# NJWEA - Fall Tech Transfer 2025 Trenchless Technologies

GEOTREE

Henkel LOCTITE

**NJWEA 2025 FALL TECHNOLOGY TRANSFER SEMINAR**
**WED OCT 22ND 2:10 – 2:50 PM**

## GEOPOLYMER OR NOT GEOPOLYMER … THAT IS THE QUESTION

1

## WELCOME TO GEOTREE'S WEBINAR

SCOTT NAIVA, P.E.; MBA – PRESENTER

- Northeast Region Manager for GeoTree Solutions (11 yrs)
- B.S. in Civil Engineering from Syracuse University, NY
- MBA from Eastern University, Saint Davids PA
- 36 Years of Engineering Consulting and Business Development Engineering Sales Experience
- Past Board Member of Mid Atlantic Society for Trenchless Technologies (MASTT)
- Active member in 4 Regional Water Environment Association Collection Committees

Scott Naiva, P.E.; MBA Northeast Region Manager, Wayne PA
Scott.Naiva@Henkel.com; c: 610-971-0362

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2

## OUTLINE OCT 2025

- What is a geopolymer? Why is this important?
  - Flexural Strength, corrosion resistance, self bonding
- How to design a geopolymer liner
  - Design method – Distributed Beam WRc -Approved
  - Apples to apples bid documents
- Case Studies
  - (BWSC) New Boston Main Interceptor and Canal Street
  - Pittsburg Water Sewer Authority (PWSA)
  - Richmond Virginia Marshall Street -1900' of 60" diameter brick pipe
  - Narragansett Bay Commission (NBC) Brick Pipe Rehab Route 6 & 10 Interchange
  - DC Water, NJ B Street (18' diam pipe) & Lower Area Trunk Sewer (42" diam pipe)
  - DelDOT – Three Large Plate Steel Culvert up to ~17' Span (Corrugations Filled)
  - PennDOT I84 – VE saves $3,000,000; Saves 8 acres of trees, 4000' access roads
  - PennDOT I95 – Philadelphia Water Dept (PWD) ~2100' 93" Brick Pipe
- Calculators - Thickness Design Calculators Pipe and Manhole

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3

## GEOPOLYMER LINING SYSTEM (GLS) CONSTRUCTION & ALTERNATIVES

TECtalks GEOTREE

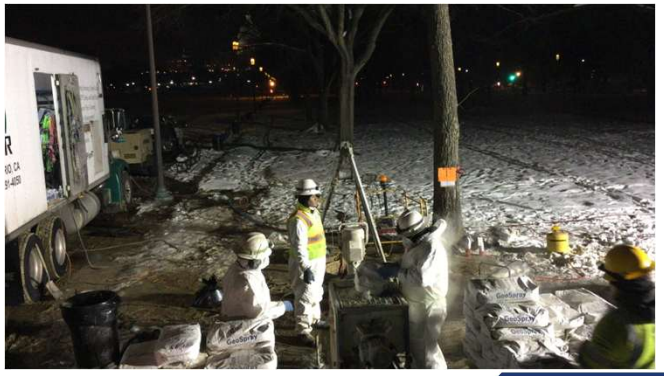
4

# NJWEA - Fall Tech Transfer 2025 Trenchless Technologies

## STRUCTURAL - GEOPOLYMER LINING SYSTEM (GLS)


5

## STRUCTURAL - GEOPOLYMER LINING SYSTEM (GLS)



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6

## GEOPOLYMER MIXING AND PUMPING

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7


8

## GEOPOLYMER SHOTCRETE APPLICATION

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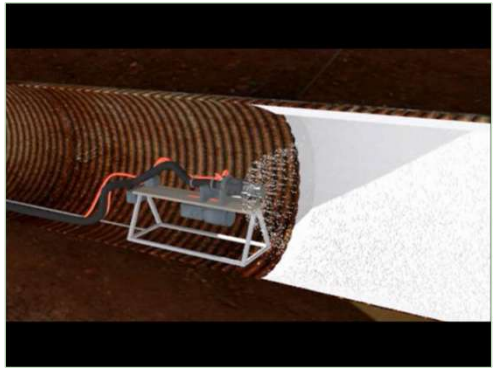
9

## GEOPOLYMER LINING SYSTEM (GLS)



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## INTERNAL BYPASS

INLET SUMP

INCOMPLETE INVERT

COMPLETED INVERT

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11

## GLS - SMALL CONSTRUCTION FOOTPRINT

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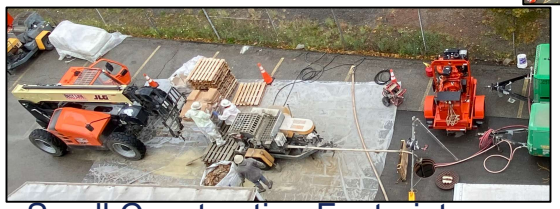
## GLS – SMALL CONSTRUCTION FOOTPRINT

Small equipment footprint allows for flexibility & planning around client needs.

13

## 101” BRICK ARCH PIPE



Near Busway

Small Construction Footprint

14

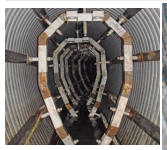
## CIPP OVER THE HOLE WET OUT: FOOTPRINT

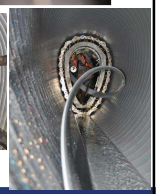
10’ Diameter CIPP Wet Out Footprint – 3 to 4 traffic lanes

15

## TRENCHLESS TECHNOLOGY ALTERNATIVE SUMMARY

| CIPP | GEOPOLYMER LINING SYSTEM (GLS) | REINFORCED OPC SHOTCRETE |
|---|---|---|



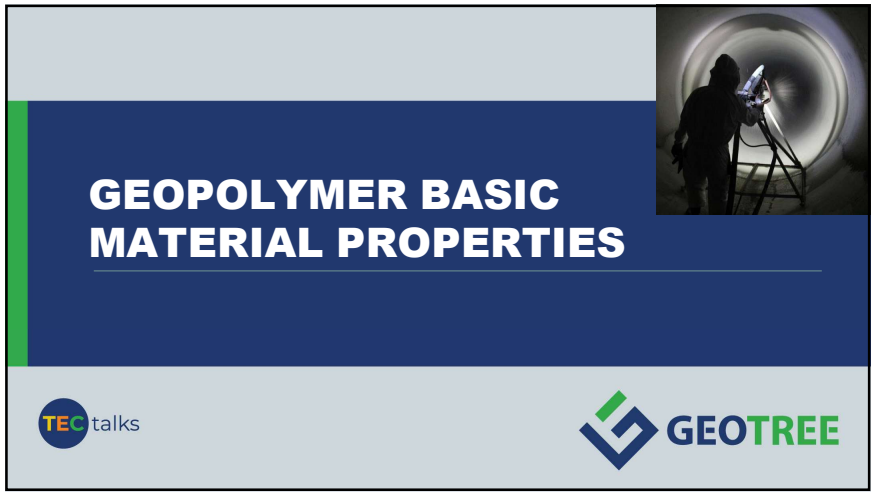


PAVED INVERT

SLIP LINE

SPIRAL

16




17

## COMPARISON OF ORDINARY PORTLAND CEMENT (OPC) WITH GEOSPRAY AND GEOSPRAY HCE

| Test Method / Description | Duration | Ordinary Portland Cement (OPC) | GeoSpray Geopolymer | GeoSpray HCE Geopolymer |
|---|---|---|---|---|
| Compressive Strength ASTM C39 / C109 (psi) | 28 days | 5,000 | 8,000 psi | |
| Flexural Strength ASTM C78 (psi) | 28 days | 500 psi | 1,500 psi | |
| X-Ray Fluorescence (XRF) testing ASTM C114 is used to verify 70% minimum of pozzolanic material composed of $SiO^2$, MgO, $Al^2O^3$, or $Fe^2O^3$ | N/A | No - usually 0 to 10% | Yes - only geopolymers have over 70% | |
| Carbon Footprint (Manufacturing) | N/A | * | * 65% to 90% less than OPC (Davidovits 2011) | |
| Chemical Corrosion Resistance DIN 19573 | Varies | Pass XWW2 ? | Pass XWW3 | Pass XWW4 |

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18

## WHAT IS A GEOPOLYMER?

**Not a Plastic**
- Not HDPE / PVC / Epoxy

**Looks and feels like cement**
- Workability
- Material Properties
- Service Life

**Chemical structure like natural stone**
- Monolithic
- Durable
- Corrosion Resistant

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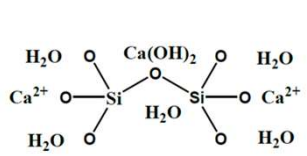
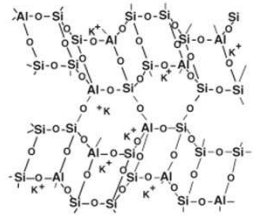
19

## GEOPOLYMER CHEMISTRY PRIMER




Typical Hydrated Ordinary Portland Cement (OPC) Structure



Typical Geopolymer Structure

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20

## SELF BONDING

Joint in Tested Sample

GeoSpray Geopolymer

Portland Based Material


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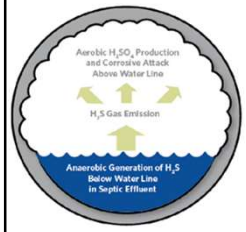
21

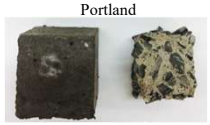
## CHEMICAL ACID RESISTANCE TESTING ASTM C-267 (MICROBIAL INDUCED ACID CORROSION)



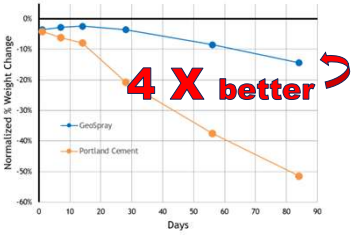

GeoSpray


Day 0 Day 84

Portland



Day 0 Day 84




**ASTM C-267:** 2" cubes soaked in 7% sulfuric acid (pH =.9) for 84 days before & after

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## CHEMICAL RESISTANCE TESTING ASTM C-267-01 TESTING PARAMETERS NEEDS TO BE DEFINED

**Chemical (including concentration):**
- 1% Sulfuric Acid – pH 1.3
- 7% Sulfuric Acid – pH 0.9

Type & size of sample: 2" cubes
Maturity (time of cure) 28 Days Cure

Volume of test solution (excess solution will cause large differences in results) 2 Liter per container

Size of container
- 10" wide x 7" long x 2.5" deep
- 12 samples per container

Time between changing test solution
- 1,7,14,28 and 56 -days

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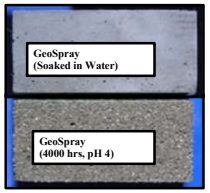
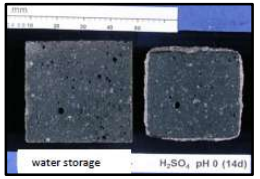
## CHEMICAL RESISTANCE CORROSION TEST DIN 19573

**Exposure Service Level XWW1 to XWW3**
- Constant pH 4 for 4000 hrs
- GeoSpray Passes XWW3
- GeoSpray for below 10ppm $H_2S$




**Exposure Service Level XWW4**
- Constant pH 1 for 70 days – 75% Residual Compressive Strength
- Constant pH 0 for 14 days – 55% Residual Compressive Strength
- GeoSpray HCE Passes XWW4
- GeoSpray HCE Certified for Highest Level >10 ppm $H_2S$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DESIGN METHODOLOGY
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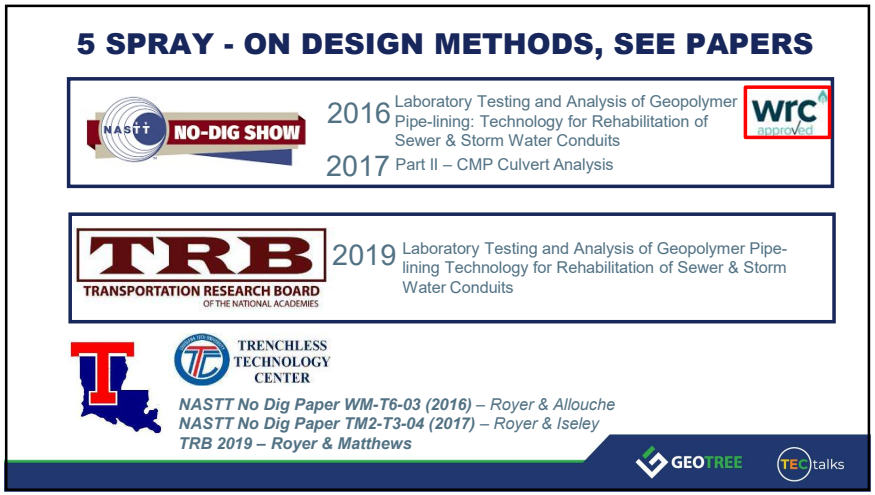
25


5 SPRAY - ON DESIGN METHODS, SEE PAPERS
NASTT NO-DIG SHOW
2016 Laboratory Testing and Analysis of Geopolymer Pipe-lining: Technology for Rehabilitation of Sewer & Storm Water Conduits
2017 Part II – CMP Culvert Analysis
wrc approved
TRB TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES
2019 Laboratory Testing and Analysis of Geopolymer Pipe-lining Technology for Rehabilitation of Sewer & Storm Water Conduits
TRENCHLESS TECHNOLOGY CENTER
NASTT No Dig Paper WM-T6-03 (2016) – Royer & Allouche
NASTT No Dig Paper TM2-T3-04 (2017) – Royer & Iseley
TRB 2019 – Royer & Matthews
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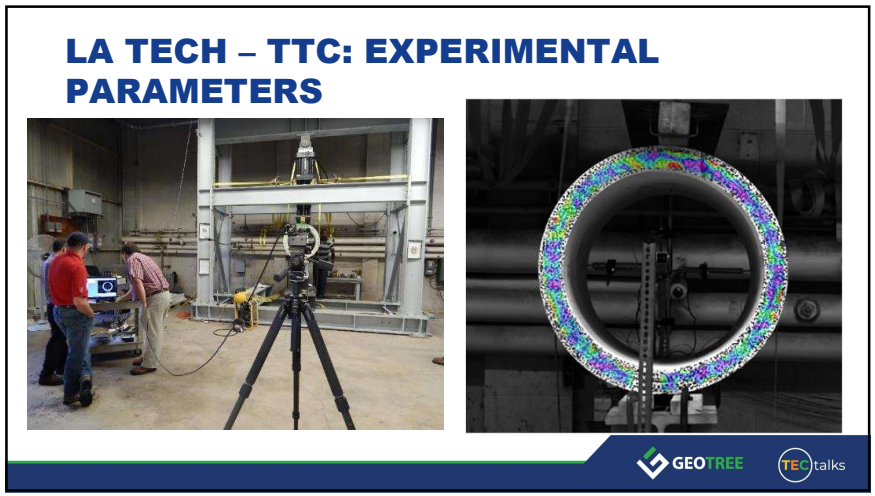
26


LA TECH – TTC: EXPERIMENTAL PARAMETERS
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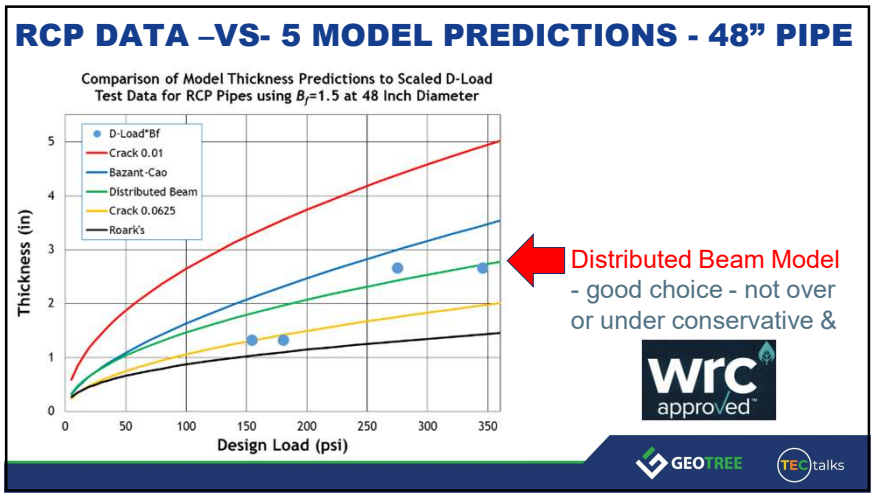
27


RCP DATA –VS- 5 MODEL PREDICTIONS - 48” PIPE
Comparison of Model Thickness Predictions to Scaled D-Load Test Data for RCP Pipes using $B_f$=1.5 at 48 Inch Diameter
D-Load*Bf
Crack 0.01
Bazant-Cao
Distributed Beam
Crack 0.0625
Roark's
Thickness (in)
Design Load (psi)
Distributed Beam Model - good choice - not over or under conservative &
wrc approved
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28

## APPLE TO APPLE COMPARISONS
## EBC TMIN CURVE

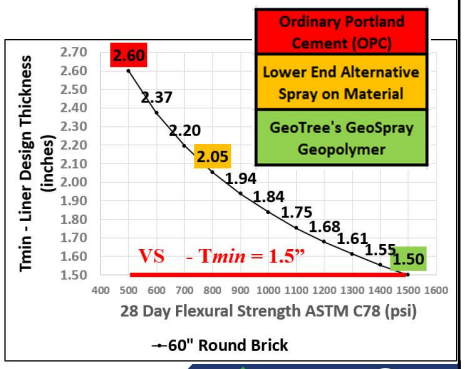
Equal Bearing Capacity Thickness minimum

EBC Tmin -vs- Flex Strength (FS)

$$EBC\ T\ min = 1.5" \sqrt{\frac{1500}{Fs}}$$

Per the distributed beam model:
1.5" @ 1500 FS = 2.05" @ 800 FS
= 2.60" @ 500 FS*

*at 500 FS, often wire mesh or rebar is added in

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29

## QAQC TESTING EVERY 42,000 POUNDS

DELAWARE

Beam molds and coolers

2" x 2" x 8" beams

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30

## BWSC – 2021 CIP REHAB OF LARGE DIAMETER SEWER MAINS
### CITY PROPER & SOUTH BOSTON

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TRENCHLESS TECHNOLOGY CENTER.

1/10/23 Boston Municipal Forum

31

## BWSC PROJECT LINING TYPES

| Diameter (in.) | CIPP (LF) | GLS (LF) ~~OPC with Epoxy~~ | Total / % Complete |
|---|---|---|---|
| 15" to 18" | 827 | | |
| 36" & 30" x 36" | 440 | | |
| Manholes 48" | | 1009 | |
| 48" Pipe | | 951 | |
| 60" & x 57" x 60" | | 501 | |
| 66" | 370 | 1825 -370 = 1455 | |
| **Total** | **1637** | **3916** | **5553' / 56%** |

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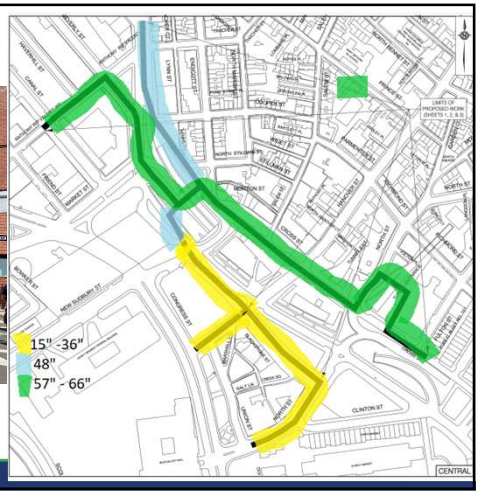
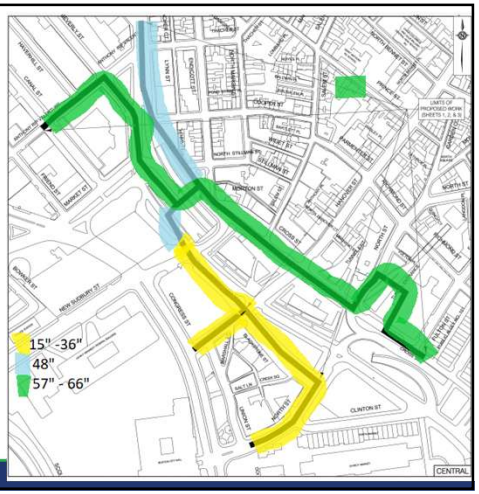
32

## PROJECT LOCATION




33

## PROJECT LOCATION


34

## OPTIONS CONSIDERED

**Dig and Replace**

– Expensive, longer construction window, greater impact to environment

**Slip Lining**

– Needed insertion pit and decreased hydraulic capacity, $$$

**Cured in Place Pipe (CIPP)**

– Permitted on bid for15", 18" & 36" pipe. Change order for and 370' of 66" Pipe

– Good option on smaller pipes, variable option for larger pipe requiring MH cover removal & external bypass

**Geopolymer Lining System (GLS)**

– Selected for small footprint, thin liner & improved hydraulics, internal bypass, excellent corrosion and scour protection, no MH cover removal, lack of cold joints

**Ordinary Portland Cement (OPC) with 125 mil Epoxy**

– Permitted on bid but not selected, similar GLS benefits but weaker strength required greater thickness and poor corrosion resistance required 125 mil epoxy, cold joints in concrete

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35


## GEOPOLYMER LINING – CLEAN AND BYPASS


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36


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GEOPOLYMER LINING – CLEAN AND BYPASS
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37


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GEOPOLYMER LINING – SPRAY CREW SET UP
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GEOPOLYMER LINING – SPRAY CREW SET UP
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GEOPOLYMER LINING – SPRAY CREW SET UP
GeoSpray HCE
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40

## GEOPOLYMER LINING – SPRAY CREW SET UP

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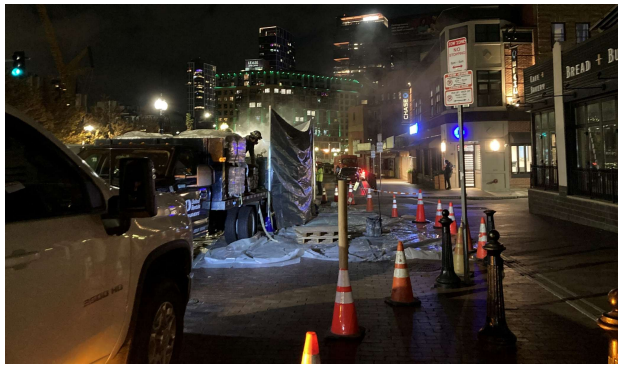
41

## GEOPOLYMER MIXING WITH WIND SCREEN



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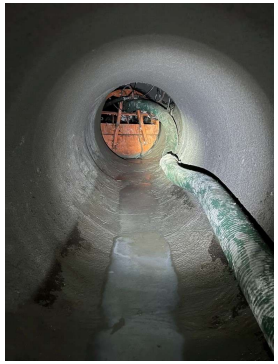
42

## GLS INTERNAL BYPASS UPSTREAM DAM



GVC Construction, Inc.

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43

## GLS INTERNAL BYPASS DOWNSTREAM OUTLET

GVC Construction, Inc.

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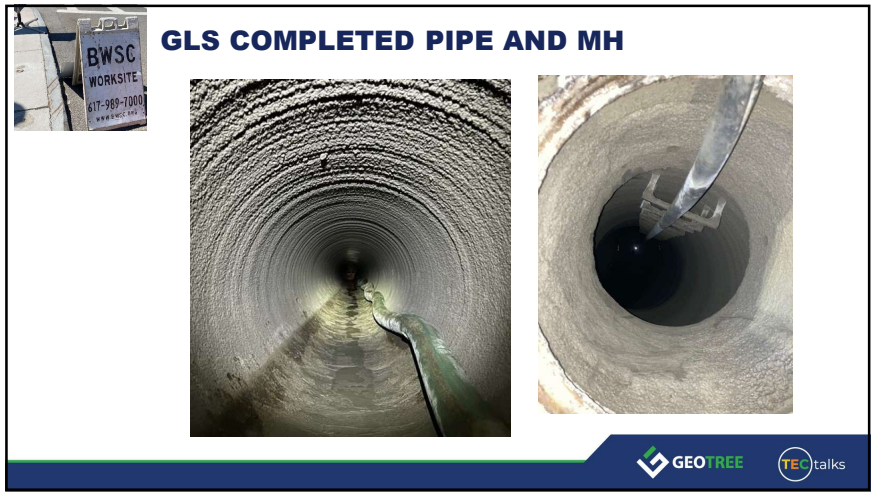
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GLS COMPLETED PIPE AND MH
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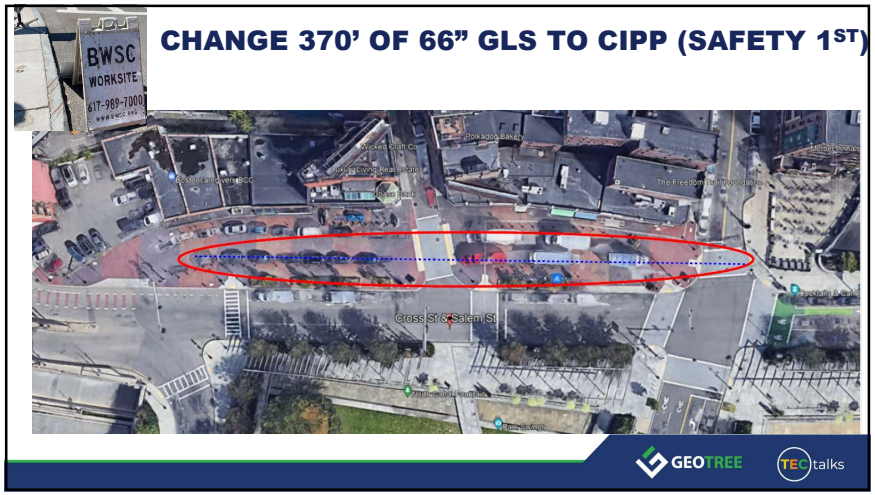
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CHANGE 370' OF 66" GLS TO CIPP (SAFETY 1ST)
Cross St & Salem St
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46


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CIPP EXPOSE 48" MH SHAFT FOR 66" CIPP
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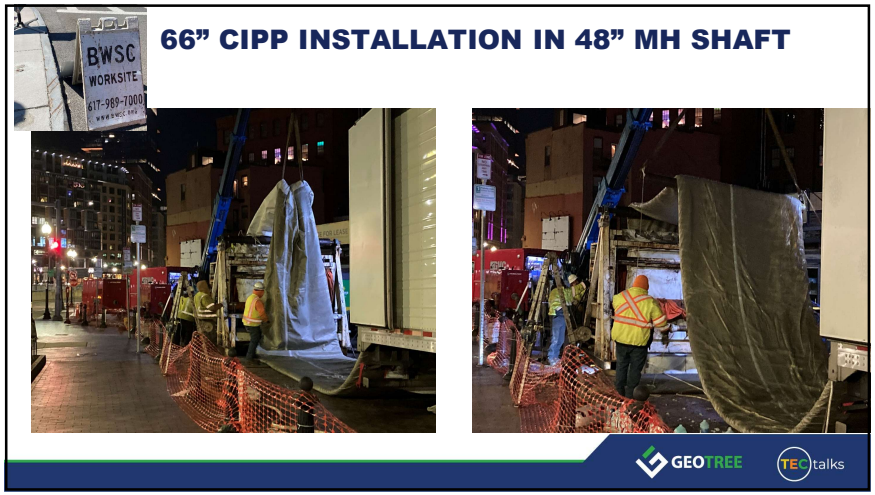
47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66" CIPP INSTALLATION IN 48" MH SHAFT
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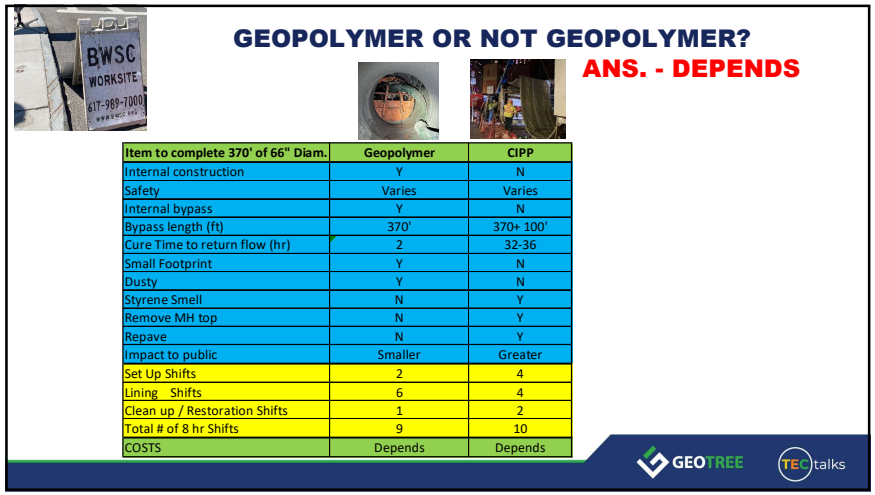
48


BWSC
WORKSITE
617-989-7000
GEOPOLYMER OR NOT GEOPOLYMER?
ANS. - DEPENDS
Item to complete 370' of 66" Diam. | Geopolymer | CIPP
Internal construction | Y | N
Safety | Varies | Varies
Internal bypass | Y | N
Bypass length (ft) | 370' | 370+ 100'
Cure Time to return flow (hr) | 2 | 32-36
Small Footprint | Y | N
Dusty | Y | N
Styrene Smell | N | Y
Remove MH top | N | Y
Repave | N | Y
Impact to public | Smaller | Greater
Set Up Shifts | 2 | 4
Lining Shifts | 6 | 4
Clean up / Restoration Shifts | 1 | 2
Total # of 8 hr Shifts | 9 | 10
COSTS | Depends | Depends
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49


CITY OF RICHMOND
PWSA LDSR 2020- 2025
PITTSBURGH WATER SEWER AUTHORITY – LARGE DIAM. SEWER REHAB
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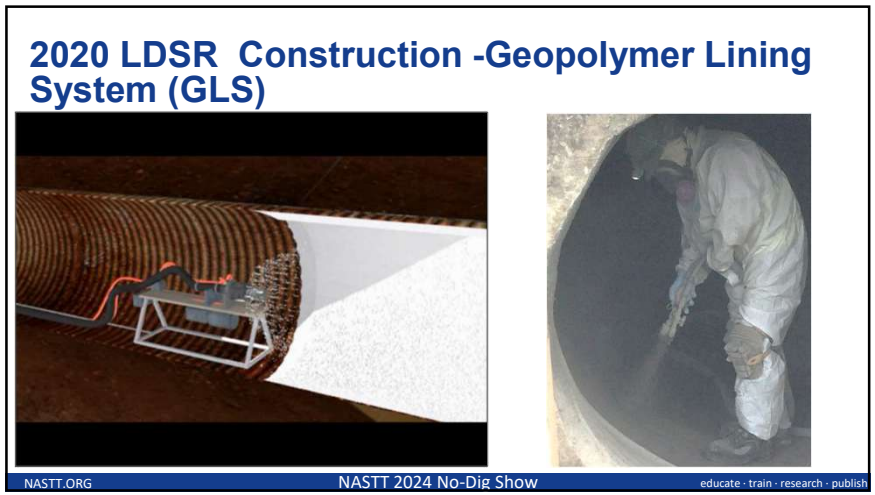
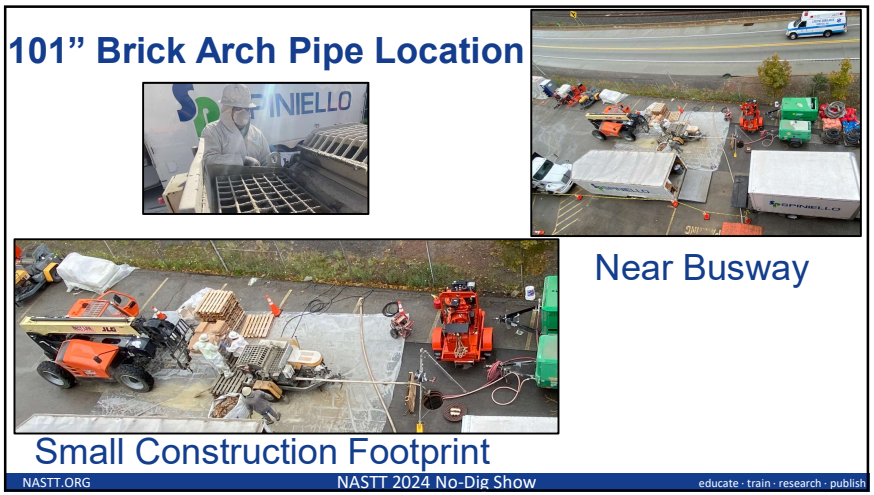
50


2020 LDSR Construction -Geopolymer Lining System (GLS)
NASTT.ORG
NASTT 2024 No-Dig Show
educate · train · research · publish

51


101” Brick Arch Pipe Location
Near Busway
Small Construction Footprint
NASTT.ORG
NASTT 2024 No-Dig Show
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52

## Mixing Operations at Busway

16% - 20% Water

Polypropylene Fibers



53



54




55



56

## CITY OF RICHMOND MARSHALL ST. 60” BRICK SEWER GEOPOLYMER REHABILITATION

TEC talks

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57

## CITY OF RICHMOND MARSHALL ST. 60” BRICK SEWER GEOPOLYMER REHABILITATION



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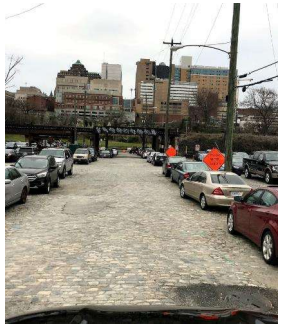
58

## CITY OF RICHMOND MARSHALL STREET 60” BRICK SEWER GEOPOLYMER REHABILITATION

**Project Details:**

- March-April 2019 Project completed in 6 weeks
- 1,900 feet of 60” brick CSO sewer
- 13 Brick MH – 20 to 22” Diameter Shafts 17’ deep
- 1.5 MGD Dry Weather Flow
- Internal By-Pass utilized
- 1.5” of GeoSpray Geopolymer mortar on 60” Pipe
- 1” of GeoSpray Geopolymer mortar on Manholes



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59

## LIMITED 20 – 22” DIAMETER MH ACCESS

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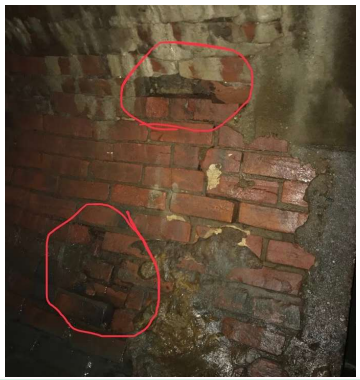
60

## PIPE DEFECTS



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61

## LINING OPTIONS CONSIDERED

- **Dig and Replace**
  - Not ideal due to pipe locations (e.g. significant community impact) and cost.
- **Cured in Place Pipe (CIPP)**
  - Required MH removal / insertion pits making it $$$. Large construction footprint with wet out process in limited area a challenge. Community impact concerns with larger disruption and styrene was not ideal.
- **Epoxy**
  - Access not an issue. Provides good corrosion resistance but expensive compared to other spray-on applications, and structural enhancement only, not stand alone.
- **Spiral (SPR)**
  - Limited access not an issue and application provides an adequate structural component, however, reduces capacity and $$$ compared to spray-on applications.
- **Ordinary Portland Cement (OPC) Shotcrete**
  - Access not an issue. Estimated life-expectancy 1/3 to 1/2 that of geopolymer applications.
- **Geopolymer Lining**
  - Strength and corrosion protection / longevity. No MH removal, small footprint, can do internal bypass without cold joint. Low cost alternative

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62

## EVALUATION MATRIX 1900' OF 60" BRICK SEWER - GEOPOLYMER SELECTION

| Factor (1 -Worst & 4 Best) | Epoxy | CIPP | SPR | OPC Gunite | GeoSpray Geopolymer |
|---|---|---|---|---|---|
| Above Ground Site Preparation | 3 | 1 | 4 | 3 | 4 |
| Bypass Pumping Requirements | 3 | 1 | 4 | 3 | 3 |
| Permit Requirements | 3 | 1 | 4 | 3 | 3 |
| Construction Duration | 2 | 1 | 3 | 4 | 3 |
| Maintain Existing Flow Capacity | 3 | 4 | 3 | 2 | 3 |
| 50 YR LifeCycle | 4 | 4 | 4 | 1 | 4 |
| Cost | 1 | 3 | 2 | 4 | 4 |
| **Overall Scores** | **19** | **15** | **24** | **20** | **24** |

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63

## EVALUATION MATRIX 1900' OF 60" BRICK SEWER - GEOPOLYMER SELECTION

| OPTION | Pipeline Rehab Cost / LF | Pipeline Rehab - for 1900' of Pipe | Internal Repairs Before Liner | Manhole Sinkhole and Misc | 15% Contingent | Initial Estimated Cost Total | 50 Yr Life Cycle Multiplier | 50 Yr Design Cost Total |
|---|---|---|---|---|---|---|---|---|
| Epoxy | $1,998 | $3,796,414 | $250,000 | $71,695 | $617,716 | $4,735,825 | 1 | $4,735,825 |
| CIPP | $1,227 | $2,331,421 | $150,000 | $621,695 | $465,467 | $3,568,583 | 1 | $3,568,583 |
| SPR | $1,244 | $2,363,400 | $50,000 | $77,695 | $373,664 | $2,864,759 | 1 | $2,864,759 |
| OPC Gunite | $502 | $954,072 | $250,000 | $85,150 | $193,383 | $1,482,609 | 2 | $2,965,211 |
| GeoSpray Geopolymer | $500 | $950,000 | $250,000 | $71,695 | $190,754 | $1,462,449 | 1 | $1,462,449 |

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64


BYPASS
CONTROL
GEOTREE
TECtalks

65


48"
Maplewood Ave
A2
A1
48"
B
GLS Set Up 1
GLS Internal or External Bypass
Shields Way
Maplewood Alley
277 LF of 66" Brick @1.5" GLS
GLS Set Up 2
C
Extra CIPP Bypass
D
Lakeview Ave
Shields Way
MH-B
SETUP 1 – MH B
NORTH SIDE

66


48"
Maplewood Ave
A2
A1
48"
B
GLS Set Up 1
GLS Internal or External Bypass
Shields Way
Maplewood Alley
277 LF of 66" Brick @1.5" GLS
GLS Set Up 2
C
Extra CIPP Bypass
D
Lakeview Ave
MH-D
MH-C
Lakeview Ave
Shields Way
SETUP 2 – MH C
SOUTH SIDE

67


48"
Maplewood Ave
A2
A1
48"
B
GLS Set Up 1
GLS Internal or External Bypass
Shields Way
Maplewood Alley
277 LF of 66" Brick @1.5" GLS
GLS Set Up 2
C
Extra CIPP Bypass
D
Lakeview Ave
Lakeview Ave
MH-D
Shields Way
MH-C
SETUP 2 – MH C
SOUTH SIDE

68

## HAND SPRAYING


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69

## COMPLETED STRUCTURES

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70

## SPINCAST MANHOLE REHAB

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71

## RI DOT / NARRAGANSETT BAY COMMISSION (NBC) REHABILITATION OF LARGE DIAMETER BRICK SEWER WITH GEOSPRAY GEOPOLYMER MORTAR

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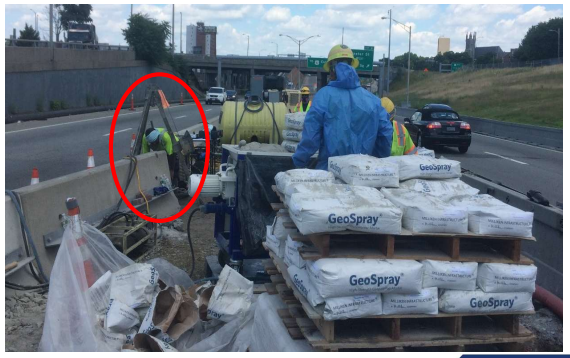
72

## GLS - SMALL CONSTRUCTION FOOTPRINT

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73

## GLS – SMALL CONSTRUCTION FOOTPRINT

Small equipment footprint allows for flexibility & planning around client needs.

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74

## GLS – SMALL CONSTRUCTION FOOTPRINT

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75

## GLS – SMALL CONSTRUCTION FOOTPRINT

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76

## CONSTRUCTION FOOTPRINT / PIPE ACCESS

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77

## INFILTRATION ISSUES

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78

## CROWN REPAIR & INFILTRATION CONTROL

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79

## LINED PIPE AT UNLINED MANHOLE

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80

## LINER THICKNESS / DEPTH GAUGES

81

## VARIOUS PIPE SIZES OF REHAB

82

## COMPLETED STRUCTURES

90 Degree bend with internal bypass

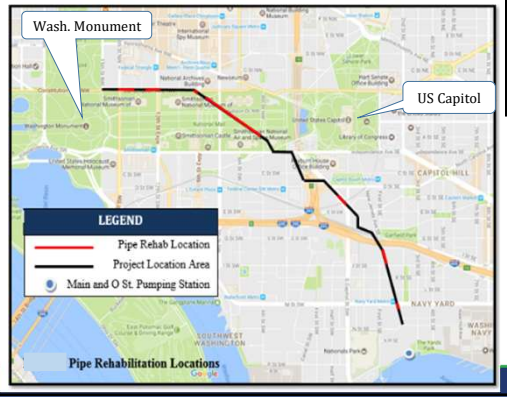
83

## DC WATER, WASHINGTON DC
## 2 CASE EXAMPLES

84

# NJWEA - Fall Tech Transfer 2025 Trenchless Technologies

## NEW JERSEY B STREET, ON NATIONAL MALL

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## MOBIL SCAFFOLDING – DOUBLE BENCH

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## PRESSURE WASHING AND SPRAYING GEOPOLYMER


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## TWO DC WATER PROJECTS

- New Jersey B Street
  - 4300 LT of 10 to 18' Diameter Brick
  - Rehab Crown Only

- Lower Area Trunk Sewer (LAT)
  - 12,000 LF of 42" Brick Rehab – choose CIPP or Geopolymer or Spiral

LOW AREA TRUNK SEWER REHABILITATION

| Item No. | ITEM DESCRIPTION | Estimated Quantity | Unit | Unit Price | | Extension Amount | | Rehabilitation Method (Indicate one method below with an "X") | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dollars | Cents | Dollars | Cents | CIPP | GP | SPR |
| 19. | Sewer Lining from MH-51423 to MH-32867 | 1 | LS | | | | | NA | X | NA |
| 20. | Sewer Lining from MH-32867 to MH-32023 | 1 | LS | | | | | NA | X | NA |
| 21. | Sewer Lining from MH-32023 to MH-51422 | 1 | LS | | | | | NA | X | NA |

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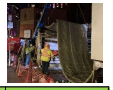
88


## GEOPOLYMER OR NOT GEOPOLYMER?



**ANS. – DEPENDS**

| Item to complete 370' of 66" Diam. | Geopolymer | CIPP |
|---|---|---|
| Internal construction | Y | N |
| Safety | Varies | Varies |
| Internal bypass | Y | N |
| Bypass length (ft) | 370' | 370+ 100' |
| Cure Time to return flow (hr) | 2 | 32-36 |
| Small Footprint | Y | N |
| Dusty | Y | N |
| Styrene Smell | N | Y |
| Remove MH top | N | Y |
| Repave | N | Y |
| Impact to public | Smaller | Greater |
| Set Up Shifts | 2 | 4 |
| Lining Shifts | 6 | 4 |
| Clean up / Restoration Shifts | 1 | 2 |
| Total # of 8 hr Shifts | 9 | 10 |
| COSTS | Depends | Depends |

- 10,000 LF 30 IN.
- 50% / 50%

**Q&A**

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89

## GEOPOLYMER OR NOT GEOPOLYMER… THAT IS THE QUESTION

**ANS. DEPENDS**

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GEOTREE

Henkel
LOCTITE

**Q&A**


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90