	6.7	7.9	9.0	10.1	11.2	13.5	15.7	17.9	20.2	22.4	24.7	26.9
10	5	2.5	3.3	4.0	4.7	5.7	6.8	7.9	9.0	10.1	11.2	13.5	15.7	17.9	20.2	22.4	24.7	26.9
12	6	2.7	3.5	4.3	5.1	6.3	7.4	8.6	9.7	10.8	12.1	14.3	16.4	18.7	20.7	22.9	24.9	26.9
16	8	3.0	3.9	4.8	5.7	7.1	8.4	9.8	11.1	12.4	13.7	16.3	19.0	21.5	23.9	26.4	28.8	31.2
20	10	3.3	4.3	5.3	6.3	7.8	9.3	10.8	12.3	13.8	15.3	18.2	21.1	23.9	26.8	29.5	32.3	35.0
25	12.5	3.6	4.7	5.8	6.9	8.6	10.3	11.9	13.6	15.2	16.9	20.1	23.3	26.5	29.7	32.8	36.0	39.0
30	15	3.8	5.0	6.3	7.5	9.3	11.1	12.9	14.7	16.5	18.3	21.8	25.4	28.9	32.3	35.7	39.1	42.5
Minimum Practical Thickness		4.5	6.0	6.0	7.5	9.0	10.5	10.5	12.0	12.0	13.5	15.0	16.5	18.0	21.0	24.0	27.0	28.5

For determining the thickness of the CIPP in Table 19 the following variables were used: E_L = 175,000 psi, S_L = 2750 psi, 2% Ovality, Safety Factor = 2.0, Soil Density = 120 lb/ft³, Soil Modulus = 1000 psi, HS-20 Highway Loading at shallow depths

Lanzo Lining Services crew preparing liner for direct inversion installation of CIPP

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Clarifier pressure pipe rehabilitation at WWTP

Quality controlled tube impregnation at one of Lanzo Lining Services' state of the art wet out facilities

The Lanzo Companies bring forty-five years of heavy construction experience in addition to over 6,000,000 feet of installed cured-in-place pipe lining experience. Our goal at Lanzo is to provide safe, cost-effective, on-time, and high quality construction services. We hold the highest level of ethics and are committed to ensuring the safety of our employees and the convenience of the people within the communities we service.

LANZO Lining Services, Inc.

Our mission is to deliver safe, environmentally friendly and low impact trenchless construction services on time at or below budget.

LANZO LINING SERVICES

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Please direct all technical questions to Fred Tingberg, Jr. (fredt@lanzo.org)

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DUNS# 808382642

CAGE# 60814

NAICS CODES

237110 – Water and Sewer Line and Related Structures
325211 – Plastic Material and Resin Manufacturing
326122 – Plastic Pipe and Pipe Fitting Manufacturing
562998 – All Other Miscellaneous Waste Management Services

CERTIFICATIONS

Federal/National:
- SBE – Small Business Enterprise

State/Regional:
- FDOT Prequalified
- MDOT Prequalified

AFFILIATIONS

North American Society for Trenchless Technology - NASTT
National Association of Sewer Service Companies - NASSCO
Water Environment Federation – WEFTEC
American Water Works Association – AWWA
American Public Works Association – APWA
The Construction Underground – TCU
Michigan Infrastructure and Transportation Association – MITA
Northeast Superintendent Association – NESA
American Society for Testing and Materials - ASTM

REFERENCE DOCUMENTS

ASTM F1216 – Standard practice for rehabilitation of existing pipelines and conduits by the inversion and curing of a resin-impregnated tube.

ASTM F1743 - Standard practice for the rehabilitation of existing pipelines and conduits by the pulled-in-place installation of cured-in-place thermosetting resin pipe (CIPP).

ASTM D5813 - Standard specification for cured-in-place thermosetting resin sewer pipe.

ASTM C581 - Standard practice for determining chemical resistance of thermosetting resins used in glass fiber reinforced structures, intended for liquid service.

ASTM D790 - Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.

LANZO Lining Services, Inc.

REHABILITATION WITH CURED-IN-PLACE-PIPE
Capabilities Statement

Lanzo Lining Services was formed in 1993 to provide a more cost-effective alternative to replacing failed pipelines using the cured-in-place pipe method (CIPP). This technology gives project owners the option to use one of the most advanced trenchless technologies to successfully rehabilitate pipelines. Lanzo Lining has over seven (7) million feet of CIPP throughout Florida, Michigan, as well as other regions within the United States and Canada. Installations have ranged in size from 4" to 144".

Lanzo Lining Services is among a handful of companies qualified to use a cured-in-place pipelining technology to rehabilitate deteriorated pipelines.

Lanzo Lining Services customers are finding the benefits of cured-in-place pipelining to regain structural integrity and reduce infiltration, inflow and exfiltration at lower cost, in less time, and with fewer inconveniences to the owner and respective communities.

Lanzo Lining Services provides high quality, cost effective and on time results while meeting all Federal, State and Municipal regulations. We hold the highest level of ethics and are committed to ensuring the safety of our employees along with the convenience and safety of the people within the communities we service.

At Lanzo Lining Services we value our employees and the residents of the communities in which we serve. Lanzo Lining Services has been leading competitor in the CIPP industry for over 17 years, originating in Pompano Beach, Florida, with offices in Deerfield Beach and Roseville, Michigan. Lanzo Lining Services is an equal opportunity employer employing a highly diverse staff of over 100 people which provides a full range of CIPP services and contracting capabilities.

SERVICES OFFERED BY LANZO LINING

- Sewer Cleaning
- Internal video inspection "CCTV"
- Manhole to manhole CIPP lining meeting ASTM F1216 & F1743.
- Trenchless Storm Sewer Rehabilitation
- Trenchless Sanitary Sewer Rehabilitation
- Lateral reinstatement and sealing
- Lateral Lining
- Manhole verification and repair
- Trenchless Forcemain rehabilitation
- Watermain Lining meeting NSF61
- Fully integrated wet out facility in Pompano Beach, Florida
- Fully integrated wet out facility in Roseville, Michigan
- QA/QC including Third party testing of liner runs installed
- 50 year service life expectancy
- 5 year warranty for all materials and workmanship
- Lanzo Citiliner - mobile wet out facility using non-styrenated "GREEN" Epoxy resins
- ISO 9002 Materials and Suppliers

Frontal view of 60 inch diameter direct inversion

Finished outfall product at the headwall

Our service is the daily solution of problems and pursuit of a quality installation. This is not simply the installation of a product but rather the accomplishment of a complete sequence of events ranging from site inspection, pipe preparation, delivery of resin impregnated felt tubes from "wet out" to installation, utility reinstatement and job site cleanup with minimal disruption to the surrounding community is the approach to every phase of the CIPP project.

PRECONSTRUCTION PHASE – prior to commencing work, a pre-construction meeting shall be held to submit and review the following:

- Work schedule, including anticipated start and completion date.
- Maintenance of traffic plan
- Material certification and other submittals
- Material safety data sheets
- Engineering calculations for liner thickness design
- By-pass pumping plan
- Sub-contracting
- Certificate of insurance submitted

CONSTRUCTION PHASE

- Inspection
- Remove all debris and televise the pipe prior to lining
- Set up approved MOT and/or lane closures
- Dewatering and by-pass pumping
- Point repair to remove obstruction prior to pipe renovation
- Tube preparation, installation, curing and cool down
- Lateral reinstatement and liner terminations
- Final inspection

POST CONSTRUCTION

- Submit pre-installation videos and sewer logs of line segments
- Submit post-installation videos and sewer logs of the completed CIPP and reinstated laterals
- Submit structural test data from an independent third party testing lab
- Submit installed CIPP thickness measurements from an independent third party testing lab

Environmentally friendly "Green Resin Formulations"

Lanzo Lining Services has remained an innovator and pioneer installer of CIPP as trenchless pipeline rehabilitation technologies have gained extraordinary acceptance due to the changing chemical environment along with enforcement of clean water regulations. Lanzo Lining has experience in many cutting edge applications such as:

- Large diameter & non-circular storm drains
- Over the hole wet out and installation
- Pressure rated force main sanitary sewer
- NSF 61 certified water main rehabilitation
- Green resin utilization in wetland or environmentally sensitive areas
- Submerged or canal enclosure pipeline rehabilitation
- Sanitary sewer collection systems
- High temperature chemical concentrations and industrial sewers
- Air duct ventilation repair & vacuum pressure line

LANZO TRENCHLESS TECHNOLOGIES

Delivering innovative trenchless technology solutions to rehabilitate the world's diverse infrastructure

CIPP REFERENCE SPECIFICATION

This CIPP Reference Specification serves as only a guideline and is not intended to encompass the requirements of every municipality or industrial application. However, the points put forth in this document have been used successfully to specify and complete CIPP projects.

First, it is the recommendation of Lanzo Trenchless Technologies that an overall project be evaluated, specified and bid with the unique underground construction technologies separated. By so doing, the strengths and economics of each technology can properly be utilized for the best final result on any given project. Once it has been determined by the project engineer that a project be completed with trenchless underground technologies to minimize disruption to the surrounding community and businesses, the next task involves specification development for advertising and bidding the project. In any given large project there may be sections of pipe best rehabilitated with sliplining or segmental sliplining, fold and form, CIPP and/or other technologies. When this is the case, separate specifications should be developed and the project bid accordingly. For example, bidding slipling, fold and form and CIPP together would typically not allow the end user to have a fold and form or CIPP project because of cost considerations. In addition, the community would not have a project devoid of digging and disruption.

When determining how and under what circumstances CIPP should be specified there are a number of factors to consider. The exclusive use of CIPP in areas where any or a combination of the following conditions may prevail:

1. Suspect structural characteristics in the host pipe where axial, radial, or longitudinal cracks, joint offsets, or shear conditions exist.
2. Pipe ovality sufficient to preclude other products from reaching its full round configuration which is required in the design of this product with ring compression theory.
3. Pipe where line and/or grade differentials may preclude other products from becoming fully rounded (i.e. lines with existing bellies, etc.).
4. Pipe where segments of pipe may be missing.
5. Pipe subject to highway loading in shallow depths where live loading is present or in deep bury locations where soil prism loading is possible.
6. Pipes under State Roads or under roads requiring FDOT maintenance. Typical common concerns of a project include traffic control, by-pass pumping, lateral reinstatement, and chemical grouting of reinstated lateral connections.

LANZO TRENCHLESS TECHNOLOGIES

SUGGESTED SPECIFICATIONS FOR CURED-IN-PLACE PIPE (CIPP)
AS RECOMMENDED BY LANZO TRENCHLESS TECHOLOGIES

1. INTENT AND DESCRIPTION

1.1 The intent of this specification is to provide a recommended set of guidelines for the reconstruction of pipelines and conduits through the use of cured-in-place pipe (CIPP). In this specification recommended references, prequalification requirements, materials, pre- and post-installation inspection tests have been provided. The process generally consists of inserting a resin impregnated fabric tube into an existing pipe or conduit, expanding the tube against the existing pipe, and curing the tube to form a pipe within a pipe. The tube my be inserted into the pipe by direct inversion or pulling in place. Curing is accomplished by either circulating heated water or steam or ambient temperature air or water to affect the desired cure throughout the pipe from access point to access point.

Although the Contractor my have an approved or licensed process, no material changes or design changes shall be undertaken unless approved by the Agency specifying the project.

2. CONTRACTOR PREQUALIFICATION EXPERIENCE

2.1 The process must be proven through previous successful installations of CIPP rehabilitation projects on lines of 8" or larger in the United States within the last five years. The footage total for these projects shall be a minimum of 1,000,000 lineal feet. Additionally the Contractor shall submit a minimum of 50,000 lf of the size specified or larger to demonstrate competence with the magnitude of the project being constructed. Experience records shall be submitted with submittals according to the guidelines of the specifying agency. Contractors using sub-contractors shall submit information about the sub-contractor (i.e. name, experience records, jobs which the general and sub-contractor have worked jointly, etc.).

3. REFERENCE DOCUMENTS

3.1 ASTM F1216 - Standard Practice for rehabilitation of existing pipelines and conduits by the inversion and curing of a resin-impregnated tube.

3.2 ASTM F1743 - Standard practice for the rehabilitation of existing pipelines and conduits by the pulled-in-place installation of cured-in-place thermosetting resin pipe (CIPP).
3.3 ASTM D5813 - Standard specification for cured-in-place thermosetting resin sewer pipe.
3.4 ASTM C581 - Standard practice for determining chemical resistance of thermosetting resins used in glass fiber reinforced structures, intended for liquid service.
3.5 ASTM D790 - Test methods for flexural properties of unreinforced and reinforced plastics and electrical insulating materials.
3.6 Plans, drawing and profiles of lines to be rehabilitated are included, as available. Videotapes may also be available for review. It is the Contractor's responsibility to visit the site and investigate the project, as necessary, for preparation of any proposal.
3.7 In the event of a conflict, documents shall have the following priorities: (1) Specifications for CIPP, (2) General conditions, (3) ASTM F1216, F1743, and D5813 (as appropriate).

4. PREBID PREQUALIFICATION SUBMITTALS

4.1 Submittals shall be made according to the guidelines of the Agency
4.2 Resin
- 4.2.1 Submit technical data sheets showing physical properties of the products modified for the CIPP process.
- 4.2.2 Submit one year chemical resistance tests of flexural properties and weight change evaluations that have been carried out with the submitted resin(s) and the fabric tube material(s) to be used on the project. The edges or surfaces of the test specimens shall not be sealed or coated unless it can be conclusively proven that these modifications can be successfully completed in the field and that these product modifications will remain intact throughout the expected life of the product. The chemicals evaluated should be consistent with those specified in ASTM F1216 and/or ASTM D5813. These tests shall be run in a manner consistent with ASTM C581 with flexural property and weight change data available at intervals of 1, 3, 6 and 12 months to establish a trend of product performance. Tests should be carried out by an accredited lab and preferably through an independent third party lab.
- 4.2.3 At any point in the project, the specifying agency may request dated certificates of analysis for each delivery of resin during the project to confirm that the specified resin is being used on the given project.

4.3 Tube Materials

4.3.1 Submit technical data sheets showing that the physical properties of the tube materials meet the requirements of ASTM D5813.

4.3.2 Submit tabular summary of calculated sewer segment design thickness and recommended dry tube thickness for each installation. Dry tube thickness shall exceed calculated design thickness for all cases.

5. POST-INSTALLATION SUBMITTALS

5.1 Submit pre-installation tapes of the line segments being rehabilitated in a format specified by the agency (i.e. full pipe circumference, resolution, color, etc.).

5.2 Submit post-installation tapes of the completed CIPP and reinstated laterals in a format specified by the agency.

5.3 Submit flexural property test data from an independent third party testing lab of each line segment installed.

5.4 Submit installed CIPP thickness measurements from an independent third party testing lab of each line segment installed.

6. MATERIALS

6.1 Flexible Tube

6.1.1 The flexible tube shall be manufactured and fabricated under quality-controlled conditions set by the process manufacturer. The tube shall be manufactured of a size that when installed it will fit snuggly to the internal circumference of the pipe or conduit being rehabilitated and have minimal wrinkling.

6.1.2 The tube thickness shall also be specified such that the installed thickness meets the requirements of the specifying agency.

6.1.3 The tube length shall be manufactured such that it will span the entire length of the access points. When the product is installed between manholes, the CIPP shall extend beyond and seal the end of each manhole.

6.1.4 The specified tube material shall have a minimum tensile strength in the longitudinal and transverse directions as specified in ASTM D5813.

6.2 Resin

6.2.1 Provide a liquid thermosetting resin that will properly saturate the tube without draining out and will produce a properly cured pipe, which is resistant to abrasion and the effluent passing through the CIPP.

6.2.2 The approved polyester resin shall be made by a reaction of isophthalic/terathalic acid, maleic anhydride, and a glycol characterized by reactive unsaturation located along the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/promoters to produce cross-linked copolymer matrices. Use of recycled polyethylene terephthalic (PET)

6.2.3 resins shall not be allowed. In addition, only branched glycol chemistry shall be allowed in the composition of the polyester resin.

6.2.4 The approved vinyl ester shall be made by a reaction of epoxy resin with methacrylic acid and characterized by reactive unsaturation located in terminal positions of the molecular chain. This resin is compounded with a reactive styrene monomer and reacted together with initiators/opromoters to produce cross-linked copolymer matrices.

6.2.5 The approved epoxy resin shall be made by a reaction of bisphenol A and epichlorhydrin producing glycidyl ether reactive sites at the terminal positions of the molecular chain. This resin is cross-linked with the reactive equivalent of a curing agent suitable for the CIPP process.

6.3 Minimum physical properties

6.3.1 The minimum physical properties of the installed CIPP shall meet the following requirements.

Property	Reference	Minimum
Flexural Modulus	ASTM D790	250,000 psi
Flexural Strength	ASTM D790	4,500 psi

7. PRECONSTRUCTION CONFERENCE

7.1 After the contract is awarded and prior to commencing work, the Contractor will attend a pre-construction meeting with the Agency. At the meeting it is recommended that the work schedule, traffic controls, materials and other submittals, major sub-contractors, by-pass pumping plan, and certificates of insurance be submitted at that time.

8. TRAFFIC CONTROL

8.1 A traffic control plan shall include detailed diagrams showing the location of all traffic control devices and the length of time for all lane closures, as well as location of any flaggers, as necessary. One lane of traffic in each direction must be maintained at all times, and local streets may only be closed with prior approval of the Traffic Engineer.

8.2 A written method of handling traffic for each different phase of the project shall be submitted and include both vehicular and pedestrian traffic.

8.3 The name and number of the Contractor representative responsible for traffic control shall be made available to solve traffic problems at each job site location.

9. PERMITS

9.1 Depending on the project and location, there may be a number of required permits that must be obtained prior to commencement of the work. An example of permits that might be required include projects within State Highway right of ways, water permits, industrial waste permits, etc.

10. PUMPING AND BY-PASS PUMPING

10.1 The contractor shall submit a written plan at the preconstruction conference outlining the by-pass pumping scheme. The plan shall describe in writing and with diagrams the logistics of by-passing each pipe segment to be rehabilitated. Typically the Contractor or Sub-Contractor will provide the pumps for a given project. The by-pass shall be designed to handle peak flows with additional capacity in the event of a rainstorm. The by-pass shall be watertight and not leak. The plan should address contingencies in the event of a major rainfall or equipment malfunction.

11. CLEANING OF SEWER LINES

11.1 The Contractor, when required, shall remove all internal debris out of the pipe prior to installing the CIPP. The Contractor shall be responsible for disposing of all the debris in accordance with Agency requirements. Any hazardous waste encountered during a project, unless otherwise specified , is considered a changed condition.

12. PATENTS

12.1 The Contractor shall warrant and hold harmless the Agency against all claims for patent infringement and any loss thereof.

Reference

Reference

Applied Felts Letter

APPLIED FELTS

September 9th , 2019

To Whom It May Concern:

Background

Applied Felts Inc. is a fully owned subsidiary of Applied Felts Ltd, part of the Rawson Group, a large non-woven textiles company. The Rawson Group was a key developer of CIPP technology beginning in 1974 and was the sole supplier of coated felt materials worldwide until the late 1980s. Applied Felts has produced inversion tube installed by qualified and certified installers operating in more than 30 countries. Millions of Linear Feet of Applied Felts' products have been in successful service over the past years within the State of Florida.

Lanzo is a fully owned certified installer of Applied Felts. Lanzo was a key developer of CIPP technology beginning in 1993 and was a major provider of CIPP technology in many forms while suiting applications ranging from Gravity Sewer to Storm to Pressure Pipe to NSF certified Watermain.

We can certify that **Lanzo Companies** is an approved installer and has installed over 4,000,000 LF in wastewater collection systems within the past 5 years. Furthermore, Lanzo has installed more than 15,000,000 linear feet of liners throughout the United States and Canada, of which 5,000,000 linear feet has been successfully installed in the South Eastern States of USA, all adhering to ASTM 1216-03.

Lanzo has installed quantities of AF liners as follows:

More than 6,000,000 LF if sanitary sewer in the 8 to 18-inch range.

More than 450,000 LF of sanitary sewer equal or greater than the size of 36-inch pipe

More than 150,000 LF of sanitary sewer equal or greater than the size of 60-inch pipe

More than 850,000 LF of STORM sewer between the sizes of 12" and 144-inch pipe

Applied Felts provides engineering support and technical assistance to its installers. Physical testing of tensile and flexural strengths is performed with many different resin systems to insure compatibility.

Specifications

Applied Felts lining materials are made of polyester needle felt with the outside layer of the tube coated with polyester polyurethane. Multiple layers of felt are constructed together to provide a wide range of liner thickness.

Quality Control & Assurance

Applied Felts, Inc. is a certified ISO 9002 manufacturer, and all materials are tested to ensure suitability to the various field applications. Each liner is typically tested in 28 different ways. Detailed traceable test data is available for any particular liner.

David Fletcher
Applied Felts

Applied Felts, Inc. 450 College Drive, Martinsville, VA 24112. Tel. (276)656-1904, Fax (276)656-1909 E-mail applied felts@[illegible]

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Completed Projects List Past 5 Years

Lanzo Job #	Project Name	Scope	Owner	Year	Pipe Dia
LN 2058	15 Mile Road Sinkhole Emergency	CIPP	Oakland Macomb Interceptor Drain Drainage District	2017	
LN 2057	Stark County Plain Twp Project No 592	CIPP	Stark County Commissioners	2017	24"-42"
LN 2055	Battle Creek Sanitary Sewer Interceptor Rehab	CIPP	City of Battle Creek	2016	48"
707	Town of Lantana Piggy Back	CIPP	Town of Lantana	2017	8-27"
702	Lauderdale-By-The-Sea Piggy Back	CIPP	Lauderdale-By-The-Sea	2016	8" -27"
701	Imperial Golf HOA Storm Sewer Lining & Rehab	CIPP	Imperial Golf Estates HOA	2016	8"-27"
699	City of Delray Bch Reclaim Water Expansion Area 12B	CIPP	City of Delray Beach	2016	8"-27"
698	Palm Springs Sussex Kent Park SS	CIPP	Village of Palm Springs	2016	8"
697	Miami Beach Palm & Hibiscus	CIPP	Miami Beach	2016	8"
693	City of Lake Worth,FL	CIPP	Lake Worth	2015	8"-27"
692	Town of Jupiter Island Gravity Sewer	CIPP	Jupiter Florida	2015	8-27"
691	Port St.Lucie Sewer Lining & Laterals	CIPP	Port St. Lucie	2015	8"-27"
690	Highpoint 5 Storm	CIPP	High Point of Delray Sec 5	2015	8"-27"
689	Travelers Resort Dade City	CIPP	Travelers Rest Resort Inc	2015	8"-27"
688	Ft. Lauderdale Annual	CIPP	City of Ft. Lauderdale	2015-2016	8"-15"
687	Turkey Creek Storm Drain 2	CIPP	Turkey Creek HOA	2015	18",24", 30"
686	Miami Beach Envirowaste SS Rehab	CIPP	Miami Beach	2015	8"-27"
685	Seacoast Utility Authority Annual	CIPP	Seacoast Utility Authority	2015-2016	8"- 18"
684	FDOT E5T27 Volusia County	CIPP	FDOT	2015	15"-48"
683	City of Hollywood Annual I&I 2015	CIPP	City of Hollywood	2015-2016	8"-48"
682	SR 70 FDOT/ Johnson Davis	CIPP	FDOT	2015	8"
681	SR 715 Culvert Repair, Vac Vision	CIPP	FDOT	2015	8"
680	Miami Beach DB Sunset Harbour	CIPP	Miami Beach	2014	8"
LN2053	Macomb Element Arm Interceptor/Manhole Rehab	CIPP	Macomb County Public Works	2015	
LN2041	Bay City 2014 Critical Sewer Relining Project	CIPP	Bay City, City of	2014	8" - 20"
LN2035	Macomb County Lakeshore Interceptor	CIPP	Macomb County	2015	42"
679	Eastpointe HOA	CIPP	HOA	2014	15",24", 30"
678	FDOT T3423 US 98 VacVision	CIPP	FDOT	2014	8"-27"
677	Maitland T94-T002	CIPP	HOA	2015	8"
676	Miami Aviation	CIPP	Miami Dade County	2014	8"-10"
675	Johnson Davis- Boynton Beach	CIPP	FDOT	2014	30"-48"
673	City of Stuart-Boca Piggy Back	CIPP	City of Stuart	2014	16"
672	Capital Circle-Vac Vision	CIPP	Leon County	2014	36"
671	Port St. Lucie Storm	CIPP	City of Port St. lucie	2014	30"
670	Port of Miami Tunnel Project	CIPP	Port of Miami	2014	8"
669	Palm Beach County Annual CIPP	CIPP	Palm Beach County Water Utilities	2014-2015	8"-21"
668	Pinellas County Annual	CIPP	Pinellas County	2014	8"-30"
LN2032	Bloomfield Township Wing Lake	CIPP	Bloomfield Township	2014	8"-15"
665	Highpoint 54in Storm	CIPP	Highpoint 5	2014	54"
664	Hinterland Boca Pump Station	CIPP	City of Boca Raton	2014	8"
663	Brevard County	CIPP	Brevard County Florida	2013	71" X 47"
661	Turkey Creek Storm Drain	CIPP	Turkey Creek HOA	2014	18"-42"
LN2033	Stark County Sanitary Engineers	CIPP	Stark County Ohio	2012	42"
660	City of Tampa Annual I&I Contract	CIPP	City of Tampa	2014	8"-30"
660	Tampa 2014 Annual I & I	CIPP	City of Tampa	2015	8"-30"
659	Boca Hills	CIPP	City of Boca Raton	2013	8"
658	FDOT-E5T07(Orlando)	CIPP	FDOT	2014	15"-60"
655	Miami Beach, Cadillac Hotel Drainage Rehab (GT McDonald)	CIPP	GT McDonald Enterprises	2013	12"
654	City of Hollywood Taft Street 60"	CIPP	City of Hollywood	2014	60"
653	West Palm Beach FPL Danella	CIPP	FPL	2013	12"
LN2027	Western Township Utility Authority	CIPP	WTUA	2014	48"
652	South Martin Regional Utility Annual	CIPP	Town of Jupiter Island	2013	8"
651	FDOT T7320 Pinellas County (APAC SE)	CIPP	FDOT	2013	8" to 24"
650	Miami Beach Venetian Islands Improvements	CIPP	City of Miami Beach	2013	8"
LN2025	City of Taylor-2012 Sanitary Sewer Rehab Program	CIPP	City of Taylor	2013	8"-12"
647	Lake Worth 7th Ave Sewer Rehab	CIPP	City of Lake Worth	2013	10" to 21"
646	Broward NCNIP BP#11 (Gianetti Contracting)	CIPP	Broward County	2013	8"
645	FDOT Southeastern Engineering 94th St Outfall	CIPP	FDOT	2013	36"
LN2020	US Steel-Jug Island	CIPP	US Steel	2013	48"
644	Imperial Golf Estates	CIPP	Imperial Golf Estate	2013	15" to 18"
642	Broward Pine Island Rd for Flow Tech	CIPP	Broward County, FL	2013	18"
641	Highland Beach Storm	CIPP	Town of Highland Beach	2013	12"
639	FDOT Volusia County	CIPP	FDOT	2013	15" to 48"
638	APAC SR 580 Pinellas	CIPP	FDOT	2013	18"
637	FDOT Winter Springs (ONAS Corp)	CIPP	FDOT	2013	18" to 48"
LN2019	City of Grand Rapids CIPP Various Locations	CIPP	City of Grand Rapids	2013	8"-36"
636	Evans Park Mount Dora	CIPP	City of Mount Dora	2012	30"
635	Ranger Construction SR 710 Beeline Hwy	CIPP	FDOT	2012	8"
634	Hillsborough County - Barrington Dr (Vac Vision)	CIPP	Hillsborough County	2012	8"
633	Belle Glade WUD 10-062R (Hinterland)	CIPP	Palm Beach County	2012	8" to 27"
632	Hallandale Beach	CIPP	Hallandale Beach, FL	2012	8" to 15"
631	Lake Nona Publix	CIPP	Lake Nona Land Company	2012	18" to 48"
629	FDOT SR 70 - Johson-Davis	CIPP	FDOT	2012	18" to 30"
626	FDOT Orange County SR 551	CIPP	FDOT	2012	18" to 24"
625	FDOT E7HR00 (Vac Vision)	CIPP	FDOT	2012	42"
623	Waneta Place Storm Drain Rehabilitation	CIPP	Sarasota County	2012	36"
622	Town of Bay Harbor Islands	CIPP	Town of Bay Harbor Islands	2012	8"
619	Village By The Bay Drainage Repairs	CIPP	Village By The Bay Condo Assoc	2012	15" to 24"
617	APAC-Southeast SR 64	CIPP	FDOT	2012	36"
616	Rockline Vac Systems	CIPP		2012	15" to 36"
613	Lauderdale-by-the-Sea	CIPP	Lauderdale-by-the-Sea	2012	8" to 12"
611	Port St. Lucie Autozone Prima Vista	CIPP	Port St. Lucie	2012	6" to 8"
609	Macomb County Culvert Repair	CIPP	Macomb County	2012	12"
608	Macomb Community College Center Campus (Proline Asphalt)	CIPP	Clinton Township	2012	6"
606	Imperial Golf Estates	CIPP	Imperial Golf Estate	2012	24"

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

604	City of Tampa, Junction Chamber #2 Effluent Pipes Rehab	CIPP	City of Tampa	2012	90" to 96"
602	Seacoast Utility Authority Annual	CIPP	Seacoast Utility Authority	2012	8" to 24"
601	Kerby Road Interceptor	CIPP	Village Grosse Point Farms	2012	54"
600	North Atlantic Drive	CIPP	Town of Lantana	2012	18"
599	D. Mancini & Sons - Miami Beach	CIPP	City of Miami Beach	2012	8"-12"
598	City of Hollywood I & I Improvements	CIPP	City of Hollywood	2012	8" to 48"
597	Hollywood Academy of Art & Science	CIPP	City of Hollywood	2012	12"
596	Harbour Ridge Culvert Improvements	CIPP	Palm City	2012	18" to 24"
595	City of Lake Worth, FL	CIPP	City of Lake Worth	2012	21"
594	West Bloomfield I & I Reduction Program	CIPP	Oakland County Water Resources	2012	8" to 27"
592	City of Hollywood, FL Emergency 48" FM	CIPP	City of Hollywood	2012	48"
591	Town of Lake Clarke Shores, South Service Area - Phase II	CIPP	Palm Beach County	2012	8" to 27"
589	Soil and Materials Engineers - St John's, MI	CIPP	City of St. John's	2012	24"
588	Village of Grosse Point Shores (Claireview Drive)	CIPP	Village of Grosse Pointe Shores	2012	8" to 27"

Qualifications

Qualifications

Qualifications

Safety

Lanzo strives to place safety as its number one Core Value.

Safety First

- At Lanzo; we are committed to be Safe for our Customers, for each other, and for the communities in which we serve.
- We are all entitled to go to a workplace where we can expect to return safely to our families after our workday.
- No Job is that important, no reward great enough to risk ourselves or each other.
- Safety is attitude, awareness, and commitment to best practices.

From 2014 to current Lanzo has not received any OSHA violations or Safety Citations and Penalties.

We can provide if required our Corporate Safety Manual if required. We also on all project develop and maintain job specific as well as site specific safety plans.

Warranty

Lanzo Trenchless Technologies offers a FIVE (5) YEAR warranty for all materials and workmanship.

Having over twenty (25) years' experience with testing methods described in this RFP, we feel comfortable that exceeding the performance anticipated with methods presently being utilized by Lanzo should be easily demonstrated. The service life expectancy for materials and resins being utilized on this project is fifty (50) years.

Our standard approach to warranty is that should there be a problem, we would quickly implement a repair as needed. The negatives that emanate from not satisfying the client in this regard, as it pertains to both ongoing work as well as reference value outweigh the cost of the repair. We have installed more than fifteen million (15,000,000) feet of this rehabilitation type.

Should we utilize any subcontractor to perform ancillary tasks such as Manhole Coatings, MOT or bypass we would extend our warranty to their portion of the work as well.

Qualifications

Resolution of Corporation

2019 FLORIDA PROFIT CORPORATION AMENDED ANNUAL REPORT

FILED
May 31, 2019
Secretary of State
5989430142CC

DOCUMENT# P93000026586

Entity Name: LANZO TRENCHLESS TECHNOLOGIES, INC.-SOUTH

Current Principal Place of Business:

125 SE 5TH COURT
DEERFIELD BEACH, FL 33441

Current Mailing Address:

125 SE 5TH COURT
DEERFIELD BEACH, FL 33441 US

FEI Number: 65-0414559

Certificate of Status Desired: No

Name and Address of Current Registered Agent:

D'ALESSANDRO, ANTONIO CARLO
125 SE 5TH COURT
DEERFIELD BEACH, FL 33441 US

The above named entity submits this statement for the purpose of changing its registered office or registered agent, or both, in the State of Florida.

SIGNATURE: ANTONIO D'ALESSANDRO — 05/31/2019

Electronic Signature of Registered Agent — Date

Officer/Director Detail :

Title	AS
Name	TILLI, MATTHEW P
Address	125 SE 5TH COURT
City-State-Zip	DEERFIELD BEACH FL 33441
Title	COO
Name	TINGBERG, FREDERICK JR.
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441
Title	SECRETARY, TREASURER
Name	TORRES, ROSAMARIA
Address	37230 WILLOW LANE
City-State-Zip	CLINTON TWP MI 48036
Title	ASST SECRETARY
Name	BEATY, ROBERT
Address	125 SE 5TH COURT
City-State-Zip.	DEERFIELD BEACH FL 33441

Title	AS
Name	PAWLOWSKI, KEVIN P
Address	2734 NE 27TH COURT
City-State-Zip	LIGHTHOUSE PT FL 33064
Title	VP
Name	D'ALESSANDRO, ANTONIO
Address	21768 REFLECTIONLANE
City-State-Zip	BOCA RATON FL
Title	VP
Name	D'ALESSANDRO, QUIRINO JR.
Address	4611 NORTH FEDERAL HWY 520
City-State-Zip	POMPANO BEACH FL 33064
Title	CHAIRMAN
Name	D'ALESSANDRO, QUIRINO SR.
Address	125 SE 5TH COURT
City-State-Zip	DEERFIELD BEACH FL 33441

Continues on page 2

I hereby certify that the information indicated on this report or supplemental report is true and accurate and that my electronic signature shall have the same legal effect as if made under oath; that I am an officer or director of the corporation or the receiver or trustee empowered to execute this report as required by Chapter 607, Florida Statutes; and that my name appears above, or on an attachment with all other like empowered.

SIGNATURE: KEVIN PAWLOWSKI — ASST SECRETARY — 05/31/2019

Electronic Signature of Signing Officer/Director Detail — Date

Qualifications

Officer/Director Detail Continued :

Title	ASST. SECRETARY
Name	TILLI, JAMES
Address	125 SE 5TH COURT
City-State-Zip:	DEERFIELD BEACH FL 33441

Qualifications

Key Personnel Resumes

Several essential key individuals will be assigned to the project and designated as the project team leaders. The leaders will have direct oversight and management of all project functions as well as the remaining project personnel, who are equally important and just as qualified in their respective positions. The team leaders will also be responsible to maintain the deliverables and ensure continual project compliance with: (but not limited to)

- OSHA, MIOSHA and all general industry standard safety laws, rules, regulations, guidelines, policies, procedures and processes
- The intended scope of services and project specifications
- Quality Assurance and Quality Control Program
- City, State, and Federal guidelines, policies, and procedures
- Design standards and objectives
- Project team communication
- Schedule requirements and objectives
- Cost control measures
- Project reporting
- Document control
- Project punch list
- Project closeout

Fred Tingberg, Jr.

Chief Operating Officer

Qualifications:

Fred Tingberg is Lanzo Lining's principle spokesperson, technical resource and business development manager. Mr. Tingberg holds a Bachelor's Degree in Materials Engineering from Rensselaer Polytechnic Institute. He has 32 years of construction product design & installation experience, with twenty years in cured in place (CIPP) trenchless pipeline rehabilitation. He is also a recipient of the Spirit of Detroit Award. From Lanzo Lining Services inception in 1993, Mr. Tingberg has overseen its growth to more than 10,000,000 LF of CIPP installed, with plants in Michigan, Ohio, Wisconsin, Florida and Canada, in diameters ranging in sizes from 6" to 108". Mr. Tingberg has served in developmental committees as an Organizational Member of ASTM and an instructor in the professional development program within CUIRE.

Technical Publications written by Fred Tingberg, Jr.:

WEFTEC 2012 Chicago Green Resin and other breaking CIPP resin technologies

NASTT No Dig '12 Nashville Non Styrenated CIPP a Safe Bet at Greektown Casino

NASTT No Dig Dallas '08 NSF 61 Water Main Lining using CIPP

AWWA '08 Conference San Antonio NSF 61 Water Main Lining using CIPP

NASTT No Dig '07 San Diego Large Diameter Box Culvert and Non-Circular Pipe Lining using CIPP

NASTT No Dig '06 Air Plenum Lining using CIPP

NASTT No Dig '99 Orlando Force Main Lining using CIPP

CUIRE Training Course Instructor 2008

CUIRE Training Course Instructor 2007

Certifications:

- State of Arizona G.C. License,
- State of Florida (CGC) G.C. License,
- Hazmat 40 Hour Safety Training & E2 Supervisor endorsement
- Patented products in Composite Polymer Technologies while a research technician at Arco Polymers, Monaca PA
- State of Georgia Utility Managers License
- State of Florida (CUC) Utility Contractors License
- Developed proprietary closure assembly for Watermain/Forcemain CIPP pressure system

Education:

- Bachelor of Science – Materials Engineering – Rensselaer Polytechnic Institute

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Experience:

Lanzo 1993 - Present

- Preparation of all RFQ, RFP, Negotiated proposals
- Oversees all Hard Dollar Bonded Construction Bidding
- Budget preparation on all Bids for Timberline System entry
- Resin & Felt Price Program & Purchasing Coordination
- Environmental & Safety compliance at) fully integrated wet out plants
- Supervisor to all project managers
- Coordinate & direct product/service expansion in all markets
- Oversees Lanzo's Lateral Lining Technical Development
- Oversees Lanzo's Watermain Lining Technical Development

Clayton Group, Inc. – District Manager 1984 - 1993

- District Manager, overseeing operations for Semsco in three counties (Dade/Broward/Palm Beach). Oversaw two distribution facilities, located in Pompano and Miami, with a staff of twenty-five, Semsco was a supplier of waterworks, sewer and drainage supplies.

Armco, Inc. – National Specification Account Manager 1980 - 1984

- Responsibility as Sales Engineer for Construction Product Sales and Development within metropolitan New York. Duties included Specification Promotion for the New York City accounts, which had a national impact for Armco. Time was divided among contractor accounts in Manhattan, New Jersey and Long Island.

John Williamson

LINING DIVISION DIRECTOR

QUALIFICATIONS

Mr. Williamson has over two decades of experience in the lining industry. He possesses specific experience with all the different phases of trenchless rehabilitation of existing utility systems. John reviews all wall thickness calculations and evaluations as to materials utilized for each CIPP Liner installation. On projects he reviews measured analysis of time requirements for bypass requirements, pit locations and placement technology to be utilized. He is also managing the day to day communication with our third party testing facility and facilitates the sending of samples and the review of reports that are returned.

EXPERIENCE

John is experienced, working as a designer, field engineer, and project engineering. John has managed a variety of municipal, industrial and private projects. He has worked on various projects with diameters and sizes of CIPP liners ranging from 4" to 108". John is experienced with both circular and non-circular pipelines, pressure lines, water-mains, as well as force-mains.

APPLIED FELTS 3/1/2017 – 11/9/2015

Martinsville, VA Technical Sales Manager/ Technical Support

- AF acquired Nova pipe, retained to help transition technology/ customer base.
- Maintain Nova Pipe customer sales and interaction; provide field technical support for contractor operations.
- New product development; Continuous improvement material. Tube design as well as tweak customer process to improve efficiency and maximize earning potential for all customers.
- Provide training for customers to improve or change process; Provide customer support for marketing, sales and engineering.

Lanton Nova Pipe 4/19/1999 – 3/1/2007

Bellingham, MA

- Assemble team to research, develop and manufacture cured in place pipe (NOVA PIPE)
- Set up test rig, made and tested materials and tube construction to determine end product.
- Produced enhanced performance liner as well as create automated tube forming equipment and proprietary bonding process for liner assembly and layer.
- Developed strategic plan to penetrate cured in place pipe market. Systematically submitted Novapipe test results and info to municipal product approval agencies worldwide to establish brand and gain inclusion to approved products list.
- Novapipe sales, marketing and technical support.

Qualifications

COMPLETED PROJECTS

Oakland Macomb Interceptor Drain – Contract 6 - Cost: $3,216,090.60
Macomb Element and Sterling Heights Arm Interceptor and Manhole Rehabilitation - Cost: $2,316,899.86
DWS-899 Detroit Emergency Sanitary Sewer Repair - Cost: $2,220,761.01
City of West Palm Beach - Cost: $7,089,516.28
Hollywood I&I Annual - Cost: $7,746,850.00
Ft. Lauderdale Annual - Cost: $1,204,992.00
Miami Beach Palm & Hibiscus - Cost $38,813,905
FDOT E5T27 Volusia Lining Project - Cost $1,456,303.00
Lauderdale-By-The-Sea Piggy Back - Cost $630,198.50
Palm Beach County Annual Contract Project# WUD 12-063(B) - Cost $2,632,238.00

LICENSES/CERTIFICATES/QUALIFICATIONS

First Aid & CPR Certified

Advanced Confined Space Training and Rescue

40-Hour Hazwoper

PACP Certified

US006732763B2

(12) United States Patent

Williamson et al.

(10) Patent No.: US 6,732,763 B2
(45) Date of Patent: May 11, 2004

(54) STRETCH-RESISTANT PIPE LINER

(75) Inventors: John S. Williamson, Mansfield, MA (US); Jim Choi, Wilbraham, MA (US)

(73) Assignee: Lantor, Inc., Bellingham, MA (US)

(21) Appl. No.: 10/154,390

(22) Filed: May 24, 2002

(65) Prior Publication Data

US 2003/0217777 A1 Nov. 27, 2003

(51) Int. Cl.[7] F16L 55/16
(52) U.S. Cl. 138/98; 138/125; 405/150.1
(58) Field of Search 138/98, 97, 125; 264/516, 36.17; 405/150.1; 156/287, 294

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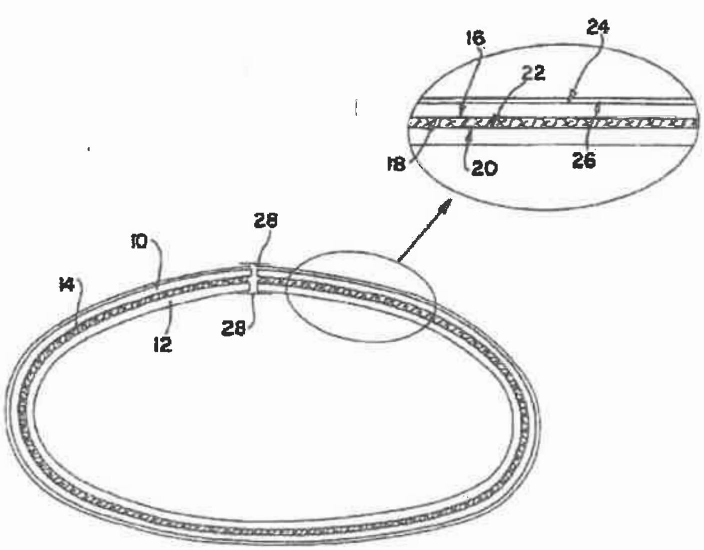
Primary Examiner—James Hook
(74) *Attorney, Agent, or Firm*—Foley & Lardner

(57) ABSTRACT

This invention provides stretch-resistant liners for lining pipes, pipes lined with stretch-resistant liners, and methods for lining pipes with stretch-resistant liners. The liners are made from a layer of stretch-resistant woven material, which may be a scrim, sandwiched between two layers of non-woven resin-impregnated material to form a laminate structure which is rolled into a tube to provide a liner having concentric sleeves.

24 Claims, 1 Drawing Sheet



Robert Bucci

Project Manager

QUALIFICATIONS

Mr. Bucci is a Professional Representative of Lanzo Construction, experienced in the management and implementation of quality control measures to insure the highest quality product in every project he is involved in. Mr. Bucci is certified for concrete, asphalt and nuclear testing and is an expert in clearly communicating the intention of the specification. Mr. Bucci is involved in the technical support of developing product, proposals, design, optimization methods for constructability of CIPP lining & pressure pipe on all lining installations. He is an effective communicator who makes decisions on scheduling of crews, equipment & product installation, as required for the project. He has demonstrated excellent management ability to effectively organize and execute multiple projects simultaneously to the full satisfaction of the owners.

EXPERIENCE

Mr. Bucci has 20 years of experience in the construction industry. He has worked at levels, ranging from laborer, foreman, production manager to superintendent. He understands the challenges this project provides and he possess the skills & knowledge to provide a quality product. His experience in the construction of major infrastructure projects include lining distribution & transmission mains, storm water, wastewater, solid waste major pipeline and treatment plant projects. He has experience at the local and regional level for large-scale projects requiring the coordination of various construction disciplines. He has worked in both private and public sector. He has worked and supervised lining projects all over the Southeast & Midwestern United States. His responsibilities include daily onsite management of project personnel, including safety meetings, implementation of M.O.T., environmental protection, compliance with permit conditions from all governing agencies, meeting schedule deadlines, coordination with the project manager and the owner representative(s) for all phases of the project to best meet community/public needs.

COMPLETED PROJECTS

City of Boca Raton, 16" Force Main Repair at St Andrews Blvd between Yamato & Glades - 2,900 lineal feet 16" FM 100 psi

Florida Department of Transportation, Winter Springs (ONAS)Drainage Rehabilitation – CIPP Rehabilitation of 1,111 LF of 18" CMP, 2,939 LF of 36" CMP, 582 LF of 42" CMP and 241 LF of 48" CMP in urban FDOT right of ways

Brevard County, Jackson Street Pipeline Rehabilitation - CIPP Rehabilitation 4 separate shots of 40 LF each lining elliptical 71"x47" culverts along Jackson Street

Sarasota County, Waneta Place Storm Drain Rehabilitation - 36" CMP and a 208 LF Cured in Place Pipe liner was installed for the rehabilitation

LICENSES/CERTIFICATES/QUALIFICATIONS

QC Manager
High School Diploma
Asphalt Paving Technician – Level 1
Earthwork Construction Inspection – Level 2
HAZMAT Certification
OSHA 30 Construction Safety & Health Safety Training
PACP Certified
Concrete Field Technician – Level 1
Nuclear Gauge Safety Training Class
Radiation Safety Officer Class

SAL D'Alessandro

Trenchless Superintendent

QUALIFICATIONS

Mr. D'Alessandro has eight years of experience in the lining industry. He possesses specific experience with all the different phases of trenchless rehabilitation of existing utility systems. Sal reviews all wall thickness calculations and evaluations as to materials utilized for each CIPP Liner installation. On projects he reviews measured analysis of time requirements for bypass requirements, pit locations and placement technology to be utilized. He is also manages the day to day communication with our third party testing facility and facilitates the sending of samples and the review of reports that are returned.

EXPERIENCE

Sal is experienced, working as a field supervisor, and project coordinator. Sal has managed a variety of municipal, industrial and private projects. He has worked on various projects with diameters and sizes of CIPP liners ranging from 4" to 108". Sal is experienced with both circular and non-circular pipelines, pressure lines, water-mains, as well as force-mains.

COMPLETED PROJECTS

Lauderdale-By-The-Sea Piggy Back – Cost $630,198.50

Imperial Golf HOA Storm Sewer Lining & Rehab - $34,602.00

City of Delray Beach Reclaim Water Expansion Area 12B – Cost $68,680.00

Palm Beach Sussex Kent Park Sanitary Sewer – Cost $181,858.00

Highpoint 5 Storm Sewer Rehab – Cost $84,240.00

Traveler's Resort Dade City – Cost $67,160.00

Fort Lauderdale Annual – Cost $1,571,795.00

Turkey Creek Storm Drain 2 – Cost $152,464.00

LICENSES/CERTIFICATES/QUALIFICATIONS

First Aid & CPR Certified

Advanced Confined Space Training and Rescue

40-Hour Hazwoper

PACP Certified

Kevin Suarez

Clean & Prep Crew Foreman

QUALIFICATIONS

Within his capacity at Lanzo he is currently involved in contract interpretation and the administration of various rehabilitation projects. His experience includes installation of all forms of liner (8"-96"). His is skilled at scheduling and planning the necessary labor, equipment and materials.

EXPERIENCE

Mr. Suarez is results-driven superintendent with a total of 5 years' experience in the construction industry. Areas of expertise consist of underground construction and sewer cleaning. His leadership has provided a good conduit of communication and he works well with management and non-management personnel, with particular strength in developing trusting, loyal relationships with customers, suppliers and workforce. In his role as clean and prep crew foreman he will be organizing, scheduling crews and assist with the performing of all phases of CCTV and cleaning operations. He can perform all phase of construction from CCTV & cleaning sewers, wet-out of CIPP liners, and the installation of CIPP liners (steam & hot water) consisting of pipe sizes 8" through 96".

COMPLETED PROJECTS

- Oakland Macomb Interceptor Drain – Contract 6 -
- Oakland Macomb Interceptor Drain – Contract 5B
- Macomb Element and Sterling Heights Arm Interceptor and Manhole Rehabilitation
- DWS-899 Detroit Emergency Sanitary Sewer Repair
- DWS-865 East Side City of Detroit Sewer Repairs Contract for Inspection and In-Place Rehabilitation of Existing Circular
- DWSD DWS-849 Design/Build services on as-needed basis for inspection and rehabilitation of 28 Outfalls in the City of Detroit
- Oakland County Sewer Rehabilitation Project

CERTIFICATIONS

PACP Certified
Confined Space Training
Manhole Safety Training
First Aid & CPR Certified
CDL Class A
Aries Operator and Technician

Tim Mulligan

Lining Crew Foreman

QUALIFICATIONS

Mr. Mulligan has 15 years of experience in the lining industry. He possesses specific experience with all the different phases of trenchless rehabilitation of existing utility systems. Tim reviews all wall thickness calculations and evaluations as to materials utilized for each CIPP Liner installation. On projects he reviews measured analysis of time requirements for bypass requirements, pit locations and placement technology to be utilized. He is also manages the day to day communication with our third party testing facility and facilitates the sending of samples and the review of reports that are returned.

EXPERIENCE

Tim is experienced, working as a field supervisor, and project coordinator. Mr. Mulligan has managed a variety of municipal, industrial and private projects. He has worked on various projects with diameters and sizes of CIPP liners ranging from 4" to 108". Sal is experienced with both circular and non-circular pipelines, pressure lines, water-mains, as well as force-mains.

COMPLETED PROJECTS

Lauderdale-By-The-Sea Piggy Back

Imperial Golf HOA Storm Sewer Lining & Rehab

City of Delray Beach Reclaim Water Expansion Area 12B

Palm Beach Sussex Kent Park Sanitary Sewer

Highpoint 5 Storm Sewer Rehab

Traveler's Resort Dade City

Fort Lauderdale Annual

Turkey Creek Storm Drain 2

LICENSES/CERTIFICATES/QUALIFICATIONS

First Aid & CPR Certified

Advanced Confined Space Training and Rescue

40-Hour Hazwoper

PACP Certified

Qualifications

Equipment Condition

Lanzo has a long history of maintaining our own equipment of fleet vehicles, heavy trucks, heavy equipment and cranes as you can see by our extensive equipment list, that control over our own destiny is the only way to insure continued success. Our maintenance program is a well-oiled machine which includes ample staff such as the Equipment Managers, Diesel Mechanics, Parts Runners, Welders, Fuel Truck Driver, and Low Boy Drivers. Our in-house maintenance and service includes two fully equipped indoor shops with overhead 10 ton cranes, on site bulk storage of fluids, spare parts stock, and fleet maintenance software and tracking system. Our Diesel Mechanics are completely mobile and provide maintenance and repair services to our heavy equipment in the field. This maintenance program in conjunction with our ability to mobilize spare heavy equipment with our Low Boy Tractor Trailer insure that down time due to equipment failure is minimized. TV Trucks and Vactor Trucks that require specialized maintenance and care in cold environments are handled and repaired by specialized and trained mechanics who are familiar with their operations and maintenance needs. This ensures that they are available for operations at all times. We also have winter storage of vehicles that allow us to keep them available and ready even in adverse conditions.

Qualifications

Equipment List

Year	Make	Model	Description	Serial #
			FLEET TRUCKS	
2015	LINCOLN	Navigator	LINCOLN NAVIGATOR	5LMJJ2HT6FEJ08459
2003	FORD	Expedition	FORD EXPEDITION	1FMRU15W33LA22233
2010	LINCOLN	Navigator	LINCOLN NAVIGATOR	5LMJJ2H57AEJ02843
2014	LAND ROVER	RANGE ROVER	RANGE ROVER SPORT	SALGS2TF1EA196237
2016	FORD	ESCAPE	FORD ESCAPE	1FMCU9G99GUB34580
2016	FORD	F-150	FORD F-150 PICKUP	1FTFX1EGXGFB68575
2016	GMC	YUKON	DENALI XL 4WD	1GKS2HKJ5GR354517
1999	FORD	F250	FORD F-250	1FTNX20F3XEE44732
2004	FORD	F250 Super Cab	FORD F-250 SUPERCAB IN SERVICE PER MARK B 1/11/2017	1FTNX21P54ED43680
2015	FORD	F-250 XL	FORD F-250 XL PICK-UP	1FT7X2A64FEC76377
2015	FORD	F-250 XL	F-250 XL SUPERCAB	1FT7X2A69FEC50163
2012	GMC	SIERRA CREW	GMC SIERRA CREW 4X4	1GT121C89CF221815
2013	FORD	ESCAPE	FORD ESCAPE	1FMCU0GX2DUA46444
2003	FORD	F250	FORD F-250 PICK-UP TRUCK	1FTSX31PX3ED38076
2015	FORD	F-250 XL	FORD-250XL 4X4 SUPERCAB	1FT7X2B60FED03797
2008	FORD	F-350	FORD F-350	1FTWX31R28EA51258
2016	FORD	F 250 XL	FORD F-250XL	1FT7X2A66GEA23448
2015	FORD	F-250 XLT	FORD F-250 XLT	1FT7X2A64FED50008
2015	FORD	F150	FORD F150	1FTEX1E8XFFB60303
2015	FORD	F250	FORD F250	1FT7X2B68FED37700
2013	FORD	F-250	FORD F250	1FT7W2B65DEB13607
2013	FORD	F-250	FORD 250	1FT7W2B61DEB15760
			HEAVY TRUCKS	
2010	INTERNATIONAL	7500 SBA 6X4	VACTOR 2115-824 PLUS (VAC S/N 10-03V-12092)	1HTWNAZT3AJ190342
1997	INTERNATIONAL	4700	INTL FLATBED BOILER	1HTSCAAN2VH496110
1997	INTERNATIONAL	4700	INTL FLATBED BOILER	1HTSCAAN4VH496111
2001	FORD	F550	F-550 CHASSIS ARIES TV	1FDAF56F21EB80514
2001	FORD	F550	F-550 CHASSIS ARIES TV	1FDAF56F51EB80538
2012	FREIGHTLINER	F3CC170 SPRINTER	FREIGHTLINER TV/CUTTER VAN	WDPPF4CC6C9520609
1991	INTERNATIONAL	4700	INTL 4700 REFRIGERATOR TRUCK	1HTSCNDNXMH320973
2015	ARIES	TR2000	TR2000 TRACTOR, 6-15IN PIPE KIT / FRAME SPREADER	TR2000-15016248

Qualifications

Year	Make	Model	Description	Serial #
2002	AEROCAP	Hi-Cube	T V Hi-Cube TV Truck	1FDXE45S72HA53473
1998	INTERNATIONAL	4900	22' Reefer Truck Tool Truck	1HTSDAAN7WH538043
1998	INTERNATIONAL	4900	22' Reefer Truck Tool Truck	1HTSDAAN4WH538047
2006	FORD	F550	F-550 CHASSIS ARIES TV	1FDAF56P46ED91584
2011	INTERNATIONAL	7400 6X4	RS CITYLINER TYPE 800 - IN SERVICE MAY 2016	1HTWGAZR5BJ356392
2008	FORD	S-DTY F-750	Rush Steam Unit	3FRXF75H78V644136
2008	FORD	F-750 / RSU 000	Rush Steam Unit	3FRXF75H58V644135
2009	VACTOR		VACTOR-7600 SFA 6X4 (VACTOR S/N 08-07V-11295)	1HTWXSBT99J086217
2015	KENTWORTH	T800	BOILER TRUCK/RUSH HEATER WITH WORK PLATFORM	1NKDL40X5FJ426720
2015	KENTWORTH	T800	BOILER TRUCK/RUSH HEATER WITH WORK PLATFORM	1NKDL40X7FJ426721
2007	PETERBILT	340	BOOM TRUCK W/NATIONAL 900A 26 TON BOOM TRUCK	2NPRLZ0X17M732773
2017	INTERNATIONAL	DURASTAR	INTERNATIONAL 26' REEFER TRUCK - LEASE #I-8650	3HAMMMMN9HL501949
2017	INTERNATIONAL	DURASTAR	INTERNATIONAL 26' REEFER TRUCK - LEASE #I-8651	3HAMMMMN5L501950
2015	KENWORTH VACTOR	T800	VACTOR 2115 - MI VACTOR	1NKDL40X2FJ431616
2016	EMAGINEERED SOLUTIONS		12" SHOOTER WITH SLIDE GATE	ESI-S12RB-U-5127-N
2016	EMAGINEERED SOLUTIONS		12" SHOOTER WITH SLIDE GATE	ESI-S12RB-U-5128-N
2016	FORD	F550	16' HIC TV CUTTER CCTV INSPECTION SYSTEM	1FDUF5GT9GEA60770
2012	NISSAN	NV3500	CUES HD TV TRUCK 2 CRAWLERS AND 2 CAMERA	1N6AF0LY3CN108007
2017	INTERNATIONAL	DURASTAR	INTERNATIONAL 26' REEFER TRUCK	3HAMMMMN9HL501949
2017	INTERNATIONAL	DURASTAR	INTERNATIONAL 26' REEFER TRUCK	3HAMMMMN5L501950
2017	INTERNATIONAL	4300	INTERNATIONAL 26' REEFER TRUCK	1HTMMMMN4JH526141
2015	INTERNATIONAL	4300	26' REFRIGERATED TRUCK	3HAMMMMN6FL744194
2016	FREIGHTLINER	2115-824P100A	VACTOR 21158254 PLUS 1	1FVHG3CYY9GHHD7620
2017	FREIGHTLINER	800HPRECOTK80	TRUCK MOUNTED JET UNIT	1FVACXDT6HHHM2321
2015			747 TRAILER JET 40 GP	1S9KU2128FD381467
1989	FORD	AEROMAX	WATER TRUCK	1FTYS95X9KVA52417
1995	GMC	TOP KICK	TOPKICK VAN	1GDL7H1J1SJ515287
2006	FORD		MECHANIC TRUCK	3FRWF65F76V315275
2000	KENWORTH	LOWBOY TRATOR	EQUIPMENT LEASE	1XKDD60X3YJ861656
		TRAILERS		
2003	SEWER EQUIP. CO		Gate Easement Machine (White)	5FLRP12173B145145

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Year	Make	Model	Description	Serial #
2005	TRIPLE CROWN	5X10 Utility Trailer	5X10 Utility Trailer 3K GVW	1NXU5X10551010395
1996	CARGO EXPRESS		CARGO INVERSION UNIT TRAILER	ICE09614119960098
1996	BEAVER		BEAVER CUTTER	1UK500F20T1019012
1995	SRECO	MD HV1800	SRECO HV1800 JET TRAILER	4H5W31729SL952004
1996	O'BRIEN	700JP	O'BRIEN 600GAL JET TRAILER	99644817296041080
2002			LARGE SEWER TRANSPORTER-ARIES	YT02012204
2004	HOTKICK		HOTKICK HEATER UNIT OM-148 LATERAL LINING	01470
2004	HOTKICK		HOTKICK HEATER UNIT OM-148 LATERAL LINING	01493
2004			MAX LINER GUN LATERAL LINING	LG001001
2004	SOEHNLE		SOEHNLE DIGITAL SCALE LATERAL LINING	7755
2004			VACUUM PUMP LATERAL LINING	LG000043
2004			HAND CALIBRATION ROLLER LATERAL LINING	KR000001
2006	BLACKROCK	TRAILER	BLACKROCK UTILITY TRAILER 8000HD	2SWUW11A96S044474
2007	INGERSOLLR	P185WIR	INGERSOLLR AIR COMPRESSOR	343329/NOVIN0200661278
2000	O'BRIEN	JET TRAILER	O'BRIEN JET TRAILER	1Z93PJ2E8YL119086
2005	SRECO	350 JET TRAILER	MODEL 350 TRAILER JET - 300 GALLON	2374 (CHASSIS VIN#2435)
1970	GREAT DANE		DROP DECK TRAILER	43611
1999	RITE	750-WO	RITE WATER HEATING BOILER BOX	26868
1999	RITE	750-WO	RITE WATER HEATING BOILER BOX	26887
2006	MQ POWER	DCA45SSIU3C	MQ POWER 36KW DIESEL GENERATOR	3774786
	60" SCAFFOLD	HOMEMADE	60" HOMEMADE SCAFFLOLD	N/A
2006	WE HAUL		TANDEM AXLE TRAILER	5NHUWE6266N057057
			MIS GROUT & CCT EQUIPTMENT GROUT SYSTEM	
2000	SRECO	JETTER	JETTER TRAILER - 600gal TANK	4H5W31726YL002661
2006	ROYAL CARGO	RSTCH 8.5X20TA3	ROYAL CARGO TRAILER	5LABE202X6M012980
2005	PACE AMERICAN	LM714TA2	PACE AMERICAN TRAILER - SAFETY TRAILER	4FPUB14235G092534
2006	SULLAIR	210HDPQ	SULLAIR 210HDPQ AIR COMPRESSER	152104
2006	SULLAIR	210HDPQ	SULLAIR 210HDPQ AIR COMPRESSER	152096
2015	PACE AMERICAN	CS7X14TA	PACE AMERICAN TRAILER - SAFETY TRAILER	53BPTEA20FU013501
1992			48' REFRIGERATED TRAILER-WHITE	IDTV61Z22NA206931
1978			COPCO FLATBED TRAILER 45' X 96"	15389
			SECA EASEMENT TRAILER	6524
1998	UTILITY	VS2R-48/162/102	48' REFRIGERATED TRAILER	1UYVS2480WM689603
2004	UTILITY	ALUM 48/162/102	48' INSULATED REEFER TRAILER	1UYVS24814M232702

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Year	Make	Model	Description	Serial #
2015	INTERNATIONAL	4300	26' REFRIGERATED TRUCK - IDEALEASE OF MIAMI U# I-8609	3HAMMMMN6FL744194
2016	YONGQIANG	4X8 UTILITY TRAILER	48X96 FOLDING TRAILER	L4WC1H811GA093989
2017	PACE AMERICAN	JV85X20TE3	PACE AMERICAN TRAILER - TOOL TRAILER	53BPTEB26HU023578
2016	GT EXPRESS	T1022275-10P	PERMALINER 22' TRAILER / F-10 TOP GUN EQUIPMENT	5GLBE2221GC000482
			SMALL EQUIPMENT	
2015	CUES	KANGAROO	CUES KANGAROO POWER CUTTER - UNIT#218	
2015	CUES	KANGAROO	CUES KANGAROO POWER CUTTER - UNIT#218	
2015	CUES	KANGAROO	CUES KANGAROO POWER CUTTER - UNIT#218	
2015	CUES	KANGAROO	CUES KANGAROO POWER CUTTER - UNIT#218	
2013	HAMMERHEAD	HG20	HAMMERHEAD HG20 WINCH	1E9WD1423CC196266
2013	HAMMERHEAD	HG20	HAMMERHEAD HG20 WINCH	1E9WD1429CC196241
2014	HAMMERHEAD	HG5	HAMMERHEAD HG5 WINCH	1E9WE07199C196158
2014	HAMMERHEAD	HG12	HAMMERHEAD HG12 WINCH	1E9WC1424EL196317
2015	HAMMERHEAD	HG12	HAMMERHEAD HG12 WINCH	1E9WC1421EC196299
2014	CIPP	8 - 18 BASIC	CIPP SVC MODEL 8-18 AIR INVERTER / SHOOTER	
1994	TAYLOR	TE155S	TAYLOR FORKLIFT TE155S	S-B5-21221
2001	TAYLOR	THD610	TAYLOR FORKLIFT THD610	29911
2010	NISSAN	CFU50LP	NISSAN FORKLIFT	CU1F2-9Q0942
1998			CAT 938 F WHEEL LOADER w/gp Bucket	1KM01745
2015	NozzTeq	LJ300C	24" TORQUE MULTI PURPOSE CUTTER	
2004			Rotating Chain Cutter 8"-16" Pipes	10.200R
2005	ENZ	EU10200RS	Rotating Chain Cutter 8"-16" Pipes	
2009	TURBO II	CHAIN CUTTER	FLEXIBLE 6" - 12" CHAIN CUTTER	P/N 1-0403
	SUPER CUTTER	PLUS 200	SUPER CUTTER PLUS 200 CHAIN CUTTER	200151-C
	BEAVER CUTTER	B-165	BEAVER CUTTER B-165	BDO 8206
			BEAVER CUTTER B-165	BDO 8106
			BEAVER CUTTER B-165	BF 09311
			BEAVER CUTTER B112 MINI	MF 02811
	BOWMAN	DOMINATOR 4-30	BOWMAN DOMINATOR 4-30 CUTTER	CD-1-06-06-0-0-4 PENN
			CUES CAMERA (PAN & TILT)	069
			CUES CAMERA (STRAIGHTLINE)	070
			CUES CAMERA (PAN & TILT)	078
			CUES CAMERA (PAN & TILT)	010
2004			"LETS" LATERAL CAMERA	04101801
2005	ARIES	PE-2600	Color Pan & Tilt Camera	05091101

Qualifications

Year	Make	Model	Description	Serial #
2005	FLOW-TEK	LJ300C	8"21" Lumberjack 300 Series	
2007	NozzTeq	LJ300C	8"21" Lumberjack 300 Series	
2007	ARIES	SEEKER	SELF LEVELING CAMERA W/200' PUSH ROD	SK3200
2015	PROTEUS	MINI CAM	PROTEUS INSPECTION SYSTEM BY MINICAM	PCU-0121
	ARIES	TITAN TR7000	TITAN TR7000 LARGE 4 WHEEL TRACTOR	LOCATE SERIAL # 2016 !!!
2016	KOHLER	CH 1000	9085 PRESSURE WASHER 7000PSI	16-11216
2016	CHEMGROUT	708354-7112	TRAILER MOUNT AIR POWERED GROUT MACHINE W/DBL HOPPER	16131225002C6GH
1999			36 X 60 DOME HEAD PLUG	
2012	CHIPPING UNIT	HOMEMADE	ALUMINUM CHIPPING UNIT - (MOBILE UNIT TO UNIT)	
			RIDGID 23717 DRAIN CLEANER	Mod # 23717
1997			STANLEY HYDRAULIC UNIT-PORTABLE	640
2000			HYD.POWER UNIT W/PUMP10209	7907
	HOMEMADE 15' PORTABLE	PINCH ROLLERS	OVER-THE-HOLE ROLLER & CONVEYOR	
	COMMERCILA ICE		INDUSTRIAL ICE MACHINE	
2006	INGERSOL RAND	PD20A-AAP-STT	2" Diaphragm Vacuum Pump - 3/4 HP Motor	HO316 417
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2015	UNICO COMNMERICAL	SLED FABRICATION	PIPE ACCESS SLED CART	HOME MADE NO S/N
2016	TITAN	SERIES 160 INCH	PORTABLE WET-OUT CONVEYOR W/RESIN MIXING SYSTEM	N/A
1997			SULLAIR 185 DPG AIR COMPRESSOR	004-124324
1997			SULLAIR 185 DPG AIR COMPRESSOR	004-124331
2007	SULLAIR	185 DPQ	SULLAIR 185 DPG AIR COMPRESSOR	200705160129
			PROSCOUT COLOR CAMERA	03021801
	HONDA	WB20X/WB30X	Honda 2" Water Pump	1259219
2007	ROL-AIR	7722HK28	8hp Gas Compressor (Honda) w/Regulator	07071549
	GENERAL	GPS	BLOWER - GP8	H30671
			VIPER TURBO GAS FOAM GENERATOR	004-152096
2006	ALLEGRO	9504	Manhole Blower (Electric Motor)	1899

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Year	Make	Model	Description	Serial #
1994			4-INCH THOMPSON PUMP / TRAILER MTD.	NOVINO200076813
1996			6-INCH THOMPSON VAC-ASST PUMP	TPM41011J1566V393
2006	ALLEGRO	9504	Manhole Blower (Electric Motor)	1898
2006	GENERAL	GP8	Manhole Blower (BRIGGS & STRATTEN Engine)	050830YA
1999	ALLEGRO		ALLEGRO MANHOLE BLOWER 9505	56282
2005	GENERAL	GP8H	Manhole Blower (Honda Engine)	33832
2001			4" TRASH PUMP	33606
2001			4" TRASH PUMP	28525
2002			4" TRASH PUMP	36991
2002			PARTNER K-700 CUT OFF SAW	023400291
2005	HONDA	WT40X	4" Trash Pump (Honda)	WT40XK2 GX340K1
2005	MULTIQUIP	QP3TH	3" Trash Pump (Honda)	3TH-5255
2006	MULTIQUIP	QP3TH	3" Trash Pump (Honda)	3TH-5212
2006	MULTIQUIP	QP4TH	4" Trash Pump (Honda)	4TH-0370
2006	MULTIQUIP	QP4TH	4" Trash Pump (Honda)	4TH-0709
2005	HONDA	WB20X	2" Water Pump (Honda)	GCAAT-1529760
2007	HONDA	WT30X	3" Trash Pump (Honda) IN SVC NOV 2011	1122831
2007	HONDA	WT40X	4" Trash Pump (Honda)	1106081
2007	MULTIQUIP	QP3TH MQ	3" Trash Pump	11899
	HONDA	WT40X	4" TRASH PUMP - ATTACHED UNIT 225	
2008	KUBOTA	SEP-21.0	INDUSTRIAL GENERATOR - ATTACHED TO U#212	0235531/002
	WACKER	PT3A	3' PUMP, ENG PA2X/GBJT S/N 10865244	112114063
2008	HONDA	WT30X	3" TRASH PUMP	1122942
2008	TSURUMI	EPT3100HA	4" PUMP	03166
2008	HONDA	WB20XT	2" Water Pump (Honda) / REPLACES UNIT #941	CBNT-1067306
	HONDA	EB5000X	HONDA GENERATOR	GC05-3872817
2010	HONDA	WT40X	4" TRASH PUMP	1114990
2010	HONDA	WT40X	4" TRASH PUMP	1114993
2010	HONDA	WT40X	4" TRASH PUMP	1111670
2011	GORMAN R	14C1-GX30	4" GAS TRASH PUMP	1482897
	GORMAN RUPP	PA4A60-4045DSH	4" DIESEL SELF=PRIME PUMP	1284077
			BROWNIES THIRD LUNG-C260X	
2004			ALUMINUM SHOOTER FOR CIPP	
2006	POWER PRO	3500	GENERATOR - 3500	ENG #HY168FB/B2017299
2006	MULTIQUIP	QP3TH	4" Trash Pump (Honda)	3TH-8710

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Year	Make	Model	Description	Serial #
2006	POWER PRO	3500	GENERATOR - 3500	ENG #HY168FB/B2017370
	NORTH STAR	13000 PPG	GENERAOR (HONDA ENGINE)	8050059
2006	HONDA	EM2500	GENERATOR - (Honda)	ENG #GC02-5669839
2007	STIHL	MS200T	14" CHAIN SAW	164677109
2007	SCHONSTEDT	GA-5Z-CX	METAL DETECTOR - REBAR LOCATOR	235068
2007	STIHL	TS400	Cut off Saw	166644774
2007	STIHL	TS-400	CUT OFF SAW	166477798
2007	*MSA*	SOLARIS	MULTIGAS DETECTOR (P/N10047226)	A5-76789
2007	*MSA*	SOLARIS	MULTIGAS DETECTOR (P/N10047226)	A5-76788
2007	*MSA*	SOLARIS	MULTIGAS DETECTOR (P/N10047226)	A5-74599
2006	*MSA*	SOLARIS	MULTIGAS DETECTOR (P/N10047226)	A5-45079
2006	*MSA*	SOLARIS	MULTIGAS DETECTOR (P/N10047226)	A5-45083
2008	STIHL	TS420	TS420 STIHL SAW	168695551
2008		PPT265	26CC POWER PRUNER/POLE SAW	11006153
2008	STIHL	TS420	14" CUTQUIK SAW	168392018C
2010			AIR IMPACT WRENCH 11IN	
2009	RKI	GX-2001 (N)	MULTIGAS DETECTOR (RED)	8X3020450
2010	RKI	GX-2001 (N)	MULTIGAS DETECTOR (RED)	9Y4020012
2016	IT-RD62-78314	ROCK DRILL	IT-RD62-78314 ROCK DRILL 7/8 X 3-1/4 30LB	N/A
2016	IT-RD62-78314	ROCK DRILL	IT-RD62-78314 ROCK DRILL 7/8 X 3-1/4 30LB	N/A
2011	*MSA*	ALTAIR 4X	ALTAIR 4X MULTIGAS DETECTOR	
2012	*MSA*	ALTAIR 4X	ALTAIR 4X MULTIGAS DETECTOR	138298
2012	*MSA*	ALTAIR 4X	ALTAIR 4X MULTIGAS DETECTOR	138299
2016	SUNITEC/SPITZNAS	CS213350010	HAND HELD CORE DRILL, WET PNUEMATIC 3.8HP	16121
2016	SUNITEC/SPITZNAS	CS213350010	HAND HELD CORE DRILL, WET PNUEMATIC 3.8HP	16122
2016	SUNITEC/SPITZNAS	CS213350010	HAND HELD CORE DRILL, WET PNUEMATIC 3.8HP	PENDING 8-17-16
2012	ECKO	*AIR MOVER*	Reversible 8" Confined Space Blower with Hose	0003576
2012	FRENCH CREEK	*TP7*	7' Adjustable Aluminum Tripod	19176
2012	FRENCH CREEK	R50G	3 Way Rescue Unit	19045
2012	FRENCH CREEK	MW50G	Work Winch	19077
2016	WACKER	PUMP PTS4V	4" TRASH PUMP W/VANGUARD (GAS ENGINE)	20280919
2016	WACKER	PUMP PTS4V	4" TRASH PUMP W/VANGUARD (GAS ENGINE)	20280918
2016	WACKER	PUMP PTS4V	4" TRASH PUMP W/VANGUARD (GAS ENGINE)	20280916
2016	WACKER	PUMP PTS4V	4" TRASH PUMP W/VANGUARD (GAS ENGINE)	20280917
2016	SOLER & PALAU	CTB42	INDUSTRIAL TUBULAR CENTRIFUGAL BLOWER	SN579371-1

Qualifications

Year	Make	Model	Description	Serial #
2016	SOLER & PALAU	CTB42	INDUSTRIAL TUBULAR CENTRIFUGAL BLOWER	SN579371-2
	TSURUMI	GOMAR	4" TRASH PUMP - P.K.12	1017682
	TSURUMI	GCARK	3" TRASH PUMP - WKT2	1005083
	TSURUMI	GCO1	2" TRASH PUMP - TE250HA WKTZ	4357811
	TITAN		3" TRASH PUMP ON WHEELS	196L55/43550P
2012	HONDA	WB20X	2" CENTRIFUGAL PUMP - HONDA GX120	WABT-1650759
	HONDA	GX270	HONDA 4500W ELECTRIC GENERATOR	GCALK-1040111
	HONDA	GX270	HONDA 4500W ELECTRIC GENERATOR	GCALK-1040115
	MAKITA	DCS-6401	MAKITA CHAIN SAW	508847562
	STIHL	STIHC-039	STIHL CHAIN SAW	1127-021-0800
	POULAN PRO	PP4218A	42CC POULAN CHAIN SAW	13296N200425-1
	STIHL	MS290	STIHL CHAIN SAW	287250125
	SEWER PLUG		24"X48" SEWER PLUG WITH "4 FLOW THRU AND 24" SLEEVE	
	SEWER PLUG		24"X48" SEWER PLUG WITH "4 FLOW THRU AND 24" SLEEVE	
	SEWER PLUG		24"X48" SEWER PLUG WITH "4 FLOW THRU AND 24" SLEEVE	
	SEWER PLUG		36"X60" SEWER PLUG WITH 36" SLEEVE	
2016	HONDA	EU2000	HONDA GENERATOR - 2K WATT	EACT-1392652
2016	HONDA	EU2000	HONDA GENERATOR - 2K WATT	EACT-1336892
2016	TEMPAIR	C-2000	PORTABLE FILTRATION UNIT 115V	12649
2016	TEMPAIR	C-2000	PORTABLE FILTRATION UNIT 115V	12834
	PRAMAC	S-6000	6000 KW GENERATOR	PWS0150336B
2016	TSURUMI		2" TRASH PUMP - W/GX160 HONDA	18176
2016	LANDA	HD40AGEB	COLD WATER BELT DRIVEN POWER WASHER 4000PSI	11072770-100135Q
2015	TORPEDO HEATER		OIL FIRED TORPEDO HEATER - 170,000 BTUH	3VE51
2016	THOMPSON	PUMP SER #6JSVEE-022	6" VAC ASSISTED HIGH PRESS PUMP TRAILER MOUNTED	TRLR SER #1T9PH1415GP634223
2016	RYOBI	RY903600	RYOBI 3600 GENERATOR	DB16233D030366
	PLUNGE CUT	890	CONCRETE CHAIN SAW	14186
	DOMEHEAD	2/1/2017	6" X 10" DOMEHEAD PLUG	
	DOMEHEAD	2/1/2017	12" X 18' DOMEHEAD PLUG	
	6" FLOW THROUGH	2/1/2017	10" X 16" - 6" FLOW THROUGH PLUG	
	6" FLOW THROUGH	2/1/2017	20" X 40" - 6" FLOW THROUGH PLUG	
	DOMEHEAD	2/1/2017	24" X 48" DOMEHEAD PLUG'S @ 3PCS	
	DOMEHEAD	2/1/2017	48" X 32" DOMEHEAD PLUG	
	4" FLOW THROUGH	2/1/2017	12" X 18' - 4" FLOW TROUGH PLUG	
	4" FLOW THROUGH	2/1/2017	10" X 16" - 4" FLOW THROUGH PLUG	

LANZO TRENCHLESS TECHNOLOGIES

Qualifications

Year	Make	Model	Description	Serial #
	2" FLOW THROUGH	2/1/2017	8" - 2" FLOW THROUGH W/HIGH PRESSURE PLUG	
	2" FLOW THROUGH	2/1/2017	24" - 2" FLOW THROUGH W/HIGH PRESSURE PLUG	
	DOMEHEAD	2/1/2017	20" X 36" DOMEHEAD PLUGS @ 2PCS	
	2" FLOW THROUGH	2/1/2017	15" X 30" - 2" FLOW THROUGH PLUG	
	4" FLOW THROUGH	2/1/2017	8" X 12" - 4" FLOW THROUGH PLUG	
	6" FLOW THROUGH	2/1/2017	12" X 18" - 6" FLOW THROUGH PLUG	
			SAFETY TOOLS	
2016	SCBA AIRHAWK II	AIRHAWK II 4500	SELF CONTAINED BREATHING APPARATUS	MULTIPLE
2015	OdaLog RT	H2S	OdaLog WIRELESS H2S LOGGER W/ OdaStat-G SOFTWARE	MULTIPLE
2015			COMMUNICATION SYSTEM - OMID 5B	MULTIPLE