Appendix A Existing Structure Naming Convention

The truss from abutment to abutment is numbered from Panel 1 (West Abutment, Baddeck side) to Panel 104 (East Abutment, Sydney Abutment). To be consistent with the original drawings, a panel is defined as a cross section of the bridge at the truss connections, as shown in Figure 8, and a bay is defined as the area between two panels. The centre of the main span is located at Panel 58. The structural members are identified as shown in Figure 9 and the bridge panel numbering is provided in Figure 10, Figure 11, and Figure 12.

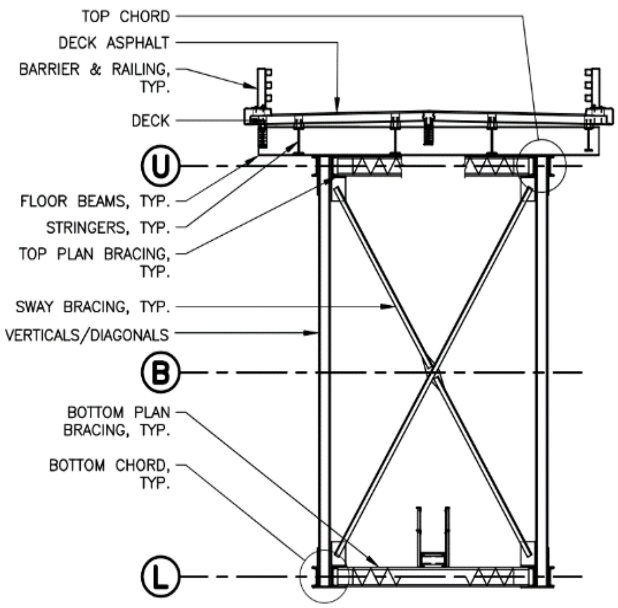

Figure 8. Bridge element identifiers – panels outside of arch

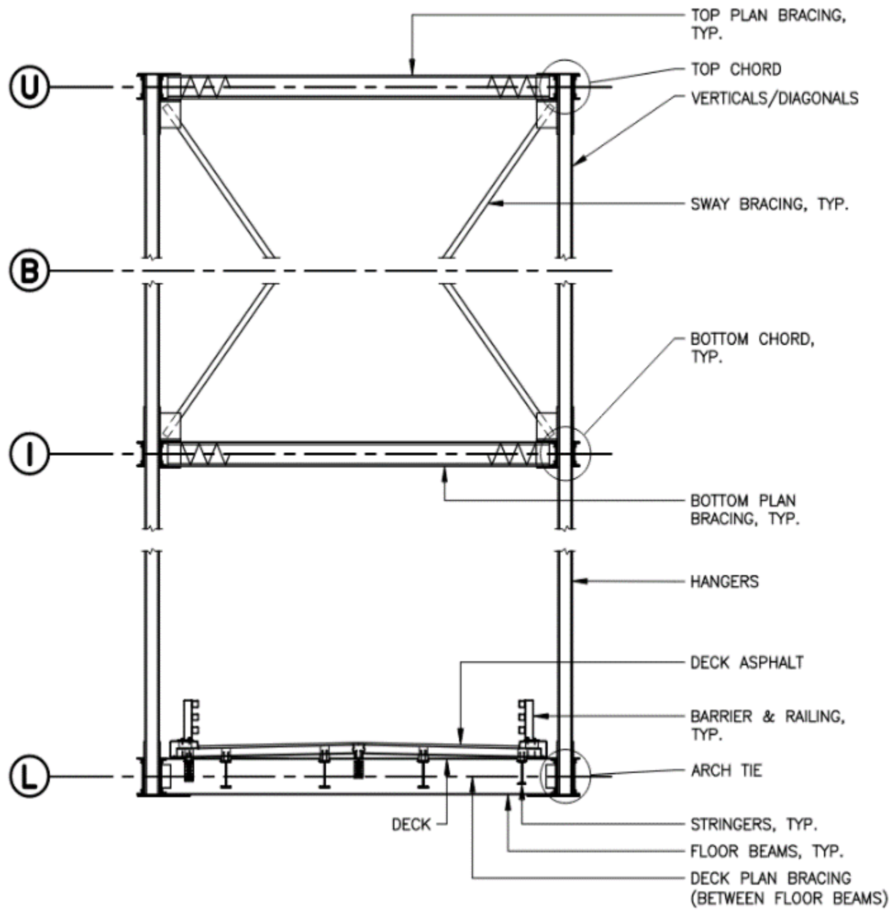

Figure 9: Bridge element identifiers – panels within arch

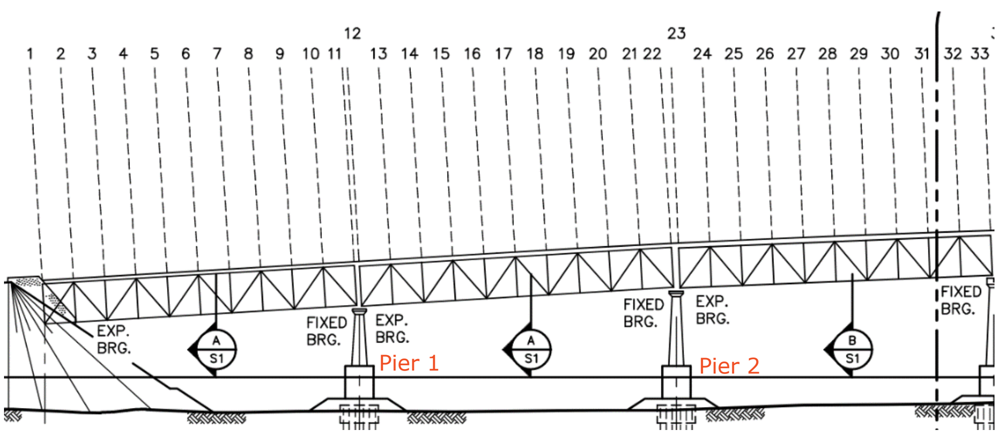

Figure 10. Elevation view of west approach and splay spans

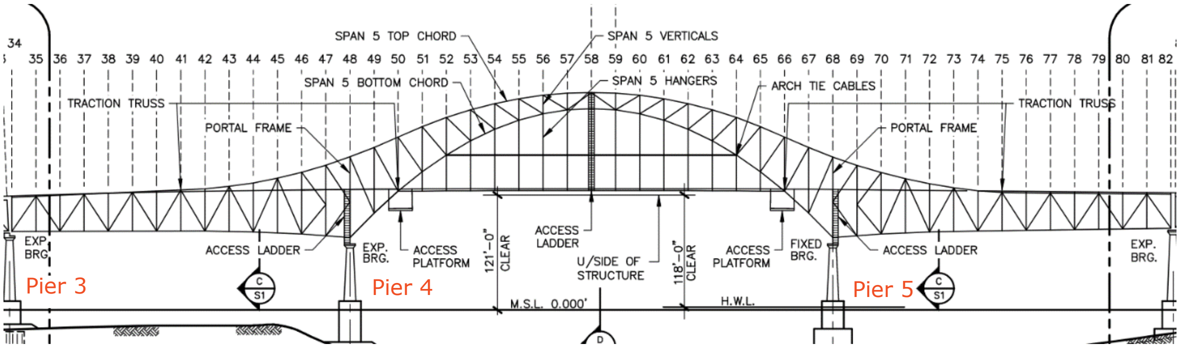

Figure 11. Elevation view of main spans

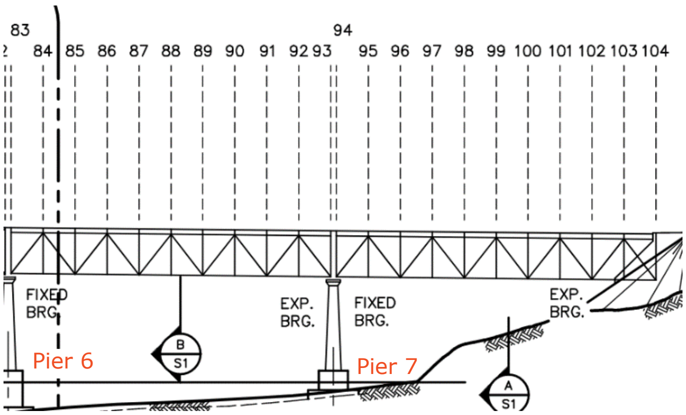

Figure 12. Elevation view of east approach and splay spans

Appendix B Overview of Pairwise Comparisons

NOVA SCOTIA PUBLIC WORKS

OVERVIEW OF PAIRWISE COMPARISONS

FOR INFORMATION

ADDRESS COWI North America Ltd
910-1809 Barrington St.
Halifax, NS B3J 3K8
Canada

TEL +1 902 407 8285
WWW cowi.com

CONTENTS

1 Background

Pairwise comparisons determine preference between seemingly independent variables when making complex decisions. Some background information on pairwise comparisons can be found in the additional references provided at the end of this note.

2 Description

Pairwise comparisons are performed on a set of criteria. To perform the comparison, criteria are directly compared in pairs to determine their overall importance in the final decision. For example, to determine the importance of three variables, ***a***, ***b***, and ***c***, we would look at the following options:

- a > b
- a < b
- a = b
- a > c
- a < c
- a = c
- b > c
- b < c
- b = c

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The most efficient way to perform this analysis is to use a matrix to compare each row against each column, as shown in the table below. A diagonal is shown in black as items cannot be compared to themselves. Also, we would only fill in the upper right half of the table because when you compare row ***a*** with row ***b***, row ***b*** is automatically compared with row ***a*.**

	vs. **a**	vs. **b**	vs. **c**	**Rating**
a		a > b: 2 a = b: 1 a < b: 0	a > c: 2 a = c: 1 a < c: 0	$\frac{\Sigma \text{ row a}}{\Sigma \text{ matrix}}$
b	b > a: 2 b = a: 1 b < a: 0		b > c: 2 b = c: 1 b < c: 0	$\frac{\Sigma \text{ row b}}{\Sigma \text{ matrix}}$
c	c > a: 2 c = a: 1 c < a: 0	c > b: 2 c = b: 1 c < b: 0		$\frac{\Sigma \text{ row c}}{\Sigma \text{ matrix}}$

In the simple example above, we used a ranking system that only allowed for comparisons of *greater than*, *less than*, or equal. However, this can be expanded to include additional preference increments (ie. *much greater than*, or *much less than*).

3 Using Pairwise Results

After performing the pairwise comparisons, the results can be used to compare different options (Option 1 vs. Option 2) with attributes ***a***, ***b***, and ***c***. When comparing the options, if attribute ***a*** was ranked the highest, it would have the most influence on the final decision.

For example, let's assume we are deciding between purchasing a car and a truck, and we want to compare the options by cost, mileage, tow capacity and aesthetics. First, to understand the influence of each of these variables, we would perform a pairwise comparison by filling out the table below:

	vs. **cost**	vs. **mileage**	vs. **tow capacity**	vs. **aesthetics**	**Rating**
cost		1	0	2	**3/12**
mileage	1		1	1	**3/12**
tow capacity	2	1		2	**5/12**
aesthetics	0	1	0		**1/12**

Our pairwise comparison entries show that our primary concern is the towing capacity, and we are least concerned with the vehicle aesthetics.

Our next step to use the pairwise examples would be to rate the ability of each option to meet our selected criteria. Then, we can get their overall score by using the pairwise rating, as shown in the table below. For this analysis, let's assume that the truck costs 150% more than the car (100 vs 67), the mileage of the car is twice that of the truck (50 vs 100), the towing capacity of the truck is ten times that of the car (100 vs 10), and that they have the same level of aesthetic appeal (100 vs 100).

	Pairwise Rating (Importance)	**Truck Score (/100)**	**Car Score (/100)**
Cost	3/12 = 25%	67	100
Mileage	3/12 = 25%	50	100
Tow Capacity	5/12 = 42%	100	10
Aesthetics	1/12 = 8%	100	100
	WEIGHTED SCORE	**79**	**62**

Based on the table above, we could conclude that the truck is the preferrable option and based on the pairwise rating, this is largely driven by its superior towing capacity.

4 Key Take-Aways

- Pairwise comparisons are a way to determine the importance of criteria to help make complex decisions
- It is a relatively simple analysis where all criteria are compared to one another directly
- Choosing appropriate criteria is essential to get meaningful results from the evaluation
- All stakeholders in a project must work together to complete the pairwise comparisons
- The pairwise ratings made by the decision-makers have a significant impact on the later scoring of the options (in our case, design scenarios)

5 Additional References on Pairwise Comparisons

Pairwise comparison - Wikipedia

Pairwise Comparison Charts 2: Setting Up and Running Them - YouTube

Appendix C Pairwise Analysis Comparison Inputs by NSDPW

Pairwise Comparisons

Revision: 0
Date: 2022-APR-21
Prepared by: COWI (2022-APR)
Categories by: COWI (2022-APR)
Reviewed by: NSPW (2022-APR)
Pairwise Inputs by: NSPW (2022-APR)

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Ranking System

1	much less important than other option
2	less important than other option
3	same importance as other option
4	more important than other option
5	much more important than other option

1. rate the "row" versus the "column, Example: Cell C15 = 1 means: Features are much less important than Cost

2. enter ratings in the light orange cells in each table (i.e., top right section)

Category Comparisons

			vs. Cost	vs. Features	vs. Risk	vs. Opportunity	vs. Social Implications	Ranking
1	Cost	The Life-cycle cost comprises the construction, maintenance demolition of the existing bridge and building relocation costs.		2	2	2	2	13%
2	Features	NSPW's key features for the rehabilitated or replacement structure.	4		3	4	4	25%
3	Risk	Events that could negatively affect project cost or schedule	4	3		3	4	23%
4	Opportunity	Potential to improve public safety, include added features or possible future benefits.	4	2	3		5	23%
5	Social Implications	Impacts to the community and the environment during construction and over the lifespan of the structure.	4	2	2	1		15%
								100%

Pairwise Comparisons

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Pairwise Inputs by: NSPW (2022-APR)

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Cat. 1: Life-Cycle Cost

			vs. Direct construction cost	vs. Owner's cost for construction	vs. Road re-alignment cost	vs. Road re-alignment cost	vs. Lifecycle and maintenance cost	Internal Ranking	Overall Rating
1.1	Direct construction cost	The cost to construct and deconstruct the bridge		3	3	3	1	17%	2%
1.2	Owner's cost for construction	The cost to design, prepare for, and manage the works	3		3	3	1	17%	2%
1.3	Road re-alignment cost	The cost to widen or realign roads	3	3		3	1	17%	2%
1.4	Relocation of existing infrastructure	The cost to relocate ancillary or adjacent structures	3	3	3		1	17%	2%
1.5	Lifecycle and maintenance cost	The cost to maintain the bridge, assuming a 0% discount rate	5	5	5	5		33%	4%
								100%	13%

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Pairwise Inputs by: NSPW (2022-APR)

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Cat. 2: Features

			vs. Wider Traffic Lanes (min. 2 Lanes)	vs. Active transportation lanes	vs. Clearance of navigational channel	vs. Use of existing highway infrastructure	vs. NSDPW owns required land	vs. Service life beyond 50 years	vs. NSDPW would like to ensure that the service life of the crossing from the time of this report is extended by at least 50 years, preferably 100 years.	Internal Ranking	Overall Rating
2.1	Wider Traffic Lanes (min. 2 Lanes)	Where possible, options should consider a deck with adequate width to accommodate two-way traffic during maintenance and inspection activities on the deck. However, only two painted lanes of traffic are required.		3	1	5	4	2	5	16%	4%
2.2	Active transportation lanes	Where possible, options should include AT lanes to accommodate flexibility of a shared use path in the future or maintenance vehicle access.	3		1	4	4	4	5	17%	4%
2.3	Clearance of navigational channel	All options must maintain existing navigational clearances at a minimum.	5	5		5	5	5	5	24%	6%
2.4	Use of existing highway infrastructure	Where possible, the existing roadway infrastructure should be re-used and/or improved.	1	2	1		3	1	5	10%	3%
2.5	NSDPW owns required land	To minimize the impacts to the community and the environment during construction and over the lifespan of the structure, options where NSDPW owns more of the land needed are considered as more favourable.	2	2	1	3		1	5	11%	3%
2.6	Service life beyond 50 years	NSDPW would like to ensure that the service life of the crossing from the time of this report is extended by at least 50 years, preferably 100 years.	4	2	1	5	5		5	17%	4%
2.7	Utility/service accommodations	Where possible, NSDPW would like to take advantage of a rehabilitated or new crossing to be able to accommodate utility and service distribution lines from service providers.	1	1	1	1	1	1		5%	1%
										100%	25%

Pairwise Comparisons

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Reviewed by: NSPW (2022-APR)
Pairwise Inputs by: NSPW (2022-APR)

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Cat. 3: Risks

			vs. Impact to trade corridors during construction	vs. Impact to trade corridors in-service	Constructability / complexity of erection sequence	vs. Climate Change	vs. Geotechnical	vs. Approvals, permitting and consultation	vs. Operational issues during service life	vs. Land acquisition	Internal Ranking	Overall Rating
3.1	Impact to trade corridors during construction	Likelihood of unplanned interruptions impacting the trade corridors (vehicular traffic, marine channel, etc.) during construction		2	2	1	1	1	1	2	6%	1%
3.2	Impact to trade corridors in-service	Likelihood of unplanned interruptions impacting the trade corridors (vehicular traffic, marine channel, etc.) with the crossing after it is in-service	4		5	3	5	5	2	4	17%	4%
3.3	Constructability / complexity of erection sequence	Increased level of effort and expertise necessary to ensure construction continues as planned, including the likelihood of requiring specialist personnel, equipment, materials or procedures which would increase cost and possibly extend schedule	4	1		2	3	2	2	5	11%	3%
3.4	Climate Change	Likelihood of changes to hydraulic requirements under bridge, environmental loading (i.e., wind, temperature, ice, seismic) or navigational clearance during the bridge service life.	5	3	4		4	4	3	5	17%	4%
3.5	Geotechnical	Likelihood of discovering negative geotechnical conditions during design/construction, which would lead to further cost and delays	5	1	3	2		4	2	5	13%	3%
3.6	Approvals, permitting and consultation	Likelihood of a design scenario to be denied Regulatory Approval, due to social, environmental impacts, or archeological findings, and possibility of the permitting process delaying design and construction, extending the schedule (e.g., presence of endangered species)	5	1	4	2	2		2	5	13%	3%
3.7	Operational issues during service life	Likelihood of major maintenance being required during the life of the bridge due to the type of bridge selected	5	4	4	3	4	4		5	17%	4%
3.8	Land acquisition	Likelihood of increased capital cost and schedule delays resulting from acquisition negotiations	4	2	1	1	1	1	1		7%	2%
											100%	23%

Pairwise Comparisons

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Categories by: COWI (2022-APR)
Reviewed by: NSPW (2022-APR)
Pairwise Inputs by: NSPW (2022-APR)

Cat. 4: Opportunities

			vs. Public safety	vs. Use of modern bridge design / methods and materials	vs. Environmental gains	vs. Local content within construction industry	vs. Technological gains	Internal Ranking	Overall Rating
4.1	Public safety	Ability to improve public safety and fully bring structure and roadway up to current codes and standards		5	4	5	5	32%	7%
4.2	Use of modern bridge design / methods and materials	Ability to optimize materials and minimize maintenance	1		5	4	3	22%	5%
4.3	Environmental gains	Potential to use sustainable practices and to exceed environmental goals during and post construction	2	1		3	3	15%	4%
4.4	Local content within construction industry	Potential that the selected option is within skillset of local construction/fabrication industry allowing them to be competitive in its design and construction	1	2	3		4	17%	4%
4.5	Technological gains	Ability to improve knowledge base of local engineers, update NSPW's structural inventory, utilization of emerging technologies, and potential to implement a structural health monitoring system.	1	3	3	2		15%	4%
								100%	23%

Pairwise Comparisons

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Pairwise Inputs by: NSPW (2022-APR)

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Cat. 5: Social Implications

			vs. Public perception	vs. Effects on nearby communities	vs. Mi'kmaq perception	vs. Stakeholder impact	vs. Architectural and aesthetics	Internal Ranking	Overall Rating
5.1	Public perception	How the public are likely to perceive each option; public acceptance		2	3	2	3	17%	3%
5.2	Effects on nearby communities	General effect on quality of life in the surrounding neighborhoods, including noise and traffic disruptions, as well as impacts on local businesses	4		4	3	4	25%	4%
5.3	Mi'kmaq perception	How the Mi'kmaq of Nova Scotia are likely to perceive each option.	3	2		2	2	15%	2%
5.4	Stakeholder impact	The effect (interruptions, access, property ownership, noise, landscape changes, etc.) of the project on stakeholder groups	4	3	4		4	25%	4%
5.5	Architectural and aesthetics	Lasting effect of the physical structure, including the sentimental value of the existing truss bridge aesthetics.	3	2	4	2		18%	3%
								100%	15%

Pairwise Comparisons

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Date: 2022-APR-21
Prepared by: COWI (2022-APR)
Categories by: COWI (2022-APR)
Reviewed by: NSPW (2022-APR)
Pairwise Inputs by: NSPW (2022-APR)

Summary of Results

Category	Item	Rating	Rank
Cost	Direct construction cost	2.2%	24
	Owner's cost for construction	2.2%	25
	Road re-alignment cost	2.2%	26
	Relocation of existing infrastructure	2.2%	27
	Lifecycle and maintenance cost	4.4%	4
Features	Wider Traffic Lanes (min. 2 Lanes)	4.0%	8
	Active transportation lanes	4.2%	6
	Clearance of navigational channel	6.0%	2
	Use of existing highway infrastructure	2.6%	21
	NSDPW owns required land	2.8%	18
	Service life beyond 50 years	4.4%	5
	Utility/service accommodations	1.2%	30
Risks	Impact to trade corridors during construction	1.4%	29
	Impact to trade corridors in-service	3.9%	9
	Constructability / complexity of erection sequence	2.6%	20
	Climate Change	3.9%	10
	Geotechnical	3.1%	16
	Approvals, permitting and consultation	2.9%	17
	Operational issues during service life	4.0%	7
	Land acquisition	1.5%	28
Opportunities	Public safety	7.4%	1
	Use of modern bridge design / methods and material	5.1%	3
	Environmental gains	3.5%	14
	Local content within construction industry	3.9%	11
	Technological gains	3.5%	15
Social Implications	Public perception	2.5%	22
	Effects on nearby communities	3.8%	12
	Mi'kmaq perception	2.3%	23
	Stakeholder impact	3.8%	13
	Architectural and aesthetics	2.8%	19

Appendix D Maintenance Plan

DECEMBER 2023
NOVA SCOTIA DEPARTMENT OF PUBLIC WORKS

SEAL ISLAND BRIDGE MAINTENANCE PLAN

COWI

ADDRESS COWI North America Ltd
910-1809 Barrington St.
Halifax, NS B3J 3K8
Canada

TEL +1 902 407 8285
WWW cowi.com

DECEMBER 2023
NOVA SCOTIA DEPARTMENT OF PUBLIC WORKS

SEAL ISLAND BRIDGE MAINTENANCE PLAN

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CONTENTS

1 Introduction

Seal Island Bridge (herein referred to as "the bridge") is located along Highway 105 in Victoria County, Cape Breton, Nova Scotia and serves as a major transportation and shipping link. The through-arch truss bridge was opened to traffic in 1961 (construction started in 1960) and is approximately 750 m long. The structure has undergone various maintenance and rehabilitation works since 1990, including a deck replacement, recoating, and various truss reinforcements. The bridge is shown in Figure 1. The existing bridge naming convention, including node and pier numbers, is provided in Appendix A.

Figure 1: Seal Island Bridge south face (looking north)

This maintenance plan has been developed for the bridge without the consideration of an expected bridge service life. Regardless of the recommendations in the Benefit Cost Analysis [1], the maintenance plan will be structured such that it helps NSDPW achieve the longest possible life from the structure.

1.1 Objective

This maintenance plan is intended to provide guidance for the maintenance, inspection, repair, and rehabilitation of the Bridge from abutment to abutment. Its purpose is to promote safe and serviceable operations over the remaining lifetime of the Bridge.

The maintenance plan includes recommended inspection types, frequencies, rehabilitations, and preventative measures to support the safe operation of the Bridge, both if the Bridge is to be replaced in 15 years or if the bridge is to remain in-service substantially longer.

2 Maintenance and Access Facilities

The maintenance and access facilities of the existing bridge are described in Table 1. Select photos showing the overall bridge and relevant access facilities are provided in Appendix B.

Table 1: Seal Island Bridge maintenance access facilities

	Permanent Access Provided	Notes
Abutment Access	East abutment: stair from the east embankment from the top of the abutment to the bottom chord. West abutment: accessed from access road embankment beneath truss.	N/A
Longitudinal Catwalk	Longitudinal access catwalks provide access between the west abutment to Pier 5 (Panel 48) and from the east abutment to Pier 6 (Panel 68). The catwalks are accessed from the abutments.	Access excludes the main span (span 5). Catwalk is discontinuous between spans and requires traversing over the end floor beams at the truss ends.
Access Platforms	No permanent access provided.	Present at Nodes 50 and 66. However, they are tagged out for use due egress issues and deterioration.
Piers	Top of the top strut accessible through longitudinal access catwalk (means of localized tie-off required to be implemented by users).	Access excludes all other components of the piers (unless provided through other engineered means).
Roadway and Deck	No permanent access provided.	Temporary access would require traffic control.
Truss Members (Below-Deck)	No permanent access provided.	Temporary access would require engineered means or an access vehicle with traffic control.
Truss Members (Above-Deck)	Access ladder at Hanger S58 (south truss) to access the top of the top chord at panel S58.	For areas other than the top chord at panel S58, temporary access would require engineered means or an access vehicle with traffic control.

3 Maintenance

Maintenance operations are categorized under three main activities that must be performed during the service life of the bridge:

1 Regular Maintenance

- Includes items that should be performed regularly, such as general cleaning of surfaces, connections and bearings and inspection of ancillary components (i.e., lighting and signage).

2 Seasonal Maintenance

- Includes items that should be performed seasonally, such as the removal of any remaining de-icing salts in the spring.

3 Long-term Maintenance

- Includes "major" items that should be performed less often than regular or seasonal maintenance items, such as bearing replacements or steel recoating.

3.1 Regular Maintenance

A description of each regular maintenance item, including the recommended frequency, is described in Table 2. Select photos showing the overall bridge and relevant items requiring maintenance are provided Appendix B.

Table 2. Regular maintenance items

	Description	Recommended Action
Deck Drainage Pipes	Periodic cleaning and flushing should be performed on all drainage components, such as deck scuppers, deck drains, drainpipes, and downspouts to prevent water and debris build-up on the deck. Water and debris build-up on the deck may lead to vehicle hydroplaning or skidding on ice. Continuous water presence also promotes deck deterioration, which is accelerated in the presence of de-icing material applied during the winter. Obstructions often occur when items such as bottles, cans, and other materials accumulate or lodge in the drains or scuppers. It is sometimes necessary to use a combination of shovels, brooms, compressed air, and/or pressure washers to remove the salt-laden dirt and debris. If left in-place, this dirt and debris will contribute to accelerate deterioration of the nearby asphalt, concrete, and steel components.	It is recommended that NSDPW adopt a time schedule for cleaning the bridge roadway surface to keep drainage devices clear from debris. The schedule for cleaning should be selected to prevent accumulation of material and can be updated based on-site observations of effectiveness. Initially, the following schedule is suggested. - Every 6 months (between winter and summer seasons) (*Note: suggest combining with "deck expansion joints"*)

	Description	Recommended Action
Deck Expansion Joints	Accumulation of dirt and debris over the top of the neoprene seals accelerates the wear and deterioration of the seals. In the absence of intervention, unrestricted movement of the joint may be compromised leading to an overstress of joint components. In total, there are seven (7) expansion joints on the bridge: strip seals in the approach spans (both abutments, Piers 1, 2, and 7) and modular joints at the ends of the main span (Piers 3 and 6).	Personnel engaged in regular maintenance activities should check accumulation of debris or malfunctioning components in an expansion joint assembly, which could be performed through a simple drive-by or audible cues that can indicate loose items or unexpected behaviour. It is recommended that NSDPW adopt a time schedule for cleaning the bridge expansion joints of salt, sand, dirt, stones, and other debris. The cleaning processed could be conducted by mechanical equipment, compressed air, and/or by rinsing with pressurized water. The schedule for cleaning should be selected to prevent accumulation of material and can be updated based on site observations of effectiveness. Initially, the following schedule is suggested. › Every 6 months (between winter and summer seasons) (*Note: suggest combining this work with "deck drainage pipes"*)
Lighting and Signage Components	Proper lighting and clear signage are necessary to provide adequate visibility and clarity of the speed limits on the bridge. The bridge has lighting along the north side of the deck.	Personnel should visually inspect all bridge lighting and signage monthly as a minimum frequency to confirm they are operational, which could be performed through a simple drive-by. Extinguished lights, luminaires, or other devices should be replaced, as required, per the supplier's recommendations. Necessary spare parts should be stored according to the supplier's requirements. An annual operation check should be performed on all electrical devices and system, including general cleaning of all signage should be performed. It is recommended that NSDPW perform the following regular maintenance activities: › Monthly: confirm all bridge lighting is operational. › Annually: perform operation check for all electrical devices and systems. › Annually: general cleaning of all signage.

	Description	Recommended Action
Navigation Lighting	Permanent, bridge mounted navigation aids are provided to help in guiding vessels passing under the main truss through the navigation channel. The navigation lights are located where the arch tie ends in the vicinity of Nodes 50 and 66.	The navigation lights should be checked monthly to see that they are operational, which can be performed visually from the west approach embankment. It is recommended that NSDPW perform the following regular maintenance activities: › Monthly: visually confirm the navigation lights are operational.
Bearings	The bridge has three sets of "fixed" non-movable bearings (six (6) total) and four sets of "free" sliding expansion bearings (eight (8) total, Lubrite) combined with curtain plates, which were installed in 1985 to replace the existing roller bearings. The bearings are located at the ends of the truss spans below the truss vertical, diagonal, and bottom chord node. In 2021, all eight expansion bearings were inspected and cleaned with the curtain plates re-installed. It is expected that minimal maintenance will be required for the bearings. However, the areas are susceptible to debris build-up due to the typical presence of the expansion joints above.	It is recommended that NSDPW perform the following regular maintenance activities: › Semi-annually: all bearings be cleared of sand, dust, and other debris.
Access System and Facilities	Maintenance of access system and facilities is important to provide adequate safety measures for personnel during maintenance and inspection work. Except for the galvanized Hanger S58 access ladder (to access top chord in main span) and the east abutment access stair, the access platforms are from original construction and are not galvanized. Normal wear of the surfaces due to foot traffic and weathering is expected but does not require remedial actions.	It is recommended that NSDPW perform the following regular maintenance activities: › Annually: identify compromised components of access systems and replace, as required.
Utility Tray	Along the truss approach spans next to the longitudinal access catwalk, aluminum utility trays are present carrying various cables as part of the electrical system on the bridge. In the main span (span 5), the utility tray, which is located outboard of the north truss, is deformed. The utility tray supports electrical cables. Despite the electrical system remaining operational, deformed and damaged utility trays can result in unsupported cables, damage to live cables, and catch points.	It is recommended that NSDPW perform the following regular maintenance activities: › Annually: identify compromised utility tray and replace, as required.

	Description	Recommended Action
Bridge Deck	The pavement surface of the bridge deck includes a bituminous wearing surface. Under normal traffic, this wearing surface may develop cracks. Traffic paint is used for lane marking. It is expected that the lane markings will need to be repainted regularly as required. Bridge railing consist of traffic rails, vertical posts, base plates, anchor bolts, and grout pads. Railing expansion splices are provided at all expansion joint locations.	The roadway surface should be cleaned of dirt, stones and other debris regularly., It is recommended that NSDPW perform the following regular maintenance activities: › Annually: visual inspection of pavement for cracking, steel traffic barrier and connections for deterioration, and concrete crash blocks for deterioration. › Upon observation: repair any observed deterioration per NSDPW's standard specifications.
Coating System	Since original construction, the superstructure has been re-coated or had the coating system repaired multiple times. NSDPW noted that there were five phases to the most recent recoating project which started in 1995 and ended in 2000-2001. It is understood that this recoating program included full removal and recoating of the entire superstructure. De-icing salts placed on the roadway during the winter season are routinely sprayed onto the exposed truss components that if left in-place, contribute to accelerate deterioration of the steel truss coating system. Removing these materials between winter and summer seasons can be performed through pressure-wash cleaning and will help extend the life span of the coating system. It is essential that the integrity of the structural steel protective coating system be intact through regular maintenance. Limiting the amount of debris accumulation on the structural steel members can mitigate the deterioration of the coating system.	It is recommended that NSDPW perform the following regular maintenance activities: › Every 6 months (between winter and summer seasons): pressure wash clean the exposed superstructure truss in the main and side spans (Span 4, 5, and 6) to remove salt and other debris from up to and including ±3 m above and below deck level (i.e. the "splash zone"). › Upon observation: any areas where paint has failed or has been damaged should be repaired as required per NSDPW's standard specifications.

3.2 Seasonal Maintenance

Provided that regular maintenance items are addressed regularly as recommended, devoted season maintenance should not be required except for measures to deal with snow and ice on the bridge, which NSDPW addresses through their 100-series highway plowing program.

It is understood that NSDPW uses roadway de-icing salts on the bridge deck to provide a roadway surface that is free and clear of ice. Use of roadway salts contributes to an increased rate of corrosion of the structural steel and deterioration of the concrete deck. If de-icing salts remain to be used, it is recommended that

NSDPW perform seasonal cleaning of the exposed superstructure as noted in Section 3.1 (Table 2).

3.3 Long-term Maintenance

The objective of long-term maintenance is to continue safe and serviceable operations during the service life of the bridge.

The long-term maintenance plan encompasses the implementation of the following:

- long term maintenance (Table 3);
- inspection (Section 4);
- repairs and rehabilitation (Section 5 and Section 6).

A description of each long-term maintenance item, including the recommended frequency, is presented in Table 3.

The expected life spans of the different bridge components vary considerably. The anticipated life spans (and intervention periods) are based on the Team's experience on similar sized structures with similar traffic volumes.

Table 3. Long-term maintenance items

	Description	Recommended Action
Bridge Concrete Deck and Roadway	The original bridge deck was replaced with a new post-tensioned concrete deck in approximately 2001. The roadway surface comprises an asphalt overlay on top of the concrete deck. The concrete deck is in good condition and features an asphalt overlay separating it from traffic, road salts, and water. Based on the 2001 redecking drawings, a waterproofing membrane was not specified.	The following long-term maintenance operations may be required in addition to regular maintenance: › 5-10 years (2028-2033): mill off and replace the surface layer of asphalt (approximately 20-30 mm) or replace asphalt layer if surface milling is not feasible. › NSDPW to continue to re-pave the bridge again in coordination with their 100-series highway re-paving works.
Deck Expansion Joints	The expected life span for deck expansion joints is in the range of 30 years whereas the life span of strip seal components is shorter, in the range of 5-10 years.	The following long term maintenance operations may be required in addition to regular maintenance: › 0-5 years (2023-2028): replace each expansion joint assembly and every 30 years after that (anticipated).

	Description	Recommended Action
Expansion Bearings	Bearings are expected to last 30-40 years. The original bearings were replaced in 1985 such that they are nearing the end of their service life. Replacing the bearings is a significant engineering exercise and the assumption is that replacement is not required unless the bridge is intended to be maintained beyond the next 15 years.	The following long term maintenance operations may be required in addition to regular maintenance: › Unless a plan is in place to replace the bridge by 2038, replace each set of expansion bearings (eight (8) in total) by 2033 and every 30 years after that (anticipated).
Structural Steel Coating	Based on records from NSDPW, the superstructure was recoated in five phases from 1995 through 2001 and featured various products ranging from epoxy/urethane coatings, Carbozinc and Carbomastic items, Amerlock items, and zinc repairs. It is understood that there is still a risk of lead-based coatings from original construction but is unclear to what extent and where these exist (and what has been removed from prior coating works).	The following long term maintenance operations may be required in addition to regular maintenance: › 0-5 years (2023-2028): localized re-coating of steel components at expansion joints and "splash zone" defined as ±3 m from top of deck. › >15 years (by 2038): full recoating of the truss superstructure (if bridge is to remain beyond next 15 years)
Concrete Sealing	Concrete deterioration can be limited through regular sealing the surfaces with a water and chloride-ion repelling penetrating sealer.	The following long term maintenance operations may be required in addition to regular maintenance: › Every 5 years: seal concrete surfaces on the top of each pier.

4 Inspection

The aim of the structural inspection plan is to maintain an acceptable level of structure integrity, public safety, comfort, and convenience for the bridge. Experience in highway bridge operations has shown that continuous and systematic inspection and maintenance of a bridge will extend its service life and reduce its operating expense.

The primary objectives of the structural inspection plan are to:

- inspect the bridge for defects and deterioration;
- observe changes in the live load or environment;
- investigate any unexpected changes of the bridge behaviour between inspections;
- minimize maintenance expenditures of the bridge, bridge components, or bridge items over time;
- provide a basis for a bridge management system for the planning and funding of rehabilitation work on the bridge.

4.1 Structural Inspections

Information useful to the continuous evaluation of the bridge can be obtained from several types of structural inspections, generally distinguished by frequency and intensity. The types of inspections discussed in this maintenance plan are the following:

1. General Inspection: day-to-day or week-to-week observations by in-house NSDPW staff.
2. Annual Inspection: scheduled visual inspection by bridge engineers and inspection crews without specialized access equipment (or only at localized areas of interest). That is, generally observations made from permanent access points, such as catwalks.
3. Detailed Inspection: scheduled in-depth inspection by bridge engineers and inspection crews with specialized access equipment. That is, access vehicles would be employed to allow inspectors to get a detailed view of inspection areas.
4. Special Inspection: scheduled special inspection for certain bridge components by qualified trained personnel.

4.1.1 General Inspections

The level of inspection is directed at detecting major surface defects that are obvious or observed during regular maintenance.

General inspections are conducted by regular NSDPW personnel during their regular maintenance duties. The intent is not search for problems but to bring to the attention of NSDPW obvious defects or operational problems that may be an indication of structural problems. This simple effort contributes to the safe operating condition of the bridge.

A general inspection should also be conducted immediately after the following events:

- accident or vehicle collision with the bridge and its barriers;
- accident or vehicle collision with bridge accessories such as luminaires or access platforms;
- fire accident on or beneath the bridge;
- prolonged extreme temperatures;
- other exceptional circumstances, e.g., extreme storms.

If the extent of damage is significant, NSDPW should request a detailed inspection immediately. In this instance, the ability of the bridge to remain in-service requires a brief initial inspection by a bridge engineer who should also determine any necessary traffic control required to restrict traffic loading on the bridge.

4.1.2 Annual Inspections

This level of inspection is directed at detecting the more obvious defects, by visual inspection of the bridge from abutment-to-abutment without the anticipated need for specialized access equipment (or only at localized areas of interest). These activities may require the use of supplementary aids such as cameras with high zoom capability or unmanned aerial vehicles (UAVs / drones). Annual inspections occur in a shorter period compared to detailed inspections.

Observations are captured based on visual findings for specific components and are typically qualitatively described with approximate extents based on the limitation of the in-situ access platforms.

Annual inspections are conducted by experienced bridge engineers and inspection crews on a pre-scheduled cycle. Note that an annual inspection is not required in years where a detailed inspection is performed (described in Section 4.1.3).

4.1.3 Detailed Inspections

This level of inspection is directed at detecting less obvious defects, by visual and non-destructive inspection of the bridge abutment-to-abutment.

The intent is to thoroughly investigate the structural condition of all bridge components. Detailed inspection requires the measurement and documentation of all areas of defects and deterioration on the bridge and, therefore, requires arm's length access and may require non-destructive investigations (such as ultrasonic testing or magnetic particle inspections by trained technicians) to supplement the visual inspection. An evaluation of the capacity of the structure may be required to complete the inspection. Additionally, a special investigation may be needed to fully understand the condition of specific structure components.

Detailed inspections are conducted by experienced bridge engineers and inspection crews on a pre-scheduled cycle. Detailed inspections may also be implemented when inconclusive results are obtained from the general inspection.

Through the advancement of drone technology, visual inspection in locations where access is difficult through drone photography and videography is a powerful and economic tool to supplement or replace a "hands-on" inspection.

4.1.4 Special Inspections

Special inspections are conducted to inspect certain components of the bridge that require their own careful consideration and are atypical to the general and detailed inspection activities. These include structural health monitoring, underwater inspection, and surveying.

In the event of a vehicle impact, traffic collision, or fire accident matters, local NSDPW staff shall determine if the matter requires a bridge inspector to perform an onsite inspection in the area of interest.

4.2 Schedule of Inspections

4.2.1 General Inspections

No schedule; part of normal maintenance on a week-to-week and month-to-month basis.

4.2.2 Annual Inspections

Ever year with the following exceptions:

- Omit in years where a detailed inspection is performed; and

- No less frequent than every two years.

4.2.3 Detailed Inspections

The first documented detailed inspection of the bridge was performed in 2018/2019. In 2021, COWI performed a focus detailed inspection of identified problem areas and regions that required additional inspection effort.

Every two (2) years (alternating with the annual inspection.

The interval between inspections may be decreased or decreased by NSDPW at their discretion depending on the results of previous detailed inspections.

4.2.4 Special Inspections

It is recommended that special inspection frequency be evaluated on a case-by-case basis depending on the scope of inspection, findings, and NSDPW's intended long term goals for the bridge.

4.3 Documentation

Inspection forms and reports should be prepared for field use, should be organized in a systemic manner, and should include sketches and room for field notes by the inspector. The completed report should be clear and detailed to the extent that notes and sketches can be fully interpreted later. Photographs should be taken in the field to illustrate defects and cross-referenced in the forms and reports where the defects are noted.

The source of all information contained in the report should be clear and the date of the inspection or other sources of data should be noted.

All signs of distress and deterioration should be noted with sufficient accuracy so that future inspections can be compared with the present condition. Recommendations for repair and maintenance should be included if warranted by the observed conditions.

4.4 Inspectors' Qualifications, Responsibilities, and Equipment

4.4.1 Qualifications of Inspectors

General inspection of the Bridge can be conducted by in-house NSDPW personnel who have a basic technical knowledge and understanding of the bridge.

Annual and detailed inspections of the Bridge should be conducted by a professional bridge engineer with a background in design and construction of bridges, specifically long span truss span bridges, or trained bridge inspectors and technicians reporting to, or under the supervision of a professional bridge engineer.

Special inspection of the Bridge should be conducted by qualified, trained, and competent personnel with a background in the scope of the special inspection.

4.4.2 Responsibilities of Inspectors

The primary responsibility of the inspector or engineer is to inspect all components of the bridge and to report on all areas of defects. The inspector should assess the causes of the defects and their impact on the performance of the bridge while prioritizing the components of the bridge on which actions needs to be taken and make recommendations, such as scheduling of future inspections, repair work, including cost estimates for such works.

The inspector should also note areas of the bridge where regular maintenance duties, described in Appendix Section D.4.1, have not been successfully performed and make recommendations for appropriate works to be conducted.

In the circumstance that there are doubts about the adequacy of construction materials or the load carrying capacity, the bridge inspector shall recommend to NSDPW additional inspection works such as material testing, material sampling, non-destructive testing, and geometry surveys.

4.4.3 Safety Considerations

The minimum recommended crew size for detailed and special inspections is two persons. The inspectors shall take proper safety precautions and comply with the safety requirements defined in the Nova Scotia's Occupational Health and Safety Act and Regulations. The inspection crew shall be certified in the relevant required first aid, fall arrest, and rescue training for the work to be performed and have compliant safety procedures to support the safe execution of the work.

Inspections that require working in aerial working platforms, swing stages, or temporary access shall be performed by persons skilled in the use of such specialized equipment.

4.4.4 Access

For general inspections, it is adequate for the field personnel, where possible, to inspect the bridge from the deck, from ground level, and from the longitudinal access catwalks while using binoculars or similar equipment.

For detailed inspections, specific access means and equipment should be employed that are suitable and efficient to perform the necessary "hands-on" inspection including but not limited to aerial work platforms, rope access technicians, or access-free means through drones.

4.5 Summary

A summary of the inspection requirements and timelines is presented in Table 4. Summary of inspection details and requirements.

Table 4. Summary of inspection details and requirements

Inspection Details		Requirements			
Level	**Description** Section 4.1	**Access** Section 4.1	**Inspector** Section 4.4	**Documentation** Section 4.3	**Schedule** Section 4.2
General	Detection of major surface defects that are obvious or observed during regular maintenance	Available permanent access points; specialized access equipment not required	NSDPW personnel who have a basic technical knowledge and understanding of the bridge.	Timely notification of a NSDPW Bridge Engineer.	During regular maintenance activities
Annual	Detection of defects through visual inspection of the bridge "abutment-to-abutment"	Available permanent access points; specialized access equipment not anticipated	Professional bridge engineer with a background in design and construction of bridges, specifically long span truss bridges, or trained bridge inspectors and technicians reporting to or under the supervision of a professional bridge engineer	Inspection Report	Annually, but may be omitted in years where a detailed inspection is performed.
Detailed	Detection of defects through "arm's length" visual and physical inspection of the bridge "abutment-to-abutment"	Arm's length; specialized access equipment required	Professional bridge engineer with a background in design and construction of bridges, specifically long span truss bridges, or trained bridge inspectors and technicians reporting to or under the supervision of a professional bridge engineer	Inspection Report	Every two (2) years (alternate with the Annual Inspection) Note: frequency can be decreased based on NSDPW discretion upon reviewing results if favourable
Special	Inspection of certain bridge components of the bridge that require their own careful consideration and are atypical to the general, annual and detailed inspection activities. Special inspections include structural health monitoring, underwater inspection, and surveying.	As required	Qualified, trained, and competent personnel with a background in the scope of the special inspection	Inspection Report	As needed

5 Special Inspection Items

An overview of the current special inspection items for the bridge is presented in Table 5. These special inspection items were recommended from the 2018/2019 Detailed Inspection Report [2] and from the structural inspection and analysis reports performed as a part of the Benefit Cost Analysis project [1, 3, 4, 5].

Table 5: Special inspection items

	Recommendation	Frequency
Superstructure (NDE and Visual)	› Rec 1 [3]: Perform NDE (MT, at a minimum) at all visually observed crack locations identified in Appendix D of HEC's 2018/2019 inspection report [2] to determine the presence and extent of cracking. › Rec 2 [3]: Develop a NDE program developed to inspect an increased number tack welds, despite no visual indications of cracking. Note: to be performed during detailed inspections if not performed out of cycle. › Rec 7 [3]: Perform NDE (MT, at a minimum) at lower portion of the vertical at N68. › Rec 6 [4]: Inspect traction truss elements visually and using ultrasonic testing (UT) and magnetic particle testing (MT) to check for signs of overstress. › Rec 8 [4]: Inspect diagonals N50U-N51I, S50U-S51I, N65I-N66U and S65I-S66U (specifically the connections) visually and using UT and MT to check for cracking. › Rec 11 [4]: Inspect (both visually and using UT and MT) floorbeam connections and monitor crack growth starting in 2023. [15 floorbeams| FB34-FB40 North and South, FB48 South, FB76-FB82 North and South]	Every two years (can be relaxed as results are received and are favourable)
Superstructure (Misc.)	› Rec 9 [4]: Assess the condition of the current hanger dampers and keep a supply of spare dampers to allow for an expeditious replacement in the event of a damper failure. › Rec 12 [4]: Monitor global bridge behaviour through routine measurement of bridge's natural frequencies using structural health monitoring. (i.e., this can be a simple method to monitor on-going section loss, bearing seizures, element connection stiffnesses- consider in Phase 4 as well)	N/A
Substructure	› Rec 21 [4]: Inspect and monitor existing cracks in the substructure until the pier repairs are completed. This can be included as part of the annual and detailed inspections. › Annual inspection: visual, with a 1-year frequency. › Detailed inspection: visual and "hands-on", with a 3-year frequency	Every year on a three-year cycle (detailed inspection on the 3rd year)

6 Rehabilitation Plan

As a part of the next phase Benefit-Cost Analysis project (Phase 3), COWI is providing NSDPW with steel rehabilitation and repair designs (under separate cover) to ensure that the bridge can remain in-service for the next 15 years (until 2038). NSDPW should consider performing these repairs as early as possible to maximize the potential longevity of the existing bridge. In addition to the Phase 3 repairs, Table 6 presents a list of general rehabilitation activities that can be expected throughout the remaining life of the structure.

Table 6. General rehabilitation and maintenance activities

General	› [2]: Repair impact damaged barrier post and rails and replace corroded / missing nuts and washers › [2]: Repair or replace the asphalt wearing surface › [2]: Complete deck soffit repairs as required › [2]: Strip coating once per layer should be mandatory at all sharp edges / corners / bolts/ fasteners › [2]: Initiate a program to repair the existing coating system on the superstructure › [2]: Temporarily support the damaged cables (utility tray)
Superstructure	› [2]: Replace heavily corroded bolts upon observation › [2]: Replace missing or severely corroded fasteners in connections › [2]: Replace severely corroded stiffening angle on top plan bracing connections › [2]: Repair / replace severely corroded sway bracing members / connection plates › [2]: Vertical bracing framed with back-to-back angle members › [2]: Replace severely corroded top and bottom plates, web plates, batten / tie plates and lattice (Plates located on top chord, bottom chord, and built-up members) › [2]: Plan bracing framed with built up members › [2]: Severe corrosion of lacing and tie plates of the built-up members of the trusses › [2]: Severe corrosion / deterioration of the connection plates and bolts at connections for the main truss, the vertical bracing, the plan bracing, and member splices › [2]: Repair the deck plan bracing located in Span 5 › [2]: Severe corrosion of local areas of members › Rec 6 [3]:Remove the observed surface gouges at (Verticals at N18U and S76U) through grinding and performed NDE following their removal (MT and UT)

Substructure

- [2]: Rehabilitate the bridge piers 1, 3, 6, 7
- [2]: Rehabilitate the bridge abutments
- [2]: Repair spalls, delaminations and wide cracks in concrete end dams
- [2]: Re-grout the granite armouring blocks in the tidal zone of the piers
- Rec 22 [4]: Further detailed assessment of the ultimate load capacities for the spread footing and pile foundations be determined; particularly if the bridge is intended to remain in use beyond 2038.
- Rec 23 [4]: Collect more information on the rock mass quality and strength where gypsum was encountered; particularly if the bridge is intended to remain in use beyond 2038.

Should the bridge remain in service beyond 15 years, a significant rehabilitation program is needed. Current issues which would need to be addressed include steel upgrades/repairs for the superstructure including the removal of existing tack welds, the implementation of a recoating program and an expansion of the pier/abutment rehabilitation program.

6.1 Rehabilitation Restrictions

Table 7 presents the current restrictions on the design of bridge rehabilitations.

Table 7. Rehabilitation restrictions

Restriction	Reference
Welding to the existing steel structure is not permitted.	Rec 9 [3, 5]: COWI recommends NSDPW avoid any further welding on the structure.

7 References

[1] COWI & Stantec, "Seal Island Bridge Benefit Cost Analysis," Nova Scotia Department of Public Works, Halifax, NS, 2023.

[2] Harbouside Enginnering Consultants, "2018/2019 Seal Island Bridge Inspection," Nova Scotia Department of Public Works, 2020.

[3] COWI, "Seal Island Bridge Inspection Investigation Finding, Superstructure Investigation Findings," Nova Scotia Department of Public Works, 2021.

[4] COWI, "Seal Island Bridge Structural Analysis, A219162-007-001-TAT-RPT-0C," Nova Scotia Department of Public Works, Halifax, NS, 2022.

[5] COWI, "Seal Island Inspection Investigation Findings, Fractured Diagonal Investigation," Nova Scotia Department of Public Works , 2021.

Appendix A Bridge Naming Convention

The truss from abutment to abutment is numbered from Panel 1 (West Abutment, Baddeck side) to Panel 104 (East Abutment, Sydney Abutment). To be consistent with the original drawings, a panel is defined as a cross section of the bridge at the truss connections, as shown in Figure 2, and a bay is defined as the area between two panels. The centre of the main span is located at Panel 58. The structural members are identified as shown in Figure 3 and the bridge panel numbering is provided in Figure 4, Figure 5, and Figure 6.

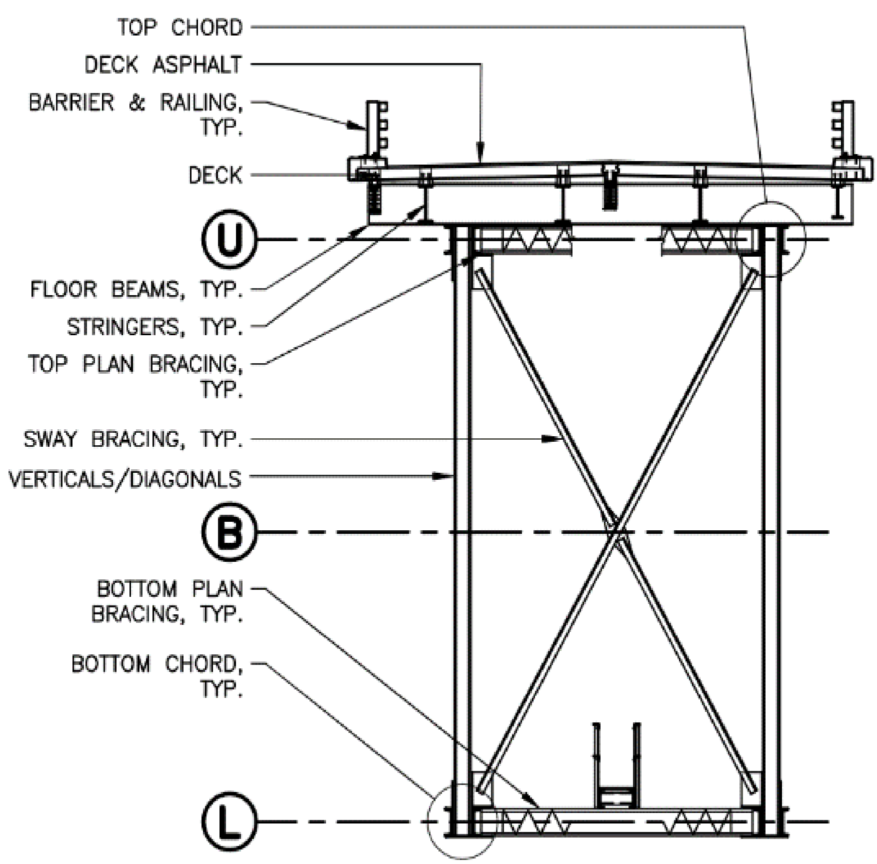


Figure 2. Bridge element identifiers – panels outside of arch

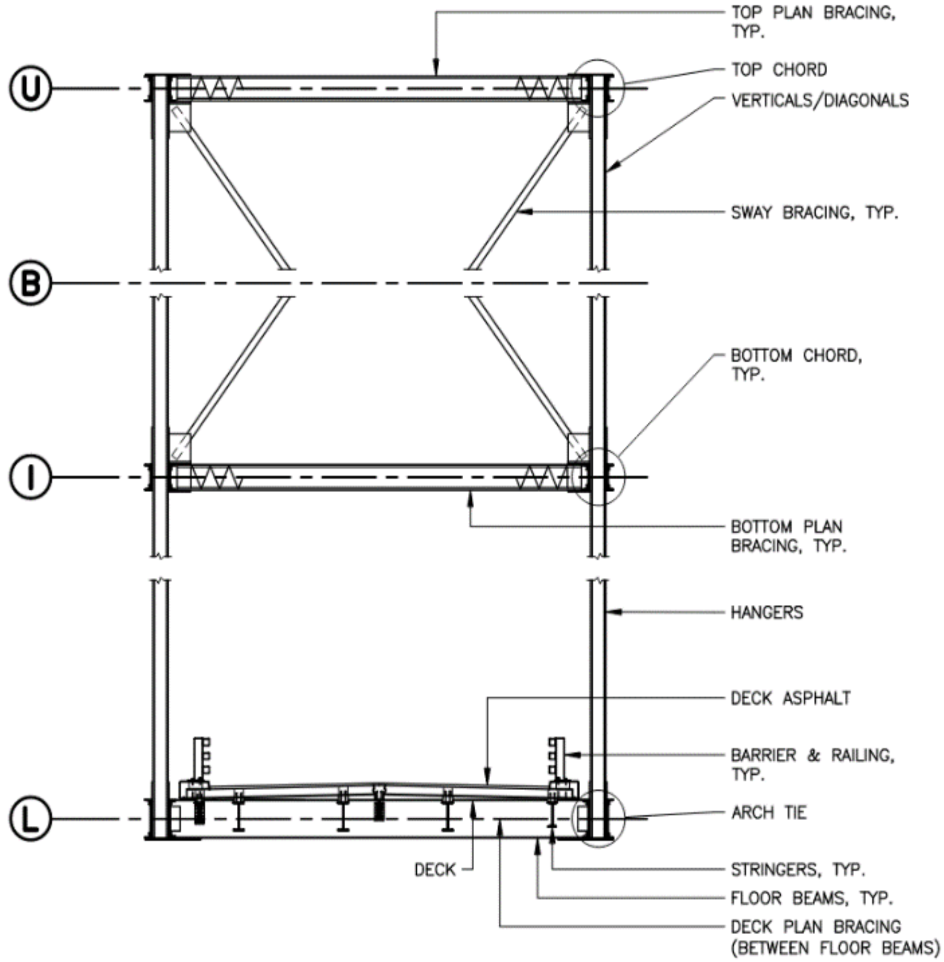


Figure 3: Bridge element identifiers – panels within arch

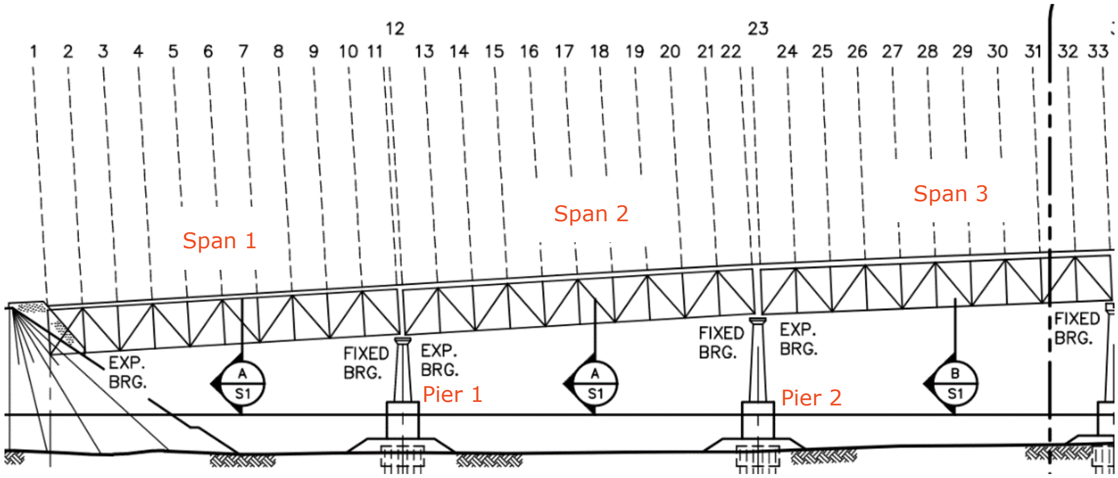


Figure 4. Elevation view of west approach and splay spans

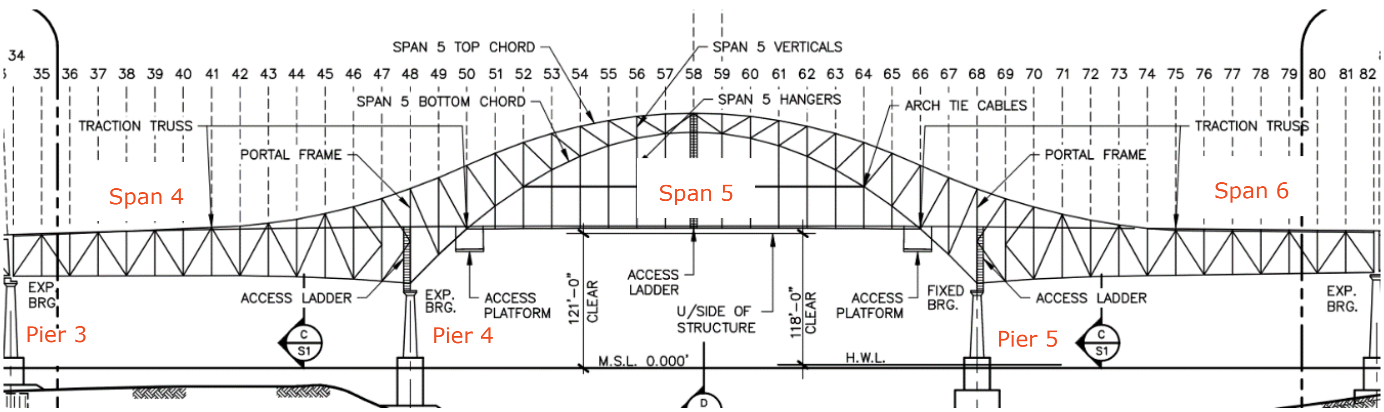


Figure 5. Elevation view of main spans

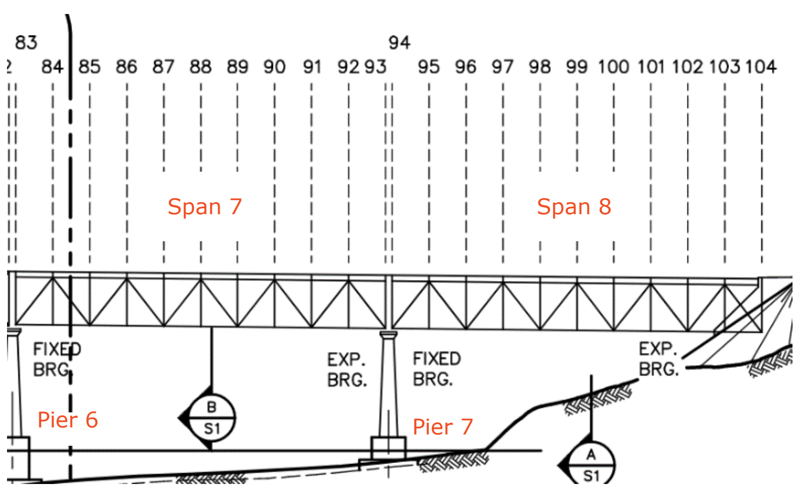


Figure 6. Elevation view of east approach and splay spans

Appendix B Select Bridge Photos

Note: photos are from 2021 during Phase 1 superstructure and substructure investigations.

Figure 7: Seal Island Bridge from Kelly's Mountain (from the west)

Figure 8: Main span of bridge (south face) from southeast embankment

Figure 9: View of overall bridge from southwest embankment

Figure 10: Bridge roadway looking west from east abutment

Figure 11: View of main span arch from roadway looking east

Figure 12: View of main span arch from roadway looking upward

Figure 13: View of single lane traffic closure on bridge in the main span

Figure 14: View of single lane traffic closure on bridge in the main span

Figure 15: View of single lane traffic closure on bridge with aerial working platform in-use

Figure 16: West approach truss from west embankment

Figure 17: East approach truss from east embankment

Figure 18: East approach truss looking west from east abutment

Figure 19: Underside view of approach truss showing longitudinal access catwalk

Figure 20: View of east approach truss (looking west) from longitudinal access catwalk

Figure 21: Top of the main span arch from at south panel 58 via ladder access (looking south)

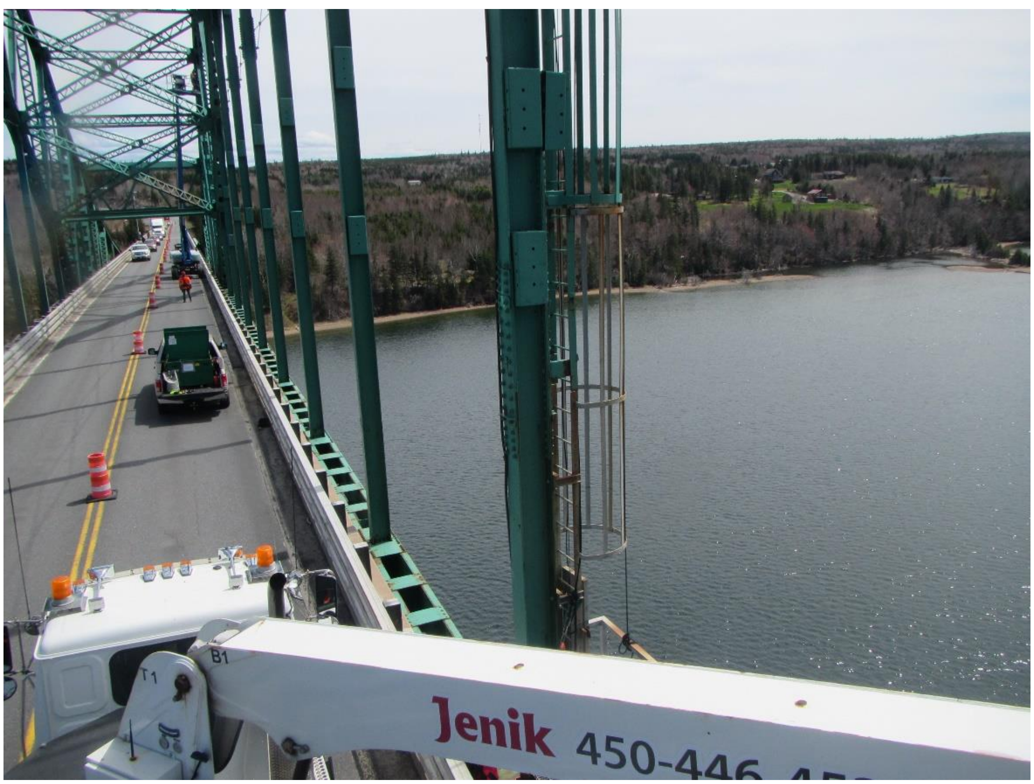


Figure 22: Access ladder at south panel 58

Figure 23: East abutment access stairs

Figure 24: East abutment access stairs

Figure 25: Example of specialized access (Jenik A-62) for under bridge inspection

Figure 26: Example of specialized access (Jenik A-62) for under bridge inspection

Figure 27: Example of specialized access (Jenik A-62) for under bridge inspection

Figure 28: Example of specialized access (Jenik A-62) for above-deck inspection

Figure 29: West abutment expansion joint at traffic barrier

Figure 30: West abutment expansion bearing

Figure 31: Pier 1 expansion joint at traffic barrier

Figure 32: Pier 1 expansion bearing

Figure 33: Pier 2 expansion joint at traffic barrier

Figure 34: Pier 2 expansion bearing

Figure 35: Pier 3 expansion joint at traffic barrier

Figure 36: Pier 3 expansion joint looking west

Figure 37: Pier 3 expansion bearing

Figure 38: Pier 4 expansion bearing

Figure 39: Pier 6 expansion joint at traffic barrier

Figure 40: Pier 6 expansion bearing

Figure 41: Pier 7 expansion joint at traffic barrier

Figure 42: Pier 7 expansion bearing

Figure 43: East abutment expansion joint

Figure 44: East abutment expansion bearing

Figure 45: Typical substructure pier (Pier 7 shown)

Figure 46: Typical substructure pier (Pier 7 shown)

Appendix E Conceptual Drawings

ALIGNMENT OPTIONS PLAN

SCALE 1:7500

-- CONCEPTUAL --

NOTES:

1. CONCEPTUAL ALIGNMENT(S) USED FOR EVALUATION PURPOSES ONLY. ACTUAL ALIGNMENT(S) TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.
2. FOR OPTIONS 1C/2A/2B/2C/2D, A REPRESENTATIVE ALIGNMENT INCLUDING AN IMPROVED HAIRPIN WAS ASSUMED TO COMPLETE THE EVALUATION.

COWI

Stantec

Designed by:	S. CLARK
Surveyed by:	-
Drawn by:	C. DELONG
Checked by:	S. CLARK
Approved by:	P. FLOWER

Manager, Structural Engineering — Date

MK.	DATE	REVISION
0	23 DEC 08	ISSUED FOR 100% REPORT

NOVA SCOTIA
Public Works

Scale:	AS SHOWN
Date:	2023 DEC 08
File No. :	N/A
Sheet No. :	1 of 9

SEAL ISLAND BRIDGE
BCA - REHABILITATION\ REPLACEMENT

HIGHWAY 105 — VICTORIA

ALIGNMENT OPTIONS PLAN

OPTION 1A/1B PLAN

SCALE 1:7500

NOTES:

1. PROPERTIES WITH BROWN SHADING ARE CROWN (NSDPW OR NSDNR). ALL OTHER PROPERTIES ARE PRIVATE. (SOURCE: NSDPW)
2. HORIZONTAL GEOMETRY IS BASED ON A BEST FIT ALIGNMENT ALONG THE CENTERLINE OF THE EXISTING HIGHWAY 105

-- CONCEPTUAL --

COWI

Stantec

Designed by:	S. CLARK
Surveyed by:	-
Drawn by:	C. DELONG
Checked by:	S. CLARK
Approved by:	P. FLOWER

Manager, Structural Engineering

Date

MK.	DATE	REVISION
0	23 DEC 08	ISSUED FOR 100% REPORT

NOVA SCOTIA
Public Works

Scale: AS SHOWN

Date: 2023 DEC 08

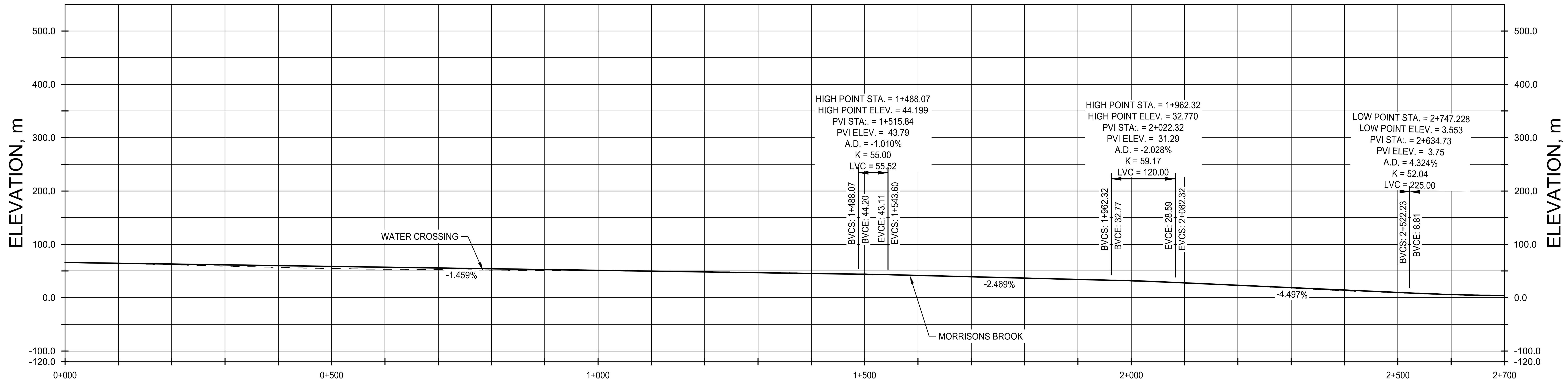
File No. : N/A

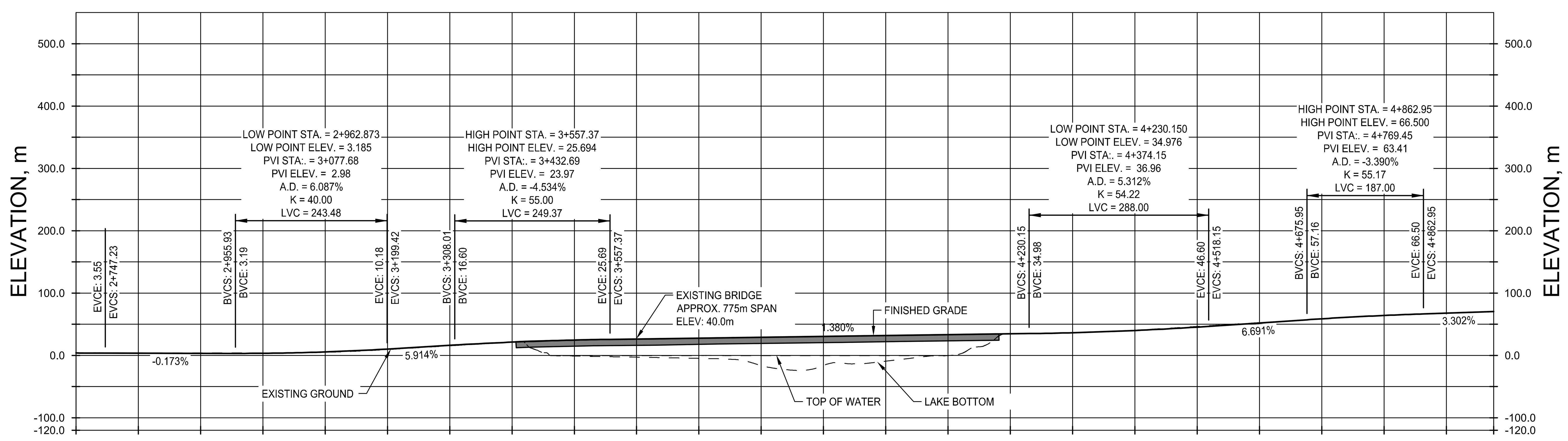
Sheet No. : 2 of 9

SEAL ISLAND BRIDGE
BCA - REHABILITATION
ALIGNMENT I

HIGHWAY 105 VICTORIA

OPTION 1A/1B
PLAN





OPTION 1A/1B PROFILE

SCALE H: 1:5000 V: 1:500

-- CONCEPTUAL --

NOTE:

1. VERTICAL GEOMETRY IS BASED ON A BEST FIT PROFILE OF THE EXISTING CENTERLINE OF HIGHWAY 105.
2. CONCEPTUAL ALIGNMENT USED FOR EVALUATION PURPOSES ONLY. ACTUAL ALIGNMENT TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

COWI
Stantec

Designed by:	S. CLARK
Surveyed by:	-
Drawn by:	C. DELONG
Checked by:	S. CLARK
Approved by:	P. FLOWER

Manager, Structural Engineering — Date

MK.	DATE	REVISION
0	23 DEC 08	ISSUED FOR 100% REPORT

NOVA SCOTIA
Public Works

Scale:	AS SHOWN
Date:	2023 DEC 08
File No. :	N/A
Sheet No. :	3 of 9

SEAL ISLAND BRIDGE
BCA - REHABILITATION
ALIGNMENT I

HIGHWAY 105 — VICTORIA

OPTION 1A/1B
PROFILE

N/A

SEAL ISLAND BRIDGE BCA REHABILITAIION OPTION 1A, 1B, 1CGENERAL ARRANGEMENT

Designed by: J. PEREZ ARMINO			
Surveyed by: -			
Drawn by: A. MACPHERSON			
Checked by: D. BETTS		0	23 DEC 08	ISSUED FOR 100% REPORT
Approved by: A. FERGUSON	Manager, Structural Engineering — Date	MK.	DATE	REVISION

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Public Works

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Sheet No. : S1 of S9

SEAL ISLAND BRIDGE BCA REHABILITATION OPTION 1A, 1B, 1C

HIGHWAY 105 VICTORIA

GENERAL ARRANGEMENT

OPTION 1C/2A/2B/2C/2D PLAN

SCALE 1:7500

-- CONCEPTUAL --

NOTE:

1. PROPERTIES WITH BROWN SHADING ARE CROWN (NSDPW OR NSDNR). ALL OTHER PROPERTIES ARE PRIVATE. (SOURCE: NSDPW)
2. ACTUAL ALIGNMENT(S) TO BE ESTABLISHED AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING. NOTE THAT A REPRESENTATIVE ALIGNMENT INCLUDING AN IMPROVED HAIRPIN WAS ASSUMED TO COMPLETE THE EVALUATION.

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Surveyed by:	-
Drawn by:	C. DELONG
Checked by:	S. CLARK
Approved by:	P. FLOWER

Manager, Structural Engineering — Date

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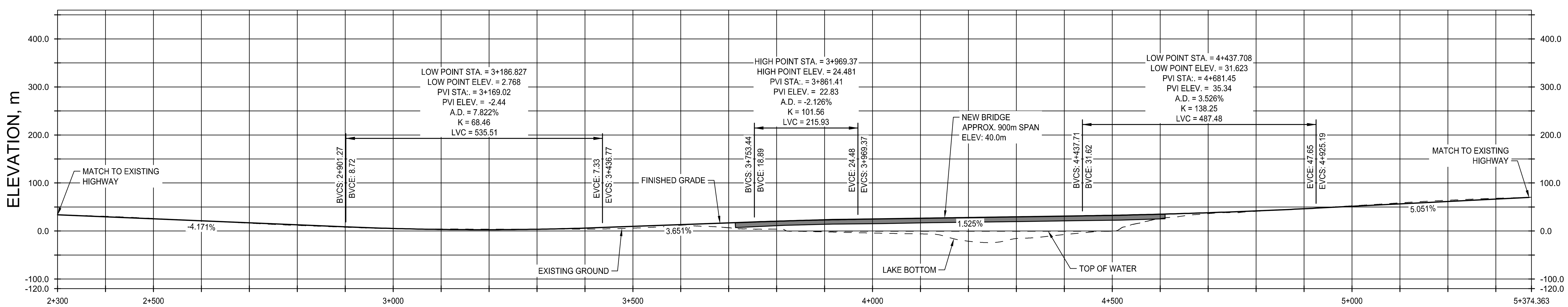
Sheet No. : 4 of 9

SEAL ISLAND BRIDGE
BCA - REPLACEMENT
ALIGNMENT II

HIGHWAY 105 VICTORIA

OPTION 1C/2A/2B/2C/2D PLAN



OPTION 1C/2A/2B/2C/2D PROFILE

SCALE H: 1:5000 V: 1:500

-- CONCEPTUAL --

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NOTE:

1. ACTUAL ALIGNMENT(S) TO BE ESTABLISHED AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING. NOTE THAT A REPRESENTATIVE ALIGNMENT INCLUDING AN IMPROVED HAIRPIN WAS ASSUMED TO COMPLETE THE EVALUATION.

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Drawn by:	C. DELONG
Checked by:	S. CLARK
Approved by:	P. FLOWER

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NOVA SCOTIA
Public Works

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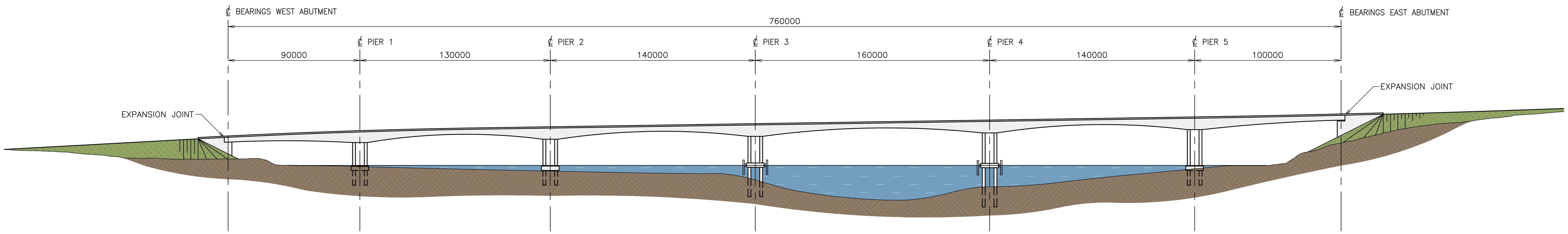
SEAL ISLAND BRIDGE
BCA - REPLACEMENT
ALIGNMENT II

HIGHWAY 105 VICTORIA

OPTION 1C/2A/2B/2C/2D PROFILE

N/A

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2A GENERAL ARRANGEMENT



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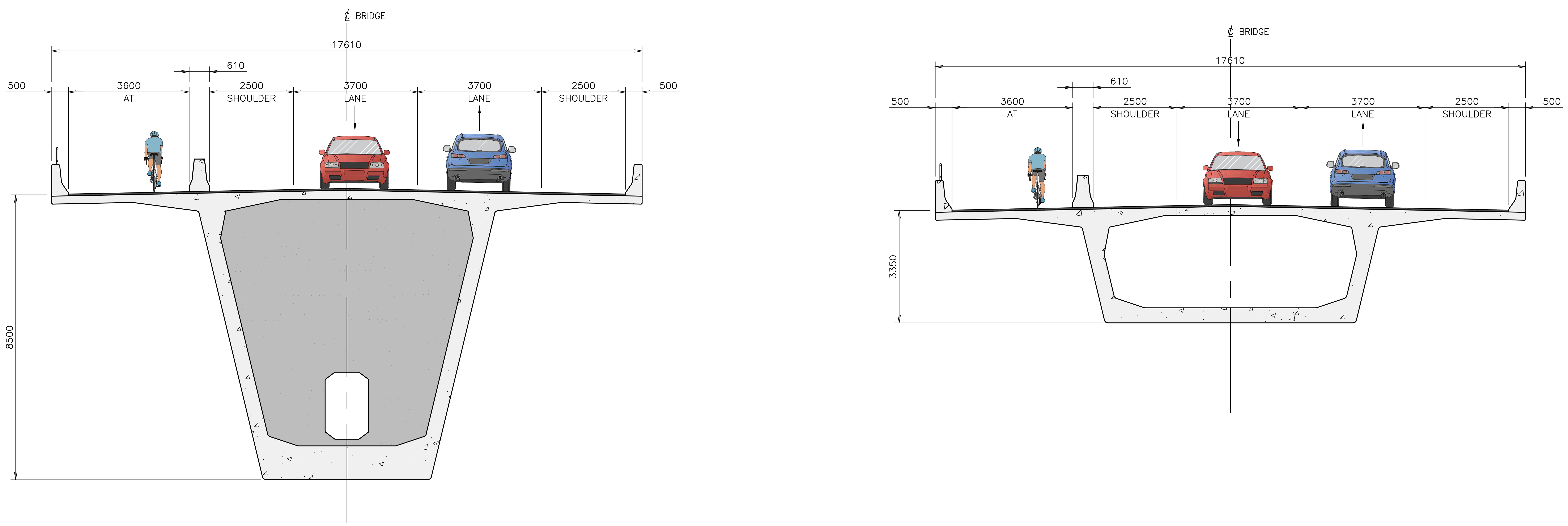

TYPICAL CROSS SECTION
1:75

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

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Approved by:	A. FERGUSON

Manager, Structural Engineering   Date

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Public Works

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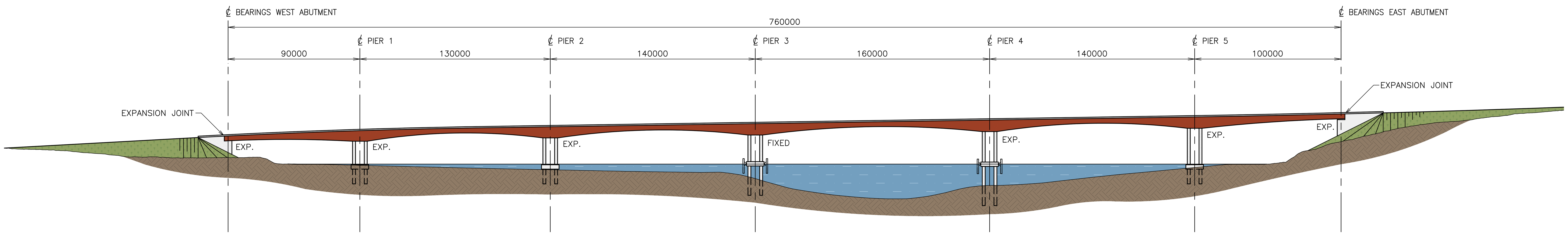
SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2A

HIGHWAY 105   VICTORIA

GENERAL ARRANGEMENT

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2B GENERAL ARRANGEMENT N/A



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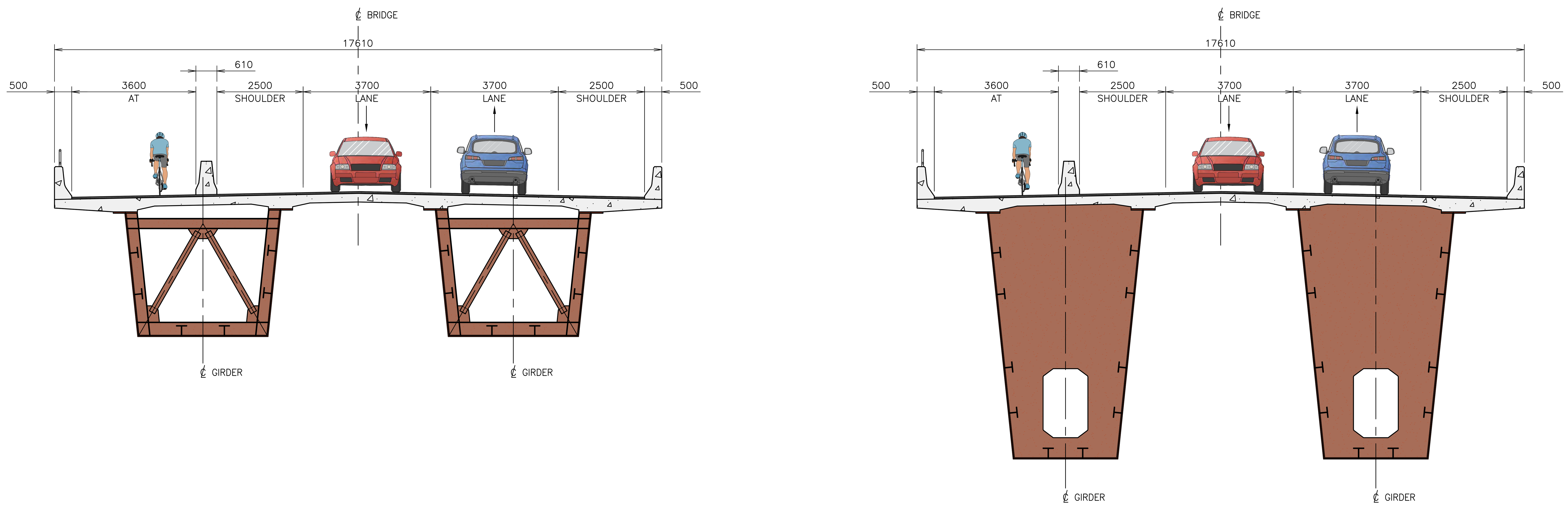

TYPICAL CROSS SECTION
1:75

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

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Manager, Structural Engineering   Date

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Public Works

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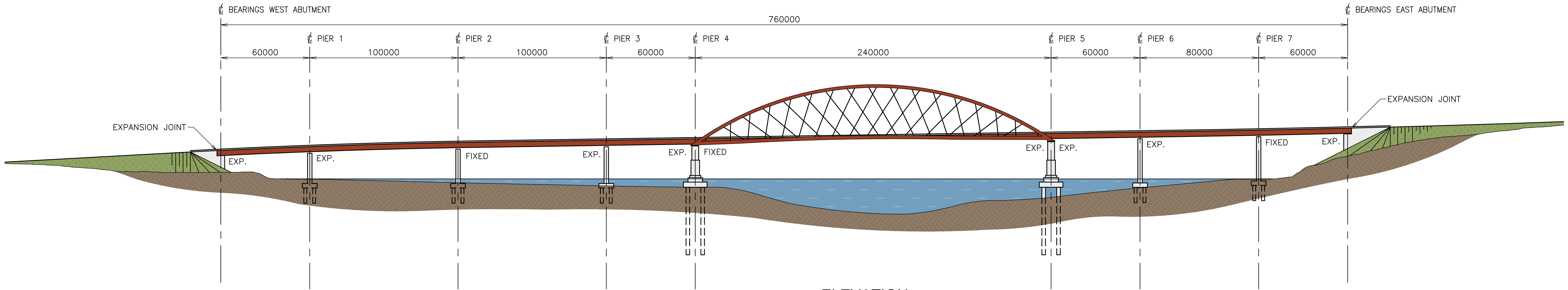
SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2B

HIGHWAY 105   VICTORIA

GENERAL ARRANGEMENT

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2C GENERAL ARRANGEMENT N/A



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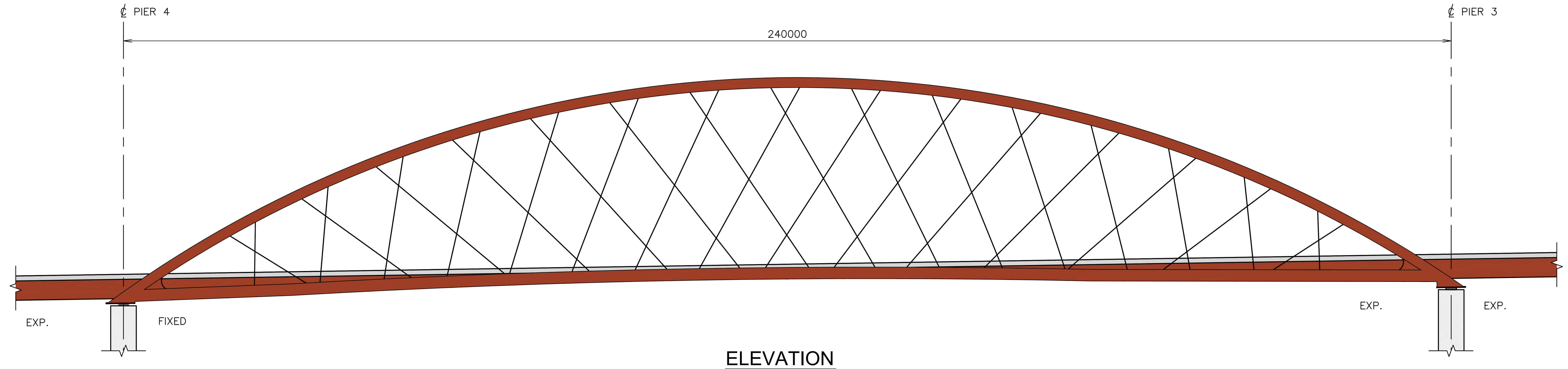

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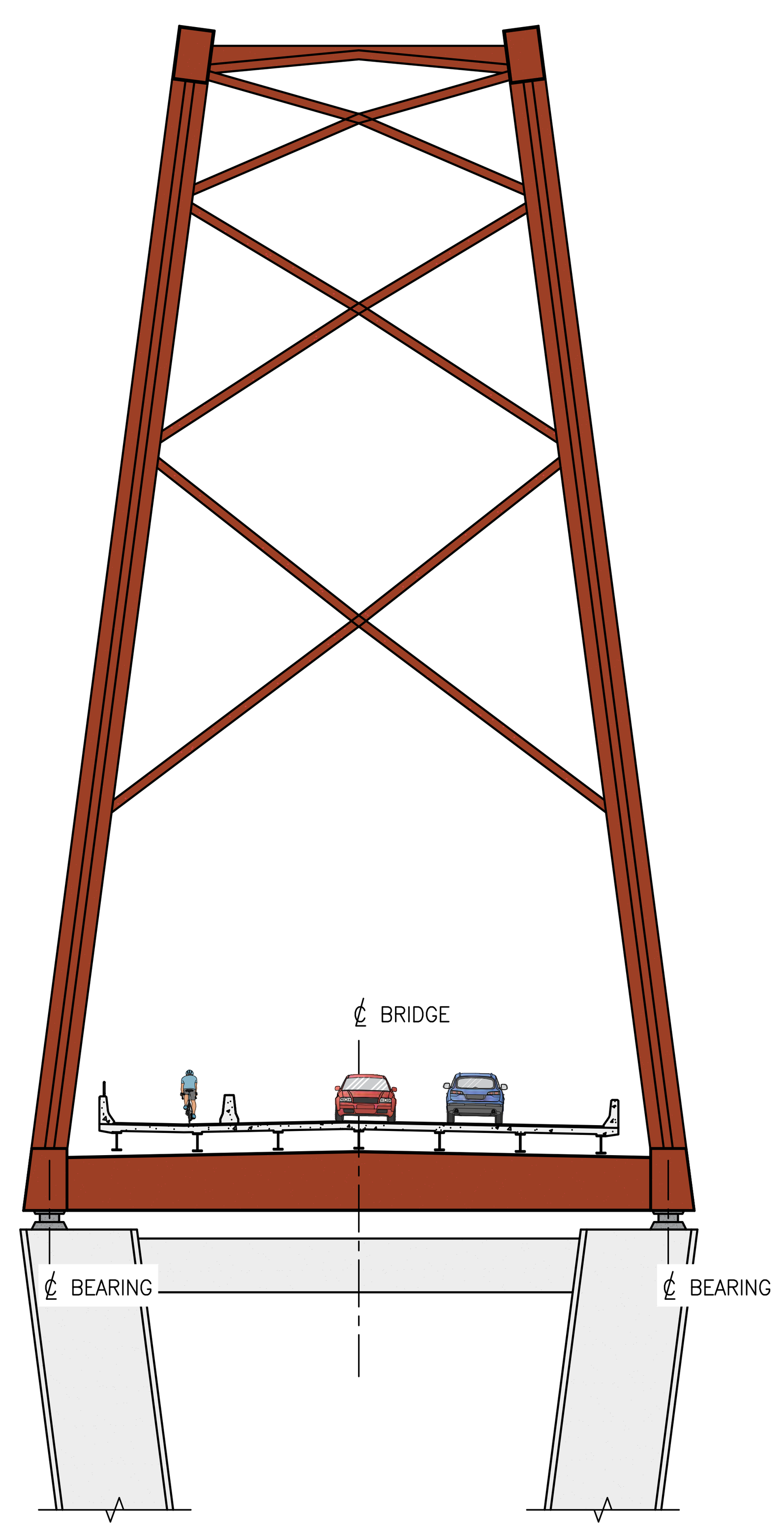

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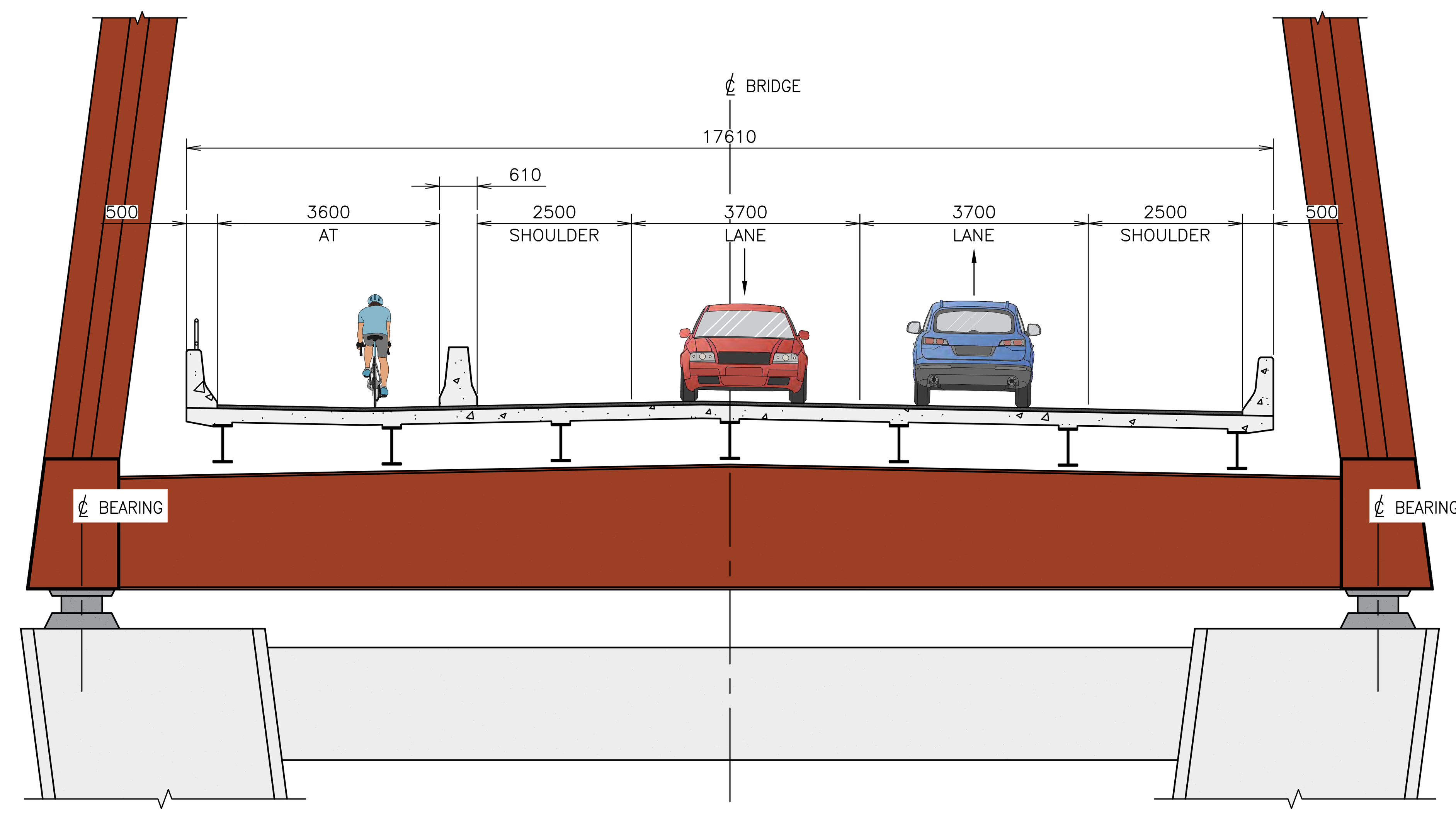

TYPICAL CROSS SECTION
1:75

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

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Drawn by:	A. MACPHERSON
Checked by:	D. BETTS
Approved by:	A. FERGUSON

Manager, Structural Engineering   Date

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Public Works

Scale:	AS SHOWN
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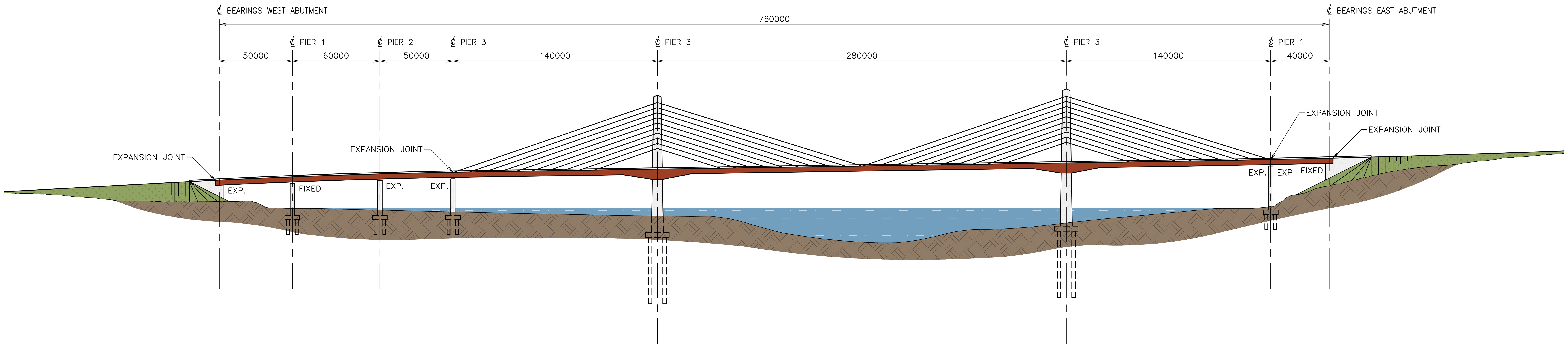
SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2C

HIGHWAY 105   VICTORIA

GENERAL ARRANGEMENT

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2D GENERAL ARRANGEMENT

N/A



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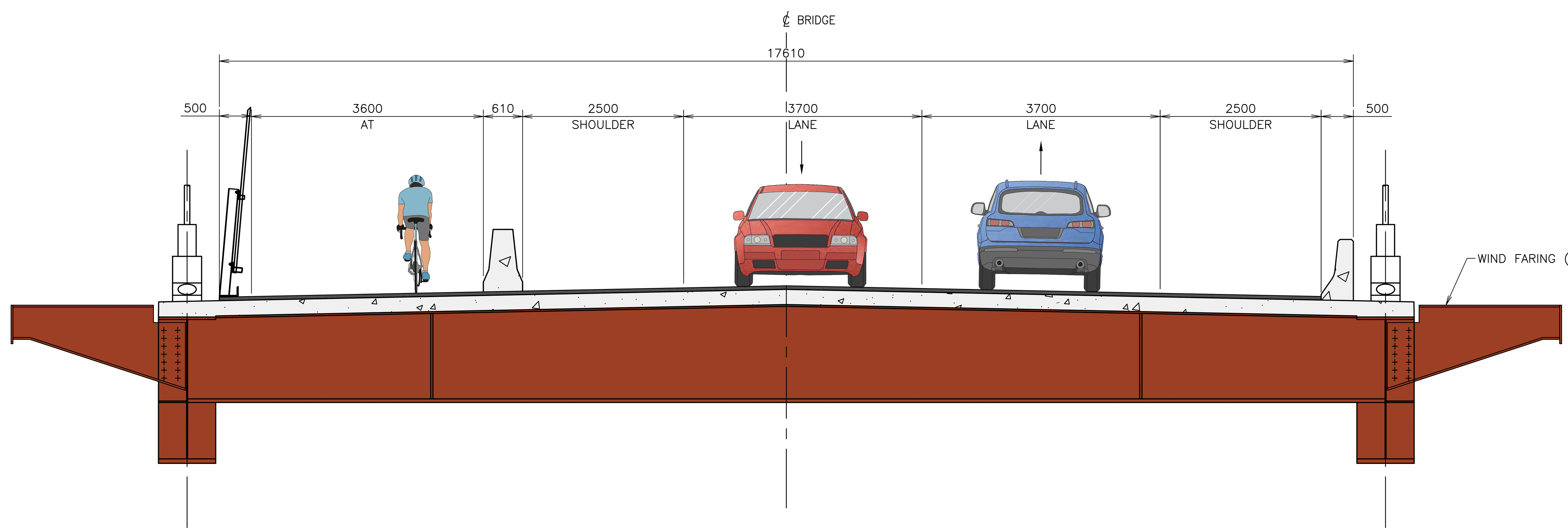

TYPICAL CROSS SECTION
1:50

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Approved by:	A. FERGUSON

Manager, Structural Engineering   Date

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Public Works

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SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 2D

HIGHWAY 105   VICTORIA

GENERAL ARRANGEMENT

OPTION 3A/3B PLAN

SCALE 1:7500

NOTE:

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-- CONCEPTUAL --

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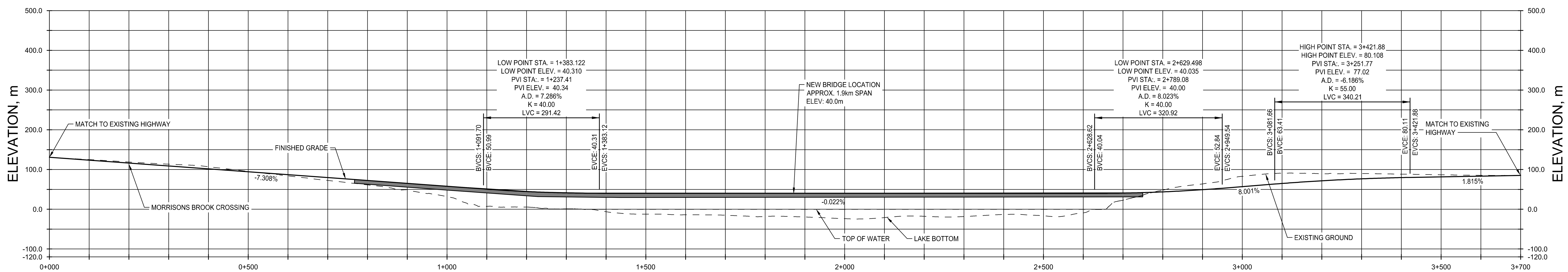
Drawn by: C. DELONG						File No. : N/A	
Checked by: S. CLARK	Manager, Structural Engineering	Date	0	23 DEC 08	ISSUED FOR 100% REPORT	Sheet No. : 6 of 9	HIGHWAY 105 VICTORIA
Approved by: P. FLOWER			MK.	DATE	REVISION		OPTION 3A/3B PLAN

NOVA SCOTIA
Public Works



OPTION 3A/3B PROFILE

SCALE H: 1:5000 V: 1:500

-- CONCEPTUAL --

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Drawn by:	C. DELONG		
Checked by:	S. CLARK		
Approved by:	P. FLOWER	Manager, Structural Engineering	Date

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SEAL ISLAND BRIDGE
BCA - REPLACEMENT
ALIGNMENT III

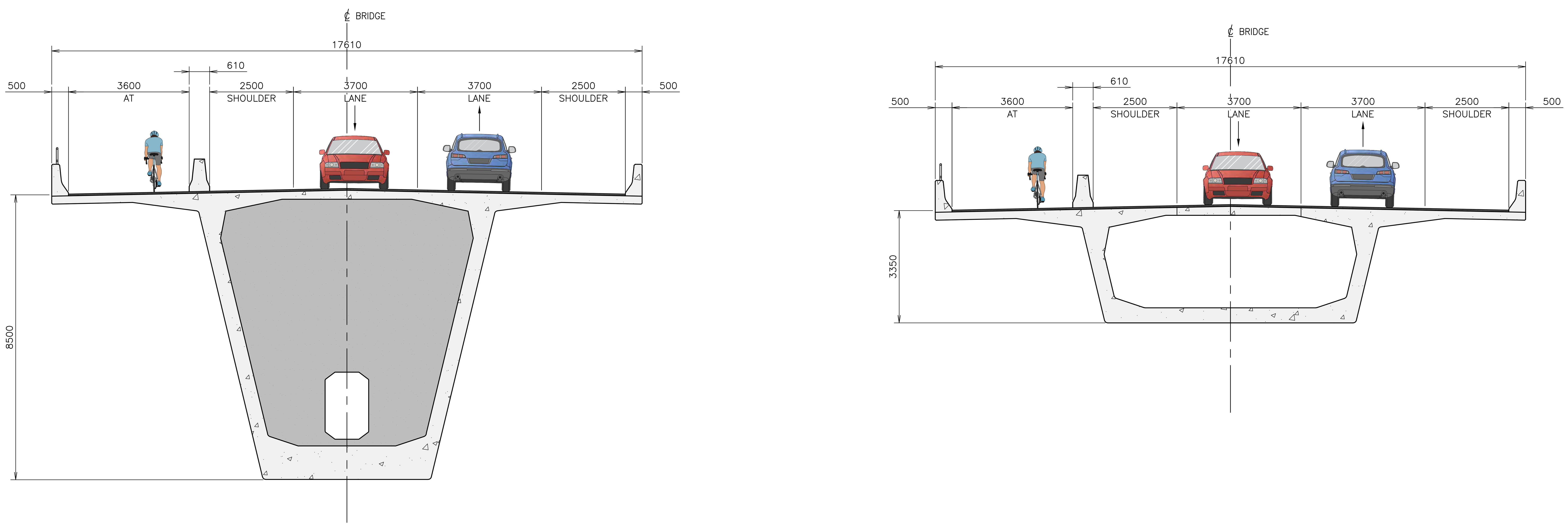
HIGHWAY 105 VICTORIA

OPTION 3A/3B
PROFILE

N/A

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 3A GENERAL ARRANGEMENT

ELEVATION
1:2500



TYPICAL CROSS SECTION
1:75

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

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Drawn by:	A. MACPHERSON
Checked by:	D. BETTS
Approved by:	A. FERGUSON

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Public Works

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SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 3A

HIGHWAY 105 — VICTORIA

GENERAL ARRANGEMENT

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 3B GENERAL ARRANGEMENT N/A

ELEVATION
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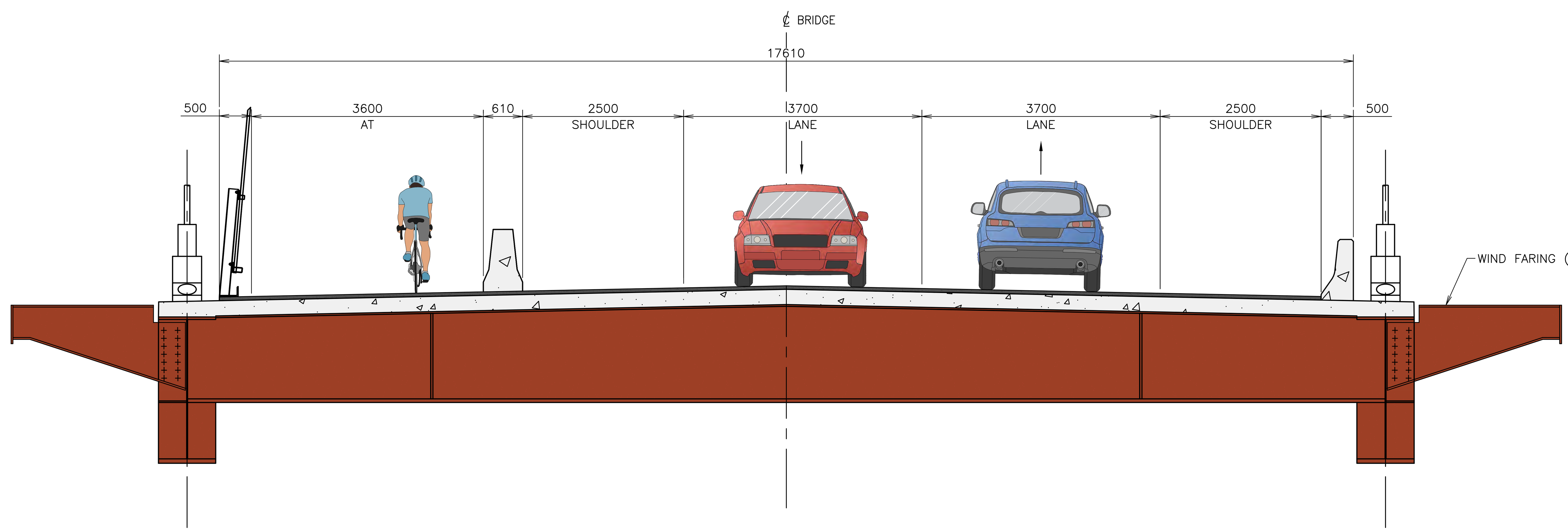

TYPICAL CROSS SECTION
1:50

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Drawn by:	A. MACPHERSON
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Approved by:	A. FERGUSON

Manager, Structural Engineering   Date

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Public Works

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SEAL ISLAND BRIDGE BCA
REPLACEMENT
OPTION 3B

HIGHWAY 105   VICTORIA

GENERAL
ARRANGEMENT

OPTION 4A/4B PLAN

SCALE 1:7500

-- CONCEPTUAL --

NOTE:

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Approved by:	P. FLOWER

Manager, Structural Engineering   Date

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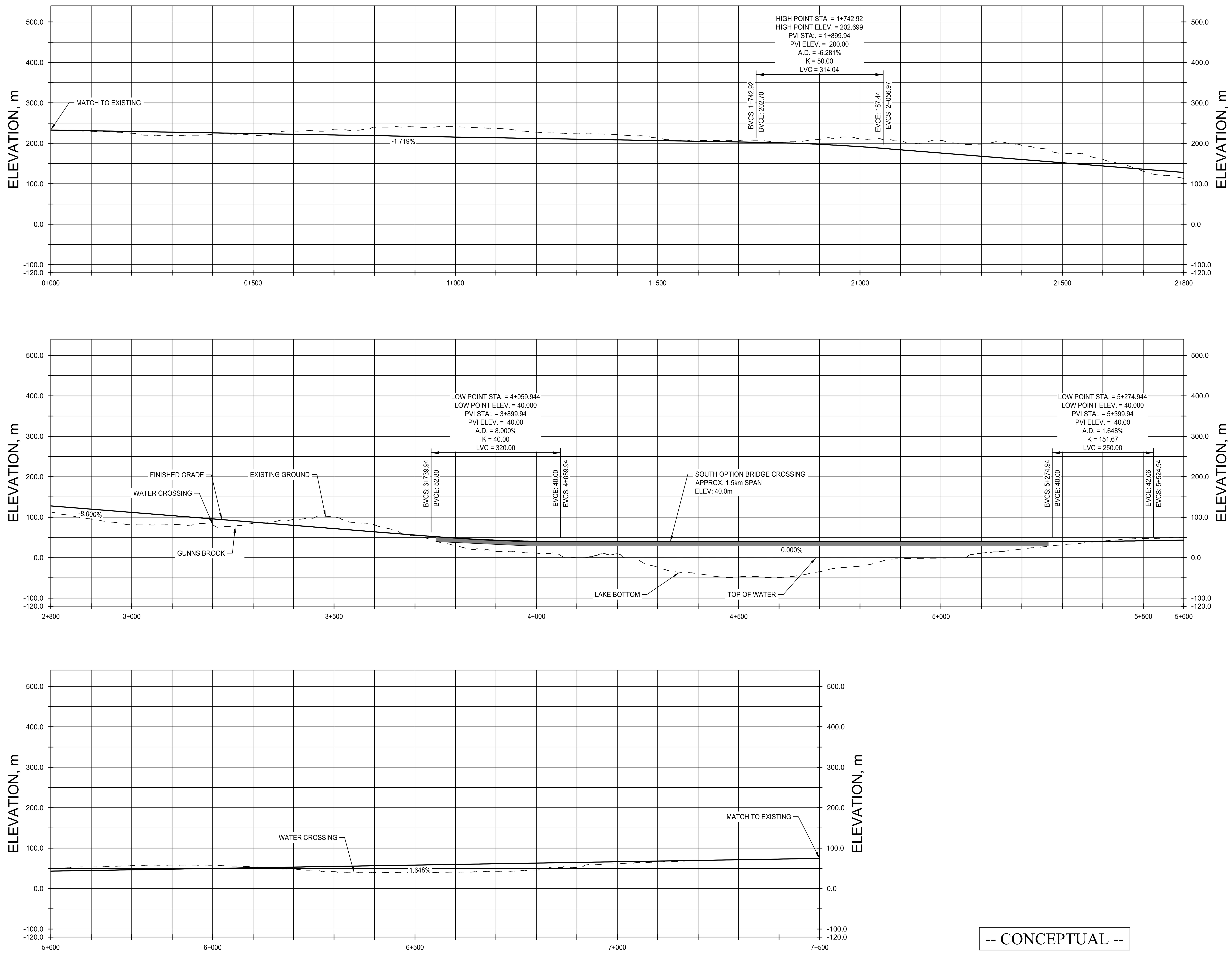
SEAL ISLAND BRIDGE
BCA - REPLACEMENT
ALIGNMENT IV

HIGHWAY 105   VICTORIA

OPTION 4A/4B
PLAN



-- CONCEPTUAL --

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NOTE:

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OPTION 4A/4B PROFILE

SCALE H: 1:5000 V: 1:500

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Surveyed by:	-
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Approved by:	P. FLOWER

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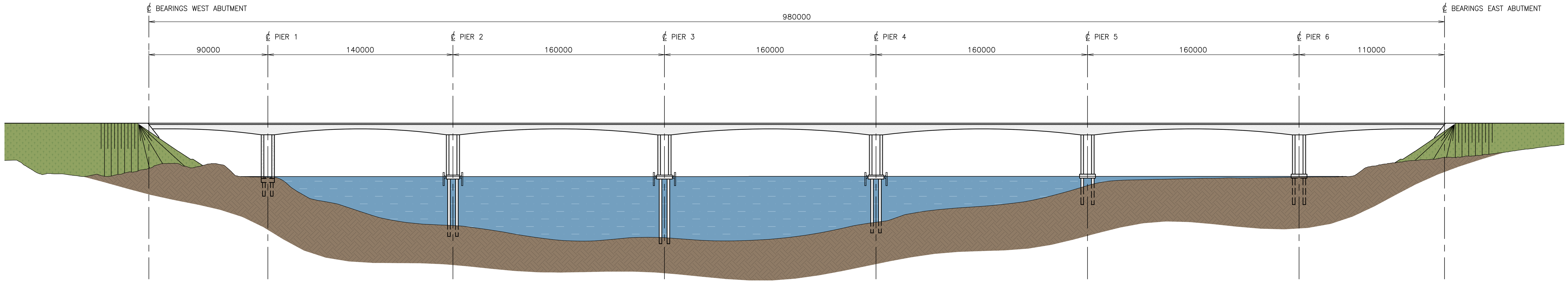
SEAL ISLAND BRIDGE
BCA - REPLACEMENT
ALIGNMENT IV

HIGHWAY 105 VICTORIA

OPTION 4A/4B
PROFILE

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 4A GENERAL ARRANGEMENT N/A



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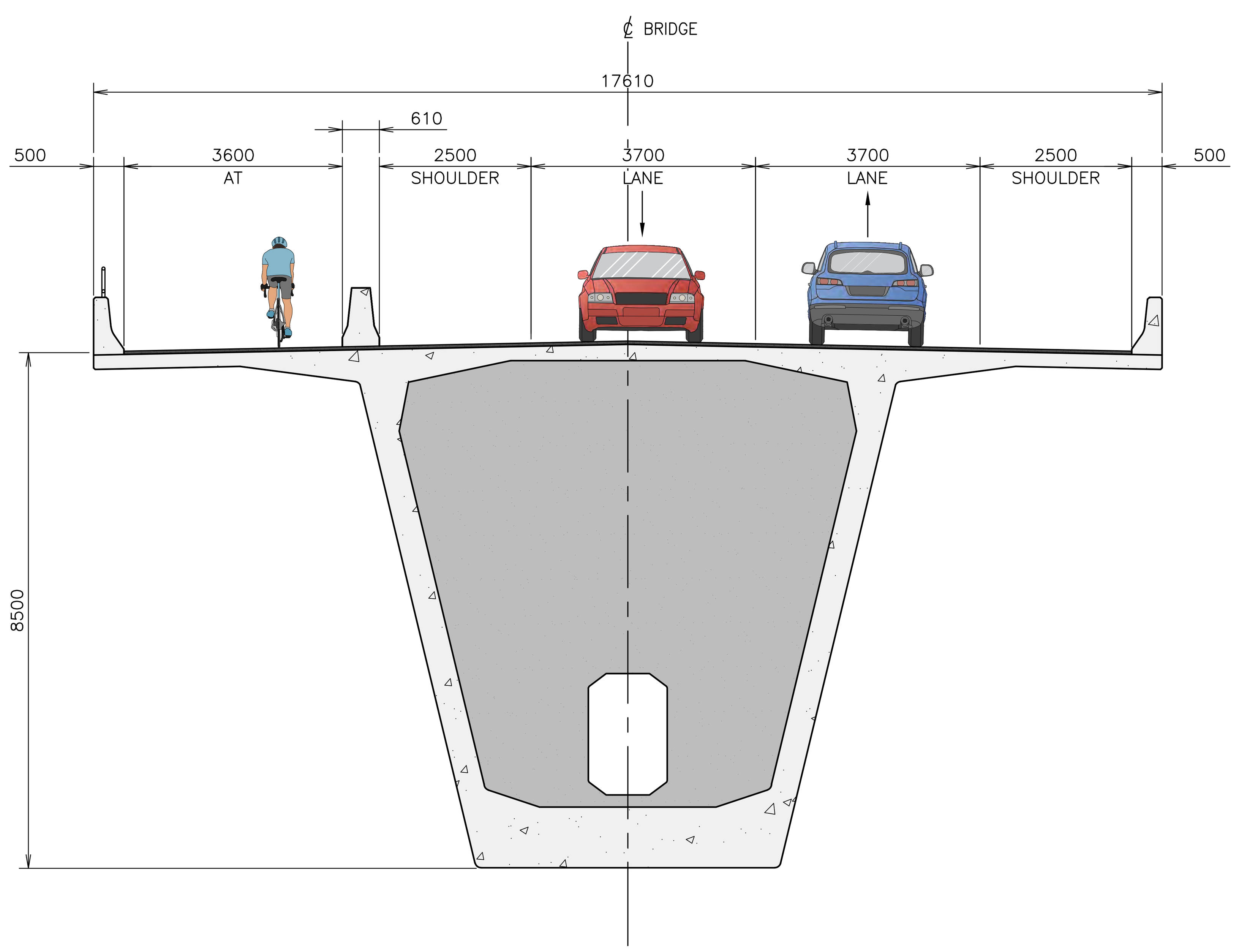

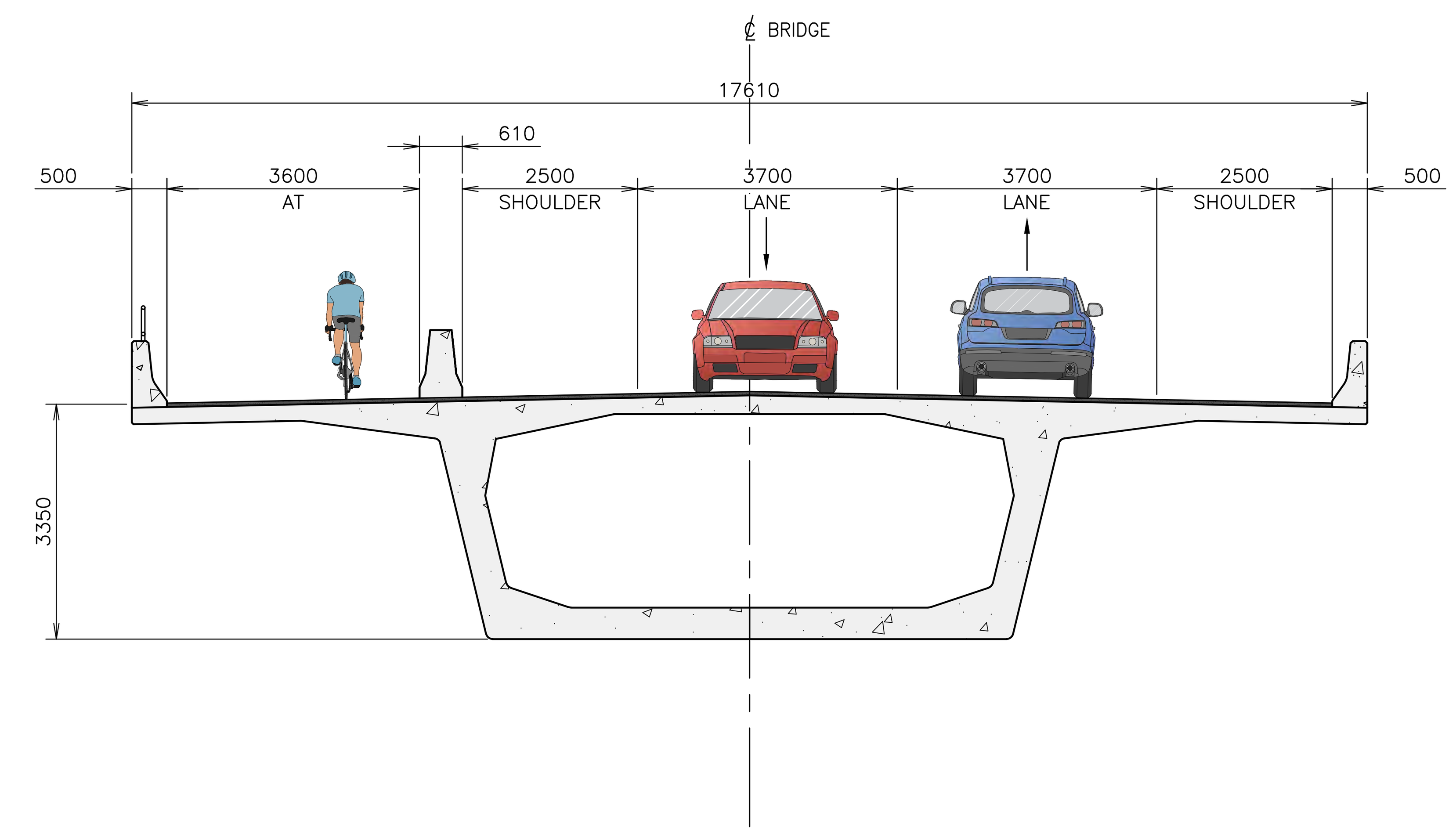

TYPICAL CROSS SECTION
1:75

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

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Surveyed by:	-		
Drawn by:	A. MACPHERSON		
Checked by:	D. BETTS		
Approved by:	A. FERGUSON		

Manager, Structural Engineering — Date

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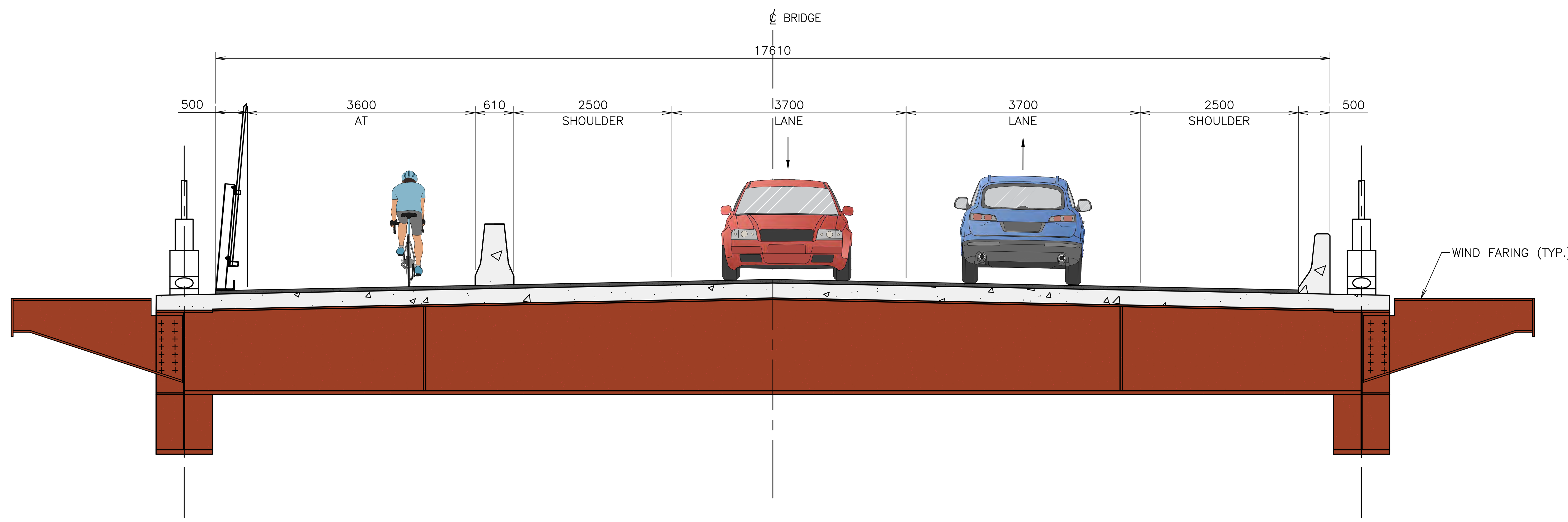
SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 4A

HIGHWAY 105 VICTORIA

GENERAL ARRANGEMENT

SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 4B GENERAL ARRANGEMENT N/A

ELEVATION
1:1500



TYPICAL CROSS SECTION
1:50

CONCEPTUAL OPTION USED FOR EVALUATION PURPOSES ONLY. ACTUAL DESIGN TO BE ESTABLISHED IN THE FUTURE AS PART OF THE SCOPING AND DESIGN PHASES OF THE REPLACEMENT CROSSING.

Designed by:	J. PEREZ ARMINO
Surveyed by:	-
Drawn by:	A. MACPHERSON
Checked by:	D. BETTS
Approved by:	A. FERGUSON

Manager, Structural Engineering   Date

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Public Works

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SEAL ISLAND BRIDGE BCA REPLACEMENT OPTION 4B

HIGHWAY 105   VICTORIA

GENERAL ARRANGEMENT

Appendix F Technical Considerations | Marine Traffic

F.1 Basis

Stantec conducted a desktop investigation of local boat and marine vessel traffic in Great Bras d'Or Lake and applicable navigational regulatory requirements related to potential project activities (i.e., potential bridge rehabilitation activities and potential activities associated with bridge decommissioning/removal and construction of a new replacement bridge). This work is intended to support an understanding of the minimum navigational clearance that may be required for a potential replacement bridge and regulatory requirements for the temporary presence of decommissioning/removal equipment and/or construction equipment operating in the waters around the bridge during project activities.

F.2 Technical Considerations – Details

Stantec contacted the groups identified in the RFP (i.e., the Canadian Coast Guard, Transport Canada's Navigation Protection Program [TC-NPP], local boating clubs, local harbour associations, and the Municipality of Victoria County), as well as local marinas, the Atlantic Pilotage Authority, and the Cape Breton Fish Harvesters Association, for information regarding local boating and marine vessel traffic in Great Bras d'Or Lake. More specifically, Stantec emailed information requests to the parties identified in Table 19.

Table 19: Parties contacted for information regarding local boat and marine vessel traffic in Great Bras d'Or Lake

Party Contacted	Contact Information	Date Contacted	Status of Response
Federal Government Agencies			
Atlantic Pilotage Authority	Julie Harvey Dispatch Manager Atlantic Pilotage Authority 1791 Barrington St, Halifax, NS dispatch@atlanticpilotage.com Tony Pierce APA Pilot tonypierce@eastlink.ca	December 14, 2022	Response received December 14, 2022.
Canadian Coast	Fallon Smith Officer in Charge, Sydney MCTS Marine Communications and Traffic Services Canadian Coast Guard Sydney, NS 902-564-7751 Safety.Sydney@innav.gc.ca	December 12, 2022	Response received December 15, 2022.
Transport Canada	Navigation Protection Program Transport Canada Atlantic Region 95 Foundry St, Moncton, NB 506-851-3113 nppatl-ppnatl@tc.gc.ca	December 12, 2022	Response received December 12, 2022.
Municipal Government			
Municipality of Victoria County	Steff MacLeod Executive & Special Projects Assistant Municipality of Victoria County 495 Chebucto Street, Baddeck, NS 902-295-3659	December 12, 2022	Response received December 13, 2022.

Party Contacted	Contact Information	Date Contacted	Status of Response
	steff.macleod@victoriacounty.ca		[*The Municipality of Victoria County advised that they have no relevant information to provide.*]
Harbour and Mooring Authorities			
Big Bras d'Or Harbour Authority	1825 B Old Route 5, Big Bras d'Or, NS 902-578-2517 warrenm1_911@hotmail.com	December 8, 2022	No response received as of March 21, 2023.
Baddeck Mooring Authority	Baddeck, NS baddeckharbour@ns.sympatico.ca	December 13, 2022	No response received as of March 21, 2023.
Boating/Yacht Clubs, Marinas, and Recreational Boating Facilities			
Baddeck Marine	Stuart Germani President / CEO Baddeck Marine 23 Water Street Baddeck, NS 902-295-2434 service@baddeckmarine.com	December 13, 2022	Response received December 15, 2022
Barra Strait Marina	415 Grand Narrows Drive, Grand Narrows, NS 902-622-1313 gnwds@hotmail.com	December 13, 2022	No response received as of March 21, 2023.
Ben Eoin Yacht Club & Marina	John Williams General Manager Ben Eoin Yacht Club 4950 NS-4, Cape Breton Regional Municipality, NS 902-828-1099 manager@beneoinmarina.com	December 8, 2022	Response received December 11, 2022.
Bras d'Or Yacht Club	1 Jones Street Baddeck, NS 902-295-2107 brasdoryacht@gmail.com	December 8, 2022	No response received as of March 21, 2023.
Ross Ferry Marine Park	685 Kempt Head Road, Ross Ferry, NS 902-674-0895 https://rossferrymarinepark.weebly.com/contact-us.html	December 13, 2022	No response received as of March 21, 2023.
Wall's Seal Island Marina	Joe Wall 902-674-2447 902-565-8890 Joe.wall1@hotmail.com	December 13, 2022	Response received March 16, 2022.
Whycocomagh Waterfront Centre and S.S. Marion Sailing Society	9650 Highway 105, Whycocomagh, NS 902-756-3580 whycocomagh.waterfront.centre@gmail.com	December 13, 2022	No response received as of March 21, 2023.
Fisheries			
Cape Breton Fish Harvesters Association	262 Commercial St, North Sydney, NS 902-794-2227 capebretonlobster@gmail.com	December 13, 2022	No response received as of March 21, 2023.

The following information regarding local boating and marine vessel traffic in the Bras d'Or Lakes system, and Great Bras d'Or Lake in particular, has been summarized based on the limited responses received to date:

- Commercial shipping vessels used to regularly transit Great Bras d'Or Lake when a former gypsum mine operated in Little Narrows. Since the gypsum mine ceased operations and entered the care and maintenance phase circa 2017, local marine traffic has been primarily limited to pleasure craft (e.g., canoes and kayaks, motorboats, sail boats, private yachts, recreational fishing vessels). Ongoing commercial marine traffic in Great Bras d'Or Lake includes commercial fishing boats that frequent Point Aconi, Alder Point, and the southern extent of Great Bras d'Or Lake; the occasional small cruise ship transiting to and from Baddeck; and the occasional bulk carrier making use of the former gypsum dock.

- Although most recreational boating activity in the Bras d'Or Lakes system typically occurs between April and November, recreational boating does occur year-round when conditions allow (i.e., if there is no ice build-up). The peak season for local marine traffic is June through October. The months when the level of local marine traffic is typically the lowest are December through March.

- Some recreational boats do not make use of local boating/yacht clubs or marinas due to their large size. These boats may anchor overnight in one of the many coves in the Bras d'Or Lakes system. The Cruising Cape Breton website (www.Cruising-Cape-Breton.info) is a well-known online resource that is often used by recreational boaters when planning a trip to the Great Bras d'Or Lakes system. It provides the following information regarding draft and mast height restrictions (Cruising Cape Breton 2019):

  - For marine traffic with a mast height (air-draft) is less than 27 m (90') and draft less than 4.1 m (13.5'), passage through the Bras d'Or Lakes does not require special considerations.

  - For marine traffic with a mast height higher than 27 m (90') or draft more than 4.1 m (13.5'), traffic must use the north entrance through the Great Bras d'Or channel to the lake and will be unable to enter St Peter's Marina.

  - For marine traffic with a mast height greater than 36 m (118') your boat will be unable to enter the lake.

  - There are three entrances to the Bras d'Or Lake system, all of which have height and draft restrictions:

    - The north entrance has a height restriction of 36 m (118') under the Seal Island Bridge and a limiting depth of 10 m (33').

    - The south entrance has a charted height restriction under the high-voltage power lines at Beaver Narrows of 27 m (90') and a limiting depth of 4.1 m (13.5') in the St Peters Canal.

- The third entrance, via Little Bras d'Or Lake, is restricted to power craft with an air-draft less than 6.4 m (21') and draft less than 3 m (10').

- Baddeck Marine noted that the current clearance at the Seal Island Bridge negatively impacts the entrance of some vessels into the Bras d'Or Lake, including but not limited to Nova Scotia Marine Ambassador, *The Bluenose II* (S. Germani, pers. comm. 2022). It is understood that the Bluenose II has passed under the Seal Island Bridge as recently as 2021 June, however, it is unclear at which conditions this occurred because the 38 m mast height exceeds the 36 m clearance under the bridge.

TC-NPP and the Municipality of Victoria advised that they do not maintain statistics on vessel types, uses, or traffic and therefore have no relevant information to provide regarding local boat and marine vessel traffic.

The Atlantic Pilotage Authority (APA) is a Crown corporation of the Government of Canada that is mandated to assist in pilotage in all Canadian waters in and around the provinces of New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland and Labrador. Within this jurisdiction, the APA has designated certain ports or waterways as compulsory pilotage areas in which vessels must have a licenced pilot or pilotage certificate holder on board while under way. One such compulsory pilotage area ("Zone B1") encompasses the portion of Great Bras d'Or Lake where the existing Seal Island Bridge is currently located; the Zone B1 compulsory pilotage area consists of all the navigable waters within a line drawn from Cape Dauphin to Point Aconi and a line drawn from Uniacke Point to Kelly Point (APA n.d.).

The APA currently has seven pilots available to provide pilotage services in Great Bras d'Or Lake; these services are provided year-round, although the level of marine traffic requiring pilotage in Great Bras d'Or Lake is typically the highest from July through October (J. Harvey, pers. comm. 2022) and the area is often inaccessible from January to April due to ice cover (T. Pierce, pers. comm. 2022). The number of marine vessels that required pilotage in Great Bras d'Or Lake in recent years ranged from two (in 2019 and 2021) to seven (in 2022) (J. Harvey, pers. comm 2022). Ships meeting certain criteria must have a pilot on board to sail within compulsory pilotage areas. The following ships are generally subject to pilotage requirements within designated compulsory pilotage areas, such as Zone B1 in Great Bras d'Or Lake:

- Canadian registered ships of more than 1,500 gross tons;

- Ships not registered in Canada;

- Oil rigs;

- Pleasure craft over 500 gross tons;

- Any combination of tug and tow, if more than one unit is being towed; and

- Ferries that are entering or leaving a port that is not one of their regularly scheduled terminals;

- When the gypsum mine in Little Narrows was operational (i.e., prior to 2017), most of the vessels piloted by the APA were approximately 225 m long and 32 m wide with a loaded draft of 9.75 m and an air draft of 35 m. Now that the gypsum mine has closed, the types of vessels requiring pilotage in Great Bras d'Or Lake primarily consist of small cruise ships (e.g., the *National Geographic Explorer* and *Le Bellot*) and private yachts that are approximately 130 m long and 18 m wide with a 4.5 m draft and an air draft of 31 m. However, a tug and barge also required pilotage for multiple trips to Iona, Cape Breton in 2022 (T. Pierce, pers. comm. 2022).

Certain vessels are not subject to compulsory pilotage, including:

- Canadian government ships;
- Canadian registered ships that are employed in catching and processing fish or other living resources of the sea; and
- Canadian registered offshore supply vessels of 5,000 gross tons or less that have an operations base in a port located within one of the areas.

Section 4 of the *Atlantic Pilotage Authority Regulations* provides a complete list of the types of vessels that are exempted from compulsory pilotage requirements.

Potential project activities are subject to regulatory and potential permitting requirements under the *Canadian Navigable Waters Act* (CNWA) and its regulations, including the *Navigable Waters Bridges Regulations* and the *Navigable Waters Works Regulations*. Neither the CNWA nor its regulations specify navigational clearance requirements for bridges.

If the existing bridge is rehabilitated rather than decommissioned/removed and replaced with a new bridge, it is assumed that there would no change to the existing structure in terms of the current navigational clearance under the existing bridge. If a replacement bridge is constructed, it is assumed that the new bridge would be designed, at a minimum, to meet the existing navigational clearances and that those clearances would be in accordance with applicable regulatory requirements. Regardless of whether the bridge is rehabilitated or decommissioned/removed and replaced, it is anticipated that applicable navigational clearance requirements for project infrastructure will be determined in consultation with TC-NPP in the context of the CNWA permitting process for the project. Refer to Appendix I for information regarding key potential environmental permitting requirements under the CNWA, including potential project-related permitting triggers for Notification and/or Approval under the CNWA, and an overview of the associated regulatory processes.

Pending the receipt of official guidance from TC-NPP through the CNWA permitting process, it may be possible to refer to the *Minor Works Order* to surmise an estimate of the potential navigational clearance that could be required for a potential replacement bridge. The *Minor Works Order*, annexed pursuant to section 28(2) of the CNWA, designates certain works as "minor works" because the Minister of Transport is of the opinion that they are likely to <u>slightly</u> interfere with navigation (i.e., unlikely to <u>substantially</u> interfere with navigation). A designated minor work therefore does not require regulatory approval under the CNWA, as long as it meets specified criteria for the applicable class of works and is carried out in compliance with specific terms and conditions. Watercourse crossings are designated as minor works under certain circumstances (e.g., in cases where the watercourse crossing is situated over or across a navigable water and the width of the navigable water is 30 m or less), provided that they meet certain requirements. As per section 34(a) of the *Minor Works Order*, one such requirement is that "*the watercourse crossing [must be] designed to ensure that the clearance available below the watercourse crossing is at least 1 m more than the height of the tallest vessel that may navigate on the navigable water at the site where the watercourse crossing is situated*".

The *Minor Works Order* may also shed some light on potentially applicable regulatory requirements with respect to the temporary presence of decommissioning/removal equipment and/or construction equipment operating in the waters around the bridge during project activities. Temporary works are designated as minor works under section 9 the *Minor Works Order* if they meet the following criteria:

> ***(a)*** *the work is installed exclusively for the construction, placement, alteration, rebuilding, removal, decommissioning, repair or maintenance of another minor work;*
>
> ***(b)*** *the work is not situated in, on, over, under, through or across a navigation channel or, if there is no navigation channel, a navigation route; and*
>
> ***(c)*** *the work does not occupy more than one-third of the width of the navigable water.*

Sections 10 and 11 of the *Minor Works Order* specify the following additional requirements related to temporary works:

> ***10.*** *The owner of a work that is designated as a minor work under section 9 must ensure that it is removed on completion of the construction, placement, alteration, rebuilding, removal, decommissioning, repair or maintenance of the minor work for which it was installed.*
>
> ***11.*** *If the construction, placement, alteration, rebuilding, removal, decommissioning, repair or maintenance of a work that is designated, or intended to be designated, as a minor work under section 9 disturbs the bed contours of a navigable water to the point of interfering or likely to interfere with navigation, the owner of the work must ensure, on completion of the removal of the work, that the bed contours of the navigable water do not and are not likely to interfere with navigation.*

Although the Seal Island Bridge project does <u>not</u> meet the criteria for a minor work (since the structure of the existing bridge is consistent with a designated "major work")[1], the navigational

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[1] The *Major Works Order* under the CNWA designates "major works" that are likely to <u>substantially</u> interfere with navigation in any navigable waters and therefore require regulatory approval under the CNWA (refer to Item #3 in Table I.1 of Appendix I, including fixed-span bridges with one or more piers below the ordinary high-water mark. As a fixed-span bridge with more than one pier below the ordinary high-water mark, the structure of the existing Seal Island Bridge is consistent with a designated major work.

clearance requirement stipulated in section 34(a) of the *Minor Works Order* for watercourse crossings may nonetheless provide a preliminary indication of the minimum navigational clearance that TC-NPP might require in relation to a potential replacement bridge. Any temporary works that may be installed for the construction, placement, alteration, rebuilding, removal, decommissioning, repair, or maintenance of the existing bridge would similarly not constitute a minor work due to the reason described above. However, sections 9–11 of the *Minor Works Order* may nonetheless provide a preliminary indication of potential requirements that TC-NPP could impose in relation to the temporary presence of project equipment operating in the waters around the bridge. It is recommended that NSDPW consult with TC-NPP to confirm these assumptions as project planning progresses.

Sections 4, 5, and 6 of the *Navigable Waters Works Regulations* specify the following regulatory requirements of general relevance to works in navigable waters such as Great Bras d'Or Lake:

> ***4.*** *No person shall build or place a work in a navigable water unless all lights, buoys and other marks required in the approval are installed and maintained to the satisfaction of the Minister.*
>
> ***5.*** *No person shall permit any tools, equipment, vehicles, temporary structures or parts thereof used or maintained for the purpose of building or placing a work in a navigable water to remain in such water after the completion of the project.*
>
> ***6.*** *Where a work or a portion of a work that is being constructed or maintained in a navigable water causes debris or other material to accumulate on the bed or on the surface of such water, the owner of that work or portion of that work shall cause the debris or other material to be removed to the satisfaction of the Minister.*

F.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

F.4 Key Takeaways

There are three entrances to the Bras d'Or Lake system, all of which have height and draft restrictions. There is an APA compulsory pilotage area ("Zone B1") that encompasses the portion of Great Bras d'Or Lake where the existing Seal Island Bridge is currently located.

Commercial shipping vessels used to regularly transit Great Bras d'Or Lake when a former gypsum mine operated in Little Narrows. Since the gypsum mine ceased operations and entered the care and maintenance phase circa 2017, local marine traffic has been primarily limited to pleasure craft (e.g., canoes and kayaks, motorboats, sail boats, private yachts, and recreational fishing vessels). Ongoing commercial marine traffic in Great Bras d'Or Lake includes commercial fishing boats that frequent Point Aconi, Alder Point, and the southern extent of Great Bras d'Or Lake; the occasional small cruise ship transiting to and from Baddeck; and the occasional bulk carrier making use of the former gypsum dock. The peak season for local marine traffic is June through October. The months when the level of local marine traffic is typically the lowest are December through March.

Potential project activities are subject to regulatory and potential permitting requirements under the CNWA and its regulations, including the *Navigable Waters Bridges Regulations* and the *Navigable Waters Works Regulations*. Neither the CNWA nor its regulations specify navigational clearance requirements for bridges. If the existing bridge is rehabilitated rather than decommissioned/removed and replaced with a new bridge, it is assumed that there would no change to the existing structure in terms of the current navigational clearance under the existing bridge. If a replacement bridge is constructed, it is assumed that the new bridge would be designed, at a minimum, to meet the existing navigational clearances and that those clearances would be in accordance with applicable regulatory requirements. Regardless of whether the bridge is rehabilitated or decommissioned/removed and replaced, it is anticipated that applicable navigational clearance requirements for project infrastructure will be determined in consultation with TC-NPP in the context of the CNWA permitting process for the project. Refer to Appendix I for information regarding key potential environmental permitting requirements under the CNWA, including potential project-related permitting triggers for Notification and/or Approval under the CNWA, and an overview of the associated regulatory processes.

Technical Considerations Review - Marine Traffic

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (A Fox)
Reviewed by: Stantec (P Flower)

Stantec COWI

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
BRIDGE AND ALIGNMENT DESCRIPTIONS	Details										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1 Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2 Active transportation lanes											
2.3 Clearance of navigational channel											
2.4 Use of existing highway infrastructure											
2.5 NSPW owns required land											
2.6 Service life beyond 50 years											
2.7 Utility/service accommodations											
Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1 Impact to trade corridors during construction	LOW | No change to navigable clearance, therefore no change to current marine traffic.	LOW | No change to navigable clearance, therefore no change to current marine traffic.	LOW | No change to navigable clearance, therefore no change to current marine traffic.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.	MODERATE | Potential impact to marine traffic during construction of new bridge.
3.2 Impact to trade corridors in-service	LOW | No change to navigable clearance, therefore no change to current marine traffic.	LOW | No change to navigable clearance, therefore no change to current marine traffic.	LOW | No change to navigable clearance, therefore no change to current marine traffic.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.	LOW | New navigational clearance to be unchanged or better.
3.3 Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4 Climate Change	MODERATE | Potential sea level rise could reduce navigational clearance of existing structure.	MODERATE | Potential sea level rise could reduce navigational clearance of existing structure.	MODERATE | Potential sea level rise could reduce navigational clearance of existing structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.	LOW | Potential sea level rise could be accounted for in new structure.
3.5 Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6 Approvals, permitting and consultation	LOW | No change to navigable clearance, therefore no change to potentially associated navigational regulatory requirements. There may be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	LOW | No change to navigable clearance, therefore no change to potentially associated navigational regulatory requirements. There may be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	LOW | No change to navigable clearance, therefore no change to potentially associated navigational regulatory requirements. There may be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.	MODERATE | New structure may be subject to regulatory requirements pertaining to navigable clearance. There may also be regulatory requirements related to the presence/operation of project vessels and equipment and/or temporary works during project activities.
3.7 Operational issues during service life	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.8 Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Technical Considerations Review - Marine Traffic

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (A Fox)
Reviewed by: Stantec (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
4.1 Public safety	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.2 Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3 Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.4 Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.5 Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1 Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2 Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3 Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4 Stakeholder impact	BETTER | Limited change to existing structure envelope thus limiting marine traffic stakeholder involvement	BETTER | Limited change to existing structure envelope thus limiting marine traffic stakeholder involvement	BETTER | Limited change to existing structure envelope thus limiting marine traffic stakeholder involvement	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders	WORSE | New structure will require consultation and involvement from marine traffic stakeholders
5.5 Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Technical Considerations Review - Community and Stakeholder

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (C Blair)
Reviewed by: Stantec (P Flower)

	Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span		Long Span		Medium Span	Long Span	Medium Span	Long Span
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
5.4	Stakeholder impact	NEUTRAL | Baseline case; assigned "Neutral" rating	NEUTRAL | Effectively similar to Option 1A	WORSE | Existing crossing location with improved alignment will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with improved alignment as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with improved alignment as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with improved alignment as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with improved alignment as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with a new alignment, as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with a new alignment, as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with a new alignment, as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"	WORSE | New crossing location with a new alignment, as well as the decommissioning of the exiting alignment, will impact both new and existing stakeholders; assumed to be "Worse"
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix G Technical Considerations | Community and Stakeholder Impact

G.1 Basis (Archaeological and Heritage Resources)

Archaeological and Heritage Resources include structures, sites, or things of historical, archaeological, paleontological, or architectural significance. The development of a new location or expansion of an existing location that will result in the disturbance of new areas with a potential to contain heritage resources. Investigations for these resources and possible mitigation is required prior to the construction activities.

G.2 Technical Considerations - Details (Archaeological and Heritage Resources)

The Province of Nova Scotia does not provide predictive model information for potential archaeological resources. It is widely held, however, that areas along existing and former watercourse and coastal shorelines, where topographical conditions (e.g., slope, dryness, elevation) are amenable to human use and habitation, are generally viewed as having elevated potential for Pre-Contact as well as Historic Period archaeological resources. However, many other areas away from shoreline may also have elevated potential for Pre-Contact archaeological resources such as hunting and gather locations, and resource extraction locations, to name a few. During the Historic Period, there was a much broader use of the land in a manner that would generally leave more physical evidence of that use, given the degree of the land use, as well as the more recent timeframe, meaning less time for the physical evidence to decay.

Ground disturbing construction activities bring with them the potential to encounter subsurface archaeological resources. To address this, a comprehensive heritage resources impact assessment must be completed for any of the bridge options where ground-breaking will be required, including temporary locations such as materials lay-down areas. This assessment must be conducted by a professional under permit from the Province of Nova Scotia.

A review of the Maritime Archaeological Resource Inventory found there are no registered archaeological sites within or near the footprints of any of the proposed options for the new bridges, nor along any of the approaches or new access roads. However, it must be noted that these areas have not been previously subject to a comprehensive archaeological assessment, so the lack of any known sites should not be taken as an indicator that no archaeological resources are present.

A review of historical aerial photographs indicates the potential for historic period home and farm steads to be present along many of the proposed new approach roads for the new bridge options north and south of the current bridge locations, as well as the realigned approach road to the existing bridge.

G.3 Technical Considerations - Evaluation (Archaeological and Heritage Resources)

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

G.4 Key Takeaways (Archaeological and Heritage Resources)

Several areas identified for Project options have elevated potential for archaeological resources, both from the Pre-Contact and Historic Periods. No comprehensive archaeological assessment of these locations has previously been completed. A comprehensive archaeological assessment of any areas identified for construction activities, permanent or temporary, is recommended. This archaeological assessment should be undertaken to allow sufficient time prior to construction to implement any resulting mitigation for identified archaeological resources up to and including a redesign if the significance of any heritage resources be such that removing them is not an approved mitigation.

G.5 Basis (Community and Stakeholder)

Communities and stakeholder groups may be impacted by potential project activities (i.e., potential rehabilitation of the existing bridge, potential removal of the existing bridge, or potential development of a new bridge). Potential impacts to the community and stakeholder groups identified in the RFP are as follows:

- Aboriginal Groups;
- Fishing;
- Trucking;
- Local residents;
- Tourism;
- Local businesses (including nearby campground)
- Boating clubs; and
- Harbour associations.

No engagement with these groups has been undertaken in support of this task; the information herein is based on publicly available information and the knowledge and experience of the Project Team.

G.6 Technical Considerations - Details (Community and Stakeholder)

The potentially impacted communities and stakeholder groups with respect to the bridge rehabilitation, removal of existing bridge, and development of a new bridge are described in Table 20.

Table 20: Potentially impacted communities and stakeholder groups and potential issues of concern

Potentially Impacted Communities and Stakeholder Groups	**Nature of Potential Interest in the Project**	**Potential Issues of Concern Associated with Project Options Under Consideration**		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
Local Residents of Surrounding Communities	It is assumed that local residents of surrounding communities include regular bridge users and others who may be exposed to project-related disturbances.	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Land expropriation (e.g., if highway construction is required for alignment improvements) • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Change to visual landscape following construction • Land expropriation (e.g., if new highway construction is required) • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts
Mi'kmaw Communities in Cape Breton (i.e., Eskasoni First Nation, Membertou First Nation, Potlotek First Nation,	Mi'kmaw communities may include regular bridge users and others who may be exposed to	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other

Potentially Impacted Communities and Stakeholder Groups	**Nature of Potential Interest in the Project**	**Potential Issues of Concern Associated with Project Options Under Consideration**		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
Wagmatcook First Nation, and We'koqma'q First Nation)	project-related disturbances. The project area may include resources of archaeological, heritage, or cultural importance to Mi'kmaw peoples. Mi'kmaw peoples may use the project area for traditional land and resource use purposes. The project could affect potential or established Aboriginal or Treaty rights.	sensory disturbance (e.g., noise, vibration, dust) during project activities • Land expropriation (e.g., if highway construction is required for alignment improvements) • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; and impacts on potential or established Aboriginal or Treaty rights	sensory disturbance (e.g., noise, vibration, dust) during project activities • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; and impacts on potential or established Aboriginal or Treaty rights	sensory disturbance (e.g., noise, vibration, dust) during project activities • Change to visual landscape following construction • Potential land expropriation (e.g., if new highway construction is required) • Economic implications of project (e.g., use of public tax dollars to fund project; potential effects on tourism industry) • Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; and impacts on potential or established Aboriginal or Treaty rights
Unama'ki Institute of Natural Resources (UINR)	UINR represents the five Mi'kmaq communities in Cape Breton (i.e., Eskasoni First Nation, Membertou First Nation, Potlotek First Nation, Wagmatcook First Nation, and We'koqma'q First	• Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; impacts on	• Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; impacts on	• Environmental impacts, including impacts on archaeological, heritage, or cultural resources; impacts on traditional land and resource use; impacts on

Potentially Impacted Communities and Stakeholder Groups	**Nature of Potential Interest in the Project**	**Potential Issues of Concern Associated with Project Options Under Consideration**		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
	Nation) on natural resource issues. UINR is responsible for aquatic research and stewardship, species management, traditional Mi'kmaq knowledge, conserved and protected areas, water quality monitoring and environmental partnerships (UINR 2020).	potential or established Aboriginal or Treaty rights; water quality impacts; and impacts on fisheries resources	potential or established Aboriginal or Treaty rights; water quality impacts; and impacts on fisheries resources	potential or established Aboriginal or Treaty rights; water quality impacts; and impacts on fisheries resources
Commercial Fishers and Mi'kmaw Fisheries	It is assumed that Great Bras d'Or Lake encompasses commercial fishing grounds as well as fishing areas that may be used by Mi'kmaw Communal Commercial Fisheries and/or Food, Social, and Ceremonial (FSC) Fisheries licence-holders.	• Disruption to fishing activities and/or space-use conflicts due to the presence and operation of project equipment • Risk of damage/loss or entanglement of fishing gear due to interactions with project equipment • Risk of vessel collisions with project equipment • Environmental impacts that could adversely affect fisheries resources and/or the success of fishing efforts (e.g., by causing a decline in target fish species)	• Disruption to fishing activities and/or space-use conflicts due to the presence and operation of project equipment • Risk of damage/loss or entanglement of fishing gear due to interactions with project equipment • Risk of vessel collisions with project equipment • Environmental impacts that could adversely affect fisheries resources and/or the success of fishing efforts (e.g., by causing a decline in target fish species)	• Disruption to fishing activities and/or space-use conflicts due to the presence and operation of project equipment • Risk of damage/loss or entanglement of fishing gear due to interactions with project equipment • Risk of vessel collisions with project equipment • Environmental impacts that could adversely affect fisheries resources and/or the success of fishing efforts (e.g., by causing a decline in target fish species)
Cape Breton Commercial Fish Harvesters Association (CBFHA)	CBFHA members represent many fisheries, including Lobster, Halibut, Crab, Mackerel, Herring, Sword Fish, Squid, eel, Sea Urchin, Clam, Mussels, Oyster, Smelt, Scallop, Tuna and Cod (CBFHA n.d.)			
Recreational Fishers	It is assumed that Great Bras d'Or Lake encompasses recreational fishing grounds.			

Potentially Impacted Communities and Stakeholder Groups	**Nature of Potential Interest in the Project**	**Potential Issues of Concern Associated with Project Options Under Consideration**		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
Local Tourism Operators and Nearby Businesses, including the North Sydney/ Cabot Trail KOA Campground and the Travels Inn Victoria County Hotel	The Bras d'Or Lakes system is a popular destination for tourists. It is assumed that local tourism operators, nearby businesses, and their employees include regular bridge users and others who may be exposed to project-related disturbances. Business customers and tourists/visitors to the area may also include bridges users and others who may be exposed to project-related disturbances.	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Land expropriation (e.g., if highway construction is required for alignment improvements) • Impacts to tourism industry • Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project) • Environmental impacts	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Impacts to tourism industry • Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project) • Environmental impacts	• Public safety • Traffic delays and/or detours during project activities • Visual impacts and other sensory disturbance (e.g., noise, vibration, dust) during project activities • Change to visual landscape following construction • Land expropriation (e.g., if new highway construction is required) • Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project) • Environmental impacts
Commercial Truck Drivers	Commercial truck drivers are regular users of Highway 105 and the existing Seal Island Bridge.	• Public safety • Traffic delays and/or detours during project activities	• Public safety • Traffic delays and/or detours during project activities	• Public safety • Traffic delays and/or detours during project activities
Boating/Yacht Clubs, Marinas, Recreational Boating Facilities	It is assumed that boat/yacht club members, customers, and other facility users include boat operators that frequent the navigable waters of Great Bras d'Or Lake.	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with

Potentially Impacted Communities and Stakeholder Groups	**Nature of Potential Interest in the Project**	**Potential Issues of Concern Associated with Project Options Under Consideration**		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
		project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances) • Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project)	project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances) Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project)	project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances) Loss of customers, loss of revenue, and other economic implications of project (e.g., use of public tax dollars to fund project)
Recreational Boaters	The Bras d'Or Lakes System is a popular destination for recreational boaters.	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances)	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances)	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine navigation (e.g., navigational routes and navigational clearances)
Harbour Authorities, Mooring Authorities, and Atlantic Pilotage Authority	These parties serve various marine users and have an interest in navigational safety within Great Bras d'Or Lake.	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine	• Disruption to marine traffic and/or space-use conflicts due to the presence and operation of project equipment • Risk of boat/vessel collisions with project equipment • Impacts on marine

Potentially Impacted Communities and Stakeholder Groups	Nature of Potential Interest in the Project	Potential Issues of Concern Associated with Project Options Under Consideration		
		Bridge Rehabilitation	***Removal of Existing Bridge***	***Development of New Bridge***
		navigation (e.g., navigational routes and navigational clearances)	navigation (e.g., navigational routes and navigational clearances)	navigation (e.g., navigational routes and navigational clearances)

G.7 Technical Considerations - (Community and Stakeholder)

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

G.8 Key Takeaways (Community and Stakeholder)

Public and stakeholder consultation and indigenous engagement are essential for the identification, scoping, and resolution or mitigation of potential issues and concerns, as well as for the exchange of information with respect to the project. The purpose of consultation and engagement is to provide information about proposed project activities and to identify any issues of concern raised by regulatory agencies, potentially affected stakeholders, the general public, and the Mi'kmaq of Nova Scotia during project planning and design and continuing throughout all phases of the project.

It is recommended that NSDPW involve the public, key stakeholders, and the Mi'kmaq of Nova Scotia early in the planning process to inform them about the project. Doing so would provide the engaged parties with the opportunity to make their concerns known to NSDPW in a timely manner so that they can be addressed through planning decisions. It will be important for NSDPW to document its consultation and engagement efforts, including what issues were raised and how they were addressed, as this information can support the environmental permitting process, including potential provincial environmental assessment (EA) requirements (if applicable, refer to Appendix I). When making an EA decision under the Nova Scotia *Environment Act*, the provincial Minister considers any concerns expressed by the public, stakeholders, and the Mi'kmaq of Nova Scotia about the adverse effects or the environmental effects of the proposed undertaking, as well as any actions taken by the proponent to address those concerns.

Technical Considerations Review - Community and Stakeholder

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (C Blair)
Reviewed by: Stantec (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1 Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2 Active transportation lanes											
2.3 Clearance of navigational channel											
2.4 Use of existing highway infrastructure											
2.5 NSPW owns required land											
2.6 Service life beyond 50 years											
2.7 Utility/service accommodations											
Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1 Impact to trade corridors during construction	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.2 Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3 Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4 Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5 Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6 Approvals, permitting and consultation	LOW - Minimal new land and permitting requirements anticipated.	LOW - Minimal new land and permitting requirements anticipated.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.
3.7 Operational issues during service life	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Technical Considerations Review - Community and Stakeholder

Stantec COWI

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (C Blair)
Reviewed by: Stantec (P Flower)

		Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	Categories	25 yrs	50 yrs	50 yrs w/ Alignment Improvement		Medium Span		Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
3.8	Land acquisition	LOW - Minimal new land and permitting requirements anticipated.	LOW - Minimal new land and permitting requirements anticipated.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.	MODERATE - New land requirements may negatively impact landowners, require additional permitting, and contain unknown constraints (e.g., heritage resources). Potential new requirement to develop Crown land may result in additional concern from Indigenous communities.
	Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
4.1	Public safety	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.2	Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3	Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.4	Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.5	Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis	NEUTRAL | Difficult to determine without prior to consultation and engagement with the public, which can vary greatly on a regional and year-by-year basis
5.2	Effects on nearby communities	NEUTRAL | Baseline case; assigned "Neutral" rating	NEUTRAL | Effectively similar to Option 1A	NEUTRAL | Alignment changes anticipated to minimally disrupt nearby communities with existing alignment generally intact	BETTER | Alignment changes anticipated to minimally disrupt nearby communities with existing alignment generally intact but AT now added	BETTER | Alignment changes anticipated to minimally disrupt nearby communities with existing alignment generally intact but AT now added	BETTER | Alignment changes anticipated to minimally disrupt nearby communities with existing alignment generally intact but AT now added	BETTER | Alignment changes anticipated to minimally disrupt nearby communities with existing alignment generally intact but AT now added	WORSE | New crossing location impacts the new communities due to a new highway alignment, while also impacting communities where the existing alignment will be decommissioned; assumed to be "Worse"	WORSE | New crossing location impacts the new communities due to a new highway alignment, while also impacting communities where the existing alignment will be decommissioned; assumed to be "Worse"	WORSE | New crossing location impacts the new communities due to a new highway alignment, while also impacting communities where the existing alignment will be decommissioned; assumed to be "Worse"	WORSE | New crossing location impacts the new communities due to a new highway alignment, while also impacting communities where the existing alignment will be decommissioned; assumed to be "Worse"
5.3	Mi'kmaq perception	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"	NEUTRAL | Difficult to assess accurately wihtout consultation and engagement with the Mi'kmaq of Nova Scotia; potential new requirement to develop Crown land may also result in additional concern from Indigenous communities. Assumed to be "Neutral"

Appendix H Technical Considerations | Hydrology

H.1 Basis

The hydrological considerations for this study examined the factors that influence the extreme water levels for the Seal Island Bridge as well as conducting analysis to determine those extreme water levels for current climate and climate change conditions for 50- and 100-year return period extremes. Once the extreme water levels were determined the rehabilitation/replacement options were evaluated in terms of water velocity and required protective measures from waves and ice.

H.2 Technical Considerations - Details

H.2.1 Hydrological Analysis

Hydrological Characterization

Based on the Ecosystem Overview and Assessment Report for the Bras d'Or Lakes, Nova Scotia (Parker et al. 2007), the volume of freshwater inputs to the lake is small relative to its surface area and due to the sheltered nature of the lake the tidal ranges are small.

Based on analysis of a comparison water elevation observations available from the Canadian Hydrographic Service measured at Duffus Point rainfall measured at the Sydney Climate station during those periods, it was determined that freshwater inputs to Bras d'Or Lake have little to no influence on the water elevation in the lake. This comparison is shown in Figure 13.

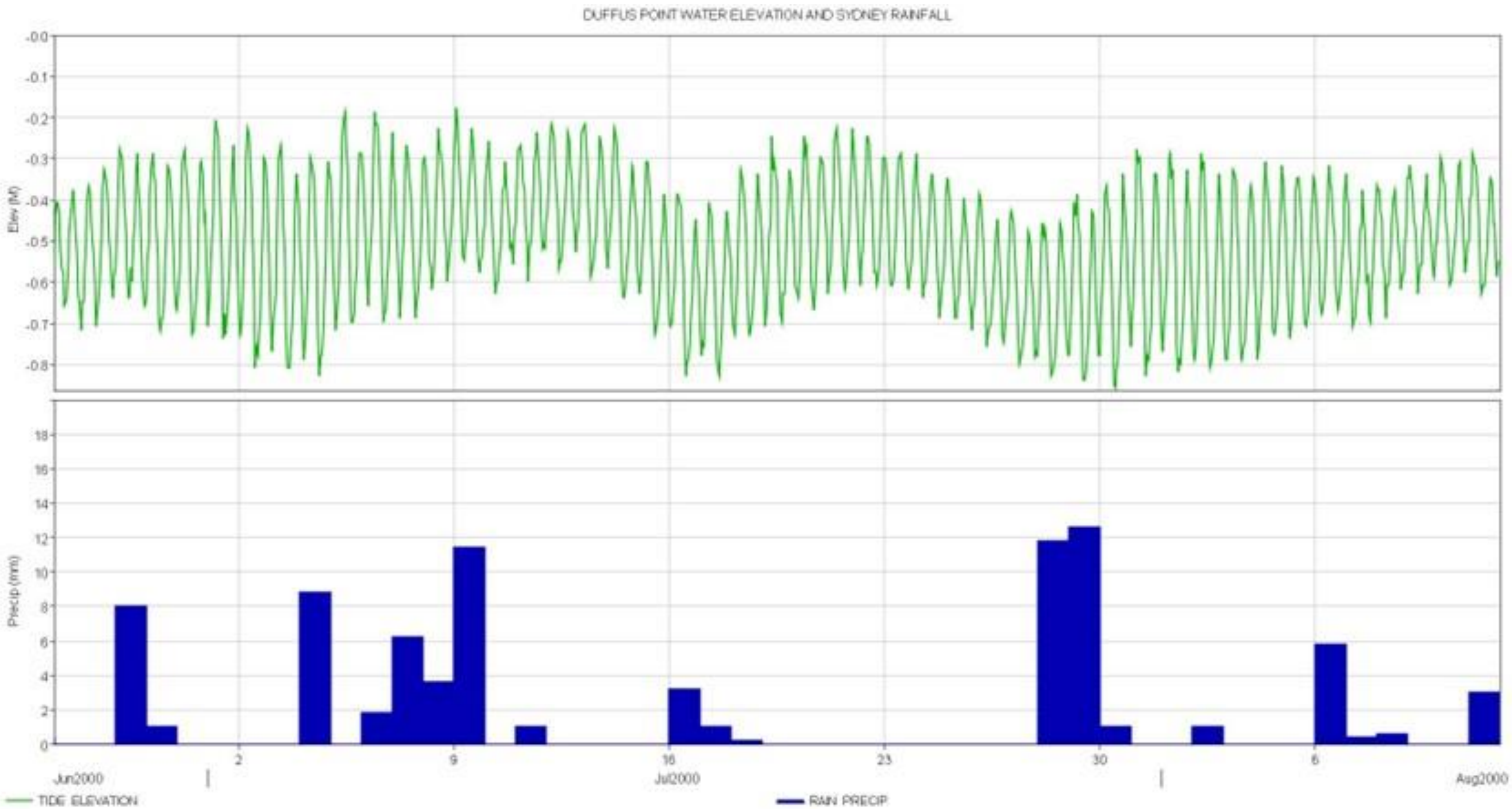

Figure 13: Sydney rainfall and Duffus Point tide elevation (CGVD 2013)

Note the actual tidal observations were only available for the period in Figure 13 above. Tidal predictions are available until present. However, to establish the influence of freshwater runoff actual observations must be used. The Duffus point tide station is the nearest station and is located approximately 8 km northeast of the existing Seal Island bridge crossing location within the Great Bras d'Or Channel.

The extreme water elevations in Bras d'Or Lake are instead governed by the intrusion of tidal waters from its connection points to the open ocean. As such the extreme water levels analyzed for this study are resultant from tides and storm surges. The development of hydrographs for these events are discussed in below.

Determination of Extreme Water Levels

Because the extreme water levels in the Great Bras d'Or Channel are governed by extreme sea levels, 50- and 100-year stage hydrographs were developed represent these extremes in the model for both current climate and climate change conditions. The Government of Nova Scotia has made available sea level rise projections for 2025, 2055, 2085 and 2100 for 13 regions across the province. The projections include total sea level rise for each time horizon as well as 10-, 25-, 50- and 100-year return period extreme total seal levels (TSL) resulting from a combination of tides and storm surges. For analysis of the Seal Island bridge the Sydney region was selected as that is the nearest to the bridge location. The current climate, 50- and 100-year return period projections converted to CGVD 2013 at Duffus Point are shown in Table 21 below:

Table 21: Current climate and climate change extreme TSL

Climate Scenario	50 Year Extreme TSL (m)	100 Year Extreme TSL (m)
Current Climate	0.803	0.873
2025	0.963	1.033
2055	1.253	1.323
2085	1.663	1.733
2100	1.903	1.973

These extreme levels in conjunction with Duffus Point tidal prediction values from a spring high tide occurring in June of 2022 were utilized to develop extreme TSL stage hydrographs for Seal Island Bridge. First climate change tidal predictions without storm surge were developed for the 2055-, 2085- and 2100-time horizons. Then these hydrographs were scaled to the extreme TSL value coinciding with the high tide. Figure 14 and Figure 15 below show the 50- and 100-year return period Extreme TSL hydrographs for current climate and climate change conditions.

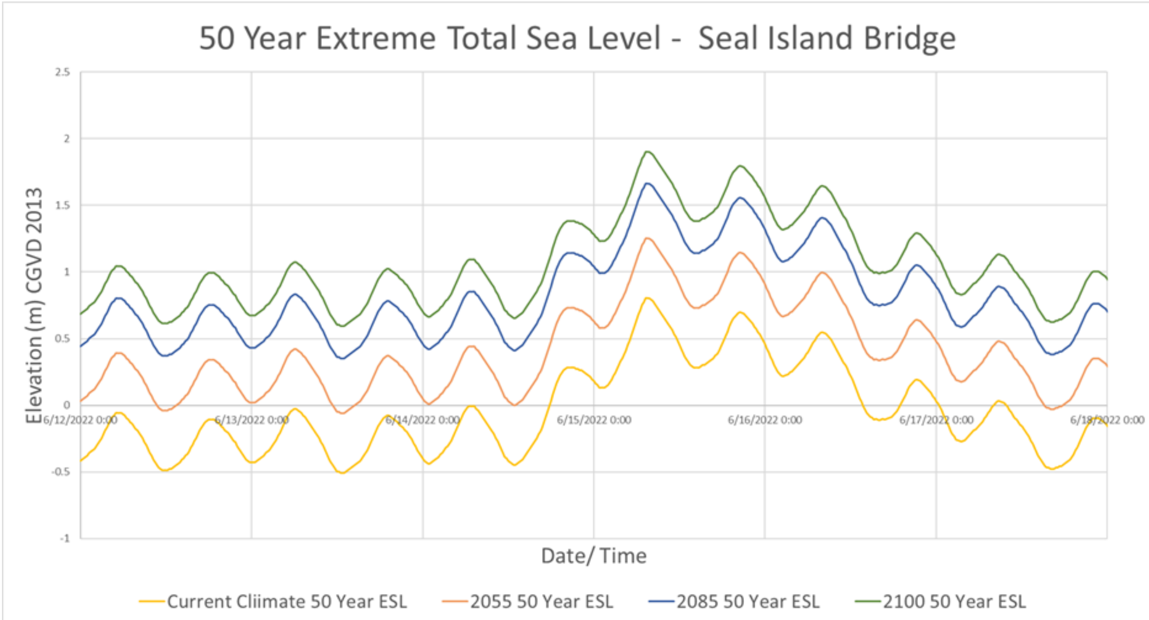

Figure 14: 50 year extreme total sea level

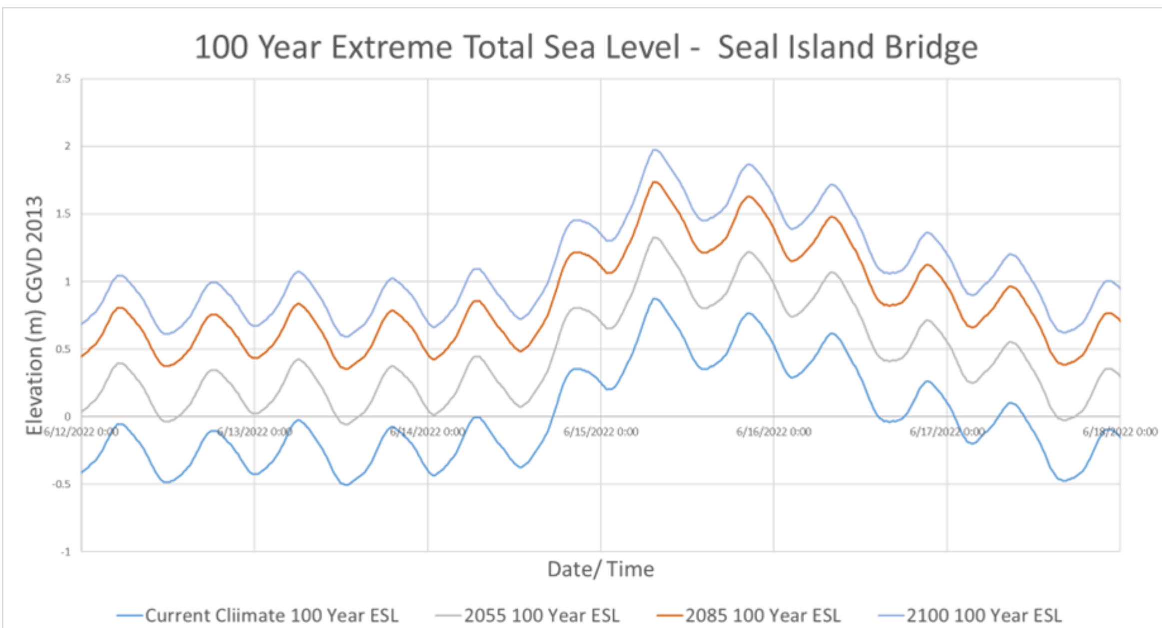

Figure 15: 100 year extreme total sea level

The above hypothetical stage hydrographs were utilized in a 2D HEC-RAS hydraulic model to assess velocities and shear stress at the crossing sites.

H.2.2 Hydraulic Analysis

Development of a Digital Elevation Model

The first step in the hydraulic analysis was to develop a Digital Elevation Model (DEM) for the area of interest including the Great Bras d'Or Channel. The digital was developed from a combination of LiDAR data publicly available from the Government of Nova Scotia as well as publicly available CHS NONNA10 bathymetric data form the Canadian Hydrographic Service. The digital elevation model of the Great Bras d'Or Channel and a close view of the existing Seal Island Bridge location is shown in Figure 16 below.

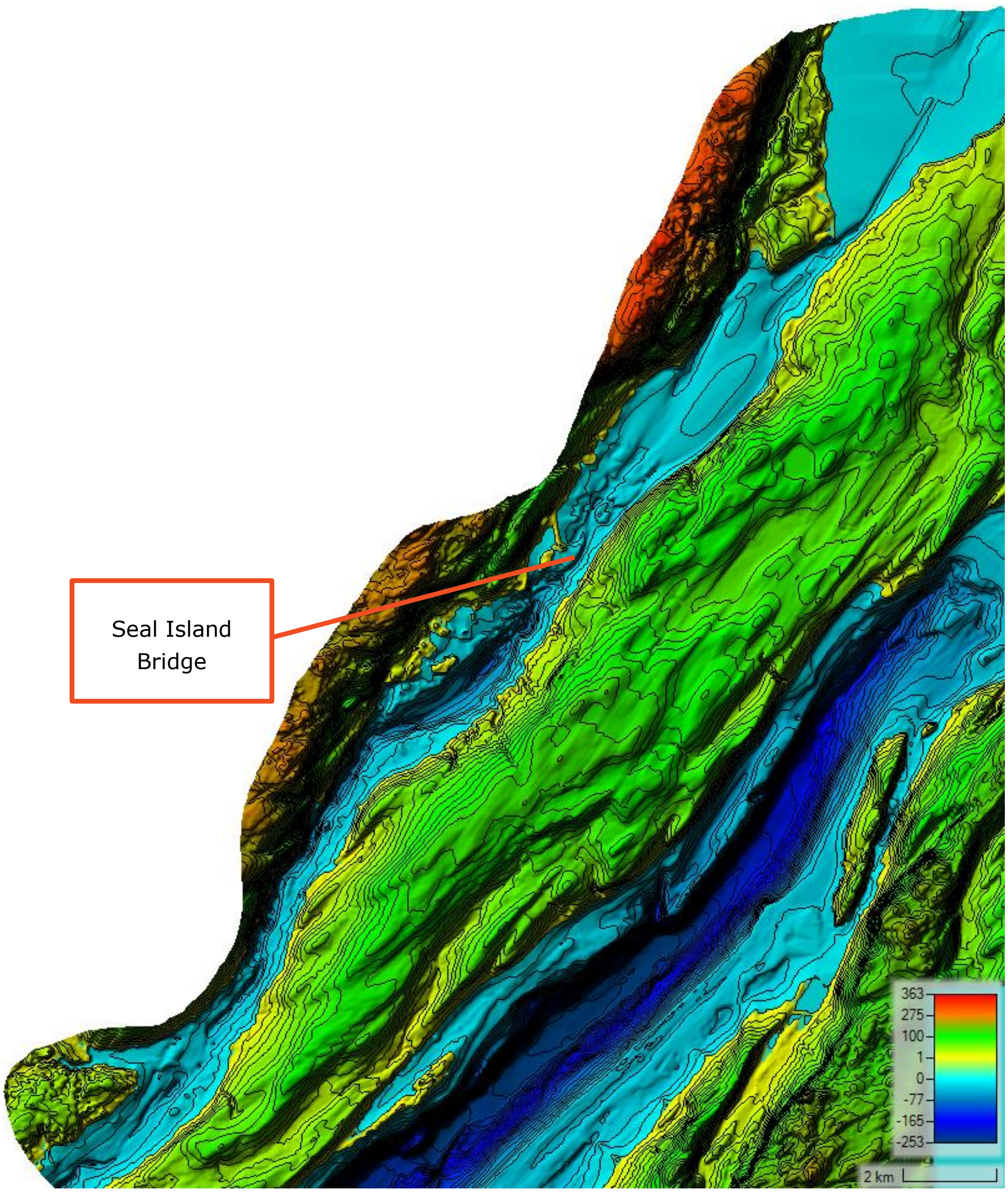

Figure 16: Digital elevation model

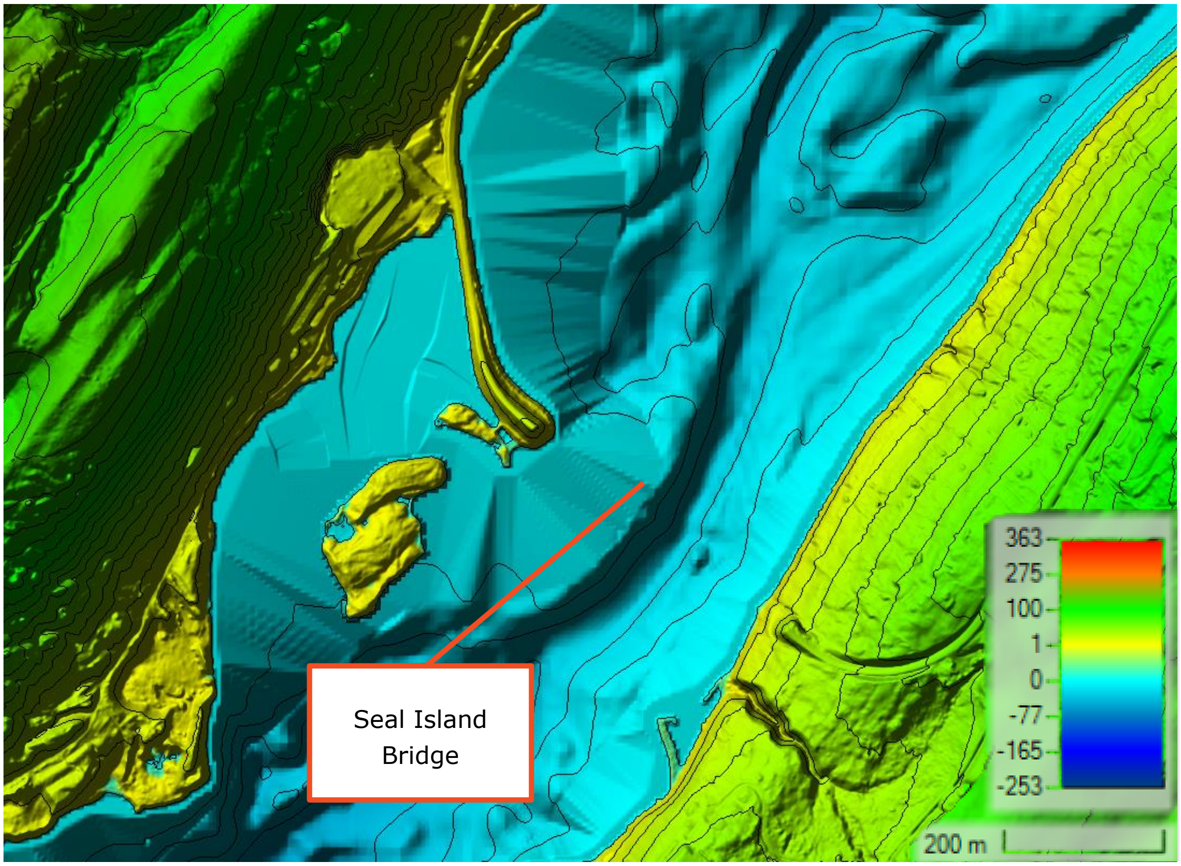

Figure 17: Digital elevation model at Seal Island Bridge

Following the creation of a digital elevation modes, a 2D hydraulic model of the Great Bras d’Or channel was created utilizing HEC-RAS software. As noted above in the hydrological analysis the governing determiner of the water level in the Great Bras d’Or channel is tidal. A such the storm surge elevation stage hydrographs for extreme current climate and climate change extreme sea levels were applied to a two-dimensional hydraulic model based on the digital elevation model to assess water velocities and shear stresses.

Hydraulic Modeling

Utilizing the DEM described above, a two-dimensional hydraulic model of the Great Bras d’Or channel was developed in HEC-RAS software. Within the model the channel was represented by a 2D flow area with a cell resolution of 20 m x 20 m within the channel. The Seal Island bridge was represented as a bridge type 2D area connection.

Six geometric scenarios were simulated in the hydraulic model including the following:

1. Option 1A/1B/1C: Existing structure rehabilitation (152 m main span);
2. Options 2A/2B/2C: Medium span structure adjacent to existing (approx. 160 m main span)
3. Options 2C: Medium span structure adjacent to the existing (approx. 240 m main span)
4. Option 2D: Long span structure adjacent to the existing (approx. 280 m main span)

5. Options 3A: Medium span structure to the north of the existing (approx. 160 m main span)
6. Options 3B: Long span structure to the north of the existing (approx. 560 m main span)
7. Options 4A: Medium span structure to the south of the existing (approx. 160 m main span)
8. Options 4B: Long span structure to the south of the existing (approx. 560 m main span)

Each of these geometric scenarios were simulated with six extreme water level scenarios including:

1. Current Climate 50-year Extreme Total Sea Level
2. Current Climate 100-year Extreme Total Sea Level
3. Year 2100 Climate Change 50-year Extreme Total Sea Level
4. Year 2100 Climate Change 100-year Extreme Total Sea Level

The existing crossing (rehabilitation) and new bridge crossings model configuration in Figure 18 through Figure 25.

Figure 18: Existing Seal Island Bridge in hydraulic model (Options 1A, 1B, 1C)

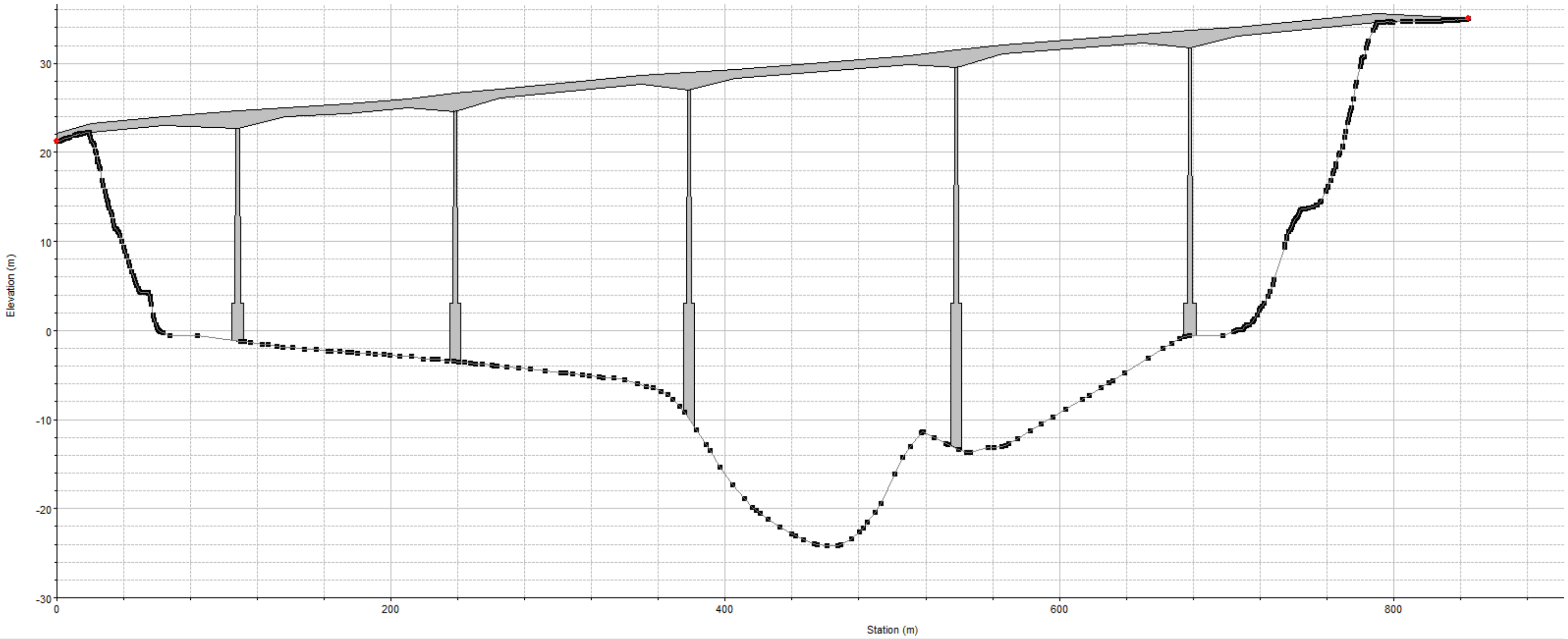

Figure 19: Options 2A and 2B in Hydraulic Model

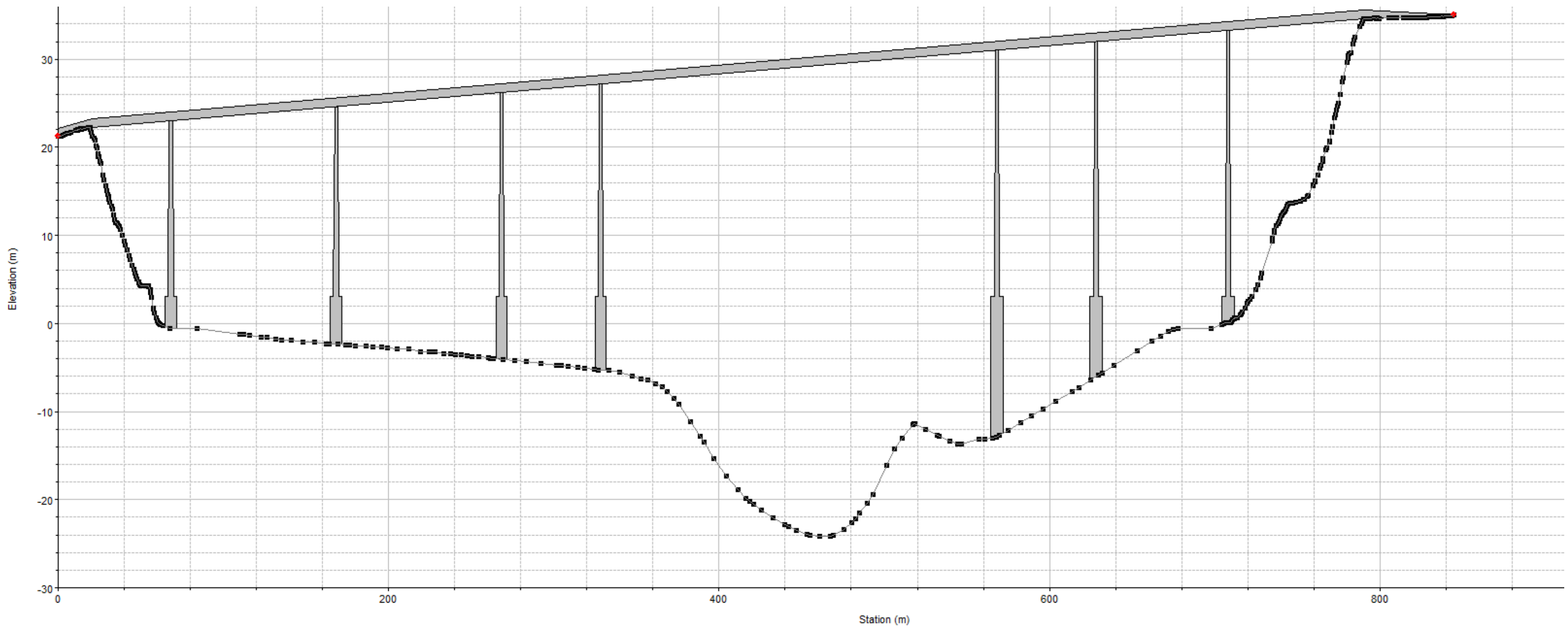

Figure 20: Option 2C in hydraulic model

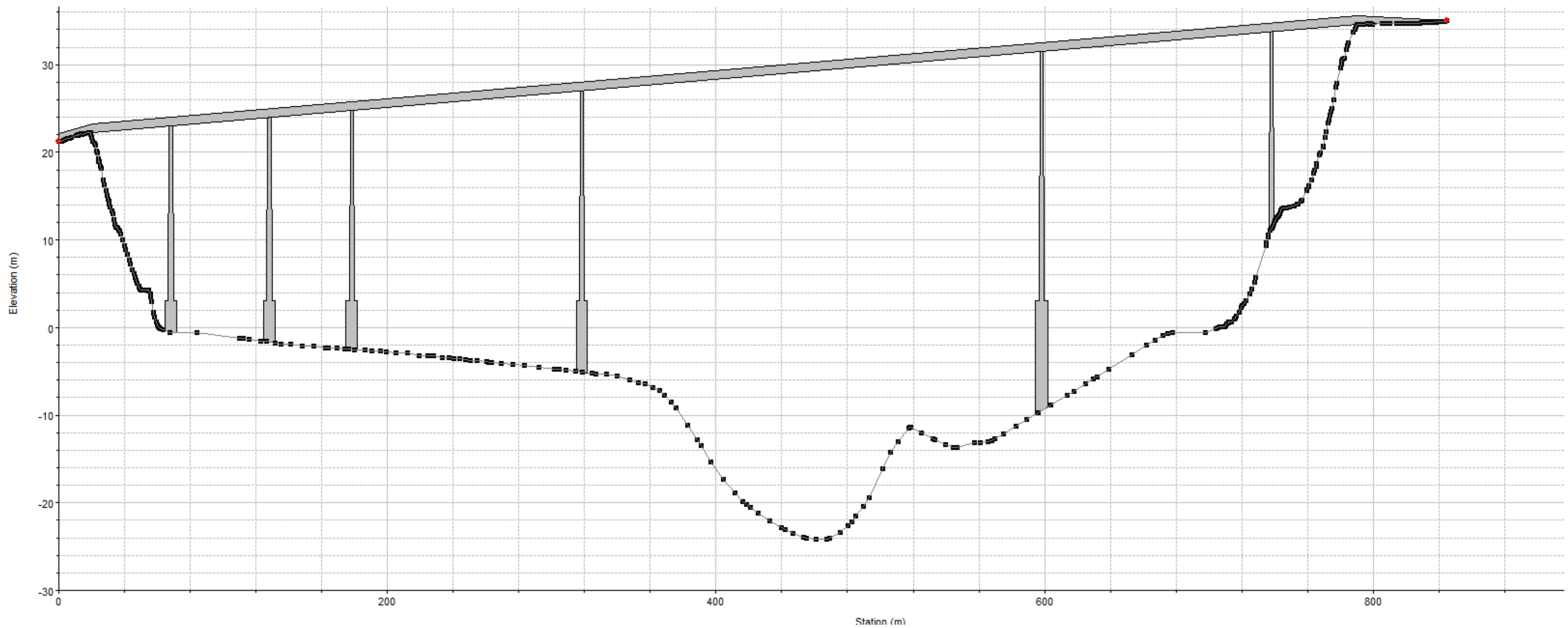

Figure 21: Option 2D in hydraulic model

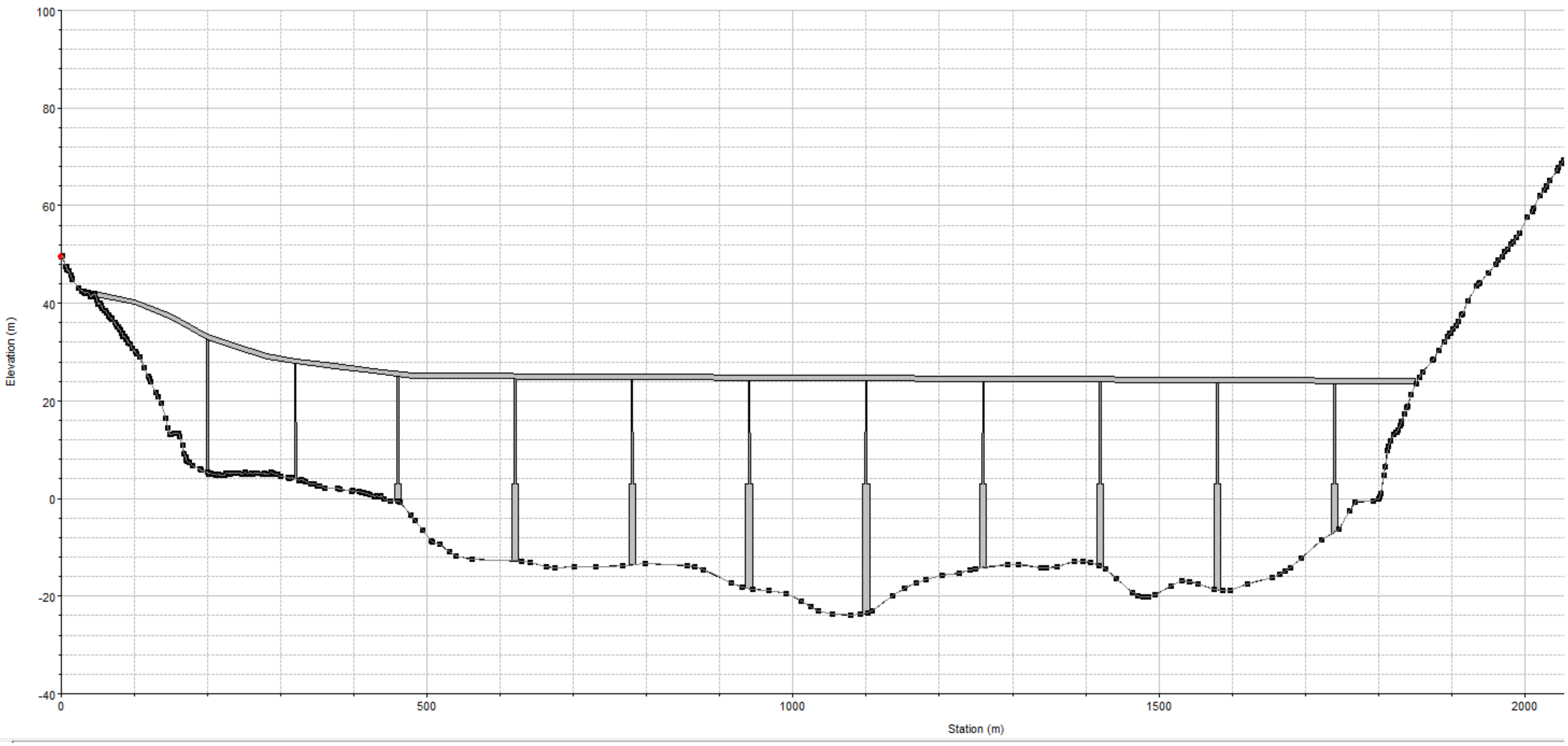

Figure 22: Option 3A in hydraulic model

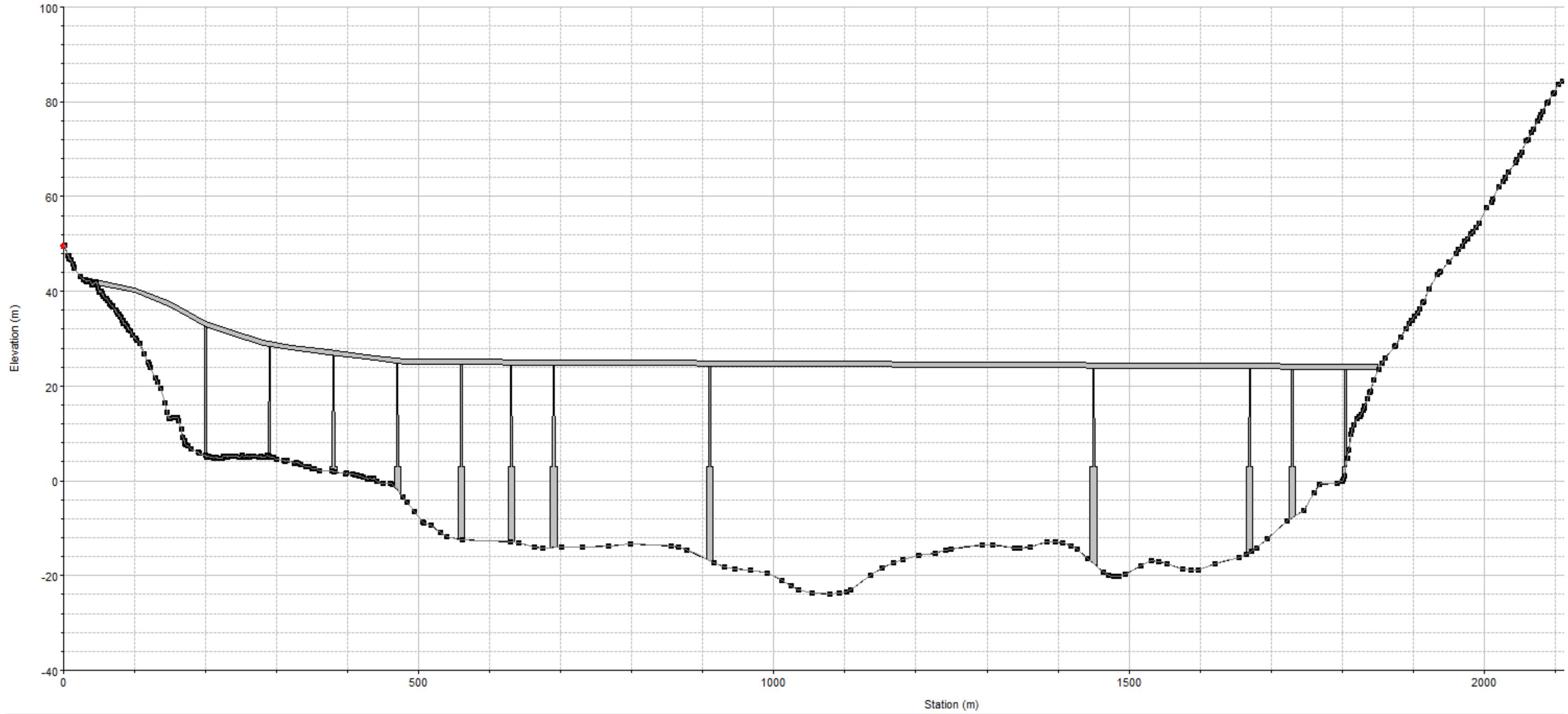

Figure 23: Option 3B in hydraulic model

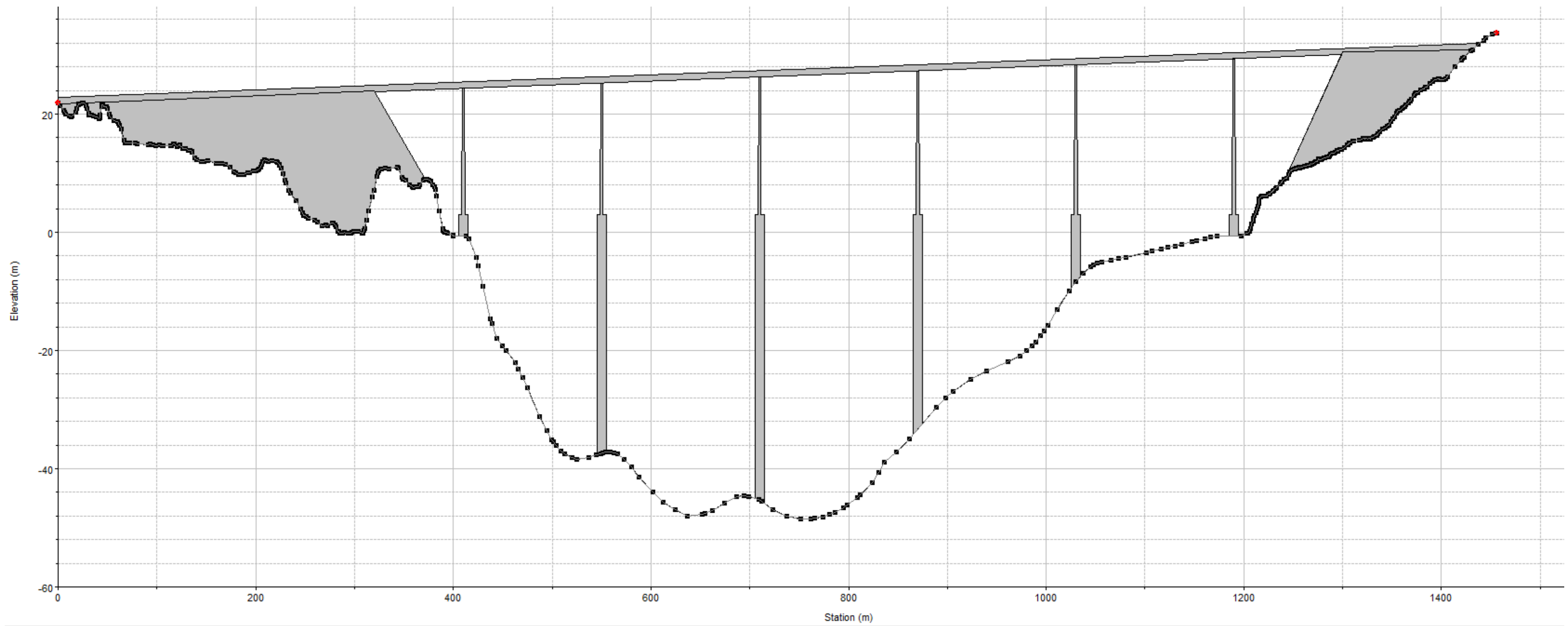

Figure 24: Option 4A in hydraulic model

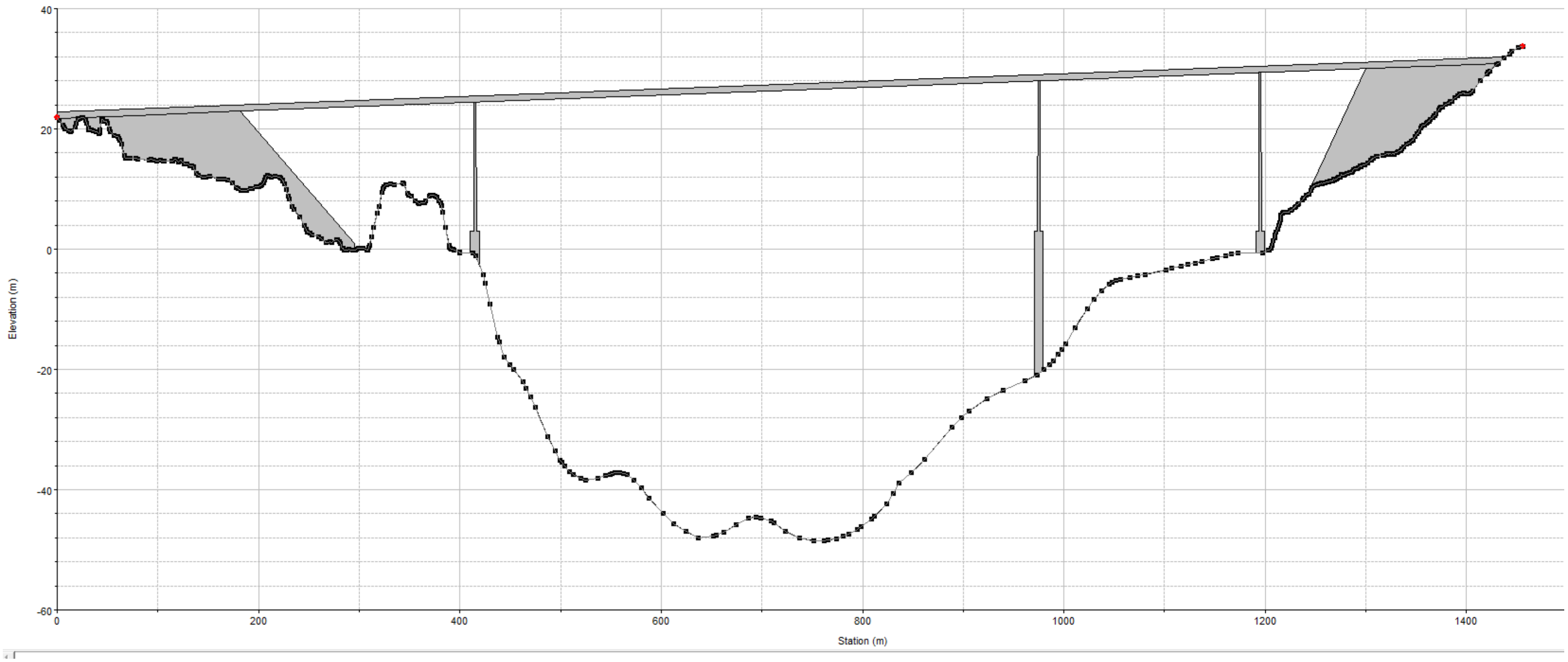

Figure 25: Option 4B in hydraulic model

Since the number of piers that require protection from hydrotechnical forces arising from wind water and ice is a key consideration. Table 22 below shows the number of required piers from each option and the deepest bathymetric elevation at the crossing location. Note that actual number of piers for the selected option may differ due to other design technical considerations.

Table 22: Hydraulic model assumed number of piers and deepest bathymetric elevation

Options	Number of Piers	Bathymetric Elevation at Deepest Point of Crossing Location (m)
1A, 1B,1C	7	-24.17
2A, 2B	5	-24.17
2C	7	-24.17
2D	6	-24.17
3A	11	-23.84
3B	12	-23.84
4A	6	-48.6
4B	3	-48.6

Note Options 3A and 3B have three and four piers respectively, that are not located in the water under normal conditions.

Hydraulic Model Results

The HEC-RAS hydraulic model results show that velocities of the water are generally low with maximum velocities between 0.07 and 0.29 m/s. The largest velocity of 0.29 m/s was at the existing location. This is expected as this location is the narrowest due to the embankment section of the crossing. The north and south locations had maximum velocities of 0.07 m/s and 0.08 m/s, respectively. Maximum velocities output by the model for each of the options are in Table 23 below.

Table 23: Maximum velocities output by hydraulic model

Options	Maximum Velocity (m/s)
1A, 1B,1C	0.29
2A, 2B	0.28
2C	0.28
2D	0.27
3A	0.08
3B	0.08
4A	0.07
4B	0.07

Figure 26 through Figure 32 below shows the velocity distributions for the year 2100 climate change 100-Year Extreme TSL for Options 1A/1B/1C, 2A/2B, 2C, 2D, 3A, 3B, 4A, and 4B.

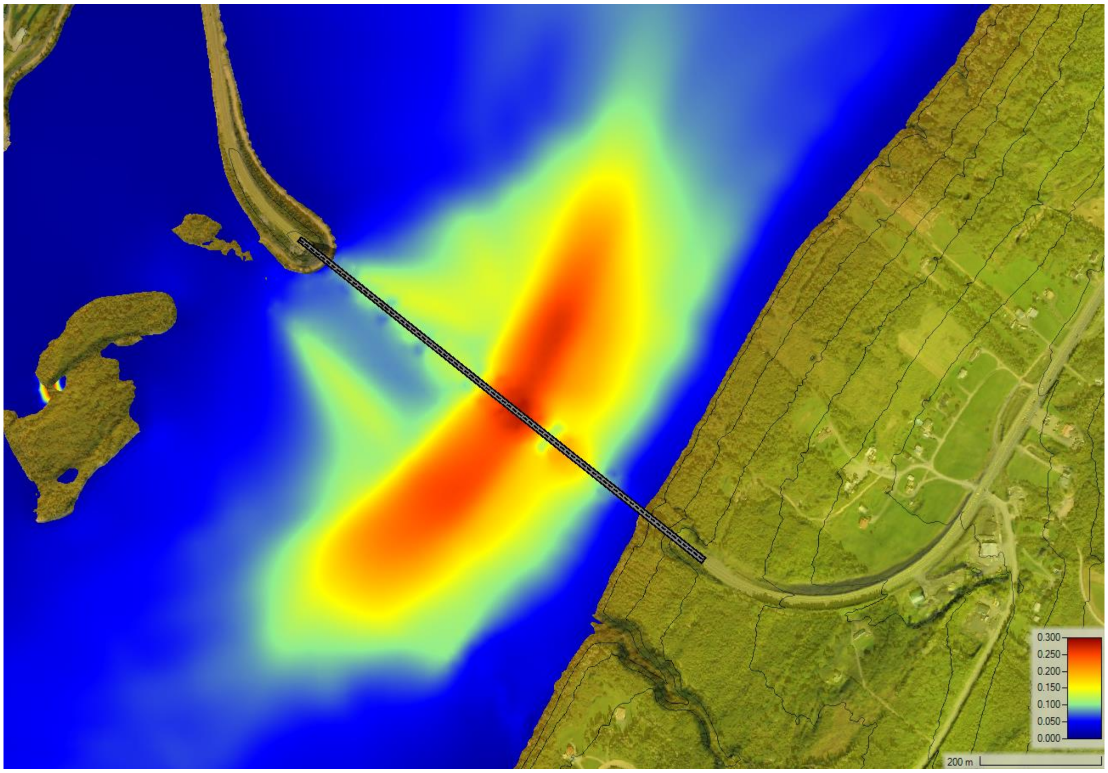

Figure 26: Existing crossing - Option 1A/1B/1C location velocity distribution

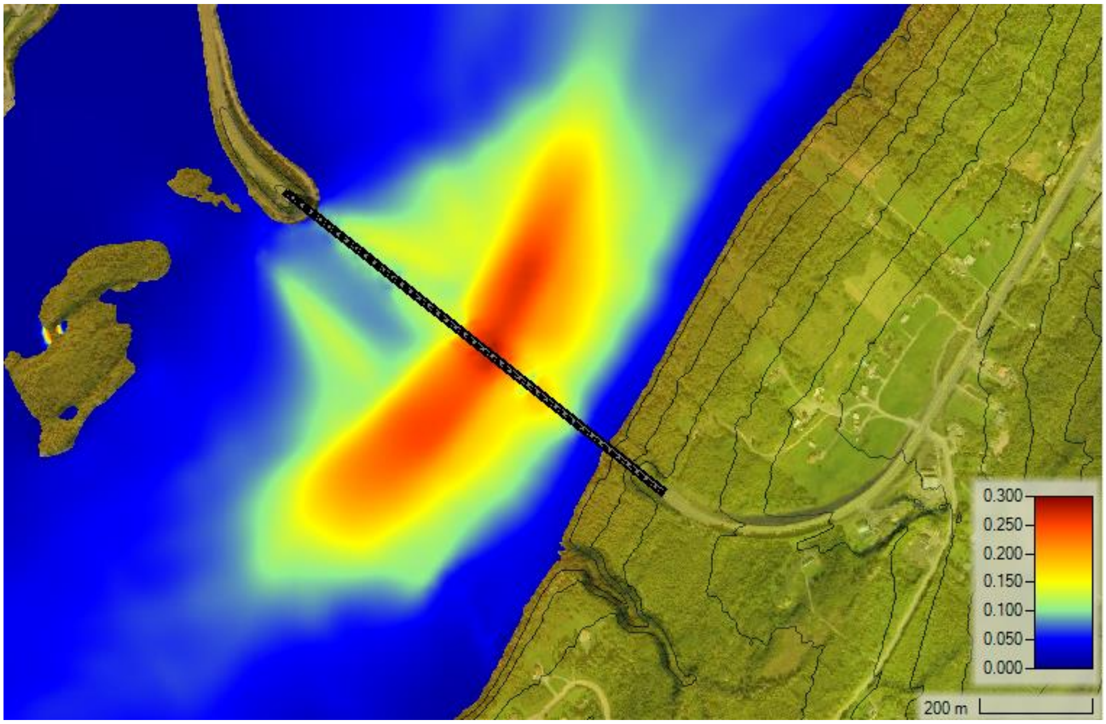

Figure 27: Option 2A/2B velocity distribution

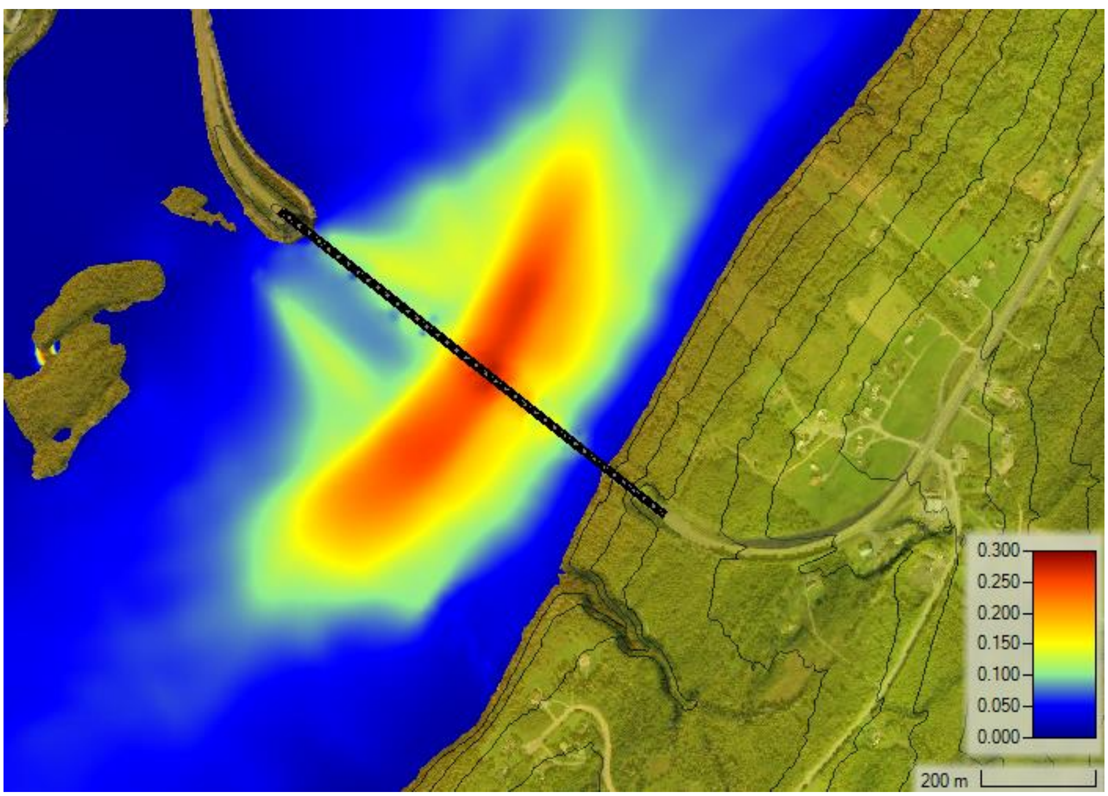

Figure 28: Option 2D velocity distribution

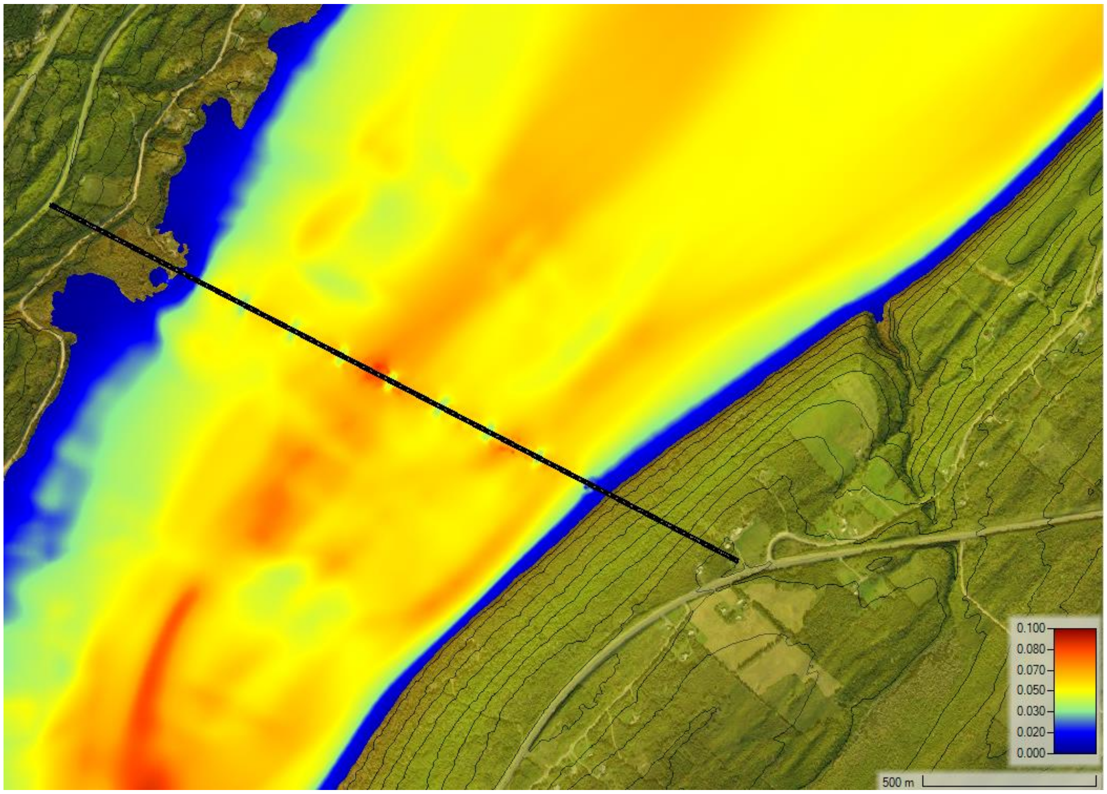

Figure 29: Option 3A velocity distribution

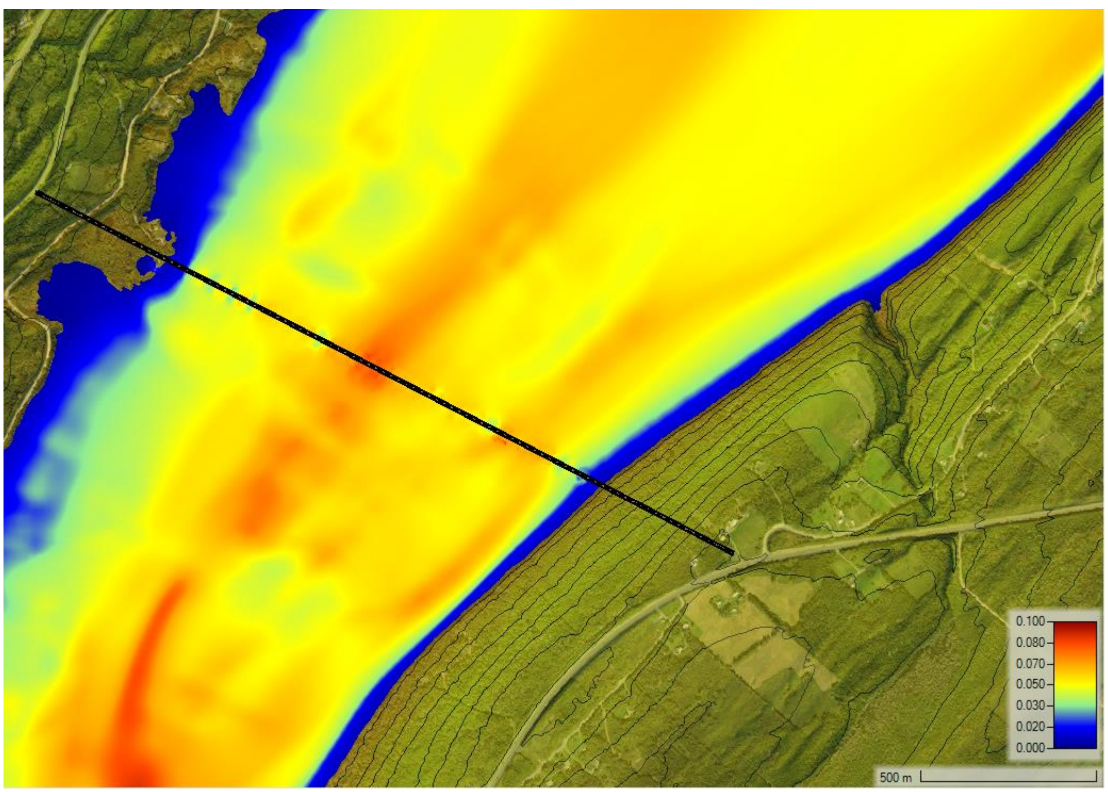

Figure 30: Option 3B velocity distribution

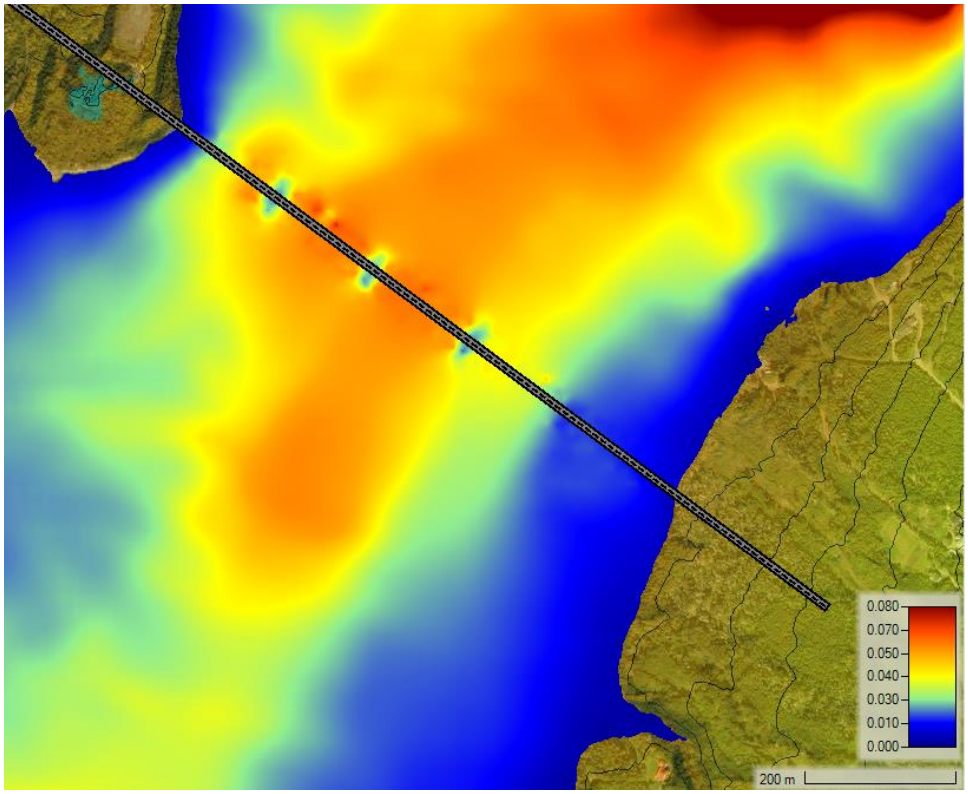

Figure 31: Option 4A velocity distribution

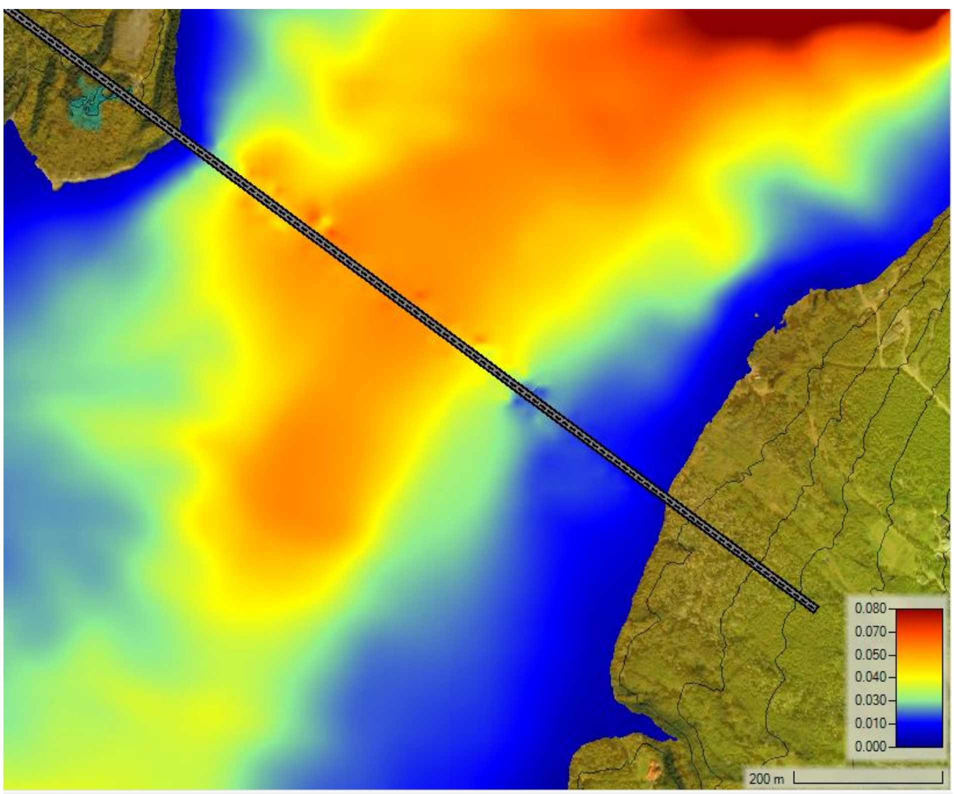

Figure 32: Option 4B velocity distribution

Shear stress distributions were similar to the velocity distributions with the maximum occurring at the existing crossing location due to the narrow nature of the crossing. The largest water shear stress of 0.94 Pa was at the existing location. This is expected as this location is the narrowest due to the embankment section of the crossing. The north and south locations had maximum shear stresses of 0.08 Pa and 0.04 Pa, respectively. Maximum shear stresses output by the model for each of the options are in Table 24 below.

Table 24: Maximum shear stresses output by hydraulic model

Options	Maximum Shear Stress (Pa)
1A, 1B,1C	0.94
2A, 2B	0.91
2C	0.91
2D	0.87
3A	0.08
3B	0.07
4A	0.04
4B	0.04

Figure 33 through Figure 40 below shows the water shear stress distributions for the year 2100 climate change 100-Year Extreme TSL for Options 1A/1B/1C, 2A/2B, 2C, 2D, 3A, 3B, 4A, and 4B.

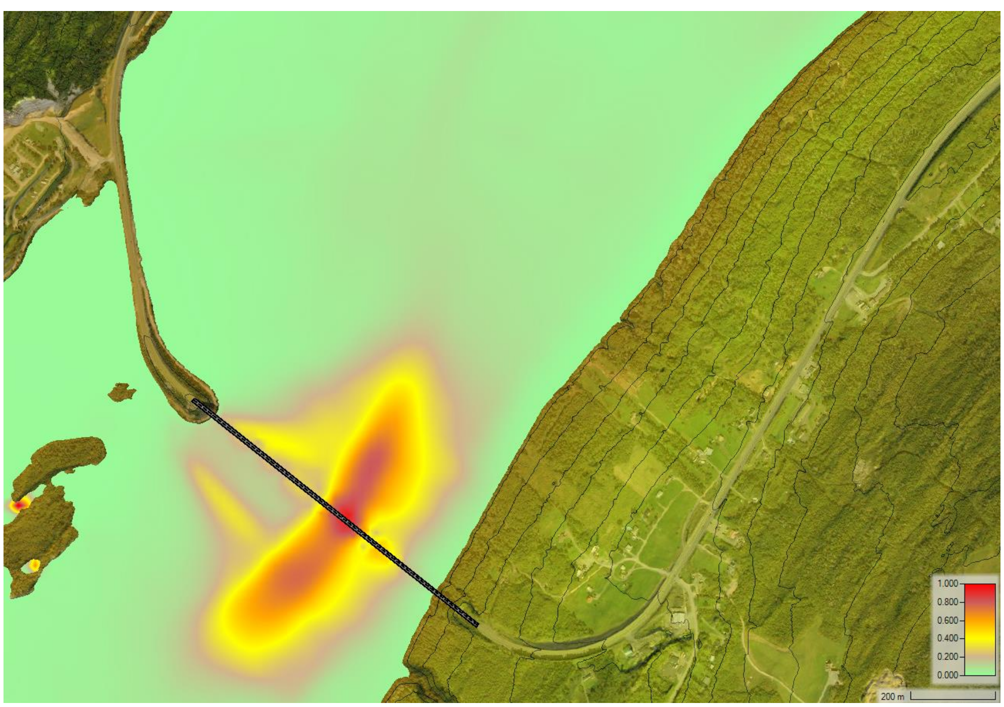

Figure 33: Existing crossing location - Option 1A/1B/1C max water shear stress

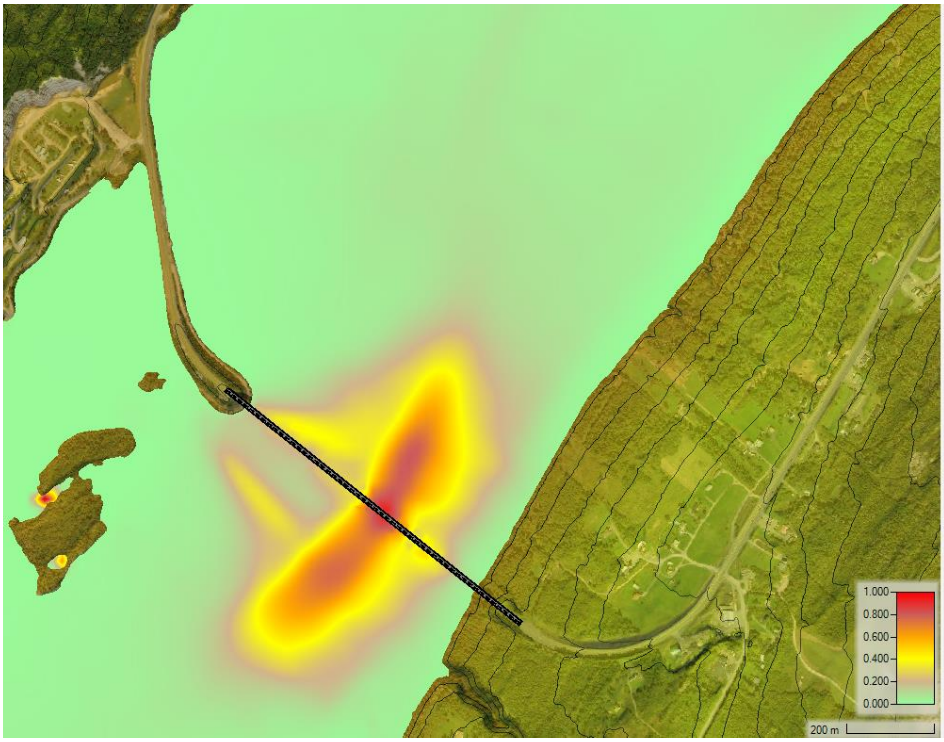

Figure 34: Option 2A/2B max water shear stress

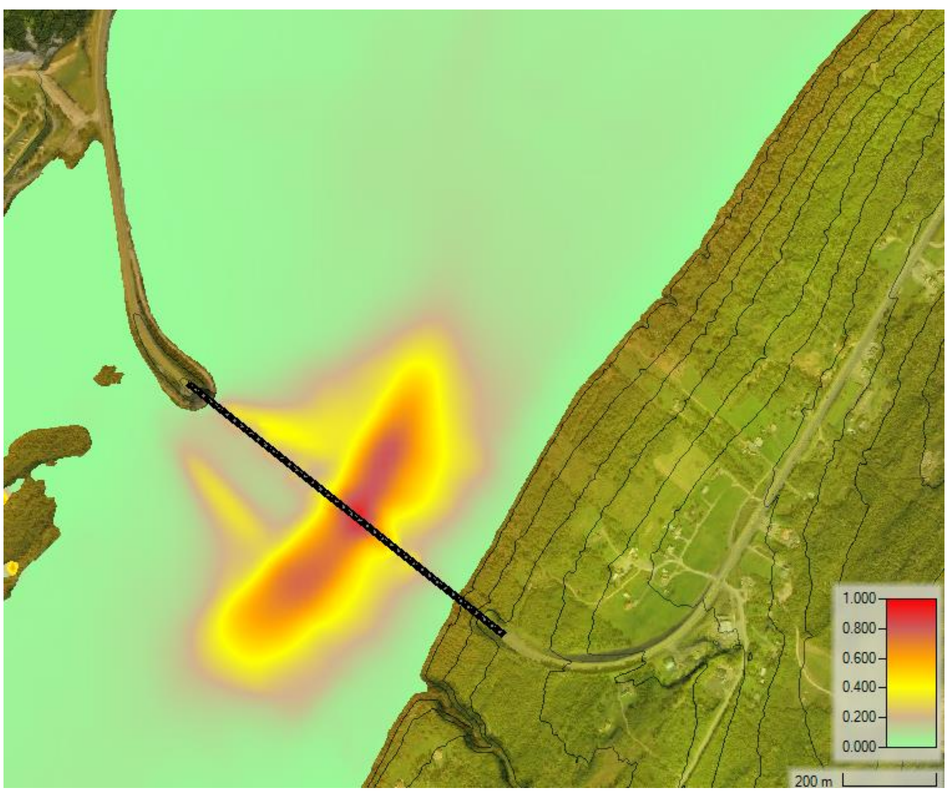

Figure 35: Option 2C max water shear stress

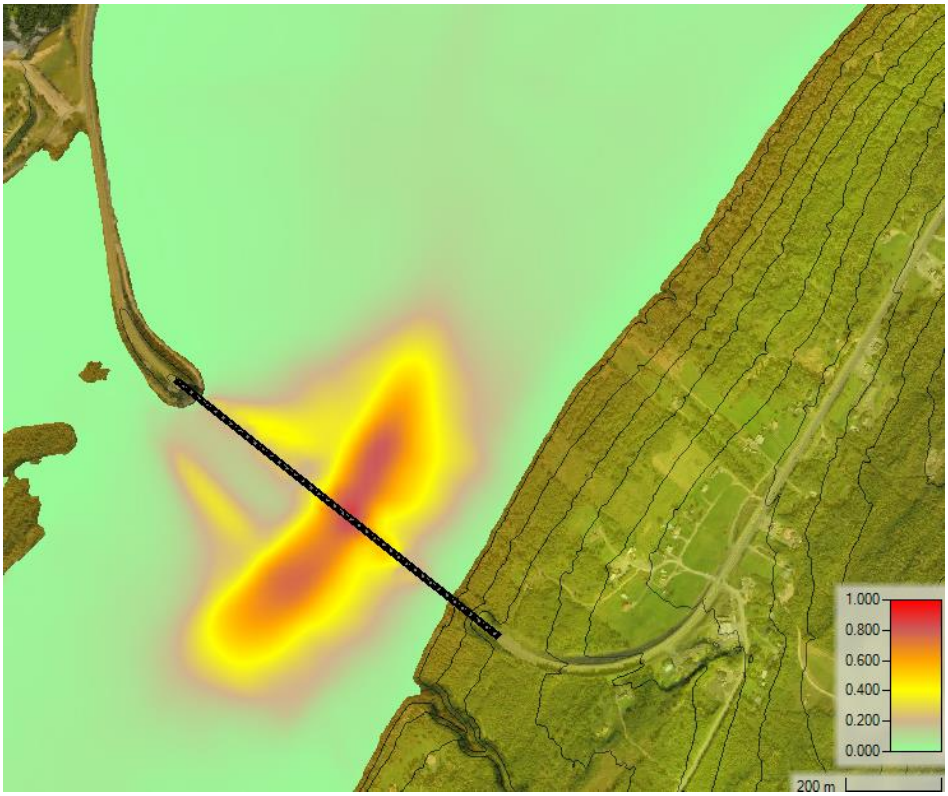

Figure 36: Option 2D max water shear stress

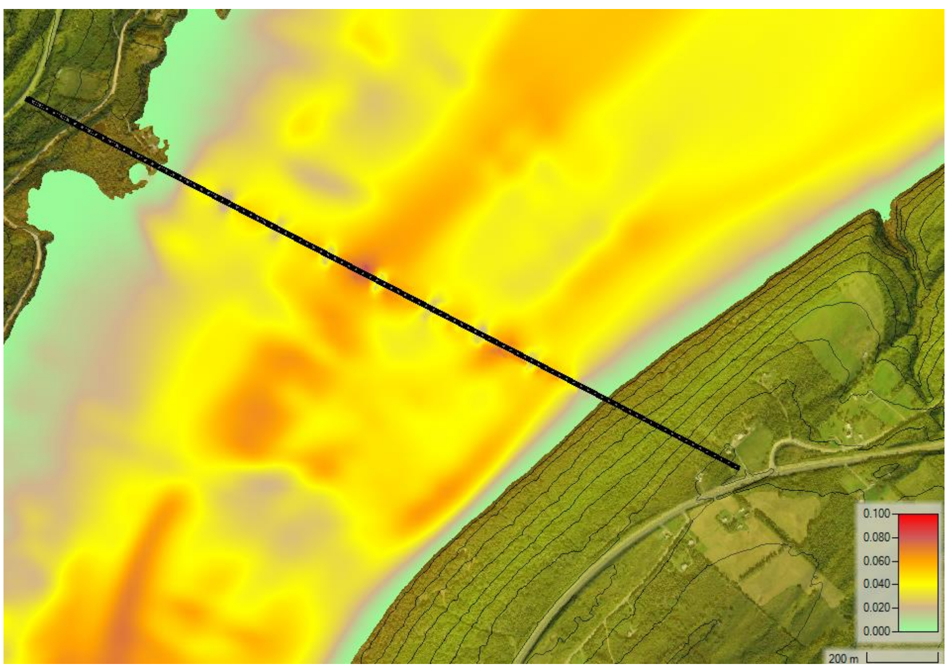

Figure 37: Option 3A max water shear stress

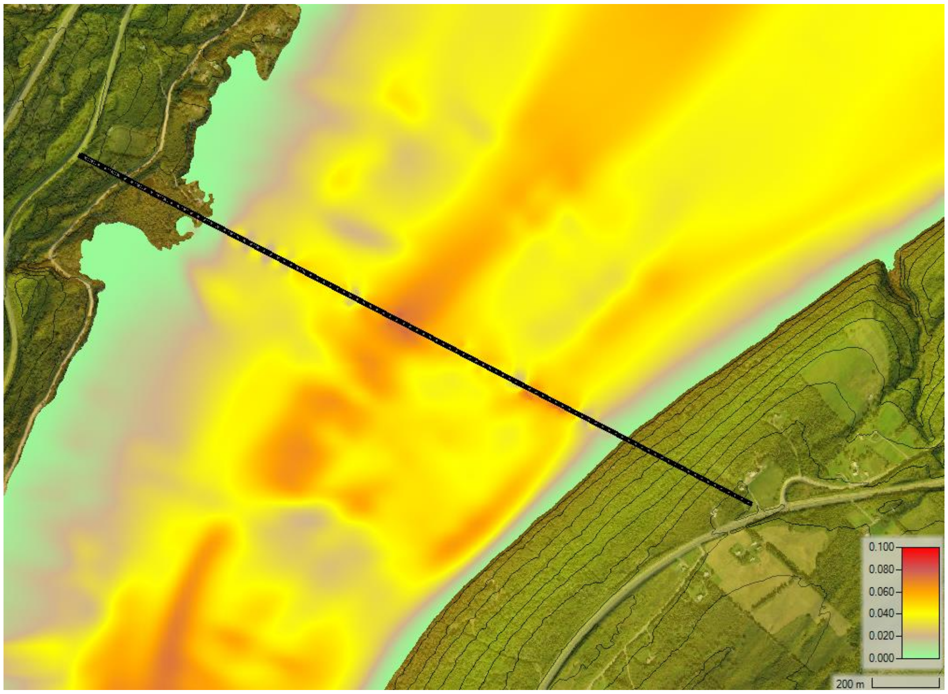

Figure 38: Option 3B max water shear stress

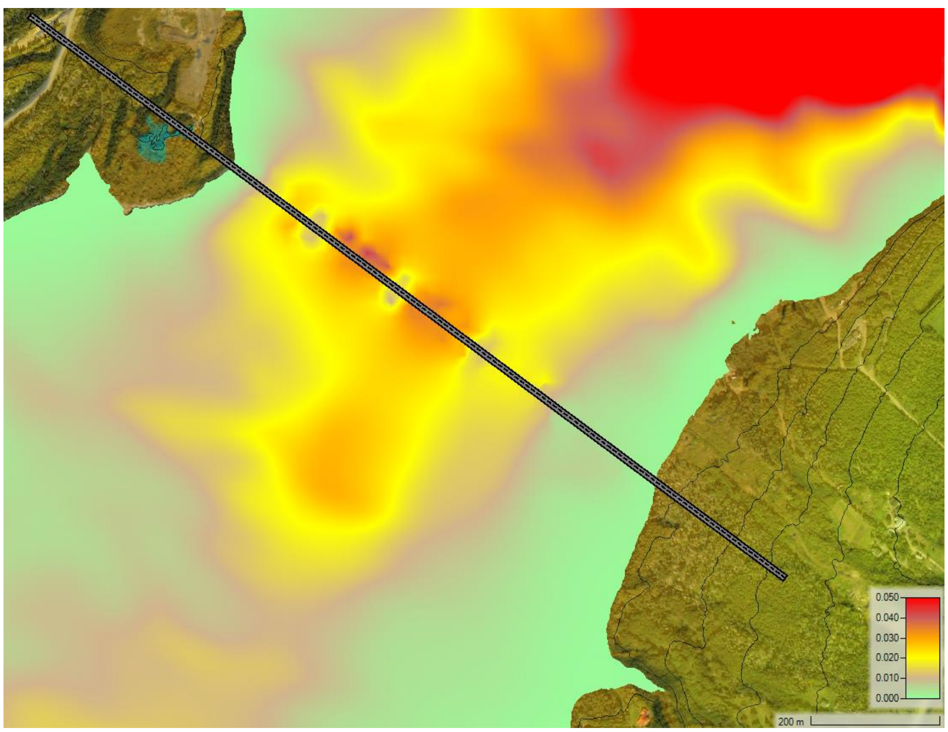

Figure 39: Option 4A max water shear stress

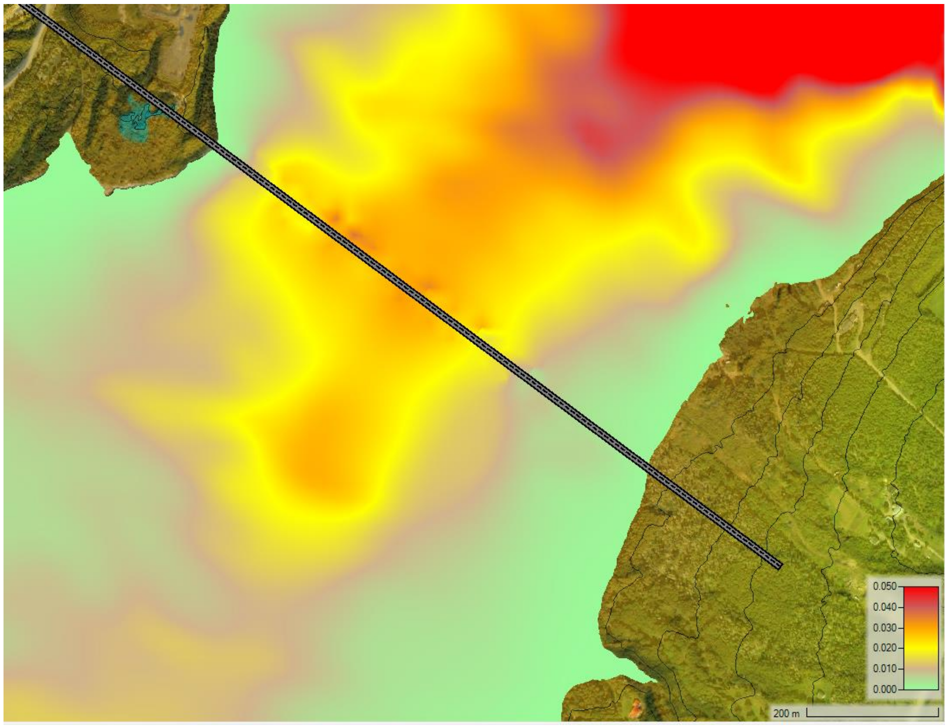

Figure 40: Option 4B max water shear stress

Wind and Wave Assessment

In addition to the tide and storm surge (Extreme TSL) induced high water levels the infrastructure of the Seals Island Bridge will need to be able to withstand additional water heights produced by wind and wave action. The bridge piers and embankment/causeway sections of the bridge are the components of the structural vulnerable to wind and waves. Per the Canadian Dam Association Guidelines, structures should be constructed such that no overtopping will occur due to wave runup and setup for the 1000-year wind at the normal water level and the smaller return period wind at the design extreme water level based on the structure classification. Since this is not a dam and the bridge is to be designed at 100-year conditions, the 100-year wind was used in this analysis at the extreme water level. As such, a frequency analysis was conducted utilizing HEC-SSP software on the hourly wind data recorded by Environment and Climate Change Canada at the Sydney climate station (8205701) to determine return period hourly wind speeds for each of the eight cardinal wind directions. Table 25 below shows the results of the frequency analysis.

Table 25: Wind frequency analysis results

Return Period (years)	Hourly Wind Speed (km/hr)							
	East	North	Northeast	Northwest	South	Southeast	Southwest	West
1000	**112.7**	**86.5**	**84.5**	**112.4**	**115.2**	**124.6**	**102.6**	**89.9**
500	106.1	84.9	82.3	105.4	110	116.2	97.8	87.8
200	97.6	82.7	79.1	96.6	103.1	106.1	91.3	84.8
100	**91.4**	**80.8**	**76.3**	**90.3**	**97.8**	**98.9**	**86.5**	**82.4**
50	85.3	78.8	73.3	84.2	92.5	92.2	81.6	79.9
20	77.3	75.8	68.8	76.5	85.3	83.9	75.1	76.2
10	71.3	73.1	64.8	70.9	79.5	77.9	70.1	73.1
5	65.1	69.9	60.2	65.3	73.2	71.8	64.8	69.6
2	55.8	63.6	52.3	57.3	63.1	62.6	56.9	63.2

Based on the US Army Corps of Engineers Coastal Engineering Manual, wave heights for normal and extreme water level for current climate and climate change conditions were determined and the minimum elevation of protection for the piers/embankment were determined. Table 26 below summarizes the results:

Table 26: Current climate and climate change wave heights

Scenario		Water Elevation (m) CGVD 2013	Embankments		Piers	
			Max Wave Runup + Setup (m)	Required Elevation of Embankment (m) CGVD 2013	Max Wave Runup + Setup (m)	Required Elevation of Pier Protection (m) CGVD 2013
Current Climate	Normal Water Level	0.013	3.69	3.7	4.77	4.78
	50 Year Extreme TSL	0.803	2.9	3.7	3.81	4.61
	100 Year Extreme TSL	0.873	2.9	3.77	3.81	4.68
Climate Change 2055	Normal Water Level	0.463	3.69	4.15	4.77	5.23
	50 Year Extreme TSL	1.253	2.9	4.15	3.81	5.06
	100 Year Extreme TSL	1.323	2.9	4.22	3.81	5.13
Climate Change 2085	Normal Water Level	0.873	3.69	4.56	4.77	5.64
	50 Year Extreme TSL	1.663	2.9	4.56	3.81	5.74
	100 Year Extreme TSL	1.733	2.9	4.63	3.81	5.54
Climate Change 2100	Normal Water Level	1.113	3.69	4.79	4.77	5.88
	50 Year Extreme TSL	1.903	2.9	4.8	3.81	5.71
	100 Year Extreme TSL	1.973	2.9	4.87	3.81	5.78

Note that wave runup and setup is dependant on the slope of the impacting face, the embankment side slopes were assumed to be 2.5:1 based on the DEM. The pier faces were assumed to be vertical resulting in the higher values of wave runup and setup.

The minimum elevation required for the underside of the bridge deck is 4.78 m for current climate and 5.78 m for the year 2100 climate change time horizon referenced to CGVD 2013. These values include the extreme TSL plus wave runup and setup. These elevations are much less than the existing 36 m of vertical navigational clearance that is to be maintained. Therefore, the hydraulic opening of the bridge is not a large concern from a hydrotechnical perspective.

Note that for options that are at the current crossing location including rehabilitation and construction of a new structure that may utilize the existing causeway/embankment on the western approach (1A, 1B, 1C, 2A, 2B, 2C, 2D), the embankment is only at a sufficient elevation to withstand waves under current climate conditions. Figure 41 below shows a profile of the existing embankment compared to 100-year extreme TSL plus associated wave height for current climate and 2055 climate change conditions.

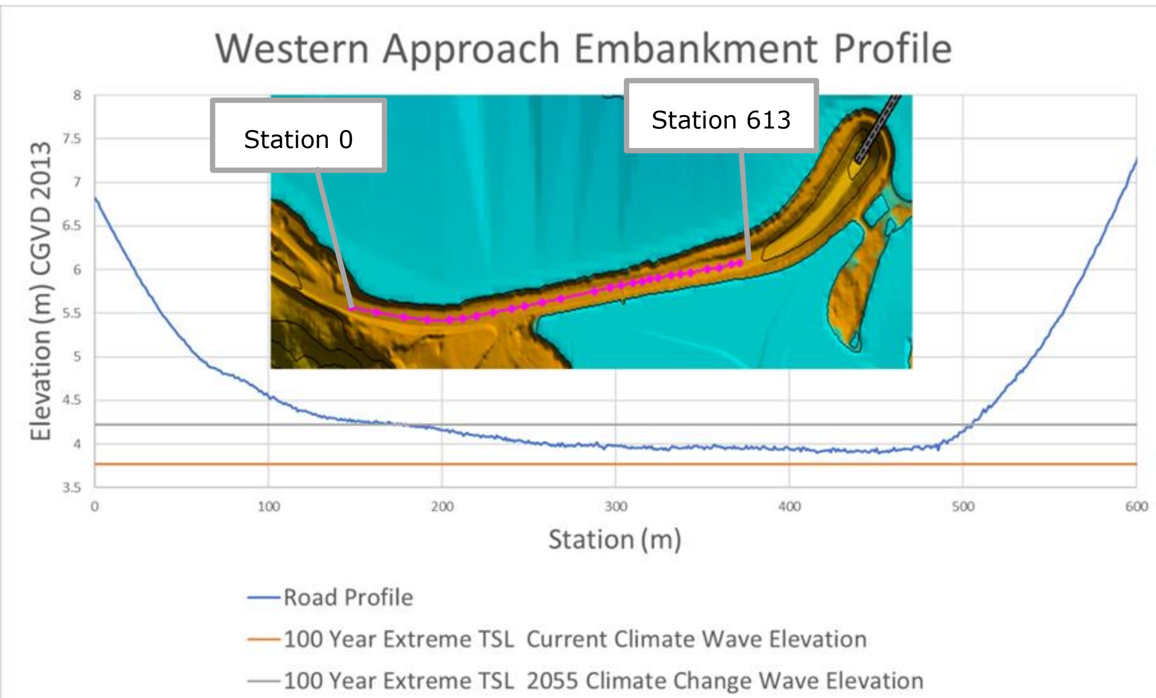

Figure 41: Western approach embankment profile

Options at the north and south crossing locations (3A, 3B, 4A, 4B) may be constructed without significant embankments sections and avoid the embankment rehabilitation.

In terms of pier quantity in the water, Options 1, 2 and 4 will have a fewer number of piers to protect from the waves with Option 4B having the fewest at three.

Armour Stone Assessment

Armour stone piers and embankment section was sized based on the USACE Engineering Manual Design of Coastal Revetments, Seawalls and Bulkheads. This manual gives a procedure for determining the W_{50} (weight of 50% or greater of the stones) required for rubble mound armour stone based on the significant wave height. For this study the wave runup resulting from the 100-year wind of 3.81 m was assessed to provide the approximate required armour stone weight. This resulted in a W_{50} for the armour stone 2160 kg. This equates to a D50 of approximately 1.2 m for the armour stone.

Ice Assessment

Based on the Ecosystem Overview and Assessment Report for the Bras d'Or Lakes, Nova Scotia (Parker et al. 2007), typical ice cover during cold winters is approximately 70% of the lakes surface though during cold winters 100% can occur. However, as noted in the Structural Analysis Report, it was noted that ice cover has not been observed in Great Bras d'Or except in 2002, when there was an observation of ice cover in the lake. The recorded thickness was noted to be 0.4 m, which is the ice thickness utilized in the analysis.

Ice loading on bridge piers or embankment structures usually results from the failure of the ice upon impacting the piers or embankment armor stone (USCE 2002). If the ice is to fail under the wind and water drag forces the equations from the CSA Design of Highway Bridges Code were used. A pier width of 6.7 m per the existing structure was assumed in the analysis. Table 27 below shows the results of this analysis:

Table 27: Ice pressure analysis results

Location	Fetch Area North of Bridge (km^2)	Fetch Area South of Bridge (km^2)	Wind Drag Force with 2-Year Hourly Wind (MN)	Water Drag Force Drag Force with Maximum Velocity (MN)	Total Drag Force (MN)	Pressure on Assumed 6.7m Wide Pier Base with 0.4m of Ice Thickness (MPa)	Ice Failed	Pressure Due to Ice Failure Upon Impacting 6.7m wide bridge pier Bridge (MPa)
Current Location	12.63	12.60	19.72	5.31	25.03	9.34	Yes	1.71
North Crossing	10.37	14.86	23.21	4.36	27.57	10.29	Yes	1.71
South Crossing	11.41	13.82	22.41	0.36	22.77	10.15	Yes	1.71

Based on the analysis, the approximate ice pressure that would be experienced at all three crossing locations is 1.71 MPa. Note this may change during detailed design of the selected option due to factors such pier width and shape.

H.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

H.4 Key Takeaways

Key takeaways for the hydrological technical consideration include the following:

- Extreme water levels in the Great Bras d'Or channel in which the are governed by tidal and storm surge effects.
- The minimum elevation required for the underside of the bridge deck is 4.78 m for current climate and 5.78 m for the year 2100 climate change time horizon referenced to CGVD 2013. These elevations include the 100-year extreme TSL plus applicable wave runup and setup. Additionally, these elevations are much less than the existing 36 m of navigational clearance that is to be maintained. Therefore, the hydraulic opening of the bridge is not a large concern from a hydrotechnical perspective. The main hydrotechnical concerns are designing the structure to withstand the wave forces resulting from waves and ice cover.
- Rehabilitation of the existing structure will likely require increasing the elevation to which bridge piers are protected from extreme water levels and waves. The height to which this is necessary is dependent on the design life of the rehabilitation and design climate change extreme water level. For example, a 25-year rehab (Option 1A) will could require a less stringent elevation of pier protection than the 50-year rehabilitation options (Options 1B and 1C).
- Options that are at the current crossing location including rehabilitation and construction of a new structure that may utilize the existing causeway/embankment on the western approach (1A, 1B, 1C, 2A, 2B, 2C, 2D), the embankment is only at a sufficient elevation to withstand waves under current climate conditions. Options at the north and south crossing locations (3A, 3B, 4A, 4B) may be constructed without significant embankments sections and avoid the embankment rehabilitation.
- Options at the existing crossing location (1B, 1C, 2A, 2B, 2C, 2D) with a longer design life will require higher raises of the western approach embankment to be protected from the projected higher water levels as a result of climate change.
- Maximum water velocities in the hydraulic model were the greatest at the existing crossing location at 0.3 m/s. The north and south crossing locations had maximum velocities of 0.08 m/s and 0.07 m/s respectively.
- Maximum water shear stress in the hydraulic model were the greatest at the existing crossing location at 0.94 Pa. The north and south crossing locations had maximum velocities of 0.08 Pa and 0.05 Pa, respectively.

- Options 1A/1B/1C, 2A/2B/2C/2D, and 4A/4B will require fewer piers to protect from wave and ice forces. Long span options at the existing location and south crossing location will have the fewest number of piers. Note the water depth at the south crossing location is approximately 25 m deeper than the existing and north locations. As such a pier at the south location may be more difficult and costly to construct than a pier at the existing or north location.

- Armour stone with a D_{50} of approximately 1.2 m will be required for erosion protection.

- Ice Pressures on will likely be due to failure upon impact of the ice and be approximately 1.71 MPa.

Technical Considerations Review - Hydrology

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (D Erl)
Reviewed by: Stantec (P Flower)

Stantec COWI

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement		Medium Span		Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1 Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2 Active transportation lanes											
2.3 Clearance of navigational channel											
2.4 Use of existing highway infrastructure											
2.5 NSPW owns required land											
2.6 Service life beyond 50 years											
2.7 Utility/service accommodations											
Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1 Impact to trade corridors during construction	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	HIGH | Required embankment upgrades will impact traffic on existing highway.	LOW | Embankment upgrades will not be required as existing roadway / structure will be decommissioned	LOW | Embankment upgrades will not be required as existing roadway / structure will be decommissioned	LOW | Embankment upgrades will not be required as existing roadway / structure will be decommissioned	LOW | Embankment upgrades will not be required as existing roadway / structure will be decommissioned
3.2 Impact to trade corridors in-service	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
3.3 Constructability / complexity of erection sequence	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
3.4 Climate Change	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	MODERATE | High future water levels due to climate change will result in the embankment potentially being overtopped by waves. Existing embankment can be upgraded to mitigate this risk.	LOW | Structures at the new crossing locations do no have the long western approach embankment to consider with climate change water levels. Clearance for navigational channel is much larger than required hydraulically.	LOW | Structures at the new crossing locations do no have the long western approach embankment to consider with climate change water levels. Clearance for navigational channel is much larger than required hydraulically.	LOW | Structures at the new crossing locations do no have the long western approach embankment to consider with climate change water levels. Clearance for navigational channel is much larger than required hydraulically.	LOW | Structures at the new crossing locations do no have the long western approach embankment to consider with climate change water levels. Clearance for navigational channel is much larger than required hydraulically.
3.5 Geotechnical	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
3.6 Approvals, permitting and consultation	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
3.7 Operational issues during service life	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
3.8 Land acquisition	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
4.1 Public safety	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
4.2 Use of modern bridge design / methods and materials	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
4.3 Environmental gains	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
4.4 Local content within construction industry	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.

Technical Considerations Review - Hydrology

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (D Erl)
Reviewed by: Stantec (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement		Medium Span		Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
4.5 Technological gains	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.	N/A | No impact on this technical consideration.
Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1 Public perception	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration
5.2 Effects on nearby communities	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration
5.3 Mi'kmaq perception	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration
5.4 Stakeholder impact	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration
5.5 Architectural and aesthetics	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration	N/A | Not applicable to this technical consideration

Appendix I Technical Considerations | Environment

I.1 Basis (Environment)

I.1.1 Hazardous Materials

Stantec reviewed existing reports and documents provided for the Seal Island Bridge to conduct a desktop assessment for the known or potential presence of hazardous building materials on the existing structure. For this assessment, the potential presence of asbestos, metals-based paint/steel coatings, lead products, mercury-containing equipment and polychlorinated biphenyls (PCBs), was considered. There are requirements for the appropriate collection, management and disposal of these materials as part of a removal associated either with deconstruction of the bridge or major renovations. While not a hazardous material for disposal, a discussion has been included related to silica exposure when working with concrete.

Background Documents

The previous drawings, photographs, a detailed bridge inspection report and information about coatings used. Drawings included the original plans from 1958, bearing replacement in 1985, deck replacement in 2001, street lighting upgrades 2006, and truss repair drawings 2016. Photographs include some original construction photographs from 1961, deck replacement photographs from 2001, unlabeled photographs of concrete pre-cast sections and unlabeled inspection photographs from 2002 to 2019; there was also an undated folder of photographs related to bridge lighting. The most recent detailed bridge inspection was conducted by Harbourside Engineering Consulting Ltd. for the Department of Transportation and Infrastructure Renewal in 2018/2019 and reported in 2020. The report includes numerous photographs of the bridge inspection. The Coatings History is in reply to a question to NSDPW seeking information about touch-up painting and products used as part of major repainting activities. NSDPW provided a table of coating information from the previous work completed which lists three areas of painting conducted in the mid to late 1990s.

Document Review

As part of our work, we reviewed the provided documents for information and abbreviations commonly associated with hazardous building materials. For example, asbestos products in architectural and structural drawings are sometimes listed as ASB, for ‘asbestos’; are sometimes present in tradenames “Johns-Manville” or “Transite”; or we know which products have been associated with asbestos such as “caulking” or “mastic sealers”, etc. Other materials were assessed based on the presence and apparent age of the material, for instance industrial lighting is a known source of mercury and potentially PCBs. Each of these items are discussed below in general with respect to the information provided.

Asbestos

Based on a review of the available original drawings, asbestos does not specifically appear to have been used in combination with the steel framing of the bridge. The approaches and piers are constructed of concrete and there have been various grouts and materials applied to cracks. No product information was provided for these materials, but depending on the age of these repairs it is possible that asbestos may be present in these types of materials. The granite blocks are held in place with mortar which is a material that we have in the past tested and found to contain asbestos. Typically, the presence of asbestos in mortar is of secondary concern to the presence of silica during outdoor removal projects. If needed, the materials could be tested to confirm the presence (or absence) of asbestos.

The concrete deck of the bridge was replaced in 2001. While asbestos was not banned in Canada until 2018, the presence of minor amounts of caulking type compounds associated with the deck installed in 2001 is not considered a significant concern. If needed, the materials could be tested to confirm the presence (or absence) of asbestos.

Sheet Lead

It was noted in the original plans that ¼" sheet lead was applied between the concrete and the ¾" Bed Plates that the metal bearings rest upon (notes on Drawing 108 from 1958). In the bearing replacement drawings from 1985, the ¾" base plates (Bed Plates) were to be retained and it is assumed that the lead is still present (details on Sheet 1 of 7, 1985). No other sheet lead products were noted in our review. While searching the internet for information about this use of lead in bridge designs, we did find reference to lead rubber bearing (LRB), however it was unclear from our review of the drawings if this type of product was utilized on this bridge. But it suggests that there may be other specialized uses of lead-containing products associated with bridge design.

Anti-fouling/corrosion Resistant Paints and Coatings

Lead and other metals were common additives to paint products to improved or change the characteristics of the paint. Lead, tin, mercury and zinc have commonly been associated with marine paints but other metals such as arsenic, copper and non-metals such as PCBs have been added to paints to improve wear and corrosion resistance. Based on the age of the structure, there may be lead and other metals in the paint present on the steel structure of the bridge. The coatings history information from the 1990s mentions several products that used an additive of powdered zinc. We reviewed product information sheets for these product (Epoxy 236 Barrust, Carbozinc 11, Dimetcote and Amerlock 400AL) and zinc was a common constituent, but lead was not listed. It was noted that we did not have access to the 1990s versions of these products. Under the Nova Scotia Landfill Disposal Guidelines, there are disposal criteria for various metals including lead, arsenic, mercury and zinc. Based on the 2019 Bridge inspection reports, there appeared to be areas of the coated steel that was flaking. Further testing of the paint would be recommended to confirm the presence / absence of metals in the coatings. This information would be used to design specifications for health and safety when working with the paint/coatings including grinding, welding, and torch cutting either as part of repair/rehabilitation work or deconstruction of the existing bridge. While unlikely to be present, a sample could also be screened for the presence of PCBs in older coatings. This information is also important to determine appropriate disposal options.

Mercury-containing Equipment

Industrial lighting has previously utilized mercury vapour for high intensity lighting such as navigation lights and streetlights. Details of the bulbs utilized on the bridge are not available, however there appear to be less than twenty lights associated with the bridge including a combination of traffic/streetlights and navigation lights on the underside and topside of the bridge.

PCB-containing Equipment

Some lighting systems traditionally used PCB-containing lamp ballasts. Typically, these ceased production in the early 1980s and stockpiles have been used up over the previous 40 years. Based on the expected continuous utilization of the lighting on the bridge and the lighting work completed in 2006, PCBs in lamp ballasts are not expected to be present. If older lighting was abandoned in-place it should be checked for PCB-containing lamp ballasts prior to disposal.

One of the documents provided was Drawing No. 110 dated June 1960 – Navigation & Aerial Obstruction Lights General Layout. On this drawing there is a connection to a power pole near Ross Ferry Road to be provided by the Power Company and new poles and a transformer that extend to the bridge on the eastern side of the bridge approach. No details were provided for this transformer in the reviewed plans. It is possible that this is an oil filled unit either pole mounted or pad mounted and prior to decommissioning of the unit it may require testing to determine the presence (or absence) of PCB oils. Ownership of this transformer should be confirmed as Nova Scotia Power may or may not be responsible for this unit. The lighting work for the roadway in 2006 included a drawing E2 that shows a buried cable for the roadway lighting and does not include the lighting for the navigation thus it is unclear if the transformer from the 1960s is still present or not.

Silica

The lower portion of the piers are made of concrete inset with granite blocks; the abutments and road deck are also made of concrete topped with asphalt. These products contain silica which is a potential respiratory hazard to workers but is not a material with special disposal requirements.

I.1.2 Rehabilitation vs Deconstruction

In keeping with the requirements of the Occupational Safety General Regulations, an assessment for hazardous building materials is recommended for the Seal Island Bridge prior to any work. This information would be used to inform specifications developed for either rehabilitation work or deconstruction activities to identify safe handling and disposal requirements. The testing of the existing coatings should include a general metals analysis as there may be concerns with the potential presence of metals other than just lead. Ideally this would also collect paint from various locations of the structure, some from well adhered locations of multi-layered coatings as well as from areas of loose and deteriorated coatings.

Rehabilitation Option Discussion

It is expected that as part of a bridge rehabilitation, metals-containing coatings represent the most tangible concern as other materials are expected to be minimal in their presence or will be left in place (such as the apparent lead sheeting present under the bed plates). The rehabilitation activities will result in the collection of some quantity of paint chips, sandblast residue mixed with paint or steel coated with paint as materials to be disposed of. Further work as part of the hazardous building materials assessment would determine if the waste coating material was suitable for disposal in province or required out of province disposal. Typically, steel materials with well adhered coatings are accepted for metal recycling regardless of the metals content of the coatings, with approval from the metal recyclers.

Based on the results of the hazardous building materials assessment, there may be sealants and similar compounds that may require abatement as asbestos, if encountered. The physical work to remove these materials does not appear to be extensive based on the reviewed photographs. The key issue would be access to the various locations which may require additional or specialized training beyond those normally present in skilled abatement workers.

Asphalt and concrete contain silica, and while the presence of silica is not a disposal concern it is a health and safety concern to be managed. In reviewing the photos included in the bridge inspection report, there appear to be various areas of concrete rehabilitation, which would be required to address areas of exposed reinforcing steel. Appropriate worker protection measures would be needed to address exposure to silica during this phase of a rehabilitation project.

It is assumed that if the roadways are reconfigured there will need to be changes to the streetlights and there may or may not need to be changes to the navigation lights. There are only a few lights on the bridge and most of the effort related to replacing lights (e.g., disposal requirements) would appear to be accessing the lights to collect them for potential disposal. If changes to the lighting systems require removal of the transformer, it should be tested to determine appropriate disposal options.

Deconstruction of Existing Bridge Discussion

Similar to the rehabilitation discussion, metals in paint are the most significant potential concern for the deconstruction option as well. Information provided in the 1958 plans indicates that between approximately 38,000 and 43,000 pounds of structural steel was used in each pier in addition to the steel supporting the spans. As part of a deconstruction project, it is expected that loose paint/coating materials will be collected for disposal to prevent material being deposited in the waterbody. Depending on if the bridge is torch-cut apart or metal shears are used, there may be additional abatement of paint needed at cut points to facilitate the deconstruction process without creating impacts to the waterbody. Additionally, there are demolition techniques to allow the possible re-use of the structural steel whether that be truss bays, girders, or other elements for uses elsewhere in lieu of disposal.

Unlike the rehabilitation option, items that would be exposed would also require collection and disposal. For example, to deal with the reported presence of the lead sheets under the bed plates, typically, sheet lead would be sent for recycling. In this instance, we are unclear if the lead under the bed plates will be recoverable as lead or if it is now so tightly bonded to the concrete that a section of concrete may need to be extracted to be disposed of as lead contaminated material with each of these bearing locations.

As noted rehabilitation section, as part of a demolition the lighting systems (active and any abandoned systems) would be removed from service, and would have to be assessed to determine appropriate disposal options.

As noted above there is a potential for asbestos-containing grouts or sealants to have been applied to the older pre-2001 concrete sections of the bridge. There may be subtle differences between abatement for rehabilitation versus abatement for deconstruction but based on the Bridge Inspection Report, older patches were described as failed so this would be assumed to be virtually the same between the two options.

There was a transformer associated with the navigation lighting system on the bridge in the 1960s which may or may not still be present. In a rehabilitation scenario it is possible that no changes would be made to the unit, however, under a deconstruction project it would be assumed that the ownership of the unit would be confirmed and the unit sent for disposal either by the utility at no cost to the owner or through the owner (the latter would require assessment to determine appropriate disposal options).

I.1.3 Climate Change

A high-level Climate Change Resilience Assessment (CCRA) has been conducted to identify the climate risks to the Seal Island Bridge at a broad systems-level based on a future climate scenario. Eleven scenarios for Seal Island Bridge design were proposed for design evaluation and benefit-cost analysis. The design scenarios are presented in Appendix O.1. The CCRA is intended to inform the NSDPW of projected changes in climate and associated risks to consider at the design evaluation stage of the Seal Island Bridge. The CCRA would also inform the project management team regarding the impact of climate change to be considered during the detailed design, construction, and operational stages of the project. This CCRA was prepared in accordance with Infrastructure Canada (INFC) Climate Lens General Guidance (latest version) (https://www.infrastructure.gc.ca/pub/other-autre/cl-occ-eng.html). The Climate Lens General Guidance recognizes the ISO 31000:2018 Standard Risk Management—Principles and Guidelines as a suitable methodology for climate change resilience assessments.

I.2 Technical Considerations – Details (Environment)

I.2.1 Climate Change

The CCRA assessed the potential future climate impacts on the infrastructure components of the proposed design scenarios referenced in Appendix O.1, and identifies the potential risks associated current and projected future climate and extreme weather events.

Identification of Climate Hazard

The CCRA identifies which climate hazards may affect the project infrastructure components under current and future climate conditions. The climate hazards are typically defined as climate events that can affect the asset. The climate hazards determined to have the most potential for impacting the project infrastructure components are listed in Table 28. A threshold value, along with the future trend of selected climate hazards and the interaction of climate hazards with the infrastructure components are also presented in Table 28. The threshold value is normally associated with a consequence or effect on an infrastructure asset and helps establish the probability that a particular climate event will occur.

Likelihood was estimated for both the historical climate data and the climate projections. The historical climate for the project site was characterized by the observations from Environment and Climate Change Canada (ECCC) weather stations and NRCANmet gridded dataset, developed in a collaboration between Natural Resources Canada (NRCan) and ECCC. Future climate for the region were retrieved from climate projections produced by Global Climate Models (GCMs) (www.climatedata.ca).

Table 28: Climate parameters selected for climate change risk assessment

Climate Variable	**Threshold**	**Future Trend**	**Impact Statements**
Temperature			
Extreme heat	Days (per year) with maximum temperature ≥ 32°C	Increasing	› Extreme heat can impact the wearing surface and expansion joints resulting in more maintenance requirements. › Extreme heat may cause discomfort to the users and O&M staff.
Extreme cold	Days (per year) with minimum temperature ≤ -30°C	Decreasing	› Extreme cold temperature may cause black ice and may increase the usage of salts resulting in increased maintenance requirements. › Extreme cold temperature may cause freezing and impact the functionality of drainage system. › Extreme cold may cause discomfort to the users and O&M staff.
Annual freeze-thaw cycles	Occurrences of 30 freeze-thaw cycles per year	Decreasing	› Temperature variation due to freezing and thawing may impact the functionality of bridge bearings. › Freeze thaw cycles may reduce the durability of concrete layer resulting in increased maintenance requirements. › Freeze thaw cycles may cause contraction/expansion of soils and thus may cause extra pressure on bridge foundation and abutments, wing walls resulting in crack, instability, etc. › Freeze thaw cycles may cause contraction/expansion of soils resulting in slope instability of embankment protection.

Table 28: Climate parameters selected for climate change risk assessment

Climate Variable	Threshold	Future Trend	Impact Statements
Precipitation			
Extreme rainfall - short duration high intensity	30 mm in 1 hr	Increasing	› High intensity rain may overwhelm the deck drain system resulting in slow drainage of excess water, which may cause local flooding. › High intensity rain may cause soil erosion resulting in slope instability of embankment protection.
Extreme rainfall – long duration	100 mm in 24 hrs	Increasing	› Long duration rain may exceed the capacity of the deck drain system resulting in local flooding. › Long duration rain may increase infiltration and impact the structural integrity of bridge abutments, wing walls. › Long duration rain may increase river water flow and impact the structural integrity of pile foundation. › Long duration rain may cause soil saturation and erosion of embankment materials resulting in changes in slope stability.
Heavy snow	Days with snowfall of ≥ 25 cm	Steady	› Freezing rain/ Heavy snow may impact the surface conditions of deck, bridge approach resulting in increased maintenance requirements. › Freezing rain/ Heavy snow may block the deck drain system resulting in increased maintenance requirements. › Freezing rain/ Heavy snow may impact the surface conditions of bridge deck, bridge approach, and AT lane resulting in safety issues for the users and O&M staff.
Freezing rain	10-15 mm of ice accumulation	Likely to increase	
Wind			
Wind gusts	Wind gusts greater than or equal to 75 km/hr	Likely to increase	› High wind speeds may cause increased loading and damages to the infrastructure components (e.g., cable, truss) of the bridge. › High wind speeds may cause debris to be blown on the bridge

Table 28: Climate parameters selected for climate change risk assessment

Climate Variable	**Threshold**	**Future Trend**	**Impact Statements**
	Wind gusts greater than or equal to 110 km/hr	Likely to increase	deck and bridge approach resulting in increased maintenance requirements. › High wind speeds may cause structural damage to the barriers of AT lanes due to high wind resulting in increased maintenance requirements. › High wind speeds may cause the safety issues to the users and O&M staff resulting in impacts on traffic operation.
Other			
Hurricanes/ tropical storms	Systems tracking within 60 nautical miles (nm) of existing bridge location	Steady	› Hurricanes/ tropical storms may cause structural damage to the infrastructure components (e.g., cable, truss) of the bridge due to high wind. › Hurricanes/ tropical storms may cause debris to be blown on the bridge deck and bridge approach resulting in increased maintenance requirements. › Hurricanes/ tropical storms may cause structural damage to the barriers of AT lanes due to high wind resulting in increased maintenance requirements. › Hurricanes/ tropical storms may cause flooding and structural damage to the bridge abutments, wing walls, foundation, and embankment protection due to erosion. › Hurricanes/ tropical storms may cause the safety issues to the users and O&M staff due to flooding and high wind.
Sea level rise	Relative sea level rise relative to 1986 to 2005	Increasing	› Sea level rise may cause flooding due to increased water level and impact the structural integrity of bridge abutments, wing walls, foundation, and embankment protection due to erosion.
Changes in wave height	Change in wave height relative to 1970 to 1999	Steady	› Increase in water level may impact the structural integrity of bridge abutments, wing walls, foundation, and embankment protection due to erosion.

Timescale of Assessment

The operational life of the proposed infrastructure ranges from at 25 to 50 years for the rehabilitation scenarios, to 100 years for the bridge replacement scenarios. Due to year-to-year variability, climate conditions are usually summarized as a 30-year average. Climate data from 1981-2010 were used to describe the baseline climate conditions. The climate projections for the 30-year period from 2041 to 2070 (referred to as the 2050s). In a similar way the 2080s cover the 30-year period from 2071 to 2100. The future climate conditions for the time periods of the 2050s (2041 to 2070) and 2080s (2071-2100) are considered for the climate risk assessment on the Project. The climate risks identified in this assessment are specific to the Representative Concentration Pathway 8.5, or the RCP 8.5 emission scenario. Climate modeling uses various greenhouse gas (GHG) emissions scenarios, known as Representative Concentration Pathways (RCPs), to project future climate variables under different concentrations and rates of release of GHGs to the atmosphere, as well as different global energy balances. RCP 8.5 is internationally recognized as the high GHG emissions scenario. Although some progress has been made, current estimates of GHG emissions are still close to following the RCP 8.5 path, therefore this assessment is based on the GHG and climate related conditions estimated under the RCP 8.5 scenario.

Infrastructure Assessment

The project infrastructure assets and infrastructure elements considered in this assessment are presented in Table 29. Only physical assets that are associated with the project were considered. Other infrastructure that may be developed along with the Project components, such as power transmission and telecommunication, were beyond the scope of the CCRA.

Table 29: List of project components being assessed

General Infrastructure Category	**Infrastructure Components**	**Design Scenarios ***										
		Rehabilitation			**New Bridge**							
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3 A**	**3B**	**4A**	**4B**
Superstructure	Steel structure (arches, hangers, steel box girders, bracings)	X	X	X		X	X	X	*Highest Ranked Option 2A-2C*	X	*Highest Ranked Option 2A-2C*	X
	Truss structure	X	X	X		X	X					
	Cable structure							X		X		X
	Concrete girders				X							
	Bearings	X	X	X	X	X	X	X		X		X
Substructure	Abutments and wingwalls	X	X	X	X	X	X	X		X		X
	Piers and pier caps	X	X	X	X	X	X	X		X		X
Deck	Deck	X	X	X	X	X	X	X		X		X
	Expansion joints	X	X	X	X	X	X	X		X		X

General Infrastructure Category	Infrastructure Components	Design Scenarios *										
		Rehabilitation			New Bridge							
		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
	Barriers and railing system	X	X	X	X	X	X	X		X		X
	Drainage system	X	X	X	X	X	X	X		X		X
	Wearing surfaces	X	X	X	X	X	X	X		X		X
	AT lane				X	X	X	X		X		X
Foundation	Foundations (including scour protection)	X	X	X	X	X	X	X		X		X
Embankment protection	Embankment protection	X	X	X	X	X	X	X		X		X
Auxiliary	Light poles	X	X	X	X	X	X	X		X		X
	Bridge approach	X	X	X	X	X	X	X		X		X
People	Users/ O&M staff	X	X	X	X	X	X	X		X		X

** Infrastructure components considered under each design scenario are marked as "X"*

The consequence impact criteria that were considered as part of this assessment are shown in Table 30. This list provides a framework for considering the potential impacts of climate on the Project's infrastructure components.

Table 30. Consequence of impact criteria

Consequence category	Description	Examples
Structural Integrity	Climate change may reduce a structure's/equipment's ability to withstand loads without failing or deforming and may exacerbate wear.	› Infrastructure failure (i.e., instability, damage) › Infrastructure deterioration (i.e., fatigue or weakening) › Increased loading and/or stress to the infrastructure component › Change in material performance (i.e., cracking)

Consequence category	Description	Examples
Operations & Maintenance	Climate change may impact the ability of O&M staff to access the worksite for maintenance or require updates to occupational health & safety procedures in maintaining safe access to worksites. Impacts from climate change result in an increase in O&M costs.	› Revisions to occupational health & safety procedures › Reduced serviceability › Increased maintenance / replacement cycles and frequencies › Increased operation and maintenance costs › Increased public health and safety hazards › Change in operational performance
Functionality	Climate change may impact the ability of the infrastructure system or component to function at its designed capacity.	› Infrastructure operates below design capacity (i.e., plugged culverts) › Service provided by infrastructure is reduced or ineffective to address climate impacts. › Temporary or permanent loss of service › Reduction in service or service quality

Risk Assessment

For this assessment, a rating scale of 1 (very low) to 5 (very high) for the likelihood of a climate event occurring was adopted as shown in Table 33. The consequence ratings are presented in Table 34, and also range from 1 (very low) to 5 (very high).

A risk rating was developed for each climate hazard / infrastructure element interaction. The risk rating is calculating my multiplying the consequence rating to the likelihood rating for each climate hazard and asset pair:

Risk Rating = Likelihood Rating x Consequence Rating

- **Likelihood Rating** represents the probability (likelihood) of occurrence of a climate event above a selected threshold
- **Consequence Rating** is a measure of the impacts on the infrastructure asset or component should the climate event occur

Using the equation "Risk Rating = Likelihood Rating x Consequence Rating" provides numerical risk ratings from 1-25. Risks are rated from "Negligible" (risk ratings of 1 to 2) to "Extreme" (risk ratings ≥20). A description of the different risk ratings, from negligible to extreme, are summarized in Table 35, and are based on risk ratings developed by Infrastructure Canada as part of their Climate Lens General Guidance.

The individual risk ratings for each climate-asset interaction were added together to characterize the total risk for each bridge option. Then the total risk scores were compared between each of the bridge options to estimate which bridge options were more at risk than others to climate change impacts. The relative risk scores associated with this analysis are provided in Table 36. These relative risk scores were carried forward as part of the pairwise analysis of risks for each bridge option.

In addition to the relative risk scores, there were several important themes related to climate change associated with the different bridge options:

- There were no extreme climate risks identified (i.e., a risk score of 25) for the bridge options.
- Many of the high risks for all bridge options were associated with:
  - extreme heat (due to potential additional long-term wear on physical components),
  - freeze-thaw cycles (due to potential additional long-term wear on physical components),
  - heavy snowfall (due to increased maintenance activities),
  - high wind events (due to structural damage and reduced accessibility),
  - hurricanes and tropical storms (due to structural damage and reduced accessibility), and
  - sea level rise (due to higher potential for flooding and erosion).
- Sea level rise was found to be a high risk for all bridge options by the end of the century.
- Adding Active Transportation lanes to some bridge options meant adding an additional asset exposed to climate risks and therefore led to small increases in total risk for those bridge options.
- Risks from extreme heat were rated as low in the baseline climate, but increased to high risk for many assets, including structural and operations and maintenance, in the 2050s and 2080s.

Table 31: Likelihood ratings based on climate event occurrence

Occurrence	Qualitative Descriptor	Descriptor	Rating
<1:50 year	Very Low	Not likely to occur in assessment period; or Not likely to become critical in assessment period	1
1:30-50 year	Low	Likely to occur once between 30-50 years; or Likely to become critical in 30 to 50-years	2
1:10-30 year	Moderate	Likely to occur once every 10 to 30 years; or Likely to become critical in 10-30 years	3
1: 1-10 year	High	Likely to occur at least once per decade; or Likely to become critical in a decade	4
>1/year	Very High	Likely to occur once or more annually; or will become critical in less than 10 years	5

Table 32: Consequence ratings

Consequence Rating	Criteria / Comments
1	**Very Low -** No serious impact from a weather event, routine maintenance will repair any damage.
2	**Low -** Some extra cost repairs and maintenance require but can be handled by operations staff. No loss of service.
3	**Moderate -** Some damage to infrastructure. Extra costs and labour required to complete repairs. Some specialized labour or equipment required to complete repairs. Some loss of service.
4	**High -** Significant damage to infrastructure. Significant extra costs and labour required to complete repairs. Specialized labour or equipment required to complete repairs. Significant loss of service.
5	**Very High -** Complete loss of the asset after a weather event. Repair not possible. Replacement of component required. Extended period of loss of service.

Table 33: Risk classification and description of risk

Risk Classification	Description of Risk
Negligible	› No permanent damage. › No service disruption occurs.
Low	› Minor asset/infrastructure component damage. › Minor service disruption may be possible. › No permanent damage. › Minor repairs or restoration expected.
Moderate	› Expected limited damage to asset or to infrastructure components. › Minor repairs and some replacement of infrastructure components may be required. › Brief service disruption may be possible.
High	› May result in significant permanent damage; or loss of asset or component that may require complete replacement. › More lengthy service disruption may be possible.
Extreme	› May result in significant permanent damage; or loss of asset or component that may require complete replacement. › Significant service disruptions may be possible.

Table 34: Climate change risk assessment summary

Design Scenario	Rank**
Rehabilitation	
1A	**Low** | Relatively Few Climate Change Risks
1B	**Low** | Relatively Few Climate Change Risks
1C	**Low** | Relatively Few Climate Change Risks
New Bridge	
2A	**Low** | Relatively Few Climate Change Risks
2B	**Moderate** | Additional Consideration of Climate Change is Likely
2C	**Moderate** | Additional Consideration of Climate Change is Likely
2D	**Moderate** | Additional Consideration of Climate Change is Likely
3A*	**Low** | Relatively Few Climate Change Risks
3B	**Moderate** | Additional Consideration of Climate Change is Likely
4A*	**Low** | Relatively Few Climate Change Risks
4B	**Moderate** | Additional Consideration of Climate Change is Likely

***Based on Total Risk Scores in Baseline and Future Climate; *Highest Ranked Option from 2A to 2C*

I.3 Technical Considerations – Evaluation (Environment)

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

I.4 Key Takeaways (Environment)

Hazardous Materials

Testing for hazardous materials is recommended regardless of the option selected as NSDPW will need to have a comprehensive understanding of the potential health hazards to properly plan and budget for the works to be undertaken regarding both the rehabilitation or the replacement of the Seal Island Bridge.

Climate Change

This climate change risk assessment identifies the climate risks to different design scenario at a broad system-level based on a future climate scenario and provides a discussion of the potential climate impacts on the infrastructure components associated with different design scenario. The climate hazards that presented the highest risks to the infrastructure components are related to extreme heat, freeze-thaw cycles, heavy snowfall, high wind events, hurricane/ tropical storms, and sea level rise. No high climate risks are identified for any climate hazard/ infrastructure component interaction. Total risk scores for each design scenario indicate that the expected climate impacts are increasing under future climate conditions for each design scenario. The climate risks identified for different design scenario are ranked from low to moderate. Once the final design is selected, it is recommended to review the climate risks identified in this assessment and to develop adaptation and resilience measures to minimize the climate impacts on the project infrastructure components.

I.5 Basis (Permitting Requirements)

It is anticipated that the project (i.e., rehabilitation or replacement of Seal Island Bridge), once officially proposed, will be subject to various legal and regulatory requirements, including several federal and provincial permits, approvals, authorizations, and other forms of regulatory consent that may be required to carry out the project (referred to herein as "permits" and "permitting requirements"). Key environmental permitting requirements that may be applicable with respect to the potential rehabilitation of the existing Seal Island Bridge and the potential decommissioning/removal of the existing bridge and construction of a new replacement bridge (either at the bridge's current location or at a new location, and either with maintenance of the bridge's current alignment or with alignment improvements) are described below to provide NSDPW with a regulatory roadmap for the various options under consideration. This regulatory roadmap and its contents are not intended to represent an exhaustive list of potential environmental permitting requirements or assurance regarding associated timelines. Project planning is in early stages with many details unknown at this time; therefore, all applicable environmental permitting requirements cannot currently be known. Stantec has provided a qualified opinion regarding potential key environmental permitting requirements to assist with planning; this information is subject to legal review and consultation with applicable regulatory authorities.

I.6 Technical Considerations – Details (Permitting Requirements)

The federal *Fisheries Act* includes pollution prevention provisions that are administered and enforced by Environment and Climate Change Canada. Section 36(3) of the *Fisheries Act* prohibits the deposit of deleterious substances of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance may enter such water. Table 35 outlines permitting requirements related to authorization under the Fisheries *Act for* potential project activities that are likely to cause death to fish and/or the harmful alteration, disruption, or destruction of fish habitat.

Table 35 provides an overview of key potentially applicable federal environmental permitting requirements, while Table 36 provides an overview of key potentially applicable provincial environmental permitting requirements for Nova Scotia. Additional federal and provincial environmental permitting requirements may also apply, depending on the option selected and detailed project description. Table 35 and Table 36 are not intended to provide a comprehensive list of all potential federal and provincial regulatory requirements and instead focuses on the main environmental permitting requirements, including those that are most likely to be applicable to the project and those that are likely to require the most time and effort to obtain.

Aboriginal and Treaty Rights are recognized and affirmed in Section 35(1) of the *Constitution Act, 1982*, which provides constitutional protection to these rights in Canada. The Supreme Court of Canada has held that the federal and provincial Crown (i.e., the Government of Canada and the Government of Nova Scotia) each have a legal duty to consult and, where appropriate, accommodate Indigenous groups when contemplating conduct that may adversely impact potential or established Aboriginal or Treaty rights. It is anticipated that NSDPW will have a legal duty to consult with Indigenous groups regarding the project since it is a provincial government department as well as the proponent of a project that that could adversely impact potential or established Aboriginal or Treaty rights. In circumstances where the federal government and/or provincial government departments other than NSDPW also have a legal duty to consult regarding the project (e.g., when contemplating the issuance of a federal or provincial environmental permit that would enable the project to proceed), procedural aspects of consultation may be delegated to NSDPW and/or NSDPW may need to provide detailed information as necessary to facilitate the consultation process. Further information regarding consultation and engagement considerations are noted in Table 35 and Table 36, where applicable.

Table 35 and Table 36 do not specifically consider wildlife-related permitting requirements because, in Stantec’s experience, there have been few (if any) occasions that have required obtaining wildlife permits in the course of project planning and permitting. However, project proponents must comply with the federal *Species at Risk Act*, federal *Migratory Birds Convention Ac*t, provincial *Wildlife Act*, and provincial *Endangered Species Act*:

- The federal *Species at Risk Act* (SARA) applies to species at risk (SAR) in Canada that are listed as threatened, endangered, or extirpated under Schedule 1 of SARA. SARA prohibits the killing, harming, or harassing of endangered or threatened SAR (sections 32 and 36) and the destruction of critical habitat of an endangered or threatened SAR (sections 58, 60, and 61).

- Migratory birds are protected under the federal *Migratory Birds Convention Act* (MBCA), which prohibits killing migratory bird species, their eggs, or their young; or disturbing, destroying, or taking a nest, egg, nest shelter, eider duck shelter, or duck box of a migratory bird (sections 5 and 6 of the Migratory Birds Regulations). The MBCA also prohibits the deposit of oil, oily wastes, or any other substances harmful to migratory birds in any waters or any area frequented by migratory birds (section 5.1 of the Act).

- Other (non-migratory) bird species not protected under the MBCA, such as raptors, are protected under the provincial *Wildlife Act*.

- Nova Scotia's *Endangered Species Act* (NS ESA) prohibits killing, injuring, possessing, disturbing, taking, or interfering with an endangered species or threatened species or any part or product thereof (section 13[a]); destroying, disturbing, or interfering with the specific dwelling place or area occupied or habitually occupied by one or more individuals or populations of an endangered or threatened species, including the nest, nest shelter, hibernaculum, or den of an endangered or threatened species (section 13[b]); contravention of any regulation made with respect to a core habitat (section 13[c]); and contravention of any order made pursuant to section 18 of the Act (section 13[e]). Endangered and threatened species are listed in the *Categorized List of Species at Risk Regulations* under the *Endangered Species Act*.

In general, the most pertinent regulatory requirement regarding the protection of wildlife is compliance with prohibitions under the MBCA, to which standard mitigation applies (e.g., avoidance of vegetation clearing during bird breeding season or directed nest searches and buffering if work cannot be avoided during the breeding season). Although wildlife permitting is not anticipated to be required in support of the project, it should be noted that potential project-related wildlife permitting requirements would generally be limited to the following (if applicable):

- A federal SAR Permit could be required under SARA if the project affects a SARA-listed aquatic or migratory bird species, any part of its critical habitat, and/or the residences of its individuals (e.g., birds' nests). For all other SAR, a Permit is only required if project activities occur on federally-owned lands. Permits are only granted for scientific research relating to the conservation of the species and conducted by qualified persons, in cases where the activity benefits the species or is required to enhance its chance of survival in the wild, or if affecting the species is incidental to the carrying out of the activity.

- A federal Scientific Collection Permit (under the *Migratory Birds Regulations* pursuant to the MBCA) could be required for the collection of migratory birds, their eggs, or their nests for scientific purposes, such as baseline or monitoring studies that require the collection of bird tissue. There is no permitting for incidental take.

- A provincial Scientific Permit (under the *General Wildlife Regulations* pursuant to the *Wildlife Act*) would allow the hunting, capturing, or export – for scientific or educational purposes – of wildlife animals, nests, or eggs that may not otherwise be legally taken in Nova Scotia. Such a permit could potentially be required depending on the nature of the environmental studies proposed to be conducted in support of the provincial EA and/or other environmental permitting requirements (as applicable), for example if specimen collection is required during baseline studies and assessment.

- A provincial Nuisance Wildlife Permit (under the *General Wildlife Regulations* pursuant to the *Wildlife Act*) could be required during the operational phase of the project if there is a need to kill or capture wildlife causing damage to project property.

The federal *Fisheries Act* includes pollution prevention provisions that are administered and enforced by Environment and Climate Change Canada. Section 36(3) of the *Fisheries Act* prohibits the deposit of deleterious substances of any type in water frequented by fish or in any place under any conditions where the deleterious substance or any other deleterious substance may enter such water. Table 35 outlines permitting requirements related to authorization under the *Fisheries Act* for potential project activities that are likely to cause death to fish and/or the harmful alteration, disruption, or destruction of fish habitat.

Table 35: Potential key federal environmental permitting requirements

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
1	Environmental Effects Determination (EED)	*Impact Assessment Act* (IAA) and associated *Physical Activities Regulations*	Public Services and Procurement Canada (PSPC), Transport Canada (TC), Fisheries and Oceans Canada (DFO), and/or Environment and Climate Change Canada (ECCC) (refer to Item #2, Item #3, Item #4, and Item #5 below in this table)	**<u>Context</u>** The IAA, which is administered by the Impact Assessment Agency of Canada (IAAC), outlines a process for assessing the impacts of "designated projects" that are carried out in Canada or on federal lands and are designated by the *Physical Activities Regulations* pursuant to the IAA, as well as other (i.e., non-designated) projects that are carried out on federal lands or outside of Canada. A federal impact assessment (IA) under the IAA is not anticipated to be required for the project since it does not involve any activities listed in the *Physical Activities Regulations*. However, requirements under sections 82 and 84–91 of the IAA may nonetheless apply to the project if any project activities or components are situated on federal lands, as defined under section 2 of the IAA. As described in Item #2, Item #3, Item #4, and Item #5 below in this table, the project may require one or more of the following: • A Crown grant from PSPC for the disposition of federal real property • Approval by the Minister of Transport under the *Canadian Navigable Waters Act* • Authorization by the Minister of Fisheries and Oceans Canada under the *Fisheries Act*. • A Disposal at Sea Permit from the Minister of Environment and Climate Change Because PSPC, TC, DFO, and ECCC are considered "authorities" (i.e., federal authorities) under section 81 of the IAA, PSPC, TC, DFO, and/or ECCC may be obligated to complete an EED (i.e., to determine the significance of environmental effects associated with the Project) in accordance with section 82 of the Act, which states: *An authority must not carry out a project on federal lands, exercise any power or perform any duty or function conferred on it under any Act of Parliament other than [the IAA] that could permit a project to be carried out, in whole or in part, on federal lands or provide financial assistance to any person for the purpose of enabling that project to be carried out, in whole or in part, on federal lands, unless* *(a) the authority determines that the carrying out of the project is not likely to cause significant adverse environmental effects; or* *(b) the authority determines that the carrying out of the project is likely to cause significant adverse environmental effects and the Governor in Council decides, under subsection 90(3), that those effects are justified in the circumstances.* Sections 85 to 91 of the IAA provide further details about the duties of authorities in relation to projects carried out on federal lands. Similar obligations would apply to any other federal authority that exercises a regulatory power or performs a regulatory duty or function to enable the Project to proceed (e.g., provision of funding or issuance of an environmental permit or approval), if applicable.	**<u>Application/Submission Requirements</u>** Although PSPC, TC, DFO, and/or ECCC, as federal authorities, are the parties that would be obligated to determine the significance of adverse effects prior to exercising any regulatory power or performing any regulatory duty or function that would permit the project to be carried out, in whole or in part, on federal lands, it is common for authorities to delegate the completion of an EED (or the completion of aspects of an EED) to the proponent of the project on federal lands. Most federal authorities have their own internal processes and templates, and associated information requirements, for determining the significance of adverse environmental effects. **<u>Regulatory Process</u>** A federal authority's determination regarding whether the carrying out of a project on federal lands is likely to cause significant adverse environmental effects must consider the following factors, as per sections 84(1)(a) to (e) if the IAA: *(a) any adverse impact that the project may have on the rights of the Indigenous peoples of Canada recognized and affirmed by section 35 of the Constitution Act, 1982;* *(b) Indigenous knowledge that is provided with respect to the project;* *(c) community knowledge that is provided with respect to the project;* *(d) comments received from the public under subsection 86(1); and* *(e) the mitigation measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project that the authority is satisfied will be implemented.* Authorities are required to post the following public notices on the online Canadian Impact Assessment Registry (the Registry): • a Notice of Intent indicating their intention to make a determination of the environmental effects of a project, and inviting the public to provide comments, in accordance with section 86(1) of the IAA • a Notice of Determination setting out the determination, in accordance with section 86(2) of the IAA). This is posted after a minimum of 30 days from the posting of the Notice of Intent. There is no formal mechanism to coordinate among multiple federal authorities with responsibilities for the same project. Coordination is often done informally in practice, with one of the authorities taking the lead in preparing a document with provision for the others to sign off on. Similarly, one authority can also take lead on Indigenous consultation as well as satisfying requirements with respect to the Registry.

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
				The project does not appear to be exempted from these requirements since bridge and highway infrastructure are not included in the *Designated Classes of Projects Order* that have been designated by the federal Minister of Environment and Climate Change as only causing insignificant environmental effects. Although a federal IA is not anticipated to be required for the project, it should also be noted that the federal Minister of Environment and Climate Change has the power to designate, by order, a physical activity that is not prescribed by the *Physical Activities Regulations*. Such a designation may be made upon request by an intervenor (within a legislated 90-day time limit following the request) or by the Minister's own initiative. The Minister may also refer an IA to a Review Panel if they are of the opinion that it is in the public interest to do so. **Potential Permitting Triggers** Potential EED requirements under the IAA could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** EED requirements could apply to potential bridge rehabilitation activities if the existing Seal Island Bridge is currently located on any federally-owned Crown lands (including submerged lands). EED requirements could also apply if any project activities associated with rehabilitation of the existing bridge are carried out, in whole or in part, on federally owned Crown lands (including submerged lands). • **Bridge Replacement –** EED requirements could apply to potential bridge replacement activities if any the lands (including submerged lands) on which the replacement bridge will be located (i.e., either at the bridge's current location or at a new location to the north or south) are federally-owned Crown lands. EED requirements could also apply if any other project activities associated with the decommissioning/removal of the existing bridge and/or the construction of a new bridge are carried out, in whole or in part, on federally owned Crown lands (including submerged lands). • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). An EED may be required if any project-related highway construction activities are carried out, in whole or in part, on federally-owned Crown lands (including submerged lands).	**Consultation and Engagement Considerations** Proponents of projects that are subject to sections 82 to 91 of the IAA may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the federal government's duty to consult.
2	Crown Grant for the Disposition of Federal Real Property	*Federal Real Properties and Federal Immovables Act* (FRPA)	Public Services and Procurement Canada (PSPC)	**Context** The term "federal real property" is defined in the FRPA as referring to any real property belonging to Her Majesty, including any real property of which Her Majesty has the power to dispose.	**Application/Submission Requirements** The application requirements will depend on the type of Crown grant disposition of real property that is required (if applicable). Given the variety of potential instruments available for the conveyance, leasing, and licensing of federal real property under the FRPA,

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				Sections 5–11 of the FRPA contain provisions relating to conveyancing, leasing, and licensing federal real property. The term "Crown grant" is used in the FRPA to refer to any of the instruments referred to in section 5 of the Act or any other instrument or act by which federal real property may be granted or federal immovables may be conceded. In accordance with section 5(1) of the FRPA, federal real property may be granted by letters patent under the Great Seal or by an instrument of grant, in a form satisfactory to the Minister of Justice, stating that it has the same force and effect as if it were letters patent. In accordance with section 5(2) of the FRPA, federal real property within Canada may, at the discretion of the Minister of Justice, be granted by any instrument by which, under the laws in force in the province in which the property is situated, real property may be transferred by a private person (e.g., deeds, commercial leases, or leases drawn in accordance with a provincial legislation pertaining to short form leases). **Potential Permitting Triggers** Potential regulatory requirements pertaining to the Crown grant disposition of real property under the FRPA could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** A Crown grant disposition of federal real property could be required in support of potential bridge rehabilitation activities if the existing Seal Island Bridge is currently located on any federally-owned Crown lands (including submerged lands), or if any project activities require the use of federally-owned Crown lands (including submerged lands). • **Bridge Replacement –** A Crown grant disposition of federal real property could be required in support of potential bridge replacement activities if any of the lands (including submerged lands) on which the replacement bridge will be located (i.e., either at the bridge's current location or at a new location to the north or south) are federally-owned Crown lands, or if any project activities associated with the decommissioning/removal of the existing bridge and/or the construction of a new bridge require the use of federally-owned Crown lands (including submerged lands). • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A Crown grant disposition of federal real property could be required in support of any project-related highway construction activities that require the use of federally-owned Crown lands (including submerged lands), if applicable.	consultation with PSPC's Real Property Branch is necessary to determine the appropriate instrument(s) and associated application requirements. **Regulatory Process** The regulatory process will depend on the type of Crown grant disposition of real property that is required (if applicable). Given the variety of potential instruments available for the conveyance, leasing, and licensing of federal real property under the FRPA, consultation with PSPC's Real Property Branch is necessary to determine the appropriate regulatory process and associated timelines. Section 5(1)(a) of the FRPA states that letters patent can still be used to grant federal real property. However, section 5(1)(b) provides for a new document, an "instrument of grant," which may be used instead of letters patent to grant federal real property. The "instrument of grant" is an alternative instrument which has the legal effect of letters patent and may be used to grant real property or any interest therein but does not have the complex processes and time delays associated with letters patent. It was thought at the time of designing the FRPA that the section 5(2) provincial instruments would be used most frequently, with the section 5(1)(b) instruments of grant being the fall-back instrument, and letters patent being used as a last resort (Government of Canada 1996). **Consultation and Engagement Considerations** If the federal government has a legal duty to consult in regards to issuing a Crown grant disposition of real property under the FRPA, NSDPW may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the federal government's duty to consult.

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3	Notification and/or Approval under the *Canadian Navigable Waters Act*	*Canadian Navigable Waters Act* (CNWA) and associated *Major Works Order* and *Minor Works Order*	Transport Canada's Navigation Protection Program (TC-NPP)	**<u>Context</u>** Under the CNWA, anyone who proposes to construct, place, alter, rebuild, remove, or decommission a work (e.g., a structure or device), other than a minor or major work, that is in, on, over, under, through, or across a navigable water may be required to go through a public notification and potential resolution[1] process or to apply to TC-NPP for regulatory approval (i.e., CNWA Approval). CNWA Approval is required for: • Works that have potential to interfere with navigation and are located within navigable waters that <u>are</u> listed in the schedule to the Act (i.e., "scheduled" navigable waters) • Works that are located within <u>any</u> navigable waters, including those that are <u>not</u> listed in the schedule to the Act (i.e., "non-scheduled" navigable waters), and have potential to interfere <u>substantially</u> with navigation Great Bras d'Or Lake, including the mouths of all connecting waterways, is listed in the schedule to the Act. The *Major Works Order* under the CNWA designates "major works" (including movable span bridges, floating span bridges, and fixed-span bridges with one or more piers below the ordinary high-water mark) that are likely to substantially interfere with navigation in any navigable waters and therefore require CNWA Approval. The *Minor Works Order* under the CNWA allows for designated "minor works" (including watercourse crossings, erosion protection works, temporary works, and dredging) to be carried out in any navigable waters without undergoing the application, review, and approval process, as long as the work meets specified criteria for the applicable class of works and is carried out in compliance with specific terms and conditions. Proposed minor works that meet all applicable requirements can proceed following submission of a "Notification of a Minor Work".	**<u>Application/Submission Requirements for CNWA Approvals</u>** The proponent initiates the process for obtaining a CNWA Approval by submitting a completed application form, including all required supporting documentation, to TC-NPP. The minimum information requirements to apply for a CNWA Approval are as follows: • A map showing the work's exact project location • The legal site description and position of the work in latitude and longitude • The plan view drawings (top down) with all related dimensions • The profile view drawings (side view) with all related dimensions • The general arrangement drawing (depicting new and entire existing work) • A detailed project description • The construction methodology explaining how the work will be done • The expected start and end dates The applicant must also deposit information about the work in locations specified by the Minister and publish a notice to advise interested parties that information has been posted for review. **<u>Regulatory Process for CNWA Approvals</u>** When processing an application for a CNWA Approval, TC-NPP completes the following activities: • The application is screened to ensure it includes all mandatory information and documents. • An NPP Officer reviews the project for impacts to navigation; this may include on-site assessments. • Additional information may be required from the proponent. Some or all of the following may also be required for some projects and conducted as parallel processes, where applicable:

[1] The resolution process allows the Minister of Transport to review navigation concerns and require approval where concerns remain unresolved for the proposed alteration, placement, rebuilding, removal or decommissioning of works in non-scheduled waters (Government of Canada 2021).

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				Proposed works that have potential to interfere with navigation in non-scheduled navigable waters may be permitted to proceed without a CNWA Approval through submission of a "Notification of Work on a Non-Scheduled Waterway". In the event that bridge rehabilitation or replacement activities include any proposed works (other than designated major or minor works) in navigable waters that will not interfere with navigation, NSDPW may proceed with such work(s) provided that a "No Interference with Navigation Notification of Work" is completed. According to TC-NPP's online Project Review Tool (Government of Canada 2022), the construction or placement of a new work does not interfere with navigation if it meets the following criteria: • It will not reduce or change the vertical or horizontal clearance available within the limits of the navigable water before construction begins. • It will not reduce or change the depth of the navigable water before construction begins. • It will not reduce visibility upstream or downstream of the work. • It will not change the ingress or egress (access and departure) routes of vessels to nearby works on the navigable water. • It will not impact any aids to navigation in the area. • It will not affect the navigable water itself, including water flow, bank characteristics, waterway bottom characteristics, or water levels. It is the proponent's responsibility to confirm that their proposed activities do not interfere with navigation. **<u>Potential Permitting Triggers</u>** Potential permitting and/or notification requirements under the CNWA could be applicable with respect to the following aspects of the project: **Bridge Rehabilitation or Bridge Replacement (Potential Triggers for Requirement to Obtain CNWA Approval) –** The *Major Works Order* designates fixed-span bridges with one or more piers below the ordinary high-water mark as major works that are likely to substantially interfere with navigation. As a fixed-span bridge with more than one pier below the ordinary high-water mark, the structure of the existing Seal Island Bridge is consistent with a designated major work. Since Great Bras d'Or Lake is listed in the schedule to the Act, rehabilitation or decommissioning/removal and replacement of Seal Island Bridge would be likely to substantially interfere with navigation within scheduled navigable waters. It is therefore anticipated that bridge rehabilitation or bridge decommissioning/removal and replacement activities will require CNWA Approval, regardless of whether the current bridge alignment is maintained or improved (assuming that the end result is a fixed-span bridge with one or more piers below the ordinary high-water mark) and regardless of whether the bridge is replaced at its current location or at a new location to the north or south of the existing bridge (assuming the new bridge remains within the scheduled navigable waters of Great Bras d'Or Lake).	• Input from other government agencies • Public review and comment • Environmental review(s) • Indigenous consultation • Governor in Council review Depending on the complexity of the application, the CWNA Approval process may take approximately 2–4 months to complete. The CNWA Approval, if granted, will list any terms and conditions with which the applicant must comply. An NPP Officer may inspect the site for compliance. **<u>Consultation and Engagement Considerations for CNWA Approvals</u>** Proponents of projects requiring CNWA Approval may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the federal government's duty to consult. For due diligence, engagement with Indigenous peoples is recommended to determine if they use watercourses near proposed Project activities for navigation purposes. Consultation with riparian/upland property owners is also recommended, where applicable. **<u>Application/Submission Requirements for CNWA Notifications</u>** To complete a Notification of a Minor Work, a Notification of Work on a Non-Scheduled Waterway, or a No Interference with Navigation Notification of Work, the proponent must deposit specific information about the work in locations determined by the Minister and publish a notice to advise interested parties that information has been posted for review. **<u>Regulatory Process for Notifications of a Minor Work</u>** The proponent should consult the *Minor Works Order* for guidance regarding requirements that need to be met for the duration of the construction, placement, alteration, rebuilding, removal, or decommissioning of the proposed work and the requirements for temporary works that are required to accomplish the proposed work. Owners of minor works must ensure that their works continue meeting the requirements for the duration of the operational life of the work. For certain classes of works under the *Minor Works Order*, proponents are required to deposit specific information on TC's External Submission website. Minimal information is required, such as a brief description of the project, the method of construction, site locations, and expected construction dates. All submitted information is published on the Common Project Search, an online registry that is accessible to the general public. For these classes of works, there is also a requirement to publish a public notice informing surrounding communities of the proposed minor works before the activity begins. The deposit and notification are voluntarily for the remainder of the classes of minor works.

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				• **Alteration of Bridge Alignment and/or Alteration of Bridge Location (Potential Triggers for Requirement to Obtain CNWA Approval and/or Requirement to Submit a Notification) –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). CNWA Approval may be required if project-related highway construction entails activities/works such as watercourse crossings, erosion protection works, and/or temporary works that have potential to interfere with navigation in scheduled navigable waters (e.g., Bras d'Or Lake or Great Bras d'Or Lake, including the mouths of all connecting waterways) or to interfere substantially with navigation in non-scheduled navigable waters. However, CNWA Approval may not be required if these activities/works can be carried out (i.e., designed and constructed or otherwise implemented) in accordance with the *Minor Works Order* and associated requirements (i.e., in such a way meets specified criteria for the applicable class of works and complies with specified terms and conditions) — in which case it is anticipated that a Notification of a Minor Work would be sufficient to address the potential effects of these project activities/works on navigation (if applicable). CNWA Approval may also be required if alteration of the bridge alignment and/or location entails other activities/works that are not designated as minor works, if these activities/works have potential to interfere with navigation in scheduled navigable waters or to interfere substantially with navigation in any navigable waters. However, CNWA Approval may not be required if these activities/works can be carried out in such a way that avoids scheduled navigable waters and does not interfere substantially with navigation in non-scheduled waters — in which case it is anticipated that a Notification of Work on a Non-Scheduled Waterway would be sufficient to address the potential effects of these activities/works on navigation (if applicable).	**Regulatory Process for Notifications of Work on a Non-Scheduled Waterway** The detailed information submitted in a Notification of Work on a Non-Scheduled Waterway is required for TC-NPP to identify potential interactions with shipping and boating activities; assess the likelihood of interference with navigation; and determine potential requirements for navigational warnings, updates to nautical charts and other navigational references, and/or issuance of Notices to Mariners. If TC-NPP determines, based on the information provided, that the Project is not likely to substantially interfere with navigation, it may be permitted to proceed without the requirement of Ministerial approval, subject to regulatory requirements and any terms and conditions applied to the Project. A CNWA Approval may be required if TC-NPP determines, based on the information provided, that the project is likely to substantially interfere with navigation. The Notification can also act as the Application for Approval, provided sufficient information about the Project is included in the Notification. Any comments must be provided to the proponent within 30 days after the publication of the notice. If any written comments are received, the proponent and the commenter(s) must attempt to resolve the concerns within 45 days of the end of the comment period. If the concerns are not resolved within that time period, the commenter(s) have an additional 15 days to request that the Minister make a decision on whether the proponent has to submit an Application for Approval in relation to the work. **Consultation and Engagement Considerations for CNWA Notifications** For due diligence, engagement with Indigenous peoples is recommended to determine if they use watercourses near proposed project activities for navigation purposes. Consultation with riparian/upland property owners is also recommended, where applicable.
4	*Fisheries Act* Authorization	*Fisheries Act* and associated *Authorizations Concerning Fish and Fish Habitat Protection Regulations*	Fisheries and Oceans Canada (DFO)	**Context** The *Fisheries Act* requires that projects avoid causing death to fish and/or the harmful alteration, disruption, or destruction (HADD) of fish habitat unless authorized by the Minister of Fisheries and Oceans Canada. Proponents of works, undertakings, or activities taking place in or near water should submit a Request for Review (RFR) to DFO's regional Fish and Fish Habitat Protection Program office when impacts to fish and fish habitat cannot be avoided and the scope of the project is not entirely covered under DFO standards and codes of practice (e.g., the code of practice for temporary and permanent clear span bridges in freshwater [DFO 2022]). Through the RFR process, DFO reviews project plans to determine potential impacts to fish and fish habitat and works with proponents to identify ways to reduce those impacts. If a proponent can design and plan their project so that death of fish and	**Application/Submission Requirements** If authorization under the *Fisheries Act* is required, an application must be prepared and submitted to DFO in accordance with the *Authorizations Concerning Fish and Fish Habitat Protection Regulations*. Part of the application process would include development of a habitat Offsetting Plan to compensate for fish habitat potentially impacted by the Project, as well as the provision of an irrevocable letter of credit issued by a recognized Canadian financial institution, or another equivalent financial guarantee, including a performance bond, to cover the costs of implementing the Offsetting Plan. In Stantec's experience, although the letter of credit must be submitted before DFO issues a *Fisheries Act* Authorization, it may be able to be deferred until after the application and Offsetting Plan are accepted by DFO. The following is a high-level overview of the application information requirements that are specified in Schedule 1 of the Regulations: • Contact information for the applicant • Detailed descriptions of:

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				the HADD of fish habitat is unlikely to occur, a *Fisheries Act* Authorization is not required, and the proponent is notified accordingly. However, if DFO determines, based on consideration of the information provided in the RFR, that death of fish and/or HADD of fish habitat will likely result from a project, the proponent is required to submit an application for authorization under section 34.4(2)(b) and/or 35(2)(b) of the *Fisheries Act*, respectively. **<u>Potential Permitting Triggers</u>** Potential permitting requirements under the *Fisheries Act* could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** Depending on the nature of proposed project activities and the extent to which they may require in-water and/or shoreline work that could impact aquatic species, benthic habitat, watercourse banks, and/or riparian vegetation, rehabilitation of Seal Island Bridge has potential to result in the death of fish and/or the HADD of fish habitat. Bridge rehabilitation activities may therefore require authorization under the *Fisheries Act*, regardless of whether the current bridge alignment is maintained or approved. • **Bridge Replacement –** It is assumed that potential bridge decommissioning/removal activities and construction activities associated with the replacement of Seal Island Bridge would entail in-water and/or shoreline work that could impact aquatic species, benthic habitat, watercourse banks, and/or riparian vegetation in such a way that is likely to result in the death of fish and/or the HADD of fish habitat, especially since it is not anticipated that it is technically feasible to replace Seal Island Bridge with a clear span bridge in accordance with DFO's applicable code of practice (DFO 2022). It is therefore anticipated that bridge decommissioning/removal and replacement activities would require authorization under the *Fisheries Act*, regardless of whether the bridge is replaced at its current location or at a new location to the north or south of the existing bridge. • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could result in physical disturbance of shoreline/riparian areas (potentially including fish habitat) and could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A *Fisheries Act* Authorization may be required if project-related highway construction entails activities/components such as watercourse crossings, erosion protection works, culverts, infilling, or other activities/components that could result in the death of fish and/or the HADD of fish habitat. However, a *Fisheries Act* Authorization may not be required for project activities/components that can be carried out (i.e., designed and constructed or otherwise implemented) in accordance with relevant DFO standards and codes of practice.	○ The proposed work, undertaking, or activity, including construction methods, engineering specifications, scale drawings, and dimensional drawings for physical works ○ Phases, schedule, and location of the proposed work, undertaking, or activity ○ Consultation activities and results for any consultations undertaken with Indigenous communities or groups and the public ○ Existing fish and fish habitat found at the location of the proposed work, undertaking, or activity ○ Potential effects of the proposed work, undertaking, or activity on fish and fish habitat ○ Measures and standards that will be implemented to avoid or mitigate death of fish and HADD of fish habitat • The number of habitat credits (i.e., a unit of measure that is agreed upon between the proponent and the Minister to quantify the benefits of a conservation project) that the applicant plans to use to offset the death of fish and the HADD of fish habitat • A detailed Offsetting Plan (i.e., a plan to offset the residual death of fish and/or the residual HADD of fish habitat that were not offset by habitat credits) An application for a *Fisheries Act* Authorization would typically also require supporting studies such as an underwater benthic habitat survey and sediment quality sampling survey. **<u>Regulatory Process</u>** It can take up to approximately 6–8 weeks for DFO to provide a determination regarding impacts to fish and fish habitat through the RFR process. Should an application for authorization be required, DFO's review can take up to 60 days following submission of the application and DFO may take up to 90 more days to issue a *Fisheries Act* Authorization after the application is deemed complete. If an aquatic species at risk or its critical habitat are also likely to be affected by the Project, the *Fisheries Act* Authorization will also serve as a permit under the federal *Species at Risk Act* and contain terms and conditions to reduce impacts on the species and its critical habitat. **<u>Consultation and Engagement Considerations</u>** The time limit for processing an application will cease in cases when DFO is required to undertake Indigenous consultation, in order to provide DFO with the time necessary to carry out meaningful consultation. Proponents of projects requiring authorization under the *Fisheries Act* may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the federal government's duty to consult. The application should include details of any public/stakeholder consultation and Indigenous engagement already undertaken by the proponent — in relation to the work, undertaking, or activity for which authorization is being sought — prior to submitting the application, if applicable.

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
5	Disposal at Sea (DAS) Permit	*Canadian Environmental Protection Act, 1999* (CEPA) and associated *Disposal at Sea Regulations* and *Disposal at Sea Permit Application Regulations*.	Environment and Climate Change Canada (ECCC)	**<u>Context</u>** The DAS provisions under Division 3 of Part 7 of CEPA are administered by ECCC and are applicable to the disposal of a substance at sea from a ship, an aircraft, a platform, or another structure. Only the types of waste and other matter specified in Schedule 5 of CEPA are eligible for marine disposal; these include inert, inorganic geological matter and uncontaminated organic matter of natural origin. **<u>Potential Permitting Triggers</u>** It is currently assumed that dredging (and potentially associated disposal at sea) is unlikely to be required in support of the project. However, if dredging is required, it would trigger the requirement for a *Fisheries Act* Authorization as well as development and implementation of an associated Offsetting Plan (refer to Item #4 above in this table) and, if ocean disposal of the dredged material is required, it would trigger the additional requirement for a DAS Permit under CEPA.	The DAS Permit application process can be complex and lengthy and is briefly summarized as follows: • Obtaining a DAS Permit is contingent upon meeting certain chemical and biological criteria, as specified in the Disposal at Sea Regulations under CEPA, for the material to be disposed. A potentially extensive sampling program may be required so that these parameters can be tested according to specific ECCC guidelines. • In addition to requiring detailed chemical and physical characterization of the materials to be disposed, the application must also include information about disposal specifications (including maximum quantity per disposal, frequency, speed during disposal, time required for discharge, track to be followed during disposal), a description of the loading site (including historical data, current uses, and proximity to sensitive areas), and consideration of alternatives to DAS, among other things. • A Notice of Application must also be published in a local newspaper. • Although there is a 90-day regulated service standard for ECCC to reach a decision after notifying the applicant in writing that the DAS Permit Application is complete, this time limit does not apply in some situations (e.g., if additional analysis or consultations are required). • The application fee for a DAS Permit is $2,500. • Long-term monitoring is conducted by ECCC. Further information regarding DAS application requirements is provided in the *Disposal at Sea Permit Application Regulations*. The DAS application and permitting process, including sampling/testing, application preparation, and regulatory review has potential to take up to a year or more.

Table 36: Potential key provincial environmental permitting requirements

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
1	Environmental Assessment (EA) Approval	Part IV of the *Environment Act* and Schedule A of the associated *Environmental Assessment Regulations* (EA Regulations)	Nova Scotia Environment and Climate Change (NSECC) – EA Branch	**<u>Context</u>** In Nova Scotia, provincial EAs are generally required for the undertakings that are listed in Schedule A of the EA Regulations, which are categorized as "Class I Undertakings" and "Class II Undertakings". Section of 3 of the *Environment Act* includes the following definition of an undertaking: "an enterprise, activity, project, structure, work or proposal that, in the opinion of the Minister, causes or may cause an adverse effect or an environmental effect, and may include, in the opinion of the Minister, a policy,	**<u>Application/Submission Requirements</u>** Section 33 of the *Environment Act* requires that "[e]very proponent of an undertaking shall (a) register the undertaking with the Minister in the time and manner prescribed by the regulations; and (b) publish a notice of the undertaking containing the information prescribed by the regulations." Section 9(1A) of the EA Regulations specifies the minimum requirements that a proponent must submit to the EA Branch to register an undertaking, as follows: • all applicable fees prescribed under the Act

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				plan or program or a modification, extension, abandonment, demolition or rehabilitation, as the case may be, of an undertaking". In accordance with section 9(1) of the EA Regulations, the registration of an undertaking must occur before a proponent proceeds with the final design of an undertaking. The following designated Class I Undertakings could be applicable to the project, depending on the nature of the activities and components that are ultimately included within the proposed scope of the project: • The construction of a new paved highway that is longer than two kilometres (km) and is designed for four or more lanes of traffic • The construction of a new paved highway that is longer than 10 km and is designed for two or more lanes of traffic • An undertaking that disrupts a total of two hectares (ha) or more of any wetland Class II Undertakings are typically larger in scale and are considered to have the potential to cause significant environmental impacts and concern to the public. These undertakings require an EA Report and formal public review which may include public hearings. The EA is referred to the EA Review Panel for all Class II Undertakings. Based on Stantec's understanding of the project, it is currently assumed that an EA for the project as a Class II Undertaking will not be required. **Potential Permitting Triggers** Potential provincial EA requirements could be applicable with respect to the following aspects of the project: • **Bridge Replacement –** A provincial EA may be required if replacement of Seal Island Bridge results in the disruption of 2 ha or more of a wetland. Decommissioning/removal of the existing bridge and construction of a replacement bridge could result in the disruption of 2 ha or more of a wetland, depending on the spatial extent of project-related physical disturbance to any wetland(s) that may be present in intertidal or terrestrial/riparian areas of the project footprint (if applicable), regardless of whether the bridge is replaced at its current location or at a new location to the north or south of the existing bridge. It is assumed that the project footprint associated with potential bridge rehabilitation activities would not spatially overlap with intertidal or terrestrial/riparian areas enough to disrupt 2 ha or more of a wetland. • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge	• an EA Registration document in the format provided by the Administrator that includes all the following: ○ the name of the proposed undertaking ○ the location of the proposed undertaking ○ the name, address, and identification of the proponent, ○ a list of contact persons for the proposed undertaking and their contact information ○ the name and signature of the Chief Executive Officer or a person with signing authority, if the proponent is a corporation ○ details of the nature and sensitivity of the area surrounding the proposed undertaking ○ the purpose and need for the proposed undertaking ○ the proposed construction and operation schedules for the undertaking ○ a description of the proposed undertaking ○ environmental baseline information ○ a list of the licenses, certificates, permits, approvals, and other forms of authorization that will be required for the proposed undertaking ○ all sources of any public funding for the proposed undertaking ○ all steps taken by the proponent to identify the concerns of the public and Indigenous peoples about the adverse effects or the environmental effects of the proposed undertaking ○ a list of all concerns expressed by the public and Indigenous peoples about the adverse effects or the environmental effects of the proposed undertaking ○ all steps taken or proposed to be taken by the proponent to address concerns of the public and Indigenous peoples identified under the preceding bullet It is at the discretion of the proponent to provide additional information beyond the minimum requirements specified in section 9(1A) of the EA Regulations. The amount of time it takes a proponent to prepare the registration document will depend on the complexity of the undertaking and the amount of information the proponent has already available. **Regulatory Process** The regulatory process for EA of a Class I Undertaking has a legislated 50-day timeline that includes completion of the following steps: • Registration of the EA Registration document • Distribution of the EA Registration document to various parties for review and comment, including a Review Committee consisting of provincial and federal government departments • The provision of opportunities for public review and comment • Review and consideration, by the EA Branch, of the information submitted during a 30-day review period

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				would result in physical disturbance of shoreline/riparian areas (potentially including wetland habitat) and could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A provincial EA may be required if the project entails the construction of a new paved highway that is longer than 2 km and is designed for four or more lanes of traffic, if the project entails the construction of a new paved highway that is longer than 10 km and is designed for two or more lanes of traffic, and/or if project-related bridge re-alignment and/or highway construction activities disrupt 2 ha or more of any wetland. Although pits and quarries larger than 4 ha in area are also designated as Class I Undertakings, pits and quarries established solely to provide fill or aggregate for road building or maintenance contracts with the NSDPW are exempted from provincial EA requirements under Section 4 of the EA Regulations. It is therefore assumed that any borrow pits/quarries that may be required in support of project-related highway construction (if applicable) would not trigger provincial EA requirements.	• Preparation, by the EA Branch, of a report to the Minister that summarizes the issues and comments and makes a recommendation for the Minister's consideration • Issuance of a written decision from the Minister advising the proponent of one of the following outcomes: ○ Additional information required (an additional 50 calendar days of government time would be required to complete the regulatory process associated with a request for additional information, with the proponent allowed up to one year to prepare the necessary addendum) ○ Undertaking approved ○ Focus Report required (an additional 108 calendar days of government time would be required to complete the regulatory process associated with a Focus Report, with the proponent allowed up to one year outside of the government time frame to prepare the Focus Report) ○ EA Report required (an additional approximately 275 days of government would be required to complete the regulatory process associated with an EA Report, with the proponent allowed up to 2 years outside of the government time frame to prepare the EA Report) ○ Undertaking rejected The potentially applicable application fees, as per the *Fees Regulations*, are as follows: • Registration of a Class I Undertaking: $17,250.40 • Focus Report: $6,634.75 • EA Report: $17,250.40 • Addendum (if additional information required): ½ registration fee • Approval Transfer: $662.85 If the undertaking is approved, the EA Approval will include any terms and conditions with which the proponent must comply. **Consultation and Engagement Considerations** The minimum information requirements that a proponent must submit to the EA Branch to register an undertaking, as specified in section 9(1A), include the following: • All steps taken by the proponent to identify the concerns of the public and Indigenous peoples about the adverse effects or the environmental effects of the proposed undertaking • A list of all concerns expressed by the public and Indigenous peoples about the adverse effects or the environmental effects of the proposed undertaking • All steps taken or proposed to be taken by the proponent to address concerns of the public and Indigenous peoples identified under the preceding bullet The provincial EA process includes the following key public input opportunities: • A 30-day public review period for all Class I registrations, as well as potentially associated submissions of additional information and Focus Reports (if applicable)

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					• Participation in proponent-led public and stakeholder consultation/engagement and Mi'kmaq engagement activities The provincial government has a legal duty to consult Indigenous groups when its conduct (e.g., the issuance of an EA Approval) has the potential to adversely impact Aboriginal or Treaty rights. Although third parties have no legal duty to consult, the provincial government may delegate procedural aspects of consultation to third parties (e.g., proponents) and/or proponents may need to provide detailed information as necessary to facilitate the government's consultation process.
2	Crown Land Lease, Right-of-Way, Easement, or Other Conveyance for the Disposition of Crown Land or any Interest in Crown Land	*Crown Lands Act*	Nova Scotia Department of Natural Resources and Renewables (NRR) – Land Services Branch	**Context** Under the *Crown Lands Act*, the Minister of Natural Resources and Renewables is responsible for provincially owned Crown lands, including submerged lands along the coast of the province. Crown lands are considered public assets which can be used for such things as economic development, recreation, and protection of biodiversity. The *Crown Lands Act* is administered by NRR and the Land Administration Division of its Land Services Branch. As per section 16(1)(a) of the *Crown Lands Act*, with the approval of the Governor in Council, the Minister may issue a grant, deed, lease, licence, or other conveyance for the disposition of Crown land or any interest in Crown land. The *Crown Land Leasing Policy* (NSDNR 2013) sets out the process for leasing provincial Crown land in Nova Scotia. As per section 16(1)(b) of the *Crown Lands Act*, with the approval of the Governor in Council, the Minister may grant a right-of-way or easement with respect to Crown land upon such terms and conditions as the Minister considers appropriate. Rights-of-way and easements across Crown land are granted where the intended use is long-term in nature, and other forms of permits, leases, or licences are not adequate/appropriate. A Crown Land Right-of-Way is adequate for access and road construction on Crown land. A Crown Land Easement is required if utility services are to be installed in addition to a roadway. **Potential Permitting Triggers** Regulatory requirements related to the disposition of provincial Crown land or an interest in provincial Crown land could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** It is assumed that the existing Seal Island Bridge already has the necessary disposition(s) of provincial Crown lands in place for ongoing operations, if the bridge is currently located on any provincial Crown lands (including submerged lands). The terms and conditions of any such disposition(s) (if applicable) may need to be revised in order to allow potential bridge rehabilitation activities to proceed. Additional disposition(s) may be required if any project activities	**Application/Submission Requirements for Crown Land Leases** The process for obtaining a Crown Land Lease is initiated by submitting a completed application form (i.e., Application for the Use of Crown Land), including all required supporting documentation, to NRR's Land Services Branch. Unless otherwise directed, the applicant must also complete the following requirements and comply with any other applicable government regulations, by-laws, or policies before a Crown Land Lease will be issued: • Pay all fees and charges associated with the issuance of the Lease. • Submit a Development Plan. • Submit a survey plan of the boundaries of the Lease. Surveys must be prepared by a Nova Scotia Land Surveyor who is a member of the Association of Nova Scotia Land Surveyors. • Provide an Accredited Appraiser Canadian Institute appraisal of the land value. • Provide proof of adequate liability insurance. • Submit required financial security and/or a performance bond. • Submit any additional documentation requested, which may be required based on the specific activity proposed in the application. **Regulatory Process for Crown Land Leases** NRR's Land Services Branch reviews requests for Crown Land Leases, on a first come, first served basis, following receipt of a completed Application for the Use of Crown Land. A public tendering process may be initiated if multiple requests for the same Crown land area(s) are received. NRR may reject an application if the proposed activity is not considered to be in the best interest of the Province, or at any time during the lease review process if information is received that would make the requested area not suitable for the requested purpose. The applicant may request a Comfort Letter to confirm that their Application for the Use of Crown Land has been received by NRR and is under review. The regulatory process for the issuance of a Crown Land Lease could take up to approximately two years following government acceptance of the Development Plan, depending on the complexity of the request and other factors such as the time it takes to complete Indigenous consultation. When processing an application for a Crown Land Lease, NRR's Land Services Branch will complete the following activities:

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				associated with bridge rehabilitation require the use of provincially owned Crown lands (including submerged lands). • **Bridge Replacement –** It is assumed that the existing Seal Island Bridge already has the necessary disposition(s) of provincial Crown lands in place for ongoing operations, if the bridge is currently located on any provincial Crown lands (including submerged lands). The terms and conditions of any such disposition(s) (if applicable) may need to be revised to allow potential bridge decommissioning/removal and replacement activities to proceed. The following additional disposition(s) may be required if any project activities associated with bridge decommissioning/removal and replacement require the use of provincially owned Crown lands (including submerged lands): ○ A Crown Land Lease may be required if the bridge or any of its components are proposed to be replaced at a new location on provincially owned Crown lands (including submerged lands). ○ A Crown Land Right-of-Way may be required if construction and operation of a replacement bridge at a new location requires long-term or permanent right of passage across provincially owned Crown lands (including submerged lands). ○ A Crown Land Easement may be required if a replacement bridge is constructed at a new location on provincially owned Crown lands (including submerged lands) and includes utility services. • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A Crown Land Right-of-Way may be required if construction and operation of project-related bridge and/or highway infrastructure requires long-term or permanent right of passage across provincially owned Crown lands (including submerged lands). A Crown Land Easement may be required if project-related bridge and/or highway infrastructure is proposed to be located on provincially owned Crown lands (including submerged lands) and includes utility services.	• The first step in the regulatory review process is for NRR to check the application for completeness, to confirm that the area requested is under the administration of NRR, to determine whether any legal encumbrances exist on the area that would interfere with the proposed activity, and to determine whether the proposed activity fits within the Department's policies and programs related to the use of Crown land. This process typically takes approximately 10 business days to complete. If it is determined that the application can proceed to the next step, the Applicant may request a Letter of Authority to granting interim access to the requested Crown land (e.g., to confirm its attributes). • The applicant will have up to 60 days to submit a Development Plan describing the proposed activity in detail. NRR will then evaluate the Development Plan based on the potential to conduct an acceptable activity and, if applicable, to operate a viable business. • NRR will initiate an Integrated Resource Management (IRM) review (i.e., a planning and decision-making process used by the Department to consider all the potential uses of land and determine whether the requested activity optimizes land use) to assess the Development Plan. Where necessary, NRR may refer the application to other provincial departments or agencies for review and recommendation. NRR will concurrently conduct consultation with the Mi'kmaq of Nova Scotia, following the consultation process established under the *Mi'kmaq-Nova Scotia-Canada Consultation Terms of Reference.* • NRR will send a Letter of Offer to the Applicant that sets out conditions and identifies any further requirements that may be applicable (e.g., provincial EA requirements, additional consultations with the Mi'kmaq of Nova Scotia, the need for a survey plan or land appraisal). The Letter of Offer will include an expiry date by which time the Applicant must have signed and returned the Letter of Offer. • If final approval is granted, a lease will be sent to the applicant for signature. The lease will outline the obligations of the lessee with reference to the approved Development Plan, which sets out the authorized activities. **Consultation and Engagement Considerations for Crown Land Leases** The applicant may be required to do one or more of the following to support the consultation process and/or facilitate the NRR's accommodation of the interests of the Mi'kmaq of Nova Scotia: • Conduct studies or research regarding Mi'kmaq interests within and in the vicinity of the requested Crown land. • Modify activities proposed for the requested Crown land to accommodate adverse impact(s) on Aboriginal or Treaty rights. • Make reasonable effort to negotiate, enter into, and implement a benefits agreement with the Mi'kmaq through the Assembly of Nova Scotia Mi'kmaq Chiefs. • Provide continued access to the Mi'kmaq for traditional activities (fishing, hunting, and harvesting for domestic purposes).

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					• Respect culturally significant areas important to the Mi'kmaq of Nova Scotia and provide them with continued access to those sites.
					<u>Application/Submission Requirements for Crown Land Rights-of-Way and Easements</u> The process for obtaining a Right-of-Way or Easement over Crown land is initiated by submitting a completed application form (i.e., Application for the Use of Crown Land), including all required supporting documentation, to NRR's Land Services Branch. Prior to the issuance of a Right-of-Way or Easement, unless otherwise directed, the Applicant must also complete the following requirements and comply with any other applicable government regulations, by-laws, or policies: • Pay all fees and charges associated with the issuance of the Right-of-Way or Easement. • Submit a survey plan of the boundaries of the proposed right-of-way or easement, if required. Surveys must be prepared by a Nova Scotia Land Surveyor who is a member of the Association of Nova Scotia Land Surveyors. • Provide proof of adequate liability insurance, if required. • Submit any additional documentation requested, which may be required based on the specific activity proposed in the application. **<u>Regulatory Process for Crown Land Rights-of-Way and Easements</u>** When processing an application for a right-of-way or easement over Crown land, NRR's Land Services Branch will complete the following activities: • Request a report from the Crown Land Information Management Centre to determine if the area is Crown land and if there are any encumbrances or title issues related to the Crown land where the Right-of-Way or Easement is proposed • Complete IRM review to identify special land features, uses, and resource values that may affect their decision to grant the request • Consult with the Mi'kmaq of Nova Scotia in accordance with the *Mi'kmaq-Nova Scotia-Canada Consultation Terms of Reference* to determine if the proposed Right-of-Way or Easement could impact Aboriginal or Treaty rights. • Make a decision that considers all the environmental, social, and economic information gathered and balances resource uses and values so that long term sustainable values are optimized, special land features and uses are protected, and conflicts are minimized • Seek approval of the Minister or Cabinet **<u>Consultation and Engagement Considerations for Crown Land Rights-of-Way and Easements</u>** Proponents of projects requiring a Crown Land Right-of-Way or Easement may be required to provide detailed information and/or take certain actions to support the government-led consultation process and/or facilitate the government's accommodation of the interests of the Mi'kmaq of Nova Scotia, similar to what is described above with respect to the Crown Land Lease regulatory process.

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					If the consultation process identifies issues that could impact the creation of the Right-of-Way or Easement, the applicant may be required to pay for additional reviews of the property, such as an archaeological survey and subsurface testing of the proposed Right-of-Way or Easement.
3	*Beaches Act* Permit	*Beaches Act* and associated *Beaches Regulations*	NRR	**Context** A "beach" is defined under the Beaches Act as "that area of land on the coastline lying to the seaward of the mean high watermark and that area of land to landward immediately adjacent thereto to the distance determined by the Governor in Council, and includes any lakeshore area declared by the Governor in Council to be a beach". The *Beaches Act* may apply to the shoreline of Great Bras d'Or Lake since that body of water it is a tidally-influenced estuary that is connected to the open sea. However, this assumption should be confirmed with NRR. As per section 6 of the *Beaches Regulations*, no person shall develop a beach without the prior written authorization and approval of the Minister. As per section 6 of the *Beaches Regulations*, except as provided in the Act or with a permit from the Minister, no person shall, while on a beach, wilfully remove, deface or injure any natural object, tree, shrub, plant or grass; wilfully remove, deface, damage or destroy a signboard, sign or notice placed on a beach or adjacent to a beach; wilfully remove or displace any rock, mineral, fossil, sand, gravel or other aggregate or object of natural curiosity or interest; display a sign or advertisement; or alter, damage or destroy any watercourse. As per section 9 of the *Beaches Regulations*, except with a permit from the Minister, it shall be an offence to have or use a vehicle on a beach. As per section 10 of the *Beaches Regulations*, except with a permit from the Minister, no person shall operate a vessel in excess of five miles per hour within 200 feet of a beach when another person is known by the operator of the vessel to be present on the beach. **Potential Permitting Triggers** Potential permitting requirements under the *Beaches Act* could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation or Bridge Replacement –** The *Beaches Act* may be relevant with respect to potential bridge rehabilitation activities, potential bridge decommissioning/removal and replacement activities, the potential use of project vehicles and equipment in the intertidal area (beach), and/or the potential installation of associated infrastructure in the intertidal area (beach), which is provincial Crown land in most cases, regardless of whether the current bridge alignment is maintained or	If a *Beaches Act* Permit is anticipated to be required in support of the Project, information regarding the application/submission requirements, regulatory process, and consultation and engagement considerations should be requested from NRR.

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				improved and regardless of whether the bridge is replaced at its current location or at a new location to the north or south of the existing bridge. • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge would result in physical disturbance of shoreline/riparian areas (including beach areas) and could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). The *Beaches Act* may be relevant with respect to potential bridge re-alignment activities, potential project-related highway construction activities, the use of project vehicles and equipment, and/or the potential installation of associated infrastructure in the intertidal area (beach).	
4	Watercourse Alteration Approval	Division I of the *Activities Designation Regulations* under the *Environment Act*	NSECC	**<u>Context</u>** Section 5A(2) of the *Activities Designation Regulations* designates altering a watercourse or water resource, or the flow of water in a watercourse or water resource, as an activity that requires regulatory approval, unless it requires a notification under section 5B of the Regulations (refer to Item #5 below in this table) or is exempt under section 5D of the Regulations. Section 3 of the *Environment Act* includes the following relevant definitions: • "watercourse" means the bed and shore of every river, stream, lake, creek, pond, spring, lagoon, or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and all groundwater. • "water resource" means all fresh and marine waters comprising all surface water, groundwater, and coastal water. **<u>Potential Permitting Triggers</u>** The potential requirement for a Watercourse Alteration Approval could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** Depending on the nature of proposed project activities and the extent to which they may require in-water or shoreline work that could alter the bed or bank of Great Bras d'Or Lake and/or the flow of water in Great Bras d'Or Lake, rehabilitation of Seal Island Bridge has potential to result in alteration of a watercourse and/or water resource. Bridge rehabilitation activities may therefore require a Watercourse Alteration Approval, regardless of whether the current bridge alignment is maintained or approved. • **Bridge Replacement –** Activities associated with the decommissioning/removal and replacement of Seal Island Bridge may alter	**<u>Application/Submission Requirements</u>** The process for obtaining a Watercourse Alteration Approval is initiated by submitting a completed application form, including all required supporting documentation, to NSECC. Section 6(1) of the *Approval and Notification Procedures Regulations* under the *Environment Act* specifies the required information that must accompany an application for regulatory approval in support of an activity designated under the *Activities Designation Regulations* (e.g., an application for a Watercourse Alteration Approval). Depending on the type of watercourse alteration proposed, it may be necessary to provide details such as calculations for sizing of structure, upstream watershed area, watercourse slope, watercourse velocity, channel width, channel depth, and whether or not the watercourse contains fish habitat. Applications for erosion protection works must also include calculations for erosion protection material sizing. Additional supporting documentation that is required for removal of material applications includes the following: • 1:50,000 topographic map with alteration location marked • pre-construction photos • work plan for in-the-dry installation (water control) • erosion and sediment control plan • calculations for erosion protection material sizing **<u>Regulatory Process</u>** Government processing time is typically approximately 60 business days following receipt of a complete application, including all necessary supporting documentation. Once an application has been accepted by NSECC as complete, the application form and supporting documentation undergo a technical review and evaluation to determine if the activity being proposed meets the minimum standards, policies, guidelines, procedures, and regulations that are administered by NSECC. If the application fails to meet these criteria, NSECC staff will advise which specific criteria have not been met to the satisfaction of the Department. DFO, Transport Canada, local authorities, and community organizations may also be involved in the application review

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				the bed or bank of Great Bras d'Or Lake. Following construction, the presence of the replacement bridge may alter the flow of water in Great Bras d'Or Lake (e.g., by altering the local current regime in proximity to the bridge). It is therefore anticipated that bridge replacement activities would require a Watercourse Alteration Approval, regardless of whether the bridge is replaced at its current location or at a new location to the north or south of the existing bridge. The potential requirement for a Watercourse Alteration Approval could conceivably be avoided (i.e., a Watercourse Alteration Notification may be sufficient) if bridge decommissioning/removal and replacement activities can be carried out (i.e., designed and constructed or otherwise implemented) in such a way that meets the criteria for notification under section 5B of the Regulations (refer to Item #5 below in this table). However, it is to be determined if it is technically feasible to carry out a bridge decommissioning/removal and replacement project of this scale in accordance with the notification criteria. • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A Watercourse Alteration Approval may be required if project-related highway construction entails activities/components such as watercourse crossings (e.g., culverts, bridges), erosion protection works, in-stream structures, beaver dam removal, removal of other material, watercourse diversion, water intake/dry hydrant installation, infilling, or other activities/components that could alter a watercourse and/or the flow of water in a water resource — unless any such activities/components meet the criteria for notification under section 5B of the Regulations to be sufficient (refer to Item #5 below in this table) or are exempt under section 5D of the Regulations. The potential exemptions specified under section 5D of the Regulations include the maintenance of such alterations or structures, if the work is done above the ordinary high-water mark.	process. If the application meets all applicable criteria, NSECC may issue a Watercourse Alteration Approval. The Approval, if granted, will list any terms and conditions with which the applicant must comply. Watercourse Alteration Approvals are valid until the expiry date shown on the Approval and can be renewed. It is the responsibility of the Approval holder to initiate the renewal process; no notice is sent by NSECC. Potentially applicable application, administrative, and usage fees are specified in the *Fees Regulations* under the *Environment Act*. **<u>Consultation and Engagement Considerations</u>** Proponents of project requiring a Watercourse Alteration Approval may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the NSECC's duty to consult. The application should include a description of any public/stakeholder consultation or Indigenous engagement activities undertaken or proposed by the applicant, if applicable.
5	Watercourse Alteration Notification	Division I of the *Activities Designation Regulations* under the *Environment Act*	NSECC	**<u>Context</u>** As indicated above, section 5A(2) of the *Activities Designation Regulations* designates altering a watercourse or water resource, or the flow of water in a watercourse or water resource, as an activity that requires an approval (refer to Item #4 above in this table), unless it requires a notification under section 5B of the Regulations or is exempt under section 5D of the Regulations. Section 3 of the *Environment Act* includes the following relevant definitions:	**<u>Application/Submission Requirements</u>** The process for Watercourse Alteration Notification is initiated by submitting a completed notification form, including all required supporting documentation, to NSECC. Section 24(3) of the *Approval and Notification Procedures Regulations* under the *Environment Act* specifies the required information that must accompany a notification in support of an activity designated under the *Activities Designation Regulations* (e.g., a Watercourse Alteration Notification). Depending on the type of watercourse alteration proposed, it may also be necessary to provide additional details on the notification form, such as calculations for sizing of structure, upstream

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				• "watercourse" means the bed and shore of every river, stream, lake, creek, pond, spring, lagoon, or other natural body of water, and the water therein, within the jurisdiction of the Province, whether it contains water or not, and all groundwater. • "water resource" means all fresh and marine waters comprising all surface water, groundwater, and coastal water. Each of the following watercourse alterations is designated under section 5B of the Regulations as an activity requiring notification: • constructing or modifying a single culvert or other single closed-bottom structure for the purpose of a road, railbed, trail, or footpath crossing, if all the following conditions are met: ○ the length of the culvert or structure is 25 m or less ○ the watercourse slope is less than 8.0% ○ the watershed of the watercourse crossing is 20 square kilometres (km^2) or less in area ○ the work begins on or after June 1 and ends on or before September 30 • constructing or modifying a bridge or other open-bottom structure for the purpose of a road, railbed, trail or footpath crossing, if all the following conditions are met: ○ the bed of the watercourse is not altered ○ the bank of the watercourse is altered ○ the length of the span is 15 m or less for a bridge, or 3,600 mm or less for a structural plate arch or other open-bottom structure ○ the length of any structural plate arch installed is 25 m or less ○ work that alters the bank of the watercourse begins on or after June 1 and ends on or before September 30 • a bank alteration not included under the preceding bullets, if all the following conditions are met: ○ the width of the portion of the bank that is altered is 5 m or less ○ the bed of the watercourse is not altered ○ the work begins on or after June 1 and ends on or before September 30 **<u>Potential Permitting Triggers</u>** The potential requirement for a Watercourse Alteration Notification could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation –** Constructing or modifying a bridge or other open-bottom structure for the purpose of a road, railbed, trail or footpath	watershed area, watercourse slope, watercourse velocity, channel width, channel depth, and whether or not the watercourse contains fish habitat. No other documents are required with the notification form; however, as part of an audit, a proponent may be asked to provide information used to plan the watercourse alteration (e.g., the calculations used to size a culvert or other crossing structure). **<u>Regulatory Process</u>** Government processing time is typically approximately five business days following receipt of a complete notification, including all necessary supporting documentation. Once a notification has been accepted by NSECC as complete, the notification form and supporting documentation undergo a technical review and evaluation to determine if the activity being proposed meets the minimum standards, policies, guidelines, procedures, and regulations that are administered by NSECC. If the notification fails to meet these criteria, NSECC staff will advise which specific criteria have not been met to the satisfaction of the Department. If the notification meets all applicable criteria, NSECC will issue a Notification Receipt. The Notification Receipt may list terms and conditions with which the applicant must comply. Notification projects must be completed between June 1 and September 30. The summer months are a low-flow period for the watercourse, which means the watercourse alteration work should have less impact. Notifications that are received after September 25 will be valid from June 1 to September 30 of the following year. A Watercourse Alteration Approval will be required from NSECC (refer to Item #4 above in this table) if the activities associated with the Watercourse Alteration Notification are not completed by September 30. **<u>Consultation and Engagement Considerations</u>** The notification should include a description of any public/stakeholder consultation or Indigenous engagement activities undertaken or proposed by the applicant, if applicable.

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
				crossing is identified under section 5B of the Regulations as a potential notification trigger. However, since the length of the existing bridge spans is greater than 15 m, it is assumed that rehabilitation of Seal Island Bridge would not meet the criteria specified in section 5B of the Regulations. As indicated above (refer to Item #4 above in this table), bridge rehabilitation activities may instead require a Watercourse Alteration Approval. • **Bridge Replacement –** The potential requirement for a Watercourse Alteration Approval could conceivably be avoided (i.e., a Watercourse Alteration Notification may be sufficient) if bridge decommissioning/removal and replacement activities can be carried out (i.e., designed and constructed or otherwise implemented) in such a way that meets the criteria for notification under section 5B of the Regulations. However, it is to be determined if it is technically feasible to carry out a bridge decommissioning/removal replacement project of this scale in accordance with the notification criteria. It is therefore anticipated that bridge replacement activities would instead require a Watercourse Alteration Approval, as indicated above (refer to Item #4 above in this table). • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-alignment or twinning of a portion of Highway 105 or new highway construction). A Watercourse Alteration Notification may be required if project-related highway construction entails activities/components such as: ○ constructing or modifying a single culvert or other single closed-bottom structure for the purpose of a road, railbed, trail or footpath crossing, if the conditions specified under section 5B of the Regulations are met; ○ constructing or modifying a bridge or other open-bottom structure for the purpose of a road, railbed, trail or footpath crossing, if the conditions specified in section 5B of the Regulations are met; or ○ a bank alteration, if the conditions specified in section 5B of the Regulations are met. If the conditions specified in Section 5B of the Regulations are not met, project-related highway construction activities/components may instead require Watercourse Alteration Approval, as indicated above (refer to Item #4 above in this table).	

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
				The potential exemptions specified under section 5D of the Regulations include the maintenance of such alterations or structures, if the work is done above the ordinary high-water mark.	
6	Wetland Alteration Approval	Division I of the *Activities Designation Regulations* under the *Environment Act*	NSECC	**<u>Context</u>** Section 5A of the *Activities Designation Regulations* designates altering a wetland, or the flow of water in a wetland, as an activity that requires regulatory approval, unless it is exempt under the *Nova Scotia Wetland Conservation Policy* (NSECC 2019). As per section 3 of the *Environment Act*, "wetland" means land commonly referred to as a marsh, swamp, fen or bog that either periodically or permanently has a water table at, near or above the land's surface or that is saturated with water, and sustains aquatic processes as indicated by the presence of poorly drained soils, hydrophytic vegetation and biological activities adapted to wet conditions. The *Nova Scotia Wetland Conservation Policy* (NSECC 2019) defines the following as Wetlands of Special Significance (WSS): • All salt marshes • Wetlands that are within or partially within a designated Ramsar site, Provincial Wildlife Management Area (Crown and Provincial lands only), Provincial Park, Nature Reserve, Wilderness Area, or lands owned or legally protected by non-government charitable conservation land trusts • Intact or restored wetlands that are project sites under the North American Waterfowl Management Plan and secured for conservation through the Nova Scotia Eastern Habitat Joint Venture • Wetlands known to support species at risk (SAR) as designated under the federal *Species at Risk Act* or the Nova Scotia *Endangered Species Act* • Wetlands in designated protected water areas as described within section 106 of the *Environment Act* In accordance with the *Nova Scotia Wetland* Conservation *Policy* (NSECC 2019), the provincial government will not support or approve proposed alterations to a wetland classified as a WSS, or alterations that pose a substantial risk to a WSS, with the following exceptions: • Alterations that are required to maintain, restore, or enhance a WSS • Alterations deemed to provide necessary public function, based on an EA (if required) with public review or other approvals (e.g., Wetland Alteration Approval) as appropriate The *Nova Scotia Wetland Conservation Policy* (NSECC 2019) states that an approval is not required for the following:	**<u>Application/Submission Requirements</u>** The process for obtaining a Wetland Alteration Approval is initiated by submitting a completed application form, including all required supporting documentation, to NSECC. However, NSECC recommends that proponents complete desktop WSS and SAR screenings prior to applying, as additional surveys or studies may be required depending on the outcome of these screenings. Section 6(1) of the *Approval and Notification Procedures Regulations* under the *Environment Act* specifies the required information that must accompany an application for regulatory approval in support of an activity designated under the *Activities Designation Regulations* (e.g., an application for a Wetland Alteration Approval). Applicants are required to retain the services of a person or persons qualified in the fields of wetland hydrology and wetland ecology to complete wetland delineation(s) in accordance with the US Army Corps of Engineers methodology and functional assessment(s) in accordance with the Wetland Ecosystem Service Protocol for Atlantic Canada (WESP-AC). The qualified person or persons should prepare a report that includes the following minimum information, to be submitted with the application. Wetland evaluations should be conducted during the growing season (June 1 to September 30) and completed within the same year as the application is submitted (i.e., within 12 months). However, out-of-season and older wetland evaluations may be submitted for consideration. Wetland compensation is required in cases where a wetland is permanently altered and/or there is impairment or loss of wetland functions. Wetland compensation usually involves restoring wetland habitat, but may also include the enhancement, creation, or expansion of wetland habitat, or other activities. Typically, NSECC requires primary compensation at a 2:1 ratio (e.g., 1 km^2 of altered wetland will require 2 km^2 of wetland restoration). However, this ratio is subject to change depending on various factors. Secondary compensation may include wetland enhancement, stormwater retention wetlands or wastewater treatment wetlands, preserving WSS, interpretive centres, development of public education, and/or wetland research. Wetland studies, interpretive centres and public education will most commonly be accompanied by a 1:1 restoration ratio (NSECC n.d.). Ideally, the application package should include a detailed Wetland Compensation Plan, or a signed commitment in the form of a Letter of Understanding (LOU). However, a Letter of Intent (LOI) can be used as a substitution, with a detailed compensation plan to follow within six months following approval of the application (NSECC n.d.). **<u>Regulatory Process</u>** Some activities require an EA Approval prior to the issuance of a Wetland Alteration Approval (refer to Item #4 above in this table).

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
				• Wetlands on federal lands (these are managed under the *Federal Policy on Wetland Conservation*) • Wetlands less than 100 square metres (m^2) in total area • Wetlands constructed specifically for wastewater or stormwater treatment • Wetlands created by humans on upland habitats not for the purpose of fulfilling compensation requirements under Wetland Alteration Approvals (e.g., excavated ponds) • Wetlands designated as "Marshlands" under the *Agricultural Marshland Conservation Act* as agricultural land • Wetlands within agricultural drainage ditches • Wetlands that develop as the unintended result of urban, commercial, industrial, or agricultural construction projects completed less than 20 years before the current calendar year • Linear developments that are less than 10 m wide and less than 600 m^2 in total area (e.g., forest access roads, secondary roads, and driveways) through shrub or wooded swamps that are not classified as WSS • Periodic or emergency maintenance for public safety or protection of adjacent properties and infrastructure in wetlands that develop within the medians or drainage ditches of transportation corridors or those within the footprint of existing utility corridors or electrical generation, transmission, and distribution infrastructure • Harvesting trees or mowing agricultural fields in a wetland **<u>Potential Permitting Triggers</u>** The potential requirement for a Wetland Alteration Approval could be applicable with respect to the following aspects of the project: • **Bridge Rehabilitation or Bridge Replacement –** A Wetland Alteration Approval may be required if construction activities associated with rehabilitation or replacement of Seal Island Bridge result in alteration of a wetland or the flow of water in a wetland. This potential permitting requirement applies to any wetland alteration that involves less than 2 ha of impact to a single wetland or affects multiple wetlands or wetland complexes by less than 2 ha each. Impacts that are greater than 2 ha to a single wetland or wetland complex would trigger provincial EA requirements (refer to Item #4 above in this table). • **Alteration of Bridge Alignment and/or Alteration of Bridge Location –** Altering the alignment and/or location of Seal Island Bridge could necessitate changes to the highway approaching the bridge (e.g., re-	Government processing time is typically approximately 60 business days following receipt of a complete application, including all necessary supporting documentation. Once an application has been accepted by NSECC as complete, the application form and supporting documentation undergo a technical review and evaluation to determine if the activity being proposed meets the minimum standards, policies, guidelines, procedures, and regulations that are administered by NSECC. If the application fails to meet the necessary criteria, NSECC staff will advise which specific criteria have not been met to the satisfaction of the Department. If the application meets all applicable criteria, NSECC may issue a Wetland Alteration Approval. The Approval, if granted, will list any terms and conditions with which the applicant must comply. Applications are reviewed and considered against the following mitigation sequence (i.e., hierarchy of priorities): avoidance of adverse effects, minimization of unavoidable adverse effects, and compensation for residual adverse effects that cannot be avoided. If detailed plans or agreements for compensation have not been submitted with application, they must be submitted within six months after approval. Physical work for compensation projects must be completed within two years after application approval, unless otherwise directed. Wetland Alteration Approvals are valid until the expiry date shown on the Approval (to a maximum of 10 years) and can be renewed. It is the responsibility of the Approval holder to initiate the renewal process; no notice is sent by NSECC. **<u>Consultation and Engagement Considerations</u>** Proponents of project requiring a Wetland Alteration Approval may need to provide detailed information and/or conduct engagement activities as necessary to facilitate fulfillment of the NSECC's duty to consult. The application should include a description of any public/stakeholder consultation or Indigenous engagement activities undertaken or proposed by the applicant, if applicable.

Item #	Potential Environmental Permitting Requirement	Applicable Legislation/ Regulations	Regulator	Context and Potential Permitting Trigger(s)	Application/Submission Requirements, Regulatory Process, and Consultation and Engagement Considerations
				alignment or twinning of a portion of Highway 105 or new highway construction). A Wetland Alteration Approval may be required if project-related highway construction entails activities/components that could affect wetland function and habitat, including, but not limited to, infilling, draining, flooding, or excavating. This potential permitting requirement applies to any wetland alteration that involves less than 2 ha of impact to a single wetland or affects multiple wetlands or wetland complexes by less than 2 ha each. Impacts that are greater than 2 ha to a single wetland or wetland complex would trigger provincial EA requirements (refer to Item #4 above in this table).	

I.7 Technical Considerations – Evaluation (Permitting Requirements)

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

I.8 Key Takeaways (Permitting Requirements)

Several federal and provincial environmental permitting requirements have potential to apply to the project. The length of time required and associated costs to obtain regulatory consent may vary considerably depending on project details, particularly the nature of the project (i.e., bridge rehabilitation or bridge decommissioning/removal and replacement) and siting (i.e., potential overlap of project activities/components with federal/provincial Crown lands and environmentally sensitive features such as watercourses and wetlands). Based on the limited information that is currently available regarding the nature, extent, and location of potential project activities, rehabilitating the existing bridge structure at its current location and maintaining its current alignment appears to be the project option with the least onerous environmental permitting requirements. This is based on the assumption that this project option ─ relative to the other options under consideration ─ would entail the least amount of in-water work below the high-water mark, as well as the least amount of intertidal/shoreline/riparian and upland terrestrial disturbance associated with potential project-related changes to bridge and highway infrastructure, and is less likely to result in delays associated with potential permitting requirements pertaining to provincial/federal Crown lands (including submerged lands) (if applicable). However, it is necessary to gain a better understanding of the extent of potential interactions between the project and wetlands before selecting a preferred option from an environmental regulatory and permitting perspective, as impacts that are greater than 2 ha to a single wetland or wetland complex would trigger provincial EA requirements.

As project planning proceeds, it would be helpful to revisit potential environmental permitting triggers and refine this regulatory roadmap, including the development of a project workplan. In that sense this should be considered an iterative planning tool. Understanding likely the environmental permitting process and requirements is beneficial to inform project planning and reduce risks.

Technical Considerations Review - Environment

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (C Blair)
Reviewed by: Stantec (P Flower)

Stantec COWI

<table>
<tr><th rowspan="3">Categories</th><th colspan="3">Rehabilitate</th><th colspan="4">New Bridge
Existing Location</th><th colspan="2">New Bridge
New Location - North</th><th colspan="2">New Bridge
New Location - South</th></tr>
<tr><th>25 yrs</th><th>50 yrs</th><th>50 yrs w/ Alignment Improvement</th><th colspan="3">Medium Span</th><th>Long Span</th><th>Medium Span</th><th>Long Span</th><th>Medium Span</th><th>Long Span</th></tr>
<tr><th>1A</th><th>1B</th><th>1C</th><th>2A</th><th>2B</th><th>2C</th><th>2D</th><th>3A</th><th>3B</th><th>4A</th><th>4B</th></tr>
<tr><td>BRIDGE AND ALIGNMENT DESCRIPTIONS</td><td colspan="11">Details</td></tr>
<tr><td>Bridge type</td><td colspan="3">Existing arch with truss approach spans</td><td>Concrete box</td><td>Steel box</td><td>Network arch</td><td>Cable stayed</td><td>(Highest Ranked 2A-2C)</td><td>Cable stayed</td><td>(Highest Ranked 2A-2C)</td><td>Cable stayed</td></tr>
<tr><td>Main span length (m)</td><td colspan="3">152 m</td><td colspan="3">≈152 m</td><td>≈280 m</td><td>Min. 152 m</td><td>≥ 560 m</td><td>Min. 152 m</td><td>≥ 560 m</td></tr>
<tr><td>Alignment route</td><td colspan="2">Existing (I)</td><td colspan="5">Improved Existing (II)</td><td colspan="2">New North (III)</td><td colspan="2">New South (IV)</td></tr>
<tr><td>Alignment limitations</td><td colspan="2">Existing alignment; existing speed</td><td colspan="5">Existing alignment improved; min. 70 km/hr</td><td colspan="4">New alignment; min. 90 km/hr</td></tr>
<tr><td>Category 2. FEATURES</td><td colspan="11">Details | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"</td></tr>
<tr><td>2.1 Wider Traffic Lanes (min. 2 Lanes)</td><td colspan="11" rowspan="7">N/A | Not a component of this technical consideration.</td></tr>
<tr><td>2.2 Active transportation lanes</td></tr>
<tr><td>2.3 Clearance of navigational channel</td></tr>
<tr><td>2.4 Use of existing highway infrastructure</td></tr>
<tr><td>2.5 NSPW owns required land</td></tr>
<tr><td>2.6 Service life beyond 50 years</td></tr>
<tr><td>2.7 Utility/service accommodations</td></tr>
<tr><td>Category 3. RISKS</td><td colspan="11">Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"</td></tr>
<tr><td>3.1 Impact to trade corridors during construction</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.2 Impact to trade corridors in-service</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.3 Constructability / complexity of erection sequence</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.4 Climate Change</td><td>Low | Relatively Few Climate Change Risks</td><td>Low | Relatively Few Climate Change Risks</td><td>Low | Relatively Few Climate Change Risks</td><td>Low | Relatively Few Climate Change Risks</td><td>Moderate | Additional Consideration of Climate Change is Likely</td><td>Moderate | Additional Consideration of Climate Change is Likely</td><td>Moderate | Additional Consideration of Climate Change is Likely</td><td>Low | Relatively Few Climate Change Risks</td><td>Moderate | Additional Consideration of Climate Change is Likely</td><td>Low | Relatively Few Climate Change Risks</td><td>Moderate | Additional Consideration of Climate Change is Likely</td></tr>
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<tr><td>3.6 Approvals, permitting and consultation</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>LOW | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be relatively less onerous for bridge rehabilitation options (particularly with maintenance of existing alignment) than for new bridge construction.</td><td>MODERATE | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be slightly more onerous for new bridge construction.</td><td>MODERATE | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be slightly more onerous for new bridge construction.</td><td>MODERATE | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be slightly more onerous for new bridge construction.</td><td>MODERATE | Anticipate permit and approvals required regardless of option selected. Potential permitting requirements may be slightly more onerous for new bridge construction.</td></tr>
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<tr><td>Category 4. OPPORTUNITIES</td><td colspan="11">Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"</td></tr>
<tr><td>4.1 Public safety</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
</table>

Technical Considerations Review - Environment

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (C Blair)
Reviewed by: Stantec (P Flower)

	Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement		Medium Span		Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
4.2	Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3	Environmental gains	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	LOW | Minimal change anticipated; no environmental gains.	MODERATE | New footprint will result in new areas to be impacted by construction and presence of new bridge.	MODERATE | New footprint will result in new areas to be impacted by construction and presence of new bridge.	MODERATE | New footprint will result in new areas to be impacted by construction and presence of new bridge.	MODERATE | New footprint will result in new areas to be impacted by construction and presence of new bridge.
4.4	Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.5	Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix J Technical Considerations | Aesthetics

J.1 Basis

Aesthetics of the rehabilitation or new crossings have a significant and far-reaching impact on the local community. An improved crossing, by means of a rehabilitated or new bridge, will be an opportunity to promote tourism and marketing for this area of the province. Considering the extensive costs of any new major piece of infrastructure, aesthetics should be taken into account along with other technical considerations, as the rehabilitated and/or replacement bridge will be a landmark that will last for at least a century.

The existing crossing is a steel through-arch truss bridge, which was common structure type in the 1960s but not as common or practical in today's age primarily due to labour intensive installation for truss-to-truss connections, advancement of alternative bridge material performance (e.g., concrete), more efficient structures (longer spans), and state of the art construction sequences.

Recognizing that a visibly appealing structure is important to NSDPW, COWI considered multiple bridge structure types that are appropriately selected for the given alignments. Through conversations with NSDPW, COWI understands that is not strong preference from NSDPW (or through their perception of the local community) that the visual consistency of a steel arch truss bridge needs to be maintained for the new crossing options.

J.2 Technical Considerations - Details

For the rehabilitation options, the overall bridge aesthetics are restricted to the existing through-arch bridge type. While strengthening and/or incorporation of additional features is possible, the overall structure arrangement and aesthetics would be virtually unchanged. For this reason, bridge aesthetics represent a limited impact on all rehabilitation options besides potential benefit of maintaining the existing structure appearance.

For the new crossing options, there are numerous bridge types that could be implemented including haunched girder bridges, cable-stayed bridges, extradosed bridges, arch bridges, suspension bridges and many others. Considering the limited number of complex or signature structures within Nova Scotia, a new crossing would present an opportunity for a unique structure in the province. Some aesthetic considerations for each type of new bridge considered in this study are discussed below:

- Concrete segmental and steel box bridges can span long distances with slender, non-intrusive, elegant superstructures supported by tall piers that can be shaped to include architectural details.

- Network arches are slender and transparent highly efficient structures. The arches are above the roadway level, presenting similarities to the existing bridge. Network arches are typically made of steel, which can be painted to make the bridge visually appealing.

- Cable-stayed (and extradosed) bridges are structures that are usually perceived as engineering wonders. Main towers (or pylons) are typically tall structures (for some options reaching over 150m in height) and therefore highly visible from the surrounding area. While this provides opportunities to positively impact the bridge surroundings also make necessary that they are carefully designed making sure a gracious structure is built.

Table 37 showcases examples of bridges designed by the Team that are similar to the those that are proposed for the Seal Island Bridge. They are provided for reference and were used as inspiration for project.

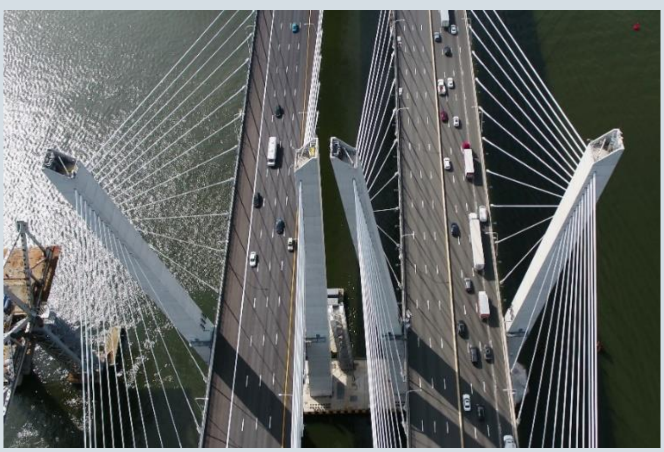
Table 37: Considered bridge types and representative examples

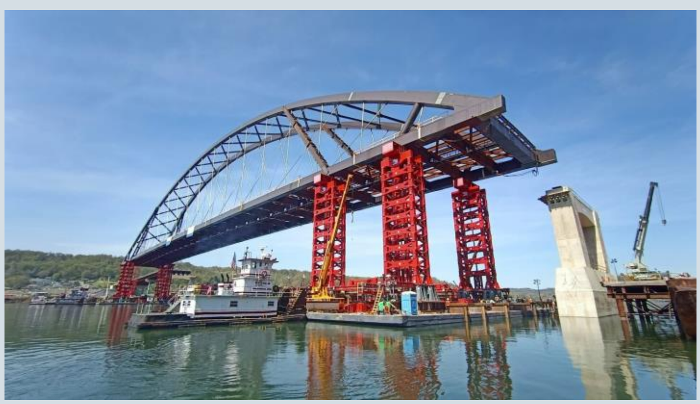
Bridge Type	Representative Bridge Example
Segmental / Haunched Box	Confederation Bridge (Between NB and PEI, Canada):  South Fork American River Bridge (El Dorado County, California, USA):  Clarence L. Gosse Bridge (South Maitland, NS, Canada) 

Cable-Stayed

Alex Fraser Bridge (Delta, BC, Canada):

Governor Mario M. Cuomo Bridge (Tarrytown, NY, USA):



Extradosed	Golden Ears Bridge (Langley, BC, Canada): 
Network Arch	Wellsburg Bridge (Richmond, VA, USA) – opened in fall 2023:  

J.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

J.4 Key Takeaways

All rehabilitation options will maintain the existing through-arch truss bridge. This is a conservative approach from the point of view of aesthetics. It maintains the current visual configuration of the crossing, one that has organically become part of the landscape of the area over the years.

The new crossing options provide more opportunities with regards to aesthetics. Each new crossing options, ranging from concrete boxes, steel boxes, network arches, and cable stayed (or extradosed), include elements that can contribute to enhance the site visually and the experience of those crossing the bridge and those enjoying the surrounding area.

- Concrete segmental and steel box bridges are able to span long distances with slender, non-intrusive, elegant superstructures supported by tall piers that can be shaped to include architectural details.

- Network arches are slender and transparent highly efficient structures. The arches will be above the roadway level, presenting similarities to the existing bridge. Network arches are made of steel, which can be painted to make the bridge visually appealing according to NSDPW's preferences.

- Cable stayed (and extradosed) bridges are structures that are usually perceived as engineering wonders. Main towers (or pylons) are typically tall structures (for some options reaching over 150m in height) and therefore highly visible from the surrounding area. While this provides opportunities to positively impact the bridge surroundings also make necessary that they are carefully designed making sure a gracious structure is built.

Technical Considerations Review - Aesthetics

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			

	Category 2. FEATURES	Details | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"
2.1	Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*
2.2	Active transportation lanes	
2.3	Clearance of navigational channel	
2.4	Use of existing highway infrastructure	
2.5	NSPW owns required land	
2.6	Service life beyond 50 years	
2.7	Utility/service accommodations	

Category 3. RISKS

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

	Category 3. RISKS	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
3.1	Impact to trade corridors during construction	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.2	Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3	Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4	Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5	Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6	Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.7	Operational issues during service life	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.8	Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Category 4. OPPORTUNITIES

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

	Category 4. OPPORTUNITIES	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.1	Public safety	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.2	Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3	Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.4	Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Technical Considerations Review - Aesthetics

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

Stantec COWI

	Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.5	Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	NEUTRAL | Aesthetics effectively maintained to existing bridge	NEUTRAL | Aesthetics effectively maintained to existing bridge	NEUTRAL | Aesthetics effectively maintained to existing bridge	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public	NEUTRAL | Negligible indication from NDSPW that new aesthetics are important to public
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	NEUTRAL | Aesthetics effectively maintained to existing bridge	NEUTRAL | Aesthetics effectively maintained to existing bridge	NEUTRAL | Aesthetics effectively maintained to existing bridge	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics	BETTER | New bridge options featuring modern aesthetics

Appendix K Technical Considerations | Active Transportation

K.1 Basis

In its current form, the existing bridge roadway width is very narrow and does not have the space or dedicated delineation for active transportation (AT) users, however, it represents the shortest route for cycling users between two major destinations of the Cabot Trail and Sydney, NS.

The existing structure presents itself as a "bottleneck" for cyclists as it has narrow lanes, no shoulders and no cycling features creating frustration and safety concerns for all levels of AT users. A new bridge design will include active transportation features the follow design standards recommended by Transportation Association of Canada (TAC) for a protected or buffered facility. This new design will consider safety, winter maintenance, current standards, and the consideration of a rest area and/or look-off feature at the crest of the bridge. Incorporating AT lanes can additional benefits related to tourism; however, these potential benefits were not accounted for in this technical consideration.

Active Transportation features were not considered on the roadway (other than paved shoulder), only bridge options to include Active Transportation.

K.2 Technical Considerations – Details

An integral active transportation network is vital to healthy and safe living and is now a consideration of most new transportation infrastructure projects. With the existing North Sydney / Cabot Trail KOA campground on the west end of the existing bridge location, an AT facility will consider cycling and pedestrian activity out of this site. The province of Nova Scotia and Bicycle Nova Scotia has a Blue Route (https://blueroute.ca/status-map/, Figure 42) to distinguishing a provincial cycling network throughout the province and currently does not show the route extending up Kelly's Mountain towards the bridge. With input from NSDPW it was advised there is considerable interest and demand for cycling infrastructure on the bridge and approaches to bridge to complete the network as it is the shortest route from Sydney to Cabot Trail. To meet the criteria for the blue route to go across the bridge a separate path to the highway is needed and not in the scope of this exercise.

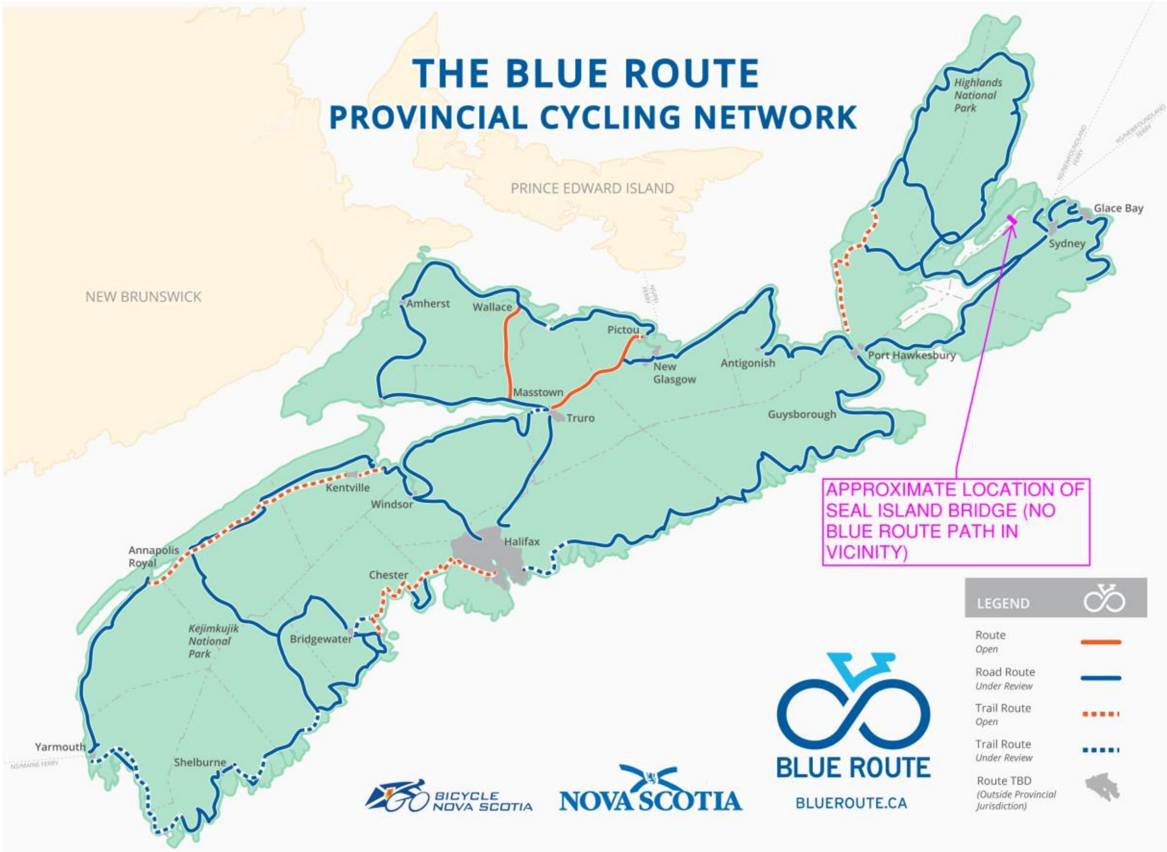


Figure 42: The Blue Route Provincial Cycling Network (accessed on 2022 Dec 16 from: https://blueroute.ca/status-map/) with the Seal Island Bridge approximate location in identified

The known existing condition of the bridge specific to AT considerations are as follows:

- Two (2) lane bridge with no shoulders or AT facilities; and
    - Posted speed limit 90 km/h;

A new bridge design will include active transportation features the follow design standards recommended by Transportation Association of Canada (TAC) in the Geometric Design Guide for Canadian Roads (2017) for a protected or buffered facility. The following is a description of those items for consideration.

- TAC – Buffered Bike Lanes (Figure 43 and Figure 44):

- Defined primarily by white pavement markings running parallel to the roadway where at least one of the markings acts as a longitudinal buffer to increase separation between cyclists and adjacent motor vehicles.

- The buffer space is typically demarcated with a pavement marking such as hatched stripping and can decrease ambiguity as to the extent of the lane.

- Recommended Standards from Transportation Association of Canada (TAC) in the Geometric Design Guide for Canadian Roads (2017, Table 5.3.2: Design Domain: Width of Buffered Bike Lane) include a width of buffered bike lane including buffer = 3.0 m.

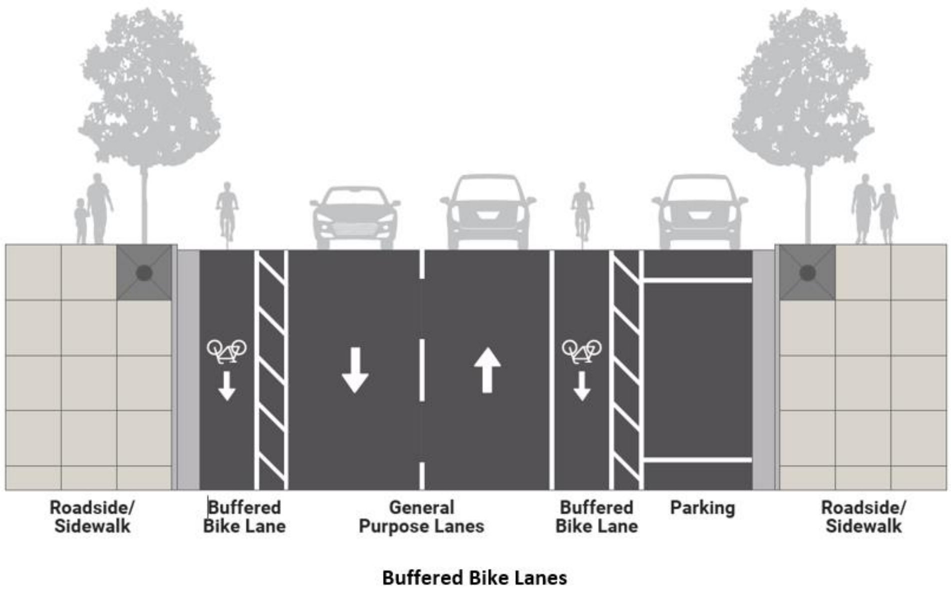


Figure 43: Buffered bike lanes (drawing adapted from TAC Geometric Design Guide for Canadian Roads,Figure 5.3.2 Buffered Bike Lanes)

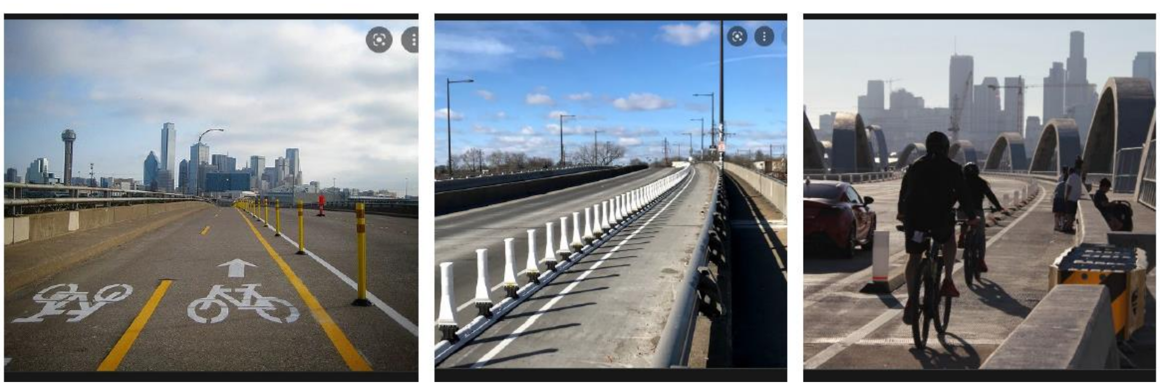


Figure 44: Representative examples of buffered bike lanes

<u>TAC – Protected Bike Lanes (Figure 45 and Figure 46):</u>

- An exclusive on-roadway bikeway delineated by a vertical barrier or physical separation from motor vehicle travel lanes which is designed to minimize or prevent encroachment on the bike lane by a motor vehicle.
- The type of delineator is determined by the volume and speed of the roadway.
- The protected lane can be unidirectional or bidirectional.
- Recommended Standards from Transportation Association of Canada (TAC) in the Geometric Design Guide for Canadian Roads (2017, Table 5.3.3: Design Domain: Width of Protected Bike Lane):
  - Recommended width of protected unidirectional bike lane including delineator:
    - Lower limit: 2.1 m (0.3 m wide delineator plus 1.8 m clear width); and
    - Upper limit: 3.5 m (1.0 m wide delineator plus 2.5 m clear width).
  - Recommended width of protected bidirectional bike lane including delineator:
    - Lower limit: 3.3 m (0.3 m wide delineator plus 3.0 m clear width); and
    - Upper limit: 4.6 m (1.0 m wide delineator plus 3.6 m clear width).

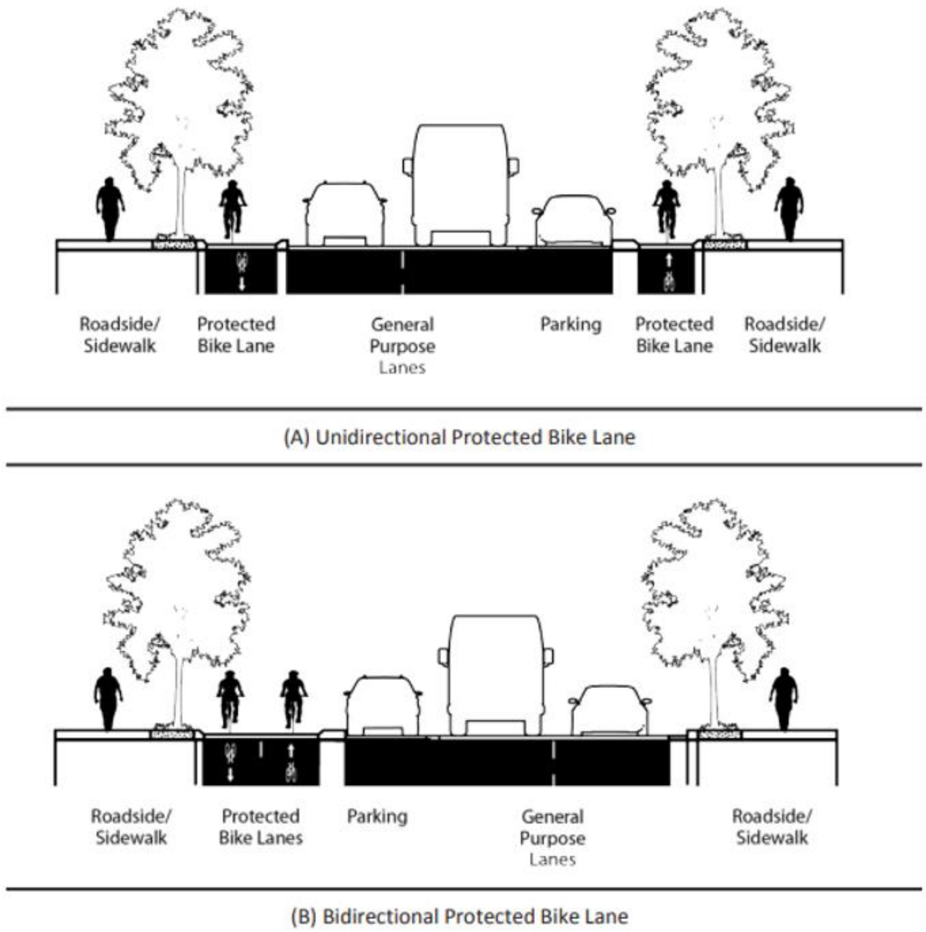


Figure 45: Unidirectional and bidirectional protected bike lanes. Image: TAC Geometric Design Guide for Canadian Roads Figure 5.3.3 Protected Bike Lanes

Figure 46: representative examples of protected bike lanes

Selection Framework:

Section 5.4 of the TAC guidelines provides a facility selection framework to help transportation practitioners determine which bikeway facility best suits their local conditions. Selection framework can be used in numerous ways to select and evaluate bikeway facility during design process.

Motor vehicle speed and volume on the roadway aligned with the bikeway are key considerations identifying a suitable bikeway facility. Higher motor vehicle speeds require increased separation for best safety and comfort, while higher volumes increase the number of potential conflicts. From TAC, Figure 5.4.1 (Bikeway Facilities, by Roadway Posted Speed) illustrates the recommended facility for various speeds (Figure 47).

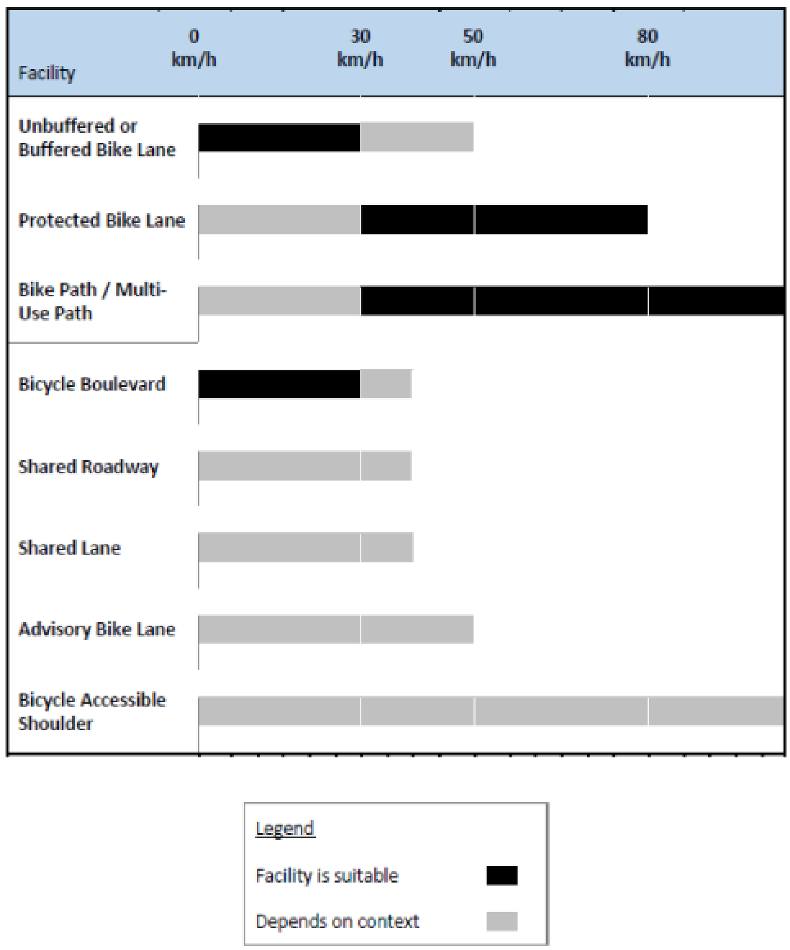


Figure 47: Bicycle facility types based on roadway speeds, (Image: TAC Geometric Design Guide for Canadian Roads, Figure 5.4.1)

For motor vehicle speeds between 50 km/h and 80 km/h cyclists should be separated from motor vehicle traffic by a physical barrier or be outside the roadway cross-section. The most suitable facilities are a protected bike lane with barrier delineators or a multi-use path located outside clear zone.

For motor vehicle speeds greater than 80 km/h the most suitable facility is a bike path / multi-use path located outside the clear zone.

TAC – Bikeway Facilities at Bridges or Tunnels (Figure 48):

- Bridges and tunnels present significant width constraints when integrating bikeway and pedestrian facilities.

- Protective railings, fences and barriers should be a recommended height of 1.2 m to prevent cyclists from falling over the railing. Additional horizontal clearance will be required in these locations since this height is above the bicycle handlebar height.

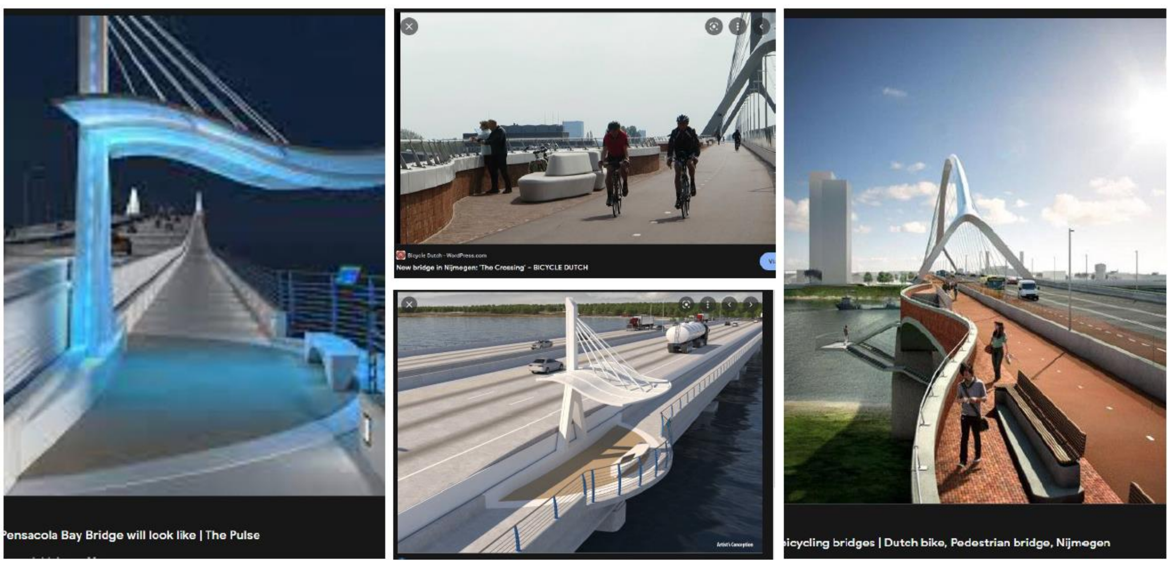


Figure 48: Represetative examples of active transportation lanes on bridges

K.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

K.4 Key Takeaways

A summary of the Transportation Association of Canada (TAC) standards for active transportation is as follows:

- Buffered Bike lanes are suitable for a maximum speed of 30 km/h and up to 50 km/h if enhancements are included.

- A Protected Bike lane is suitable across the bridge if the posted speed was reduced to 80 km/h. This type of facility would not accommodate pedestrians which would limit the attractiveness and use of the proposed viewing platform.

- TAC indicates that with the current posted speed of 90 km/h the conditions are suitable for a Bike Path / Multi-Use Path. This would still need to be protected or located outside the clear zone. This could be unidirectional or bidirectional. Considering maintenance, viewing platform, and safety it is recommended that a 3.3 m to 4.6 m wide bidirectional bike path be provided (including delineator width). Which side to design the bike path should be left to stakeholder input.

- Considering the single bidirectional path across the bridge, an active transportation crossing across Highway 105 will be required to safely get users from one side of highway to the other. Typical crossings of this nature are not on high-speed facilities. A speed reduction, illumination and geometric cues should be considered to improve warning and safety of crossing.

- Protective railings, fences and barriers should be a recommended height of 1.2 m to prevent cyclists from falling over the railing. Additional horizontal clearance will be required in these locations since this height is above the bicycle handlebar height. Depending on the design of the bridge and railings additional bike path lane width should be considered to address high winds. For consideration, TAC details a “Practical” dimension of 6.0 m for bidirectional bike paths and should be used if it is determined high winds are a concern.

- Lighting should be included for the active transportation lanes.

- There is no absolute maximum grade for bikeway facilities, however long steep grades are a deterrent to cycling. A grade of less than 4% is ideal for cyclists and should be used to design the bike path leading up to and across the bridge.

- A rigid barrier wall should be used to separate the bike path from the vehicular traffic lanes.

- Bicycle parking provides an important end of trip functionality for cyclists and should be incorporated into the design of the bridge. Bicycle racks and/or a coral should be located on both sides of the structure and at the viewing platform.

- The bike path must be maintained in each season it is open.
  - Maintenance includes street sweeping to remove debris, surface repair, inspection, and snow clearing in the winter
  - If the bike path is closed during winter season the following should be developed:
  - Communication plan to advise potential users of the dates bike path is closed.
  - Signing in field at each approach warning users of the closures.
  - Mitigating measures and consideration for potential users during winter.
  - A Risk Assessment should be conducted in detailed design to determine an appropriate maintenance strategy.

Technical Considerations Review - Active Transportation

Revision: 0
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Reviewed by: STANTEC (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**

BRIDGE AND ALIGNMENT DESCRIPTIONS	Details										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			

Category 2. FEATURES

Details | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"

	Category 2. FEATURES	Details
2.1	Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*
2.2	Active transportation lanes	
2.3	Clearance of navigational channel	
2.4	Use of existing highway infrastructure	
2.5	NSPW owns required land	
2.6	Service life beyond 50 years	
2.7	Utility/service accommodations	

Category 3. RISKS

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

	Category 3. RISKS	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
3.1	Impact to trade corridors during construction	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.2	Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3	Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4	Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5	Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6	Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required	Moderate | Consultation with AT community and users required
3.7	Operational issues during service life	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.8	Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Category 4. OPPORTUNITIES

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

	Category 4. OPPORTUNITIES	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.1	Public safety	LOW | Without dedicated AT lane, AT users may opt to use existing crossing/alignment that it was not intended for	LOW | Without dedicated AT lane, AT users may opt to use existing crossing/alignment that it was not intended for	LOW | Without dedicated AT lane, AT users may opt to use existing crossing/alignment that it was not intended for	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic	HIGH | Inclusion of AT separates AT users from vehicular traffic
4.2	Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3	Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

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<table>
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Existing Location</th><th colspan="2">New Bridge
New Location - North</th><th colspan="2">New Bridge
New Location - South</th></tr>
<tr><th>25 yrs</th><th>50 yrs</th><th>50 yrs w/ Alignment Improvement</th><th colspan="3">Medium Span</th><th>Long Span</th><th>Medium Span</th><th>Long Span</th><th>Medium Span</th><th>Long Span</th></tr>
<tr><th>1A</th><th>1B</th><th>1C</th><th>2A</th><th>2B</th><th>2C</th><th>2D</th><th>3A</th><th>3B</th><th>4A</th><th>4B</th></tr>
<tr><td>4.4 Local content within construction industry</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
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<tr><td>Category 5. SOCIAL IMPLICATIONS</td><td colspan="11">Details | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"</td></tr>
<tr><td>5.1 Public perception</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>5.2 Effects on nearby communities</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>5.3 Mi'kmaq perception</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
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</table>

Appendix L Technical Considerations | Traffic

L.1 Basis

Highway 105 and the Seal Island Bridge are a significant component of Nova Scotia's provincial highway network, linking significant goods and people movement (heavy vehicles, recreational vehicles, passenger vehicles and cyclists) to the eastern portions of Cape Breton Island. The current Seal Island Bridge is 753 m long with narrow lanes and shoulders, and steep grades with a switch back on the approaches.

Traffic analysis will include considerations for the potential reduction of collisions and improvements to safety for all bridge users, and will specifically address the following:

- the overall cross section configuration of the bridge (two lanes versus three lanes) and available shoulder widths;
- review current traffic count data to develop growth projections for future traffic volumes;
- emergency response;
- maintenance and inspection of the structure;
- snow clearing;
- high-sided vehicles; and
- variable message signage for bridge and traffic notifications.

Through collaboration with NSDPW, the Team confirmed that four lanes for the highway and bridge crossing were not required or desired. For the highway, two lanes are considered with climbing lanes and the bridge crossing would have additional bridge width to permit a lane closure (for maintenance/inspection or a vehicle breakdown) and have sufficient width to accommodate two traffic lanes.

L.2 Technical Considerations - Details

Overall Cross Section and Configuration:

Traffic along this corridor has a mix use of commercial vehicles, recreation vehicles and active transportation users. The existing roadway design is tailored more for the commuter driver (passenger vehicles and commercial vehicles) due to the posted speed limit of 100 km/h outside of the bridge and 90 km/h on the bridge (except the advisory speed of 40 km/h at the existing switchback) and lack of shoulders in some locations.

Designing the future facility to address recreation vehicles and active transportation users (refer to Appendix K) would enhance safety and meet the demands of these users. Geometric and operational facility context considerations like fully paved shoulders, lower posted speed, illumination approaching bridge, post mounted delineators, designated parking lots at bridge (both sides), multi-use paths and designated pedestrian/trail crossings may enhance safety and the overall experience for all users along the highway mainline and across the bridge.

Refer to Appendix M Technical Considerations | Highway Design.

Review of Traffic Volumes:

Historical ADT volumes were also received for the 42-year period between 1978 and 2020, these volumes were used to determine the annual growth per year within the project limits, which are as follows:

- 1.5%/year in the last 39 years between 1978 and 2017;
- 1.1%/year in the 21 years between 1996 and 2017;
- 1.8%/year in the 9 years between 2008 and 2017; and
- 7.7%/year in the 6 years between 2011 to 2017.

A shown above, highway growth patterns have the potential to change rapidly and have a sharp decrease or increase from year to year. Understanding short term growth rates (7.7% from 2011 to 2017) helps designers determine current traffic volume trends however, applying those rates for 10, 20, 50 or 100 years into the future would drastically not reflect anticipated traffic patterns. The more historical years available (1978 to 2017) to determine a growth rate (1.5%) provides a more constant and reflective pattern indication to what the facility has been experiencing over a longer period. This method is mainly used in rural areas where significant growth is not anticipated. As such, the growth rate for the scope of the BCA was selected as 1.5%.

For recent data, NSDPW provided Highway 105 seasonal (ADT) volumes for the years 2011, 2014, 2017, 2020, and 2021. Traffic volumes from the year 2020 and 2021 were omitted from the analysis since they were significantly lower than 2017 due to the impacts of the Covid-19 pandemic. The analysis showed an annual increase of 1.5% per year between the years 1978 and 2017. This growth rate was then applied to the most recent pre-pandemic traffic volumes (2017) that reflected the historical trends of the area as traffic volumes are anticipated to return to pre-pandemic levels in the near future (Table 38).

Table 38: Projected traffic volumes for Highway 105 at the Seal Island Bridge

Location, Road Name	Data Type	Time Period of Analysis					% Comm	Linear Growth Rate
		2017	2023	2048	2073	2123		
Highway 105 at Seal Island Bridge	ADT	6,180	6,740	9,050	11,370	16,000	12.0	1.50%
	DHV	620	680	910	1140	1,600		
	LOS	A	B	C	D	E		

The existing and future traffic volumes within the project limits were analyzed to determine if and when the need for additional lanes on the structure would be required. The analysis showed that currently during the design hour, Highway 105 is operating at a very good level of service A. By 2123 using the assumed linear growth rate, the two lane capacity is expected to be nearing capacity. Additional lanes in each direction are not expected to be required during the life span of the structure and if needed, NSDPW can investigate the value of a three lane arrangement with the proposed two "wide" lanes for the new crossings (not applicable for the rehabilitation options).

Review of Traffic Collisions:

In 2022 December, NSDPW provided traffic collision data in the vicinity of the Seal Island Bridge for the time period between 2013 and 2022 (10 years, 26 locations, some missing GPS data), including contributing factors, environmental factors, and weather conditions to give an idea of what may have caused the collision. The data is presented in Table 39 and the visualization of this data based on GPS coordinates is presented in Figure 49. This data represents the officially documented data and additional traffic situations may not have been captured; as such, only official data has been analyzed in this review.

Table 39: Highway 105 collision data near Seal Island Bridge (2013-2022, from NSDPW)

Collision Year	Driver Factor/Consideration	Unusual Environment Circumstance	Weather Conditions	Collision Configuration
2013	No driver action as contributing factor	None	Overcast, cloudy but no precipitation	Ran off road to left
	Not Applicable	Glare or reflection	Clear	Approaching sideswipe
	No driver action as contributing factor	Glare or reflection	Clear	Approaching sideswipe
	No driver action as contributing factor	Limited visibility	Snowing	Right angle collision

Collision Year	**Driver Factor/Consideration**	**Unusual Environment Circumstance**	**Weather Conditions**	**Collision Configuration**
2014	No driver action as contributing factor	Limited visibility	Freezing rain, sleet, hail	Ran off road to right
	No driver action as contributing factor	None	Clear	One vehicle crossing path of other to the right
	Improper passing / lane changes	None	Clear	One vehicle crossing path of other to the right
	Driving too fast for conditions	None	Clear	Ran off road to left
2015	Driving too fast for conditions	None	Clear	Ran off road to right
	No driver action as contributing factor	Limited visibility	Snowing	Not Applicable
	No driver action as contributing factor	None	Clear	Head-on collision
	Not Applicable	None	Clear	Head-on collision
	No driver action as contributing factor	None	Clear	Ran off road to right
2017	Other than listed values	None	Clear	Ran off road to left
2018	Unknown	None	Clear	Ran off road to right
	Unknown	Animal in roadway	Clear	Hit moving or stationary object on road surface
	Following too closely	None	Raining	Rear-end collision
	No driver action as contributing factor	None	Raining	Rear-end collision
	No driver action as contributing factor	Other than listed values	Clear	Ran off road to right
2019	No driver action as contributing factor	Other than listed values	Strong wind	Ran off road to right
	No driver action as contributing factor	Animal in roadway	Overcast, cloudy but no precipitation	Hit moving or stationary object on road surface
	No driver action as contributing factor	Obstruction on road	Clear	Hit moving or stationary object on road surface
	No driver action as contributing factor	None	Clear	Ran off road to right
	Backing unsafely	None	Clear	Hit parked motor vehicle
2020	No driver action as contributing factor	Other than listed values	Fog, mist, smog	Hit moving or stationary object on road surface
	Other than listed values	Other than listed values	Fog, mist, smog	Hit moving or stationary object on road surface

Collision Year	Driver Factor/Consideration	Unusual Environment Circumstance	Weather Conditions	Collision Configuration
	No driver action as contributing factor	Other than listed values	Snowing	Approaching sideswipe
	Unknown	Unknown	Snowing	Ran off road to right
2021	Driving too fast for conditions	Other than listed values	Snowing	Ran off road to right
	Driving too fast for conditions	Other than listed values	Clear	Ran off road to right
2022	No driver action as contributing factor	None	Clear	Ran off road to right

Figure 49: Visualization of vehicle collisions in vicinity of Seal Island Bridge (2013-2022, data from NSDPW)

A review of collision data for the ten-year period from 2013-2022 was conducted. There were 31 collisions on this section of Highway 105, however GPS data is not available until 2018. Since 2018, there have been 17 collisions. A distribution of crashes by location (with respect to bridge) is shown in Table 40. There is a relatively even spread of collision on both sides of the bridge and only one collision on the bridge.

Table 40: Seal Island Bridge traffic collision data – collision location (2013-2022, data from NSDPW)

Year	Collision Location					Total
	West of Bridge	West Approach	On Bridge	East Approach	East of Bridge	
2013	*GPS data not available*					-
2014						-
2015						-
2016						-
2017						-
2018	4	0	0	1	0	5
2019	0	1	1	1	2	5
2020	0	0	0	2	2	4
2021	0	1	0	0	1	2
2022	1	0	0	0	0	1
Total	5	2	1	4	5	17

A distribution of crashes by type is shown in Table 41. Single motor vehicle (SMV) crashes accounted for 21 of the 31 collisions over the past 10 years.

Table 41: Seal Island Bridge traffic collision data – collision type (2013-2022, data from NSDPW)

Year	Collision Type						Total
	Angle	Approaching	Turning Movement	SMV	Rear end	Sideswipe	
2013	1	2	0	1	0	0	4
2014	2	0	0	2	0	0	4
2015	0	2	0	3	0	0	5
2016	0	0	0	0	0	0	0
2017	0	0	0	1	0	0	1
2018	0	0	0	3	2	0	5
2019	0	0	0	5	0	0	5
2020	0	1	0	3	0	0	4
2021	0	0	0	2	0	0	2
2022	0	0	0	1	0	0	1
Total	3	5	0	21	2	0	31

A distribution of crashes by environmental conditions is shown in Table 42. Most crashes occurred during clear conditions. In cases where environmental conditions were noted, snow was the most prevalent while strong wind only accounted for one instance.

Table 42: Seal Island Bridge traffic collision data – collision environmental conditions (2013-2022, data from NSDPW)

Year	Environment					Total
	Clear	Rain	Snow	Fog, mist, smog	Strong Wind	
2013	3	0	1	0	0	4
2014	3	0	1	0	0	4
2015	4	0	1	0	0	5
2016	0	0	0	0	0	0
2017	1	0	0	0	0	0
2018	3	2	0	0	0	5
2019	4	0	0	0	1	5
2020	0	0	2	2	0	4
2021	1	0	1	0	0	2
2022	1	0	0	0	0	1
Total	20	2	6	2	1	31

A distribution of crashes by classification is shown in Table 43. There were no fatal collisions within the study area over the past five years. Five collisions involved injuries and the remaining 26 collisions were property damage only.

Table 43: Seal Island Bridge traffic collision data – collision classification (2018-2022, data from NSDPW)

Year	Classification			Total
	Property Damage	Injury	Fatal	
2013	3	1	0	4
2014	4	0	0	4
2015	3	2	0	5
2016	0	0	0	0
2017	1	0	0	1
2018	5	0	0	5
2019	4	1	0	5
2020	3	1	0	4
2021	2	0	0	2
2022	1	0	0	1
Total	26	5	0	31

Emergency Response:

The Nova Scotia Emergency Responders Traffic Management Manual, developed by the Select Committee of the Office of the Fire Marshal, Public Safety Division, Province of Nova Scotia, is a unique contribution to the field of temporary traffic control at emergency scenes on streets, roads, and highways throughout Nova Scotia. The Manual combines the basic principles and guidelines of temporary traffic control with combined years of experience in accommodating traffic at emergency scenes on the roads of the Province of Nova Scotia.

The manual details the various component areas of an emergency closure and the safe requirements for each. Refer to Figure 50.

For the existing and future Seal Island bridge consideration in the design of horizontal and vertical curves should be explored so that the visibility of First Responders is considered. If it is determined that the ultimate design cannot accommodate minimum sight distances to address sight obstructions a detailed assessment of each location should be completed and consider if site conditions require permanent features to help mitigate obstructions. These could be PVMS, advance flashing signs, illumination or signing.

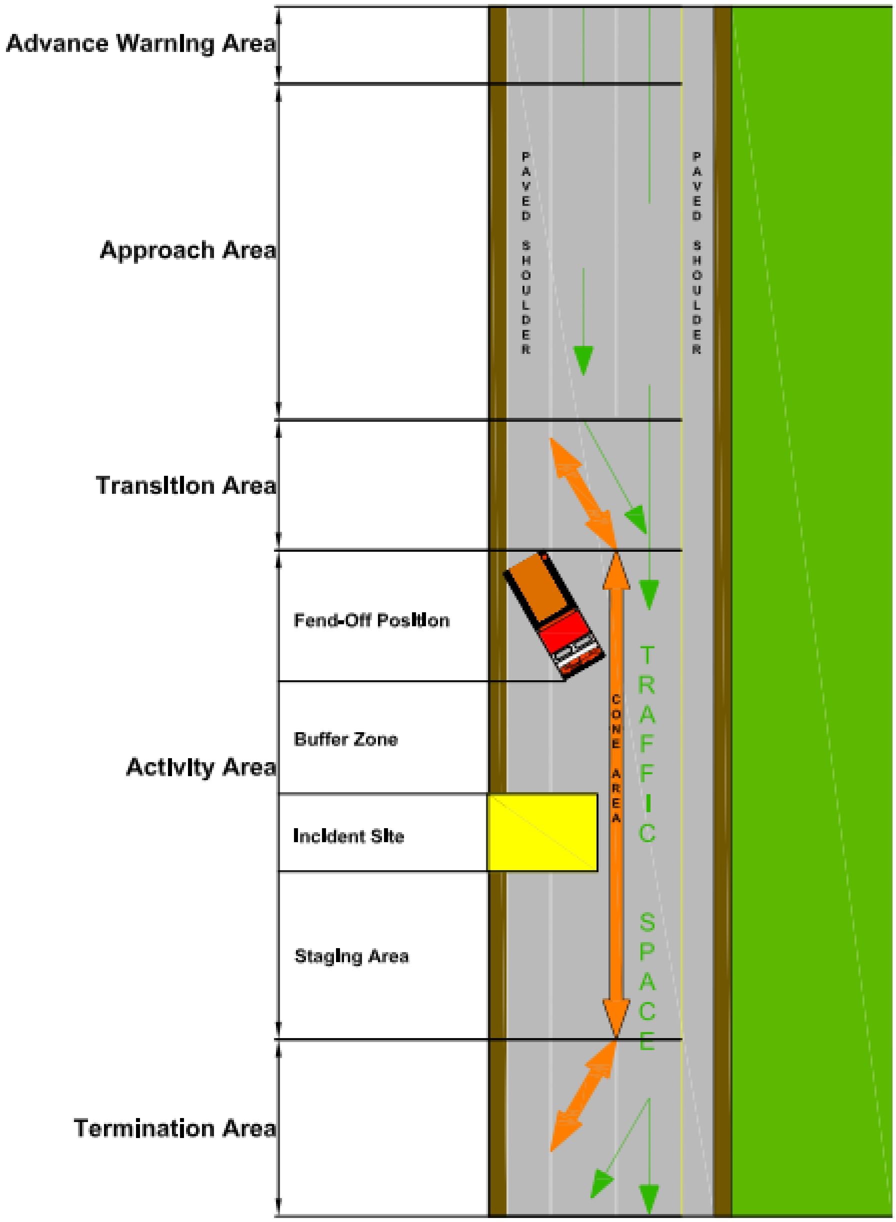

Figure 50: Emergency Closure Component Areas (ref. Nova Scotia Emergency Responders Traffic Management Manual)

<u>Maintenance and Inspection of the Structure</u>:

The existing two-lane bridge structure is narrow and requires a minimum of single lane closures to perform typical inspection and maintenance activities.

Despite the existing traffic volumes not necessitating lane expansion, NSDPW request is to provide additional width on structure to accommodate maintenance and inspection vehicles while maintaining two traffic lanes.

With the introduction of an Active Transportation multi-use path for future bridge design, pathway dimensions and material should consider existing and future maintenance procedures and equipment to ensure provincial inspection and safety standards can be met.

In addition, by utilizing Variable Message Signs (VMS) well before the bridge (being installed in near future) and at the bridge that can advise and warn users of maintenance work will warn approaching users of the work at the structure so they may alter their route.

Snow Clearing:

For snow-clearing during winter months, various service levels are required for the different types of roads, in accordance with NSDPW guidelines (ref. https://novascotia.ca/tran/winter/WinterMaintenanceStandards.pdf). The infographic is provided for information in Figure 51.

SERVICE TIMES

Type of Road	Clearing Time
100-Series and trunk highways, and other high traffic roads	**8 hours** after snow stops
Secondary routes and other medium traffic roads	**12 hours** after snow stops
Local paved roads, most subdivision and residential streets	**24 hours** after snow stops
Gravel roads	**24 hours** after snow stops

Figure 51: Nova Scotia Snow Clearing Service Times (ref. https://novascotia.ca/tran/winter/WinterMaintenanceStandards.pdf)

Highway 105 at Seal Island Bridge is considered a 100-Series highway and requires snow and ice to be cleared within 8 hours from the time snow/ice stops falling. Work starts before the storm with salt being applied before, during and after the storm if required to ultimately achieve bare pavement.

With the introduction of the Active Transportation multi-use path across the bridge a maintenance strategy is required for clearing snow that is consistent with the mainline highway but separate due to the AT lane delineation and smaller widths compared to the roadway. Equipment, resources, monitoring shall form part of this strategy, including considerations to whether the AT lanes will be open seasonally or year round.

High-Sided Vehicles:

The Seal Island Bridge monitoring system consists of three wind sensors that are utilized to trigger bridge closures. A report was completed in 2013 (Seal Island Bridge Wind Warning System Analysis, AMEC, 2013 March) that presented an analysis of wind speed and direction. A summary of the report finding is shown below:

- All three sensors show winds are predominantly southwesterly or northeasterly for both sustained and gust wind speeds, with southwest winds being more common. This corresponds with the general wind climatology of Nova Scotia, as influenced by global circulation patterns and typical storm tracks over the area.

- As the threshold increases from 50 to 60 to 70 km/h, a peak in the number of hours in the November/December timeframe can be seen. Wind gusts can reach 110 to 140 km/h.

A distribution of crashes by environmental conditions is shown in Table 42. In cases where environmental conditions were noted, strong wind only accounted for one instance.

Variable message signs should be connected to the three wind sensors on the bridge with advisory messages for high sided vehicles. Safe wind thresholds should be determined so that wind sensors can automatically update VMS signs to warn high sided vehicles to either proceed with caution or find alternative route.

Variable Message Signs:

During weather conditions when visibility and pavement friction is reduced (e.g., snow, rain, icy conditions) or during high winds, real-time safety information notifications to bridge users is helpful to remind drivers to adjust their speed and following distances and to provide specific warning messages in advance of locations where it is known that blowing snow and icy roads are a problem.

This can be achieved with variable message signs that are spaced before the bridge. These dynamic signs can also be used to warn drivers of incidents and work zone related activities ahead. Weather-activated speed limit signs should also be considered.

L.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

L.4 Key Takeaways

Designing the future facility to address recreation vehicles and active transportation users (see Active Transportation) would enhance safety and meet the demands of these users.

- Historically traffic grew at various rates for various time periods in the area. The analysis showed an annual increase of 1.5% per year between the years 1978 and 2017 best represents the historical traffic volume trends in the area.

- Currently during the design hour, Highway 105 is operating at a very good level of service A and will not reach two lane capacity (level of service E) in the year 2123.

- Additional lanes in each direction are not expected to be required for traffic capacity during the next 100 years (by 2123) and if needed, NSDPW can investigate the value of a three lane arrangement with the proposed two “wide” lanes for the new crossings (not applicable for the rehabilitation options)..

- A review of collision data for the ten-year period from 2013-2022 was conducted. There were 31 collisions on this section of Highway 105, however only 17 of which have GPS data.

- Single motor vehicle (SMV) crashes accounted for 21 of the 31 collisions.

- Most crashes occur during clear conditions.

- There were no fatal collisions within the study area over the past five years. Five collisions involved injuries and the remaining 26 collisions were property damage only.

- Future bridge designs should address and mitigate horizontal and vertical curve challenges of First Responders and bridge users.

- The existing and future two-lane bridge structure requires a minimum of single lane closures to perform typical inspection and maintenance activities. With the introduction of an Active Transportation multi-use path for future bridge design, pathway dimensions and material should consider existing and future maintenance procedures and equipment to ensure provincial inspection and safety standards can be met. In addition, by providing VMS at and well before the bridge that can advise and warn users of maintenance work will warn approaching users of the work at the structure so they may alter their route. By providing this, maintenance and inspection will still require traffic control but minimally impede all (vehicular and active) bridge users.

- Highway 105 at Seal Island Bridge is considered a 100-Series highway and requires snow and ice to be cleared within 8 hours from the time snow/ice stops falling. Work starts before the storm with salt being applied before, during and after the storm if required to ultimately achieve bare pavement. With the introduction of the Active Transportation multi-use path across the bridge a maintenance strategy is required for clearing snow that is consistent with the mainline highway. Equipment, resources, monitoring shall form part of this strategy.

- Winds are predominantly southwesterly or northeasterly for both sustained and gust wind speeds, with southwest winds being more common. This corresponds with the general wind climatology of Nova Scotia, as influenced by global circulation patterns and typical storm tracks over the area. As the threshold increases from 50 to 60 to 70 km/h, a peak in the number of hours in the November/December timeframe can be seen and can reach 110 to 140 km/h.

- Variable Message Signs should be strategically located on both sides of the bridge to warn of traffic, weather and emergency conditions.

Technical Considerations Review - Traffic

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (J Worron)
Reviewed by: Stantec (P Flower)

Stantec COWI

<table>
<tr><th rowspan="3">Categories</th><th colspan="3">Rehabilitate</th><th colspan="4">New Bridge
Existing Location</th><th colspan="2">New Bridge
New Location - North</th><th colspan="2">New Bridge
New Location - South</th></tr>
<tr><td>25 yrs</td><td>50 yrs</td><td>50 yrs w/ Alignment Improvement</td><td colspan="3">Medium Span</td><td>Long Span</td><td>Medium Span</td><td>Long Span</td><td>Medium Span</td><td>Long Span</td></tr>
<tr><td>1A</td><td>1B</td><td>1C</td><td>2A</td><td>2B</td><td>2C</td><td>2D</td><td>3A</td><td>3B</td><td>4A</td><td>4B</td></tr>
<tr><th>BRIDGE AND ALIGNMENT DESCRIPTIONS</th><th colspan="11">Details</th></tr>
<tr><td>Bridge type</td><td colspan="3">Existing arch with truss approach spans</td><td>Concrete box</td><td>Steel box</td><td>Network arch</td><td>Cable stayed</td><td>(Highest Ranked 2A-2C)</td><td>Cable stayed</td><td>(Highest Ranked 2A-2C)</td><td>Cable stayed</td></tr>
<tr><td>Main span length (m)</td><td colspan="3">152 m</td><td colspan="3">≈152 m</td><td>≈280 m</td><td>Min. 152 m</td><td>≥ 560 m</td><td>Min. 152 m</td><td>≥ 560 m</td></tr>
<tr><td>Alignment route</td><td colspan="2">Existing (I)</td><td colspan="5">Improved Existing (II)</td><td colspan="2">New North (III)</td><td colspan="2">New South (IV)</td></tr>
<tr><td>Alignment limitations</td><td colspan="2">Existing alignment; existing speed</td><td colspan="5">Existing alignment improved; min. 70 km/hr</td><td colspan="4">New alignment; min. 90 km/hr</td></tr>
<tr><th>Category 2. FEATURES</th><th colspan="11">Details | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"</th></tr>
<tr><td>2.1 Wider Traffic Lanes (min. 2 Lanes)</td><td colspan="11" rowspan="7">N/A | Not a component of this technical consideration.</td></tr>
<tr><td>2.2 Active transportation lanes</td></tr>
<tr><td>2.3 Clearance of navigational channel</td></tr>
<tr><td>2.4 Use of existing highway infrastructure</td></tr>
<tr><td>2.5 NSPW owns required land</td></tr>
<tr><td>2.6 Service life beyond 50 years</td></tr>
<tr><td>2.7 Utility/service accommodations</td></tr>
<tr><th>Category 3. RISKS</th><th colspan="11">Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"</th></tr>
<tr><td>3.1 Impact to trade corridors during construction</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.2 Impact to trade corridors in-service</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.3 Constructability / complexity of erection sequence</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.4 Climate Change</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
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<tr><td>3.6 Approvals, permitting and consultation</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
<tr><td>3.7 Operational issues during service life</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
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<tr><th>Category 4. OPPORTUNITIES</th><th colspan="11">Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"</th></tr>
<tr><td>4.1 Public safety</td><td>LOW | No alignment improvements results in no change to existing traffic management</td><td>LOW | No alignment improvements results in no change to existing traffic management</td><td>MODERATE | Alignment improvements to existing, specfically at hairpin, improve safety and traffic management.</td><td>MODERATE | Alignment improvements to existing, specfically at hairpin, improve safety and traffic management.</td><td>MODERATE | Alignment improvements to existing, specfically at hairpin, improve safety and traffic management.</td><td>MODERATE | Alignment improvements to existing, specfically at hairpin, improve safety and traffic management.</td><td>MODERATE | Alignment improvements to existing, specfically at hairpin, improve safety and traffic management.</td><td>HIGH | New alignment design results in maximum improvements to safety and traffic management.</td><td>HIGH | New alignment design results in maximum improvements to safety and traffic management.</td><td>HIGH | New alignment design results in maximum improvements to safety and traffic management.</td><td>HIGH | New alignment design results in maximum improvements to safety and traffic management.</td></tr>
<tr><td>4.2 Use of modern bridge design / methods and materials</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td><td>N/A | Negligible impact on this tech. consideration</td></tr>
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	Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.4	Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.5	Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration	N/A | Negligible/unknown impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix M Technical Considerations | Highway Design

M.1 Basis

During the original site selection for the for the Trans-Canada Highway in the area, the selection of the Seal Island Bridge was selected as controversial. The crossing replaced two ferry services crossing the Great Bras d’Or: one at the northeastern end between New Campbellton-Big Bras d'Or and the other at the southwestern end at Big Harbour-Ross Ferry.

For various reasons, it was decided to place the bridge halfway between the two ferry services on account of an outcry by communities fearing the loss of their transportation links. Unfortunately, this required a massive modification to the Trans-Canada Highway route on the eastern slope of Kelly's Mountain (240 m high), resulting in a 180° "switchback" as part of the 23 km of approach road to the bridge.

Alternatives to continue the highway further east on a gradual descent of Kelly's Mountain toward New Campbellton, crossing at the northern end of the Great Bras d'Or channel were rejected. Likewise, a route between Beinn Bhreagh and Kempt Head at the extreme southwestern end of the channel (much wider waterway but avoiding Kelly's Mountain altogether) was not constructed.

There is a history of traffic collisions located at the Kelly’s Mountain Switchback due to the nature of the existing alignment. The new alignment options provide an opportunity to improve, modify, or replace the existing alignment. These alignment considerations are the subject of this technical consideration, resulting in four new alignments:

- (I) Existing alignment: no change to existing alignment (applies to Options 1A & 1B);
- (II) Improved existing alignment: improvements to existing alignment, including hairpin improvements (applies to Options 1C, 2A, 2B, 2C & 2D);
- (III) New north alignment: new alignment to the north of the existing alignment (applies to Options 3A & 3B); and
- (IV) New south alignment: new alignment to the south of the existing alignment (applies to Options 4A & 4B).

The above alignments were created in collaboration with NSDPW in advance of the BCA work to provide early convergence on alignment locations, which primarily dictate the implications of the remaining technical considerations, including the bridge considerations.

M.2 Technical Considerations - Details

Described below is a high-level overview of how the alignment options were derived and the overall objectives of the highway design technical consideration in collaboration with NSDPW:

- Design criteria (TAC and NSDPW) for horizontal and vertical geometry for Alignment III (Option 3A/3B, New Bridge, new Location to the north) and Alignment IV (Option 4A/4B New

Bridge, new Location to the south) is based on a 90 km/h design/posted speed limit. The design criteria for Alignment II (Option 1C and 2A/2B/2C/2D, existing alignment improvements) is based on 70 km/h design/posted speed limit, which has alignment improvements at the hairpin turn location. Other than the hairpin turn location, the facility is designed for 90 km/h.

- Basis for geometric design in accordance with TAC's Geometric Design Guidelines for Canadian Roads and NSDPW's highway design guidelines. Culverts designed in accordance with provincial and federal guidelines, standards and regulations. Bridge-sized culverts designed in accordance with CSA-S6, latest version (Canadian Highway Bridge Design Code).

- NSDPW design criteria per S-2015-001 – Highway Design Guidelines. For typical cross section criteria, i.e., travel lane width, paved shoulder width and slopes, the Major Arterial B was used. However, for geometry and grade criteria, the Major E Collector was used. This criterion allows for a reduced design/posted speed facility and is consistent with the existing facility and other similar sections of Highway 105, meeting driver expectations. Alignment options were determined to yield the lowest earthworks volumes (cut/fill) using the maximum vertical grade of 8% for a Major E Collector. Flatter grades were not possible without adding significant length to the roadway on the west approaches.

- Climbing lane on westbound lanes on west side of the crossing for both Alignment III (Option 3A/3B, New Bridge, new Location to the north) and Alignment IV (Option 4A/4B New Bridge, new Location to the south).

- Alignment III (Option 3A/3B, New Bridge, new Location to the north) and Alignment IV (Option 4A/4B New Bridge, new Location to the south) can be constructed offline, minimizing impacts to traffic on the existing Highway 105. Alignment II (Option 1C and 2A/2B/2C/2D, existing alignment improvements) will have an impact on traffic during construction.

- New watercourse crossings will be required for nearly all alignment options. Alignment III (Option 3A/3B, New Bridge, new Location to the north) and Alignment IV (Option 4A/4B New Bridge, new Location to the south) include significant clearing, grubbing and earthworks requirements. Most notably, these options also include significant rock excavations and blasting, yielding large volumes of surplus blasted rock after cut/fill and crushing for aggregates are satisfied.

- AT not considered on roadway. AT lane was only a consideration for along the bridge crossing.

- A New Campbellton crossing location (approximately 9 km to the north of the existing bridge where existing channel is narrowest) was ruled out as a potential new crossing option due to multiple negative considerations including protected areas, cemetery, marshland/wetland,

and due to the approaches being at lower elevations and not conducive to a bridge with a large navigation opening.

Considering the above criteria and elements, refer to the alignment drawings presented in Appendix E.

M.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

M.4 Key Takeaways

General:

- Some of the alignment options have steeper grades than others (8% versus 6%), while some have more desirable horizontal geometry (350 m radius curves versus 190 m radius curve).

- A transition from the roadway cross section to the bridge cross section will be required at the ends of the bridges to allow for the development of the AT lane on the structures where AT has been included. No allowance, such as a widened paved shoulder, has been made for the roadway concept design and will need to be a future consideration at the detailed design stage.

(I) Existing alignment (applies to Options 1A/1B):

- No notable changes to alignment; matches existing condition.

(II) Improved existing alignment (applies to Options 1C/2A/2B/2C/2D):

- Re-use of significant portion of existing highway. Improvements to hairpin curve will allow for a more desirable alignment and allow for an increase in the speed limit (from advisory speed of 40 km/h at hairpin to 70 km/h). Much of the construction work related to improving the existing alignment will require more traffic management considerations due to the work on or adjacent to the existing Highway 105, however, the cut/fill associated with the roadway work is minimal.

- NSDPW does not own all the anticipated land required to improve the existing alignment, specifically the area between the existing Highway 105 and Stewart Road along the western approach. The actual alignments to be established in the future as part of the scoping and design phases may impact adjacent land owners.

(III) New north alignment (applies to Options 3A/3B):

- Involves large cuts/fills to achieve the maximum grades, adding significant costs for these options due to rock blasting requirements.

- Involves notable impacts on private and crown-owned properties, requiring land acquisition at multiple locations.

- Presents advantages over improvements to existing alignment, including construction that is offline and away from traffic, except at tie-in locations. Other advantages are a more desirable alignment and higher operating speeds compared to the existing Highway 105 alignment through Kelly's Mountain, even though the new profile is steeper than the existing.

(IV) New south alignment (applies to Options 4A/4B):

- Involves large cuts/fills to achieve the maximum grades, adding significant costs for these options due to rock blasting requirements.

- Involves notable impacts on private and crown-owned properties, requiring land acquisition at multiple locations.

- Presents advantages over improvements to existing alignment, including construction that is offline and away from traffic, except at tie-in locations. Other advantages are a more desirable alignment and higher operating speeds compared to the existing Highway 105 alignment through Kelly's Mountain, even though the new profile is steeper than the existing.

Technical Considerations Review - Highway Design

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (S Clark)
Reviewed by: Stantec (P Flower)

Stantec COWI

		Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	Categories	**1A**	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
	BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
	Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
	Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
	Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
	Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
	Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1	Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2	Active transportation lanes											
2.3	Clearance of navigational channel											
2.4	Use of existing highway infrastructure											
2.5	NSPW owns required land											
2.6	Service life beyond 50 years											
2.7	Utility/service accommodations											
	Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1	Impact to trade corridors during construction	N/A | No alignment improvements means no impact from roadway construction	N/A | No alignment improvements means no impact from roadway construction	MODERATE | Roadway improvements at the hairpin, etc. require traffic disruptions	MODERATE | Roadway improvements at the hairpin, etc. require traffic disruptions	MODERATE | Roadway improvements at the hairpin, etc. require traffic disruptions	MODERATE | Roadway improvements at the hairpin, etc. require traffic disruptions	MODERATE | Roadway improvements at the hairpin, etc. require traffic disruptions	LOW | New alignment is primarily offline and away from existing traffic; disruption limited to existing tie-in	LOW | New alignment is primarily offline and away from existing traffic; disruption limited to existing tie-in	LOW | New alignment is primarily offline and away from existing traffic; disruption limited to existing tie-in	LOW | New alignment is primarily offline and away from existing traffic; disruption limited to existing tie-in
3.2	Impact to trade corridors in-service	MODERATE | Existing alignment deficiencies limit posted and operational speeds	MODERATE | Existing alignment deficiencies limit posted and operational speeds	LOW | The alignment improvements at the hairpin will allow for higher posted and operational speeds	LOW | The alignment improvements at the hairpin will allow for higher posted and operational speeds	LOW | The alignment improvements at the hairpin will allow for higher posted and operational speeds	LOW | The alignment improvements at the hairpin will allow for higher posted and operational speeds	LOW | The alignment improvements at the hairpin will allow for higher posted and operational speeds	LOW | New alignment will allow for higher posted and operational speeds	LOW | New alignment will allow for higher posted and operational speeds	LOW | New alignment will allow for higher posted and operational speeds	LOW | New alignment will allow for higher posted and operational speeds
3.3	Constructability / complexity of erection sequence	N/A | No alignment improvements means no impact from roadway construction and constructability	N/A | No alignment improvements means no impact from roadway construction and constructability	MODERATE | Alignment improvements (hairpin, west approach) require traffic management	MODERATE | Alignment improvements (hairpin, west approach) require traffic management	MODERATE | Alignment improvements (hairpin, west approach) require traffic management	MODERATE | Alignment improvements (hairpin, west approach) require traffic management	MODERATE | Alignment improvements (hairpin, west approach) require traffic management	MODERATE | New alignment is primarily offline, but require significant cuts/fills	MODERATE | New alignment is primarily offline, but require significant cuts/fills	MODERATE | New alignment is primarily offline, but require significant cuts/fills	MODERATE | New alignment is primarily offline, but require significant cuts/fills
3.4	Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5	Geotechnical	N/A | No alignment improvements means no geotechnical requirements	N/A | No alignment improvements means no geotechnical requirements	MODERATE | Limited changes to alignment for improvement, however, geotechnical investigation required	MODERATE | Limited changes to alignment for improvement, however, geotechnical investigation required	MODERATE | Limited changes to alignment for improvement, however, geotechnical investigation required	MODERATE | Limited changes to alignment for improvement, however, geotechnical investigation required	MODERATE | Limited changes to alignment for improvement, however, geotechnical investigation required	HIGH | New alignment will require a significant geotechnical investigation	HIGH | New alignment will require a significant geotechnical investigation	HIGH | New alignment will require a significant geotechnical investigation	HIGH | New alignment will require a significant geotechnical investigation
3.6	Approvals, permitting and consultation	N/A | No alignment improvements means no approvals, permitting and consultation	N/A | No alignment improvements means no approvals, permitting and consultation	MODERATE | Alignment improvements will require approvals, permitting and consultation	MODERATE | Alignment improvements will require approvals, permitting and consultation	MODERATE | Alignment improvements will require approvals, permitting and consultation	MODERATE | Alignment improvements will require approvals, permitting and consultation	MODERATE | Alignment improvements will require approvals, permitting and consultation	HIGH | New alignment will require approvals, permitting and consultation	HIGH | New alignment will require approvals, permitting and consultation	HIGH | New alignment will require approvals, permitting and consultation	HIGH | New alignment will require approvals, permitting and consultation
3.7	Operational issues during service life	HIGH | Existing alignment deficiencies remain resulting in no change in current operational challenges	HIGH | Existing alignment deficiencies remain resulting in no change in current operational challenges	LOW | Alignment improvements (hairpin, west approach) will result in reduced operational issues	LOW | Alignment improvements (hairpin, west approach) will result in reduced operational issues	LOW | Alignment improvements (hairpin, west approach) will result in reduced operational issues	LOW | Alignment improvements (hairpin, west approach) will result in reduced operational issues	LOW | Alignment improvements (hairpin, west approach) will result in reduced operational issues	MODERATE | New alignment will increase the number of kilometers of highway to maintain, assuming the original Highway 103 is kept in service to access New Campbellton Road, Stewart Road and New Harris	MODERATE | New alignment will increase the number of kilometers of highway to maintain, assuming the original Highway 103 is kept in service to access New Campbellton Road, Stewart Road and New Harris	MODERATE | New alignment will increase the number of kilometers of highway to maintain, assuming the original Highway 103 is kept in service to access New Campbellton Road, Stewart Road and New Harris	MODERATE | New alignment will increase the number of kilometers of highway to maintain, assuming the original Highway 103 is kept in service to access New Campbellton Road, Stewart Road and New Harris

Technical Considerations Review - Highway Design

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (S Clark)
Reviewed by: Stantec (P Flower)

Stantec COWI

	Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
3.8	Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
4.1	Public safety	LOW | No alignment improvements means no improvements to safety at the hairpin	LOW | No alignment improvements means no improvements to safety at the hairpin	MODERATE | Alignment improvements at the hairpin will improve public safety	MODERATE | Alignment improvements at the hairpin and the west approach will improve public safety	MODERATE | Alignment improvements at the hairpin and the west approach will improve public safety	MODERATE | Alignment improvements at the hairpin and the west approach will improve public safety	MODERATE | Alignment improvements at the hairpin and the west approach will improve public safety	HIGH | New alignment will better align geometry and operating speeds to improve public safety	HIGH | New alignment will better align geometry and operating speeds to improve public safety	HIGH | New alignment will better align geometry and operating speeds to improve public safety	HIGH | New alignment will better align geometry and operating speeds to improve public safety
4.2	Use of modern bridge design / methods and materials	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design
4.3	Environmental gains	N/A | No alignment changes results in no opportunities	N/A | No alignment changes results in no opportunities	MODERATE| Limited potential to use sustainable practices exceed environmental goals during and post construction, but, re-using existing alignment	MODERATE| Limited potential to use sustainable practices exceed environmental goals during and post construction, but, re-using existing alignment	MODERATE| Limited potential to use sustainable practices exceed environmental goals during and post construction, but, re-using existing alignment	MODERATE| Limited potential to use sustainable practices exceed environmental goals during and post construction, but, re-using existing alignment	MODERATE| Limited potential to use sustainable practices exceed environmental goals during and post construction, but, re-using existing alignment	LOW | High potential to use sustainable practices and to exceed environmental goals during and post construction, but, notable cut/fills required for new alignment	LOW | High potential to use sustainable practices and to exceed environmental goals during and post construction, but, notable cut/fills required for new alignment	LOW | High potential to use sustainable practices and to exceed environmental goals during and post construction, but, notable cut/fills required for new alignment	LOW | High potential to use sustainable practices and to exceed environmental goals during and post construction, but, notable cut/fills required for new alignment
4.4	Local content within construction industry	N/A | No alignment changes results in no opportunities	N/A | No alignment changes results in no opportunities	HIGH | Alignment improvements at the hairpin means within means of local contractors	HIGH | Alignment improvements at the hairpin means within means of local contractors	HIGH | Alignment improvements at the hairpin means within means of local contractors	HIGH | Alignment improvements at the hairpin means within means of local contractors	HIGH | Alignment improvements at the hairpin means within means of local contractors	HIGH | New alignment within means of local contractors	HIGH | New alignment within means of local contractors	HIGH | New alignment within means of local contractors	HIGH | New alignment within means of local contractors
4.5	Technological gains	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design	N/A | No correlation with highway design
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix N Technical Considerations | Highway Lighting

N.1 Basis

Where the existing bridge is retained and rehabilitated, the existing illumination systems shall, at a minimum, be replaced with LED luminaires. Replacement lighting mounted on existing poles shall be modelled to meet, at a minimum, current TAC standards as closely as possible. New illumination systems shall be provided for new bridge and approach road options and shall meet current standards to illuminate fully the required areas on the bridge deck to expressway-highway levels with low pedestrian activity. New illumination systems shall also be provided for active transportation corridors on new bridge options where those corridors are not adequately illuminated by the roadway luminaires.

This appendix will review the opportunities and constraints related to the provision of bridge and approach road illumination:

- Overview of bridge and approach road illumination objectives;
- Overview of guides and standards applicable to the design of lighting systems for the bridge and approach roads;
- Overview of bridge and approach road luminaire selection; and
- Overview of considerations for the installation of luminaires and associated services.

N.2 Technical Considerations - Details

The objective of highway lighting is to provide adequate illumination of the bridge deck and the approach roads to the bridge for the safety of the bridge and road users. For illustrative purposes, the existing bridge lighting is shown in Figure 52.

Options that retain the existing bridge will make provision for the replacement of the existing luminaires with new LED luminaires that provide the same or improved level and quality of illumination. Prior to installing replacement lighting mounted on existing poles, modelling should be performed using AGi32 or similar computer based software to meet current TAC standards. Associated systems (luminaire controls, power supply conduits, etc.) will also be replaced.

Figure 52: Seal Island Bridge at night showing existing light poles along north truss through long exposure (photo from NSDPW; Source: MacNeil Photo by Rob Romard (date unknown))

Options to construct a new bridge and approach roads will include new LED luminaires and associated systems that shall meet standards, regulations and guidelines that are current at the time of design, and will include illumination of the approach road, bridge deck and the active transportation corridors on the bridge. Computer based software (e.g., Agi32 or similar) will be used to model illumination levels to meet or exceed TAC standards and will include consideration of mounting height, spacing, inclination, and other relevant parameters. Similarly, new luminaire controls and power distribution systems will be designed to be compatible with the new luminaires. The need for the inclusion of obstruction lighting to identify the extents of the bridge structure to aircraft is a consideration beyond the scope of this exercise but can be incorporated during the future design works.

The most current versions of the following guides and standards are pertinent to be considered as part of this assessment and during the detailed design phase for new bridge construction, which are:

- Canadian Aviation Regulations. SOR/96-433. Standard 621 – Obstruction Marking and Lighting.

- Canadian Standards Association. C22.1. Canadian Electrical Code, Part 1.

- International Dark-Sky Association (IDA) standards (IDA and IES 2011).
- Province of Nova Scotia Highway Design Guidelines, Highway Lighting design guidelines and associated drawings.
- Transportation Association of Canada. Guide for the Design of Roadway Lighting.
- Transportation Association of Canada. Guide for the Illumination of Isolated Rural Intersections.

Consideration should be given to the disruption to the movement of road traffic during construction activities on the existing bridge and its approach roads. Similarly, consideration should be given to the design, selection, and placement of luminaires on the approach roads at the points where existing roadways join the new approach roads. The need for periodic maintenance and the repair or replacement of damaged luminaires and associated systems shall be taken into consideration when designing the positioning of the luminaire support systems and the placement of the associated systems (controls, conduits, etc.).

Consideration should be given to the selection of luminaires that are in compliance with the International Dark-Sky Association standards to minimize light trespass where light escapes outwards (spill) or upwards (sky glow) and does not illuminate the intended surface. The quality of light emitted from the luminaire will be selected to give consideration to minimizing the impact on birds (primarily seabirds and migratory songbirds) by selecting luminaires that do not emit light that may disorient the birds or attract their food sources (insects). The use of ‘occupancy sensors’ to control the luminaires for the alternative transportation corridor will be considered to reduce energy consumption and light trespass. If needed to supplement the operation of surveillance cameras, infra-red illuminators can be considered in place of visible-light luminaires.

Attention shall be given to the operating environment to ensure reliable and consistent operation of luminaires and their controls.

Replacing the existing luminaires on the existing rehabilitated bridge would likely include luminaire types that could cost-effectively re-use some of the existing electrical infrastructure. These would include ‘cobra-head’ fixture types suited to the configuration of the road deck and bridge structure, or ‘period’ fixtures of the type shown in Figure 53 to add an artistic aesthetic to

Figure 53: Typical 'period' roadway lighting. Source: Holophane (n.d.).

the lighting system. The selected replacement luminaires must meet the Department's LED Highway Light Standards and Performance Specifications.

Options for the selection of luminaires for a new bridge may include a single fixture type suitable for the illumination of both the vehicle and the active transportation corridor. Selection will be dependent on the bridge's structure as this will impact the size, type and orientation of pole and fixture that may be used. A typical fixture is shown in Figure 54, below, for illumination of both sides of the roadway.

Figure 55 shows a typical offset roadway lighting system that could be placed at the side or the centre of a bridge. Final design selection would depend on the construction of the bridge and the location of structural support systems.

Figure 54: Route 138, Trois-Rivières, Quebec. Source: Google (August 2022).

Figure 55: Typical offset roadway lighting suitable for edge or median installation. Source: www.holophane.com (n.d.).

Other types of lighting as shown in Figure 56 and consisting of handrail or guardrail luminaires may provide additional illumination to supplement the lighting of the active transportation corridor.

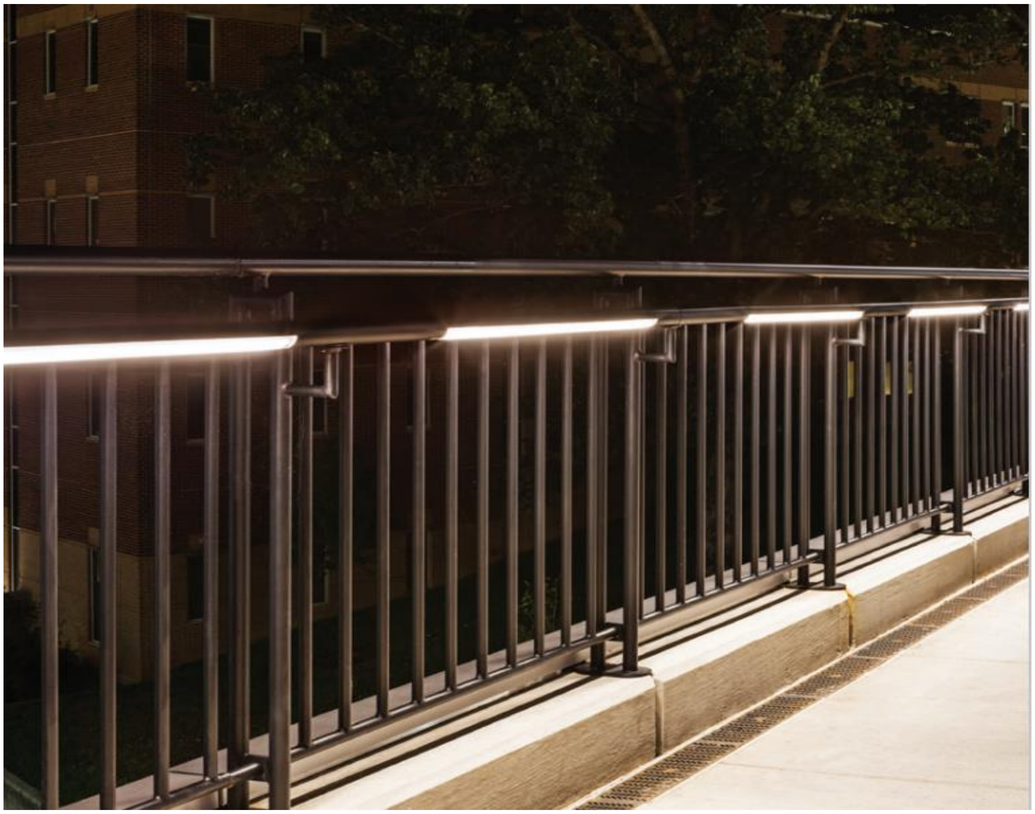

Figure 56: Typical bridge handrail lighting. Source: www.intenselighting.com (n.d.).

N.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

N.4 Key Takeaways

- A rehabilitated or new bridge may be designed to include many aspects of modern bridge lighting design practice to provide a functional and appealing illumination system that satisfies technical and aesthetic requirements. Whereas changes to the lighting of the existing bridge will be limited to simple and less sophisticated solutions. Rehabilitation of the bridge presents an opportunity to investigate the existing lighting and improve it to modern standards.

- New approach roads will require illumination with luminaires and associated systems that meet current standards.

- Planning for future maintenance and repairs will need to be included in the design to minimize cost and disruption to bridge users.

Technical Considerations Review - Highway Lighting

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (S Bygrave)
Reviewed by: Stantec (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1 Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2 Active transportation lanes											
2.3 Clearance of navigational channel											
2.4 Use of existing highway infrastructure											
2.5 NSPW owns required land											
2.6 Service life beyond 50 years											
2.7 Utility/service accommodations											
Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1 Impact to trade corridors during construction	MODERATE | Disruption of traffic during construction to remove/modify luminaires	MODERATE | Disruption of traffic during construction to remove/modify luminaires	MODERATE | Disruption of traffic during construction to remove/modify luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires	LOW | Disruption of traffic contained to non-bridge to install luminaires
3.2 Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3 Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4 Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5 Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6 Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	LOW | Approach lighting may require consultation with local residents	LOW | Approach lighting may require consultation with local residents	LOW | Approach lighting may require consultation with local residents	LOW | Approach lighting may require consultation with local residents
3.7 Operational issues during service life	MODERATE | Disruption of traffic during maintenance	MODERATE | Disruption of traffic during maintenance	MODERATE | Disruption of traffic during maintenance	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing	LOW | Access for maintenance on roadway/crossing
3.8 Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	LOW | Approach road lighting may require easements	LOW | Approach road lighting may require easements	LOW | Approach road lighting may require easements	LOW | Approach road lighting may require easements
Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
4.1 Public safety	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels	MODERATE | Improved illumination levels
4.2 Use of modern bridge design / methods and materials	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires
4.3 Environmental gains	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	LOW | Limited to installation of energy efficient luminaires	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'	MODERATE | Energy efficient luminaires, reduction of 'light spill'
4.4 Local content within construction industry	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers	MODERATE | Local labour; Low potential for local manufacturers

Technical Considerations Review - Highway Lighting

Revision: 0
Date: 2023-DEC-08
Prepared by: Stantec (S Bygrave)
Reviewed by: Stantec (P Flower)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.5 Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1 Public perception	N/A | Despite minimal opportunity for enhanced user experience, unknown impact on public perception	N/A | Despite minimal opportunity for enhanced user experience, unknown impact on public perception	N/A | Despite minimal opportunity for enhanced user experience, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception	N/A | Despite the opportunity to present attractive improved user experience of new roadway/bridge with lighting, unknown impact on public perception
5.2 Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents	NEUTRAL | New bridge and roadway lighting may impact local residents
5.3 Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4 Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5 Architectural and aesthetics	NEUTRAL | Minimal opportunity for enhanced appearance, however, lighting to be improved	NEUTRAL | Minimal opportunity for enhanced appearance, however, lighting to be improved	NEUTRAL | Minimal opportunity for enhanced appearance, however, lighting to be improved	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting	BETTER | Opportunity to present attractive appearance of new roadway/bridge with lighting

Appendix O Technical Considerations | Structural

O.1 Basis

Eleven options were assessed for the new Seal Island Bridge. These options accommodate four potential alignments (existing, enhanced existing, north of the existing bridge, and south of the existing bridge), design strategies (rehabilitation vs. new design), span lengths, service life requirements, materials, and structure types. The 11 options are:

- 1A: Rehabilitation (existing bridge), 25-yr lifespan, 2 lanes (no change to existing capacity)
- 1B: Rehabilitation (existing bridge), 50-yr lifespan, 2 lanes (no change to existing capacity)
- 1C: Rehabilitation (existing bridge), 50-yr lifespan, 2 lanes (with existing alignment improvements)
- 2A: New bridge (concrete box girder), adjacent to the existing bridge, improved existing alignment, medium span, two lanes with widened shoulders, active transportation (AT)
- 2B: New bridge (steel box girder), adjacent to the existing bridge, improved existing alignment, medium span, two lanes with widened shoulders, AT
- 2C: New bridge (network arch), adjacent to the existing bridge, improved existing alignment, medium span, two lanes with widened shoulders, AT
- 2D: New bridge (cable-stayed), adjacent to the existing bridge, improved existing alignment, long span, two lanes with widened shoulders, AT
- 3A: New bridge (highest ranked bridge type from 2A-2C), new alignment to the north of existing structure, medium span, two lanes with widened shoulders, AT
- 3B: New bridge (cable-stayed), new alignment to the north of existing structure, long span, two lanes with widened shoulders, AT
- 4A: New bridge (highest ranked bridge type from 2A-2C), new alignment to the south of existing structure, medium span, two lanes with widened shoulders, AT
- 4B: New bridge (cable-stayed), new alignment to the south of existing structure, long span, two lanes with widened shoulders, AT

This appendix will cover the structural considerations for each option, including existing bridge constraints, risks associated with limited as-built information of the existing structure, and selection of bridge types to represent economic but modern design elements. Also included are the plan, profile, and general arrangement views for the concept development of each option.

O.2 Technical Considerations - Details

The structural features of the options that rehabilitate the existing bridge to extend its service life will be constrained by the existing steel superstructure type and material, pier location and arrangement, the existing bearing articulation, keeping the existing steel barrier, the expansion joint locations, and the existing deck type (replaced in 2001). There can be exceptions, as the rehabilitation options may require strengthening or replacement of certain elements where the opportunity for improvements will be investigated. Ultimately, the structure will keep most of the current structural features and configuration if it is rehabilitated, but any new components will be in accordance with NSDPW's Standard Specification Manual (latest edition at time of publishing this report).

For replacement bridge options, NSDPW has requested the following structural design considerations where possible:

- minimize the number of expansion joints.
  - while expansion joints cannot be fully avoided due to the lengths of the crossings, design measures including minimizing the overall number of joints will mitigate the risk of accelerated deterioration requiring repair;
  - integral abutments are not feasible due to the crossing length being too large.
  - similarly, semi-integral abutments, although theoretically possible, would not be practical for the total span crossings lengths considered.;
- approach slabs present at either end of the bridge;
- ground slopes to be 2H:1V;
- conformance with CAN/CSA S6-19 (Canadian Highway Bridge Design Code), including the CL-625 live load;
- concrete deck to be reinforced concrete (with waterproofing membrane and asphalt wearing surface); and
- all reinforcing for approach slab, decks, barriers, and crash blocks to be Glass Fibre Reinforced Polymer (GFRP) reinforcing while all other reinforcing to be galvanized.

A comparison between the relevant structural criteria between the rehabilitation options (1A/1B/1C) and the new crossing options (2A/2B/2C/2D, 3A/3B, and 4A/4B) is presented in the table on the proceeding pages:

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	**New Design Crossing Considerations** Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
Existing Bridge Deficiencies and Constraints	From the Phase 1 investigations [5] [3], there are known cracks on steel superstructure components of the structure. These typically begin at tack welds located at truss nodes in all spans. Some of the cracks observed have propagated into the parent material. The superstructure steel has poor weldability, low fracture toughness, ductility, and yield strength. Additionally, the substructure is deteriorating due to highly permeable concrete (increased freeze-thaw deterioration) combined with Alkali Aggregate Reactivity (AAR) resulting in map cracking, spalling, and efflorescence throughout. From the Phase 2 Structural Analysis [2], there are various structural elements with demand-over-capacity ratios (D/Cs) exceeding 1.0 that require attention. Additionally, the structure has been found to be sensitive to wind such a buffeting analysis was required to refine the wind loads from CSA S6-19 requirements.	*Not applicable.*
Bridge Location Considerations	By rehabilitating the existing structure, the bridge location remains unchanged.	For the replacement (new) options, there are three potential alignments. For Options 2A through 2D, the new bridge would be adjacent to the existing structure where the waters are the shallowest (~5-10 m depth) with the main span traversing the navigational channel (~20 m depth). For the new options to the north and south of the existing crossing, the bridge cross the lake over depths exceeding 20 m (north option) and 40 m (south option) for a notable portion of the crossing length that will require deep foundations in the water. As a result, crossing options with longer spans (Options 3B/4B) were selected to minimize the number of piers in the water.

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	New Design Crossing Considerations Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
Bridge Code Considerations Since Original Construction	The original design was performed in accordance with CAN/CSA S6-1952 which has significant differences from the current design standards. These differences include, but are not limited to: › the use of Allowable Stress Design (ASD) rather than the current Load and Resistance Factor Design (LRFD), › reduced loading (live, wind, temperature, ice, etc.), › no explicit vessel impact design.	Replacement bridge options will be designed in accordance with the latest version of CAN/CSA S6 (latest edition when design starts), which includes modern provisions such as: Load Resistance Factor Design (LRFD), varying material resistance factors, design loads, vessel collision, ice load, seismic considerations, and other aspects. For the long span replacement options, there would likely be a requirement to go beyond the standards with more refined analyses and site-specific studies.

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	New Design Crossing Considerations Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
Development of Cable Supported Structures	At the time of construction, truss structures were common and cable-supported structures were generally limited to suspension bridges.	In the modern era, cable supported structures, including suspension bridges and cable-stayed (including extradosed) bridges, have become customary for moderate and long span structures. Span lengths for these bridges vary from approximately 200 meters to as much as 2,023 meters (the Çanakkale 1915 Bridge in Turkey). With the current bridge technology, suspension bridges have become a competitive option only for spans well over the 500-600 meters. For instance, the Gordie Howe Cable-Stayed Bridge between Windsor and Detroit has a main span of 800 meters (approx.), which demonstrates the efficiency of cable-stayed bridges for moderately long spans. While cable stayed bridges are included as options for situations where they have been deemed efficient, other bridge types are included (concrete box, steel box, network arch) to represent the present-day capabilities of non-cable-supported structures. Current cable-stayed bridge technology utilizes stay cables that would last for the entire design life of the structure without major rehabilitation work. It is also customary to design the bridge to allow replacement of stay cables with minimal interruptions to traffic in the event that they are damaged or excessively deteriorate during service. However, some stay cable components, such as dampers, would require regular inspections and maintenance. One known adverse attribute of cable-stayed bridges is that in cold weather climates, such as Nova Scotia, there is the possibility for ice to build up on the cables. Built-up ice can fall from cables in large sheets and create hazardous conditions and cause traffic disruptions. Mitigation measures include designing the pylons to lean away from the roadway.

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	**New Design Crossing Considerations** Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
New Materials and Design Details	There are considerable limitations for the application of new materials or design details for rehabilitation options. Existing deficiencies associated with the steel truss superstructure (steel with poor toughness and weldability), aged and deteriorated substructure concrete, bearing articulations and resulting number and location of maintenance intensive expansion joint locations will remain. Special attention would be required for the use of new materials in combination with the existing materials with poorer characteristics.	Material selections and design details for all new crossing options would result in reduced demand for future intervention and maintenance works compared to the existing structure. While expansion joints cannot be fully avoided due to the lengths of the crossings, design measures including minimizing the overall number of joints will mitigate the risk of accelerated deterioration requiring repair. A structural health monitoring system (SHMS) could also be incorporated into a new crossing, which would supplement periodic inspections with real time monitoring capabilities to verify that the structure continues to perform as expected under actual service conditions.
Staged Construction Options	*Not applicable in regard to global construction stages for rehabilitation options.* *Work anticipated for rehabilitation and reinforcement of the existing structure will be phased and coordinated to minimize traffic disruptions. It is likely that there will be a need for single lane closures for the duration of the rehabilitation work (over a number of years) with full bridge closures for critical erection stages. If single lane closures are exclusively overnight, efficiency is impacted whereas if they are permitted during the day, the traffic interruptions are significant.*	Given overall dimensions of all new crossing options, construction would be staged to optimize the use of construction equipment and reduce the overall construction duration. Additionally, most replacement bridge options include different structural systems along the length of the bridge (e.g., options 2D, 3B, and 4B have a cable-stayed main spans with "conventional" approach spans) which allows construction of the separate systems to happen concurrently.
Navigational Clearance	Bridge to maintain existing navigational clearances (*unless a feature's existence requires further encroachment*).	Bridge to meet or exceed current navigational clearances.
Seismic Considerations	From the Phase 2 Structural Analysis report, a preliminary analysis was performed assuming that the geotechnical site is Class D or better has shown that the bridge is in the seismic performance category 1 (SPC 1), regardless of the bridge period, T. Therefore, as per CAN/CSA S6-19, Cl. 4.4.5.1, earthquake loads were not considered in the structural analysis of the existing structure.	At this time, seismic updates to the CAN/CSA S6 bridge code are not anticipated to have a notable change to future seismic requirements for this region and as such, they are assumed be nearly negligible for new bridge crossings. However, as the crossing will likely be classified as a lifeline bridge, the structural design will have to be performed assuming a seismic performance category 2 (SPC 2).

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	**New Design Crossing Considerations** Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
Geotechnical Constraints	There is limited as-built geotechnical information available, and therefore, new geotechnical investigations would be required as part of the detailed rehabilitation designs.	New investigations would be required for all new bridge options.
Durability and Service-Life Considerations	The existing bridge is aged and is notably deteriorated throughout. While all rehabilitation techniques to be instituted would consider robustness and durability, the structural details and material performances of the existing structure are out of date and would continue to plague/impact the durability performance of the existing structure. Furthermore, even following a major rehabilitation, the current level of intervention and maintenance activities could expected until the structure is replaced. The poor toughness and ductility of the steel and ongoing concrete deterioration processes, such as like AAR, represent durability challenges that cannot be fully rectified/eliminated through rehabilitation. Furthermore, the existing bearing articulation and expansion joint locations would remain. Outside of existing concrete to remain, reinforced concrete will be GFRP (approach slab, decks, barriers, and crash blocks) with all other reinforcing galvanized, in accordance with NSDPW's standard specification, unless technically not viable given the construction sequencing.	All replacement crossing options would incorporate modern service life design practices into their design to reliably achieve a 100-year service life and reduced maintenance needs. With a new design, additional durability measures could be implemented to minimize the need for future maintenance and intervention through careful selection of materials and design methodology. Expansion joints would be designed with ease of access, maintenance and replacement in mind. Additionally, the amount of expansion joints would be minimized further reducing future maintenance needs. Concrete would be reinforced with GFRP where possible (approach slab, decks, barriers, and crash blocks) and all other reinforcing would be galvanized in accordance with NSDPW's standard specification. Furthermore, implementing the current concrete construction standards would result in better concrete durability and reduce the potential for aggregate reactivity.
Active Transportation	The existing bridge is unable to accommodate AT lanes due to the narrow, two-lane roadway and predicted structural limitations.	AT lanes will be accommodated for each option within the bridge deck width.

	Existing Bridge and Rehabilitation Considerations Options 1A, 1B, 1C	**New Design Crossing Considerations** Options 2A, 2B, 2C, 2D, 3A, 3B, 4A, 4B
Maintenance Considerations	The existing truss bridge requires significant maintenance considering its age of 60+ years. The truss arrangement provides a significant surface area of steel that requires inspection and recoating. Presently, the existing substructure has no permanent access, making maintenance of these areas challenging. Refer to Appendix D Maintenance Plan for additional details and considerations.	While a new bridge would not be maintenance-free, significantly reduced maintenance demands are foreseen. Maintenance demands of new structures tend to be reduced compared to older structures, as they are at the beginning of their service life. Also, modern designs take into consideration the long term durability of materials and details to minimize maintenance through the entire life of the structure While maintenance would remain a necessity, implementation of maintenance-friendly details in the design of a new crossing would reduce the frequency of intervention while also increasing safety for the maintenance workers.
Access Systems and Security	The existing truss bridge has limited access systems. The approach and splay trusses are only accessible between the bottom chords while the main span above-deck truss (top chord only) is accessible on the north truss at midspan at truss panel 58. <u>All other access is required through a special above- or below-deck access vehicle, which requires single lane closure (at a minimum)</u>. The substructure has no permanent access and would require temporary scaffolding or rope access. Currently, the security systems (fencing) restrict access to the public through dated and undersized fencing and locked gates. This has resulted in unauthorized access by the public to the below-deck catwalk as evidenced by the presence graffiti.	All new bridge options would allow for the use of access systems that are maintenance friendly. Possible access systems could be through longitudinal and transverse catwalks, access platforms, internal access (within box girders), or a mobile (motorized) traveller system. Additionally, <u>all new designs would feature a deck with adequate width to accommodate two-way traffic during maintenance and inspection activities on the deck</u>. Public access to access systems could be restricted through fit-for-purpose fencing and gate options to mitigate unauthorized access by the public. Any motorized equipment could follow lock-out/tag-out procedures to control access to trained personnel only.
Bridge Drawings and Known Geometry	The as-built documentation of the existing bridge has negligible information on the truss bridge connections, which presents a significant challenge to NSDPW, future consultants, and future contractors working on the structure to appropriately evaluate the existing bridge during any rehabilitation work. Technology exists (e.g. 3D Lidar scans) to provide this information, however, it requires significant effort to post-process the data in to provide an appropriate level of confidence.	As is standard in today's construction industry, all new bridges would have accurate as-built information for future use. Technology advancements today in 3D modeling Building Information Modelling (BIM) would allow NSDPW to request the design and as built information in 3D models to provide the highest degree of accuracy.

The conceptual options, presented in Section 6 and Appendix E, represent feasible options that capture the essence of the above considerations to achieve various realistic bridge crossing options that interface with the proposed alignments.

O.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

O.4 Key Takeaways

Rehabilitating the existing bridge presents an opportunity to re-use the existing structure and alignment (including some small improvements). However, significant effort would be required to achieve a service-life beyond 50 years and would not significantly change the inherit characteristics of the structure (i.e., narrow roadway/deck, poor material characteristics, increased maintenance requirements).

A new bridge crossing would use state-of-the-art designs, materials, and techniques to meet the requirements of modern design standards while achieving a 100-year service life to improve durability and reduced future maintenance. The placement of the new crossings adjacent to the existing structure would strategically take advantage of the existing alignment where the waters are the shallowest. The new crossings to the north and south of the existing bridge would improve the highway alignment, however, they would be in deeper waters (20 to 40 m in depth), which would pose significant challenges to construction of the substructure and pier foundations.

Technical Considerations Review - Structural

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

Stantec COWI

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			

Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"
2.1 Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*
2.2 Active transportation lanes	
2.3 Clearance of navigational channel	
2.4 Use of existing highway infrastructure	
2.5 NSPW owns required land	
2.6 Service life beyond 50 years	
2.7 Utility/service accommodations	

Category 3. RISKS — **Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
3.1 Impact to trade corridors during construction	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.2 Impact to trade corridors in-service	HIGH | Single-lane closures required for future work and inspection, which impact the public	HIGH | Single-lane closures required for future work and inspection, which impact the public	HIGH | Single-lane closures required for future work and inspection, which impact the public	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic	LOW | New crossing width to accommodate interruptions but sustain minimum two total lanes for traffic
3.3 Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4 Climate Change	HIGH | Limited ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); no change navigational clearance	HIGH | Limited ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); no change navigational clearance	HIGH | Limited ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); no change navigational clearance	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained	MODERATE | Ability to accommodate changes to environmental loading (i.e., wind, temperature, ice, seismic); navigational clearance maintained
3.5 Geotechnical	MODERATE | Limited as-built geotechnical information available; new investigations required	MODERATE | Limited as-built geotechnical information available; new investigations required	MODERATE | Limited as-built geotechnical information available; new investigations required	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing	HIGH | New investigations required for new crossing
3.6 Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.7 Operational issues during service life	HIGH | Significant structural challenges and shortcomings with existing bridge	HIGH | Significant structural challenges and shortcomings with existing bridge	HIGH | Significant structural challenges and shortcomings with existing bridge	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings	LOW | Limited operational issues during service for new design crossings
3.8 Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Category 4. OPPORTUNITIES — **Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

Technical Considerations Review - Structural

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

		Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
		25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	Categories	**1A**	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
4.1	Public safety	LOW | Minimal opportunity to improve safety beyond necessary rehab. measures	LOW | Minimal opportunity to improve safety beyond necessary rehab. measures	LOW | Minimal opportunity to improve safety beyond necessary rehab. measures	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards	HIGH | New design can accommodate current design and safety standards
4.2	Use of modern bridge design / methods and materials	LOW | Minimal opportunity for modern design elemens given constraints of existing structure (geometry, truss arrangement)	LOW | Minimal opportunity for modern design elemens given constraints of existing structure (geometry, truss arrangement)	LOW | Minimal opportunity for modern design elemens given constraints of existing structure (geometry, truss arrangement)	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials	HIGH | New design can accommodate modern design methods and materials
4.3	Environmental gains	MODERATE | Some potential to use sustainable (and re-use/recycling) practices and to exceed environmental goals during and post construction	MODERATE | Some potential to use sustainable (and re-use/recycling) practices and to exceed environmental goals during and post construction	MODERATE | Some potential to use sustainable (and re-use/recycling) practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction	HIGH | High potential to use sustainable practices and to exceed environmental goals during and post construction
4.4	Local content within construction industry	HIGH | Local engineering firms have experience in this design	HIGH | Local engineering firms have experience in this design	HIGH | Local engineering firms have experience in this design	MODERATE | Local engineering firms may have some experience in this design option	MODERATE | Local engineering firms may have some experience in this design option	MODERATE | Local engineering firms may have some experience in this design option	LOW | Local engineering firms are unlikely to have some experience in this design option	MODERATE | Local engineering firms may have some experience in this design option	LOW | Local engineering firms are unlikely to have some experience in this design option	MODERATE | Local engineering firms may have some experience in this design option	LOW | Local engineering firms are unlikely to have some experience in this design option
4.5	Technological gains	MODERATE | Some opportunity for new technology given contraints of existing truss bridge	MODERATE | Some opportunity for new technology given contraints of existing truss bridge	MODERATE | Some opportunity for new technology given contraints of existing truss bridge	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains	HIGH | New bridge design can accommodate new technological gains
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix P Technical Considerations | Vessel Collision

P.1 Basis

The navigational channel under the Seal Island Bridge is one of the main entrances to the Bras d'Or Lake system and has a vertical clearance of approximately 36 m, a 10 m limiting depth and 122m navigation channel width. With the available clearances, considerable sized vessels may transit the channel beneath the bridge and therefore the bridge is susceptible to significant pier impact loads due to vessel collision.

Vessel collision is a design consideration for the rehabilitation and new options. The existing bridge was not explicitly designed for vessel collision and as such, there are potentially more limitations on the existing structure compared to new options, which can be adequately detailed for the anticipated vessel impact.

The basis of this technical consideration is to collect information regarding the vessel traffic in the area, including vessel geometry, weights, and transit speed. With the information collected, the existing structure will be assessed to determine whether it meets the current standards presented in CSA S6-19 A3.3.

P.2 Technical Considerations – Details

P.2.1 Background

MarineTraffic, a company that provides vessel movement data, was contacted to provide records of vessel traffic around the Seal Island Bridge. MarineTraffic monitors vessels by gathering data from network coastal AIS-receiving stations and satellite receivers and can provide real-time and historical vessel tracking data for all bodies of water and ports around the world.

In 2022 October, COWI requested MarineTraffic provide historical vessel traffic data from 2012 through 2022 (representing a 10-year period) through the navigational channel of the existing crossing, represented in Figure 57. For data collection, readings were taken within a 1.5 km band upstream and downstream of the Seal Island Bridge, as represented in Figure 58.

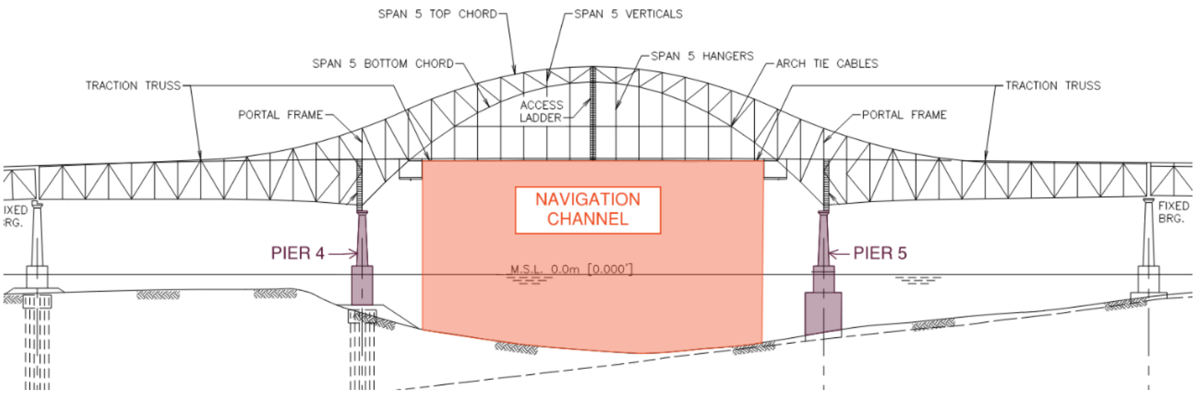

Figure 57: Navigational channel approximation superimposed on the existing crossing

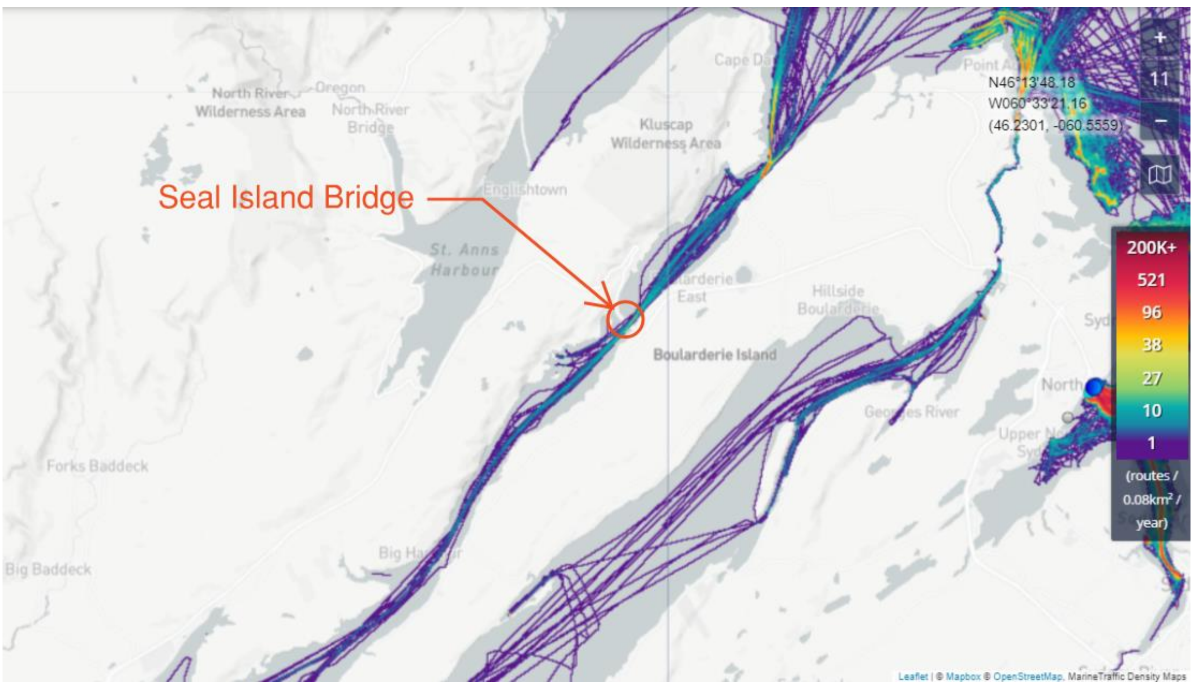

Figure 58: MarineTraffic data around Seal Island Bridge navigational channel (ref: www.marinetraffic.com)

For this project, the following parameters were included in the data request from MarineTraffic:

- Vessel types/ Categories:
  - Any vessels with Dead Weight Tonnage (DWT) exceeding 100 tons
- Parameters:
  - MMSI
  - Ship Name
  - Longitude
  - Draft (max and min)
  - Length
  - Course
  - Speed
  - Last Port
  - Gross Tonnage (GRT)
  - Moulded Depth
  - Vessel Type
  - IMO
  - Timestamp
  - Latitude
  - Destination
  - Width
  - Heading
  - Dead Weigh Tonnage
  - Previous Port
  - Next Port
  - Net tonnage

Although requested, the moulded depth data was incomplete and DWT before 2015 was not collected by MarineTraffic. The raw data from Marine Traffic provides vessel data every few minutes and it was processed to remove all duplicated records for the same vessel. The remaining data was then grouped by DWT. Table 44 below presents the annual number of vessel transits within each given year for each vessel and the average annual number of vessel transits from 2015 to 2022, which was used to perform the calculations presented in this appendix. The following sections outline how the data was captured and processed.

Table 44. Annual vessel transits under the Seal Island Bridge (data from MarineTraffic)

VESSEL NAME	DWT (ton)	LOA (m)	2015	2016	2017	2018	2019	2020	2021	2022	Average (2015-2022)
ALGOMA MARINER	37690	225	15	0	0	0	0	0	0	0	1.88
RADCLIFFE R LATIMER	37257	225	2	0	0	0	0	0	0	0	0.25
ATLANTIC HURON	36920	224	1	0	0	0	0	0	0	0	0.13
ALGOMA DISCOVERY	34752	223	2	0	0	0	0	0	0	0	0.25
LE BELLOT	1359	132	0	0	0	0	0	0	0	2	0.25
NATIONAL GEOGRAPHIC EXPLORER	1301	112	2	4	4	0	2	0	0	4	2.00
FRAM	984	114	0	0	0	2	0	0	0	0	0.25
FRAM	957	114	0	0	0	0	2	0	0	0	0.25
HEBRIDEAN SKY	645	91	0	0	0	2	0	0	0	0	0.25
SILVER EXPLORER	635	108	0	0	2	0	0	0	0	0	0.25
ASPEN ALTERNATIVE	452	50	0	0	0	1	0	0	0	0	0.13
LOIS M	400	36	0	0	0	0	0	0	0	6	0.75

VESSEL NAME	DWT (ton)	LOA (m)	2015	2016	2017	2018	2019	2020	2021	2022	Average (2015-2022)
ARCHIMEDES	356	71	0	0	0	0	0	0	0	1	0.13
REEF CHIEF	227	49	0	1	0	0	0	0	0	0	0.13
AUROR	192	61	1	0	0	0	0	0	0	0	0.13
ATLANTIC LARCH	145	31	0	0	0	0	0	0	2	0	0.25
ANGIAMO	133	43	0	1	0	0	0	0	0	0	0.13

P.2.2 Determining the Annual Frequency of Collapse

To determine the risk of catastrophic failure due to a vessel collision, CAN/CSA S6-19 adopted the method implemented by AASHTO. In this method, the annual frequency of collapse (*AF*) is calculated for each bridge component at risk of vessel collision and vessel class. The bridge components considered at risk for collision in this study are shown in Figure 59 below.

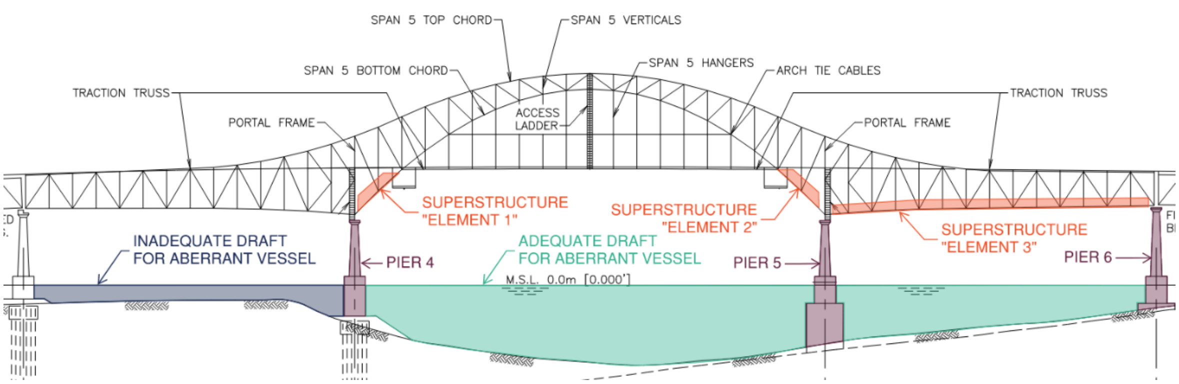

Figure 59. Elements considered during vessel impact study

As per CSA S6-19, *AF* is calculated as per the equation below:

$AF = (N)(PA)(PG)(PC)(PF)$

where *N* is the number of vessels, *PA* is the probability of aberrancy, *PG* is the geometric probability, *PC* is the probability of collapse, and *PF* is the protection factor. These probabilities are discussed in the following sections.

After determining the *AF* for each bridge component, the *AF* for the entire bridge is taken as the sum of the individual component *AF* values.

<u>Probability of Aberrancy (*PA*)</u>

The probability of aberrancy depends on the amount of traffic, water current, mechanical failure, and human error. CAN/CSA S6-19 provides equations to calculate the aberrancy of commercial class vessels. For the calculations, it was assumed that the water current was 2.65 knots parallel to the bridge and that there is no significant cross current. The PA of the largest vessel was determined to be 7.64x10-5. To be conservative, the aberrancy for cruise ships was assumed to be same as commercial vessels.

<u>Geometric Probability (*PG*)</u>

The geometric probability, PG, is defined as the probably of an aberrant ship in the vicinity of the bridge striking a navigation span pier. The probability of ship collision with a pier is assumed to be normally distributed over the width of the waterway. The mean of the distribution is located at the centerline of the navigation channel and the standard deviation is equal to the overall length of the design vessel, LOA. PG is defined as the area under the normal distribution curve over the combined width of the pier and the vessel, and the length of superstructure that do not have sufficient clearance, demonstrated graphically in Figure 60 and Figure 61.

PG was calculated for each structural element by considering vessel max draught, air draft, vessel length, bridge clearance, and distance from structural elements to centerline of vessel transit path, as shown in Table 45.

In order for an aberrant vessel to impact Pier 6, two criteria were checked: (1) the vessel must have a maximum draught depth less than the limiting depth of 6.1 m at Pier 6 and (2) Its length multiplied by three (3*LOA) must be not less than the distance from Pier 6 to the centerline of the vessel transit path, which is 183 m (CSA 6-19. Cl. A3.3.5.1). Otherwise, PG at Pier 6 is 0.

In order for an aberrant vessel to impact the full Span 6 (*S*uperstructure Element 3 in Figure 59), in addition to the *PG* requirement above, the vessel also needs to have an air draft greater than the vertical clearance of Span 6, which is approximately 24 m. If a vessel's air draft is greater than the vertical clearance at span 6, but the max draught doesn't pass the water depth limit at pier 6, the vessel can only hit a portion of Span 6. Additionally, if only a portion of Span 6 is within 3**LOA, PG* of the superstructure was considered simply assuming half of Span 6.

To hit the superstructure elements encroaching on the clearance within Span 5, between Piers 4 and 5 (Element 1 and element 2 shown in Figure 59), a vessel's air draft must be greater than vertical clearance at these locations which is approximately 27 m. Otherwise, PG of these elements was considered to be 0.

By considering all these collision cases above, the sample PG values for Pier 4/5, pier 6, and superstructure elements 1-3 were calculated and summarized in Table 45.

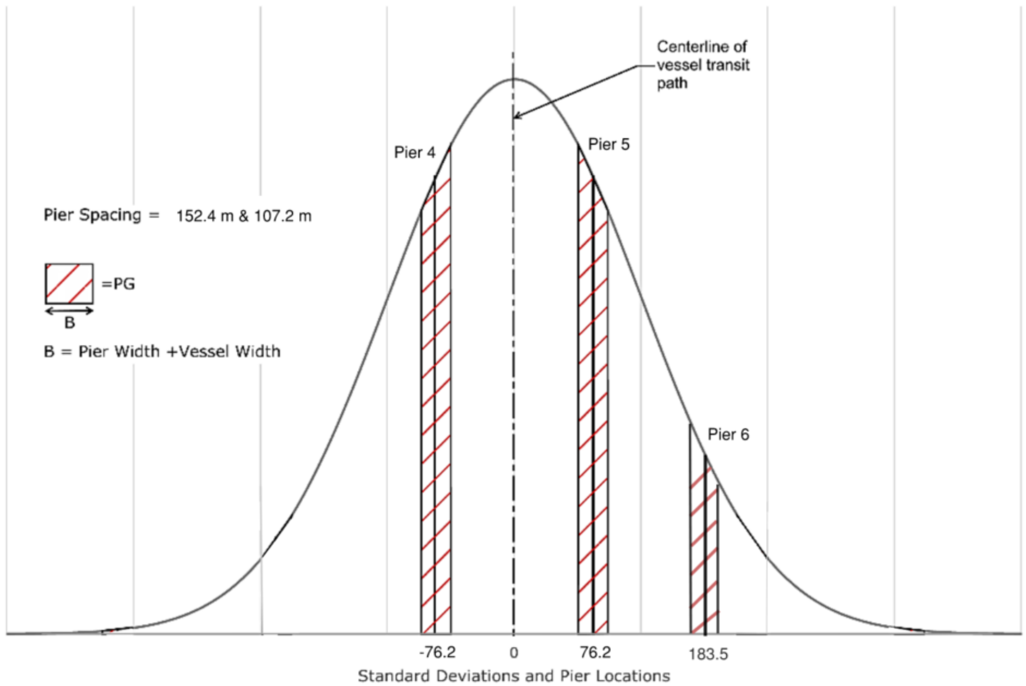

Figure 60. Geometric probability of pier collision (for LE BELLOT, as an example)

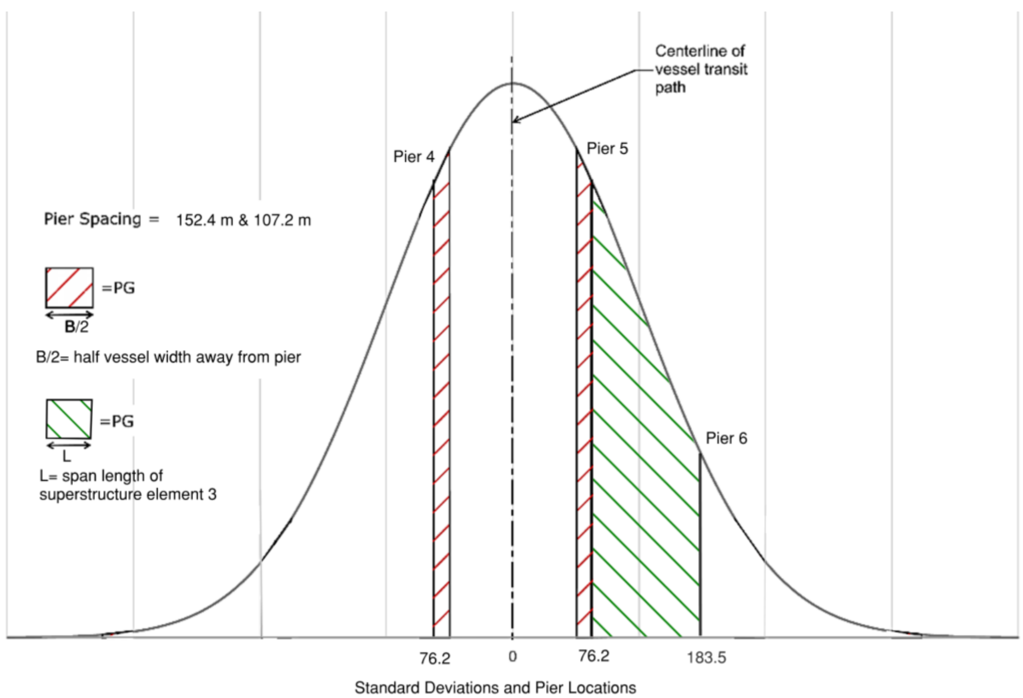

Figure 61. Geometric probability of superstructure collision (for LE BELLOT, as an example)

Table 45. Geometric probability factors

VESSEL NAME	LOA (m)	3xLOA (m)	Air draft (m)	Max draught (m)	Collisions Considered
ALGOMA MARINER	225.46	676.38	28.39	10.1	Piers 4 and 5, Half of Span 6, Span 5
RADCLIFFE R LATIMER	225	675	33.32	6	**All**
ATLANTIC HURON	224.37	673.11	24	9.53	Piers 4 and 5, Half of Span 6, Span 5
ALGOMA DISCOVERY	223	669	39.36	7.4	Piers 4 and 5, Half of Span 6, Span 5
LE BELLOT	131.5	394.5	36*	4	**All**
NATIONAL GEOGRAPHIC EXPLORER	112	336	30*	4.74	**All**
FRAM	113.65	340.95	30*	5.1	**All**
FRAM	113.65	340.95	30*	5.1	**All**
HEBRIDEAN SKY	90.6	271.8	30*	4	**All**
SILVER EXPLORER	108	324	22.5*	4.38	Piers 4, 5 and 6
ASPEN ALTERNATIVE	50	150	15.11*	2.8	Piers 4 and 5
LOIS M	36	108	9.79*	4.8	Piers 4 and 5
ARCHIMEDES	70.6	211.8	21.6*	3.5	Piers 4, 5 and 6
REEF CHIEF	49.09	147.27	14.37*	2.4	Piers 4 and 5
AUROR	60.97	182.91	24.6*	2*	Piers 4 and 5
ATLANTIC LARCH	31.4	94.2	26.88*	4.78	Piers 4 and 5, Half of Span 6, Span 5
ANGIAMO	42.56	127.68	20.84*	2.85	Piers 4 and 5

**information is not published and value was obtained by scaling vessel photos from MarineTraffic*

Table 46. Navigation Channel PG

		PG			
VESSEL NAME	**DWT (ton)**	**Piers 4 and 5**	**Superstructure Elements 1/2**	**Superstructure Element 3**	**Pier 6**
ALGOMA MARINER	37690	0.0551	0.0402	0.1399	0
RADCLIFFE R LATIMER	37257	0.0555	0.0405	0.2428	0.0009
ATLANTIC HURON	36920	0.0551	0.0402	0.1399	0
ALGOMA DISCOVERY	34752	0.0054	0.0391	0.14094	0
LE BELLOT	1359	0.0695	0.0471	0.2428	0.0006
NATIONAL GEOGRAPHIC EXPLORER	1301	0.0724	0.0471	0.2428	0.0004
FRAM	984	0.0991	0.0783	0.2400	0.0004
FRAM	957	0.0991	0.0783	0.2400	0.0004
HEBRIDEAN SKY	645	0.0755	0.0490	0.1980	0.0002
SILVER EXPLORER	635	0.0723	0	0	0.0004
ASPEN ALTERNATIVE	452	0.0445	0	0	0
LOIS M	400	0.0262	0	0	0
ARCHIMEDES	356	0.0709	0	0	0.00004
REEF CHIEF	227	0.0442	0	0	0
AUROR	192	0.1525	0	0	0
ATLANTIC LARCH	145	0.0154	0.0101	0.0076	0
ANGIAMO	133	0.0442	0	0	0

Probability of Collapse (PC)

The probability of collapse, *PC*, measures whether an element struck by an aberrant vessel will collapse. As per AASHTO and CSA S6-19, this factor depends on the ultimate bridge element resistance and vessel impact force, which was calculated using the maximum speed measured speed from MarineTraffic along each vessel transit path. The value of *PC* is determined as follows, using the code equations:

- In cases where the element resistance exceeds the vessel impact force, the *PC* is equal to zero;

- In cases where the element resistance is in the range of 10% to 100% of the vessel impact force, the *PC* varies linearly between 0.10 and zero; and

- In cases where the element resistance is less than 10% of the ship impact force, *PC* varies linearly between 0.10 and 1.0.

For the piers, Piers 4 and 5 have similar geometry, but because Pier 4 has pile foundation while pier 5 is on gravity foundation, Pier 4 was assumed to have higher resistance than Pier 5. Conservatively, the resistance of Pier 5 was considered to govern for both Piers 4 and 5. To calculate capacity of Pier 5, both global stability and local component collision were considered, and the results showed that local component collision governs the design. For collision with local component, there are two scenarios:

- vessel hits pier shaft and causes shear failure; and

- vessel hits pier foundation only

Conservatively, the PC for Pier 6 was taken as 1.0. This assumes that any potential impact to the pier causes failure.

For the superstructure elements, a conservative impact resistance was assumed to be 30 kN to calculate *PC* for deck mast impacts. Simplified resistance calculations showed that this assumption was reasonable. For deck house impacts, a value of 1.0 was assumed for *PC*.

P.2.3 Annual Frequency of Collapse of the Existing Bridge

According to CAN/CSA S6-19 A3.3, critical or essential bridges must have an *AF* value of less than 0.0001 (1/10000 years). This value means that the annual frequency of collapse or probability of failure is 1/10000. For the existing bridge, the annual frequency of collapse was determined to be 0.00008047 (1/12427 years), which meets the code requirements for critical or essential bridges.

P.2.4 Key Variables

Some variables can change and have a significant influence on the annual frequency of collapse, such as superstructure resistance, vessel size, and number of vessels.

<u>Superstructure Resistance</u>

Superstructure element 3 has the most significant contribution to the total *AF* calculation for the whole bridge. In the current study, 30 KN mast impact resistance was conservatively used for individual superstructure elements, and *PC* was assumed to be 1 for deck house impact. Therefore, if superstructure resistance can be refined, both the probability of collapse ratio and *AF* value can significantly be reduced.

Vessel Size

Larger vessels pose more risk to the Bridge as a collision is more likely to cause significant damage or collapse. Based on the current vessel geometry and vertical clearance at superstructure elements 1-3, most of the ship collision force on the superstructure is calculated as mast collision force. However, if taller vessels pass through the bridge, more deck house collision force should be considered, which is 10 times greater than mast collision force. In that case, the probability of collapse ratio and *AF* value could be increased significantly. Therefore, if any significant changes to the vessel traffic under the bridge occur, this assessment should be updated.

Number of Vessels

Each time a vessel that could potentially impact the bridge transits beneath the Bridge, there is a risk of collision with the pier and superstructure that could cause significant damage or collapse. Therefore, the total cumulative risk is directly proportional to the number of times a given vessel transits in an average year. Each transit slightly increases the probability that a vessel could become aberrant, especially for large vessels. Large vessels typically have a long vessel length, *LOA*, which increases their potential to impact the superstructure of Span 6 (Superstructure Element 3). This study showed that superstructure element 3 has the greatest contribution to the total risk. Therefore, if more large vessels pass through the bridge in the future, the *AF* value could increase significantly.

P.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

P.4 Key Takeaways

The following are the key takeaways from the vessel impact study:

- New bridge designs can account for potential vessel collision through design of piers and superstructure elements.
- Existing bridge was not designed for vessel collision.
- Existing bridge was assessed according to the method presented in CAN/CSA S6-19 A3.3 and it was determined that the annual frequency of collapse (AF) is 0.00008047 which meets the code requirement of ≤ 0.0001 for critical or essential bridges.
- The annual frequency of collapse, *AF*, of the bridge is dominated by potential superstructure impact, especially in Span 6 (Superstructure Element 3).

Technical Considerations Review - Vessel Collision

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

Stantec COWI

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			

	Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"
2.1	Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*
2.2	Active transportation lanes	
2.3	Clearance of navigational channel	
2.4	Use of existing highway infrastructure	
2.5	NSPW owns required land	
2.6	Service life beyond 50 years	
2.7	Utility/service accommodations	

Category 3. RISKS

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
3.1	Impact to trade corridors during construction	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.2	Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3	Constructability / complexity of erection sequence	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.4	Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5	Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6	Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.7	Operational issues during service life	LOW | Future vessel impact to existing bridge likely to require inspection, maintenance, or rehabilitation	LOW | Future vessel impact to existing bridge likely to require inspection, maintenance, or rehabilitation	LOW | Future vessel impact to existing bridge likely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation	HIGH | Future vessel impact to new bridge unlikely to require inspection, maintenance, or rehabilitation
3.8	Land acquisition	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Category 4. OPPORTUNITIES

Details | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"

		1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.1	Public safety	LOW | Existing bridge not designed explicitly for vessel impact	LOW | Existing bridge not designed explicitly for vessel impact	LOW | Existing bridge not designed explicitly for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact	HIGH | New bridge can be adequately designed/detailed for vessel impact
4.2	Use of modern bridge design / methods and materials	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.3	Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

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		Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	Categories	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
4.4	Local content within construction industry	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.5	Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
	Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1	Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2	Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3	Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4	Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5	Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix Q Technical Considerations | Constructability and Site Considerations

Q.1 Basis

A major consideration for each alignment and subsequent crossing option is constructability and site considerations, which NSDPW was defined as:

- High-level Constructability review of each option (note: detailed constructability review for the two highest rated options is provided in Section 7);
- Traffic interruptions and management during construction;
- Connections to the approach roads;
- Implications for infrastructure, roads, buildings, wharves, utilities, etc.; and
- Property ownership, applicability of easements, ROW and Land Acquisition.

With these considerations effectively all occurring during construction, the in-service impacts for each option would be minimal.

Q.2 Technical Considerations - Details

The four unique alignments are:

1. Existing (where bridge is rehabilitated);
2. New bridge adjacent to existing with improved existing alignment;
3. New alignment to the north of the existing bridge; and
4. New alignment to the south

The subsequent tables below summarize constructability and site considerations for each alignment.

	Existing Alignment Options 1A, 1B	**Improved Existing Alignment** Options 1C, 2A, 2B, 2C, 2D	**New Alignment** Options 3A, 3B, 4A, 4B
Constructability *(High-Level)*	The existing alignment would only be left as-is for rehabilitation options. These activities range from, but are not limited to, steel and concrete strengthening (or replacement) and localized and major re-coating. Although the constructability is primarily related to means & methods for the contractor, the existing structure has limited access platforms such that specific access equipment would be required for the work.	The improved existing alignment options include: › a 50-year rehabilitation (similar discussion to "existing alignment"), › new medium span bridge options, › a new long-span cable-stayed option. New bridges would be built just to the south of the existing crossing to maximize the re-use of the existing roadway and to capitalize on the shallow waters, which are exclusively located in the vicinity of the existing bridge. The roadway improvements are primarily limited to the hairpin turn area and could take place with minimal constructability challenges.	The new north and south roadway alignments both rank high as it relates to constructability as they are away from the existing Highway 105. Both options would involve significant earthworks and blasting through rock, which could be done safely due to their remoteness. Access to the alignments would be favourable for the importing of materials, equipment and labour force. The bridge constructability would more challenging due to accessibility and the deep water at the crossings.
Traffic Interruptions + Management	Semi-permanent single lane closure during work (similar to the 2000-01 deck replacement) will be required to facilitate access equipment, mobilization. Management will be through full-time traffic control or signaled intersections as the work progresses.	Improvements to existing alignment would be adjacent to existing alignment with small impacts to traffic. Traffic interruptions would be isolated partial or full roadway closures during critical interfacing staging between new and existing alignments. Management would be through isolated traffic control.	New alignment would be separate from existing alignment. Minimal interruptions would be anticipated at tie-in locations. Management would be through isolated traffic control.
Connections to Approach Roads	Not applicable; re-use of existing highway.	Improvement on existing alignment with tie-ins to the existing highway.	Two connections to the existing highway alignment would be required. Re-alignment would occur once new highway is fully constructed. Connections for Stewart Road, New Campbellton Road and Kempt Head Road would need to be considered.

Implications for Infrastructure	Minimal; re-use of existing highway.	Minimal implications limited to the hairpin turn location.	The new North and South alignments would impact infrastructure as portions of the existing Highway 105 would potentially be abandoned, decommissioned or downgraded to a rural road. New connections at Stewart Road, New Campbellton Road and Kempt Head Road would need to be considered.
Property Ownership Easements, ROW, Land Acquisitions	Minimal; re-use of existing highway.	The improved existing alignment would impact properties for both private and public owner, primarily at the hairpin turn location and east of the hairpin. Land acquisitions will be facilitated by purchase or expropriation methods. Impacts would be limited to the west side of the Bras d'Or Lake.	The new alignments would impact both private and publicly (crown) owned properties. Land acquisitions would be facilitated by purchase or expropriation methods. Impacts would be present on both sides of the Bras d'Or Lake.

Q.3 Technical Considerations - Evaluation

Refer to the attached evaluation matrix for the item-by-item evaluation for this technical consideration for each option.

Q.4 Key Takeaways

The following are the key takeaways from the constructability and site considerations review:

- A new bridge adjacent with an improved existing alignment would have a roadway would have minimal constructability challenges for the roadways. Similarly, the new north and south alignment options could be constructed away from live traffic, creating minimal disruptions, except at tie-in locations.

- Excluding the as-is existing alignment, all other alignment options have an impact on both public and private properties. Some private properties are owner-occupied or businesses, while others are unoccupied woodland. There are several high-valued waterfront properties that could be impacted and could require costly expropriation to acquire the land.

- Under most of the alignments, there would be impacts to some existing minor roads, namely Stewart Road, New Campbellton Road and Kempt Head Road, that would potentially require new connections to the updated alignment.

For a detailed constructability review for the two highest rated options, refer to Section 7 of the main report.

Technical Considerations Review - Constructability / Site Considerations

Stantec COWI

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Reviewed by: COWI (D Betts)

		Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	Categories	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
		1A	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
	BRIDGE AND ALIGNMENT DESCRIPTIONS	**Details**										
	Bridge type	Existing arch with truss approach spans			Concrete box	Steel box	Network arch	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed	(Highest Ranked 2A-2C)	Cable stayed
	Main span length (m)	152 m			≈152 m			≈280 m	Min. 152 m	≥ 560 m	Min. 152 m	≥ 560 m
	Alignment route	Existing (I)		Improved Existing (II)					New North (III)		New South (IV)	
	Alignment limitations	Existing alignment; existing speed		Existing alignment improved; min. 70 km/hr					New alignment; min. 90 km/hr			
	Category 2. FEATURES	**Details** | Rating assignments are ranked either No, N/A, or Yes if the specific feature is present in the evaluation option, including supporting narrative, as applicable. Text to be in the following form: "Rating Assignment | narrative text"										
2.1	Wider Traffic Lanes (min. 2 Lanes)	*N/A | Not a component of this technical consideration.*										
2.2	Active transportation lanes											
2.3	Clearance of navigational channel											
2.4	Use of existing highway infrastructure											
2.5	NSPW owns required land											
2.6	Service life beyond 50 years											
2.7	Utility/service accommodations											
	Category 3. RISKS	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
3.1	Impact to trade corridors during construction	HIGH | Signficant single-lane closures anticiapted for rehabilitation work	HIGH | Signficant single-lane closures anticiapted for rehabilitation work	HIGH | Signficant single-lane closures anticiapted for rehabilitation work	MODERATE | New crossing adjacent to existing bridge and will utilize existing bridge during construction; some tie-ins to existing highway will be required. marine channel impacts limited	MODERATE | New crossing adjacent to existing bridge and will utilize existing bridge during construction; some tie-ins to existing highway will be required. marine channel impacts limited	MODERATE | New crossing adjacent to existing bridge and will utilize existing bridge during construction; some tie-ins to existing highway will be required. marine channel impacts limited	MODERATE | New crossing adjacent to existing bridge and will utilize existing bridge during construction; some tie-ins to existing highway will be required. marine channel impacts limited	LOW | New crossing in a new location; utilize existing bridge during construction; marine channel impacts limited	LOW | New crossing in a new location; utilize existing bridge during construction; marine channel impacts limited	LOW | New crossing in a new location; utilize existing bridge during construction; marine channel impacts limited	LOW | New crossing in a new location; utilize existing bridge during construction; marine channel impacts limited
3.2	Impact to trade corridors in-service	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.3	Constructability / complexity of erection sequence	LOW | Limited to rehabilitation/reinforcement work but engineering temporary access required	LOW | Limited to rehabilitation/reinforcement work but engineering temporary access required	LOW | Limited to rehabilitation/reinforcement work but engineering temporary access required	MODERATE | Launching/movable gantry, cranes, and marine work anticipated	MODERATE | Launching/movable gantry, cranes, and marine work anticipated	MODERATE | Launching/movable gantry, cranes, and marine work to transport arch anticipated	HIGH | Launching/movable gantry, cranes, marine work, and stay cable installation anticipated	MODERATE | Launching/movable gantry, cranes, and marine work anticipated	HIGH | Launching/movable gantry, cranes, marine work, and stay cable installation anticipated	MODERATE | Launching/movable gantry, cranes, and marine work anticipated	HIGH | Launching/movable gantry, cranes, marine work, and stay cable installation anticipated
3.4	Climate Change	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.5	Geotechnical	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.6	Approvals, permitting and consultation	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.7	Operational issues during service life	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
3.8	Land acquisition	LOW | Re-use of existing alignment requires negligible land acquisition capital costs	LOW | Re-use of existing alignment requires negligible land acquisition capital costs	MODERATE | Alignment improvements will require land acquisition capital costs on west approach	MODERATE | Alignment improvements will require land acquisition capital costs on west approach	MODERATE | Alignment improvements will require land acquisition capital costs on west approach	MODERATE | Alignment improvements will require land acquisition capital costs on west approach	MODERATE | Alignment improvements will require land acquisition capital costs on west approach	HIGH | New alignment will require significant land acquisition capital costs	HIGH | New alignment will require significant land acquisition capital costs	HIGH | New alignment will require significant land acquisition capital costs	HIGH | New alignment will require significant land acquisition capital costs
	Category 4. OPPORTUNITIES	**Details** | Rating assignments are ranked either Low, Moderate, High, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										

Technical Considerations Review - Constructability / Site Considerations

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (A Ferguson)
Reviewed by: COWI (D Betts)

Categories	Rehabilitate			New Bridge Existing Location				New Bridge New Location - North		New Bridge New Location - South	
	25 yrs	50 yrs	50 yrs w/ Alignment Improvement	Medium Span			Long Span	Medium Span	Long Span	Medium Span	Long Span
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
4.1 Public safety	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.2 Use of modern bridge design / methods and materials	LOW | Rehabilitation (member reinforcement, strengthening, etc.) has minimal opportunity for modern construction methods on truss bridges	LOW | Rehabilitation (member reinforcement, strengthening, etc.) has minimal opportunity for modern construction methods on truss bridges	LOW | Rehabilitation (member reinforcement, strengthening, etc.) has minimal opportunity for modern construction methods on truss bridges	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment	HIGH | New design can accommodate modern design sequencing, methodology, and equipment
4.3 Environmental gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
4.4 Local content within construction industry	HIGH | Rehabilitation and existing truss bridge has been performed in province in the past	HIGH | Rehabilitation and existing truss bridge has been performed in province in the past	HIGH | Rehabilitation and existing truss bridge has been performed in province in the past	LOW | New bridge type not common in NS/Atlantic region including local industry	MODERATE | New bridge type common in NS/Atlantic region including local industry but this is larger scale	LOW | New bridge type not common in NS/Atlantic region including local industry	LOW | New bridge type not common in NS/Atlantic region including local industry	LOW | New bridge type not common in NS/Atlantic region including local industry	LOW | New bridge type not common in NS/Atlantic region including local industry	LOW | New bridge type not common in NS/Atlantic region including local industry	LOW | New bridge type not common in NS/Atlantic region including local industry
4.5 Technological gains	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
Category 5. SOCIAL IMPLICATIONS	**Details** | Rating assignments are ranked either Worse, Neutral, Better, or Not Applicable (N/A) with supporting narrative, as applicable. Text to be in the following form: "Value assignment | narrative text"										
5.1 Public perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.2 Effects on nearby communities	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.3 Mi'kmaq perception	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.4 Stakeholder impact	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration
5.5 Architectural and aesthetics	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration	N/A | Negligible impact on this tech. consideration

Appendix R Cost Estimates

A high-level cost estimate was performed for this study based on rates from similar projects. While our Team expects that the costs are indicative of the anticipated actual cost of each option, they should not be used for financial planning purposes. A summary of the rates is provided below. All costs are in Canadian Dollars corresponding to the year of this report (2023).

- Rehabilitation options:
  - Existing truss spans rehabilitation: $90,000-$110,000 / m
  - Existing pier rehabilitation: $3,000,000 lump sum
- Replacement options:
  - Replacement (medium span) cast-in-place segmental: $8,000 / sq m
  - Replacement (medium span) haunched steel box girder: $10,000 / sq m
  - Replacement (medium span) steel network arch: $10,000 / sq m
  - Replacement (medium span) cable-stayed: $10,000 / sq m
  - Replacement (long span) cable-stayed: $14,000 / sq m
  - Replacement (medium span) cast-in-place segmental in deep water: $11,000 / sq m
  - Replacement (all types) typical approach spans: $5,000 / sq m
- Demolition of the existing bridge:
  - Main, side, and approach spans: $1,600 / sq m.
- Road Re-alignment cost:
  - Approach roadways: $2,700-$3,100 / m
- Life Cycle and Maintenance Costs:
  - Estimated on an option-by-option basis for anticipated life cycle activities for maintenance and inspection.
- Right of way and impacted property costs:
  - Land acquisition costs have been estimated to range between $1,600,000 to $3,200,000 lump sum.
- Permitting:
  - Rehabilitation: $ 190,000 lump sum
  - Replacement: $ 230,000 to $435,000 lump sum

Costs per square metre (sq m) are costs per unit area of bridge deck. Costs per metre (m) are costs per unit length of bridge or roadway.

Contingency values of 20% and 30% for the rehabilitation and replacement options, respectively, were used in this assessment. The higher contingency for rehabilitation corresponds to increased uncertainty of the condition of the structure at time of rehabilitation when compared to constructing a replacement.

Note that in the cost summary above is that a rehabilitation of the existing structure carries a higher unit rate than the replacement options. Rehabilitation of an in-service structure, with on-going traffic, presents significant additional challenges which are not present with a new structure.

The construction and maintenance costs for all bridge options are based on high-level estimates. The construction costs for this study are based on the Team's previous experience, known costs from the industry, and are typically high-level cost estimates per square metre of bridge deck, as this approach was deemed reasonable for this level of this benefit-cost analysis. Maintenance costs were developed based on similar projects performed by the Team that had truss bridges and/or roadway improvements performed. Owner's costs were developed based on varying percentages of total construction costs depending on the level of complexity associated with each option.

The land acquisition costs were derived using ViewPoint (www.viewpoint.ca), which indicates the current assessed values of the properties. A factor was applied to the values to estimate a representative fair market value cost for each impacted property. Depending on the severity of the impact of the new alignment on the property, it was determined that either the full property was to be acquired or only a portion of the property was needed, and the fair market costs were calculated accordingly. For the permitting costs, depending on whether it was a replacement option or rehabilitation option, each was assessed for their associated permitting requirements based on the Team’s experience on other similar projects. Federal, Provincial and local permitting requirements were considered and included in the estimate of probable cost tables.

This estimate of probable costs is presented based on the Team's experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of the Team (COWI and Stantec) and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Costs are intended to be sufficient in detail for comparison purposes only – these costs should not be used for budgeting purposes. To prepare a detailed cost estimate for the purposes of budgeting and financing, preliminary design of the structure and erection sequences are required.

Detailed cost breakdowns are included in this section for each bridge option in the attached tables.

Cost Estimate - Option 1A

Stantec COWI

Estimate Type : Preliminary
Option: Option 1A | Rehabilitation (25-Yr)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	760.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs 0-25)	m	1			231.4	231.4	$ 90,000	$ 20,826,270	30%	$ 6,248,000	$ 27,075,000
2		Rehabilitation: Main and Side Spans (Yrs 0-25)	m	1			367.1	367.1	$ 90,000	$ 33,042,960	30%	$ 9,913,000	$ 42,956,000
3		Rehabilitation: East Approach Spans (Yrs 0-25)	m	1			154.3	154.3	$ 90,000	$ 13,887,810	30%	$ 4,167,000	$ 18,055,000
4		Rehabilitation: Concrete Piers (Jacketing)	LS	3				3.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	1				1.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 25)	sq m	0.75		17.6	0.0	13.2	$ 5,000	$ 66,038	20%	$ 14,000	$ 81,000
12		Replacement: Main and Side Spans (Yr 25)	sq m	0.75		17.6	760.0	10037.7	$ 8,000	$ 80,301,600	20%	$ 16,061,000	$ 96,363,000
13		Replacement: East Approach Spans (Yr 25)	sq m	0.75		17.6	0.0	13.2	$ 5,000	$ 66,038	20%	$ 14,000	$ 81,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition (Replacement)	LS	1				1.0		$ -	20%	$ -	$ -
17		Permitting (Rehabilitation Crossing)	LS	1				1.0	$ 190,000	$ 190,000	20%	$ 38,000	$ 228,000
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 202,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 202,000,000	$ 24,240,000		$ -	$ 24,240,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 202,000,000	$ 14,140,000		$ -	$ 14,140,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 202,000,000	$ 20,200,000		$ -	$ 20,200,000
24								0%	$ 202,000,000	$ -		$ -	$ -
25								0%	$ 202,000,000	$ -		$ -	$ -
26								0%	$ 202,000,000	$ -		$ -	$ -
27								0%	$ 202,000,000	$ -		$ -	$ -
28								0%	$ 202,000,000	$ -		$ -	$ -
29								0%	$ 202,000,000	$ -		$ -	$ -
30								0%	$ 202,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 59,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 1A

Stantec COWI

Estimate Type : Preliminary
Option: Option 1A | Rehabilitation (25-Yr)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20%	$ 1,728,000	$ 10,368,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	25	LS	1		25.0	$ 100,000	$ 2,500,000		$ -	$ 2,500,000
52		Existing Bridge | Biennial Inspections (every two years)	Events	12.5	LS	1		12.5	$ 200,000	$ 2,500,000		$ -	$ 2,500,000
53		Existing Bridge | Detailed Inspection (every two years)	Events	12.5	LS	1		12.5	$ 400,000	$ 5,000,000		$ -	$ 5,000,000
54		Existing Bridge | EJ Replacement (every 25 years)	Events	1	LS	7		7.0	$ 300,000	$ 2,100,000		$ -	$ 2,100,000
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	7		7.0	$ 500,000	$ 3,500,000		$ -	$ 3,500,000
56		Existing Bridge | Re-Paving (every 20 years)	Events	1	m	752.9		752.9	$ 10,000	$ 7,528,560		$ -	$ 7,529,000
57		Existing Bridge | Repainting (every 25 years)	Events	1	m	752.9		752.9	$ 44,000	$ 33,125,664		$ -	$ 33,126,000
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	75	LS	1		75.0	$ 100,000	$ 7,500,000		$ -	$ 7,500,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	37.5	LS	1		37.5	$ 200,000	$ 7,500,000		$ -	$ 7,500,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	15	LS	1		15.0	$ 300,000	$ 4,500,000		$ -	$ 4,500,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	2	LS	2		4.0	$ 500,000	$ 2,000,000		$ -	$ 2,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	2		2.0	$ 300,000	$ 600,000		$ -	$ 600,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	3	m	760.0		2280.0	$ 11,000	$ 25,080,000		$ -	$ 25,080,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	760.0		0.0	$ 28,000	$ -		$ -	$ -
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 104,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 380,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 1B

Stantec COWI

Estimate Type : Preliminary
Option: Option 1B | Rehabilitation (50-Yr)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	760.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs 0-50)	m	1			231.4	231.4	$ 90,000	$ 20,826,270	30%	$ 6,248,000	$ 27,075,000
2		Rehabilitation: Main and Side Spans (Yrs 0-50)	m	1			367.1	367.1	$ 90,000	$ 33,042,960	30%	$ 9,913,000	$ 42,956,000
3		Rehabilitation: East Approach Spans (Yrs 0-50)	m	1			154.3	154.3	$ 90,000	$ 13,887,810	30%	$ 4,167,000	$ 18,055,000
4		Rehabilitation: Concrete Piers (Jacketing)	LS	7				7.0	$ 3,000,000	$ 21,000,000	30%	$ 6,300,000	$ 27,300,000
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	2				2.0	$ 3,000,000	$ 6,000,000	30%	$ 1,800,000	$ 7,800,000
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 50)	sq m	0.5		17.6	0.0	8.8	$ 5,000	$ 44,025	20%	$ 9,000	$ 54,000
12		Replacement: Main and Side Spans (Yr 50)	sq m	0.5		17.6	760.0	6691.8	$ 8,000	$ 53,534,400	20%	$ 10,707,000	$ 64,242,000
13		Replacement: East Approach Spans (Yr 50)	sq m	0.5		17.6	0.0	8.8	$ 5,000	$ 44,025	20%	$ 9,000	$ 54,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition (Replacement)	LS	1				1.0		$ -	20%	$ -	$ -
17		Permitting (Rehabilitation Crossing)	LS	1				1.0	$ 190,000	$ 190,000	20%	$ 38,000	$ 228,000
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 205,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 205,000,000	$ 24,600,000		$ -	$ 24,600,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 205,000,000	$ 14,350,000		$ -	$ 14,350,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 205,000,000	$ 20,500,000		$ -	$ 20,500,000
24								0%	$ 205,000,000	$ -		$ -	$ -
25								0%	$ 205,000,000	$ -		$ -	$ -
26								0%	$ 205,000,000	$ -		$ -	$ -
27								0%	$ 205,000,000	$ -		$ -	$ -
28								0%	$ 205,000,000	$ -		$ -	$ -
29								0%	$ 205,000,000	$ -		$ -	$ -
30								0%	$ 205,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 60,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 1B

Estimate Type : Preliminary
Option: Option 1B | Rehabilitation (50-Yr)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20% $ -	$ -
32								0.0		$ -	20% $ -	$ -
33								0.0		$ -	20% $ -	$ -
34								0.0		$ -	20% $ -	$ -
35								0.0		$ -	20% $ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20% $ 1,728,000	$ 10,368,000
37								0.0		$ -	20% $ -	$ -
38								0.0		$ -	20% $ -	$ -
39								0.0		$ -	20% $ -	$ -
40								0.0		$ -	20% $ -	$ -
		-									**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-										*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
41	Relocation of Existing Infrastructure	N/A						0.0		$ -	$ -	$ -
42								0.0		$ -	$ -	$ -
43								0.0		$ -	$ -	$ -
44								0.0		$ -	$ -	$ -
45								0.0		$ -	$ -	$ -
46								0.0		$ -	$ -	$ -
47								0.0		$ -	$ -	$ -
48								0.0		$ -	$ -	$ -
49								0.0		$ -	$ -	$ -
50								0.0		$ -	$ -	$ -
		-									**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-										*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	50	LS	1		50.0	$ 100,000	$ 5,000,000	$ -	$ 5,000,000
52		Existing Bridge | Biennial Inspections (every two years)	Events	25	LS	1		25.0	$ 200,000	$ 5,000,000	$ -	$ 5,000,000
53		Existing Bridge | Detailed Inspection (every two years)	Events	25	LS	1		25.0	$ 400,000	$ 10,000,000	$ -	$ 10,000,000
54		Existing Bridge | EJ Replacement (every 25 years)	Events	2	LS	7		14.0	$ 300,000	$ 4,200,000	$ -	$ 4,200,000
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	14		14.0	$ 500,000	$ 7,000,000	$ -	$ 7,000,000
56		Existing Bridge | Re-Paving (every 20 years)	Events	2	m	752.9		1505.7	$ 10,000	$ 15,057,120	$ -	$ 15,058,000
57		Existing Bridge | Repainting (every 25 years)	Events	2	m	752.9		1505.7	$ 44,000	$ 66,251,328	$ -	$ 66,252,000
58								0.0		$ -	$ -	$ -
59								0.0		$ -	$ -	$ -
60								0.0		$ -	$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	50	LS	1		50.0	$ 100,000	$ 5,000,000	$ -	$ 5,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	25	LS	1		25.0	$ 200,000	$ 5,000,000	$ -	$ 5,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	10	LS	1		10.0	$ 300,000	$ 3,000,000	$ -	$ 3,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	1	LS	2		2.0	$ 500,000	$ 1,000,000	$ -	$ 1,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	2		2.0	$ 300,000	$ 600,000	$ -	$ 600,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	2	m	760.0		1520.0	$ 11,000	$ 16,720,000	$ -	$ 16,720,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	760.0		0.0	$ 28,000	$ -	$ -	$ -
68								0.0		$ -	$ -	$ -
69								0.0		$ -	$ -	$ -
70								0.0		$ -	$ -	$ -
											Sub-Total of Life Cycle and Maintenance Cost:	**$ 144,000,000**
												Cost rounded-up to nearest 1M CAD
											Estimated Probable Total Project Cost in 2023 CAD:	**$ 420,000,000**
												Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 1C

Estimate Type : Preliminary
Option: Option 1C | Rehabilitation (50-Yr + Alignment Update)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Stantec COWI

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	760.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs 0-50)	m	1			231.4	231.4	$ 90,000	$ 20,826,270	30%	$ 6,248,000	$ 27,075,000
2		Rehabilitation: Main and Side Spans (Yrs 0-50)	m	1			367.1	367.1	$ 90,000	$ 33,042,960	30%	$ 9,913,000	$ 42,956,000
3		Rehabilitation: East Approach Spans (Yrs 0-50)	m	1			154.3	154.3	$ 90,000	$ 13,887,810	30%	$ 4,167,000	$ 18,055,000
4		Rehabilitation: Concrete Piers (Jacketing)	LS	7				7.0	$ 3,000,000	$ 21,000,000	30%	$ 6,300,000	$ 27,300,000
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	2				2.0	$ 3,000,000	$ 6,000,000	30%	$ 1,800,000	$ 7,800,000
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 50)	sq m	0.5		17.6	0.0	8.8	$ 5,000	$ 44,025	20%	$ 9,000	$ 54,000
12		Replacement: Main and Side Spans (Yr 50)	sq m	0.5		17.6	760.0	6691.8	$ 8,000	$ 53,534,400	20%	$ 10,707,000	$ 64,242,000
13		Replacement: East Approach Spans (Yr 50)	sq m	0.5		17.6	0.0	8.8	$ 5,000	$ 44,025	20%	$ 9,000	$ 54,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 3,130,000	$ 3,130,000	20%	$ 626,000	$ 3,756,000
17		Permitting (Rehabilitation Crossing)	LS	1				1.0	$ 190,000	$ 190,000	20%	$ 38,000	$ 228,000
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 208,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 208,000,000	$ 24,960,000		$ -	$ 24,960,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 208,000,000	$ 14,560,000		$ -	$ 14,560,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 208,000,000	$ 20,800,000		$ -	$ 20,800,000
24								0%	$ 208,000,000	$ -		$ -	$ -
25								0%	$ 208,000,000	$ -		$ -	$ -
26								0%	$ 208,000,000	$ -		$ -	$ -
27								0%	$ 208,000,000	$ -		$ -	$ -
28								0%	$ 208,000,000	$ -		$ -	$ -
29								0%	$ 208,000,000	$ -		$ -	$ -
30								0%	$ 208,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 61,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 1C

Estimate Type : Preliminary
Option: Option 1C | Rehabilitation (50-Yr + Alignment Update)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20%	$ 1,728,000	$ 10,368,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	50	LS	1		50.0	$ 100,000	$ 5,000,000		$ -	$ 5,000,000
52		Existing Bridge | Biennial Inspections (every two years)	Events	25	LS	1		25.0	$ 200,000	$ 5,000,000		$ -	$ 5,000,000
53		Existing Bridge | Detailed Inspection (every two years)	Events	25	LS	1		25.0	$ 400,000	$ 10,000,000		$ -	$ 10,000,000
54		Existing Bridge | EJ Replacement (every 25 years)	Events	2	LS	7		14.0	$ 300,000	$ 4,200,000		$ -	$ 4,200,000
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	14		14.0	$ 500,000	$ 7,000,000		$ -	$ 7,000,000
56		Existing Bridge | Re-Paving (every 20 years)	Events	2	m	752.9		1505.7	$ 10,000	$ 15,057,120		$ -	$ 15,058,000
57		Existing Bridge | Repainting (every 25 years)	Events	2	m	752.9		1505.7	$ 44,000	$ 66,251,328		$ -	$ 66,252,000
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	50	LS	1		50.0	$ 100,000	$ 5,000,000		$ -	$ 5,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	25	LS	1		25.0	$ 200,000	$ 5,000,000		$ -	$ 5,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	10	LS	1		10.0	$ 300,000	$ 3,000,000		$ -	$ 3,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	1	LS	2		2.0	$ 500,000	$ 1,000,000		$ -	$ 1,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	1	LS	2		2.0	$ 300,000	$ 600,000		$ -	$ 600,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	2	m	760.0		1520.0	$ 11,000	$ 16,720,000		$ -	$ 16,720,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	760.0		0.0	$ 28,000	$ -		$ -	$ -
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 144,000,000**
													Cost rounded-up to nearest 1M CAD
												Estimated Probable Total Project Cost in 2023 CAD:	**$ 430,000,000**
													Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 2A

Estimate Type : Preliminary
Option: Option 2A | Replacement (Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	760.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2	Direct Construction Cost	Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3	Direct Construction Cost	Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4	Direct Construction Cost	Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5	Direct Construction Cost	Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6	Direct Construction Cost	Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7	Direct Construction Cost	Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8	Direct Construction Cost							0.0		$ -	30%	$ -	$ -
9	Direct Construction Cost							0.0		$ -	30%	$ -	$ -
10	Direct Construction Cost							0.0		$ -	30%	$ -	$ -
11	Direct Construction Cost	Replacement: West Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
12	Direct Construction Cost	Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	760.0	13383.6	$ 8,000	$ 107,068,800	20%	$ 21,414,000	$ 128,483,000
13	Direct Construction Cost	Replacement: East Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
14	Direct Construction Cost							0.0		$ -	20%	$ -	$ -
15	Direct Construction Cost							0.0		$ -	20%	$ -	$ -
16	Direct Construction Cost	Land Acquisition	LS	1				1.0	$ 3,130,000	$ 3,130,000	20%	$ 626,000	$ 3,756,000
17	Direct Construction Cost	Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18	Direct Construction Cost	Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19	Direct Construction Cost							0.0		$ -	20%	$ -	$ -
20	Direct Construction Cost							0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 149,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 149,000,000	$ 17,880,000		$ -	$ 17,880,000
22	Owner's Cost For Construction	Construction Supervision (X% Construction)	LS	1	7%			7%	$ 149,000,000	$ 10,430,000		$ -	$ 10,430,000
23	Owner's Cost For Construction	Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 149,000,000	$ 14,900,000		$ -	$ 14,900,000
24	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
25	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
26	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
27	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
28	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
29	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
30	Owner's Cost For Construction							0%	$ 149,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 44,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 2A

Stantec COWI

Estimate Type : Preliminary
Option: Option 2A | Replacement (Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20%	$ 1,728,000	$ 10,368,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000		$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 300,000	$ 6,000,000		$ -	$ 6,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	2		6.0	$ 500,000	$ 3,000,000		$ -	$ 3,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	2		4.0	$ 300,000	$ 1,200,000		$ -	$ 1,200,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	760.0		3040.0	$ 11,000	$ 33,440,000		$ -	$ 33,440,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	760.0		0.0	$ 28,000	$ -		$ -	$ -
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 64,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 270,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 2B

Stantec COWI

Estimate Type : Preliminary
Option: Option 2B | Replacement (Medium Span, Steel Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	760.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	760.0	13383.6	$ 10,000	$ 133,836,000	20%	$ 26,768,000	$ 160,604,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 3,130,000	$ 3,130,000	20%	$ 626,000	$ 3,756,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 181,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 181,000,000	$ 21,720,000		$ -	$ 21,720,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 181,000,000	$ 12,670,000		$ -	$ 12,670,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 181,000,000	$ 18,100,000		$ -	$ 18,100,000
24								0%	$ 181,000,000	$ -		$ -	$ -
25								0%	$ 181,000,000	$ -		$ -	$ -
26								0%	$ 181,000,000	$ -		$ -	$ -
27								0%	$ 181,000,000	$ -		$ -	$ -
28								0%	$ 181,000,000	$ -		$ -	$ -
29								0%	$ 181,000,000	$ -		$ -	$ -
30								0%	$ 181,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 53,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 2B

Estimate Type : Preliminary
Option: Option 2B | Replacement (Medium Span, Steel Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20%	$ 1,728,000	$ 10,368,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000		$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 300,000	$ 6,000,000		$ -	$ 6,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	2		6.0	$ 500,000	$ 3,000,000		$ -	$ 3,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	7		14.0	$ 300,000	$ 4,200,000		$ -	$ 4,200,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	760.0		3040.0	$ 11,000	$ 33,440,000		$ -	$ 33,440,000
67		Replacement Bridge | Repainting (every 25 years)	Events	3	m	760.0		2280.0	$ 28,000	$ 63,840,000		$ -	$ 63,840,000
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 131,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 380,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 2C

Estimate Type : Preliminary
Option: Option 2C | Replacement (Medium Span, Network Arch)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	320.0	m
Main and Side Spans:	240.0	m
East Approach Spans (Sydney side):	200.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	1		17.6	320.0	5635.2	$ 6,000	$ 33,811,200	20%	$ 6,763,000	$ 40,575,000
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	240.0	4226.4	$ 10,000	$ 42,264,000	20%	$ 8,453,000	$ 50,717,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	1		17.6	200.0	3522.0	$ 6,000	$ 21,132,000	20%	$ 4,227,000	$ 25,359,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 3,130,000	$ 3,130,000	20%	$ 626,000	$ 3,756,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 137,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 137,000,000	$ 16,440,000		$ -	$ 16,440,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 137,000,000	$ 9,590,000		$ -	$ 9,590,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 137,000,000	$ 13,700,000		$ -	$ 13,700,000
24								0%	$ 137,000,000	$ -		$ -	$ -
25								0%	$ 137,000,000	$ -		$ -	$ -
26								0%	$ 137,000,000	$ -		$ -	$ -
27								0%	$ 137,000,000	$ -		$ -	$ -
28								0%	$ 137,000,000	$ -		$ -	$ -
29								0%	$ 137,000,000	$ -		$ -	$ -
30								0%	$ 137,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 40,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 2C

Estimate Type : Preliminary
Option: Option 2C | Replacement (Medium Span, Network Arch)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20% $ -	$ -
32								0.0		$ -	20% $ -	$ -
33								0.0		$ -	20% $ -	$ -
34								0.0		$ -	20% $ -	$ -
35								0.0		$ -	20% $ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20% $ 1,728,000	$ 10,368,000
37								0.0		$ -	20% $ -	$ -
38								0.0		$ -	20% $ -	$ -
39								0.0		$ -	20% $ -	$ -
40								0.0		$ -	20% $ -	$ -
		-									**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-										*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
41	Relocation of Existing Infrastructure	N/A						0.0		$ -	$ -	$ -
42								0.0		$ -	$ -	$ -
43								0.0		$ -	$ -	$ -
44								0.0		$ -	$ -	$ -
45								0.0		$ -	$ -	$ -
46								0.0		$ -	$ -	$ -
47								0.0		$ -	$ -	$ -
48								0.0		$ -	$ -	$ -
49								0.0		$ -	$ -	$ -
50								0.0		$ -	$ -	$ -
		-									**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-										*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency	Cost
		-										
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -	$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -	$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -	$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -	$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -	$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -	$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -	$ -	$ -
58								0.0		$ -	$ -	$ -
59								0.0		$ -	$ -	$ -
60								0.0		$ -	$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000	$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000	$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 300,000	$ 6,000,000	$ -	$ 6,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	4		12.0	$ 500,000	$ 6,000,000	$ -	$ 6,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	11		22.0	$ 300,000	$ 6,600,000	$ -	$ 6,600,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	760.0		3040.0	$ 11,000	$ 33,440,000	$ -	$ 33,440,000
67		Replacement Bridge | Repainting (every 25 years)	Events	3	m	760.0		2280.0	$ 24,842	$ 56,640,000	$ -	$ 56,640,000
68								0.0		$ -	$ -	$ -
69								0.0		$ -	$ -	$ -
70								0.0		$ -	$ -	$ -
											Sub-Total of Life Cycle and Maintenance Cost:	**$ 129,000,000**
												Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 320,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 2D

Stantec COWI

Estimate Type : Preliminary
Option: Option 2D | Replacement (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	760.0	m
West Approach Spans (Baddeck Side):	160.0	m
Main and Side Spans:	560.0	m
East Approach Spans (Sydney side):	40.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	3200.0	m
West Approach Roadway:	2700.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	500.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	1		17.6	160.0	2817.6	$ 5,000	$ 14,088,000	20%	$ 2,818,000	$ 16,906,000
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	560.0	9861.6	$ 10,000	$ 98,616,000	20%	$ 19,724,000	$ 118,340,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	1		17.6	40.0	704.4	$ 5,000	$ 3,522,000	20%	$ 705,000	$ 4,227,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 3,130,000	$ 3,130,000	20%	$ 626,000	$ 3,756,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 230,000	$ 230,000	20%	$ 46,000	$ 276,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 160,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 160,000,000	$ 19,200,000		$ -	$ 19,200,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 160,000,000	$ 11,200,000		$ -	$ 11,200,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 160,000,000	$ 16,000,000		$ -	$ 16,000,000
24								0%	$ 160,000,000	$ -		$ -	$ -
25								0%	$ 160,000,000	$ -		$ -	$ -
26								0%	$ 160,000,000	$ -		$ -	$ -
27								0%	$ 160,000,000	$ -		$ -	$ -
28								0%	$ 160,000,000	$ -		$ -	$ -
29								0%	$ 160,000,000	$ -		$ -	$ -
30								0%	$ 160,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 47,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 2D

Estimate Type : Preliminary
Option: Option 2D | Replacement (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			3200.0	3200.0	$ 2,700	$ 8,640,000	20%	$ 1,728,000	$ 10,368,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 11,000,000**
		-											*Cost rounded-up to nearest 1M CAD*
Item		**Description**	**Unit**	**Units**	**Height (m)**	**Width (m)**	**Length (m)**	**Quantity**	**Estimated Unit Price**	**Estimated Cost**	**Contingency**		**Cost**
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*
Item		**Description**	**Unit**	**Events**	**Unit**	**Unit Qty**		**Quantity**	**Estimated Unit Price**	**Estimated Cost**	**Contingency**		**Cost**
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000		$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 300,000	$ 6,000,000		$ -	$ 6,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	3		9.0	$ 500,000	$ 4,500,000		$ -	$ 4,500,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	8		16.0	$ 300,000	$ 4,800,000		$ -	$ 4,800,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	760.0		3040.0	$ 11,000	$ 33,440,000		$ -	$ 33,440,000
67		Replacement Bridge | Repainting (every 25 years)	Events	3	m	560.0		1680.0	$ 19,447	$ 32,671,579		$ -	$ 32,672,000
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 102,000,000**
													Cost rounded-up to nearest 1M CAD
												Estimated Probable Total Project Cost in 2023 CAD:	**$ 320,000,000**
													Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 3A

Stantec COWI

Estimate Type : Preliminary
Option: Option 3A | Replacement to North (Option 2A style Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	1720.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	1720.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	2225.0	m
West Approach Roadway:	1225.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	1000.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contignecy	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	1720.0	30289.2	$ 8,000	$ 242,313,600	20%	$ 48,463,000	$ 290,777,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 1,617,000	$ 1,617,000	20%	$ 324,000	$ 1,941,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 435,000	$ 435,000	20%	$ 87,000	$ 522,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										Sub-Total of Estimated Direct Construction Cost:	$ 310,000,000
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 310,000,000	$ 37,200,000		$ -	$ 37,200,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 310,000,000	$ 21,700,000		$ -	$ 21,700,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 310,000,000	$ 31,000,000		$ -	$ 31,000,000
24								0%	$ 310,000,000	$ -		$ -	$ -
25								0%	$ 310,000,000	$ -		$ -	$ -
26								0%	$ 310,000,000	$ -		$ -	$ -
27								0%	$ 310,000,000	$ -		$ -	$ -
28								0%	$ 310,000,000	$ -		$ -	$ -
29								0%	$ 310,000,000	$ -		$ -	$ -
30								0%	$ 310,000,000	$ -		$ -	$ -
		-										Sub-Total of Estimated Owner's Cost for Construction:	$ 90,000,000
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 3A

Estimate Type : Preliminary
Option: Option 3A | Replacement to North (Option 2A style Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost		Contingency	Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			2225.0	2225.0	$ 2,700	$ 6,007,500	20%	$ 1,202,000	$ 7,210,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 8,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost		Contingency	Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost		Contingency	Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 200,000	$ 20,000,000		$ -	$ 20,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 600,000	$ 12,000,000		$ -	$ 12,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	4		12.0	$ 500,000	$ 6,000,000		$ -	$ 6,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	6		12.0	$ 300,000	$ 3,600,000		$ -	$ 3,600,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	1720.0		6880.0	$ 11,000	$ 75,680,000		$ -	$ 75,680,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	1720.0		0.0	$ -	$ -		$ -	$ -
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 128,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 540,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 3B

Stantec COWI

Estimate Type : Preliminary
Option: Option 3B | Replacement to North (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	1770.0	m
West Approach Spans (Baddeck Side):	560.0	m
Main and Side Spans:	1000.0	m
East Approach Spans (Sydney side):	210.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	2225.0	m
West Approach Roadway:	1225.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	1000.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	1		17.6	560.0	9861.6	$ 6,000	$ 59,169,600	20%	$ 11,834,000	$ 71,004,000
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	1000.0	17610.0	$ 14,000	$ 246,540,000	20%	$ 49,308,000	$ 295,848,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	1		17.6	210.0	3698.1	$ 6,000	$ 22,188,600	20%	$ 4,438,000	$ 26,627,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 1,617,000	$ 1,617,000	20%	$ 324,000	$ 1,941,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 435,000	$ 435,000	20%	$ 87,000	$ 522,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 412,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 412,000,000	$ 49,440,000		$ -	$ 49,440,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 412,000,000	$ 28,840,000		$ -	$ 28,840,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 412,000,000	$ 41,200,000		$ -	$ 41,200,000
24								0%	$ 412,000,000	$ -		$ -	$ -
25								0%	$ 412,000,000	$ -		$ -	$ -
26								0%	$ 412,000,000	$ -		$ -	$ -
27								0%	$ 412,000,000	$ -		$ -	$ -
28								0%	$ 412,000,000	$ -		$ -	$ -
29								0%	$ 412,000,000	$ -		$ -	$ -
30								0%	$ 412,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 120,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 3B

Estimate Type : Preliminary
Option: Option 3B | Replacement to North (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			2225.0	2225.0	$ 2,700	$ 6,007,500	20%	$ 1,202,000	$ 7,210,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 8,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 200,000	$ 20,000,000		$ -	$ 20,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 600,000	$ 12,000,000		$ -	$ 12,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	4		12.0	$ 500,000	$ 6,000,000		$ -	$ 6,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	14		28.0	$ 300,000	$ 8,400,000		$ -	$ 8,400,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	1770.0		7080.0	$ 11,000	$ 77,880,000		$ -	$ 77,880,000
67		Replacement Bridge | Repainting (every 25 years)	Events	3	m	1770.0		5310.0	$ 21,672	$ 115,080,000		$ -	$ 115,080,000
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 250,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 790,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 4A

Stantec COWI

Estimate Type : Preliminary
Option: Option 4A | Replacement to South (Option 2A style Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	980.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	980.0	m
East Approach Spans (Sydney side):	0.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	5600.0	m
West Approach Roadway:	3750.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	1850.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	980.0	17257.8	$ 11,000	$ 189,835,800	20%	$ 37,968,000	$ 227,804,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	0		17.6	0.0	0.0	$ 5,000	$ -	20%	$ -	$ -
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 2,646,000	$ 2,646,000	20%	$ 530,000	$ 3,176,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 435,000	$ 435,000	20%	$ 87,000	$ 522,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 248,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-									
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%	12%	$ 248,000,000	$ 29,760,000		$ -	$ 29,760,000
22		Construction Supervision (X% Construction)	LS	1	7%	7%	$ 248,000,000	$ 17,360,000		$ -	$ 17,360,000
23		Other Owner's Costs (X% Construction)	LS	1	10%	10%	$ 248,000,000	$ 24,800,000		$ -	$ 24,800,000
24						0%	$ 248,000,000	$ -		$ -	$ -
25						0%	$ 248,000,000	$ -		$ -	$ -
26						0%	$ 248,000,000	$ -		$ -	$ -
27						0%	$ 248,000,000	$ -		$ -	$ -
28						0%	$ 248,000,000	$ -		$ -	$ -
29						0%	$ 248,000,000	$ -		$ -	$ -
30						0%	$ 248,000,000	$ -		$ -	$ -
		-								**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 72,000,000**
		-									*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 4A

Estimate Type : Preliminary
Option: Option 4A | Replacement to South (Option 2A style Medium Span, Concrete Box)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			5600.0	5600.0	$ 3,100	$ 17,360,000	20%	$ 3,472,000	$ 20,832,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 21,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000		$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 600,000	$ 12,000,000		$ -	$ 12,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	2		6.0	$ 500,000	$ 3,000,000		$ -	$ 3,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	2		4.0	$ 300,000	$ 1,200,000		$ -	$ 1,200,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	980.0		3920.0	$ 11,000	$ 43,120,000		$ -	$ 43,120,000
67		Replacement Bridge | Repainting (every 25 years)	Events	0	m	980.0		0.0	$ -	$ -		$ -	$ -
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 80,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 430,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

Cost Estimate - Option 4B

Estimate Type : Preliminary
Option: Option 4B | Replacement to South (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Inputs

BRIDGE:

Existing Bridge Width:	10.2	m
Existing Bridge Total Length:	752.9	m
West Approach Spans (Baddeck Side):	231.4	m
Main and Side Spans:	367.1	m
East Approach Spans (Sydney side):	154.3	m
Replacement Bridge Width:	17.6	m
Replacement Bridge Total Length:	1060.0	m
West Approach Spans (Baddeck Side):	0.0	m
Main and Side Spans:	1000.0	m
East Approach Spans (Sydney side):	60.0	m

ROADWAY APPROACHES (REPLACEMENT CROSSING ONLY):

Approach Roadway Width:	11.1	m
Approach Roadway Total Length	5600.0	m
West Approach Roadway:	3750.0	m
Bridge Roadway Roadway:	0.0	m
East Approach Roadway:	1850.0	m

CONTINGENCY AND MULTIPLIERS:

Contingency for Direct Construction Costs:

Rehab. Contingency	30%
Replacement Contigency	20%

Owner's Cost Multipliers as % of Direct Construction Cost:

Engineering/Design	12%
Constr. Supervision	7%
Other Owner's Costs	10%

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
1	Direct Construction Cost	Rehabilitation: West Approach Spans (Yrs N/A)	m	0			231.4	0.0	$ -	$ -	30%	$ -	$ -
2		Rehabilitation: Main and Side Spans (Yrs N/A)	m	0			367.1	0.0	$ -	$ -	30%	$ -	$ -
3		Rehabilitation: East Approach Spans (Yrs N/A)	m	0			154.3	0.0	$ -	$ -	30%	$ -	$ -
4		Rehabilitation: Concrete Piers (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
5		Rehabilitation: Concrete Abutments (Jacketing)	LS	0				0.0	$ -	$ -	30%	$ -	$ -
6		Demolition: Approach Spans	sq m	1		10.2	385.7	3938.5	$ 1,600	$ 6,301,608	30%	$ 1,891,000	$ 8,193,000
7		Demolition: Existing Main and Side Spans	sq m	1		10.2	367.1	3748.9	$ 1,600	$ 5,998,252	30%	$ 1,800,000	$ 7,799,000
8								0.0		$ -	30%	$ -	$ -
9								0.0		$ -	30%	$ -	$ -
10								0.0		$ -	30%	$ -	$ -
11		Replacement: West Approach Spans (Yr 0-100)	sq m	1		17.6	0.0	17.6	$ 5,000	$ 88,050	20%	$ 18,000	$ 107,000
12		Replacement: Main and Side Spans (Yr 0-100)	sq m	1		17.6	1000.0	17610.0	$ 14,000	$ 246,540,000	20%	$ 49,308,000	$ 295,848,000
13		Replacement: East Approach Spans (Yr 0-100)	sq m	1		17.6	60.0	1056.6	$ 5,000	$ 5,283,000	20%	$ 1,057,000	$ 6,340,000
14								0.0		$ -	20%	$ -	$ -
15								0.0		$ -	20%	$ -	$ -
16		Land Acquisition	LS	1				1.0	$ 2,646,000	$ 2,646,000	20%	$ 530,000	$ 3,176,000
17		Permitting (Rehabilitation Crossing)	LS	0				0.0		$ -	20%	$ -	$ -
18		Permitting (Replacement Crossing)	LS	1				1.0	$ 435,000	$ 435,000	20%	$ 87,000	$ 522,000
19								0.0		$ -	20%	$ -	$ -
20								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Direct Construction Cost:**	**$ 322,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	% Construction			Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
21	Owner's Cost For Construction	Engineering/Design (X% Construction)	LS	1	12%			12%	$ 322,000,000	$ 38,640,000		$ -	$ 38,640,000
22		Construction Supervision (X% Construction)	LS	1	7%			7%	$ 322,000,000	$ 22,540,000		$ -	$ 22,540,000
23		Other Owner's Costs (X% Construction)	LS	1	10%			10%	$ 322,000,000	$ 32,200,000		$ -	$ 32,200,000
24								0%	$ 322,000,000	$ -		$ -	$ -
25								0%	$ 322,000,000	$ -		$ -	$ -
26								0%	$ 322,000,000	$ -		$ -	$ -
27								0%	$ 322,000,000	$ -		$ -	$ -
28								0%	$ 322,000,000	$ -		$ -	$ -
29								0%	$ 322,000,000	$ -		$ -	$ -
30								0%	$ 322,000,000	$ -		$ -	$ -
		-										**Sub-Total of Estimated Owner's Cost for Construction:**	**$ 94,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Cost Estimate - Option 4B

Estimate Type : Preliminary
Option: Option 4B | Replacement to South (Long Span, Cable Stayed)
Orignator: COWI (A Ferguson) / Stantec (P Flower)
Checker: COWI (D Betts)
Reviewed by: COWI (J P Armino)

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
31	Road Re-Alignment Cost	Rehabilitation: Roadwork Approaches	m	0				0.0		$ -	20%	$ -	$ -
32								0.0		$ -	20%	$ -	$ -
33								0.0		$ -	20%	$ -	$ -
34								0.0		$ -	20%	$ -	$ -
35								0.0		$ -	20%	$ -	$ -
36		Replacement: Roadwork Approaches	m	1			5600.0	5600.0	$ 3,100	$ 17,360,000	20%	$ 3,472,000	$ 20,832,000
37								0.0		$ -	20%	$ -	$ -
38								0.0		$ -	20%	$ -	$ -
39								0.0		$ -	20%	$ -	$ -
40								0.0		$ -	20%	$ -	$ -
		-										**Sub-Total of Estimated Road Re-Alignment Cost:**	**$ 21,000,000**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Units	Height (m)	Width (m)	Length (m)	Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
41	Relocation of Existing Infrastructure	N/A						0.0		$ -		$ -	$ -
42								0.0		$ -		$ -	$ -
43								0.0		$ -		$ -	$ -
44								0.0		$ -		$ -	$ -
45								0.0		$ -		$ -	$ -
46								0.0		$ -		$ -	$ -
47								0.0		$ -		$ -	$ -
48								0.0		$ -		$ -	$ -
49								0.0		$ -		$ -	$ -
50								0.0		$ -		$ -	$ -
		-										**Sub-Total of Relocation of Existing Infrastructure:**	**$ -**
		-											*Cost rounded-up to nearest 1M CAD*

Item		Description	Unit	Events	Unit	Unit Qty		Quantity	Estimated Unit Price	Estimated Cost	Contingency		Cost
		-											
51	Life Cycle and Maintenance Cost	General Maintenance | Existing Bridge (annually)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
52		Existing Bridge | Biennial Inspections (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
53		Existing Bridge | Detailed Inspection (every two years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
54		Existing Bridge | EJ Replacement (every 25 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
55		Existing Bridge | Bearing Set Replacement (every 40 years)	Events	0	LS	0		0.0	$ -	$ -		$ -	$ -
56		Existing Bridge | Re-Paving (every 20 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
57		Existing Bridge | Repainting (every 25 years)	Events	0	m	0.0		0.0	$ -	$ -		$ -	$ -
58								0.0		$ -		$ -	$ -
59								0.0		$ -		$ -	$ -
60								0.0		$ -		$ -	$ -
61		General Maintenance | New Bridge (annually)	Events	100	LS	1		100.0	$ 100,000	$ 10,000,000		$ -	$ 10,000,000
62		Replacement Bridge | Biennial Inspections (every two years)	Events	50	LS	1		50.0	$ 200,000	$ 10,000,000		$ -	$ 10,000,000
63		Replacement Bridge | Detailed Inspection (every 5 years)	Events	20	LS	1		20.0	$ 300,000	$ 6,000,000		$ -	$ 6,000,000
64		Replacement Bridge | EJ Replacement (every 25 years)	Events	3	LS	2		6.0	$ 500,000	$ 3,000,000		$ -	$ 3,000,000
65		Replacement Bridge | Bearing Set Replacement (every 40 years)	Events	2	LS	3		6.0	$ 300,000	$ 1,800,000		$ -	$ 1,800,000
66		Replacement Bridge | Re-Paving (every 20 years)	Events	4	m	1060.0		4240.0	$ 11,000	$ 46,640,000		$ -	$ 46,640,000
67		Replacement Bridge | Repainting (every 25 years)	Events	3	m	1000.0		3000.0	$ 18,000	$ 54,000,000		$ -	$ 54,000,000
68								0.0		$ -		$ -	$ -
69								0.0		$ -		$ -	$ -
70								0.0		$ -		$ -	$ -
												Sub-Total of Life Cycle and Maintenance Cost:	**$ 132,000,000**
													Cost rounded-up to nearest 1M CAD

Estimated Probable Total Project Cost in 2023 CAD: $ 570,000,000

Cost rounded-up to nearest 10M CAD

DISCLAIMER:
This estimate of probable costs is presented on the basis of experience, qualifications, and best judgement. It has been prepared in accordance with acceptable principles and practices. Market trends, non-competitive bidding situations, unforeseen labour and material adjustments and the like are beyond the control of COWI and Stantec and as such we cannot warrant or guarantee that actual costs will not vary from the estimate provided.

https://cowi.sharepoint.com/sites/A219162-project/Shared Documents/50-WorkInProgress/10-Documents/008 Benefit Cost Analysis/50-Cost Estimates/A219162-008-SIB BCA Cost Estimate-0; [Option4B]

Appendix S Evaluation and Reporting

Comparison Matrix

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Reviewed by: NSPW (2023-APR)
Pairwise Inputs by: NSPW (2022-APR)

Key Aspects (highest influence from Pairwise)

			Rehabilitate			New Bridge Existing Location				New Bridge North Alignment		New Bridge South Alignment	
			25 yrs	50 yrs	25 yrs w/Alignment Update	Medium Span			Long Span	Medium	Long	Medium	Long
Item	**Category**	**Overall Pairwise Rating**	**1A**	**1B**	**1C**	**2A**	**2B**	**2C**	**2D**	**3A**	**3B**	**4A**	**4B**
4.1 Public safety	Opportunities	7.4%	0	0	0	100	100	100	100	100	100	100	100
2.3 Clearance of navigational channel	Features	6.0%	100	100	100	100	100	100	100	100	100	100	100
4.2 Use of modern bridge design / methods and materials	Opportunities	5.1%	0	0	0	100	100	100	100	100	100	100	100
1.5 Lifecycle and maintenance cost	Cost	4.4%	78	57	57	100	64	65	80	66	0	91	63
2.6 Service life beyond 50 years	Features	4.4%	0	0	0	100	100	100	100	100	100	100	100
2.2 Active transportation lanes	Features	4.2%	0	0	0	100	100	100	100	100	100	100	100
3.7 Operational issues during service life	Risks	4.0%	0	0	50	100	100	100	100	100	100	100	100
2.1 Wider Traffic Lanes (min. 2 Lanes)	Features	4.0%	0	0	0	100	100	100	100	100	100	100	100
		TOTAL SCORE	**48**	**47**	**44**	**77**	**75**	**76**	**73**	**69**	**62**	**69**	**64**
		RANKING	**10**	**11**	**12**	**1**	**3**	**2**	**4**	**5**	**8**	**6**	**7**

Comparison Matrix

COWI

Stantec

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Reviewed by: NSPW (2023-APR)
Pairwise Inputs by: NSPW (2022-APR)

	Category 1. LIFE-CYCLE COST	Weight	Importance (Pairwise	Score										
1.1	Direct construction cost		13	76	75	74	96	84	100	92	37	0	60	33
1.2	Owner's cost for construction		25	76	75	74	95	84	100	91	38	0	60	33
1.3	Road re-alignment cost		23	77	77	77	77	77	77	77	100	100	0	0
1.4	Relocation of existing infrastructure		23	100	100	100	100	100	100	100	100	100	100	100
1.5	Lifecycle and maintenance cost		15	78	57	57	100	64	65	80	66	0	91	63

	Category 2. FEATURES	Weight	Importance (Pairwise	Score										
2.1	Wider Traffic Lanes (min. 2 Lanes)		16	0	0	0	100	100	100	100	100	100	100	100
2.2	Active transportation lanes		17	0	0	0	100	100	100	100	100	100	100	100
2.3	Clearance of navigational channel		24	100	100	100	100	100	100	100	100	100	100	100
2.4	Use of existing highway infrastructure		10	100	100	100	100	100	100	100	0	0	0	0
2.5	NSDPW owns required land		11	100	100	0	0	0	0	0	0	0	0	0
2.6	Service life beyond 50 years		17	0	0	0	100	100	100	100	100	100	100	100
2.7	Utility/service accommodations		5	0	0	0	100	100	100	100	100	100	100	100

Comparison Matrix

COWI

Stantec

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Reviewed by: NSPW (2023-APR)
Pairwise Inputs by: NSPW (2022-APR)

	Category 3. RISKS	Weight	Importance (Pairwise	Score										
3.1	Impact to trade corridors during construction		6	0	0	50	50	50	50	50	100	100	100	100
3.2	Impact to trade corridors in-service		17	50	50	50	100	100	100	100	100	100	100	100
3.3	Constructability / complexity of erection sequence		11	100	100	100	50	50	50	0	50	0	50	0
3.4	Climate Change		17	0	0	0	50	50	50	50	100	100	100	100
3.5	Geotechnical		13	50	50	50	0	0	0	0	0	0	0	0
3.6	Approvals, permitting and consultation		13	100	100	100	50	50	50	50	50	50	50	50
3.7	Operational issues during service life		17	0	0	50	100	100	100	100	100	100	100	100
3.8	Land acquisition		7	100	100	50	50	50	50	50	0	0	0	0

	Category 4. OPPORTUNITIES	Weight	Importance (Pairwise	Score										
4.1	Public safety		32	0	0	0	100	100	100	100	100	100	100	100
4.2	Use of modern bridge design / methods and materials		22	0	0	0	100	100	100	100	100	100	100	100
4.3	Environmental gains		15	0	0	0	50	50	50	50	50	50	50	50
4.4	Local content within construction industry		17	100	100	100	50	50	50	0	50	0	50	0
4.5	Technological gains		15	50	50	50	100	100	100	100	100	100	100	100

	Category 5. SOCIAL IMPLICATIONS	Weight	Importance (Pairwise	Score										
5.1	Public perception		17	50	50	50	50	50	50	50	50	50	50	50
5.2	Effects on nearby communities		25	50	50	50	100	100	100	100	0	0	0	0
5.3	Mi'kmaq perception		15	50	50	50	50	50	50	50	50	50	50	50
5.4	Stakeholder impact		25	100	100	50	0	0	0	0	0	0	0	0
5.5	Architectural and aesthetics		18	50	50	50	100	100	100	100	100	100	100	100

Category 1. Cost

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Pairwise Inputs by: NSPW (2022-APR)

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| COSTS IN MILLIONS OF DOLLARS (CAD) |

	Category 1. LIFE-CYCLE COST		Rehabilitate			New Bridge - Existing Location				New Bridge - North		New Bridge - South	
	MAX TOTAL POINTS: 13	Pairwise %	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
1.1	Direct construction cost	17	202	205	208	149	181	137	160	310	412	248	322
1.2	Owner's cost for construction	17	59	60	61	44	53	40	47	90	120	72	94
1.3	Road re-alignment cost	17	11	11	11	11	11	11	11	8	8	21	21
1.4	Relocation of existing infrastructure	17	0	0	0	0	0	0	0	0	0	0	0
1.5	Lifecycle and maintenance cost	33	104	144	144	64	131	129	102	128	250	80	132
	Total Cost (Rounded to nearest 10 Million CAD)	-	**380**	**420**	**430**	**270**	**380**	**320**	**320**	**540**	**790**	**430**	**570**

	Rehabilitate			New Bridge - Existing Location				New Bridge - North		New Bridge - South	
	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
1.1	76	75	74	96	84	100	92	37	0	60	33
1.2	76	75	74	95	84	100	91	38	0	60	33
1.3	77	77	77	77	77	77	77	100	100	0	0
1.4	100	100	100	100	100	100	100	100	100	100	100
1.5	78	57	57	100	64	65	80	66	0	91	63
SCORE	10.8	9.8	9.8	12.6	10.5	11.3	11.5	9.0	4.4	8.9	6.5

Category 2. Features

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Pairwise Inputs by: NSPW (2022-APR)

	Category 2. FEATURES			Rehabilitate			New Bridge - Existing Location				New Bridge - North		New Bridge - South	
	MAX TOTAL POINTS	25.0	Pairwise %	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
2.1	Wider Traffic Lanes (min. 2 Lanes)		16	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.2	Active transportation lanes		17	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.3	Clearance of navigational channel		24	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.4	Use of existing highway infrastructure		10	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No	No
2.5	NSDPW owns required land		11	Yes	Yes	No	No	No	No	No	No	No	No	No
2.6	Service life beyond 50 years		17	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2.7	Utility/service accommodations		5	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
			SCORE	11.3	11.3	8.5	22.2	22.2	22.2	22.2	19.6	19.6	19.6	19.6

Category 3. Risks

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Pairwise Inputs by: NSPW (2022-APR)

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	Category 3. RISKS	Pairwise %	Rehabilitate 1A	Rehabilitate 1B	Rehabilitate 1C	New Bridge - Existing Location 2A	New Bridge - Existing Location 2B	New Bridge - Existing Location 2C	New Bridge - Existing Location 2D	New Bridge - North 3A	New Bridge - North 3B	New Bridge - South 4A	New Bridge - South 4B
	MAX TOTAL POINTS 23.3		Probability of Occurrence										
3.1	Impact to trade corridors during construction	6	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low
3.2	Impact to trade corridors in-service	17	Moderate	Moderate	Moderate	Low	Low	Low	Low	Low	Low	Low	Low
3.3	Constructability / complexity of erection sequence	11	Low	Low	Low	Moderate	Moderate	Moderate	High	Moderate	High	Moderate	High
3.4	Climate Change	17	High	High	High	Moderate	Moderate	Moderate	Moderate	Low	Low	Low	Low
3.5	Geotechnical	13	Moderate	Moderate	Moderate	High	High	High	High	High	High	High	High
3.6	Approvals, permitting and consultation	13	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
3.7	Operational issues during service life	17	High	High	Moderate	Low	Low	Low	Low	Low	Low	Low	Low
3.8	Land acquisition	7	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	High	High	High	High
		SCORE	10.6	10.6	12.5	14.1	14.1	14.1	12.8	16.0	14.7	16.0	14.7

Category 4. Opportunities

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Stantec

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Pairwise Inputs by: NSPW (2022-APR)

	Category 4. OPPORTUNITIES			Rehabilitate			New Bridge - Existing Location				New Bridge - North		New Bridge - South	
	MAX TOTAL POINTS	23.3	Pairwise %	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
				Probability of Occurrence										
4.1	Public safety		32	Low	Low	Low	High	High	High	High	High	High	High	High
4.2	Use of modern bridge design / methods and materials		22	Low	Low	Low	High	High	High	High	High	High	High	High
4.3	Environmental gains		15	Low	Low	Low	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
4.4	Local content within construction industry		17	High	High	High	Moderate	Moderate	Moderate	Low	Moderate	Low	Moderate	Low
4.5	Technological gains		15	Moderate	Moderate	Moderate	High	High	High	High	High	High	High	High
			SCORE	5.6	5.6	5.6	19.6	19.6	19.6	17.7	19.6	17.7	19.6	17.7

Category 5. Social Implications

Revision: 0
Date: 2023-DEC-08
Prepared by: COWI (D Betts)
Categories by: COWI (A Ferguson)
Pairwise Inputs by: NSPW (2022-APR)

	Category 5. SOCIAL IMPLICATIONS			Rehabilitate			New Bridge - Existing Location				New Bridge - North		New Bridge - South	
	MAX TOTAL POINTS	15.0	Pairwise %	1A	1B	1C	2A	2B	2C	2D	3A	3B	4A	4B
5.1	Public perception		17	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
5.2	Effects on nearby communities		25	Neutral	Neutral	Neutral	Better	Better	Better	Better	Worse	Worse	Worse	Worse
5.3	Mi'kmaq perception		15	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
5.4	Stakeholder impact		25	Better	Better	Neutral	Worse	Worse	Worse	Worse	Worse	Worse	Worse	Worse
5.5	Architectural and aesthetics		18	Neutral	Neutral	Neutral	Better	Better	Better	Better	Better	Better	Better	Better
			SCORE	9.4	9.4	7.5	8.9	8.9	8.9	8.9	5.1	5.1	5.1	5.1