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August 23, 2024

DRAFT

Mr. James Faulkner, Chair
Town of Charlotte Selectboard
159 Ferry Road
Charlotte, Vermont 05445

Re: Spear Street over Mud Hollow Brook
Structure Replacement Cost Analysis

Dear Chair Faulkner:

On the evening of July 9th and into the early morning hours of July 10th, the existing 10-foot diameter corrugated steel metal plate culvert that passes the flows from Hollow Brook under Spear Street experienced a catastrophic failure and was washed away.

In reviewing the evidence left behind, it appears that the 10-diameter culvert became clogged with a large tree root ball which, perhaps coupled with other debris, caused the saturation of the fill around the culvert and, coupled with the overtopping of the road surface and erosion on the downstream embankment, caused the culvert to fail. This has left a substantial void in the road surface which has required that the road be closed to thru traffic between Carpenter road and Irish Hill Road in Shelburne.

The Town of Charlotte is seeking permission from the State of Vermont Department of Environmental Conservation (DEC) to replace the pre-existing 10-foot diameter steel plate culvert.

Coordination with the State of Vermont - In working with representatives from the Vermont Agency of Transportation (VTrans) and the State DEC (Jaron Borg, State River Management covering west central Vermont from Bethel to Charlotte), the State policy on the placement of new or replacement structures was examined. It was noted that generally, the goals of that policy is to facilitate the placement of structures that:

- Provide adequate hydraulic capacity to pass the design storm event.
- Enable aquatic organism passage through the structure.
- Minimize the potential for debris accumulation and clogging.

Achieving these goals can most readily be achieved by constructing a structure that provides a clear span (opening) width that is equal to the "Bank Full" width of the associated stream or river. The Initial Stream Hydraulics Report from the VTrans indicated that the Bank Full width was 26 feet.

Background - The Town, in good faith and to stay ahead of supply chain issues while looking to re-open Spear Street as quickly as possible, pre-purchased replacement materials that would double the hydraulic capacity of the pre-existing 60' long, 10' diameter culvert. The proposed "Twin" 10-foot dimeter culvert installation was reviewed with Mr. Jaron Borg on Wednesday August 7th,

Stream Structure Policy - Based on the VTrans Hydraulics Report, Mr. Borg was concerned that the total width of the Twin Culvert installation would not satisfy the 26-foot side Bank Full findings Normally, the State would be looking for a Bridge or equivalent with a 26-feet clear distance from abutment to abutment. This clear width would to be able to more readily pass large debris and to minimize clogging potential.

In cooperation with Mr. Borg, VTrans agreed to re-examine their initial recommendation of the stream Bank Full Width. On August 17th, Mr. Borg reported back that a closer examination of the stream characteristics upstream of the road crossing indicated that the design Bank Full Width should be set at 18-feet.

Mr. Borg indicated in his correspondence with the Town that the pre-purchased Twin Culvert Material would now partially satisfy the Bank Full Width standard in the State's stream crossing policy but it would still need to have adequate supplemental protections installed. One method that was discussed was the possibility of the construction of a Debris Trap. This Debris Trap would be placed upstream of the Twin Culvert installation and would need to be of such character that it would intercept large debris from reaching the 10-foot diameter openings of the Twin Culvert installation. The Debris Trap would also need to be large enough so that it could still pass the design flow without creating a significant damming effect upstream. Simply stated, the Debris Rack would need to have at least double the opening size of the Twin Culverts to still have reserve hydraulic capacity to pass flows around the accumulated debris.

Mr. Borg indicated that the only way that the State would allow the replacement of the existing failed culvert with the Twin Culvert solution, in lieu of a Bridge type installation, would be if it could be demonstrated that the combined capital costs and long term

operational/maintenance costs of the Twin Culvert option was less than that of a new Bridge Structure.

This Cost Comparison Analysis seeks to:

- Identify both the initial capital costs for both the Twin Culvert option and the Bridge option.
- Provide a cost for the construction of a debris trap for the Twin Culvert Solution
- Identify a scope of work and estimated costs for the maintenance of both the Twin Culvert and Bridge options.
    - Identify a Present Value of the maintenance costs
- Identify design lives for the Twin Culvert and Bridge Solutions
    - Identify a Present Value Cost for the Twin Culvert and Bridge scintillation options.

Capital Costs

In order to provide the best data to enable the comparison of the two options, we utilized as a basis for the creation of the estimates of probable construction costs (Cost Estimate), recent bid results from VTrans for various pipe culvert, box culvert and bridge projects to develop the Cost Estimates. For a recent culvert project in Williston, the unit prices from the top three bidders were averaged and assigned for the analysis of the two structure options. This approach provided a slight conservative approach to the development of the project costs. For the material costs for the Twin-Culvert option, the material costs paid by the Town of Charlotte was utilized.

Each of the Cost estimates include a pair of contingency line items. The first is a 5% Estimating Contingency (lack of design plans to work from and relied upon prior project design as a basis of the quantity calculations) and a 15% Construction Contingency which represents an acknowledgement that as the project designs evolve that more costs may be uncovered. Larger or smaller numbers could be employed with the understanding that this will either reduce or increase the difference in the costs between the two options reviewed in this analysis.

The capital costs do not include soft costs associated with design and permitting. Both of the reviewed options provide a similar level of complexity (and cost) so we do not believe that these will unduly influence the results of this analysis.

Construction Scope of Work

Twin Culvert Option

- Temporary Stream Bypass
- Embedment of the Culverts 3-feet down into the stream channel to facilitate small and modest size aquatic species to pass though the culverts
- Use of cathodic protection with sacrificial anodes to minimize the affects of corrosion to the metal culverts.
- Installation of a bituminous invert up to the mid-point of the culverts.
- Construction of a concrete cut-off wall below the culverts and concrete headwalls on both the upstream and downstream sides of the 6-foot long culvert installation.
- Construction of a Debris Trap on the upstream side of the culverts.
- Placement of stone fill (riprap) on both the upstream and downstream sides to tie the wingwall in with the existing conditions.
- Placement of Flowable Fill Concrete between the culverts up to the mid-point. This will minimize void spaces that otherwise represent weak points where infiltrate water could cause subsequent undermining of the culverts.
- Placement of structural backfill over the culverts and between the headwall up to the road design grade.
- Placement of a new pavement surface and replacement guardrail system.
- Site Restoration.

Based on the cost breakdown outlined in Attachment 1, the estimated cost for the construction of the **Twin Culvert option is $670.000**

Bridge Option:

- Temporary Stream Bypass.
- Construction of concrete bridge abutments and wing walls.
    - A 20-foot clear span was chosen to mirror the 20’ opening provided in the Culvert option.
- Stabilization of the stream channel post construction of the abutments.
- Placement of stone fill (riprap) on both the upstream and downstream sides to tie the wingwall in with the existing conditions.
- Placement of the bridge deck and waterproofing system
- Placement of bridge railing/parapet system

- Paving of the bridge deck and road approaches.
- Placement of new guard rail and approach rail systems
- Site Restoration.

Based on the cost breakdown outlined in Attachment 2, the estimated cost for the construction of the **Bridge Option is $810.000**

Design Life
The assignment of a design life is important in comparing costs of dissimilar options. There may be conditions in which one option would need to be built and rebuilt several times to equate to the design life of a much more durable option.

Bridge - The recommended design life for a 20-foot clear span concrete voided slab bridge superstructure with a concrete abutment substructure typically ranges between 75 to 100 years. The exact design life often depends on factors such as environmental conditions, maintenance practices, and the specific design standards.

In many cases, modern bridges are designed for a 100-year service life to ensure long-term durability and reliability. *For this analysis the design life of the Bridge option was set at 100-years.*

Culvert Option - For the twin 10-foot diameter (10 and 12-gauge) aluminized steel corrugated pipe culverts, with concrete headwalls and wingwalls, buried 3 feet into the stream channel, the recommended design life typically ranges between 50 to 75 years.

Key Factors Influencing Design Life:

- Wall Thickness (12 Gauge**):** The 12-gauge thickness provides a balance between structural strength and cost. However, it's on the thinner side compared to heavier gauges, which may slightly reduce its lifespan in more aggressive environments.
- Aluminized Coating**:** The aluminized coating offers enhanced corrosion resistance compared to galvanized steel, contributing to a longer service life.
- Environmental Conditions: The actual lifespan will be influenced by soil and water chemistry, with more aggressive environments potentially reducing the design life.
- Installation Quality**:** Proper installation, including adequate bedding, backfill, and compaction, is crucial to achieving the expected design life.

- Maintenance Practices: Regular inspections and maintenance are essential to prevent issues like corrosion or joint separation, which can significantly impact longevity.

While 50 years is a conservative estimate, with optimal conditions and consistent maintenance, the culverts could last closer to 75 years. *For this analysis the design life of the culvert section was conservatively set at 50 years to reflect the thin gauge of the culverts but being offset by the use of a cathodic protection system.*

Replacement Costs
Since the design life of the culvert option is less than the bridge option, we needed to identify what those replacement costs would be to be able to compare the costs of construction and operation over the longer design life of the bridge. We reviewed a number of options for the means of replacing the installed 10-foot diameter culverts once they had outlived their design life.

Cut and Cover - The cost for traditional excavation, removal and replacement within the confines of the existing concrete headwalls, cut and cover removal and replacement is **approximately $280,000** (Attachment 3).

Centrifugally Cast Concrete Pipe - The option of rehabilitating the culverts with Centrifugally Cast Concrete Pipe (CCCP) for the 10-foot diameter corrugated metal culverts was reviewed. This process applies centrifugally placed concrete as a new inner wall to the existing culvert, essentially converting it to a concrete culvert. The cost for this work varies based on several factors, including the length of the pipe, site conditions, and specific project requirements. However, a general tool used by the industry for estimating the cost is approximately $5.00 per inch of pipe diameter per linear foot. For a 10-foot (120-inch) diameter pipe, this would translate to around $600 per linear foot of the culverts. For two 60-foot long culvers this equates to $72,000 plus the costs for stream diversion and project set-up. In this case the stream diversion costs will be reduced from those costs for new construction because flows can be diverted through one culvert and then switched to the other**. The total cost for this method is approximately $150,000** (Attachment 4). This option was chosen for the comparative analysis.

Operational (Maintenance) Costs

Within Attachments 5 and 6 we have provided a summary of the recommended maintenance scope for both the Culvert and Bridge Options respectively. The recommended actions and associated costs occur in different periods of the life of each structure. In order to provide a suitable means of annuitizing these costs, a Present Value cost was developed for those maintenance costs over the life of both the Culvert option and the Bridge option.

The cost analysis presumes that the accrued value of money held by the Town would accrue at a 2% annual interest rate. Some may counter that the costs incurred by the Town over time will essentially follow the rate of inflation, and the tax rate will reflect this, so a $5,000 cost this year will essentially be the same as an inflation adjusted amount in the future.

Example:
For a $5,000 cost that is incurred once every 5 years, presuming that the interest rate of accumulated moneys is 2%, the Present Value (Worth) of that expenditure in the future is:

$$PV = \$5{,}000(1 + 0.02)^{-5} = \$4{,}528$$

That same cost when annuitized over the 5-year period has an annualized payment (sinking fund) amount of: $A = \$5000[0.02/1 + 0.02)^{5} - 1] = \$961$

When all the recommended maintenance and precautionary measures were computed, the total Present Value (PV) annualized costs were:

Bridge Total PV Annualized Maintenance Costs = $11,816
Culvert Total PV Annualized Maintenance Costs = $12,865

Total Life Cycle Cost

This analysis extends the capital construction costs and the on-going maintenance costs over a 100-year period to reflect the longer design life of the bridge option.

Outlined on the following page are the values included in Attachment 7 which summarize the capital and on-going maintenance costs for the Culvert and Bridge Options.

Capital Costs					2%	Value of Money				
	$ 670,000	Twin Culvert Option								
	$ 56,000	PV of Twin Culvert Repair Option in 50 Years								
	$ 726,000	Total PV Culvert Option Installation Cost								
	$ 810,000	Bridge Option								
Maintenance Costs										
	$12,865	Culvert Option Annualized Present Value of Maintenance Costs								
	$554,000	Culvert Present Value of Maintenance Costs of 100 Years								
	$11,407	Bridge Option Annualized Present Value of Maintenance Costs								
	$492,000	Bridge Present Value of Maintenance Costs of 100 Years								
Total Lifetime Cost										
	$ 1,280,000	Culvert Option								
	$ 1,302,000	Bridge Option								

This summary indicates that the Culvert Option is marginally less expensive than the Bridge Option.

Summary

The initial costs f the Culvert Option is less than the Bridge Option primarily to the reduced amount of concrete required to construct the bridge abutments and wingwalls.

The Culvert option had a higher annualized maintenance costs due in part to the requirement to remove any accumulated debris from the Debris Rack.

We recognize that some will think that the identified maintenance costs appear on the high side. In the ideal scenario, these work scope items represent a well-managed system. Many of these tasks are managed directly by the Road Commissioner and as such are not broken out as third-party expense in the Town's Highway Budget. This analysis presumes that third parties would execute these tasks at current rates.

Some individuals may question the costs of construction as being too high or others as being too low. The values identified in this study are intended primarily for comparison purposes, but ultimately, we believe they can e what can be achieved with a fast track, stream lined approach.

This completes our summary of the findings associated with this cost analysis. If you should have any questions, please feel free to contact me at 802-864-2323 x310 or at dmarshall@cea-vt.com.

Respectfully.

David S. Marshall, P.E.
Principal Engineer

Enclosures:

1- Culvert Option Construction Costs
2- Bridge Option Construction Costs
3- Culvert Replacement Option Costs
4- CCCP Culvert Repair Option Costs
5- Culvert Maintenance Scope
6- Bridge Maintenance Scope
7- Lifetime Cost Analysis Summary
8- Twin Culvert Option Site Plan
9- Bridge Option Site Plan

Cc: CEA File 24148.00
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Attachment 1

Twin Culvert Installation

Spear Street over Mud Hollow Brook

Estimate of Probable Construction Cost

August 22, 2024

Unit Price	Total	Unit	Qty	Unit Bids Received			Normalized	Total
203.15	COMMON EXCAVATION	CY	120	$ 30	$ 28	$ 45	$ 34.33	$ 4,120
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	260	$ 52	$ 51	$ 51	$ 51.33	$ 13,347
203.31	SAND BORROW	CY	80	$ 40	$ 54	$ 59	$ 51.10	$ 4,088
204.3	GRANULAR BACKFILL FOR STRUCTURES	CY	300	$ 55	$ 58	$ 94	$ 69.08	$ 20,723
204.3	3' CHANNEL FILL IN CULVERTS	CY	90				$ 130.00	$ 11,700
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	150	$ 55	$ 60	$ 72	$ 62.17	$ 9,325
402.13	AGGREGATE SHOULDERS, RAP	TON	15	$ 180	$ 97	$ 100	$ 125.67	$ 1,885
404.11	TACK COAT, EMULSIFIED ASPHALT	CWT	1	$ 200	$ 100	$ 350	$ 216.67	$ 217
406.023	BITUMINOUS CONCRETE PAVEMENT, TYPE IIS, QA TIER III	TON	31	$ 190	$ 300	$ 150	$ 213.33	$ 6,613
406.043	BITUMINOUS CONCRETE PAVEMENT, TYPE IVS, QA TIER III	TON	18	$ 230	$ 300	$ 105	$ 211.67	$ 3,810
406.07	BITUMINOUS LINING OF CULVERT BOTTOM	TON	1				$ 2,000.00	$ 2,000
507.11	REINFORCING STEEL, LEVEL I	LB	2,000	$ 3	$ 3	$ 4	$ 3.25	$ 6,500
507.12	STEEL DEBRIS RACK	LS	1				$ 40,000	$ 40,000
541.22	CONCRETE, CLASS B	CY	60	$ 1,200	$ 1,560	$ 2,000	$ 1,586.67	$ 95,200
541.22	CONCRETE, FLOWABLE FILL	CY	50				$ 500	$ 25,000
601.0057	120 INCH CSP .109 (2-2/3 × 1/2) Materials	LS	1				$ 100,000	$ 100,000
601.0057	120 INCH CSP .109 (2-2/3 × 1/2) Assembly and Install	LS	1				$ 15,000	$ 15,000
601.1001	CATHODIC PROTECTION	LF	120				$ 50	$ 6,000
613.1001	STONE FILL, TYPE I	CY	60	$ 250	$ 300	$ 300	$ 283.33	$ 17,000
613.1002	STONE FILL, TYPE II	CY	40	$ 135	$ 150	$ 500	$ 261.67	$ 10,467
614.1	TEMPORARY RELOCATION OF STREAM	EACH	1	$45,460	$49,962	$50,000	$ 48,474.00	$ 48,474
621.021	REMOVE AND RESET GUARDRAIL	LF	160	$ 40	$ 36	$ 75	$ 50.33	$ 8,053
631.1	FIELD OFFICE, ENGINEER'S	LS	1	$15,000	$ 1,000	$ 5,600	$ 7,200.00	$ 7,200
631.16	TESTING EQUIPMENT, CONCRETE	LS	1	$ 750	$ 1,000	$ 750	$ 833.33	$ 833
631.17	TESTING EQUIPMENT, BITUMINOUS	LS	1	$ 750	$ 1,500	$ 750	$ 1,000	$ 1,000
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$ 148,250	$ 189,115	$ 197,000	$ 75,000	$ 75,000
646.4171	DURABLE 4 INCH YELLOW LINE, RECESSED TYPE A TAPE	LF	320	$ 18	$ 22	$ 25	$ 21.67	$ 6,933
649.11	GEOTEXTILE FOR ROADBED SEPARATOR	SY	250	$ 6	$ 16	$ 8	$ 9.83	$ 2,458
651.16	TURF ESTABLISHMENT, SPECIALTY SEED	SY	800	$ 2	$ 1	$ 4	$ 2.17	$ 1,733

Attachment 1

651.35	**TOPSOIL**	**CY**	**100**	$ 105	$ 30	$ 50	$ 61.67	$ 6,167
653.02	**MONITORING EPSC PLAN**	**HR**	**10**	$ 55	$ 15	$ 135	$ 68.33	$ 683
653.2001	**ROLLED EROSION CONTROL PRODUCT, TYPE I**	**SY**	**800**	$ 2	$ 4	$ 2	$ 2.67	$ 2,133
653.4701	**SILT FENCE, TYPE I**	**LF**	**160**	$ 6	$ 10	$ 19	$ 11.77	$ 1,884
653.4702	**SILT FENCE, TYPE II**	**LF**	**40**	$ 7	$ 8	$ 14	$ 9.57	$ 383
653.5	**BARRIER FENCE**	**LF**	**240**	$ 5	$ 5	$ 3	$ 4.43	$ 1,064
653.55	**PROJECT DEMARCATION FENCE**	**LF**	**350**	$ 3	$ 3	$ 3	$ 3.11	$ 1,087

	Estimated Tota;	$ 558,082
5%	Estimating Contingency	$ 27,904
15%	Construction Contingency	$ 84,014
	Total Estimated Cost of Construction	**$ 670,000**

Attachment 2

New Bridge Installation

Spear Street over Mud Hollow Brook

Estimate of Probable Construction Cost

August 22, 2024

Unit Price	Total	Unit	Qty	Unit Bids Received			Normalized	Total
203.15	COMMON EXCAVATION	CY	110	$ 30	$ 28	$ 45	$ 34.33	$ 3,777
203.27	UNCLASSIFIED CHANNEL EXCAVATION	CY	160	$ 52	$ 51	$ 51	$ 51.33	$ 8,213
203.31	SAND BORROW	CY	80	$ 40	$ 54	$ 59	$ 51.10	$ 4,088
204.3	GRANULAR BACKFILL FOR STRUCTURES	CY	300	$ 55	$ 58	$ 94	$ 69.08	$ 20,723
204.3	CHANNEL BOTTOM RE-ESTABLISHEMENT	CY	30				$ 200.00	$ 6,000
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	150	$ 55	$ 60	$ 72	$ 62.17	$ 9,325
402.13	AGGREGATE SHOULDERS, RAP	TON	15	$ 180	$ 97	$ 100	$ 125.67	$ 1,885
404.11	TACK COAT, EMULSIFIED ASPHALT	CWT	1	$ 200	$ 100	$ 350	$ 216.67	$ 217
406.023	BITUMINOUS CONCRETE PAVEMENT, TYPE IIS, QA TIER III	TON	31	$ 190	$ 300	$ 150	$ 213.33	$ 6,613
406.043	BITUMINOUS CONCRETE PAVEMENT, TYPE IVS, QA TIER III	TON	18	$ 230	$ 300	$ 105	$ 211.67	$ 3,810
406.38	HAND PLACED BITUMINOUS CONCRETE PAVEMENT, SHIM	SY	58.67				$ 34.00	$ 1,995
507.11	REINFORCING STEEL, LEVEL I	LB	4,500	$ 3	$ 3	$ 4	$ 3.25	$ 14,625
541.22	CONCRETE, CLASS B	CY	170	$ 1,200	$ 1,560	$ 2,000	$ 1,586.67	$ 269,733
541.31	PRECAST VOIDED SLAB BEAMS	SF	672				$ 60.00	$ 40,320
531.16	BEARING DEVICE ELASTOMERIC BEARING PADS	EACH	14				$ 940	$ 13,160
519.10	BRIDGE MEMBRANE WATERPROOFING	SF	728				$ 15.00	$ 10,920
541.42	CURB/PARAPET AND GUARD RAIL SYSTEM	LF	40				$ 800.00	$ 32,000
613.1001	STONE FILL, TYPE I	CY	60	$ 250	$ 300	$ 300	$ 283.33	$ 17,000
613.1002	STONE FILL, TYPE II	CY	120	$ 135	$ 150	$ 500	$ 261.67	$ 31,400
614.1	TEMPORARY RELOCATION OF STREAM	EACH	1	$45,460	$49,962	$50,000	$ 48,474.00	$ 48,474
621.021	TRANSITION GUARD RAIL	EACH	4				$ 4,500.00	$ 18,000
621.021	REMOVE AND RESET GUARDRAIL	LF	160	$ 40	$ 36	$ 75	$ 50.33	$ 8,053
631.1	FIELD OFFICE, ENGINEER'S	LS	1	$15,000	$ 1,000	$ 5,600	$ 7,200.00	$ 7,200
631.16	TESTING EQUIPMENT, CONCRETE	LS	1	$ 750	$ 1,000	$ 750	$ 833.33	$ 833
631.17	TESTING EQUIPMENT, BITUMINOUS	LS	1	$ 750	$ 1,500	$ 750	$ 1,000	$ 1,000
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$ 148,250	$ 189,115	$ 197,000	$ 75,000	$ 75,000
646.4171	DURABLE 4 INCH YELLOW LINE, RECESSED TYPE A TAPE	LF	320	$ 18	$ 22	$ 25	$ 21.67	$ 6,933
649.11	GEOTEXTILE FOR ROADBED SEPARATOR	SY	250	$ 6	$ 16	$ 8	$ 9.83	$ 2,458
651.16	TURF ESTABLISHMENT, SPECIALTY SEED	SY	800	$ 2	$ 1	$ 4	$ 2.17	$ 1,733

Attachment 2

651.35	**TOPSOIL**	**CY**	**100**	$ 105	$ 30	$ 50	$ 61.67	$ 6,167
653.02	**MONITORING EPSC PLAN**	**HR**	**10**	$ 55	$ 15	$ 135	$ 68.33	$ 683
653.2001	**ROLLED EROSION CONTROL PRODUCT, TYPE I**	**SY**	**800**	$ 2	$ 4	$ 2	$ 2.67	$ 2,133
653.4701	**SILT FENCE, TYPE I**	**LF**	**160**	$ 6	$ 10	$ 19	$ 11.77	$ 1,884
653.4702	**SILT FENCE, TYPE II**	**LF**	**40**	$ 7	$ 8	$ 14	$ 9.57	$ 383
653.5	**BARRIER FENCE**	**LF**	**240**	$ 5	$ 5	$ 3	$ 4.43	$ 1,064
653.55	**PROJECT DEMARCATION FENCE**	**LF**	**350**	$ 3	$ 3	$ 3	$ 3.11	$ 1,087
							Estimated Tota;	$ 678,891
						5%	Estimating Contingency	$ 33,945
						15%	Construction Contingency	$ 97,164
							Total Estimated Cost of Construction	**$ 810,000**

Attachment 3

Twin Culvert Replacement

Spear Street over Mud Hollow Brook

Estimate of Probable Construction Cost

August 22, 2024

Unit Price	Total	Unit	Qty	Unit Bids Received			Normalized	Total
203.15	COMMON EXCAVATION	CY	330	$ 30	$ 28	$ 45	$ 34.33	$ 11,330
203.31	SAND BORROW	CY	80	$ 40	$ 54	$ 59	$ 51.10	$ 4,088
204.3	3' CHANNEL FILL IN CULVERTS	CY	90				$ 130.00	$ 11,700
301.35	SUBBASE OF DENSE GRADED CRUSHED STONE	CY	70	$ 55	$ 60	$ 72	$ 62.17	$ 4,352
402.13	AGGREGATE SHOULDERS, RAP	TON	7	$ 180	$ 97	$ 100	$ 125.67	$ 880
404.11	TACK COAT, EMULSIFIED ASPHALT	CWT	1	$ 200	$ 100	$ 350	$ 216.67	$ 217
406.023	BITUMINOUS CONCRETE PAVEMENT, TYPE IIS, QA TIER III	TON	15	$ 190	$ 300	$ 150	$ 213.33	$ 3,200
406.043	BITUMINOUS CONCRETE PAVEMENT, TYPE IVS, QA TIER III	TON	9	$ 230	$ 300	$ 105	$ 211.67	$ 1,905
406.07	BITUMINOUS LINING OF CULVERT BOTTOM	TON	1				$ 2,000.00	$ 2,000
541.22	CONCRETE, FLOWABLE FILL	CY	50				$ 500	$ 25,000
601.0057	120 INCH CSP .109 (2-2/3 × 1/2) Materials	LS	1				$ 100,000	$ 100,000
601.0057	120 INCH CSP .109 (2-2/3 × 1/2) Assembly and Install	LS	1				$ 15,000	$ 15,000
601.1001	CATHODIC PROTECTION	LF	120				$ 50	$ 6,000
614.1	TEMPORARY RELOCATION OF STREAM	EACH	1	$45,460	$49,962	$50,000	$ 10,000	$ 10,000
621.021	REMOVE AND RESET GUARDRAIL	LF	80	$ 40	$ 36	$ 75	$ 50.33	$ 4,027
631.1	FIELD OFFICE, ENGINEER'S	LS	1	$15,000	$ 1,000	$ 5,600	$ 7,200.00	$ 7,200
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$ 148,250	$ 189,115	$ 197,000	$ 20,000	$ 20,000
646.4171	DURABLE 4 INCH YELLOW LINE, RECESSED TYPE A TAPE	LF	160	$ 18	$ 22	$ 25	$ 21.67	$ 3,467
649.11	GEOTEXTILE FOR ROADBED SEPARATOR	SY	130	$ 6	$ 16	$ 8	$ 9.83	$ 1,278

	Estimated Tota;	$ 231,643
5%	Estimating Contingency	$ 11,582
15%	Construction Contingency	$ 36,775
	Total Estimated Cost of Construction	**$ 280,000**

Attachment 4

Twin Culvert Repair w/ CCCP

Spear Street over Mud Hollow Brook

Estimate of Probable Construction Cost

August 22, 2024

Unit Price	Total	Unit	Qty	Unit Bids Received			Normalized	Total
203.15	COMMON EXCAVATION	CY	360	$ 30	$ 28	$ 45	$ 34.33	$ 12,360
204.30	3' CHANNEL EXCAVATION FROM CULVERTS AND CLEANING	CY	70				$ 160.00	$ 11,200
204.30	3' CHANNEL FILL IN CULVERTS	CY	70				$ 130.00	$ 9,100
601.0057	120 INCH Centrifugally Cast Concrete Pipe INSTALLATION	Dia-Inch-Feet	14400				$ 5.00	$ 72,000
614.1	TEMPORARY RELOCATION OF STREAM	EACH	1	$45,460	$49,962	$50,000	$ 10,000	$ 10,000
635.11	MOBILIZATION/DEMOBILIZATION	LS	1	$ 148,250	$ 189,115	$ 197,000	$ 10,000	$ 10,000
							Estimated Tota;	$ 124,660
							5% Estimating Contingency	$ 6,233
							15% Construction Contingency	$ 19,107
							Total Estimated Cost of Construction	**$ 150,000**

Culvert Maintenance Scope and Costs

Spear Street over Mud Hollow Brook

August 19, 2024

2% Annual Interest Rate

	Item	Frequency		Published Estimated Cost Range	Carried Cost	Annualized Cost	Purpose:	Notes:
Routine Maintenance:								
1	**Inspection:**	Annually or biannually.	1	$1,500 to $3,000 per inspection.	$ 1,500	$1,500	Check for signs of erosion, joint separation, structural damage, sediment buildup, or blockages.	Purpose: Check for signs of corrosion, joint separation, deformation, sediment buildup, blockages, and any damage to the concrete headwalls and wingwalls. Focus Areas: Inspect the interior and exterior of the culverts, the junctions with headwalls and wingwalls, and any exposed areas for early signs of wear or damage.
2	**Cleaning & Debris Removal:**	Annually, or after major storms/flooding events	1	$2,000 to $6,000 per cleaning.	$ 3,000	$3,000	Remove sediment, debris, and vegetation that could obstruct water flow or cause damage.	Purpose: Remove debris, sediment, and vegetation that may obstruct water flow or cause damage. Ensure that the culverts remain clear to maintain their full hydraulic capacity.
3	**Joint and Seal Inspection and Repair:**	Every 1-3 years.	3	$2,000 to $5,000 depending on the extent of the work.	$3,000	$980	Ensure watertight seals and prevent infiltration or exfiltration.	Purpose: Ensure that the joints and seals between pipe sections are intact to prevent water infiltration and soil loss. Repair any compromised joints to avoid undermining or structural issues.
4	**Minor Concrete Repairs (Headwalls and Wingwalls):**	As needed, typically identified during inspections.	1	$1,000 to $3,000 per repair, depending on severity.	$500	$500	Repair cracks, spalling, or other damage to prevent further deterioration.	Purpose: Address any cracks, spalling, or other damage to the concrete components to prevent further deterioration.
Periodic Maintenance:								
1	**Structural Inspection (including underwater if needed):**	Every 5 years.	5	$3,000 to $7,000 per inspection.	$ 3,000	$576	Assess the integrity of the culverts, headwalls, and wingwalls, including any buried sections.	Purpose: A thorough inspection of the culverts, including assessing the aluminized coating's condition and any potential structural weaknesses. This may include non-destructive testing methods.
2	**Sediment and Scour Assessment:**	Annually, with more detailed assessments after major flooding.	1	$1,500 to $4,000 per assessment.	$ 1,500	$1,500	Monitor and address sediment buildup or scour around the culverts and headwalls.	Purpose: Evaluate the extent of sediment accumulation within the culverts and scour around the headwalls and wingwalls. Address any issues that could affect the structural integrity of the culverts or the surrounding infrastructure.
3	**Lining or Coating of Culvert Interior (if needed):**	Every 10-20 years, depending on wear and corrosion.	15	$10,000 to $30,000.	$ 15,000	$867	Extend the lifespan of the culverts by protecting against corrosion and abrasion.	Reapply protective coatings or linings to the interior of the culverts to mitigate corrosion and extend the service life.
4	**Rehabilitation or Replacement of Damaged Sections:**	As needed, typically following a detailed inspection.	20	$15,000 to $50,000 depending on the scope.	$ 15,000	$617	Address significant structural deterioration or damage.	Purpose: Address any significant structural damage or deterioration that could compromise the culverts' integrity.
5	**Concrete Repairs on Headwalls and Wingwalls:**	Every 10-15 years.	15	$5,000 to $15,000.	$ 15,000	$ 867	Repair or replace deteriorated concrete to maintain structural integrity.	Purpose: Repair or reinforce the concrete structures to maintain their integrity and ensure they continue to protect the culverts effectively.
Preventivie Measures:								
1	**Scour Protection (around culverts, headwalls, and wingwalls):**	Every 5 years, with additional checks after significant storm events.	5	$5,000 to $15,000.	$ 5,000	$ 961	Install or reinforce scour protection measures to prevent undermining of structures.	Purpose: Install or reinforce scour protection measures around the culverts and headwalls to prevent undermining, which could lead to structural failure.
2	**Vegetation Management:**	Annually or as needed.	2	$1,000 to $3,000 per year.	$ 1,000	$ 495	Manage vegetation around the culverts to prevent root damage and ensure clear water flow.	Purpose: Control vegetation around the culverts to prevent root intrusion, which can damage the structure, and to ensure that water flow is not obstructed.

Attachment 5

Documentation and Record Keeping:

1	**Maintenance Documentation:**	Ongoing.	1	$1,000 to $2,000 per year.	$ 1,000	$ 1,000	Keep detailed records of inspections, maintenance activities, and any repairs.	Keep detailed records of all inspections, maintenance activities, and any repairs or modifications performed on the culverts. This helps in tracking the condition of the culverts over time and in planning future maintenance.

Summary:

	Annualized Maintenace Cost	**$12,865**
50	**Present Value of Annualized Costs over the Life of the Structure**	**$404,255**
100	**Present Value of Annualized Costs over the Life of the Bridge**	**$554,447**

Regular inspections and cleaning are critical to preventing blockages and ensuring structural integrity.

Periodic detailed inspections and maintenance of the aluminized coating, joints, and concrete elements help extend the lifespan.

Preventive measures, such as scour protection and vegetation management, are essential to avoid structural issues that could lead to premature failure.

Proper and timely maintenance of these culverts is crucial for ensuring their long-term functionality and extending their design life.

Attachment 5

Bridge Maintenance Scope and Costs

Spear Street over Mud Hollow Brook

August 19, 2024

2% Annual Interest Rate

	Item	Frequency		Published Estimated Cost Range	Carried Cost	Annualized Cost	Purpose:	Notes:
Routine Maintenance:								
1	**Inspection:**	Annually or biannually.	1	$2,000 to $5,000 per inspection.	$2,000	$2,000	Early detection of wear, damage, or deterioration.	Regular visual inspections (annually or biannually) to identify any early signs of wear, damage, or deterioration in the concrete, joints, and reinforcement .Special attention should be given to the deck surface, expansion joints, drainage systems, and abutments.
2	**Cleaning of Deck & Drainage Systems**	Annually, or more frequently if in debris-prone areas.	1	$1,000 to $3,000 per cleaning.	$1,000	$1,000	Remove debris, dirt, and contaminants.	Clearing debris from the deck, expansion joints, and drainage systems to prevent water accumulation and ensure proper drainage. Cleaning the bridge deck and substructure to remove dirt, salt, and other contaminants that can cause corrosion.
3	**Joint Sealing Inspection and Repair**	Every 1-3 years.	3	$2,000 to $6,000 depending on the extent of the work	$3,000	$980	Prevent water infiltration through expansion joints.	Replacing or repairing seals in expansion joints to prevent water infiltration, which could lead to corrosion of reinforcing steel or deterioration of concrete.
4	**Minor Surface Repairs (Crack Sealing, Pothole Patching)**	As needed, typically identified during inspections.	1	$500 to $3,000 per repair, depending on the severity.	$500	$500	Prevent further deterioration and water ingress.	Minor repairs to the bridge deck, such as patching cracks or filling potholes, to prevent further deterioration.Sealing cracks in the concrete to prevent water ingress and freeze-thaw damage.
Periodic Maintenance:								
1	**Detailed Structural Inspection**	Every 5 years.	5	$5,000 to $10,000 per inspection.	$5,000	$961	Assess the condition of structural components, including concrete and reinforcement.	More extensive repairs to the concrete deck or abutments may be required if significant cracking, spalling, or other damage is detected. Reinforcement of areas showing signs of corrosion, such as adding additional protective coatings or cathodic protection systems.
2	**Sediment and Scour Assessment:**	Annually, with more detailed assessments after major flooding.		$1,500 to $4,000 per assessment.			Monitor and address sediment buildup or scour around the culverts and headwalls.	Purpose: Evaluate the extent of sediment accumulation within the culverts and scour around the headwalls and wingwalls. Address any issues that could affect the structural integrity of the culverts or the surrounding infrastructure.
2	**Deck Resurfacing or Overlay**	Every 10-20 years, depending on traffic and wear.	10	$15,000 to $40,000.	$15,000	$1,370	Protect and extend the life of the deck surface.	Applying a new surface overlay to the bridge deck every 10-20 years, depending on the level of traffic and environmental exposure. This helps to protect the underlying concrete and improve skid resistance.
3	**Rehabilitation or Strengthening of Structural Components**	As needed, typically following detailed inspections.	20	$10,000 to $50,000 depending on the scope.	$30,000	$1,235	Address significant deterioration or damage.	Depending on inspection results, structural rehabilitation or strengthening might be necessary, such as adding additional reinforcement, or in some cases, replacing damaged sections of the bridge.
4	**Abutment and Wingwall Maintenance**	As needed, typically following detailed inspections.	20	$10,000 to $50,000 depending on the scope.	$15,000	$617	Address significant deterioration or damage.	Monitoring and addressing any settlement, erosion, or scour around the abutments.Repairing or reinforcing the abutments as needed to maintain stability and support for the bridge superstructure.
5	**Repainting or Coating of Steel Components (if present)**	Every 10-15 years.	15	$3,000 to $7,000.	$ -	$0	Prevent corrosion of exposed steel elements.	If the bridge has any exposed steel components (e.g., in reinforcement or connectors), periodic repainting or recoating is necessary to prevent corrosion.
Preventive Meaures:								
1	**Waterproofing**	Every 5 years.	5	$5,000 to $15,000.	$ 3,000	$576	Ensure effective waterproofing of the deck.	Ensuring that the bridge deck is properly waterproofed to prevent water penetration, which can lead to deterioration of the concrete and reinforcement
2	**Vegetation Management:**	Annually or as needed.	2	$1,000 to $3,000 per year.	$ 1,000	$495	Manage vegetation around the culverts to prevent root damage and ensure clear water flow.	Purpose: Control vegetation around the culverts to prevent root intrusion, which can damage the structure, and to ensure that water flow is not obstructed.

Attachment 6

2	**Drainage System Maintenance**	Annually, with more detailed checks every 5 years.	5	$1,000 to $3,000 annually; $5,000 to $10,000 for detailed maintenance.	$ 1,000	$192	Ensure effective drainage to prevent water-related damage.	Regularly inspecting and maintaining the drainage system to ensure it effectively removes water from the bridge deck and substructure.
3	**Scour Protection Inspection**	Annually, with more detailed inspections after significant flooding events.	5	$2,000 to $5,000 per inspection.	$ 2,500	$480	Prevent scour around abutments.	Installing or maintaining scour protection around the abutments, particularly in areas prone to high water flow or flooding.
Documentation and Record-Keeping:								
1	**Maintenance Documentation**	Ongoing.	1	$1,000 to $2,000 per year.	$ 1,000	$1,000	Keep detailed records of inspections, maintenance activities, and repairs.	Maintaining detailed records of all inspections, maintenance, and repairs performed on the bridge is crucial for planning future work and ensuring long-term structural integrity.Effective maintenance will significantly extend the lifespan of the bridge, ensuring safety and reducing the need for major rehabilitation or replacement.

	Annualized Maintenace Cost	**$11,407**
100	**Present Value of Annualized Costs over the Life of the Structure**	**$491,627**

Attachment 6

Attachment 7

Lifetime Cost Analysis Summary

Spear Street Structure over Mud Hollow Brook

Estimates of Probable Construction Cost

August 23, 2024

Capital Costs 2% Value of Money

$	670,000	Twin Culvert Option
$	56,000	PV of Twin Culvert Repair Option in 50 Years
$	726,000	Total PV Culvert Option Installation Cost
$	810,000	Bridge Option

Maintenance Costs

$12,865	Culvert Option Annualized Present Value of Maintenance Costs
$554,000	Culvert Present Value of Maintenance Costs of 100 Years
$11,407	Bridge Option Annualized Present Value of Maintenance Costs
$492,000	Bridge Present Value of Maintenance Costs of 100 Years

Total Lifetime Cost

$	1,280,000	Culvert Option
$	1,302,000	Bridge Option