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Appendix A

Existing Conditions

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Technical Memorandum
Physical Condition - Patterson Side Road Bridges 1 and 2

Date: January 30, 2023 **Project No.:** 300051839.0000

Project Name: Patterson Side Road Bridges 1 (B22162016) and 2 (B22164017)

Client Name: Town of Caledon

Submitted To: Project File Report

Submitted By: Andrew Dawson, P.Eng.

Reviewed By: Matthew Brooks, P.Eng.

As part of the Schedule B Environmental Assessment (MCEA) for the Patterson Side Road and Duffy's Lane Bridges, R.J. Burnside & Associates Limited (Burnside) has completed a visual inspection of the Patterson Side Road structures and reviewed all available background information for the bridges to evaluate the various options as part of the MCEA, considering the physical environment. The Patterson Side Road Bridges are located on Patterson Side Road, with Bridges 1 (B22162016) and 2 (B22164017) located approximately 300 m southwest and 20 m northeast of Duffy's Lane, respectively.

Structure Background Information

Patterson Side Road Bridge 1 (B22162016)

The existing structure consists of a 7.0 m (+/-) span (7.4 m +/- parallel to road) cast-in-place concrete T Beam structure, with an overall structure width of approximately 7.4 m (+/-) and a driving platform width of approximately 6.4 m between barriers. The structure is skewed at an angle of approximately 18.4° to perpendicular. Portions of the original drawings were obtained during background review, but no date was present on the available drawings. It is estimated that the structure was constructed in the 1950s.

By comparison of the current structure to the original drawings, a rehabilitation has occurred previously, at an unknown date. This rehabilitation consisted of removal of the existing barrier and increasing the height of the curb, with a new curb mounted guide rail barrier. This rehabilitation increased the amount of fill over the bridge from approximately 200 to

500-700 mm. It is unknown whether the structure was evaluated at the time of rehabilitation to confirm if it could carry the increased dead loads. As such, it is recommended that a structure evaluation be considered if the original structure is to remain to confirm it can carry the additional dead load without limiting the live (truck) loads. Background review also indicated that a rehabilitation design for the widening and repair of the bridge was completed in 2001; however, based on the site review the designed rehabilitation was never completed.

Patterson Side Road Bridge 2 (B22164017)

Patterson Bridge 2 consists of a 13.7 m (+/-) span, cast-in-place concrete rigid frame with an overall structure width of approximately 8.7 m (+/-) and a driving platform width of approximately 7.67 m between barriers. The structure was originally constructed in 1957 and later rehabilitated in 2001.

Preliminary consideration regarding repair or replacement alternatives has been evaluated previously by GHD Limited (GHD). The options of a concrete overlay rehabilitation versus full structure replacement were analyzed. GHD's recommendation was to proceed with rehabilitation of the structure. However, this analysis considered cost and physical condition of the structure only but did not take into consideration aspects such as provisions to increase driving platforms and adjust vertical alignments to meet current Town standards. These considerations will be further evaluated within the MCEA.

Physical Condition

On October 27, 2020, Andrew Dawson, P.Eng., and Devin Soeting, C.E.T., from Burnside conducted a Field Investigation to review the physical conditions of Patterson Side Road Bridges 1 and 2. The previous 2019 OSIM inspections (completed by GHD Limited) and Detailed Deck Condition Surveys (DDCS) (completed by Bridge Check Canada) were also reviewed in consideration of analyzing the condition of the structures. A summary of the findings for each structure are below:

Patterson Side Road Bridge 1 (B22162016)

Overall, the structure was noted to be in fair condition overall with light scaling and hairline to narrow cracking throughout, localized moderate to severe defects (wet areas, delaminations, spalls, etc.) on the abutments wingwalls and soffit. The DDCS also identified probable active corrosion in 29% of the deck top, 14% of the east abutment, 26% of the west abutment and 56% of the wingwalls. The noted physical defects at the structure could be repaired as part of a major rehabilitation of the bridge by completing conventional concrete patch repairs.

Bridge 1 is not well aligned with the watercourse in its current condition. The watercourse currently flows into the northwest wingwall and abutment corner and flows through the bridge are concentrated along the west abutment. This poor alignment has caused scour on the northwest embankment, requiring additional steel sheet piles to be installed to retain the fill

slope. It has also caused scouring along the east abutment, reducing the cover over the footings.

Patterson Side Road Bridge 2 (B22164017)

Overall, Patterson Bridge 2 was noted to be in fair condition overall, with minor surface defects (scaling, narrow cracks) throughout, and localized moderate to severe defects. A medium to wide crack with efflorescence was noted on the soffit near the centerline, indicating moisture penetration through the concrete deck. Delaminations and spalling were also noted on the soffit. Previous patching of the concrete was observed, but the bonding of these patches to the original concrete are failing in some locations. All of the noted defects at the structure could be repaired as part of a major rehabilitation of the bridge, which would likely require a concrete overlay on the deck, and significantly large patch repair areas.

The DDCS confirmed the presence of a waterproofing membrane which is generally in good condition, but also indicated probable corrosion in 36.6% of the deck top area. Given that there is 8.6% of the deck area with high corrosion potential (<-0.45V), and delamination planes were found in 75% of the deck cores, the removal limits are estimated to be above 10% of the deck area, and a concrete overlay would be the recommendation for deck top repairs. The DDCS also indicated probable active corrosion in 100% of the west abutment, 78% of the east abutment and 98% of the wingwalls. With this extent of probable corrosion occurring, the degradation rate of the structure will likely accelerate in the future if no action is taken.

The watercourse at Bridge 2 flows predominantly along the west abutment, which has caused some erosion along the toe of embankments adjacent to the intersection.

Geometry – Width

Patterson Side Road currently carries two lanes of traffic, with a paved width of approximately 7 - 7.5 m and gravel shoulder widths ranging from 0.5 m to 1.0 m, with an overall platform width of approximately 9.0 m. As previously noted, the widths of Bridge 1 and 2 are 6.4 m and 7.67 m, respectively. As such the roadway currently narrows at each of the bridge crossings.

A road reconstruction design is currently in the final stages for the portion of Patterson Side Road where Bridge 1 and 2 are located. The design, which is being completed by Morrison Hershfield, consists of a 9.0 m wide paved platform on the approaches to the bridge, with 3.0 m lanes and 1.5 m paved shoulders. However, the road width will transition current driving platform width between barriers over the existing bridges. It should be noted however that this proposed road platform configuration does not meet the Town's current standards as outlined in the Transportation Master Plan.

The Town's October 2017 Transportation Master Plan (TMP) recommends that the segment of Patterson Side Road accommodate a 'Shared On-Road Cycling Route'. The total driving platform required for a rural road with the desired 1.5 m wide Signed Bikeway (per Table 4.5 of the TMP) would be 10.0 m, as illustrated in Figure 1 (excerpt of Figure 4.1 of Caledon's TMP).

Figure 1 - Rural Road Cross-Section

Review of the TAC Geometric Design Guide for Canadian Roads[1] and MTO Design Supplement (April 2020) were also reviewed for comparison to the Town's 2017 TMP standards. The 10.0 m wide Town standard platform would meet the minimum requirements, provided that the design speed of the roadway is 70 km/hour or less. If the desired design speed were to be 80 km/hour, the required shoulder and side clearance (distance between edge of lane and bridge barrier) widths would be 2.0 m, for a total platform width of 11.0 m.

Given the narrow platform width of the existing bridges, the structures are deficient with respect to platform width and cannot accommodate the shared on-road bicycle lanes or provide the recommended side clearances. To rectify the geometric deficiencies, the structures could be widened as part of a major rehabilitation or replaced with a new two lane structure.

Geometry – Profile

Patterson Side Road in the Town of Caledon is considered a rural collector road and has a posted speed limit of 60 km/hour at the site. The structures are on a vertical curve portion of the roadway profile. As previously mentioned, Morrison Hershfield is currently in the stage of finalizing the design for a reconstruction of Patterson Side Road, which includes the subject area of the structures. The proposed road reconstruction reduces the speed limit of the roadway to the northeast and southwest of the structure to 40 km/hour; however, the posted speed limit at the bridge locations is noted to remain as 60 km/hour based on Morrison Hershfield's '100% Submission' drawings, dated August 28, 2020.

As per the MTO Design Supplement for TAC – April 2020:

> *"Design speed should be greater than or equal to the legal posted speed. Generally, the desirable practice of selecting the design speed for new construction and reconstruction is 20 km/h greater than the posted legal speed, unless circumstances warrant a reduction.*
>
> *A design speed equal to the maximum posted speed is accepted where warranted by such factors as low traffic volumes, rugged terrain and economic considerations. This practice would be more appropriate for minor collector*

[1] Chiu, M., Clayton, C., Millen, G. et al. 2017. *Geometric Design Guide for Canadian Roads*. Ottawa, ON: Transportation Association of Canada

and local roads. A design speed equal to the legal posted speed is the normal practice for Secondary highways"

In order to achieve the *desirable* 80 km/hour design speed (20 km/hour greater than currently posted), significant adjustments to the road profile would be required. Preliminary profile options indicate 3-4 m of fill would be required in areas of the existing bridges and the intersection with Duffy's Lane. Such increases would only be feasible with full structure replacements. This magnitude of increase would also result in grading conflicts to the adjacent watercourse, significant property acquisitions or retaining walls and significant reconstruction of the Duffy's Lane intersection and adjacent bridge structure. Additionally, the substantial increase in the profile would have negative hydraulic impacts during larger storm events and would require a significantly larger span structure to attempt to offset these impacts.

Therefore, given the above constraints of the site, it is recommended that the road profiles be designed for a 60 km/hour design speed, to match the current maximum posted speed limit, as per normal practice for Secondary highways.

To meet the minimum required design speed equal to the legal posted speed (60 km/hour), the minimum K-factors for crest and sag curves in accordance with TAC Geometric Design Guides are 11 and 18, respectively. Given that the Patterson Side Road reconstruction profiles (completed by Morrison Hershfield) have more abrupt curvature rates than these standards, adjustments to the road profile should be considered as part of the bridge improvement works. If the Town desires to meet the *desirable* design speed of 20 km/hour above the posted speed limit, consideration should be given to reducing the speed limit to 40 km/h in the vicinity of the bridges, which would match the speed limit of the roadway approaching the bridges.

To rectify the profile / sight distance deficiencies at the site to meet the 60km/hour design speed criteria, increases to the road profiles at the bridge locations up to approximately 0.65 m and 0.45 m would be required for Bridges 1 and 2, respectively. To achieve these profile increases on the existing structures, significant structural overlays would be required, which would likely require strengthening and load posting of the existing structures and therefore are not considered feasible for rehabilitation options. Replacement of the structures would allow for the 60 km/hour design speed profiles to be achieved without load postings.

With regard to hydraulics, the existing structures pass the 50-year design storm flows with clearances greater than the minimum requirements for a Collector Road. As such, the consideration for increasing the road profile is to improve sight lines only. For further information regarding hydraulic performance of the existing and proposed structures, please refer to the Hydraulic Report.

A Preliminary Plan and Profile Drawing for a 60 km/hour design speed and 10.0 m paved platform width is available in Appendix A.

Load Capacity

Both Patterson Bridges 1 and 2 do not have load limit postings on the structures. However, Heavy Truck traffic is currently restricted on Patterson Side Road by Town By-Law, as identified by the Rb-62 signage at intersections. The By-Law restricts *commercial* vehicles over 12 tonnes from using the structures unless use of the roadway is required for delivery or collection purposes with no alternative route. The by-law excludes emergency response vehicles, Town/Region/Province and utility vehicles from these restrictions.

As previously noted, Patterson Side Road Bridge 1 has had additional deadload added to the structure, with the amount of fill over the structure increased from 200 mm in the original design to 600-700 mm under current conditions. This addition of dead loads can affect the structure's capacity for carrying traffic loading.

Additionally, the required live load capacities have increased since the time of the original design of the structure. As such, if the current structures are to remain, a structure evaluation is recommended to be completed on both structures to determine if a more restrictive load posting would be required.

If it is determined that a load posting is applicable at either structure, there is a potential that strengthening of the existing bridges during a major rehabilitation may help increase the allowable loading.

Evaluation of Alternatives

The MCEA for the Patterson Side Road Bridges has identified the following four options for each of the structures:

1. Do Nothing
2. Rehabilitation
3. Rehabilitation with Widening; or
4. Replacement.

Cross-sections outlining the general scopes of work for each of the proposed options above (excluding the Do Nothing option) are provided in Appendix B.

Each alternative is to be evaluated based on its ability to improve the physical environment at the site, which is the intent of this Technical Memo. Table 1 and Table 2 are a summary of the physical environments that were considered, the noted deficiencies and the effectiveness of each option to rectify the deficiency and identify a Preferred Solution.

Table 1: Evaluation of Alternatives, Physical Environment - Patterson Bridge 1

	EA Options			
	Do Nothing	**Rehabilitation**	**Rehab. & Widen**	**Replacement**
Physical Condition	Defects not addressed; Structure generally in fair condition with limited (10 years +/-) service life remaining; Alignment with watercourse not improved	All defects can be addressed to extend the service life to 20-25 years. Alignment with watercourse not improved	All defects can be addressed to extend the service life to 20-25 years (limited by existing substructure); Alignment with watercourse not improved	A new structure will not have any defects and all issues will be addressed; Service life of 75 years expected; Alignment with watercourse improved.
Geometry – Width	No improvement to driving platform width.	No improvement to driving platform width.	Structure can be widened as part of a major rehabilitation to meet desired platform width.	A new structure can be constructed to the desired platform width.
Geometry – Profile	No opportunity to improve profile and sight lines. Design speed of less than 40 km/hour	Opportunity for minor improvement to profile and sight lines (40 km/hour design speed).	Opportunity for minor improvement to profile and sight lines (40 km/hour design speed).	Sight distance can be improved to meet 60 km/hour design speed.
Load Capacity	No opportunity to improve capacity of the structure. May require load posting	Reinforced concrete deck overlay to replace granular fill and improve capacity.	Reinforced concrete deck overlay to replace granular fill and improve capacity.	A new bridge will not have any load restrictions.
Cost	No immediate costs, service life of structure is > 10 years.	$385,000.00 (See Appendix C)	$1,150,000.00 (See Appendix C)	$1,895,000.00 (See Appendix C) Based on 16.25m span bridge
Preferred Option	Least Preferred	Less preferred	Somewhat Preferred	**Most Preferred**

Table 2: Evaluation of Alternatives, Physical Environment - Patterson Bridge 2

	EA Options			
	Do Nothing	**Rehabilitation**	**Rehab. & Widen**	**Replacement**
Physical Condition	Defects not addressed; Structure generally in fair condition with limited (10-15 years) service life remaining; Alignment with watercourse not improved	All defects can be addressed to extend the service life to 20-25 years. Alignment with watercourse not improved	All defects can be addressed to extend the service life to 20-25 years (limited by existing substructure); Alignment with watercourse not improved	A new structure will not have any defects and all issues will be addressed; Service life of 75 years expected; Alignment with watercourse improved.
Geometry – Width	No improvement to driving platform width.	No improvement to driving platform width.	Structure can be widened as part of a major rehabilitation to meet desired platform width.	A new structure can be constructed to the desired platform width.
Geometry – Profile	No opportunity to improve profile and sight lines. Design speed of less than 40 km/hour	Opportunity for minor improvement to profile and sight lines (40 km/hour design speed).	Opportunity for minor improvement to profile and sight lines (40 km/hour design speed).	Sight distance can be improved to meet 60 km/hour design speed.
Load Capacity	No opportunity to improve capacity of the structure. May require load posting	Opportunity to strengthen structure & provide minor capacity improvement	Opportunity to strengthen structure & provide minor capacity improvement	A new bridge will not have any load restrictions.
Cost	No immediate costs, service life of structure is > 10 years.	$675,000 (See Appendix C)	$1,095,000.00 (See Appendix C)	$2,175,000.00 (See Appendix C) Based on a 14.0m span bridge.
Preferred Option	Least Preferred	Less preferred	Somewhat Preferred	**Most Preferred**

For reference, Preliminary Cost Estimates have been provided and enclosed within the document.

Summary

The Preferred option to address the physical and geometric deficiencies for both Patterson Side Road Bridges 1 and 2 is to replace the structures with new, wider platform structure.

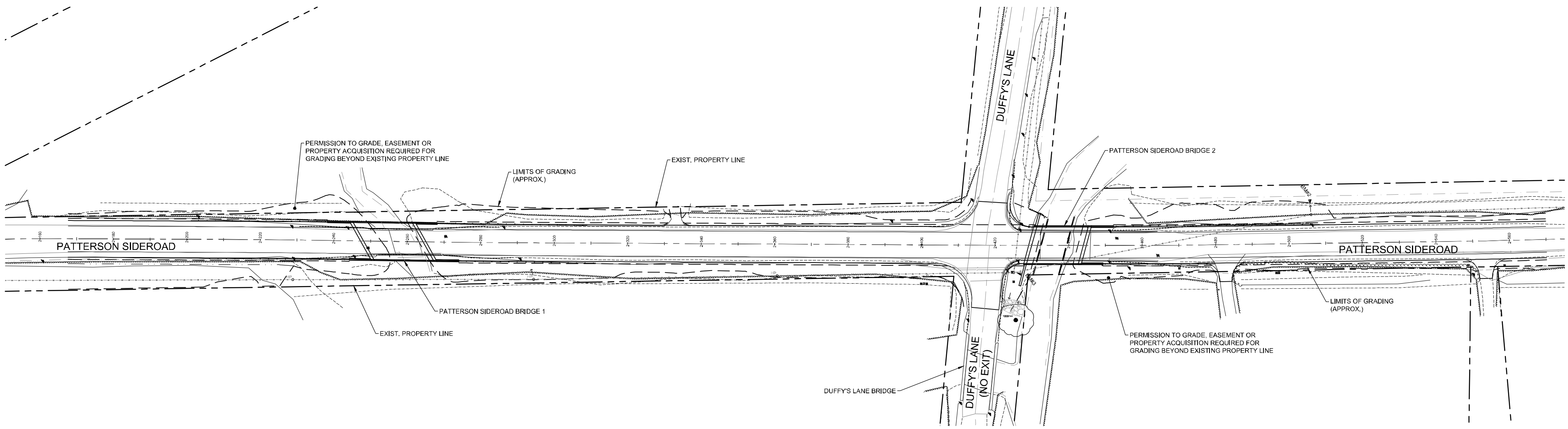
If you have any questions or comments do not hesitate to contact the undersigned.

R.J. Burnside & Associates Limited

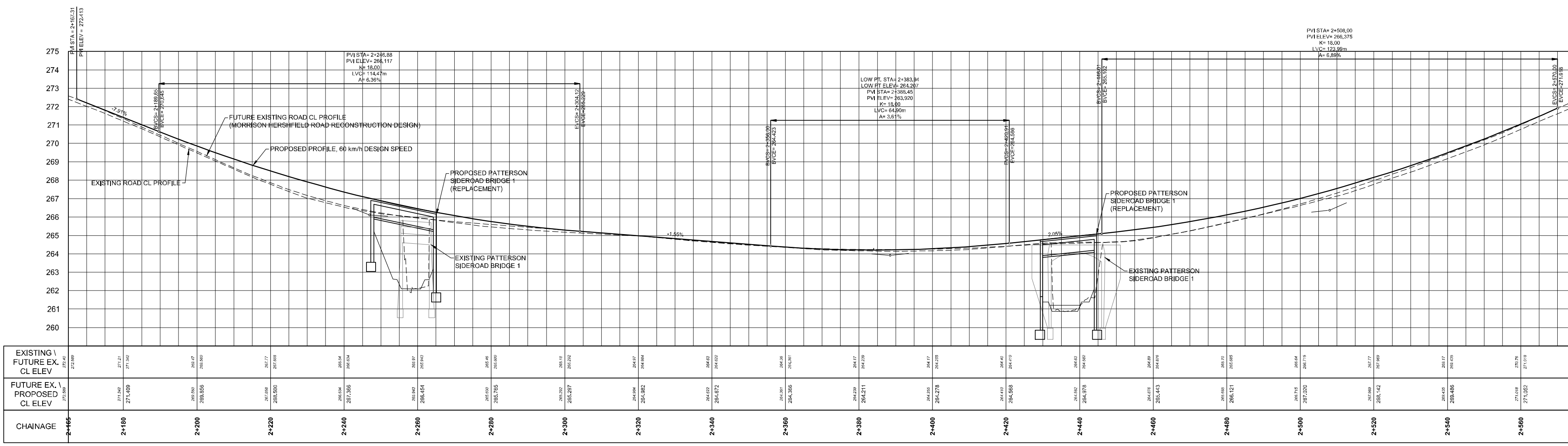
Andrew Dawson, P.Eng.
Project Engineer

AD:jm

Enclosure(s) Appendix A – 051839 Patterson EA P&P
Appendix B – Patterson EA Bridge Cross Sections
Appendix C – Bridge 1 Cost Estimates
Bridge 2 Cost Estimates



PLAN
1:500



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Client: TOWN OF CALEDON

Figure Title: PATTERSON SIDEROAD BRIDGES

PLAN AND PROFILE - 60 kmh

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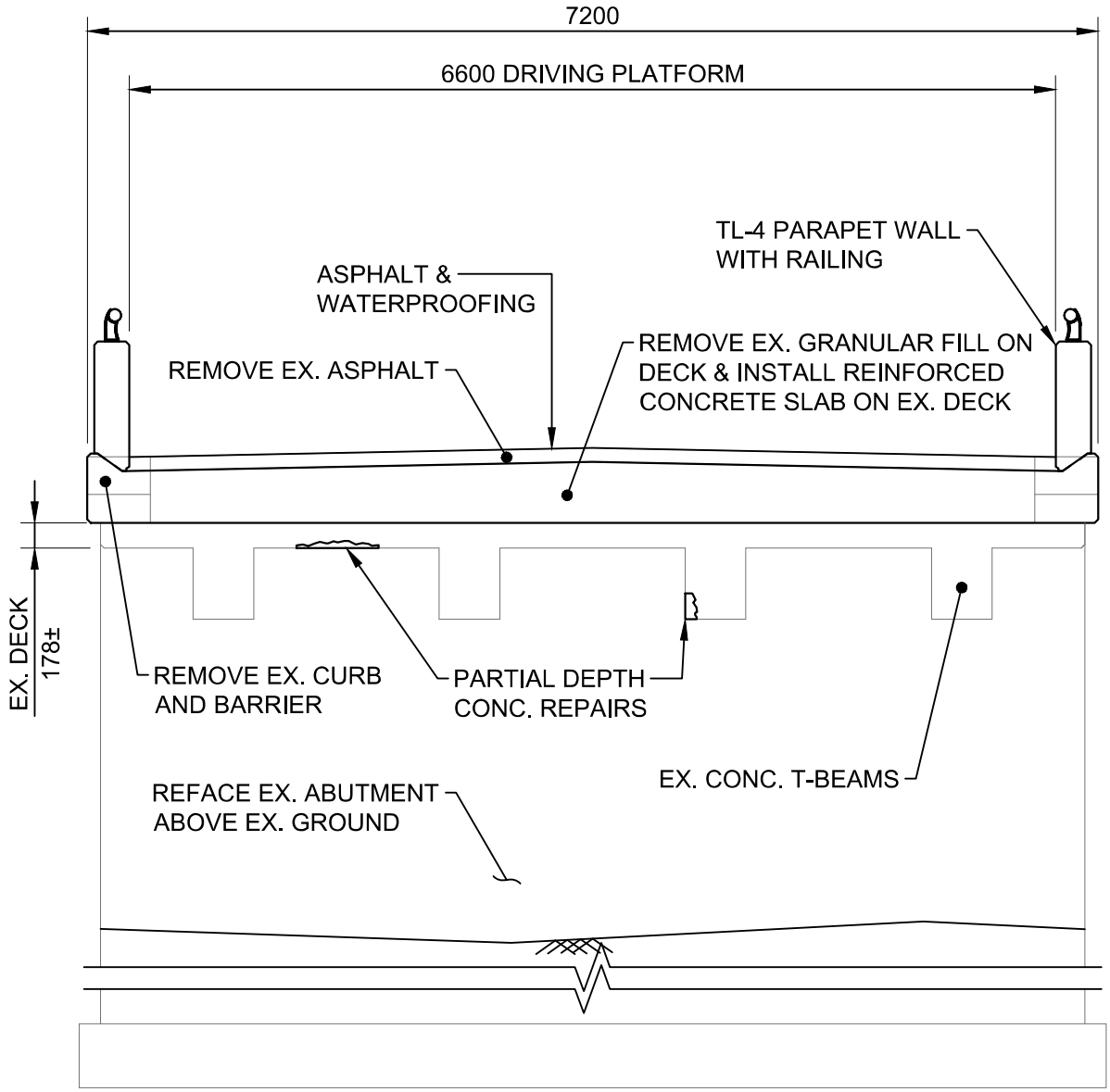
Scale		Project No.	
AS NOTED		300051539.7000	



BRIDGE 1 - OPTION 2 - REHABILITATION

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Figure Title

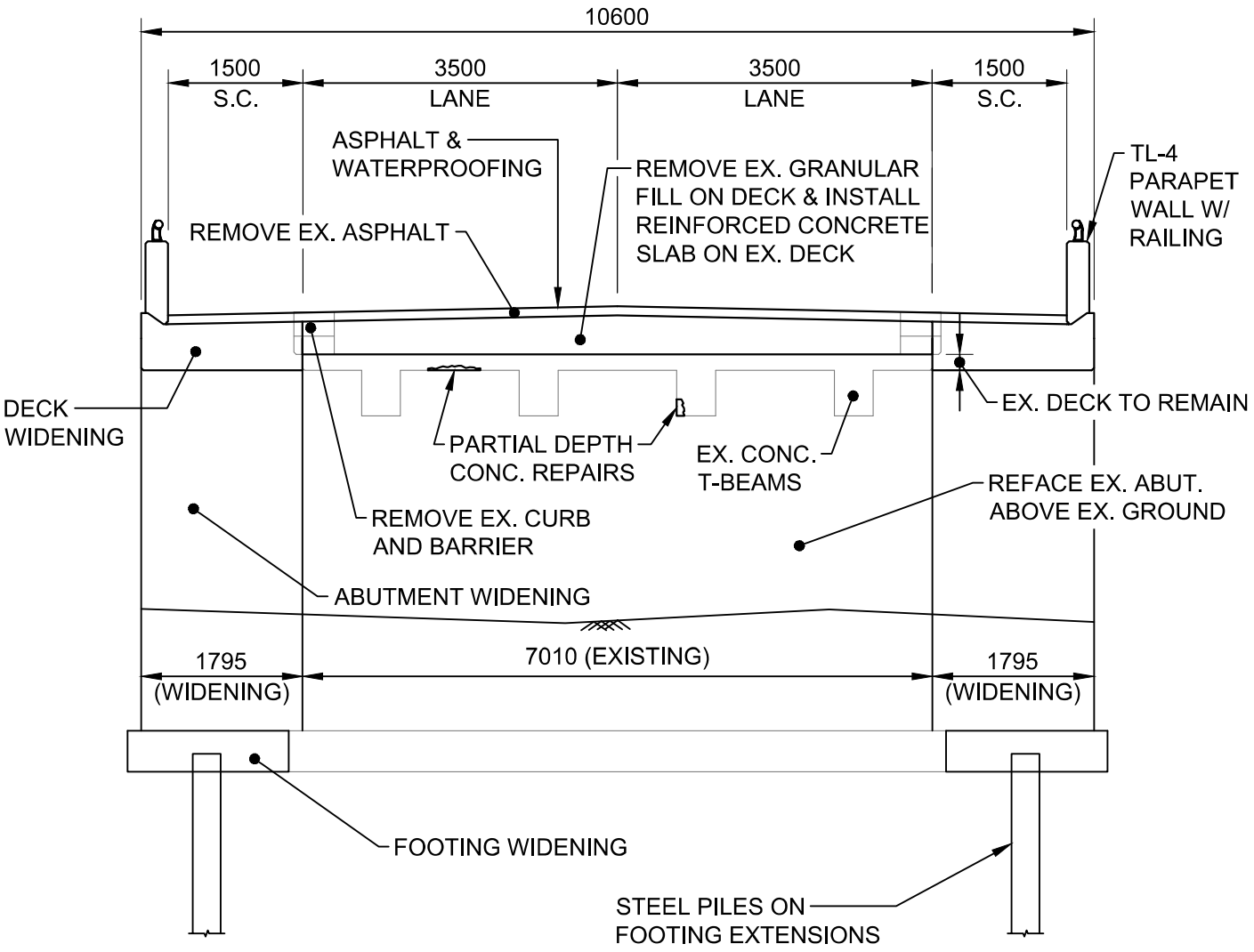
PATTERSON SIDEROAD BRIDGES

BRIDGE 1 - OPTION 2 - REHABILITATION

Client

TOWN OF CALEDON

Drawn	Checked	Date	Figure No.
AD	MB	21/02/08	**B1.2**
Scale		Project No.	
AS NOTED		300051839.7000	



BRIDGE 1 - OPTION 3 - REHABILITATION & WIDENING

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Figure Title

PATTERSON SIDEROAD BRIDGES

BRIDGE 1 - OPTION 3 - REHABILITATION & WIDENING

Client

TOWN OF CALEDON

Drawn	Checked	Date	Figure No.
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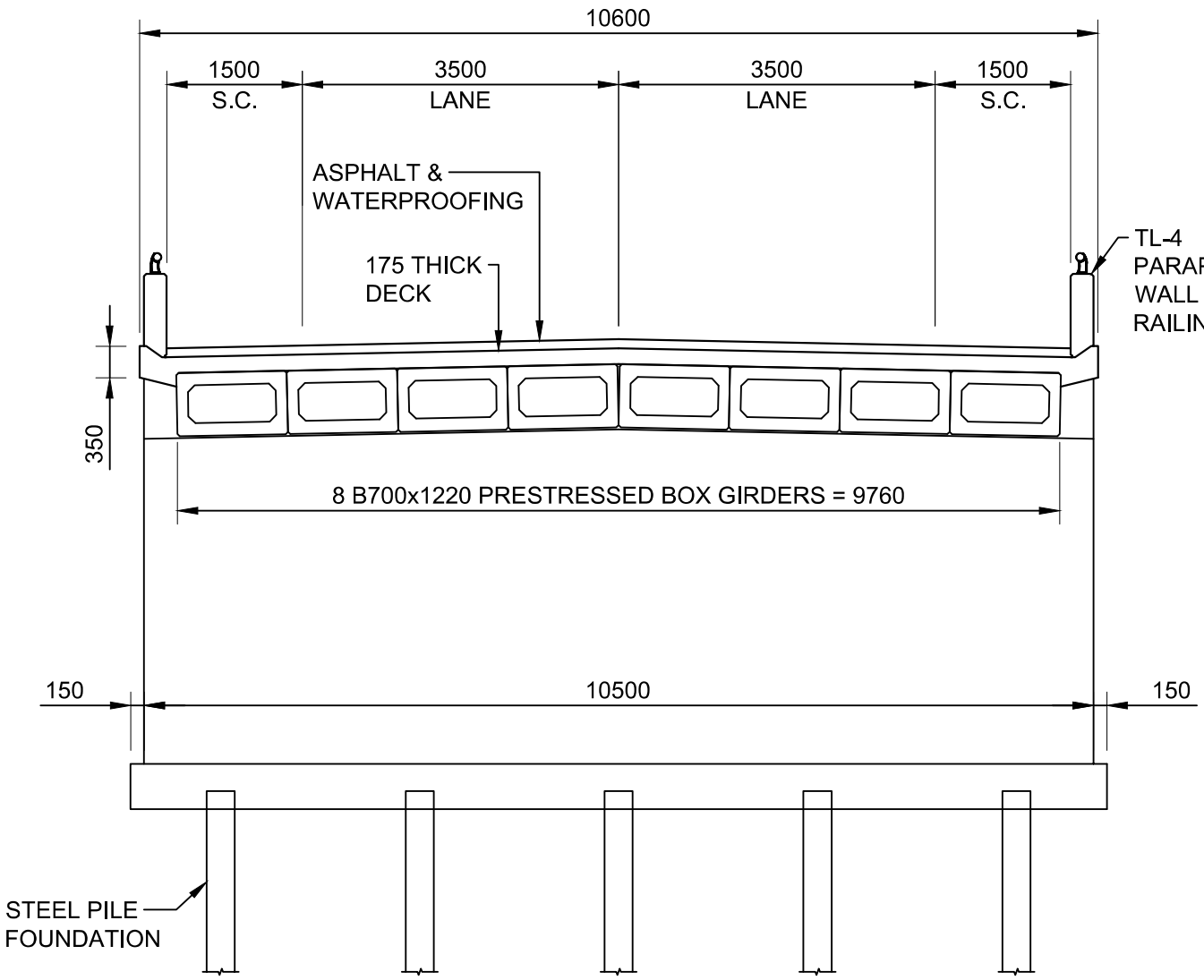
Scale		Project No.	
AS NOTED		300051839.7000	



BRIDGE 1 - OPTION 4 - REPLACEMENT

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Figure Title

PATTERSON SIDEROAD BRIDGES

BRIDGE 1 - OPTION 4 - REPLACEMENT

Client

TOWN OF CALEDON

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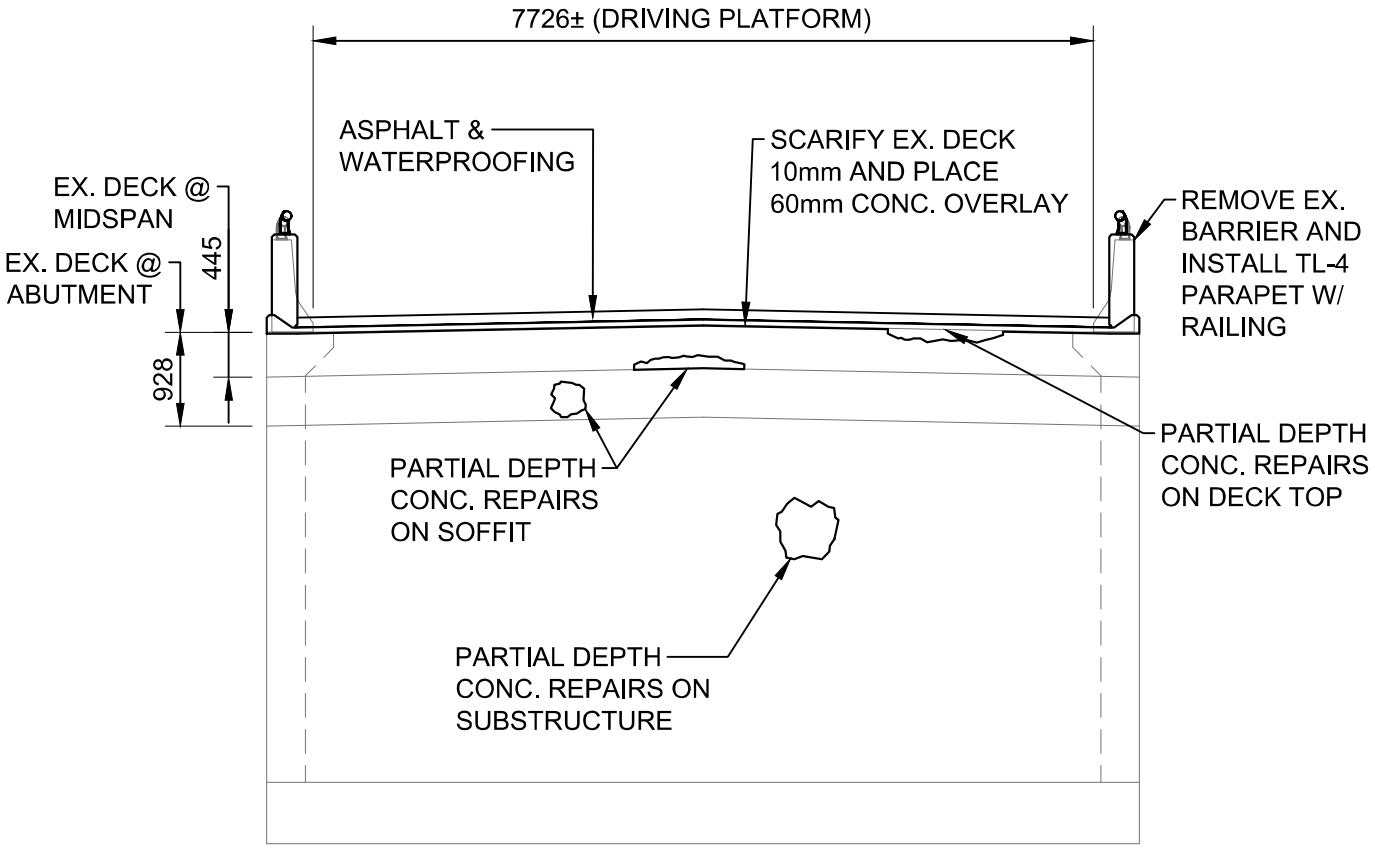
Scale		Project No.	
AS NOTED		300051839.7000	



BRIDGE 2 - OPTION 2 - REHABILITATION

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BURNSIDE

Figure Title

PATTERSON SIDEROAD BRIDGES

BRIDGE 2 - OPTION 2 - REHABILITATION

Client

TOWN OF CALEDON

Drawn	Checked	Date	Figure No.
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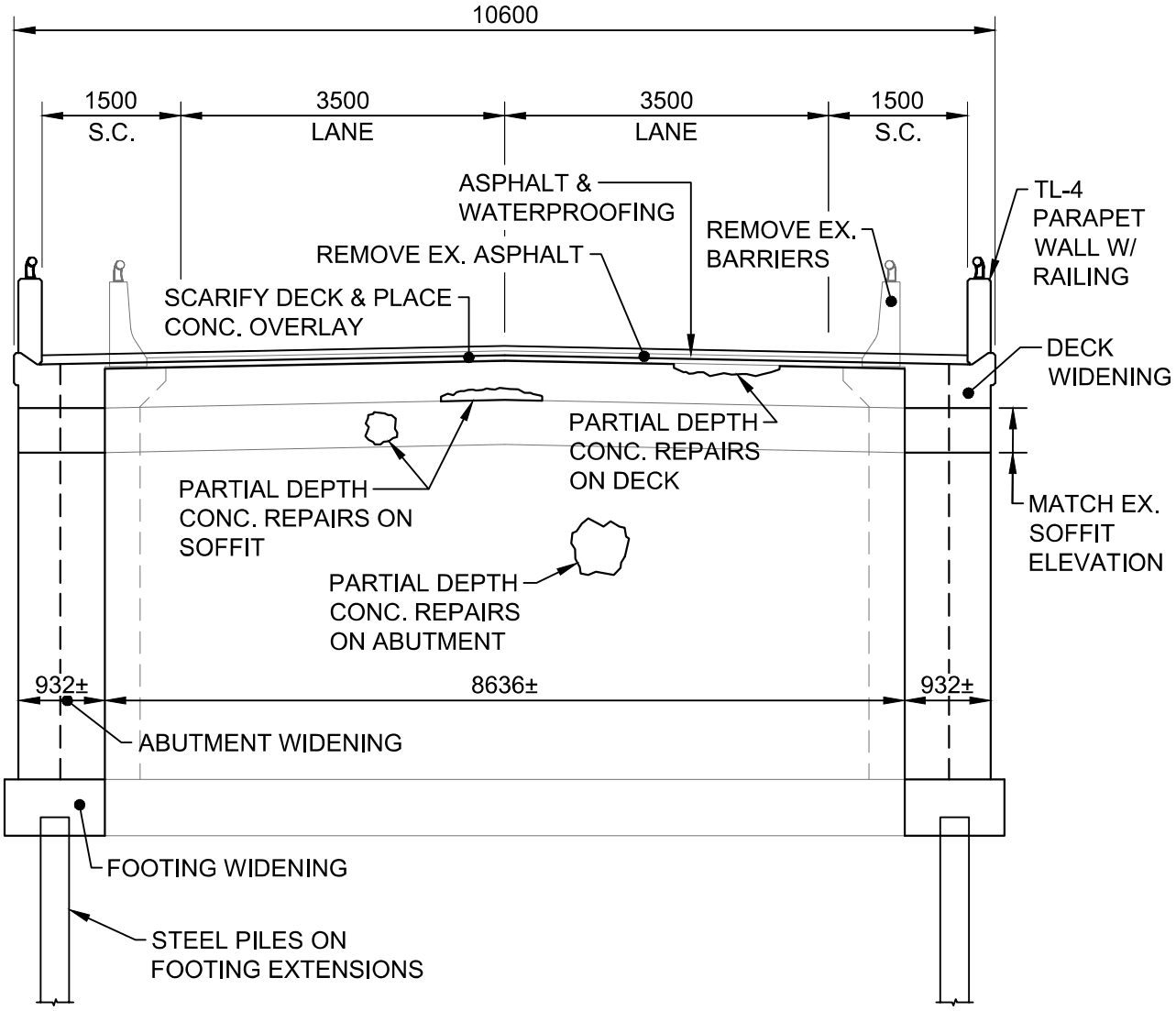
Scale		Project No.	
AS NOTED		300051839.7000	



BRIDGE 2 - OPTION 3 - REHABILITATION & WIDENING

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Figure Title

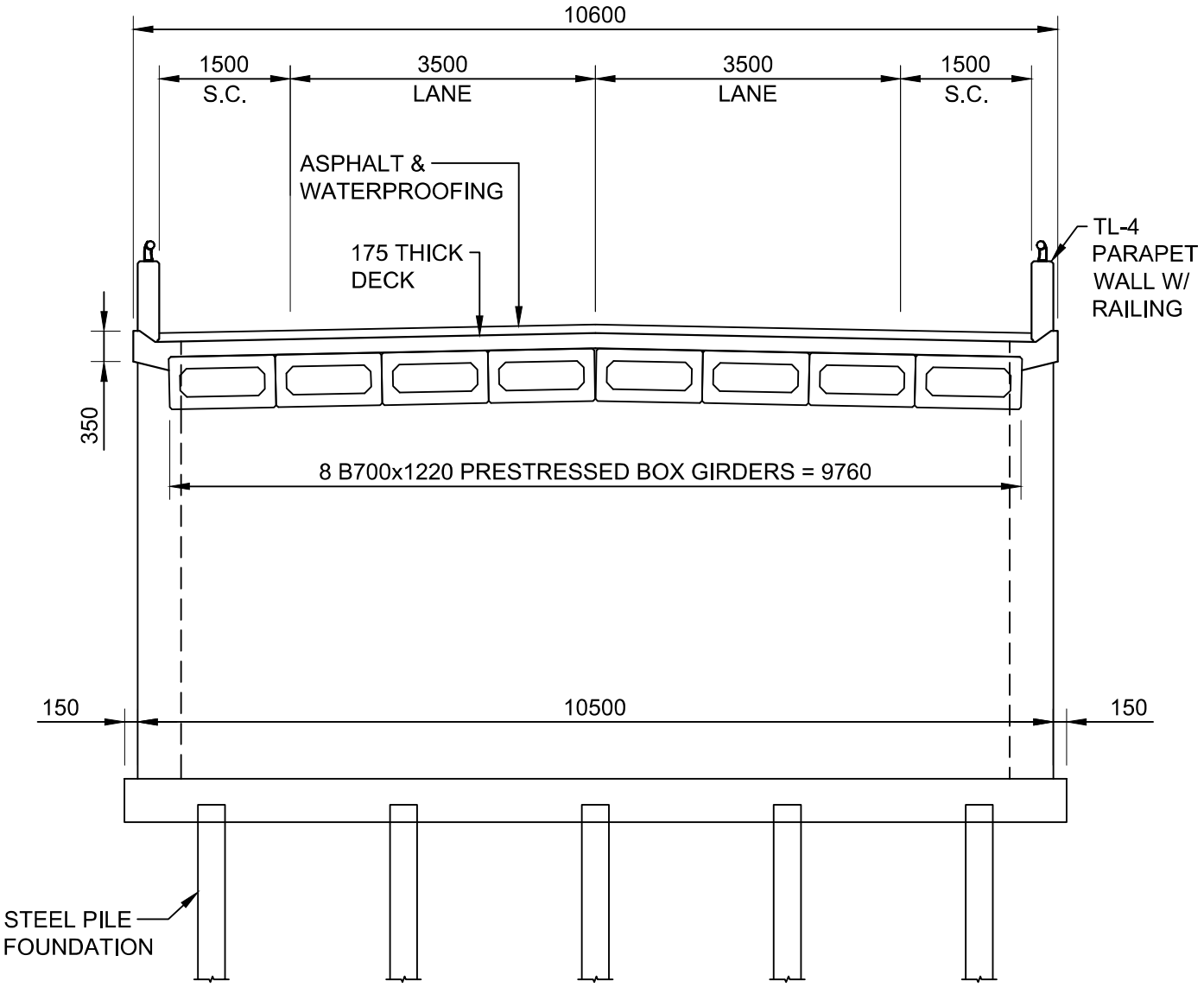
PATTERSON SIDEROAD BRIDGES

BRIDGE 2 - OPTION 3 - REHABILITATION & WIDENING

Client

TOWN OF CALEDON

Drawn	Checked	Date	Figure No.
AD	MB	21/02/24	**B2.3**
Scale		Project No.	
AS NOTED		300051839.7000	



BRIDGE 2 - OPTION 4 - REPLACEMENT

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BURNSIDE

Figure Title

PATTERSON SIDEROAD BRIDGES

BRIDGE 2 - OPTION 4 - REPLACEMENT

Client

TOWN OF CALEDON

Drawn	Checked	Date	Figure No.
AD	MB	21/02/24	**B2.4**
Scale		Project No.	
AS NOTED		300051839.7000	

Client:	**Town of Caledon**
Project:	**Patterson Road Bridge 1**
Project No.:	**300051839.7**
Date:	**February 22, 2021**

REHABILITATE EXISTING BRIDGE - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$40,000.00	$40,000.00
2	Contract Bonds and Insurance	1	LS	$15,000.00	$15,000.00
3	Construction Layout	1	LS	$7,500.00	$7,500.00
4	As-Built Drawings	1	LS	$2,500.00	$2,500.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$10,000.00	$10,000.00
7	Waterway Control	1	LS	$10,000.00	$10,000.00
8	Remove Existing Guide Rail	115	m	$15.00	$1,725.00
9	Asphalt Removal - Full Depth	255	sq.m	$12.50	$3,187.50
10	Removal of Ex. Fill from Deck	1	LS	$5,000.00	$5,000.00
11	Concrete Removals, Partial Depth - Type A	0.5	cu.m	$5,000.00	$2,500.00
12	Concrete Removals, Partial Depth - Type B	0.6	cu.m	$12,500.00	$7,500.00
13	Concrete Removals, Partial Depth - Type C	0.7	cu.m	$12,500.00	$8,750.00
14	Hot Mix HL-3	20	t	$200.00	$4,000.00
15	Hot Mix HL-8	40	t	$200.00	$8,000.00
16	Pavement Markings	120	m	$20.00	$2,400.00
17	Granular 'A'	150	t	$22.00	$3,300.00
18	Earth Excavation for Structure	1	LS	$5,000.00	$5,000.00
19	Steel Beam Guide Rail	95	m	$150.00	$14,250.00
20	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
21	Steel Beam Energy Attenuating System	4	ea.	$4,500.00	$18,000.00
22	Concrete in Deck Overlay	1	LS	$37,500.00	$37,500.00
23	Concrete in Barrier Wall	1	LS	$20,000.00	$20,000.00
24	Concrete in Abutment Refacing	1	LS	$8,500.00	$8,500.00
25	Concrete Patches, Partial Depth, Form & Pump	0.6	cu.m	$7,000.00	$4,200.00
26	Dowels into Concrete	200	ea.	$20.00	$4,000.00
27	Barrier Wall Railing	1	LS	$10,000.00	$10,000.00
28	Steel Reinforcing	1	LS	$12,500.00	$12,500.00
29	Stainless Reinforcing Steel	1	LS	$20,000.00	$20,000.00
30	Bridge Deck Waterproofing	59	sq.m	$75.00	$4,425.00
31	Joint Fillers, Seals and Compounds	1	LS	$2,500.00	$2,500.00
32	Rip-Rap	125	t	$65.00	$8,125.00
33	Topsoil, Imported	40	cu.m	$60.00	$2,400.00
34	Seed and Cover	400	sq.m	$5.00	$2,000.00
35	Heavy Duty Silt Fence Barriers	100	m	$20.00	$2,000.00
36	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
37	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
38	Smooth Run River Stone	100	t	$90.00	$9,000.00
	Estimated Construction Cost Subtotal				$336,862.50
	15% Contingency				$50,529.38
	Project Cost Subtotal				$387,391.88
	13% H.S.T.				$50,360.94
	TOTAL ESTIMATED PROJECT COST				$437,752.82

Note - Total estimated construction price does not include any cost for property

Client:	**Town of Caledon**
Project:	**Patterson Road Bridge 1**
Project No.:	**300051839.7**
Date:	**February 22, 2021**

REHABILITATE & WIDEN BRIDGE (10.0m Wide Platform) - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$60,000.00	$60,000.00
2	Contract Bonds and Insurance	1	LS	$20,000.00	$20,000.00
3	Construction Layout	1	LS	$15,000.00	$15,000.00
4	As-Built Drawings	1	LS	$5,000.00	$5,000.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$30,000.00	$30,000.00
7	Waterway Control	1	LS	$60,000.00	$60,000.00
8	Remove Existing Guide Rail	115	m	$15.00	$1,725.00
9	Asphalt Removal - Full Depth	720	sq.m	$12.50	$9,000.00
10	Removal of Ex. Fill from Deck	1	LS	$5,000.00	$5,000.00
11	Remove Ex. Concrete Curbs & Wingwall Tops	1	LS	$12,500.00	$12,500.00
12	Concrete Removals, Partial Depth - Type A	0.5	cu.m	$5,000.00	$2,500.00
13	Concrete Removals, Partial Depth - Type B	0.6	cu.m	$12,500.00	$7,500.00
14	Concrete Removals, Partial Depth - Type C	0.7	cu.m	$12,500.00	$8,750.00
15	Hot Mix HL-3	90	t	$150.00	$13,500.00
16	Hot Mix HL-8	190	t	$150.00	$28,500.00
17	Pavement Markings	320	m	$20.00	$6,400.00
18	Granular 'A'	150	t	$22.00	$3,300.00
19	Granular 'B' - Type 1 Roadway	350	t	$18.00	$6,300.00
20	Granular 'B' - Backfill to Structure	2400	t	$20.00	$48,000.00
21	Pipe Subdrain	52	m	$15.00	$780.00
22	Earth Excavation for Structure	1	LS	$40,000.00	$40,000.00
23	Unwatering Structure Excavation	1	LS	$40,000.00	$40,000.00
24	Steel Beam Guide Rail	95	m	$150.00	$14,250.00
25	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
26	Steel Beam Energy Attenuating System	4	ea.	$4,500.00	$18,000.00
27	Supply Equipment for Installing Driven Piles	1	LS	$50,000.00	$50,000.00
28	H Piles - HP 310 x 110	160	m	$500.00	$80,000.00
29	Driving Shoes	8	ea.	$450.00	$3,600.00
30	Concrete in Footings	1	LS	$9,000.00	$9,000.00
31	Concrete in Structure Widening	1	LS	$60,000.00	$60,000.00
32	Concrete in Wingwalls	1	LS	$65,000.00	$65,000.00
33	Concrete in Deck Overlay	1	LS	$37,500.00	$37,500.00
34	Concrete in Barrier Wall	1	LS	$22,000.00	$22,000.00
35	Concrete in Approach Slabs	1	LS	$40,000.00	$40,000.00
36	Concrete in Abutment Refacing	1	LS	$8,500.00	$8,500.00
37	Dowels into Concrete	650	ea.	$20.00	$13,000.00
38	Barrier Wall Railing	1	LS	$10,000.00	$10,000.00
39	Steel Reinforcing	1	LS	$55,000.00	$55,000.00
40	Stainless Reinforcing Steel	1	LS	$25,000.00	$25,000.00
41	Bridge Deck Waterproofing	89	sq.m	$75.00	$6,675.00
42	Joint Fillers, Seals and Compounds	1	LS	$7,500.00	$7,500.00
43	Rip-Rap	150	t	$65.00	$9,750.00
44	Topsoil, Imported	60	cu.m	$60.00	$3,600.00
45	Seed and Cover	600	sq.m	$5.00	$3,000.00
46	Heavy Duty Silt Fence Barriers	200	m	$20.00	$4,000.00
47	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
48	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
49	Smooth Run River Stone	120	t	$90.00	$10,800.00
				Estimated Construction Cost Subtotal	$1,001,030.00
				15% Contingency	$150,154.50
				Project Cost Subtotal	$1,151,184.50
				13% H.S.T.	$149,653.99
				TOTAL ESTIMATED PROJECT COST	$1,300,838.49

Note - Total estimated construction price does not include any cost for property

Client:	**Town of Caledon**
Project:	**Patterson Sideroad Bridge 1**
Project No.:	**300051839.7**
Date:	**February 22, 2021**

REPLACE BRIDGE (10m Wide Platform, 16.25m Span) - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$60,000.00	$60,000.00
2	Contract Bonds and Insurance	1	LS	$20,000.00	$20,000.00
3	Construction Layout	1	LS	$25,000.00	$25,000.00
4	As-Built Drawings	1	LS	$5,000.00	$5,000.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$75,000.00	$75,000.00
7	Waterway Control	1	LS	$60,000.00	$60,000.00
8	Remove Existing Guide Rail	115	m	$15.00	$1,725.00
9	Remove Existing Asphalt	1350	sq.m	$12.50	$16,875.00
10	Hot Mix HL-3	165	t	$150.00	$24,750.00
11	Hot Mix HL-8	375	t	$150.00	$56,250.00
12	Pavement Markings	580	m	$8.00	$4,640.00
13	Granular 'A'	700	t	$22.00	$15,400.00
14	Granular 'B' - Type 1 Roadway	1900	t	$18.00	$34,200.00
15	Granular 'B' - Backfill to Structure	1600	t	$20.00	$32,000.00
16	Earth Borrow	1600	t	$16.00	$25,600.00
17	Pipe Subdrain	400	m	$15.00	$6,000.00
18	Earth Excavation for Structure	1	LS	$50,000.00	$50,000.00
19	Unwatering Structure Excavation	1	LS	$50,000.00	$50,000.00
20	Steel Beam Guide Rail	95	m	$150.00	$14,250.00
21	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
22	Steel Beam Energy Attenuating System	4	ea.	$4,500.00	$18,000.00
23	Supply Equipment for Installing Driven Piles	1	LS	$50,000.00	$50,000.00
24	H Piles - HP 310 x 110	400	m	$500.00	$200,000.00
25	Driving Shoes	20	ea.	$450.00	$9,000.00
26	Concrete in Footings	1	LS	$30,000.00	$30,000.00
27	Concrete in Substructure	1	LS	$135,000.00	$135,000.00
28	Concrete in Deck	1	LS	$60,000.00	$60,000.00
29	Concrete in Barrier Wall	1	LS	$22,000.00	$22,000.00
30	Concrete in Approach Slabs	1	LS	$40,000.00	$40,000.00
31	Barrier Wall Railing	1	LS	$10,000.00	$10,000.00
32	Steel Reinforcing	1	LS	$80,000.00	$80,000.00
33	Stainless Reinforcing Steel	1	LS	$25,000.00	$25,000.00
34	Fabrication of Prestressed Girders	1	LS	$225,000.00	$225,000.00
35	Delivery of Prestressed Girders	1	LS	$30,000.00	$30,000.00
36	Erection of Prestressed Girders	1	LS	$50,000.00	$50,000.00
37	Bridge Deck Waterproofing	185	sq.m	$75.00	$13,875.00
38	Joint Fillers, Seals and Compounds	100%	LS	$7,500.00	$7,500.00
39	Rip-Rap	175	t	$65.00	$11,375.00
40	Topsoil, Imported	110	cu.m	$60.00	$6,600.00
41	Seed and Cover	1100	sq.m	$5.00	$5,500.00
42	Heavy Duty Silt Fence Barriers	350	m	$20.00	$7,000.00
47	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
43	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
44	Smooth Run River Stone	155	t	$90.00	$13,950.00

Estimated Construction Cost Subtotal	$1,647,590.00
15% Contingency	$247,138.50
Project Cost Subtotal	$1,894,728.50
13% H.S.T.	$246,314.71
TOTAL ESTIMATED PROJECT COST	$2,141,043.21

Note - Total estimated construction price does not include any cost for property

Client:	**Town of Caledon**
Project:	**Patterson Road Bridge 2**
Project No.:	**300051839.8**
Date:	**February 24, 2021**

REHABILITATE EXISTING BRIDGE - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$40,000.00	$40,000.00
2	Contract Bonds and Insurance	1	LS	$15,000.00	$15,000.00
3	Construction Layout	1	LS	$7,500.00	$7,500.00
4	As-Built Drawings	1	LS	$2,500.00	$2,500.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$10,000.00	$10,000.00
7	Waterway Control	1	LS	$10,000.00	$10,000.00
8	Access to Work Area, Work Platform & Scaffolding	1	LS	$40,000.00	$40,000.00
9	Remove Existing Guide Rail	122	m	$15.00	$1,830.00
10	Remove Existing Barriers	48.1	m	$200.00	$9,620.00
11	Asphalt Removal - Full Depth	252	sq.m	$12.50	$3,150.00
12	Asphalt Removal - From Concrete Deck	206	sq.m	$17.50	$3,605.00
13	Deck & Approach Slab Scarification	206	sq.m	$35.00	$7,210.00
14	Concrete Removals, Partial Depth - Type A	5.1	cu.m	$4,000.00	$20,400.00
15	Concrete Removals, Partial Depth - Type B	4.5	cu.m	$7,500.00	$33,750.00
16	Concrete Removals, Partial Depth - Type C	5.0	cu.m	$6,000.00	$30,000.00
17	Hot Mix HL-3	60	t	$200.00	$12,000.00
18	Hot Mix HL-8	115	t	$200.00	$23,000.00
19	Pavement Markings	275	m	$20.00	$5,500.00
20	Granular 'A'	150	t	$22.00	$3,300.00
21	Earth Excavation for Structure	1	LS	$5,000.00	$5,000.00
22	Steel Beam Guide Rail	92	m	$150.00	$13,800.00
23	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
24	Steel Beam Energy Attenuating System	2	ea.	$4,500.00	$9,000.00
25	Concrete in Deck & Approach Slab Overlay	1	LS	$40,000.00	$40,000.00
26	Concrete in Barrier Wall	1	LS	$20,000.00	$20,000.00
27	Concrete Patches, Form & Pump	9.5	cu.m	$7,000.00	$66,500.00
28	Galvanic Cathodic Protection System	70.0	sq.m	$500.00	$35,000.00
29	Dowels into Concrete	750	ea.	$20.00	$15,000.00
30	Replace Deck Drains	4	ea.	$1,500.00	$6,000.00
31	Barrier Wall Railing	1	LS	$10,000.00	$10,000.00
32	Steel Reinforcing	1	LS	$7,500.00	$7,500.00
33	Stainless Reinforcing Steel	1	LS	$20,000.00	$20,000.00
34	Bridge Deck Waterproofing	123	sq.m	$75.00	$9,225.00
35	Joint Fillers, Seals and Compounds	1	LS	$5,000.00	$5,000.00
36	Rip-Rap	125	t	$65.00	$8,125.00
37	Topsoil, Imported	40	cu.m	$60.00	$2,400.00
38	Seed and Cover	400	sq.m	$5.00	$2,000.00
39	Heavy Duty Silt Fence Barriers	125	m	$20.00	$2,500.00
40	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
41	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
42	Smooth Run River Stone	100	t	$90.00	$9,000.00

Estimated Construction Cost Subtotal	$585,515.00
15% Contingency	$87,827.25
Project Cost Subtotal	$673,342.25
13% H.S.T.	$87,534.49
TOTAL ESTIMATED PROJECT COST	$760,876.74

Note - Total estimated construction price does not include any cost for property

Client:	**Town of Caledon**
Project:	**Patterson Road Bridge 2**
Project No.:	**300051839.8**
Date:	**February 24, 2021**

REHABILITATE & WIDEN EXISTING BRIDGE - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$40,000.00	$40,000.00
2	Contract Bonds and Insurance	1	LS	$15,000.00	$15,000.00
3	Construction Layout	1	LS	$7,500.00	$7,500.00
4	As-Built Drawings	1	LS	$2,500.00	$2,500.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$10,000.00	$10,000.00
7	Waterway Control	1	LS	$10,000.00	$10,000.00
8	Temporary Protection System	1	LS	$75,000.00	$75,000.00
9	Access to Work Area, Work Platform & Scaffolding	1	LS	$40,000.00	$40,000.00
10	Remove Existing Guide Rail	122	m	$15.00	$1,830.00
11	Remove Existing Barriers	48.1	m	$200.00	$9,620.00
12	Asphalt Removal - Full Depth	252	sq.m	$12.50	$3,150.00
13	Asphalt Removal - From Concrete Deck	206	sq.m	$17.50	$3,605.00
14	Deck & Approach Slab Scarification	206	sq.m	$35.00	$7,210.00
15	Concrete Removals, Partial Depth - Type A	5.1	cu.m	$4,000.00	$20,400.00
16	Concrete Removals, Partial Depth - Type B	4.5	cu.m	$7,500.00	$33,750.00
17	Concrete Removals, Partial Depth - Type C	5.0	cu.m	$6,000.00	$30,000.00
18	Hot Mix HL-3	60	t	$200.00	$12,000.00
19	Hot Mix HL-8	115	t	$200.00	$23,000.00
20	Pavement Markings	275	m	$20.00	$5,500.00
21	Granular 'A'	150	t	$22.00	$3,300.00
22	Earth Excavation for Structure	1	LS	$25,000.00	$25,000.00
23	Supply Equipment for Installing Driven Piles	1	LS	$50,000.00	$50,000.00
24	H Piles - HP 310 x 110	160	m	$500.00	$80,000.00
25	Driving Shoes	8	ea.	$450.00	$3,600.00
23	Steel Beam Guide Rail	92	m	$150.00	$13,800.00
24	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
25	Steel Beam Energy Attenuating System	2	ea.	$4,500.00	$9,000.00
26	Concrete in Deck & Approach Slab Overlay	1	LS	$40,000.00	$40,000.00
27	Concrete in Deck Widening	1	LS	$35,000.00	$35,000.00
28	Concrete in Substructure Widening	1	LS	$75,000.00	$75,000.00
29	Concrete in Footings Widening	1	LS	$7,500.00	$7,500.00
30	Concrete in Barrier Wall	1	LS	$20,000.00	$20,000.00
31	Concrete Patches, Form & Pump	9.5	cu.m	$7,000.00	$66,500.00
32	Galvanic Cathodic Protection System	70.0	sq.m	$500.00	$35,000.00
33	Dowels into Concrete	100	ea.	$20.00	$2,000.00
34	Deck Drains	4	ea.	$1,500.00	$6,000.00
35	Barrier Wall Railing	1	LS	$10,000.00	$10,000.00
36	Steel Reinforcing	1	LS	$35,000.00	$35,000.00
37	Stainless Reinforcing Steel	1	LS	$20,000.00	$20,000.00
38	Bridge Deck Waterproofing	152	sq.m	$75.00	$11,400.00
39	Joint Fillers, Seals and Compounds	1	LS	$7,500.00	$7,500.00
40	Rip-Rap	125	t	$65.00	$8,125.00
41	Topsoil, Imported	60	cu.m	$60.00	$3,600.00
42	Seed and Cover	600	sq.m	$5.00	$3,000.00
43	Heavy Duty Silt Fence Barriers	125	m	$20.00	$2,500.00
44	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
45	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
46	Smooth Run River Stone	100	t	$90.00	$9,000.00
				Estimated Construction Cost Subtotal	$952,990.00
				15% Contingency	$142,948.50
				Project Cost Subtotal	$1,095,938.50
				13% H.S.T.	$142,472.01
				TOTAL ESTIMATED PROJECT COST	$1,238,410.51

Note - Total estimated construction price does not include any cost for property

Client:	**Town of Caledon**
Project:	**Patterson Sideroad Bridge 2**
Project No.:	**300051839.8**
Date:	**February 24, 2021**

REPLACE BRIDGE (10m Wide Platform, 14m Span) - PROJECT COST ESTIMATE

				Engineering Estimate	
Item No.	Description	Contract Quantity	Unit	UNIT PRICE	ESTIMATED PRICE
1	Mobilization/Demobilization	1	LS	$60,000.00	$60,000.00
2	Contract Bonds and Insurance	1	LS	$20,000.00	$20,000.00
3	Construction Layout	1	LS	$25,000.00	$25,000.00
4	As-Built Drawings	1	LS	$5,000.00	$5,000.00
5	Traffic Control and Signing	1	LS	$7,500.00	$7,500.00
6	Earth Excavation (Grading)	1	LS	$75,000.00	$75,000.00
7	Waterway Control	1	LS	$60,000.00	$60,000.00
8	Temporary Protection System	1	LS	$75,000.00	$75,000.00
9	Remove Existing Guide Rail	122	m	$15.00	$1,830.00
10	Remove Existing Asphalt	2310	sq.m	$12.50	$28,875.00
11	Hot Mix HL-3	280	t	$150.00	$42,000.00
12	Hot Mix HL-8	680	t	$150.00	$102,000.00
13	Pavement Markings	1050	m	$8.00	$8,400.00
14	Granular 'A'	1320	t	$22.00	$29,040.00
15	Granular 'B' - Type 1 Roadway	3500	t	$18.00	$63,000.00
16	Granular 'B' - Backfill to Structure	2220	t	$20.00	$44,400.00
17	Earth Borrow	1175	t	$16.00	$18,800.00
18	Pipe Subdrain	150	m	$15.00	$2,250.00
19	Earth Excavation for Structure	1	LS	$60,000.00	$60,000.00
20	Unwatering Structure Excavation	1	LS	$50,000.00	$50,000.00
21	Steel Beam Guide Rail	92	m	$150.00	$13,800.00
22	Steel Beam Guide Rail Structural Connection	4	ea.	$2,500.00	$10,000.00
23	Steel Beam Energy Attenuating System	4	ea.	$4,500.00	$18,000.00
24	Supply Equipment for Installing Driven Piles	1	LS	$50,000.00	$50,000.00
25	H Piles - HP 310 x 110	580	m	$500.00	$290,000.00
26	Driving Shoes	20	ea.	$450.00	$9,000.00
27	Concrete in Footings	1	LS	$40,000.00	$40,000.00
28	Concrete in Substructure	1	LS	$155,000.00	$155,000.00
29	Concrete in Deck	1	LS	$52,500.00	$52,500.00
30	Concrete in Barrier Wall	1	LS	$15,000.00	$15,000.00
31	Concrete in Approach Slabs	1	LS	$40,000.00	$40,000.00
32	Barrier Wall Railing	1	LS	$6,500.00	$6,500.00
33	Steel Reinforcing	1	LS	$90,000.00	$90,000.00
34	Stainless Reinforcing Steel	1	LS	$20,000.00	$20,000.00
35	Fabrication of Prestressed Girders	1	LS	$150,000.00	$150,000.00
36	Delivery of Prestressed Girders	1	LS	$30,000.00	$30,000.00
37	Erection of Prestressed Girders	1	LS	$50,000.00	$50,000.00
38	Bridge Deck Waterproofing	162	sq.m	$75.00	$12,150.00
39	Joint Fillers, Seals and Compounds	1	LS	$7,500.00	$7,500.00
40	Rip-Rap	175	t	$65.00	$11,375.00
41	Topsoil, Imported	127	cu.m	$60.00	$7,620.00
42	Seed and Cover	1270	sq.m	$5.00	$6,350.00
43	Heavy Duty Silt Fence Barriers	500	m	$20.00	$10,000.00
44	Temporary Rock Flow Checks	4	ea.	$600.00	$2,400.00
45	Temporary Straw Bale Flow Checks	4	ea.	$300.00	$1,200.00
46	Smooth Run River Stone	155	t	$90.00	$13,950.00
				Estimated Construction Cost Subtotal	$1,890,440.00
				15% Contingency	$283,566.00
				Project Cost Subtotal	$2,174,006.00
				13% H.S.T.	$282,620.78
				TOTAL ESTIMATED PROJECT COST	$2,456,626.78

Note - Total estimated construction price does not include any cost for property

R.J. Burnside & Associates Limited 3 Ronell Crescent Collingwood ON L9Y 4J6 CANADA
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Technical Memorandum
Physical Condition – Duffy's Lane Bridge

Date: January 30, 2023 **Project No.:** 300051839.0000

Project Name: Duffy's Lane Bridge

Client Name: Town of Caledon

Submitted To: Project File Report

Submitted By: Andrew Dawson, P.Eng.

Reviewed By: Matthew Brooks, P.Eng.

As part of the Schedule B Environmental Assessment (MCEA) for the Patterson Side Road and Duffy's Lane Bridges, R.J. Burnside & Associates Limited (Burnside) has completed a visual inspection of the Duffy's Lane structure and reviewed all available background information for the bridge to evaluate the various options as part of the MCEA, considering the physical environment. The Duffy's Lane Bridge (B22072010) is located on the no-exit portion of Duffy's Lane, approximately 30 m southeast of Patterson Side Road.

Structure Background Information

The existing structure consists of a 9.1 m (+/-) span (9.35 m +/- parallel to road) cast-in-place concrete rigid frame, arch soffit structure with an overall structure width of approximately 8.8 m (+/-) and a driving platform width of approximately 7.3 m (+/-) between raised concrete curbs. The structure is skewed at an angle of approximately 12 ° to perpendicular. The structure is supported on a wooden pile foundation and was constructed in 1957.

The existing structure has undergone a previous minor rehabilitation in 2000. The rehabilitation consisted of localized concrete repairs to the deck top, soffit and abutments, as well as replacement of the existing barrier system. Migrating corrosion inhibitors and concrete sealer were also applied to exposed surfaces of concrete during the rehabilitation. Although not indicated on the design drawings, the detailed deck condition survey completed in 2015 identified presence of a concrete overlay which may have been installed during the 2000 rehabilitation.

More recently, The Town of Caledon has retained Greer Galloway Consulting Engineers to complete design services for an additional rehabilitation of the existing structure. This project is currently between the 60% and 90% design stage. The current scope of proposed rehabilitation work consists of full depth barrier and curb removal and replacement with a concrete parapet wall on curb, removal of asphalt, partial depth concrete repairs to the deck, soffit and exposed substructure, waterproofing and paving and deck drain replacement.

Structure Use and Access

The Town of Caledon considers Duffy's Lane to be a Rural Local Undivided road south of Patterson Side Road. The section of road is a no-exit, no-winter-maintenance road with low traffic volumes (ADT < 400). These low traffic volumes classify the subject portion of the road as a 'special road' in accordance with Chapter 11 of the March 2020 TAC Geometric Design Guide for Canadian Roads.

There are no residences with municipal addresses along Duffy's Lane south of the structure as the majority of the lands are part of the Albion Hills Conservation Park owned by the Toronto and Region Conservation Authority (TRCA). However, three properties (#8519, #8541 and #8575 Patterson Side Road) east of Duffy's Lane have corridors within their parcel fabric adjoining Duffy's Lane, south of the structure. Some of these parcel corridors are used as alternative access points to the above noted properties. The roadway south of the structure also provides an additional point of access to the Albion Hills Conservation Park; however, the public access point for the Park is located at 16500 Regional Road 50.

Heavy Truck traffic is currently limited on the structure due to the current By-Law restrictions on Patterson Side Road. The By-law generally restricts *commercial* vehicles over 12 tonnes from gaining access to the no-exit roadway and bridge. However, exemptions to the By-Law are made for Heavy Trucks completing delivery or collection with no alternative route, emergency response vehicles, Town/Region/Province vehicles and utility vehicles.

Given that there are no municipal addresses south of the structure, the roadway and bridge are generally used by passenger vehicles for alternative access to the Albion Hills Conservation Park and hiking trails, as well as alternate access for residents with adjoining properties. As such, traffic volumes are not anticipated to increase beyond 400 vehicles per day in the future.

It is noted that there are additional access points to the hiking trails via the Albion Hills Conservation Park main entrance (16500 Regional Road 50) or the nearby Caledon Trailway Path, located on Patterson Side Road, 350 m west of Duffy's Lane. As such, reduction of the structure's capacity, removal of the structure or conversion to a pedestrian only structure would only directly affect the three adjoining residential property owners and the Albion Hills Conservation Park.

Physical Condition

On October 27, 2020, Andrew Dawson, P.Eng., and Devin Soeting, C.E.T., from Burnside conducted a Field Investigation to review the physical conditions of the Duffy's Lane Bridge. The previous 2019 OSIM inspections completed by GHD Limited and 2015 Detailed Deck Condition Survey (DDCS) completed by Exp. were also reviewed in consideration of analyzing the condition of the structure. The previous OSIM inspection and Detailed Deck Condition Survey are enclosed with this document for reference. A summary of the condition of the structure is provided below:

Wearing Surface

The asphalt wearing surface was generally in good to fair condition overall, with localized fair to poor areas in locations of previous asphalt patches resulting from the deck condition survey. Minor settlement was observed at the approaches of the structure.

Barrier

The existing barrier system was noted to be in generally good condition overall, with light to moderate scaling and localized small spalls. The current barrier system does not meet current test level requirements for vehicle impact and as such, may not prevent errant vehicles from leaving the structure.

Curbs

The existing curbs are in fair to poor condition overall, with disintegration, spalling, severe scaling and narrow to wide cracks.

Deck

The concrete deck top was unable to be visually inspected due to the overlying asphalt wearing surface; however, the detailed deck condition survey completed in 2015 indicated that the deck top is in fair to good condition and confirmed the presence of a waterproofing system with generally good bond to the deck. The condition survey also identified the presence of a concrete overlay ranging from 50 to 120 mm. The overlay does not appear to have additional reinforcing steel, as no steel was encountered within this region by any of the deck cores.

The chloride content measured in the original concrete (below overlay) exceeded the threshold value necessary to activate corrosion in 2 of the 3 cores tested. Although the testing of chloride content was not conducted to the depth of reinforcing steel at all locations, it is anticipated that the value of chloride at the reinforcing steel level is exceeded in both of these tested areas. In the overlay, chloride content exceeded the corrosion threshold in the same two core locations, but only within the bottom portion of the overlay. This indicates that the chlorides in the original concrete below the overlay are potentially migrating upwards into the overlay.

Overall, the corrosion potential survey indicates that approximately 45% of the deck surface has a greater than 90% probability that reinforcing steel corrosion was occurring at the time of the measurements (2015). It is reasonable to assume that this number may have increased since the time of the survey.

Soffit

Sounding of the concrete during the 2020 site inspection identified that the majority of the soffit is severely delaminated and in poor condition overall. Based on comparison of the 2020 investigation to the extents of delamination noted during the 2015 study, it appears that the degree of poor areas has significantly increased. This illustrates that the corrosion of the bottom layer of steel may be accelerating, resulting in more delaminated areas. Several efflorescence stained medium to wide cracks also indicate moisture penetration through the deck slab which may be leading to increased rates of corrosion. Medium to wide cracking and severe scaling were also noted along the exterior soffit and fascia.

Substructure

The existing abutments are generally in good condition overall, with hairline to medium cracking with efflorescence, light scaling, small spalls and localized delaminations.

The existing wingwalls are generally in good condition, areas of severe scaling noted on the west walls and localized delaminations.

Geometry – Width

The existing roadway has a paved driving platform width of approximately 7.25 - 7.5 m up to the south limits of the structure. South of the structure, the roadway becomes a gravel roadway with a 5.75 - 6 m travelled platform width and 1.25 – 1.5 m shoulders. As previously mentioned, the width of the driving platform between raised curbs on the structure is approximately 7.3 m.

The subject roadway does not have a posted regulatory speed limit. Generally, for unposted rural roads, a speed limit of 80km/h is assumed. However, general overview of the roadway indicates the road has not been designed for such an operating speed and it is recommended that the Town consider posting a reduced regulatory speed. The Town's Transportation Master Plan identifies the desired operating speed for Local roads to be 30 to 40 km/hour, and it is recommended that the Town consider posting the road as such. Given the proximity of the structure to the intersection, operating speeds at the bridge location are anticipated to be approximately 30 km/hour at the bridge.

The Town's Transportation Master Plan requires 3.5 m through lanes with 1.5 m wide shoulders for typical rural and local road cross-sections. As such, in order to meet the Town's typical standard for a two-lane structure, a 10.0 m wide driving platform is required. However, it is recognized that due to the low-volume nature of this road, the Town may

accept a reduced driving platform, as the frequency of traffic conflicts on 'special roads' associated with stopped vehicles generally does not justify additional width for sheltering them.

Based on the 'special road' classification, traffic volumes (ADT < 100, ADTT < 15) and the Town's typical desired 40 km/hour operating speed for local roads, the TAC Geometric Design Guide for Canadian Roads[1] and 2020 MTO Design Supplements recommend a minimum approach Roadway Width of 6.0 m between side slopes, or 7.0 m wide where guiderail is present. Additionally, as shown in Figure 1, the MTO Structural Design Manual allows bridges on Low Volume Roads to have minimum lane and shoulder widths of 2.75 m and 0.25 m, respectively. As such, the minimum driving platform width required for a two-lane bridge on this Low Volume Road is 6.0 m. Given the presence of guiderail on the approaches, the overall recommended width of the approach roadway is 7.0 m, and it is recommended that this width be carried across the bridge when considering a two-lane structure, to avoid narrowing of the platform.

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TABLE 1: MINIMUM LANE, SHOULDER AND BRIDGE WIDTHS

AADT	Design Speed (km/h)	# Lanes	Min. Lane Width (m)	Min. Shoulder Width (m)	Min. Bridge Width (m)[1]
≤ 200	≤ 60	1	3.0	0.5	4.0[2,3,4] (4.9m max)[5]
		2[6]	2.75	0.25	6.0
	≥ 70	2	3.0	0.5	7.0
> 200 and ≤ 400[7]	≤ 40	1	3.0	0.5	4.0[2,3,4] (4.9m max)[5]
		2[6]	2.75	0.25	6.0
	50 to 60	2	3.0	0.5	7.0
	≥ 70	2	3.3[8]	0.6[8]	7.5[8]

Figure 1: Minimum Bridge Widths for Low Volume Roads (MTO Structural Manual)

Given the 7.3 m platform width of the existing structure, this structure would be considered to have meet the minimum requirements for a Low Volume Road bridge. To achieve additional side clearances, the raised curbs could be removed during a rehabilitation to maximize the platform width without widening the overall structure. Alternatively, to achieve the Town standard, structure replacement would be required.

It is further recognized that due to the low traffic volumes, the Town may consider a single -lane, two-way structure with a bridge width between 4.0 m and 4.9 m. Right-of-way control signage (such as 'narrow bridge', 'yield to oncoming traffic', 'stop if oncoming traffic',

[1] Chiu, M., Clayton, C., Millen, G. et al. 2017. *Geometric Design Guide for Canadian Roads*. Ottawa, ON: Transportation Association of Canada

etc.) should be placed at the structure to indicate to bridge users of the reduction to one-way traffic.

Geometry – Profile

The Duffy's Lane Bridge is located approximately 30 m from the intersection of Patterson Side Road. Based on this proximity to the intersection, vehicles travelling along Duffy's Lane in the vicinity of the bridge structure will be accelerating or decelerating. Based on passenger vehicle acceleration and deceleration rates[2] it is anticipated that vehicles north of the structure will be travelling at a speed of 30 km/hour or less, with speeds decreasing closer to the intersection.

The current road has a profile with rates of grade changes comparable to a design speed of approximately 20 km/hour and is considered sub-standard for the anticipated operating speed of the road.

The intersection at Patterson Side Road is anticipated to be raised as part of the profile improvement works along Patterson Side Road between the bridges east and west of the intersection. To tie into this raised profile, adjustments to Duffy's Lane road profile will also be required. Based on preliminary design profiles, a 30 km/hour design speed vertical curve can be obtained to tie the raised intersection into the north end of the existing Duffy's Lane bridge. If the Duffy's Lane bridge is to be replaced, road profile adjustments of 40 km/hour or higher are achievable. The final road profile under the replacement scenario will depend on the geometry of the proposed replacement structure. Preliminary drawings illustrating road profile adjustments have been enclosed for reference.

Load Capacity

It is noted that the required live load capacities have increased since the time of the original design of the structure. There are currently no visual signs of distress in the structure that would indicate it is being over-stressed as a result of current vehicular loading; however, this may be due to loading being generally limited to passenger vehicles. If the existing structure is to remain, a structural evaluation would be recommended to confirm if the structure has adequate capacity to carry current design vehicle loading, or if a load posting is required.

Design Alternatives

The EA for the Duffy's Lane Bridge has identified the following five options for consideration:

1. Do Nothing – Future Asset Disposal / Removal
2. Rehabilitation
3. Replacement – Vehicular Bridge – Two-lane
4. Replacement – Vehicular Bridge – Single Lane, Modular
5. Replacement – Pedestrian Bridge

[2] Exhibit 2-24 and 2-25, A Policy on Geometric Design of Highways and Streets, AASHTO, 2001

A brief description of each alternative is provided below. General arrangement drawings showing the general scopes of work for each of the proposed options (excluding the Do-Nothing option) are enclosed within this document.

Do Nothing – Future Asset Disposal / Removal

The Do Nothing alternative is to leave the existing system in place and not complete any improvements to the Bridge. The existing structure may carry out its remaining service life until the overall condition of the structure warrants it un-safe. Based on its current condition and evidence of accelerating corrosion of reinforcing steel since the 2015 inspection, it is anticipated that the remaining service life of the structure is 5-10 years. At the end of its service life, the structure would be required to be removed and barriers placed in front of the structure, closing the road at each end of the bridge. This option would result in no through vehicular or pedestrian traffic at the end of the existing structures service life. In the interim, load posting requirements for the structure should be evaluated as previously discussed and the value of the posting shall be re-evaluated as the structure continues to degrade.

Rehabilitation

This alternative consists of rehabilitating the existing structure to rectify the identified deficiencies outlined above. The required repairs/improvements include:

- Full depth curb removal and reconstruction of outer deck edges and wingwall tops;
- Removal of asphalt wearing surface;
- Partial depth concrete repairs to soffit, deck top and substructure;
- Removal and replacement of barrier system;
- Installation of erosion and scour protection;

This option allows for the driving platform width to be maximized within the constraints of the existing footprint of the bridge by removal of the raised curbs. This widened platform would exceed the minimum driving platform width for Low Volume Road bridges but would not meet the Town's standard 10.0 m width.

Rehabilitation of the structure will address the physical deficiencies noted on the accessible surfaces. The condition of the bridge structure may be improved, and the overall service life of the structure can be increased with rehabilitation. It is anticipated that rehabilitating the structure would extend the service life to approximately 20 years.

If a structural evaluation identifies that load posting of the structure is required, standard rehabilitation outlined in the scope of work above would not increase the overall capacity. Although near surface strengthening is an option, it has not been considered as part of the scope of work for this alternative due to it being a considerable cost for a structure with very limited heavy truck traffic.

Replacement – Vehicular Bridge – Two Lane

This option considers removal of the existing structure and replacement with a new, two-lane vehicular bridge. The proposed structure in this alternative would consist of a 10.0 m wide driving platform to meet the Town's typical cross-section. The roadway width would taper to be reduced to the 7 m south of the bridge in the interim but can be widened in the future as required. Alternatively, the structure width could be reduced to as low as 7.0 m if the Town is willing to accept the recommended TAC/MTO minimums based on the low traffic volumes, which are lesser than the Town's standard 10.0 m platform width.

With a two-lane structure designed to full vehicular load requirements, this alternative allows for increased traffic utilization in the future if it were to be required.

It is anticipated that a pre-cast concrete rigid frame structure of slightly larger span would be utilized and supported on deep foundations. Based on preliminary structure geometry, the road could be designed to the desired 40 km/hour local road operating speed by reconstructing the road profile over a length of approximately 70 m from the intersection.

Replacement of the bridge addresses all deficiencies noted, including improvements to structure width, road profiles and load capacity. The proposed structure is expected to have a service life of 75 years, provided that the Town completes typical maintenance and repairs as required over the lifespan.

Replacement – Vehicular Bridge – Single Lane, Modular

A single lane vehicular bridge is also considered to be a viable alternative, as it maintains vehicular access south of the structure at a lower cost, in consideration of the low traffic volumes.

The single-lane structure would be a one-lane, two-way structure and would require right-of-way signage as previously discussed to notify users of the structure of the reduction from a two-lane road to a single-lane structure. The one-lane structure would provide a 4.15 m (+/-) wide driving platform, which allows for adequate clearance for snow-plough vehicles.

It is anticipated that a structure designed to meet the MTO exceptions to the Canadian Highway Bridge Design Code for Low Volume Roads would be utilized for this alternative. Several modular bridges are available that provide a cost-effective solution for structures of these requirements, including typical Bailey Bridge structures, or pre-fabricated girder type structures such as Lessard Welding's Modular Type Municipal Bridges; the latter of which has been the assumed structure used for evaluation of this alternative.

A larger span (15 m +/-) prefabricated structure could be installed on cast-in-place abutments supported on deep foundations placed behind the existing abutments. This allows for the construction of the bridge to occur without impeding on the watercourse, reducing the construction costs and environmental impacts associated with waterway control. Upon

installation of the new abutments, the existing abutments could be removed to at or above the existing grades level and help aid in scour prevention.

Road profile adjustments over approximately 70 m would similarly be required to obtain a design speed of 40 km/hour under this alternative.

The replaced structure is expected to have a service life of 75 years, provided that the Town completes typical maintenance and repairs as required over the lifespan.

Replacement – Pedestrian Bridge

This alternative involves replacement of the existing crossing with a pedestrian bridge. As such, this option limits the capacity of the crossing to pedestrians only and would eliminate vehicular access to the properties with alternate access south of the structure and to the Albion Hills Conservation Park alternative access point.

For preliminary design purposes, a prefabricated weathering steel (or galvanized) through-truss bridge with timber deck (Eagle Bridge, Algonquin Bridge, or similar) has been assumed. The structure would be founded on cast-in-place concrete abutments supported by helical pile foundations, installed beyond the existing structure abutments. Spanning beyond the existing abutments will allow for the existing structure to be cut off and utilized as scour protection retaining wall in front of the proposed foundation system.

The structure would provide a 2.4 m wide platform to allow for pedestrian and bicycle crossing of the watercourse. To span over the existing structure, a 15 m long structure is recommended.

The pedestrian structure is expected to have a service life of 75 years, provided that the Town completes typical maintenance and repairs as required over the lifespan.

Evaluation of Alternatives

Each alternative is to be evaluated based on its ability to improve the physical environment at the site, which is the intent of this Technical Memo. Table 1 overleaf is a summary of the physical environments that were considered, the noted deficiencies and the effectiveness of each option to rectify the deficiency and identify a preferred solution. For reference, Preliminary Cost Estimates have been provided and enclosed within the document.

Table 1: Evaluation of Alternatives, Physical Environment – Duffy's Lane Bridge

		EA Options				
		Do Nothing	**Rehabilitation**	**Replace – Vehicular – Two Lane**	**Replace – Vehicular – Single Lane**	**Replace - Pedestrian**
Physical Condition		Defects not addressed; Structure generally in fair to poor condition with limited (5-10 years) service life remaining;	Defects can be addressed to extend the service life to 20 years.	A new structure will not have any defects and all issues will be addressed; Service life of 75 years expected	A new structure will not have any defects and all issues will be addressed; Service life of 75 years expected	A new structure will not have any defects and all issues will be addressed; Service life of 75 years expected;
Geometry – Width		No improvement to driving platform width; Minimum width for 2-Lane Low Volume Road met; Town Standard width not met.	Opportunity to remove raised curbs to increase side clearances over structure. Minimum width for 2-Lane Low Volume Road met; Town Standard width not met.	Replacement structure can be designed to meet Town standard two-lane platform width (10.0 m).	Replacement structure designed for single-lane, two-way structure. Right-of-way control required on approaches.	Pedestrian width bridge; narrower than approach roadways.
Geometry – Profile		Existing sightlines and profile maintained. 30 km/hour design speed curves to tie into raised intersection.	Existing sightlines and profile maintained. 30 km/hour design speed curves to tie into raised intersection.	Opportunity for minor improvement to profile and sight lines (40 km/hour design speed).	Opportunity for improvements to profile and sight lines up to 50 km/hour design speed.	Not applicable
Load Capacity		Load posting to be considered due to corrosion of embedded reinforcing steel.	Load posting requirements to be evaluated based on current design loading.	A new bridge will not have any load restrictions.	A new bridge will not have any load restrictions.	Pedestrian loading only. Opportunity to design for maintenance vehicle loading, if desired.
Property Access		Alternate access for three residences and Conservation Park removed in future (5-10 years).	Vehicular and pedestrian access to alternative entrances for three residences and Conservation Park remains.	Vehicular and pedestrian access to alternative entrances for three residences and Conservation Park remains.	Vehicular and pedestrian access to alternative entrances for three residences and Conservation Park remains.	Vehicular access to alternative entrances of three residences and Conservation Park removed; Pedestrian access remains.
Cost (Excl. HST)		$100,000 to remove structure and install barricades when condition warrants removal (5-10 years)	$482,000.00 (See Appendix C)	$1,357,000.00 (See Appendix C)	$646,000.00 (See Appendix C)	$444,000.00 (See Appendix C)
Service Life		5 – 10 years	20 years	75 Years	75 Years	75 Years
Preference	**Vehicle access required**	Least Preferred	Less Preferred	Somewhat Preferred	**Most Preferred**	Least preferred
	Pedestrian only access required	Least Preferred	Somewhat Preferred	Less Preferred	Less Preferred	**Most Preferred**
	No access required	**Most Preferred**	Somewhat preferred	Least Preferred	Less Preferred	Less Preferred

Summary

The Preferred option to address the physical and geometric deficiencies for the Duffy's Lane Bridge is heavily dependent on the access requirements that will need to be maintained. Access requirements will be further investigated as part of the MCEA process to determine what the overall best suited alternative is. The Preferred option for each level of access requirement is as outlined in Table 1 above.

If you have any questions or comments do not hesitate to contact the undersigned.

R.J. Burnside & Associates Limited

Andrew Dawson, P.Eng.
Project Engineer

AD:jm

Enclosure(s) Structure B22072010 OSIM Inspection, dated October 2, 2019
Detail Bridge Condition Survey, Duffy Lane Structure (Dec. 18, 2015, by exp Services Inc.)
Drawings – Preliminary Plan and Profile Options
Preliminary Cost Estimates