City of Quinte West

Modular bridges for low volume roads - a case study of the Hill Road bridge replacement

Robert Jackson, P.Eng.

Manager of Engineering Services

Agenda

- Existing bridge condition and requirement/need to replace
- Initial replacement procurement
- Consideration of alternatives
- Selected replacement option - modular bridge
- Replacement process

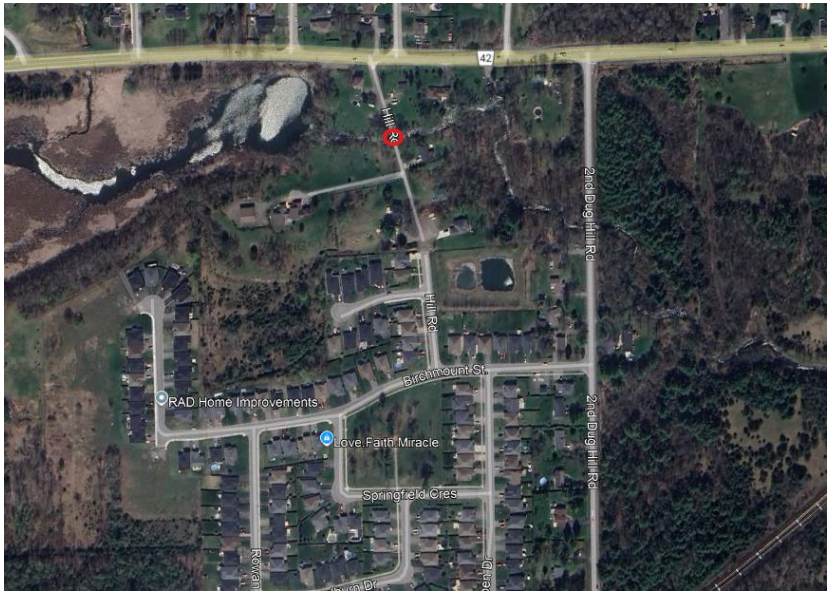
Where is Quinte West:

What Quinte West is known for:

- CFB Trenton, home of the Canadian Forces Skyhawks
- Mouth of the Trent-Severn Waterway

Hill Road location and background

- Local road, less than 100 AADT
- Used as an emergency route for subdivision to the south
- Hill Road bridges Mayhew creek which is a tributary to the to the Trent River
- Original bridge was built in the 1920s
- Existing bridge 20ft span.



Existing Hill Road bridge condition

- Overall BCI of 22.1
- 4 ton load restriction
  - Maintenance and emergency access issues

Beams / Main Longitudinal Elements	Floor Beams	Sq. m	200.0						0.0	0.0	0.0	
	Girders	Sq. m	200.0	61.7		27.1		34.6	12341.8	4072.3	33.0	
	Inside boxes (sides & bottoms)	Sq. m	200.0						0.0	0.0	0.0	
Abutments	Abutment walls	Sq. m	900.0	8.0			4.0	4.0	7200.0	1440.0	20.0	
	Ballast walls	Sq. m	350.0						0.0	0.0	0.0	
	Bearings	Ea.	1,000.0						0.0	0.0	0.0	
	Wingwalls	Sq. m	350.0	12.0			6.0	6.0	4200.0	840.0	20.0	
Piers	Bearings	Ea.	1,000.0						0.0	0.0	0.0	
	Caps	Sq. m	900.0						0.0	0.0	0.0	
	Shafts/columns/Pile Bents	Sq. m	900.0						0.0	0.0	0.0	
Retaining Walls	Barrier Systems on walls	Sq. m	200.0						0.0	0.0	0.0	
	Railing System on Walls	m	200.0						0.0	0.0	0.0	
	Walls	Sq. m	350.0						0.0	0.0	0.0	
Bracing	Bracing	Ea.	500.0						0.0	0.0	0.0	
Coating	Railing Systems / Hand Railings	m	125.0						0.0	0.0	0.0	
	Structural Steel	Sq. m	80.0						0.0	0.0	0.0	
Note: Sections including bearings, diaphragms, deck drains, expansion joint sealants, embankments, foundations, stringers, streams, and accessories were not included as they do not impact the calculation.								**Total:**	**42898.0**	**9460.8**	**22.1**	

Figure 46 : Load Limit Sign.

Existing Hill Road bridge condition

Figure 1 : East Elevation.

Figure 2 : West Elevation.

Existing Hill Road bridge condition

Figure 7 : Wood Deck Top (Typ.).

Figure 18 : Interior Span (Typ.).

Existing Hill Road bridge condition

Figure 30 : Northeast Wingwall_Evidence of Severe Disintegration.

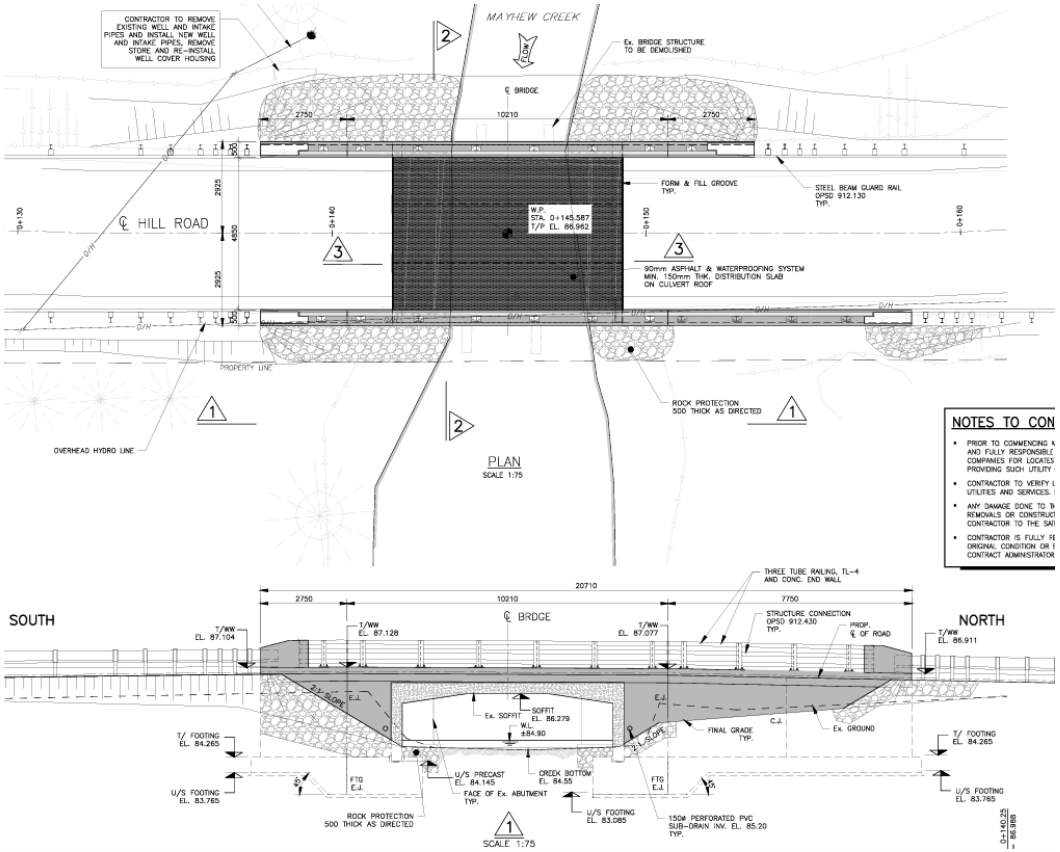
Figure 34 : Stringer I beam North End_Evidence of Severe Corrosion & Section Loss.

Initial City procurement - replacement

- Council allotted a **total budget of $740,000** for the replacement (consulting and construction).
- Through RFP the City hired a Consulting firm to complete the design of the replacement structure in 2021.
- The Consultant recommended a cast-in-place replacement option. Initially the City asked for a 2 lane option, initial tender was **$1,050,000.**
- The City scaled back design to single lane bridge.

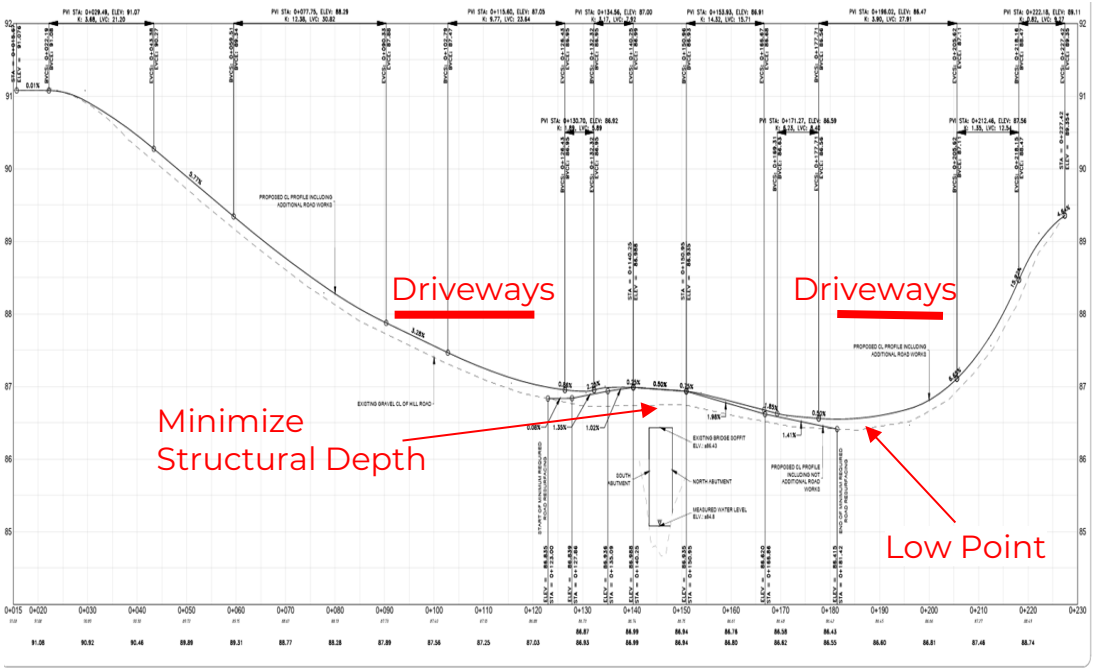
2nd procurement

- Tender result: **$929,130.07** (construction only, not including consulting/inspection or testing)
- City abandoned viability of the initial concept



Constraits

- Maintain hydraulic performance.
- Maintain existing low point in the road (flow around point, to minimize upstream flooding).
- Maintain existing driveway elevations

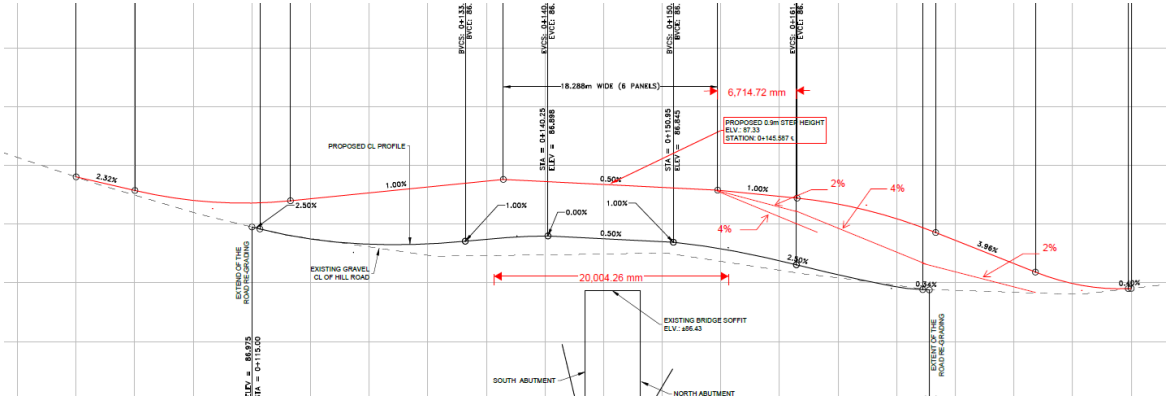


Consideration of alternatives - culverts (3rd and 4th attempt)

- 3.89m x 2.69m CSPA - The City had this existing culvert sitting in Colonial Yard:
  - Rejected because it resulted in a 15-20% loss of hydraulic capacity.
- Considered the ideal culvert size
  - Rejected due to unacceptable road grade raises, and impacts to upstream flooding potential.

Consideration of alternatives - bridges

- Consideration of bridges from the major modular bridge suppliers for a 40ft (12.2m) span (nearly double the original span) to avoid in water work.
- Structure height was the deciding factor.



Selection of best alternative - modular bridge

- 40ft municipal bridge was selected made by Lessard Bridge (Northern Mat and Bridge Co.)
- Had the lowest structure height (bottom of girder to top of deck).
- Maintained and improved hydraulic performance.
- No load restrictions

Table 1: Water Level Comparison Between Existing and Proposed Bridge Structures Immediately Upstream of Hill Road

Event	Qpeak	Water Surface Elevation		
		Existing	Proposed	Diff.
	m^3/s	m		
Timmins	33.0	86.76	86.70	-0.06
0.2% AEP / 500-Yr	20.5	86.34	86.01	-0.33
0.5% AEP / 200-Yr	18.5	86.23	85.94	-0.29
1% AEP / 100-Yr	16.8	86.13	85.88	-0.25
2% AEP / 50-Yr	15.2	86.05	85.82	-0.23
10% AEP / 10-Yr	11.4	85.83	85.67	-0.16

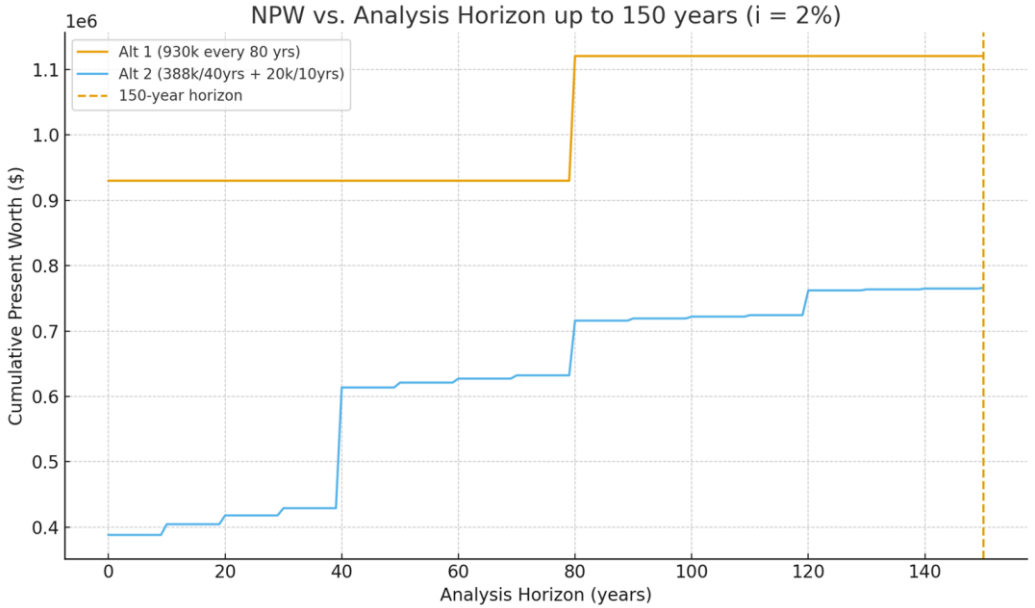
Photo 6: Upstream face of new 15.2m span x 6.1m wide Lessard Modular bridge.

Sole source procurement- Lessard Bridge

- Council Approved the sole source based on site constraints of the Lessard Bridge supplied by Northern Bridge and Mat Co.
  - Bridge Supply: ~$145,000
  - Construction: ~180,000
  - Contingency: ~$18,000
  - TOTAL: ~$343,000
- Engineering and inspection costs: $45,000
- TOTAL: $388,000 < $740,000 (budget)

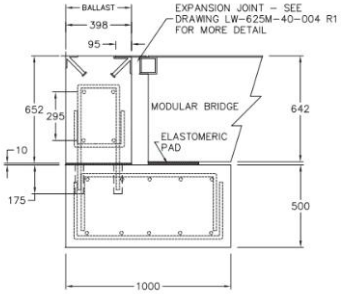
Net present worth analysis comparison

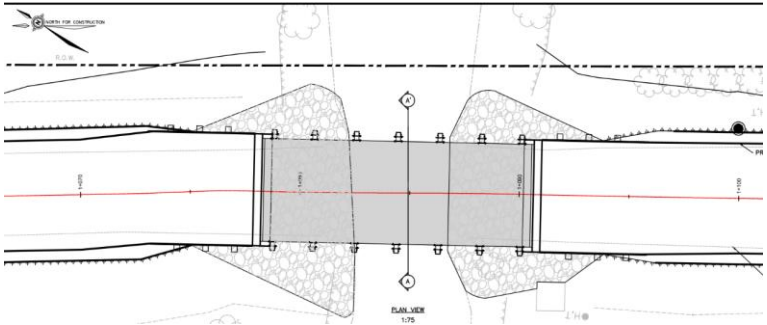
- A comparison of the original tendered design (alternative 1) with the modular bridge (alternative 2).
- NPW:
  - Alt 1 ($930k every 80 yrs): **$1,120,752**
  - Alt 2 ($388k/40 yrs + $20k/10 yrs): **$765,989**

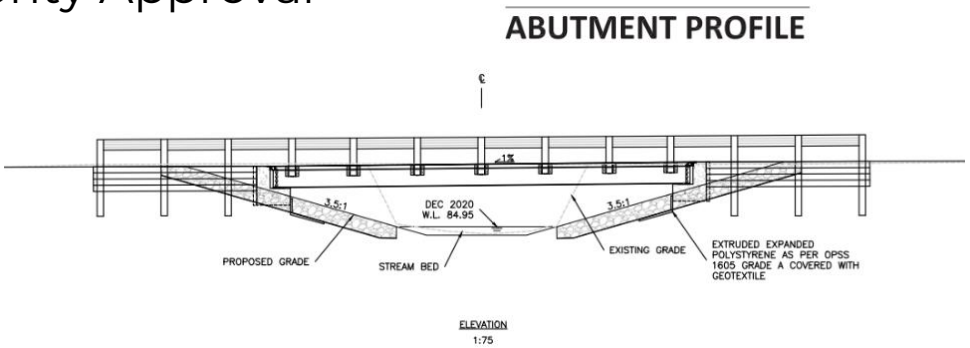


Final design

- Avoid inwater work with the longer span
- L Shape pre-cast abutments
- Obtained Conservation Authority Approval







Construction process

- Day 1: remove existing bridge
- Day 2: install rip-rap/ sope stabilization
- Day 3: install abutments / super-structure
- Day 4: backfill abutments and guard rail installation
- Day 5: interim-completion of guard rails and open bridge

Day 1 - remove existing bridge

Day 1 - remove existing bridge

Day 1 - sandbag working area/ brake foundations

Day 1 - foundation removal

Day 2 - preparation for abutments

Day 2 - preparation for abutments

Day 2 - preparation for abutments/ rip rap

Day 3 - placement of the abutments

Day 3 - placement of the abutments

Day 3 - placement of the superstructure

Day 3 - placement of the superstructure

Day 3 - placement of the superstructure

Day 4 - backfill abutments and guard rail install

Day 4 - backfill abutments and guard rail install

Day 5 - completion of guard rail and opening of bridge

Final completion

Final completion

Questions?