

Alleviating CSOs in St. Louis

HARLEM BADEN TRUNK SEWER REHABILITATION

Property of Gresham, Smith and Partners





Let's get TECHNICAL Material Options Pros vs. Cons



The PROGRAM

St. Louis MSD Cityshed Program Overview





The **PROJECT**

Watershed Project Big Picture Harlem Baden Rehab Project



The PROGRAM



Property of Gresham, Smith and Partners





The PROJECT

Harlem-Baden Relief Phase IV (Hebert) Trunk Sewer

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Harlem-Baden Relief Phase IV (Hebert) Complaints - 2010





HARLEM BADEN RELIEF PHASE IV (HEBERT) - TRUNK SEWER REHABILITATION

Harlem-Baden Relief Phase IV (Hebert) Claims - 2010





Harlem-Baden Relief Phase IV (Hebert) Design & Construction Packages (Design Study)





Package Connectivity and Phased Construction

The PROJECT – Rehab... Package 8



SCOPE:

- The work to be done under this contract consists of the rehabilitation of approximately 6,799 lineal feet of combined sewers, varying in size from 48" x 48" to 122" x 144" utilizing trenchless methods
- Rehabilitation of approximately 492 lineal feet of manhole.
- Wanted comparison of rehab alternatives to be "apples to apples".
- Wanted minimal impact for construction and access using existing easements.
- Long term rehab alternatives, as the trunk sewer will gradually be converted from a combined sewer to a predominately sanitary sewer as the Packages are constructed.



WHAT WE THOUGHT....

- The project consists of the rehabilitation of approximately 7,000 feet of the 8-foot and 12-foot horseshoe trunk sewers requiring:
 - 109,900 square feet of shotcrete liner
 - 1,240 feet of CIPP Lining, and
 - 400 square feet of spot repairs.

WHAT WE GOT...

In actuality, the project consists of the rehabilitation of

UPSTREAM - WEST

- 10 LF of 24" diameter RCP
- 16 LF of 36" diameter RCP
- 250 LF of triple 42" diameter RCP
- 627 LF of 60" diameter RCP
 - **DOWNSTREAM EAST**
- 1,150 LF of 72"x84" horseshoe reinforced concrete arch
- 56 LF of 72"x96" horseshoe reinforced concrete arch
- 1,200 LF of 78"x92" horseshoe reinforced concrete arch
- 120 LF of 92"x94" horseshoe reinforced concrete arch
- 1,060 LF of 122"x144" horseshoe reinforced concrete arch

- 824 LF of 72" diameter RCP
- 746 LF of 48"x48" RCB
- 991 LF of 60"x60" RCB
- 115 LF of 84"x72" RCB







TRUNK SEWER REHABILITATION

Let's get technical!

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Harlem Baden (Hebert) Trunk Sewer Rehabilitation – Package 8



RECAP..... why are we doing this project?

- Trunk Sewer constructed circa 1908 1948
- Harlem Baden watershed covers approx. 300 acres within the Bissell Point Service Area
- Long history of street flooding, yard flooding and basement back-ups
- Project is one of eight construction packages proposed to relieve wet weather related overflows
- Goal of the eight construction packages is to alleviate flooding by "soft separating" the storm water from the combined sewer flows.



DESIGN CONSIDERATIONS

- Structural Condition
- Current & Future Flows
- Hydraulics
- Potential Solids Deposition
- Increased Corrosion Potential
- Timing of "Soft" Separation
- Service Life
- Construction Disturbance & Impacts











REHAB EAST







REHAB EAST – PLANS





COMPLEX AREAS



Brock Auto Parts - Challenging property; excavation required on property

LRA Property – recently sold by LRA to Landscaping Company





BROCK AUTO PARTS – Triple 42-inch Sewer Replacement Area

HARLEM BADEN RELIEF PHASE IV (HEBERT) - TRUNK SEWER REHABILITATION



WHY are we doing this project?

Let's check out the sewer condition.....





Horseshoe Sewer Record Drawing – December 28, 1908

HARLEM BADEN RELIEF PHASE IV (HEBERT) - TRUNK SEWER REHABILITATION



 Significant Evidence of Leakage





- Typical Connection
- Mineral deposits
- Infiltration stains





- Needs patch around service connection
- Exposed reinforcing steel at connection





- Tap break-in
- Fair to good condition
- No protrusion
- 41-inch VCP
- Manhole in view





- Moderate corrosion
- Exposed reinforcing steel





- Tap Break-in
- Structural damage (moderate-severe)
- 31-inch VCP
- Full of debris





- Cast-in-place horseshoeshaped sewer
- Inlaid brick invert







WHY are we doing this project?

Sewer is in need of repairs to extend useful service life and have it function within the overall intent of the Harlem Baden project.



ALTERNATIVE REHAB METHODS

- Reinforced Shotcrete
- Cementitious Liner w/ Corrosion Protection
- Spray Applied Geopolymer Liner
- Cured-in-place Pipe (CIPP)
- Spiral Wound Pipe Renewal (SPR)
- Sliplining





- Spray-on or handapplied method of rehabilitation
- Concrete conveyed through a hose and pneumatically projected at high velocity onto a surface
- Reinforcing steel wire mesh, reinforcing bars, welded wire fabric and/or specified fibers
- District has used shotcrete on previous rehab projects



Old Mill Creek Sewer Rehabilitation - Coastal Gunite Construction Company.

Reinforced Concrete Shotcrete Liner



Advantages

- Lateral connections do not have to be excavated
- Small equipment footprint

Disadvantages

- Bypass pumping required for cleaning, placing steel, application and cure
- 24-hr cure time
- Installation rate is approximately 40 LF/day



Photo Courtesy SAK Construction

Reinforced Concrete Shotcrete Liner



MATERIAL - UNIT COST

 For fully deteriorated condition, reinforced liner thickness is approximately 8 inches

Thickness	Cost per
of Liner	square foot
2"	\$21
4"	\$24
6"	\$54
10"	\$58



Coastal Gunite Construction Company.

Reinforced Concrete Shotcrete Liner



- Strong-Seal[®], and CentriPipe[®] provide a protective lining and structural repair to the pipe
- Fiber-reinforced, can be mixed with calcium aluminate or Con-Shield to inhibit corrosion



CentriPipe[®] Lining System – AP/M Permaform

Cementitious Liner



Advantages

- No bonding agent required
- Laterals connections do not have to be excavated
- Small equipment
 footprint
- 2-hr cure time (accelerated mix)

Disadvantages

- Bypass pumping required for cleaning, application and cure
- Installation rate is approximately 50 LF/day



Storm Seal[®] - The Strong Company, Inc.

Cementitious Liner



CEMENTITIOUS LINER WITH ADDITIVE MATERIAL UNIT COST

 Note: For fully deteriorated condition, reinforced liner thickness may be closer to 8 inches

Thickness of Liner	Cost per square foot
1 to 1.5"	\$21



Storm Seal[®] - The Strong Company, Inc. (*Municipal Sewer and Water Magazine*)

Cementitious Liner



- CIPP liners are most cost effective in smaller diameter pipes, typically less than 36" diameter.
- 12-foot horseshoe sewer would be one of the largest CIPP ever installed!
- For these reasons, CIPP was not recommended for this project.



UCOnline.com

CIPP – CURED IN PLACE PIPE



- Sliplining involves inserting a smaller diameter pipe into an existing pipeline or sewer to improve its integrity or flow characteristics.
- Annular space between the liner and the host pipe is grouted
- Considered circular HOBAS (CCFRPM) pipe for this project, but noncircular shapes are available



Hobas® Non-circular Pipe Sliplining

SLIPLINING



Advantages

- Minimal bypass pumping
- New structural pipe
- Minimal loss of capacity with non-circular pipe

Disadvantages

- Multiple, large access points required
- Significant loss of capacity using circular pipe.
- Prohibitive costs using non-circular pipe
- Loss of cross sectional area & hydraulic capacity



Hobas[®] CCFRPM SLIPLINING PIPE, UCOnline

SLIPLINING



COST – Material Cost

Hobas[®] Circular Pipe:

Existing Size	New Size	Cost/FT
60"	54"	\$288
72"	69"	\$433
48"x48"	44"	\$213
60"x60"	54"	\$415
84"x72"	69"	\$433
72"x84"	69"	\$433
72"x96"	69"	\$514
78"x92"	72"	\$455
92"X94"	72"	\$563
122"x144"	110"	\$772



Relining to Raise Capacity, Kimberly Paggioli, May 08, 2017, Water and Wastes Digest

SLIPLINING





SLIPLINING – Access Pits

HARLEM BADEN RELIEF PHASE IV (HEBERT) - TRUNK SEWER REHABILITATION



- Spray-on aluminosilicate based fiber reinforced mortar
- Geopolymer facilitates the creation of a new structural pipe
- Structural liner that inhibits water infiltration
- Rebuilds the structure surface and protects it from hydrogen sulfide corrosion.



9-ft diameter CMP Lining – GeoSpray® Milliken Infrastructure

GEOPOLYMER LINING SYSTEM



Advantages

- Process can span lengths of 500 feet from the point of access
- Installation rate is approximately 100 LF per day
- Cure time approximately 3 hrs

Disadvantage

 Bypass pumping required for cleaning, application and curing.



9-ft diameter CMP Lining – GeoSpray[®] Milliken Infrastructure

GEOPOLYMER LINING SYSTEM



COST – Material Cost

Approximate costs and thicknesses for fully deteriorated condition:

Size	Cost/FT	Lining Thickness
48"x48"	\$385	1"
60"x60"	\$564	1.5"
72"	\$564	1.5"
72"x84"	\$572	1.5"
72"x96"	\$960	1.5"
78"x92"	\$615	1.5"
92"x94"	\$790	1.75"
122"x144"	\$1080	2"



In process lining application

GeoSpray® Milliken Infrastructure

GEOPOLYMER LINING SYSTEM



- Spiral wound pipe renewal (SPR) is currently approved for use by the District.
- It is also included in the standard pay item list.
- The specification is based on the Sekisui SPR[™] process.



Spiral wound pipe renewal Image: SEKISUI SPR Europe GmbH

SPR – SPIRAL WOUND PIPE RENEWAL



Advantages

- Minimal bypass pumping required
- Minimal loss of capacity because the SPR shape matches host pipe.
- Process can span lengths of 500 feet from the point of access
- No special access required Disadvantage
- Connections to existing laterals and manholes must be renewed by excavation or by accurately locating all connections and reinstating them internally. Internal reinstatement may require additional bypass pumping.



Typical Completed Service Lateral Connection

SPR - SPIRAL WOUND PIPE RENEWAL



COST – Material Cost

Based on information gathered from previous experience, estimated unit costs are shown below.

Size	Cost/FT
48"x48"	\$550
60"x60"	\$700
72"	\$700
72"x84"	\$700
72"x96"	\$810
78"x92"	\$810
92"x94"	\$810
122"x144"	\$1200



Spiral wound pipe renewal Image: SEKISUI SPR Europe GmbH

SPR - SPIRAL WOUND PIPE RENEWAL



TYPICAL BYPASS PUMPING SET UP





TYPICAL BYPASS PUMPING – SET UP COST

Phase 1 – Rehab East Suction MH: 16G1-138C Discharge MH: 16G3-231C (this manhole number was estimated since it is not listed on the plans) Distance: 2,257' Flowrate: 580 GPM

Two 6" Quiet Flow™ diesel trash pumps. One primary and one standby. 6" suction hose. 6" hi-pressure hose discharging through and isolating check valves respectively, through a common 8" tee. 8" HDPE SDR26 discharge pipe will convey the flow near MH# 16G4-293C where it will increase to 12" HDPE SDR26. The pumps will operate automatically via float controls. The standby pump will be outfitted with an auto phone dialer.

BYPASS WEEKLY RENTAL

\$ 11,637.00
\$ 21,243.00
\$ 30,446.50
\$ PER CALENDAR DAY
\$ 2,200.00
\$.30 over delivered cost.
\$ 210.00/day



TYPICAL BYPASS PUMPING COST

Rehab Method	Production Rate (LF/day)	Number of Production Days	Estimated Bypass Cost
Shotcrete	40	172	\$ 1.1 M
Cementitious	50	137	\$ 920 K
Geopolymer	100	69	\$ 400 K
Sliplining / SPR	350	20	\$ 251 K



Material Choice CONSIDERATIONS

- Construction Access
- Flow Control & Bypass Pumping
- Structural Integrity
- Design Life
- Cost (including by-pass pumping)
- Production Rate
- Cure Time
- Surface Preparation
- Reinstatement & Renewal of existing sewer connections
- Track record
- Host Pipe Sizes & Shapes
- Wet weather (Big Safety Concern)







Recommended Solution

- A Geopolymer lining system was recommended as part of a long term monitoring project to extend the useful life of the trunk sewer and protect the trunk against Hydrogen Sulfide corrosion in the future fully separated condition.
- Reaches will be entered into Maximo and monitored over time from the current combined condition to the future, predominantly sanitary flow condition.

Geopolymer Lining	Total Construction
Cost	Cost
162,342 sf = \$5,043,823	\$6,961,699



THANK YOU!!

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QUESTIONS?



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