Montgomery County Design-Bid-Build Uses Innovative Reline Solution

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CONTECH® ENGINEERED SOLUTIONS
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The Challenges: Can it be Replaced ?

96” Culvert under Germantown Rd in Gaithersburg, MD

- Major MSE/modular block retaining wall on upstream end
- 26’ of cover height
- Difficult to detour traffic during construction
- All major utilities involved

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The Challenges: Can it be Relined?

- 470’ long, 96” culvert has a vertical elbow 102’ from outlet end
- Hydraulics have to work (including outlet velocities)

2015 Site Visit

- The supports are aged and appear to have been installed during the original construction.
- This means the soil prism above the pipe could be variable from a soil arching standpoint.

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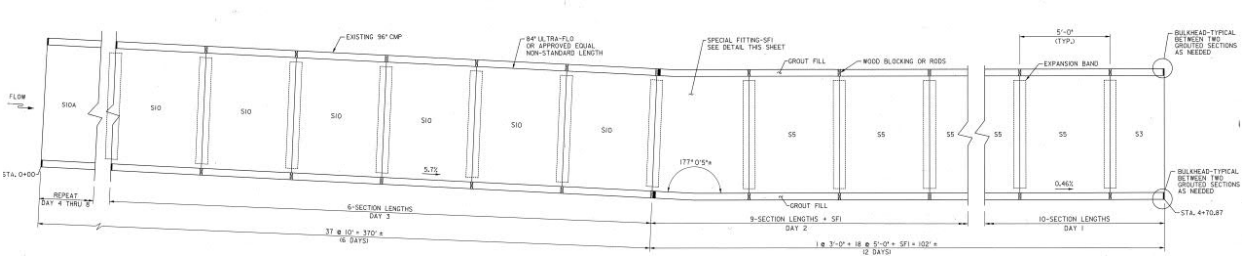
2015 Site Visit

- Corroded invert shows a full corrosion failure in this section.
- The result is inward, rotational movement of the side wall.
- A structural rehab method is needed.

Consulting Engineer's Solution:

Reline with 84" diameter, 12 gage Aluminized Type 2 spiral rib CMP (n=.012, service life = 100 years)



Profile View

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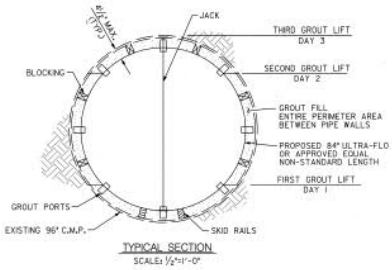

Details

Low Bidder was Concrete General of Gaithersburg, MD

- They mobilized and began preliminary work.

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A 20’ long section of the 96” host pipe shifted

- Workers were inside that section at the time
- Soil arch had sheared
- Safety of workers became a higher risk
- New 84” pipe no longer a clean fit

What are the options?

- Switch to open cut? no
- Stabilize the pipe with invert paving and box struts, then figure out another reline option? yes

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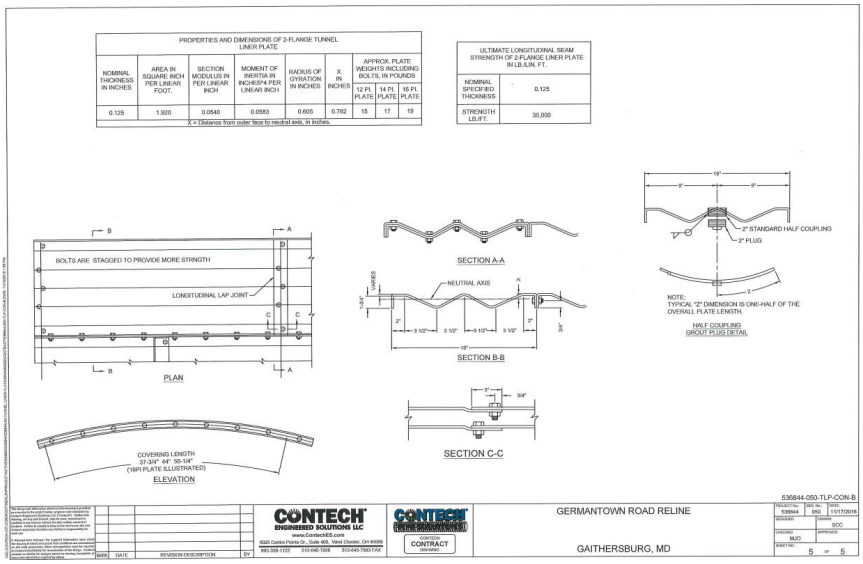
The Answer: Aluminum Tunnel Liner Plate



PROPERTIES AND DIMENSIONS OF 2-FLANGE TUNNEL LINER PLATE

NOMINAL THICKNESS IN INCHES	AREA IN SQUARE INCH PER LINEAR FOOT.	SECTION MODULUS IN PER LINEAR INCH	MOMENT OF INERTIA IN INCHES⁴/4 PER LINEAR INCH	RADIUS OF GYRATION IN INCHES	X IN INCHES	APPROX. PLATE WEIGHTS INCLUDING BOLTS, IN POUNDS		
						12 PL PLATE	14 PL PLATE	16 PL PLATE
0.125	1.920	0.0840	0.0583	0.605	0.782	15	17	19

X = Distance from outer face to neutral axis, in inches.

ULTIMATE LONGITUDINAL SEAM STRENGTH OF 2-FLANGE LINER PLATE IN LB/LIN. FT.

NOMINAL SPECIFIED THICKNESS	0.125
STRENGTH LB/FT.	35,000

BOLTS ARE STAGGED TO PROVIDE MORE STRNGTH

LONGITUDINAL LAP JOINT

PLAN

COVERING LENGTH
37-3/4" 44" 50-1/4"
(16PI PLATE ILLUSTRATED)

ELEVATION

SECTION A-A

NEUTRAL AXIS

SECTION B-B

SECTION C-C

2" STANDARD HALF COUPLING

2" PLUG

NOTE:
TYPICAL "Z" DIMENSION IS ONE-HALF OF THE OVERALL PLATE LENGTH.

HALF COUPLING GROUT PLUG DETAIL

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800-338-1122 513-645-7000 513-645-7993 FAX

CONTRACT DRAWING

GERMANTOWN ROAD RELINE

GAITHERSBURG, MD

536844-050-TLP-CON-B

PROJECT No. 536844 | DES. No. 050 | DATE 11/17/2016
DESIGNED MJO | DRAWN SDC | CHECKED MJO | APPROVED
SHEET NO. 5 OF 5

Aluminum Tunnel Liner Plate

- Allows for tunneling as needed
- Safe working environment is built as you go
- Extremely durable
- Heaviest plate weighs 19 lbs
- AASHTO LRFD design method is in place

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The Answer: Aluminum Tunnel Liner Plate

Structural Design Check for Liner Plate

Per AASHTO LRFD Bridge Design Specifications, Section 12, 2014

$P_L = (P(1+IM/100)m)/A_{LL}$		0.05	(ksf)			
Height of Cover / Span		3.800				
C_d		1.30				
P_{FD}, Factored Dead Load Crown Pressure	$=\eta_{EV}\,\gamma_{EV}$ x H x p $=\eta_{EV}\,\gamma_{EV}$ x Cd x p x S	6.1425	(ksf)			(3.5.1)
P_{FL}, Factored Live Load Crown Pressure	$=\eta_{LL}\,\gamma_{LL}\,P_L$	0.0000	(ksf)			
P_{DL}, Factored Design Lane Load Crown Pressure	$=\eta_{LL}\,\gamma_{LL}$ m DL/10	0.1344	(ksf)			
Factored Thrust (standard structures)						
	F_{min} = greater of 15/S or 1	1.00	(dimensionless)			(12.7.2.2-4)
	F_1 = greater of 0.75S/lw or F_{min}	1.00	(dimensionless)			(12.7.2.2-3)
C_L, Width of Culvert on which LL is applied	= lw ≤ s	6.50	(ft)			(12.7.2.2-2)
T_L, Factored Thrust	$=(P_{FD}+P_{DL})S/2+(P_{FL}\,C_L\,F_1)/2$	20.40	(kip/ft)			(12.7.2.2)
R_w, Wall Resistance	$R_w = \Phi_w F_y A_w$	46.080	(kip/ft.)	> T	20.400 OK	(12.7.2.3-1)
F_{cr}, Critical Buckling Stress	If: $S < \frac{r}{k}\sqrt{\frac{24E_m}{F_u}}$	32.050	(ksi)			
	Then: $F_{cr} = F_u - \frac{\left(\frac{F_u k S}{r}\right)^2}{48E_m}$	Upper Case Controls				(12.7.2.4-1)
	unless $S > \frac{r}{k}\sqrt{\frac{24E_m}{F_u}}$	Then:	$F_{cr} = \frac{12E_m}{\left(\frac{kS}{r}\right)^2}$			(12.7.2.4-2)
R_b, Buckling Resistance	$R_b = \Phi_w F_{cr} A_w$	61.54	(kip/ft.)	> T	20.400 OK	(12.7.2.3-1)
C_S, Stiffness	$C_S = EI/S^2$	0.096	(kip/in.)	> FFR	0.050 OK	(12.13.3.5-1)
R_s, Factored Seam Strength	$R_s = \Phi_{SS} SS$	23.450	(kip/ft.)	> T	20.400 OK	(12.7.2.5)

Assessment of Host Pipe

- Exploratory holes allowed for assessment of supporting backfill
- This helped determined when the timber box strutting could be removed

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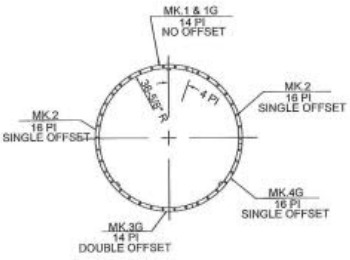
Assessment of Host Pipe

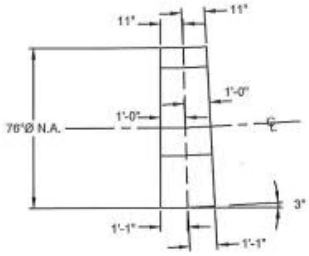
- If voids were found, a 'U' shaped cut allowed for the host wall to be opened up at the time of liner plate assembly and blocking
- Openings were located at top of voids
- Openings allowed grout to fill the voids during liner grouting

Aluminum Tunnel Liner Plate

- 5 plates per ring with No Offset, Single Offset and Double Offset plates
- 3 degree elbow was factory made



END VIEW
SCALE: N.T.S.



76"Ø TLP ELBOW DETAIL
SCALE: 1" = 5'

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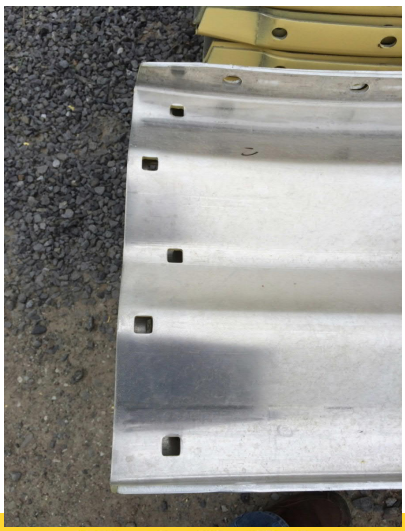
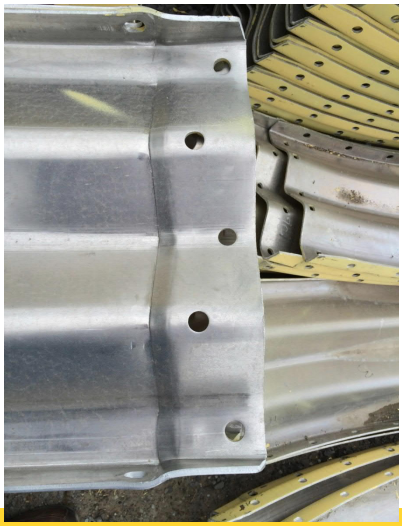
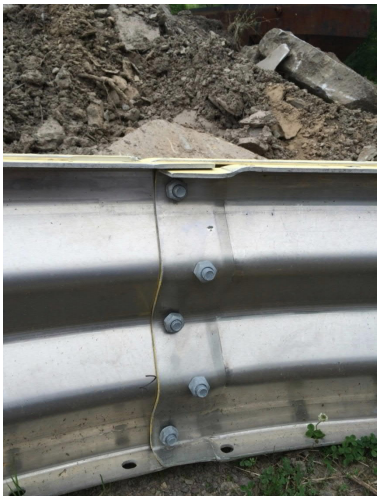
Aluminum Tunnel Liner Plate – no offset (L), offset (R)



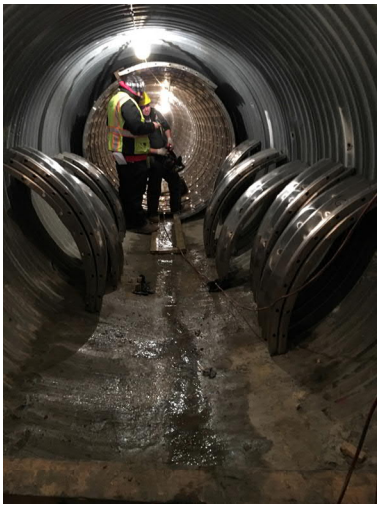


Aluminum Tunnel Liner Plate – structural seam (L), grout port (R)



Assembly of Tunnel Liner Plate

- Staging in a solid area of the host pipe (supports could be removed well ahead of the assembly at this location)



Aluminum Tunnel Liner Plate

- Blocking allowed for immediate transfer of loads and provided uplift resistance during grouting

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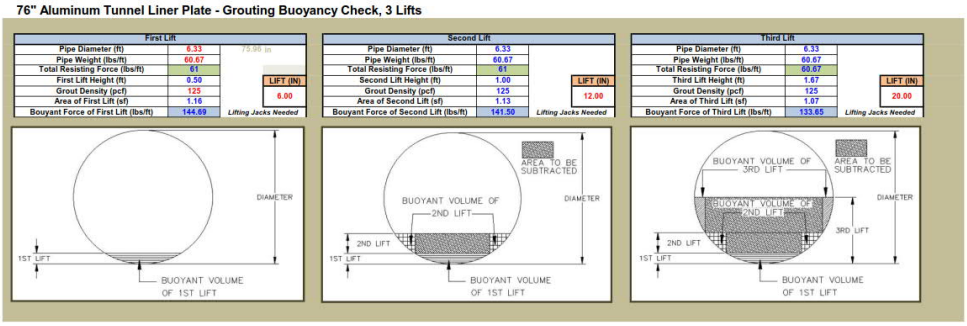
Grout was pumped through the new pipe wall through 2” diameter ports

- 3 lift grouting plan using 125 pcf grout



Acknowledgements

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Questions?

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