Project Report

December 2, 2019

City of Kingston Third Crossing of the Cataraqui River Parks Canada Environmental Impact Analysis

Detailed Impact Analysis Report - Section 3

Table of Contents

List of Tables

List of Figures

3. Analysis of Potential Environmental Effects

As described in Section 1, this impact analysis has been undertaken in accordance with PCA's DIA requirements, intended for complex projects that require an in-depth analysis of project-environment interactions with Valued Components. Section 1 also provided an identification of the temporal and spatial boundaries of the anticipated project-environment interactions and therefore the potential to affect the environmental components. Section 2 provided background data collection, identification of data gaps and the design and implementation of baseline studies to fill data gaps on the natural and socioeconomic features and conditions of the Study Area. This section (Section 3) identifies the effects that are likely to occur on the environmental components as a result of implementing the Project, based on information obtained on the existing conditions.

3.1 Valued Components

3.1.1 Greater Cataraqui Marsh Provincially Significant Wetland

As identified in Sections 1 and 2, effects to the Greater Cataraqui Marsh PSW are anticipated to occur. Within Ontario, PSWs are determined by an evaluation using a preassigned list of ranked criteria that include groundwater storage and release, provision of habitat for wildlife species (including SAR), ecosystem productivity and biodiversity and human utility values (Ontario, 2014a). This section is intended to address impacts to the PSW from the Project.

The Greater Cataraqui Marsh provides habitat for a wide range of terrestrial and aquatic wildlife species. Habitat features within the marsh that may be impacted during construction activities include feeding areas for migratory waterfowl and bird species, fish spawning and foraging grounds, reptile overwintering, among other Significant Wildlife Habitat. These disruptions, alterations could lead to a decrease in biodiversity within the marsh and a reduction in sensitive species, including SAR, that could potentially change the significance of the wetlands as a whole.

Habitat fragmentation may result from construction activities by disrupting animal movement connectivity and territories for wildlife within the area. Tree clearing operations will reduce the amount of shoreline habitat for aquatic birds as well as limit movement for mammalian species that rely on cover along the perimeter of the marsh. Additionally, movement of fish may be restricted during in-water works and could potentially cause spawning disruptions.

Construction activities also have a high potential to affect the water quality within the marsh, including increased turbidity, resuspension of contaminants within the sediments, leading to a decline in habitat quality. By extension of these potential effects, human utility values such as public use and enjoyment of this section of the Greater Cataraqui Marsh PSW could also be impacted. The potential effects associated with construction may lead to an overall decline in the functionality of the wetland which could cause changes to local surface hydrology, potentially impacting flood plains throughout the region.

Overall, the Greater Cataraqui Marsh would be expected to retain its PSW status when re-evaluated after completion of the Project. The initial wetland evaluation conducted in 1990 and was assessed as significant due to the number of special features, specifically rare and at-risk species located within the wetland (Ecological Services 1990a and b). Impacts to these species are discussed in the Sections below. Additionally, the Greater Cataraqui is relatively unique, in that it is categorized as a coastal wetland, of substantial size (over 500 ha). These factors would provide sufficient rationale for future evaluations to determine the wetland is significant under the Ontario Wetland Evaluation System.

As noted in Section 2 CRCA's 2018 watershed report card ranks the wetlands as "fair" health condition whereas the 2013 report card ranked the wetlands of the lower Cataraqui River as "poor". Given the potential impacts as described below there is potential for the watershed to be regress back to a poor rating during construction as a result of reduced aquatic vegetation, wildlife use and water quality effects. These would all expected to be reversed during operations with post construction monitoring likely showing a return to the "good" ranking with increased wetland size.

Potential effects on the natural and social environment within the Study Area and specific to the Greater Cataraqui Marsh PSW are further discussed in the subsequent sections.

3.1.2 Fish and Fish Habitat

3.1.2.1 Fish Species and Life Stages Likely Affected by the Project

As presented in Section 2.2.2, 29 species of finned fish are known to inhabit or seasonally use the Study Area and to a lesser degree the Project Location. Additionally, 18 species are confirmed, or thought be using the Study Area for spawning and/or nursery; eight are thought to use the habitat as general adult habitat likely spawning elsewhere; and three (3) are known not to spawn within the Study Area and use it primarily as a migration corridor to upstream or downstream spawning habitats. Although noted as potentially present, alewife and gizzard shad are not expected to use the Study Area for any reason, with occurrence data likely from sporadic use of no significant importance. In addition to finned fish, 15 mussels species have been identified as potentially using the Project Location.

For the purpose of this impact analysis, species have been grouped into similar categories (where possible) that share or rely on similar habitats for similar purposes. Table 3.1 below outlines the groupings or individual species that will be carried forward.

Table 3.1: List of Fish Species that will be Considered in the Impact Analysis

Grouping Name	Species Name	Anticipated Usage
Finned Fish		
American Eel		Migration – General Habitat
Lake Sturgeon		Potentially Low Use General Habitat (South end of Study Area)
Largemouth Bass		All Life Stages
Smallmouth Bass		General Adult Habitat – Within Navigation Channel
Esox & Gars	Northern pike	All Life Stages
	Muskellunge	All Life Stages
	Longnose Gar	All Life Stages
CRA - Panfish	Black Crappie	Confirmed - All Life Stages
	Bluegill	Confirmed - All Life Stages
	Pumpkinseed	Confirmed – All Life Stages
	Rock Bass	General Adult Habitat
	Yellow Perch	Confirmed – All Life Stages
	White Perch	All life Stages
Salmonids	Chinook Salmon	Migration
	Coho Salmon	Migration
Bullheads	Brown Bullhead	General Adult Habitat
	Yellow Bullhead	General Adult Habitat
Project Location Dependent Forage Fish	Banded Killifish	All Life Stages
	Blackchin Shiner	All Life Stages
	Brook Silverside	All Life Stages
	Central Mudminnow	All Life Stages

Grouping Name	Species Name	Anticipated Usage
General Usage Forage Fish	Eastern Silvery Minnow	All Life Stages
	Golden Shiner	All Life Stages
	Blacknose Shiner	General Adult Habitat
	Bluntnose Minnow	General Adult Habitat
	Johnny Darter	General Adult Habitat
Bowfin		All Life Stages
White Sucker		General Adult Habitat
Mussels	Mucket	Potentially All Life Stages
	Elktoe	
	Triangle Floater	
	Cylindrical papershell	
	Eastern Elliptio	
	Spike	
	Plain Pocketbook	
	Creek Heelplitter	
	Fluted-Shell	
	Fragile Papershell	
	Black sandshell	
	Pink Heelsplitter	
	Eastern Floater	
	Giant Floater	
	Creeper	

3.1.2.2 Fish Habitat Likely Affected by the Project

Project components or construction activities with the potential to affect fish habitat include the following:

- Areas temporarily lost and areas permanently altered by causeway and work platforms, temporary piles and work area isolations.
- Areas temporarily affected by reduced flow and passage during construction period due to causeway installation.
- Areas lost by the permanent footprint of the bridge piers and western abutment.

Each of the above effects are further explained below.

3.1.2.3 Potential Effects to Fish and Fish Habitat

The following sections will outline the effects to fish and fish habitat from the various Project components and construction methods. Certain potential effects on Fish and Fish habitat as water quality, sediment quality, aquatic vegetation and hydrological processes are assessed separately with all factors combined in Section 5 in determining the potential for significant residual effect. For the purpose of this assessment, these mitigatable potential effects have been for discussion below.

3.1.2.4 Potential Effect on Fish During Construction

Potential effects on fish during construction include:

- Noise and vibration by construction equipment during caissons installation.
- In-water pier foundation (caisson) placement.
- Impacts to fish from construction lighting.

Potential effects to fish habitat during construction include:

- Construction of the causeways, work platforms and trestle piles and staging areas.
- Barriers to fish movement.
- Areas affected by flow alteration.
- Spills and Sediment releases.

3.1.2.4.1 Noise and Vibration Impacts

Some degree of noise and vibration effects is anticipated to occur within fish habitat during the installation of the caissons and trestle piles. The caisson outer steel casings and the trestle piles are expected to be installed with either impact or vibratory hammers. Underwater noise modelling was undertaken by JASCO Applied Sciences to assess noise and vibration from impact hammers and assessed the impact to fish and turtles. The report, included as Appendix G, found that the maximum distance for mortality or potential mortal injury to fish caused by noise or vibration was between 2 and 3 m; to fish eggs and larvae was 5 m; and 7 m for injury (including recoverable injury) for impact hammer installation. As described in Section 1 impact hammering will only occur on the temporary piles with all caissons being vibro hammered into place primarily through the causeway which further reduces effect to fish. Additional mitigation measures are described in Section 4.

3.1.2.4.2 In-Water Pier Foundation (Caisson) Placements

As previously described, pier foundation construction for Piers 18 and 19 will take place within the river with the caissons lowered to and then driven into the riverbed. Finned fish would generally be expected to avoid the encroaching caissons as result of the noise being generated and slow rate of movement. Mitigation are outlined in Section 4 to avoid undue loss of fish during the caisson placement.

All activities conducted within the caissons should have no additional adverse effect, with the exception of noise and vibrations described in Section 3.1.2.4.1.

3.1.2.4.3 Pile Installation During Restricted Timing Window

Under the current project schedule 70 of the 78 planned trestle piles will be installed within the restricted fish timing window outside the AETC. Given these will be installed during the higher spring flow periods and within the natural main flow path, with flows being further increased by the AETC directing flows toward the central 230 m opening. In order to install the piles in precise locations for the trestle bridge structure, a 43 m long floating template will need to be progressively moved across the site, this combine with a significant variation in depth adjacent the navigation channel making exclusion impractical. For this reasons isolating the area(s) around the pile installation is not thought to be feasible. Therefore, an evaluation of the potential effects to fish as a result of noise generated during the pile installation is included within this DIA.

As outlined in Section 2 there is a diverse fish community within the area, Bowfin fish assessment results from 2010 boat electro-fishing and seine netting within (April 12) and shortly after (July 19 and 20) the spring spawning period are indicative of the wetland's ability to support a diverse and abundant warm water, fish community. The April sampling period identified spring spawning species throughout sampled areas with specific spawning notes of eight (8) northern pike captures along the western shoreline at transect 3 for Figure 2-2 and an abundant of spawning condition yellow perch at the offshore transects of 5, 6 and 7. In addition to the April observation the July 20 sampling recorded young of the year (YOY) fish at every sampling location with the exception of transect 12. Unfortunately, the 2010 sampling protocol does not allow for an accurate catch per unit effort to determined given the width of the electrofishing field, or netting width has not been included. Nonetheless general conclusions can be drawn and combined with known literature to evaluate the potential harm to fish, fish eggs and fry during the spring restricted window. Generally, literature is more available for the larger bodied CRA, for those reasons this assessment does not include the forage fish community potentially impacted. Each species confirmed or likely to be spawning within the Study Area is presented individually below with potential effects outlined in Table 3.2

As noted in Table 3.2 pile installation during the restricted window is expected to have negative effects on largemouth bass and yellow perch, with a lesser potential for bluegill and smallmouth bass, minimal potential northern pike, muskellunge, longnose gar, pumpkinseed and little to no potential for lake sturgeon, black crappie and white sucker.

Table 3.2: Fish Effects Evaluation of Working Within the Restricted Timing Window

Species Name	Spawning Habitat Preference	Water Temperature Range	Project Location Spawning Usage	Spawning Timing	Anticipated Works Within That Window	Impacted habitat area of the Anticipated Works	Conservative Estimate of fish loss within impacted area with no mitigations	Other potential impacts
Largemouth Bass	Males clear up to 0.9 m in diameter or 0.63 m² nest on substrate within vegetation with nest usually 9.15 m apart. Females lay eggs within the nest, that males guard diligently with an average of 5000-7000 fry surviving per nest.	15.6 – 18.3	All wetted areas	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m² impact area per pile assuming 7 m impact distance as per Jasco totaling 3480 m²	All twenty piles equaling 3,487 m² or 0.1% of the similar available habitat within the PSW estimated at 3,150,000 m².	Assuming Nests every 9.15 m apart or each male occupies 263 m² and 6,000 fry per nest. Year 2020 would produce 79,551 less fry,	
Lake Sturgeon	Moving waters with coarse substrates 0.5 to 5 m in depth	13 – 18	None	May 1 – June 30	Up to twenty-five 0.9 m diameter piles. For a total of 174 m² impact area per pile assuming 7 m impact distance as per Jasco	N/A	None	Not currently thought to spawning within or upstream of the Project Area.
Smallmouth Bass	Males clear a nest up to 1.8 m in diameter, in 0.6 to 6 m of water on sandy, gravel or rocky bottoms, usually near rocks, logs or more rarely dense vegetation	12.8 – 20.0	Navigation Channel	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m² impact area per pile assuming 7 m impact distance as per Jasco totaling 3480 m²	Potentially yet unlikely - 3,480 m² or 0.1% of the similar available habitat within the PSW estimated at 3,150,000 m².	Smallmouth bass wouldn't be expected to use the heavily vegetated areas in proximity to the pile driving, this is supported by no YOY Smallmouth bass captures in 2010 sampling	None
Northern pike	Spawning occurs immediately after ice off generally in heavily vegetated floodplains and shorelines of lakes, rivers, streams and marshes during the spring freshet.	4.4 -11.1	Shoreline Emergent Communities	March 15 – May 31	Up to fifty-five, 0.9 m diameter piles. For a total of 174 m² impact area per pile assuming 7 m impact distance as per Jasco totaling 9,570 m²	None	Northern Pike are not expected to use the offshore areas for spawning purposes therefore no eggs would be expected to be impacts, given the distance from the shorelines and potential spawning locations shown in Figure 2-2.	Spring movement into upstream reaches of the PSW may be disrupted.
Muskellunge	Spawning occurs in heavily vegetated areas generally associated with shorelines	9.4 to 15	Shoreline areas within a few meters of shore	April 1 – May 31	Up to fifty-five, 0.9 m diameter piles. For a total of 174 m² impact	None	Muskellunge are not expected to use the offshore areas for spawning purposes therefore no	Spring movement into upstream reaches of the

Species Name	Spawning Habitat Preference	Water Temperature Range	Project Location Spawning Usage	Spawning Timing	Anticipated Works Within That Window	Impacted habitat area of the Anticipated Works	Conservative Estimate of fish loss within impacted area with no mitigations	Other potential impacts
	and islands in 0.30 to 0.5 m water depth				area per pile assuming 7 m impact distance as per Jasco totaling 9,570 m²		eggs would be expected to be impacts, given the distance from the shorelines and potential spawning locations shown in Figure 2-2.	PSW may be disrupted.
Longnose Gar	Shallow water Spawns over aquatic vegetation in larger congregations.	~ 19	All Wetted Areas	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m^2 impact area per pile assuming 7 m impact distance as per Jasco totaling 3480 m²	3,480 m² or 0.1% of the similar available habitat within the PSW estimated at 3,150,000 m².	Although spawning may be occurring within the 3,487 m² impacted area, it is thought to be unlikely, given, the relatively low population or records within the PSW, no captures in 2010 or other notable congregations of Longnose Gar within the PSW.	Spring movement into upstream reaches of the PSW may be disrupted.
Black Crappie	Males crest nests in vegetated waters between 0.25 and 0.6 m deep, With colonial nests approximately 2 m apart.	19 to 20	Shoreline areas within a few meters of shore	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m^2 impact area per pile assuming 7 m impact distance as per Jasco totaling 3480 m²	None	Black Crappie are not expected to use the offshore areas for spawning purposes therefore no eggs would be expected to be impacts, given the distance from the shorelines and potential spawning locations.	None
Bluegill	Males create colonial nesting areas with as many as 30 nest per 15 m² approximately 0.75 to 1 m of water. With sparse vegetation and firmer substrates. Multiple females are known to uses the same nests, resulting a wide range of the number of fry emerging from a single (4670 to 224,900)	19 – 24.5	Sporadic Areas Anticipated throughout Project Location	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m^2 impact area per pile assuming 7 m impact distance as per Jasco totaling 3480 m²	Appears there is a significant deviation from the literature and the 2010 catch results, whereas the 2010 data indicates abundant YOY bluegills and pumpkinseeds captured shortly thereafter the spawning period. Possible explanations include the miss	Assuming a single 20 nest colony is present and an average of 114,785 fry per nest. The impacted colony would produce 2.3 million less fry within the PSW.	None
Pumpkinseed	Males crest nests in vegetated waters usually in depths of 0.15 to 0.3 m nearshore. In suitable	20 – 27.8	Shoreline areas within a few meters of shore	May 15 – June 30	Up to twenty, 0.9 m diameter piles. For a total of 174 m^2 impact area per pile assuming		Pumpkinseeds are not expected to use the offshore areas for spawning purposes therefore no eggs would be expected to be	None

Species Name	Spawning Habitat Preference	Water Temperature Range	Project Location Spawning Usage	Spawning Timing	Anticipated Works Within That Window	Impacted habitat area of the Anticipated Works	Conservative Estimate of fish loss within impacted area with no mitigations	Other potential impacts
	conditions nests can be numerous and in close proximity. With an average fry survival of 8074/nest.				7 m impact distance as per Jasco totaling 3480 m²	labelling of YOY for recent 1+ year fish. This explanation is likely as literature states bluegill and pumpkinseed fry are minute and transparent after Hatch. Growing to 18 – 81 mm by October. Based on this it is assumed reported YOY on July 19 would have been too small for capture using electro-fishing and dip nets.	impacts, given the distance from the shorelines and potential spawning locations.	
Yellow Perch	Spawning occurs near rooted vegetation, submerged brush or fallen trees. With gelatinous stings or tubes up to 2.1 m in length, 100 m in width and weight up to 0.9 kg, generally are semi floating and attached to submergent vegetation where they stay unguarded until hatching. Literature states egg masses within Lake Ontario range from 3035 to 61,465 eggs/ mass.	6.7 – 12.2	All wetted wetland areas	March 15 – May 31	Up to fifty-five, 0.9 m diameter piles. For a total of 174 m^2 impact area per pile assuming 7 m impact distance as per Jasco totaling 9,570 m²	8,700 m² or 0.3% of the similar available habitat within the PSW estimated at 3,150,000 m².	Bowfin's April 2010 sampling indicated spawning yellow perch within the central portion of the wetland with Yellow Perch within the top three relative abundance at 11 of 12 transects. Furthermore, the July 2010 sampling indicated YOY yellow perch captured at seven (7) of 15 sampling locations. This indicates this PSW is a highly productive yellow perch area.	None
White Sucker	Moving waters within streams, rivers or lake shoals	8-12	None	April 15 – June 15		None	None	Potential for avoidance of the area during

Species Name	Spawning Habitat Preference	Water Temperature Range	Project Location Spawning Usage	Spawning Timing	Anticipated Works Within That Window	Impacted habitat area of the Anticipated Works	Conservative Estimate of fish loss within impacted area with no mitigations	Other potential impacts
	with clean gravels to cobble substrates 0.5 to 5 m in depth							migrations to or from Kingston Mills upstream. No documented spawning at Kingston Mills however suitable habitat present,

3.1.2.4.4 Causeway Installation

Similar to the foundation placements, the installation of the causeways (approximately 32,750 m²) presents a potential effect to fish if installed un-mitigated, this could be from degraded water quality or crushing leading to undue stress or mortality. Mitigation measures are described in Section 4 and the Aquatic Exclusionary Turbidity Curtain - Appendix H.

3.1.2.5 Potential Effects on Fish Habitat

The following sections outline the anticipated effects to the fish habitat.

3.1.2.5.1 Construction Causeways, Work Platforms and Trestle Piles

A component of the Project construction strategy is the use of construction staging areas to provide access from the east and west shores.

3.1.2.5.1.1 Western Causeway Access

The western causeway and work platform construction effects are scheduled to last 18 to 37 months depending on the causeway section. The offshore area for example is scheduled to be in place 18 months, whereas the nearshore area is scheduled to be construction in place for 37 months.

The western access extends approximately 812 m off shore at the base and covers a riverbed area of approximately 28,785 m². Habitat impacted by the western causeway and construction platform is described in Sections 2.2.2.1; Sampling Site 3 and Sampling Site 7. These Sections describe relative habitat transects that will be overprinted by the western causeway and work platforms while Sections 2.2.2.1; Transect Site A, Sampling Site 2 and Sampling Site 6 are within 50 to 100 m and also expected to be representative.

As described in Section 2, the western littoral area is expected to provide habitat of varying importance for most fish species identified inhabiting (none migrators) the Study Area. Specifically, this area is believed to be of most importance to CRA Panfish, Esox and Gars, Largemouth Bass and variety of common forage fish, with least importance to American Eel, Lake Sturgeon, Smallmouth Bass and the remaining common forage fish that likely use the deeper areas of the navigation channel or the rockier eastern shoreline.

The largest effect of the western causeway is expected to be on the CRA Panfish, Esox and Gars and Largemouth Bass as well as the Project Location dependent forage fish groups. These four groups require shallow, vegetated waters for spawning and nursery habitat with slightly deeper water used for foraging or general adult habitat. The significance of the construction impacts is believed to be an evaluation of scale of habitat impacted versus retained during the construction period, as well as the availability of expected new or enhanced habitat available since the purchase and assumed re-vegetation of Music Marina.

As noted, the western causeway will affect a total of 28,785 m² of wetted area with 26,800 m² being non-previously dredged littoral habitat whereas similar available habitat (heavily vegetated, open water portion, ≤2 m deep) located within the boundaries of the Cataraqui PSW is approximately 3,150,000 m². This construction loss of habitat represents 0.85% of the similar habitat available in the immediate area. Transitioning from construction (loss) to longer term operations, the impacts are being evaluated as a permanent alteration (see Section 3.1.2.6.2 for operational effects). Excavation of the granular materials below the existing riverbed bathymetry is expected to result in re-suspension of sediments. Sediment resuspension will result in increased TSS in the water column, potentially affecting the Greater Cataraqui River's suitability for the fish species currently present within the Study Area, effects to water quality are described in Section 3.1.4. As described within Section 1, the intent is to excavate the base layer of the causeway until reaching 100 mm below the existing river bottom.

Further details regarding causeway removal are provided within the Bridge Design and Construction Methodology (Appendix B).

3.1.2.5.1.2 Eastern Causeway Access and Work Platforms

The eastern shoreline has a relatively similar profile as the western with approximately 0.8 m water depth reached 4-6 m off shore. Generally, the eastern shore has a greater percentage of rock, reduced sedimentary deposition and subsequently less aquatic vegetation. The littoral zone is considerably smaller within the eastern edge of the navigable channel 75 m off shore. Subsequently the eastern causeway length and overall size is reduced. The eastern causeway extends approximately 75 m off shore at the base and includes two construction working platforms, in total the eastern causeway overprints a total of 3,965 m². . Habitat effected by the eastern causeway is described in Section 2.2.2.3. This section represents the habitat transect that will be overprinted by the eastern causeway while Transect Site C is within 50 m and is also expected to be representative.

The eastern causeway construction activities are anticipated to effect approximately 61 m of rocky vegetated shoreline and 3,690 m² of semi vegetated littoral zone. The loss of vegetated shoreline is not expected to significantly impact any of the noted species. The shoreline emergent community has an increased shrub percentage in comparison to the western side as such would be expected to be of lesser spawning value then the west or much of the PSW (Figure 2.2). The rockier shoreline is likely providing suitable spawning habitat for native bullheads and Johnny Darters, but is not within the suitable depths for Smallmouth Bass. As further described in the mitigation and offsetting sections below, shorelines are to be rehabilitated.

Construction of the eastern causeway will cause the temporary loss and permanent alteration of 3,690 m² of littoral habitat. Similar to the western area, the eastern littoral area is expected to provide habitat of varying importance's for most species identified inhabiting (none migrators) the Study Area. Unlike the western shore the rockier eastern likely provided habitat for juvenile American Eel with effects further described in Section 3.1.6.1.1. Overall effects of the eastern shore are expected to be lesser then the western considering the reduction in size, reduced littoral area impacts and habitat quality. The largest potential impact remains to be on the CRA Panfish, Esox, Largemouth Bass and Gars as well as the Project Location dependent forage fish groups as shallow, vegetated waters for spawning and nursery habitat exists albeit at what appears to be lesser quality. This is generally supported by Bowfin's electro-fishing captures results, although it is acknowledged that specific preference by species or individuals of a species may in fact prefer the eastern habitats therefore it is considered as the same quality as the western area within the quantitative calculations below. The significance of the temporary impacts is believed to be an evaluation of scale of habitat impacted versus retained during the construction period.

As noted, the eastern causeway will impact 3,690 m² of littoral habitat whereas the Cataraqui PSW offers 3,150,000 m² of similar habitat. This construction loss of habitat represents 0.12% of the similar habitat available. Contrary to the western side, the transitioning from construction loss to longer term permanent habitat alteration during operations is not expected to be as impactful. This is due to the current rockier or harder substrate conditions resulting in less vegetation naturally occurring. The removal of the causeway material to 100 mm below the existing river bottom will allow the impacted area to return to pre-construction conditions over time; however, it is noted that sedimentary deposition and subsequent vegetation growth may take longer relative to the western side. This is primarily due to the reduced unconsolidated sediments within the immediate adjacent areas that may infill and voids, as well as am anticipated reduced rate of sediment deposition potential based on a general river morphology.

Considering this existing substrate conditions and the robust nature of the submergent macrophyte species that dominate the Cataraqui River, it is expected that vegetation will recolonize to the extent that is currently present. Based on the above it is anticipated vegetation growth similar to those noted in Section 2.2.2 would be seen approximately 6 years post construction based on the Music Marina offset area. In the event that vegetation does not recolonize at the predicted rate active, management measures will be implemented to accelerate the rate of revegetation.

3.1.2.5.1.3 Trestle Piles

On the east side of the river alongside the location of the permanent bridge between Piers 17 and 20 a temporary trestle is to be placed. This will be placed within the previously described shallow littoral areas as well as directly adjacent the Canal. The canal contains the deepest habitat (4.5 m) and has been historically dredged to allow navigation through the Rideau Canal. This area has reduced sedimentary deposition and lesser aquatic vegetation.

The trestle consists of two temporary components, the main trestle span and trestle finger that will allow access to the piers. In total 78 piles with a diameter of 900mm will be required for the trestle and temporary main span. Resulting in a temporary footprint of 49.6 m^2 at its greatest extent during construction.

In contrasts to the littoral shallow habitat the waters within the navigation channel are expected to provide a cooler thermal refuge area, a corridor for migraters and a conduit for predatory fish to move in, out and around the productive littoral area. This area is believed to provide suitable general habitat for adult Smallmouth Bass and American Eel, with a lesser potential for Lake Sturgeon that may frequent waters closer to Lake Ontario. The trestle will cause the construction loss (22-26 months) of 49.6 m^2 of habitat. This temporary loss represents 0.01% of the similar habitat (Rideau Canal area in the vicinity of the project is 550,000 m^2).

3.1.2.5.2 Flow Alterations

Flow alterations have the potential to effect fish and fish habitat, as river hydrology often dictates the habitat present within river segments. The placement of east and west causeways will result in flow and water movement alternations between the scheduled onset of construction and complete removal. The altered flow is expected to impact water velocities and vectors throughout the Study Area. Due to the uniqueness of the area, flow velocities and vectors change daily depending river discharges, Lake Ontario levels, wind directions and lake surges. The existing vegetation and fish community is expected to be adapted to this habitat. Although flow is expected to be altered once the causeways are in place, these conditions are likely to occur at various times throughout the year regardless of the presence of the presence of the causeways. An exception to this statement is the area within and immediate adjacent the 220 m opening where flow alterations will occur. Further information regarding potential effects of the Project on the hydrology of the Study Area is available in Section 3.1.13.

As shown in Section 3.1.13, an increase in velocities under average conditions is expected to be relatively minimal with a maximum increase of approximately 0.5 m/s at the western end of the 220 m opening within the causeway. Moving eastward velocity changes reduce to <0.2 m/s, in both cases, maximum velocities within the 220 m opening is not expected to surpass 0.9 m/s under average condition. Furthermore, the five causeway openings within the causeway have been modelled to possess minimal velocities with the causeway in place, however this detail may be beyond the limitations of the model. Nonetheless, velocities within the openings are expected to be within swimming speeds of migrating fish species shown in Table 3.3 below. During average flow periods or southerly winds, the five (5) openings are expected to pass all types of fish with minimal flows modelled. Flows through the openings will be confirmed upon installation to ensure passage is feasible as outlined in Section 8.

Similar to average conditions the model shows the largest increases at the western end of the causeway opening with increase up to 0.8 m/s when compared to the same 50-year event with no causeway in place. Also similar to the average scenario the model showed minimal velocities within the five causeway openings. Table 3.3 depicts velocity range of 0.5 to 1.3 m/s under the 50-year event. It is important to note this velocity would be very short term <1 hour and is in a northern/upstream direction and would not expect to limit any migrations. Nonetheless, velocities have been compared to the swimming speeds of fish requiring passage in Table 3.3 below.

3.1.2.5.3 Fish Movement

The placement of the east and west causeways would be considered a negative effect to movement if it prevented fish from completing their lifecycle. Fish movement is undertaken in order to reach spawning areas, feeding areas, and refuge areas.

There will be an approximate 220 m wide opening in association with the Rideau Canal navigation channel, as well as five (5) approximately two (2) m wide openings provided within the western causeway. The intent of the openings is to reduce impacts to aquatic biota movement resulting from the causeway.

Larger fish such as Largemouth Bass, can also complete lifecycles in areas north and south of the causeway, and the designed passages should maintain connectivity between habit north and south of the causeways. Some fish, such as the fall spawning and migratory salmonids are known to spawn in the northern reaches of the Study Area, however the 220 m wide river opening is expected to provide two-way passage under all flow conditions including the 50-year event. Antidotal information also suggest a Northern Pike migration may occur within the spring months to northern spawning areas. Both the 220 m opening and the installed openings would be expected to facilitate this movement based on modelled velocities and documented swim speeds presented in Table 3.3 below. Table 3.3 presents the 50% value of fish and assumes a 600 mm long fish with sustained speeds for 300 seconds and burst speeds of 30 seconds using the DFO Fish protection tool.

Table 3.3: Swimming Speeds of Anticipated Migratory Fish

Fish species	Sustained Swimming Speed in m/s for 300 sec	Burst Speed in m/s for 30 Secs
American Eel	0.67	1.55
Chinook and Coho Salmon	1.65	2.93
Northern Pike	0.89	1.91

As shown in Table 3.3 Salmonids would be expected to pass through the opening using sustained swimming speeds, whereas Northern Pike and American Eel may require a combination of burst and sustained swimming techniques. This assumes the modelled state is consistent through the opening profile which is not likely to occur given the riverbed irregularities associated with the navigational channel. Furthermore, with a change in wind direction or speed the average condition is not expected to be as regular as normally seen in a riverine habitat.

3.1.2.5.4 Spills and Sediment Releases

The Project has the potential to affect the quality of the fish habitat within the Study Area through potential releases of sediment and deleterious substances (fuel, foreign material) into the Cataraqui River during construction and operations as described in Section 3.4. Spills of deleterious substances may directly impact fish within the Study Area, or indirectly impact fish by degrading the quality of the habitat (water quality, sediment quality).

3.1.2.6 Operations Phase

During the operation phase of the Project, potential effects to fish and fish habitat could include:

- Permanent habitat alteration from causeway and work platforms.
- Permanent loss of habitat due to footprint of the bridge piers (caissons) and western abutment.

3.1.2.6.1 Causeway Access and Work Platforms

As noted previously, the causeway will result in a construction wetted area loss of 32,475 m². Upon completion of the required works the causeway and work platforms will be removed working in reverse towards shore. The excavation of causeway materials will extend below the existing substrate elevation and the retention of the base material is considered a permanent habitat alteration as result of the time lapse required for full return of form and function of the habitat. Furthermore, although form and function may fully re-instate the sub-surface substrates will permanently be altered. Based on past IPD project experience, the infill of the Music Marina Channels and infill of utility channels completed within the Study Area, sedimentation is anticipated to occur within 3-5 years, creating soft substrates over and among the causeway material left behind. Considering this sedimentation and the robust nature of the submergent macrophyte species that dominate the Cataraqui River it is expected that vegetation will recolonize to pre-construction densities. In the event that vegetation does not recolonize at the predicted rate active, management measures will be implemented to accelerate the rate of revegetation. Further to the revegetation (i.e. new plants) it is expected periphery vegetation will seek out the open waters with less competition within one or two growing seasons, re-establishing form and function within the outside 5 m rapidly. This theory is expected to be validated by the pre-construction survey to take place in Fall of 2019, the pre-construction survey will compare results from the 2010 baseline habitat assessment that reported reduced vegetation within the managed Music Marina and associated navigational channel. These conditions are assumed to have persisted during marina operations up to 2013, with 2014 representing the first growing season without marina maintenance activities. Impacts of boat traffic from the boat ramp (as the Music Marina docks were removed) and reduced vegetation within the navigational channel is evident in September 2015 Google Earth imagery. Any changes in anticipated re-vegetation timelines will be presented in a monitoring timeline change and discussed with relevant regulatory agencies.

In total permanent alteration of approximately 30,490 m^2 of vegetated littoral habitat representing approximately 1% of similar habitat available within the PSW and 1,985 m^2 of habitat within Music Marina will be altered. Littoral habitat would be expected to remain similar depths upon removal and return to similar form and function. The area within the Music Marina left at an elevation of approximately 74 masl returning it to the pre marina depths within the causeway footprint. The proposed causeway route is currently dominated by four submergent macrophyte species: Valisneria americana, Potamogeton crispus, Elodea canadensis, and Myriophyllum spicatum. All are aggressive colonizers known for their ability to establish and maintain their presence in the Cataraqui River.

Infilling by aquatic macrophytes, once the causeway is removed to 10cm below riverbed depth, is primarily expected to be by vegetative means, rather than through seed banks. This is consistent with the literature for the spread of the main four plants associated with the causeway (Abernethy and Willby, 1999; Smith and Barko, 1990; Catling and Dobson, 1985; Vari, 2013). The rapid colonization by vegetative means is also a characteristic of these species, for example Bolduan et al. (1994) noted that a single P. crispus could produce up to 9600 turions/m^2/year, and Spicer and Catling (1988) measured up to 5,000 Elodea vegetative pieces deposited per square meter of sediment. Smith and Barko (1990) also note how milfoil stolons can stretch in from adjacent vegetated areas to cover newly bare substrates for a length of up to 2 m per year.

3.1.2.6.2 Permanent Loss of Habitat Due to Footprint of the Bridge Piers and Western Abutment

In total 21 piers with 44 caissons will be placed below the highwater mark of the Cataraqui River, 19 of the piers will have two identical 1.63-m diameter drilled shaft caissons each constructed of a steel caisson filled with concrete and steel reinforcement and will be constructed from the dry via construction platforms. The remaining two piers will have three caissons each and be built in the wet as previously described. The west abutment will be reinforced concrete with wingwalls that are founded on ten 1000 mm diameter caissons rock socketed into the bedrock.

In total the 21 piers and their 44 caissons will cause the loss of 92 m² of wetted area all of which will be within the littoral zone and thus 92 m² of fish habitat. While the western abutment will lead to a loss of an additional 86 m² of wetted area and littoral fish habitat. Similar to all the above effects the loss in habitat will have the greatest impact on the species or groups that rely on shallow, vegetated littoral habitat for all or critical life stages as outlined in Table 3.1.

The largest impact would be expected to be on the CRA Panfish, Largemouth Bass, Esox and Gars as well as the Project Location dependent forage fish groups. Unlike the other impacts there is no timeframe associated with the impact other than the lifespan of the bridge itself (>100 years). There is no mitigation nor alternative use for the piers within the aquatic habitat for which it is being placed. For comparison sake the 92 m² of littoral habitat occupied by this permanent footprint of the piers and drilled shafts equates to <0.004% of the similar 3,150,000 m² PSW habitat. While the 86 m² of littoral habitat lost as result of the western abutment represents 0.003%. The pier and abutment wetted area loss is proposed to be offsetting by a seawall removal and shoreline grading along the western shore immediately adjacent to the bridge as described below.

3.1.3 Birds and Habitat

3.1.3.1 Bird Species Likely Affected by the Project

Bird species that are likely affected by the Project are discussed below.

As shown in Section 2.2.3, 174 common species (excluding SAR) are known to use the Study Area, either seasonally or year-round, with fewer species utilizing the Project Location.

For the purpose of this impact analysis, species have been grouped into categories based on preferred nesting habitat. Species that select nest sites in several habitat types were assigned a category based on their predominant selection preference. Table 3.4 outlines the categories and the number of species therein. Please refer to Section 2.2.3 on the nesting habitat preferences for each species observed within the Study Area (Table 2-6).

Table 3.4: Predominant Habitat Type for Common Birds within Recorded within 5 km of the Study Area

Predominant Habitat Type	Total Species
Forest	98
Wetland/Riparian	37
Grassland/Open	15
Shoreline	11
Thicket/Ravine	8
Urban/Cliff	5
Total:	**174**

3.1.3.2 Bird Habitat Likely Affected by the Project

Bird habitat affected by the Project is discussed below.

Project components or construction activities with the potential to affect bird habitat include the following:

- Areas temporarily impacted and areas permanently altered by work platforms, temporary piles and work area isolations.
- Areas impacted by the permanent footprint of the bridge piers and western abutment.

Each of the above effects are explained in further detail below.

3.1.3.3 Potential Effects on Birds and Bird Habitat

The following sections will outline the effects on birds and bird habitat from the various Project components and construction methods.

3.1.3.3.1 Construction Phase

Potential effects on birds and bird habitat during construction include:

- Noise and vibration from construction equipment.
- Human presence and collision with vehicles and machinery.
- Loss of habitat due to tree and vegetation clearing.

3.1.3.3.1.1 Noise Impacts

Effects to birds and bird habitat as a result of noise generation are possible during the installation of steel casings and trestle piles with the use of either a vibratory hammer alone or vibratory and impact hammers for pile driving. .

The following inputs have formed the basis of this analysis. Activity timing is presented in the Construction Schedule (Figure 1.13):

- A combination of vibratory and impact hammers would be used for any temporary pile driving, with impact hammer use limited to between one (1) and 14 minutes per pile.
- The installation of the temporary trestle will require a total of 78 piles to be installed. Pile driving will be conducted on between two and eight days per month, on which two to four piles can be installed per day from February 2020 through July 2020. Approximately one to two hours of vibratory or impact hammer use is expected on a day when pile driving is being conducted, with impact hammer use limited to between one and 14 minutes per pile.
- The installation of steel casings for the piers will require a total of 44 piles to be installed over the course of a 13-month period (extending from May 2020 through May 2021). Pile driving using a vibratory hammer only (i.e. no impact hammer) will be intermittent for a total of approximately two hours over a duration of approximately two days, per pile.
- Falsework installation for the superstructure will require the installation of 24 piles. Piles driving will be conducted on between 4 and 8 days between July and August 2020. Approximately one to two hours of vibratory or impact hammer use is expected on a day when pile driving is being conducted, with impact hammer use limited to between one and 14 minutes per pile.
- The results risk of auditory effects to birds due to the installation of steel casings and trestle piles are based on the following research driven thresholds (See Appendix I):
  - Auditory injury in birds could occur at levels of approximately 125 dBA.
  - Auditory impairment in birds could occur at levels greater than 93 dBA.
  - Auditory masking and behavioural disturbance could occur at levels greater than 55 dBA.

Noise modelling completed by the IPD team in September of 2019 to assess the effects of vibratory and impact hammer use installation methods are present in Table 3.5 and Table 3.6 below. It is important to note that the distances associated with noise generation remain true regardless of the number of installations that occurring at any given time (i.e. effect is not cumulative), however the distances extend from all sources. Equally important to note is that these distances represent the maximum distance, recorded upstream or downstream traveling over the water with significantly reduced distance achieved overland as a result of existing noise barriers/attenuators.

For the purpose of this effect assessment the extreme distance noise threshold (Rmax) has been used, however R95% is also provided which represents 95% of the noise distance where all but the greatest 5% of modelled points extend.

Table 3.5 Illustrates the Sound Pressure Level (SPL) at various distances generated during vibratory hammering of the caissons or piles.

Table 3.5: SPL at Generated during Vibratory Hammering

SPL	R max (m)	R95% (m)
>95	<10	<10
95	<10	<10
90	<10	<10
85	12	12
80	23	23
75	45	45
70	77	77
65	140	140
60	243	243
55	490	390

Table 3.6 Illustrates the Sound Pressure Level (SPL) at various distances generated during impact hammering of the temporary trestle piles.

Table 3.6: SPL Generated During Impact Hammering

SPL	Rmax (m)	R95% (m)
>95	3	3
95	10	10
90	18	18
85	36	36
80	64	64
75	113	64
70	190	140
65	380	305
60	680	614
55	1200	910

As previously stated, these noise levels and associated distances represent to maximum distance over water. In order to assess the worst-case scenario in terms of noise generation two scenarios have been modeled.

Figure 3.1 illustrates the use of two vibratory hammers simultaneously, one located at the western causeway, installing a steel casing; the other on the trestle bridge installing a temporary trestle pile. This configuration was chosen as it relates to a possible instance occurring during the 2020 breeding bird season.

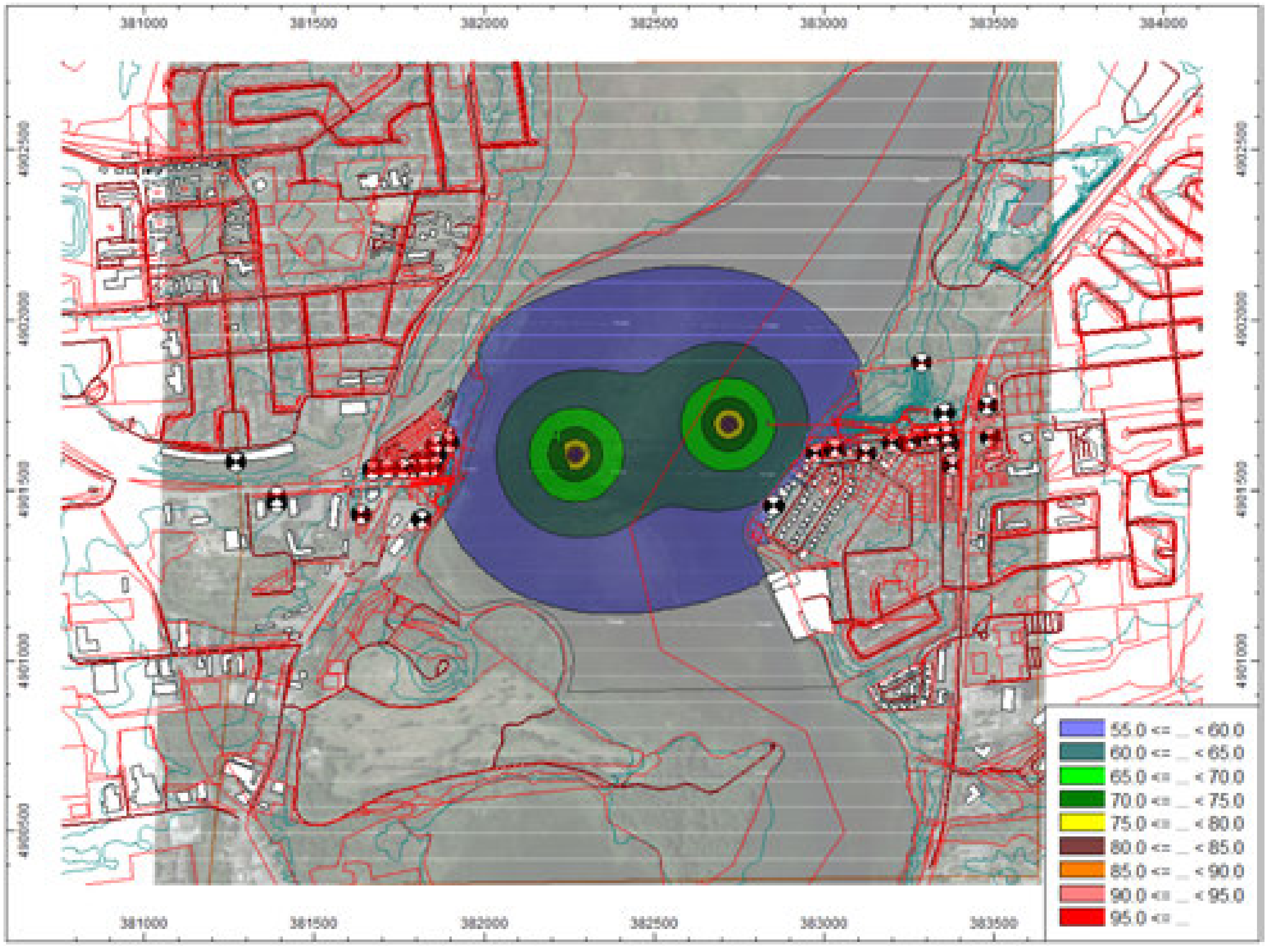


Figure 3.1: Two Vibratory Hammers Running Simultaneously to Install Steel Casing and Temporary Trestle Pile

Figure 3.2 illustrates the same locations, however the western causeway steel casing being installed with vibrating hammer, while the temporary trestle pile on the east is being installed simultaneously with an impact hammer for between one and 14 minutes.

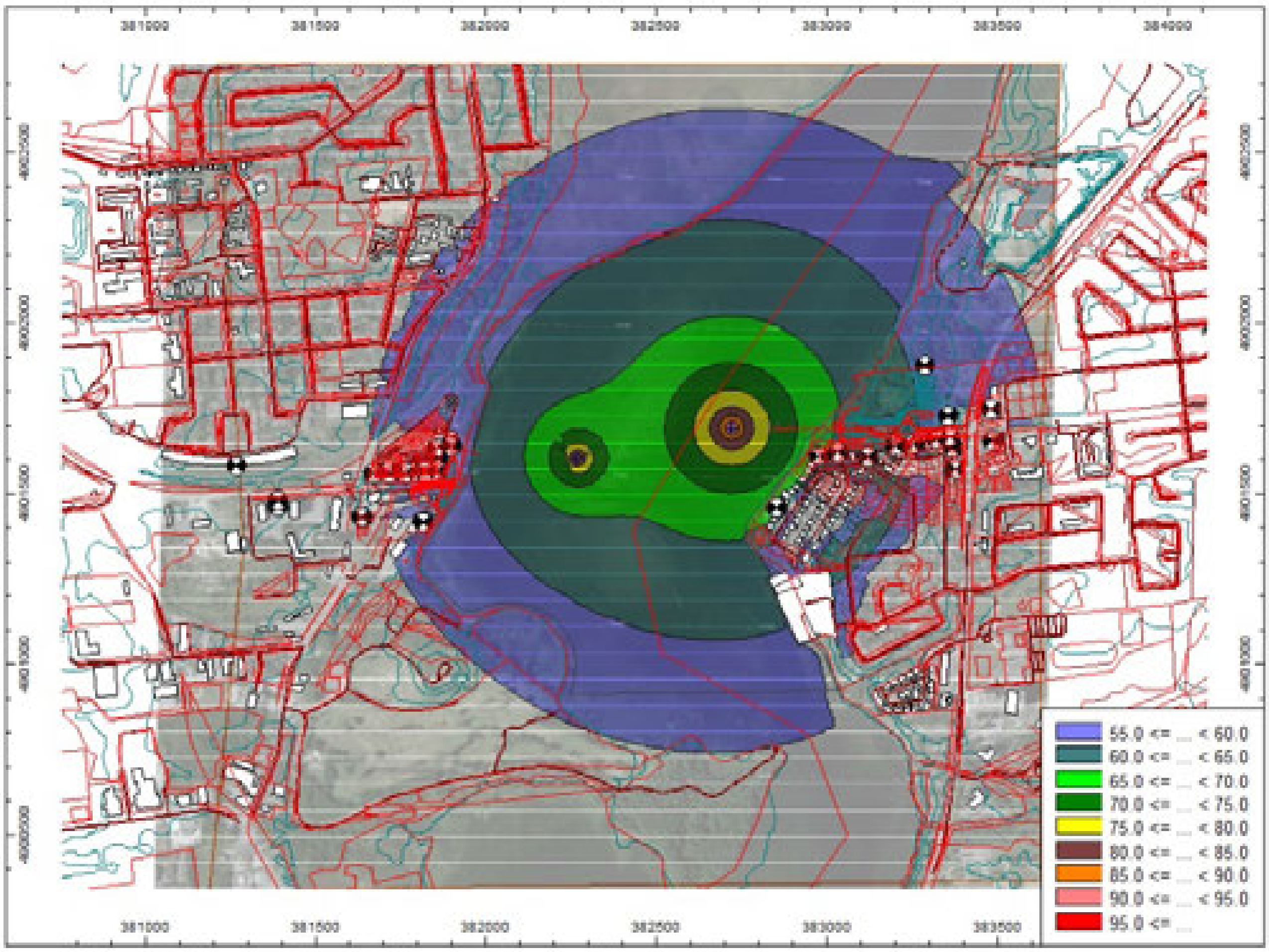


Figure 3.2: One Vibratory Hammer Installing Steel Casing and One Impact Hammer Installing Temporary Trestle Pile for Between One and 14 Minutes

Based on these modelled scenarios, the effect of the use of vibratory and impact hammer is not expected to cause auditory injury to birds with limited for auditory impairment limited to within 10 m of operating equipment.

Auditory masking and behavioural disturbance (which has the potential to occur as at levels greater than 55 dBA) is possible, specifically in areas that do not normally experience these sounds levels (i.e. open water areas, the shorelines of Belle Island and the cattail marsh to the north) during the breeding season, mitigation measures are required to address this potential effect, as presented in Section 4.

3.1.3.3.1.2 Human Presence and Collisions with Vehicles/Machinery

The effects on birds and bird habitat from human presence and collisions with vehicles/machinery within the Study Area are discussed below.

During construction activities, the increased presence and activities of both humans and vehicles/machinery will disturb birds and bird habitat within and adjacent the Project Location. General construction activities will result in increased vehicle traffic, and risk of collisions between birds and vehicles/machinery.

These effects will primarily occur during construction activities along the east approach, including the causeway installation, pier foundation placements along the shoreline, and other enabling works (i.e. vegetation removals, access road installation, etc.).

3.1.3.3.1.3 Tree and Vegetation Clearing

The effects on birds and bird habitat from tree and vegetation clearing within the Study Area are discussed below.

Construction of the Project will require grubbing and clearing of trees, shrubs and groundcover in the Project Location. The Project footprint on the east approach will result in a loss of up to 1.93 ha of woodland and will impact (clear or fragment) 2.15 ha. Vegetation removals along the edge of woodland areas may result in:

- Damage to adjacent trees/shrubs and groundcover outside of work area.
- Creation of new forest edge boundaries within wooded areas.
- Disturbance to the rooting zone through soil compaction and rutting.
- Mitigation for these potential effects is provided in Section 4.

3.1.3.3.2 Operations Phase

Potential effects on birds and bird habitat during operation include:

- Light impacts.
- Noise impacts.

3.1.3.3.2.1 Potential Light Impacts

Effects from operational bridge lighting on birds and bird habitat are discussed below.

As outlined in the 2017 Technical Memorandum by Golder included as Appendix J of this report, potential impacts on birds include alterations in migratory behavior, feeding behaviors and foraging success, predation events, reproductive behavior, and the ability to respond to stressors. The magnitude of these effects from artificial lighting are generally influenced by three main factors: intensity, colour/spectral composition and duration.

The artificial bridge and roadway lighting have potential to negatively impact birds, as follows:

- Artificial lighting that is pointed upward, horizontally or near-horizontal increases the visibility of the light source from a distance, thereby increasing the illuminated area and producing more ‘sky glow’ and light trespass. As per the City and IESNA standards noted earlier, the proposed illumination design levels for the roadway and multi-use pathway are considerably higher than full moonlight.
- Birds tend to exhibit different responses to various wavelengths of light pollution. For example, red lights have been shown to affect the navigational abilities of migrating birds, while blue-green lighting had no effect, and nesting birds tend to find white light most disruptive. As such, the bridge lighting may potentially affect birds differently according to seasonality.
- The majority of nocturnal and crepuscular wildlife activity occurs immediately after dusk and before dawn, which coincides with the times when artificial lighting is needed.

To reduce the impacts of lighting on adjacent natural areas (including bird habitat) during operations on adjacent natural areas including bird habitat, the lighting source will provide the lowest illumination possible, while still meeting safety requirements and no additional mitigation measures are required.

3.1.3.3.2.2 Potential Noise Impacts

Effects from operational noise on birds and bird habitat are discussed below.

Once the bridge is open to the public, increased and sustained noise levels due to vehicular traffic are expected. Based on available research, the potential effects of traffic noise from bridge operations was considered for birds. The following impacts have potential to occur:

- If other background noise is below 45 dBA, traffic from the bridge could cause behavioural disturbances in birds at a radius of 500 m around the bridge. At background levels over 45 dBA (due to other sources of sound), traffic impacts would be considered negligible. Similar to construction any potential operation effects would be within the open water area that provides little nesting habitat. As background noise levels increase such as onshore or near other roads the potential impact zone decreases. Noise modelling for operational traffic is presented in Table 5-1 in Appendix K.

Mitigation for potential noise impacts is detailed further in Section 4.0.

3.1.4 Surface Water and Sediment Quality

Effects on surface water and sediment quality from construction and operation are discussed below.

In terms of water quality, both Cadmium and Silver seasonal averages exceeded the PWQO and CCME guidelines on multiple occasions (Tables 2-7 and 2-8). Sources of elevated cadmium levels within the water column can include corrosion of galvanized pipes, erosion of natural deposits, discharge from metal refineries, runoff from waste batteries and paints (Water Quality Association, 2013), sewage sludge, and fertilizers (Government of Canada, 1986). Elevated concentrations of Silver within freshwater systems include emissions from smelting operations, manufacture and disposal of certain photographic and electrical supplies, coal combustion, cloud seeding and sewage discharges (Howe and Dobson, 2002).

Within the sediment, a majority of parameters in exceedance of the sediment quality guidelines were heavy metals such as lead, copper, chromium and zinc—metals which were historically used for metal smelting and other heavy industrial processes. Elevated levels of PAH's within the sediment of the Cataraqui River are also indicative of petroleum combustion, most notably at heavy industrial sites but also present in wastewater effluent or sewage overflows.

Both water quality and sediment quality exceedances were examined when determining the potential sources of contamination to the Cataraqui River. Historical metal smelting operations within Lyndenham (northeast of the Greater Cataraqui Marsh) occurred adjacent to a tributary of the Rideau Canal—the watercourse contiguous with the Cataraqui River (Postovit, 2017). A number of other historical industrial operations operated in proximity to the Cataraqui River, potentially accounting for elevated metal and PAH concentrations within the sediments. As metal smelting operations have significantly decreased in the Kingston area, many of these contaminants that may have at one time been suspended within the water column have accumulated within the sediment of the watercourse. Contaminants are often bound to the sediment in areas with slow moving water, such as marshes, reducing any contaminants from impacting the water column. Contaminants within the water column such as Cadmium and Silver are also likely a result of heavy industrial operations within the area today. Sewer discharge may also be a point source of contamination for the Cataraqui River; A number of overflow pipes are located along the west shore of the lower Cataraqui River. Elevated heavy metals and nutrients within the water and the sediment may be indicative of sewage contamination within the Study Area.

Construction activities throughout the duration of the Project will disturb the sediment within the Project Location, increasing the chances of sediment resuspension within the water column. During sediment disturbance, sediment bound contaminants such as heavy metals can be suspended into the water column in a soluble form that allows for plant and animal uptake. Heavy metal contamination within aquatic plants can lead to die off and alterations in growth patterns. Additionally, many heavy metals, primarily lead (shown to exceed in Section 2.2.4.2), can both bioaccumulate and bio magnify within the food web, causing behavioural and physiological impairments within wildlife.

In addition to the release of sediment bound containments into the water column, high levels of total suspended sediments can itself have detrimental effects on vegetation, fish, aquatic wildlife and users.

Increases in suspended sediments within the water column can also result in increased water temperatures. Dissolved oxygen will be depleted areas of warmer water, leading to detrimental effects described above. Temperature variation within the watercourse can also alter habitat for fish and wildlife, including turtle overwintering or fish spawning grounds. Both increased suspended solids as well as contaminant resuspension would both reduce the filtering capacity of the wetland itself due to the combination of many of the associated effects described above. Mitigation measures will be discussed in Section 4.

Additionally, a Permit to Take Water has been prepared for the uptake of water used for the drilling and coring operation within the steel casings for the drilled shafts. Before releasing the water back into the Cataraqui River, it will be treated to meet the CCME Water Quality Guidelines for the Protection of Aquatic Life. Treatment will include using storage tanks to treat the water for pH and sediment retention bags to treat the water in a batch process. The release of water is not expected to cause a disruption to the bottom sediment or the turbidity curtain as the amount of water (no more than 150m3 per each of the 44 shafts) can be discharged at a regulated rate. By having a regulated rate, increased turbidity and erosion can be prevented. The flow rate would dissipate at the outflow location decreasing the overall velocity of the discharge to the point at which the turbidity curtain has been designed for. This would prevent water released within the turbidity curtain from carrying sediment either under or around the curtain. The dissipaters can be constructed or rip rap, sandbags, gravel or other non-erodible material and inspected before, during and after discharge to identify and document potential issues. Any issues with sediment and erosion control measures would then be repaired or replaced immediately to ensure it is working as intended.

The discharge area will be located directly over the river to eliminate any overland flow that would alternatively cause scouring and erosion. To control the flow at the discharge point, the pump within the treatment system will be controlled with a valve and an associated flow meter to monitor and control discharge. The overall design of the treatment system is in alignment with ESG-14-C for Treatment of Discharge Water and is designed to prevent adverse effects to water quality.

The pH of the Cataraqui River at both Kingston Mills and Lasalle Causeway falls within the regulatory standards for freshwater waterbodies. During construction activities, there is a potential for concrete to enter the watercourse; concrete is a very basic substance that can alter the pH of the watercourse and cause detrimental effects to plants and animals. Extremely alkaline waters can cause burns to fish and other wildlife and increase the chance of mortality (Environment Bay of Plenty, 2019). The following construction components have the potential to cause adverse effects associated with concrete within the Cataraqui River:

- Wastewater
- Chippings
- Dust
- Concrete Delivery
- Stormwater.

Dilution is not a viable option for reducing the effects of concrete in the water as it takes 10,000 L of clean water to neutralize the pH again after 1 L of concrete has been spilled. In order to neutralize the pH of water, CO2 is often used because when mixed with water, it will form carbonic acid; Carbonic acid will further dissociate to form a free proton that will serve as a weak acid and will ultimately lower the pH of the water (Environment Bay of Plenty, 2019). Mitigation measures to prevent concrete form entering the watercourse are further discussed in Section 4.

3.1.4.1 Cyanobacteria

Cyanobacteria presence due to construction and operation are discussed below.

Cyanobacteria (commonly known as blue-green algae) blooms are still not completely understood but occur when a combination of factors are present within a given environment. Historically, cyanobacteria blooms have been recorded in many areas throughout the Cataraqui River (Personal Communication 2019); Certain environmental conditions, such as construction activities and flow alterations, may increase the probability of a cyanobacteria bloom within the Study Area. Slow, stagnant water within the area presents optimal temperature regimes and light conditions for the species to populate. As discussed in the above section, many of the construction activities associated with the bridge construction increase the probability of suspended sediments throughout the study area. Cyanobacteria may have the opportunity to flourish and formulate blooms in these conditions due to their ability to float near the surface where light can still penetrate the water. Additionally, the resuspension of sediment from in-water works can cause unavailable forms of phosphorous and nitrogen to be released into the water column in their available form, promoting cyanobacteria growth. In addition to nutrient release from the sediment, poor Sediment and Erosion Control practices in shoreline areas during construction can lead to an increase in runoff, often containing high levels of nutrients not normally available to the aquatic biota potentially promoting cyanobacteria growth.

The presence of cyanobacteria blooms within the Study Area could cause detrimental effects to the functionality of the wetland, plants and wildlife within the area as well creating hazards for humans. Cyanobacteria often contain toxins (microcystins and neurotoxins) that are detrimental for plants, animals and humans when exposed to high concentrations. High concentrations of these toxins are often found in large floating mats that accumulate when buoyant cyanobacteria are easily pushed to shorelines from wind and wave action (WHO, 2003).

Measures to mitigate cyanobacteria blooms caused from construction activities will be discussed in Section 4.

3.1.5 Aquatic Wildlife and Vegetation

Effects on aquatic wildlife and vegetation from Project construction and operation are discussed below.

3.1.5.1 Herpetofauna

Effects on herpetofauna from Project construction and operation are discussed below.

Section 2.2.5 outlined, the potential for several non-Species at Risk (SAR) herpetofauna exists within the Study Area (Table 2.9). Species with a moderate to high potential have been subsequently carried forward to this Section and presented below in Table 3.7. Similar to other sections groupings have been established where similar species share similar habitat requirements.

Table 3.7: Herpetofauna Species with a High to Moderate Potential to be within the Study Area

Grouping Name	Species Name	Potential Study Area Use
Aquatic Residents	American Bullfrog	All Life Stages
	Green Frog	All Life Stages
Aquatic Breeders	American Toad	Breeding
	Blue-spotted Salamander	Breeding
	Eastern Red-backed Salamander	Breeding
	Gray Treefrog	Breeding
	Northern Leopard Frog	Breeding
	Red-spotted Newt	Breeding
Mudpuppy		All Life Stages
Northern Watersnake		Summer Habitat

3.1.5.1.1.1 Aquatic Residents

Two herpetofauna species were found to be have potential to be located within the Study Area and to a greater extent the PSW. American Bullfrog and Green Frogs share similar breeding, summer and overwintering habitat often coinciding together. Although all wetland habitat does support these two species their general habitat preference is relatively close to shore with adequate floating vegetation for cover and opportunity to exit the water. The relatively open SuW1 wetland community (Figure 2.10) within the Project Location would be expected to leave these species vulnerable to predation by fish and is therefore would not be expected to be used to the degree the SuW2 communities would with a greater likelihood for increase use upstream within the Cattail Marsh or downstream within the thick lily pads associated with Belle Island.

3.1.5.1.1.2 Aquatic Breeders

Six herpetofauna species were found to be have potential to be located within the terrestrial portions of the Study Area with a dependency on aquatic environment for breeding. Generally, all these species avoid or prefer breeding within aquatic environments with no or limited fish use to avoid predation during breeding and young. Ecological Land Classification (ELC) mapping of the Project Location (Figure 2.10) has not indicated any terrestrial wetlands of vernal pools. The SuW1 community would not expect to be used for breeding purposes given the lack of cover and open nature; SuW2 does provided better suitability for the some of the frog species but would still not expect to be used to the degree of the upstream and downstream wetland communities.

3.1.5.1.1.3 Mudpuppy

Mudpuppy are Canada’s only fully aquatic amphibian. They are found in a variety of habitats but prefer muddy bottomed, weedy environment (Ontario Nature, 2019a) They would be expected to be found throughout the aquatic portions of the Study Area including the Project Location. Similar to other common, relatively low mobility species Project effects would be expected during the causeway installation and any other in water works. As with the impacts to fish previously described in Section 3.1.2, impacts from the Project could potentially result in a habitat fragmentation, habitat loss and restricted movement. Some mitigation measures for fish would apply, with any offsetting planned likely benefitting the species as well.

3.1.5.1.1.4 Northern Watersnake

Northern Watersnakes are common within Ontario found in most waterbody types. There are almost exclusively found in or adjacent water sometimes overwintering in beaver lodges. (Ontario Nature, 2019b) The entire aquatic portion of the Study Area is expected to be used by the species for foraging and general habitat. Ontario Nature notes the species has been observed hunting at depth of up to 3 m and venturing kilometres offshore. Wildlife considerations have been included into the design of the of the causeway to ensure wildlife and fish passage remains possible this would be expected to reduce impacts to Northern Watersnakes as well. Reptile exclusionary mitigations and monitoring are to be implemented for both terrestrial and aquatic reptiles reducing potential impacts of reptiles during construction, furthermore any mitigations or offsetting implemented for fish considerations would also be expected to benefit this species.

3.1.5.2 Benthic Invertebrate

Effects on benthic invertebrates from Project construction and operation are discussed below.

The benthic community present within the footprint of the causeway will be lost during the construction period, leading to a short-term reduction of local benthic productivity. Following the removal of the causeway macro benthic invertebrates will recolonize the area. As described previously, the causeway is expected to be removed to a depth of 100 mm below existing grade with the 100 mm void naturally filling with fine unconsolidated substrates.

Cummins and Lauff (1969) have discussed how different substrate types have characteristic benthic fauna, and in this regard, invertebrates that prefer coarser substrates currently residing within the wetland in lower abundance would be expected to rapidly colonize the available remnant causeway materials, subsequently temporarily (1-2 years) increase overall benthic diversity in the river by providing a different substrate. This is supported by CRCA 2018 pool habitat sampling whereas a pool with a rock dominated substrate composition (bolder, cobble and gravels) hosted a greater species diversity then those reported within the wetland from past studies. Barton (1986) in his Lake Ontario wide research, where gravel, rock, and sand were found to support the highest diversity of taxa. For example, see the table from Barton (1986) in Figure 3.3, where “Rock” means bedrock, and since this is Lake Ontario, we assume it to be limestone. As previously stated, this research was conducted prior to the introduction of zebra mussels in the late 1980’s. The causeway material would expect to provide suitable habitat for Zebra and Quagga Mussels immediately after construction with a reduction of suitability as infill occurs in non-consolidated fines and organic material. Zebra mussels would be expected to begin colonizing quickly, however generally take two (2) years to reach maturity (Cary 2019). It is expected as the mussels mature infilling will likely have begun reducing their successfulness.

TABLE 3. Mean numbers of taxa per sample (expressed as 95% confidence limits) from principal substrata on transects 1 to 25. NS = not sampled.

Substratum	Depth (m) 2	5	10	20	all
Rock	8.3–12.1	10.7–14.7	11.9–23.0	10.0–11.8	11.0–13.3
Gravel	14.9–20.0	17.0–23.0	15.3–19.1	10.7–15.0	14.7–17.3
Gravel + *Cladophora*	15.2–19.8	14.2–18.6	13.5–17.0	NS	15.2–17.8
Rock + Sand	15.9–20.0	15.3–23.9	17.2–19.1	19.4–21.9	17.9–20.0
Sand	9.1–11.3	17.6–24.2	25.6–30.0	9.0–11.9	11.6–14.3
Sand + *Cladophora*	7.3–16.3	15.5–23.0	9.5–15.8	NS	10.7–17.0
Clay	10.8–16.5	13.5–17.1	12.6–23.5	15.6–20.4	14.4–17.3
Silt	NS	9.5–12.5	11.6–17.9	14.1–16.3	13.8–15.9
All	11.0–13.5	15.2–17.7	16.3–18.6	12.5–14.1	

Figure 3.3: Depth and Substrate of Benthic Taxa Collected by Barton (1986)

Based on the above literature and based on the proposed Project, it is reasonable to assume to see a slight shift in benthic invertebrate species relative abundance (including an increase of invasive Zebra and Quagga Mussels), within the causeway footprint, but would not expect to notice any measurable change when applied to the overall wetland. Although not abundant within the wetland areas, coarser substrates do exist upstream, along rocky shorelines and existing anthropogenic areas such as the boat launch. As the fine unconsolidated substrates infill the 100 mm void, the benthic invertebrate relative abundance within the Project Footprint is expected to transition back to pre-construction conditions. The macro benthic invertebrate should have no long-term impacts as a result of the causeway.

Minimal benthic invertebrate results which are currently available suggest an impairment in aquatic habitat hindering the benthic invertebrate community. This is supported by the sediment analysis completed in 2010, 2016 and 2018 that show many exceedances when compared against the provincial and federal guidelines. The Proponent has committed to conduct further sediment and benthic invertebrate sampling prior to construction. Upon completion of these, an updated evaluation of water and sediment quality, and how that relates the benthic invertebrate community, will be completed.

3.1.5.3 Aquatic Vegetation

Effects on aquatic vegetation from Project construction and operation are discussed below.

The proposed causeway will result in a construction loss of submergent vegetation. The key question is whether this will be a permanent wetland loss. To avoid permanent loss, the amount of vegetation re-establishment needs to meet a minimum of 50% coverage in spatial coverage, in water that is less than 2 m deep (OWES, 2013).

The 50% submergent macrophytes coverage meets wetland mapping requirements outlined in the 3rd edition of the Ontario Wetland Evaluation System manual (OWES, 2013). In contrast, the 1990 Cataraqui River wetland mapping (Ecological Services, 1990) using the 2nd edition (OWES, 1984) of the manual only required 25% of submergent coverage to be included as part of the wetland. It is possible that there are parts of the current mapped wetland that may not meet the current 50% coverage threshold, especially mapped parts of the wetland in close proximity to the navigation channel. The percentage cover required is not expected to be an issue for wetland recovery on the causeway route due to the aggressive colonizing abilities of the existing and adjacent vegetation.

As discussed previously, the proposed causeway route is currently dominated by four submergent macrophyte species: Valisneria americana, Potamogeton crispus, Elodea canadensis, and Myriophyllum spicatum. Each species is known for their ability to withstand impacts that will come with the causeway construction. Despite being native plants, some of these species are invasive in nature, these four plants do push out other aquatic macrophytes, with a resulting loss in biodiversity.

Sediment deposition is expected to occur within the 100mm depression, but even in its absence, the aquatic macrophytes are likely to establish to some degree on the granular substrate left behind from the causeway. Previous assessments demonstrate that the four plants of the causeway route become established on many substrates, including rock. Catling et al. (1994) offers a review of Valisneria americana, including its ability to grow on gravel substrates. Research documented in Barrat-Segretain and Cellot (2007) found *Elodea* did well on gravel, and Riis and Biggs (2003) found it could grow well on cobble and gravel. Pip (1987) found that *Potamogeton* species richness was high on a variety of surfaces including limestone, gravel, and shale, and Suren (2008), Janauer et al. (2004), and Kuhar et al. (2006) found that various species, including types found in the Cataraqui River, did well in gravel and/or cobble.

Infilling by aquatic macrophytes, once the causeway is removed to 10 cm below riverbed depth, is primarily expected to be by vegetative means, rather than through seed banks. This is consistent with the literature for the spread of the main four plants associated with the causeway (Abernethy and Willby, 1999; Smith and Barko, 1990; Catling and Dobson, 1985; Vari, 2013). The rapid colonization by vegetative means is also a characteristic of these species, for example Bolduan et al. (1994) noted that a single P. crispus could produce up to 9600 turions/m^2/year, and Spicer and Catling (1988) measured up to 5,000 Elodea vegetative pieces deposited per m^2 of sediment. Smith and Barko (1990) also note how milfoil stolons can stretch in from adjacent vegetated areas to cover newly bare substrates for a length of up to 2 m per year.

In summary, although vegetation is anticipated to recolonize within the area impacted by the causeways, where the granular material of the causeway base remains, in the short term this vegetation will not return to pre-Project conditions. It is also anticipated that vegetation will recover both slower and less densely on the granular substrate. As a result, the wetland may not recover to wetland conditions outlined in OWES 2013 for many years, although it anticipated that by six years into operation the Project Location would become re-established as mappable wetland.

3.1.6 Species at Risk

Species at Risk that are likely affected by the Project are discussed below.

As result of records review onsite investigations, habitat documents, agency consultation and preliminary public consultation, at total of 29 SAR were found to have moderate or high potential to be within the Study Area. It is important to reiterate that for the purpose of this DIA, SAR is defined as any species listed at special concern, threatened, endangered or extirpated on any of the following lists, SARA, SARO or COSEWIC. Many of the identified species do not have protection under species at risk legislation but have been treated as such for completeness. Given the importance of SAR, this section provides a complete background of each species' habitat needs and description of how they may use the Study Area in relation to the Project and Project Location. The following section follows the same headings within Table 2.11 to group SAR into wildlife categories.

3.1.6.1 SAR Fish

There are two fish SAR noted as having potential to occur within the Study Area, those being American Eel and Lake Sturgeon, both which have been noted in the above sections.

3.1.6.1.1 American Eel

American Eel are currently listed as endangered within Ontario and threatened by COSEWIC. They are thought to be throughout the Study Area, primarily using the Project Location for foraging, migration to the upper watershed and possibly limited Juvenile habitat along the eastern shore. Presence has been confirmed by MNRF through mandatory reporting and American Eel recovery initiatives which local commercial fisherman participate in.

Eels are born in the Sargasso Sea, after which young eels drift with ocean currents before migrating inland into freshwater. In the case of the Study Area, this would be up the St. Lawrence River into Lake Ontario and further up its tributaries which include the Cataraqui River. Within the freshwaters of Ontario, American Eel mature for up to 20 years prior to migrating back to the Sargasso Sea to spawn. American Eel are primarily bottom dwellers, residing in waters 0 - 10 m deep, feeding on a variety of small fish, insects and crustaceans. American Eels, particularly juveniles or Yellow Eel use a variety of habitat such as rocks, crevasses, logs and dense submergent vegetation to seek shelter (COSEWIC 2012). Within the Study Area juveniles would be expected to be using the Project Location for this purpose as well as for foraging opportunities with adult or silver eels moving freely through the navigation channel. Abundance within the Project Area is expected to be relatively low with minimal commercial fisherman reports (personal communication, MNRF 2019). Nonetheless the construction phase of the Project will result in a reduction of juvenile and adult and habitat.

3.1.6.1.2 Lake Sturgeon

Lake Sturgeon are known to inhabit the Eastern Lake Ontario basin, with presence confirmed or assumed by the NHIC to be located near the La Salle Causeway with no occurrence data north of Belle Island. This occurrence is expected to be as a result of the database grid system overlapping Lake Ontario with no known occurrences within the Cataraqui River, Study Area or Project Location. Lake Sturgeon generally inhabit areas 5-10 m deep, as such, any use of the Study Area would likely be isolated to the navigation channel that is being maintained by the 220 m wide causeway opening, as such effects to their habitat would be minimal and effects to any individuals equally low. Furthermore, mitigation measures implemented for the general fish community would also be expected to reduce any potential effects to Lake Sturgeon, should they be within the Project Location unexpectedly.

3.1.6.2 SAR Mammals

The east approach of the Project Location is an extension of Gore Road along the existing road allowance as well as the lands located to the north associated with the Pittsburgh Public Library lands at 80 Gore Rd. During Ecological Land Classification (ELC) surveys the of the woodland was described as a Dry – Fresh Sugar Maple – White Ash Deciduous Forest (FOD5-8) with an approximate area of 6.5 ha. The woodland is considered a significant woodland within the City of Kingston – Official Plan. In total the Project is expected to clear up to 1.93 ha of the woodland and impact (clear or fragment) 2.15 ha. Species at Risk bat surveys were conducted in conjunction with the arborist survey to inventory trees in the relevant portion of the Study Area associated with the Project Location. The survey was conducted in accordance with the requirements of the City of Kingston's Tree By-law 2007-170 where necessary the methods to assess bat habitat as per Ministry of Natural Resources and Forestry (MNRF) 2015 protocol were altered to suit the site conditions and reduce duplication within the data collected during the tree inventory. Site access and potentially disturbance area is restricted to the southern end of the woodland. In total the assessment encompassed 4.12 ha of the overall 6.58 ha woodland compartment.

3.1.6.2.1 SAR Bat Habitat Definition

As per MNRF 2015 Guidance Protocol an FOD5-8 woodland community meets the criteria as a woodland with potential Maternal Roost Habitat. i.e. a deciduous woodland, furthermore any shoreline or riparian habitat with a slight change in moisture regime or dominant species would also be considered potential habitat. MNRF describes suitable woodland ecosites as; Deciduous Forests (FOD), Mixedwood Forests (FOM), Coniferous Forests (FOC), Deciduous Swamp (SWD), Mixedwood Swamps (SWM) or Coniferous Swamps (SWC) as potential habitat. It is general accepted that woodlands need to be greater 0.5 ha to be considered habitat.

For the purpose of this DIA the definition of snag habitat as it relates to maternal roost bat habitat within a suitable woodland type is described as: A tree of any live or decay statues with a diameter at breast height (DBH) of ≥25 cm, that exhibits a combination or singular attribute consistent with; cracks, scars, knot holes, woodpecker cavities or loose bark. There is no height requirement for the snag or attribute, nor is there any requirements for proximity to other snags. That said, for the myotis species, generally the largest dimeter snags with habitat attributes higher in the canopy and clusters of snags <10 m from one another provide better habitat more likely to be utilized. Similarly, woodlands possessing ≥10 snags of any type per ha are viewed as higher quality habitat then those possessing <10 snags / ha. This does not mean woodlands that are of less quality do not provide habitat only that there is likely higher quality habitat within the general vicinity or management area. A total of 14 plots were surveyed within the FOD5-8 community to obtain an approximately 13% representation of the woodland as required by the City of Kingston. In total 30 snags were identified within the plots which translates to an estimated 56 snags/ha or 368 snags within the woodland assuming the plots were representative. In addition to the snags recorded within the plots 16 notable >50 cm DBH trees were also identified during the investigations.

In total 1.93 ha of the 6.58 ha will require clearing resulting in an estimated total loss of 108 snags or 29% of the ELC woodland polygon, with 71% or 260 snags retained. From a habitat usage standpoint, it is anticipated 4.43 ha of the woodland or 248 snags will remain functioning bat roosting habitat while 2.15 ha or 120 snags will either be cleared or fragmented to a degree where usage is diminished. As outline in the Recovery Strategy for Little Brown Myotis, Northern Myotis and Tri-colored Bat, roosts are utilized to provide thermal regulation, shelter from weather and predation. Individuals may switch roosts regularly and therefore, may use a network of roosts in a roosting area. The tendency to switch roosts may depend on species, sex, age, reproductive status, and roost type (e.g., natural or anthropogenic). Roost selection is thought to be a function of numerous factors at both the spatial and landscape scales. For example, at the scale of the roosting structure, tree species, diameter, height, stage of decay, availability of roosting medium, sun exposure likely affect roost selection. At the stand scale, roost selection is likely a function of canopy gaps, number of available snags, tree density and proximity to water. At the landscape scale, forest age, composition, and degree of fragmentation may affect roost selection. All three species are known to treed and forested habitat in urban and suburban areas for roosting, in addition to man-made structures found within urban and suburban landscapes (Little Brown Myotis, in particular). Many bat species (including Little Brown Myotis, Northern Myotis, and Tri-colored Bat) preferentially roost in older forest stands, compared to young forests, this is likely because increased snag availability for roosting. The above thoughts from the recovery strategy corelates well with the MNRF 2015 protocol assessment that differentiates high- and low-quality habitat between forested habitats with larger diameter presumably older snags at densities. Utilizing the 2015 protocol the forest in question is considered high quality habitat with >10 snags/ha. In addition to the density of snags, the species, woodland age and larger diameters is expected to provide ideal habitat. It is anticipated bats are utilizing the woodland for roosting purposes in some form of a rotation basis based on the known roosting selection explained above. The project is expected to remove 108 snags from southern third of the woodland while leaving the northern two thirds relatively undisturbed. Although only 1.93 ha is expected to be directly cleared an additional 0.22 ha is expected to be separated from the woodland reducing its potential as habitat due to its relatively small size. This would represent a reduction in habitat/snag quality and affect approximately 12 snags in total assuming the plots are representative. Potential impacts on each species is further explored below.

3.1.6.2.2 Northern and Little Brown Myotis

Northern Myotis and Little Brown Myotis were confirmed within the Study Area via acoustic monitoring (Golder 2018) and would be expected to be utilizing a combination of suitable snag trees and buildings in close proximity of the Study Area. These bats tend to live, forage and roost in large, decaying trees or buildings that provide warmth and have cavities (COSEWIC, 2013). Based on the results of the snag plots and additional notable tree observations, the Study Area provides high quality habitat with abundant snags. Retained snags within northern portion of the woodland would be expected to continue to provide roosting habitat, with the likely preference give to the woodland boarding the Cataraqui River given the proximity to foraging areas and ample sun exposure as result south-west orientation. Given the urban nature of the environment Little Brown Myotis will have a reduced impact given their tendencies to utilize anthropogenic buildings. Northern myotis have also been shown to use buildings and structures however not to the extent, therefore may have increased impacts as a result of the Project.

3.1.6.2.3 Tri-Colored Bat

No Tri-colored bats were recorded during Golder’s acoustic monitoring, however difficulties with equipment recording was encountered. Given Tri-colored bats are known to inhabit the Kingston area and the woodland possess suitable habitat, potential impacts are explored below. The Tri-colored Bat has shown to roost high within the canopy within dead and living leaf litter or small cracks and crevices (Bat Conservation International, 2019). Oak is the preferred roost tree species although maples are also used for roosting less frequently. It is generally accepted that that Tri-colored Bat generally avoids roosting deep within woodlands and preference is given to periphery live oaks with dead leaves, with documentation of roosting in squirrel nests and in tree cavities also occurring. Given the temporary nature of the preferred roosting habitat roost selections likely vary year to year however Tri-colored Bat has a very high site fidelity to particular leaf clusters within a season (MNRF, 2017). Foraging usually occurs along forested riparian corridors, over water (e.g., ponds and rivers) and within gaps in forest canopies. The Tri-colored Bat is less frequently encountered compared to Little Brown Myotis and Northern Myotis and rarely roosts in buildings (MNRF, 2017). The eastern woodland was noted have an abundance Oaks and Sugar Maples with suitable canopy heights, with many possessing squirrel nests that would represent ideal habitat for the Tri-Colored bats. Based on densities within the survey plots it is estimated that there is one larger Oak per 1330 m^2 of woodland area which translates into approximately 49 oaks within the woodland. Assuming equal distribution this would translate into approximately 15 being removed and two (2) being isolated within the southern portion. Conversely 32 would be retained within the northern portion of the woodland.

3.1.6.3 SAR Birds

In total 12 SAR bird are thought to have the moderate to high potential to use the Study Area (Table 2.11) for life cycle needs, it is possibly others migrate through or seasonally use however would not be expected to rely on the Study Area. Similar to previous Sections species with similar habitat requirements have been combined into wildlife groups in order to facilitate the effects analysis. Table 3.8 below depicts the groupings. Similar to noise and light effects on birds described within Section 3.1.3 would be expected to occur on SAR birds as well. As such those effects are not repeated.

Table 3.8: Potential Habitat Usage of the Study Area by Species at Risk Birds

Grouping Name	Species Name	At Risk Status			Potential Habitat Usage of Study Area
		Federal (COSEWIC)	Federal (SARA)	Provincial (SARO List)	
Bald Eagle		-	-	SC	Overwintering, Breeding
Urban	Barn Swallow	THR	THR	THR	Breeding
	Chimney Swift	THR	THR	THR	Breeding
Marsh	Black Tern	-	-	SC	Breeding

Grouping Name	Species Name	At Risk Status			Potential Habit at Usage of Study Area
		Federal (COSEWIC)	Federal (SARA)	Provincial (SARO List)	
	Least Bittern	THR	THR	THR	Breeding
	King Rail		END	END	Breeding
Nightjars	Common nighthawk	SC	THR	SC	Potential Nesting
	Eastern Whip-poor-will	THR	THR	THR	Confirmed Breeding
Eastern Meadowlark		THR	THR	THR	Breeding
Woodlands	Eastern Wood Pee-wee	SC	-	SC	Breeding
	Evening Grosbeak	SC	-	SC	Breeding
	Red Headed Woodpecker	END	-	SC	Breeding
	Wood Thrush	THR	-	SC	Breeding

3.1.6.3.1 Bald Eagle

Bald Eagles have been increasing in numbers throughout Southern Ontario for both breeding and overwintering. The field Naturalist Club of Kingston reported 71 individuals counted in December of 2018 (Ferguson, 2019). Bald Eagles congregate around open water during the winter months. Bald Eagles primarily feed on fish and dead wildlife carcasses such as White-tailed Deer especially during the winter months (Ontario, 2014b). There are no known nests within the Study Area, however old growth trees on Belle Island would appear to be suitable habitat, having large super canopy trees in close proximity to a large waterbody. The Project is not expected to impact any nesting habitat, not is it expected to impact any overwintering foraging habitat as the shallow, low flow wetland normally ices over in mid to late December. Although little usage within the Study Area and lesser so of the Project Location is currently occurring, the new bridge would likely affect summer foraging habitat opportunities over this reach of the Cataraqui River, that would possibly be used in the foreseeable future as the species continues to recover from past threats - most notably the application of DDT that has been widely accepted as the primary reason for the population decline. Since the banning of DDT, as well as other conservation efforts, populations throughout Ontario have been recovering. Based on the above, the Project is not expected to have a measurable effect on the local or regional, permanent or seasonal population.

3.1.6.3.2 Marsh SAR Birds

This group of birds includes the Least Bittern, Black Tern and the Provincially and Federally endangered King Rail. All nest in large, emergent vegetation coastal wetlands similar to the cattail portion of the wetland located at the northern end of the Study Area. However, COSEWIC Assessment states the following regarding King Rail "birds only return in successive years to large marshes that are not overgrown with cattails" this likely limits the suitability of the cattail marsh, nonetheless the Ontario Recovery Strategy indicates Kingston area currently supporting King Rail. Least Bittern and Black Tern are both expected to use the Study Area at various extents. The cattail marsh is known breeding habitat for Least Bittern and could also support Black Tern. Black Tern's are a colonial nesting bird and although not descriptive NHIC indicates a colonial nesting area within the cattail marsh circa 1993, this is expected to be relation to Black Tern. The above historic and more recent observations further demonstrate the importance of the cattail portion of the PSW and coastal wetlands in general. As demonstrated in Section 3.1.13 the hydrology within the northern portion of the Study Area is not expected to be significantly affected, with no changes in water levels as a result of the causeway or final bridge and minimal changes to the velocities. Given the marsh SAR bird habitat is not expected to be impacted by the Project Location or hydrology influences, the potential for effects are expected to be low.

3.1.6.3.3 SAR Nightjars

Eastern Whip-Poor-Will and Common Nighthawk have both been recorded within or close to the Study Area. The single known eastern whip-poor-will occurrence is from the extreme end of the Study Area, adjacent to Highway 401. Given the habitat available surrounding the recorded occurrence the likely location of the calling individual would have been north of the 401. Where habitat would be more consistent. with the likely location of the calling individual north of the 401, rather than within the Study Area. Common habitat choices include rock or sand barrens with scattered trees, savannahs, old burns or other disturbed sites in a state of early to mid-forest succession, or open conifer plantations (COSEWIC, 2009). Furthermore, although there is no data indicating minimum woodland size, small isolated woodlands are avoided, at least in Maryland (Reese, 1996). Accordingly, distance from nearby tracts of woodland may also be important

(Cink, 2002), making it unlikely that Eastern Whip-poor-will are utilizing the woodlands of the Study Area with even lesser potential for use of the woodlands within the Project Location. Conversely Common Nighthawk are commonly found in urban environments and have been known to nest on top of large flat roofed buildings that are gravelled, or any other barren habitat present (COSEWIC, 2007). As noted in the ELC work there is little suitable habitat within the Project Location for common nighthawks, however some previously disturbed areas may exist that could provide suitable habitat, furthermore as construction progresses any disturbed areas that are left unused at the onset of the breeding season may become occupied and therefore mitigation measure and environmental management plans should include measure to protect any potential ground nest discovered.

3.1.6.3.4 Eastern Meadowlark

Records review identified several SAR grassland birds however all, but Eastern Meadowlark were expected to have a low probability to occur within the Study Areas as result of the small, fragmented and urban nature of the none manicured grasslands present. Eastern Meadowlark are known to use smaller grasslands or meadows within urban areas evident by occurrence observation in OBBA and Parks Canada databases. As result of these occurrences and having suitable habitat albeit minimal and questionable suitability, the potential for Eastern Meadowlark within the Study Area was assessed to be moderate within Section 2.2.6. One small meadow is located within and adjacent the Project Location on the east north of the Gore Road extension, is expected to be impacted through construction activities and construction noise. The meadow is relatively small and surrounded by woodlands and is not expected to be overly suitable for Eastern Meadowlark. The perceived lack of suitability was further confirmed, with no Eastern Meadowlark observed during targeted surveys (Golder, 2018) nor any incidental observations by biologist and ecologist onsite during the breeding (Hatch, 2019) and non-breeding periods. Based on the lack of habitat within the Project Location and lack of occurrence data collected the potential for the Project to effect Eastern Meadowlark habitat is expected to be low provided suitable mitigation are followed for any works in or near the meadow.

3.1.6.3.5 Woodland SAR Birds

Similar to the grassland species, several woodland SAR birds were identified during the records review, however after cross referencing their respective habitat needs with the available habitat within the Study Area, many species were removed from having the potential to occur within the Study Area, most of the removed species had a minimal woodland size or interior (i.e. >100 m for edge) habitat preference which are not found within the Study Area. The remaining four species identified with potential to occur within Study Area have equal potential to be within the eastern Woodlands within the Project Location and therefore remain having a moderate potential to be affected as result of the required woodland clearing. Effects left unmitigated could result in the destruction or failure of nesting and young rearing in addition to the general habitat loss. None of four (4) species are SARA listed with all four (4) listed as special concern under SARO meaning none are currently afforded habitat protection under either legislation. However Red Headed Woodpecker and Wood Thrush are currently ranked as endangered and threatened by COSEWIC respectively meaning their habitat are likely to become protected on Federal Lands, however this would not pertain to the woodlands within the Project Location as those are regulated under the Province. As presented to MNRF in relation to the two provincial approvals to clear woodlands under their mandate, the woodland land clearing and fragmentation that would impact the above-mentioned woodland SAR totals approximately 1.93 and 0.22 ha, respectively. This clearing and fragmentation would occur within a single woodland community (FOD5-8) what was assessed to have a total size of 6.58 ha, with FOD5-8 contributing to a larger woodland of approximately 60 ha located entirely within the Study Area. The loss and fragmentation of that specific woodland within the Study Area equates a reduction in the woodland size of 3.6% this is further reduced <3% when accounting for other woodlands within the Study Area, and a fraction of a percent when comparing to the woodland areas within the City of Kingston. Given the relatively small area being impacted and that none of the woodland SAR birds habitat are currently protected under any legislation the Project affect to woodland SAR bird habitat is considered low. However, without proper mitigations, the clearing of those woodlands constitutes a high potential effect to nests, eggs and young.

3.1.6.4 SAR Herpetofauna

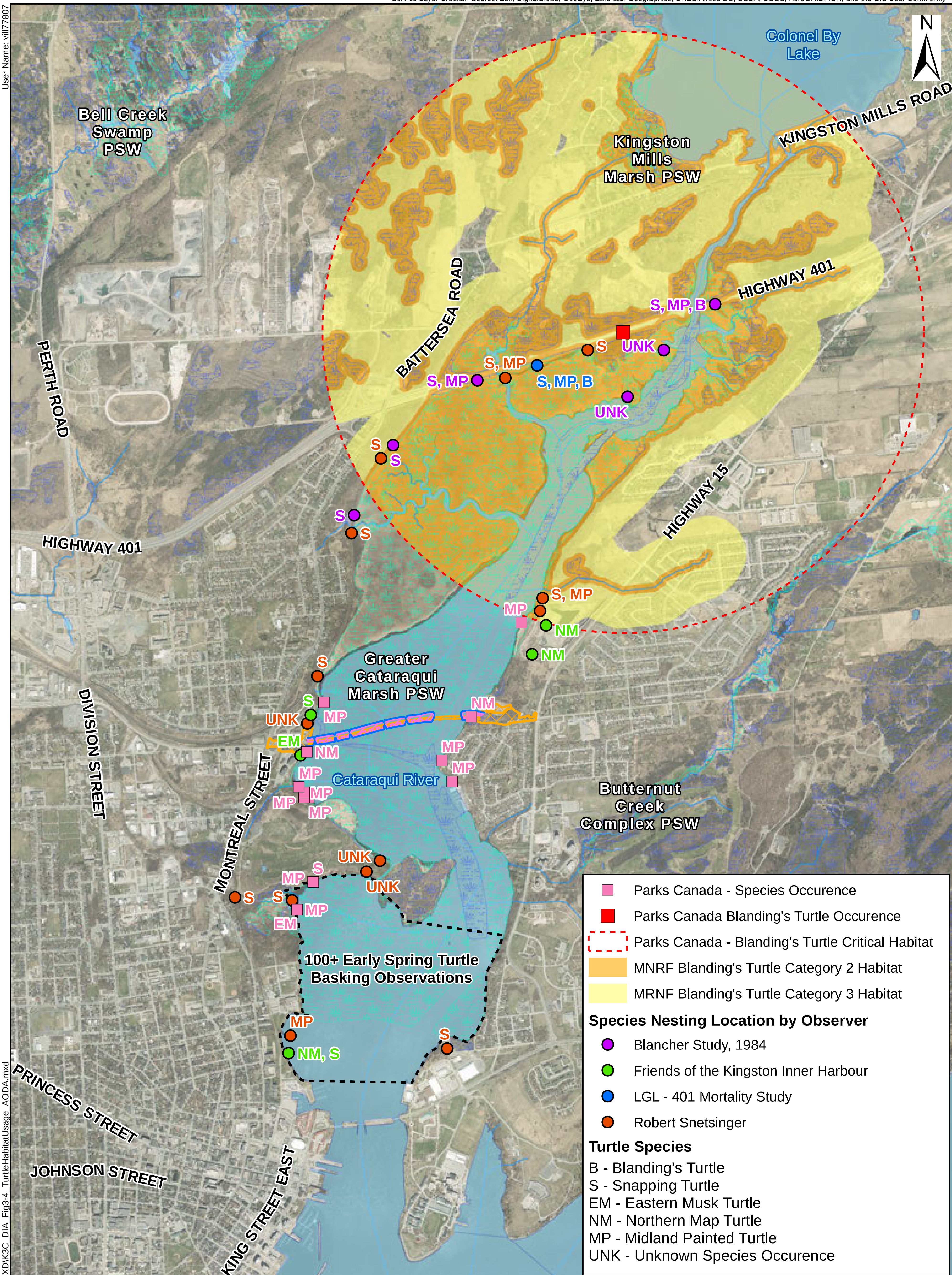
Records review and site investigations combined with the agency and public consultation has resulted in the seven herpetofauna anticipated to have a moderate to high potential to exist within the Study Area. Those include five turtles, one snake and one frog species (see Table 2.11 in Section 2.2.6). All seven species are analyzed within the following sections.

3.1.6.4.1 SAR Turtles

The shores of the Cataraqui River are known to provide turtle nesting habitat, with the open sunny areas and exposed mineral soils supporting turtle nesting habitat. All known occurrence and nest areas from various sources have been compiled and are presented in Figure 3.4. Each point does not represent a single nest, in some cases the point may represent many nesting observations. Areas of known high nesting usage include Doug Fluhrer Park, Belle Island, the quarry near Highway 15 and the areas adjacent Highway 401 (Figure 3.4). These nesting observations further enforces Golder's 2017 evaluation of the Study Area as Significant Wildlife Habitat supported by the known turtle population in the river, and the observed shoreline nesting during site investigations. Based on the provided and antidotal information the Cataraqui River downstream of Kingston Mills, and more so downstream of Highway 401, hosts a large population of Midland Painted, Snapping and Northern Map Turtles that take advantage of any suitable nesting locations that are available. A lesser population of Eastern Musk Turtle is expected to exist throughout the Study Area. North of the Project Location there does appear to be a small but persistent population of the Blanding's Turtles with observations from 1983 and 2007 both of which are from the Highway 401 corridor.

In addition to the nesting areas, Figure 3.4 depicts an assumed overwintering area south of Belle Island is also shown. This area is currently poorly defined and may be refined with further research into the overwintering tendencies for the local species. However, based on information shared by the Friends of the Kingston Inner Harbour research team, abundant Midland Painted, Snapping Turtle and Northern Map Turtles are observed annually during the known spring immergence season for each species (March – May) in the area south of Belle Island. According to the Ministry of Natural Resources and Forestry Significant Wildlife Habitat Criteria Schedules for Ecoregion 6E, for an area is to be considered a 'Turtle Wintering Area' there must be a presence of five over-wintering Midland Painted Turtles and/or one or more Northern Map Turtle or Snapping Turtle overwintering within a wetland (MNRF, 2015). Therefore, due to the presence of greater than five Midland Painted Turtles and the presence of at least one Snapping Turtle and Northern Map the area is should be considered a significant overwintering area. Given the preference difference in over wintering habitat of each species further described below the entire area has been assumed overwintering. The habitat use characteristics of each species are further discussed below.

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



User Name: vill77807

Document Path: T:\Maps\GIS_Data\CityOfKingston\MXD\K3C_DIA_Fig3-4_TurtleHabitatUsage_AODA.mxd

Legend

Project Location

- Aquatic Exclusionary Turbidity Curtain (AETC)
- Temporary Construction Components
- Permanent Components
- Unevaluated Wetland
- Provincially Significant Wetland (PSW)
- Waterbody
- Watercourse

DATA SOURCES:

1. Spatial References: NAD 1983 UTM Zone 18N
2. Sources: Waterbodies, Wetland Roads - Land Information Ontario
3. Parks Canada Turtle Information Provided by Parks Canada,2019

0 250 500 1,000 Meters

1:24,000

Project:	**City of Kingston - Third Crossing**
Figure Title:	**Combined Known Turtle Habitat Usage of the Lower Cataraqui River**
Prepared By:	HATCH, SYSTRA, Kiewit, Kingston
Date:	**November 18, 2019**
Figure: 3-4	**Page:** 1 of 1

Blanding's Turtle: Based on species occurrence records and data received in 2019, the only Blanding's Turtle observations are from the north end of the Cataraqui Marsh near Highway 401 (Blancher, 1984; LGL, 2007). This confirmed Blanding's Turtle habitat area is north of the Project Location. This coincides with habitat work of Hartwig and Kiviat (2007), Wieten et al. (2011) and Whitney et al. (2014), who found a strong Blanding's Turtle association, including overwintering habitat with emergent vegetation, such as cattails (Snider and Linck, 2011; Newton and Herman, 2009). Rowe and Moll (1991) found them to overwinter near their main activity areas. Accordingly, habitat surrounding Highway 401 is considered critical habitat for Blanding's Turtle under the Species at Risk Act. This is in part due to confirmed nesting habitat along the 401, combined with the cattail marsh that may provide overwintering for Blanding's Turtles, both of which are considered residences under SARA. Similarly using MNRF's General Habitat Description for Blanding's Turtle, Figure 3.4 illustrates Category 2 or 3 habitat within 2 km of the known occurrences. Category 1 habitat is associated with known nesting or overwintering sites that are currently unknown therefore have been omitted but would be expected to occur within the Category 2 or 3 habitat area. To date there is no known observations downstream of the Project Location within the Cataraqui River, however occurrence data does exist on Wolfe Island approximately 8 km downstream.

Eastern Musk Turtle: known concentration locations of Musk Turtles are in the inner harbor near Douglas Fluhrer Park, immediately north of Belle Island Park, and in the narrow northern reaches of the river near Highway 401. Friends of the Kingston Inner Harbor research team also documented an Eastern Musk attempting to nest on the north shore of the Belle Island, although the final active nest was not determined, but would be expected to be in close proximity to the observed nest attempt. All of these sites share similar habitat features of shallow water with extensive growths of lily pads. Research has shown a preference for such areas due to their thermal qualities, and protection from predators (Rowe et al. 2009, and Picard et al. 2011), and this was also the observation of Blancher (1984) in his work between Highway 401 and the Lasalle Causeway. This also matches with the Third Crossing field work, where Musk Turtles were only encountered in lily pad rich areas within the Study Area south of the proposed route. No lily pad rich areas were noted within the construction footprints, however following the critical habitat mapping for Eastern Musk prior to their SARA status change from Threatened to Special Concern the entire Cataraqui

River discussed above is considered habitat, specifically the Project Location would be considered habitat due to its proximity (<1.5 km) of known observation locations (Environment Canada, 2016b).

Musk Turtles are primarily a southern species that is known to be anoxia intolerant. This poses special challenges in the winter, because they cannot survive long periods buried in the mud in winter due to their sensitivity to anoxia (Ultsch and Cochran, 1994; Ultsch, 2006). Consequently, they are more likely to be found near areas that possess higher oxygen levels throughout the winter such as ice-free areas, or areas with a current. Musk Turtles are likely to overwinter south of Belle Island within the significant overwinter area, with potential around Belle Island likely closer to navigation channel. This assumption is based on the presumed anoxic or near anoxic environment that would be expected to occur within the ice covered, shallow areas of the PSW, where large amounts of vegetation decay during winter months likely consumes most of the available oxygen. The likely exception is the areas near the navigation channel. Hydrotechnical modelling has shown flows to be concentrated within this area meaning it is likely oxygenated waters from Kingston Mills are being conveyed through PSW supporting the various lifeforms. This however has not been confirmed through any water quality evaluations.

Midland Painted Turtle: Midland Painted Turtle is a small to medium-sized turtle that occupies slow moving, relatively shallow and well-vegetated wetlands. As noted in COSEWIC 2018, these turtles inhabit submergent aquatic plants, which are used for cover and feeding, and are semi-tolerant of human-altered landscapes. Suitable nesting habitat includes open, often south-facing, and sloped areas with sandy-loamy and/or gravel substrate usually within 1200 m of aquatic active season habitats with overwintering occurring in shallow water with deep organic sediments. Where adults may spend half the year submerged in wetlands with very low dissolved oxygen while inactive during hibernation.

Rollison et al. (2008) note that Midland Painted Turtles did not bury themselves in the mud in their study, while Taylor and Noll (1989) did find Painted Turtles to bury in mud in the winter, but not until late December, and movement continued up until that date. Midland Painted Turtles regularly moving long distances. MacCulloch and Secoy (1983) have observed the length of river used by individuals averaged about 6 km in adult males (max. length 26 km), 3 km in adult females (max. length 8 km), and about 0.5 km in juveniles (max. length

1.5 km). As noted above the Friends of the Kingston Inner Harbor have documented a high abundance of Painted Turtles downstream of Belle Island during early spring emergence basking surveys indicating this area provides over wintering habitat for the local turtle population. Given this documented areas is well within the travel range of river inhabiting Midland Painted Turtles and is known to host a high abundance of early spring turtles it is likely the turtles inhabiting the Study Area overwinter down river, however the majority of the open water portion of the PSW should be considered potential overwintering habitat, as a result of water depths, sediment depths and the Midland Painted's ability to withstand anoxic environments.

Northern Map Turtle: Of the five turtle species found within the river, Map Turtles are the most likely to exhibit long range water movements (e.g., see Pluto and Bellis (1988), Carriere et al. (2009) and Picard et al. (2011)). The reasons for movements are varied, but can be related to thermoregulation, overwintering, feeding, and nesting. Map Turtles are expected to congregate and move within proximity to shoreline areas for feeding purposes, especially for zebra mussels (Bulté and Blouin-Demers, 2008). Carriere and Blouin-Demers (2010) also found a preference for near shore areas, and especially those with lily pads.

Freedberg et al. (2005) noted the homing ability of map turtles, including those purposefully displaced over long distances, indicating an ability to overcome obstacles in order to return to natal sites. Northern Map Turtle nesting is occurring on adjacent uplands of the Cataraqui PSW.

As noted by Environment Canada (Environment Canada, 2016b) overwintering sites for the Northern Map Turtle are typically deep, oxygen-rich lake or river bottoms that are sheltered from ice, with sand or gravel substrate and varied bottom features, such as exposed ledges, boulders, and tree trunks (Flaherty 1982; Bonin 1998; Graham et al. 2000; Ultsch 2006; Carrière 2007). Northern Map Turtles have been recorded hibernating at depths between 0.3 and 11.3 m (Bernier and Rouleau 2010; Harrison 2011; Rouleau and Bernier 2011). This species requires an oxygen-rich environment for over-wintering as they are relatively intolerant of anoxic environments (Ultsch 2006).

All of the above appears to be occurring within the lower reaches of Cataraqui River. Friends of the Kingston Inner Harbour research team have documented high usage of the lower areas south of Belle Island during early spring emergence basking surveys indicating this area being sought out for overwintering potential. Furthermore, preliminary results of tagging and tracking efforts on map turtles has documented at least one female map turtle tagged downstream Belle Island travelling upstream to the quarry north of the study area for nesting. This would indicate a seasonal movement of Map Turtles using the upper reaches while overwintering south of Belle Island. Additionally, Parks Canada has provided occurrence data that shows observations of Northern Map turtles at the east and west abutment locations, at this time it is unknown if those observations were of basking or nesting turtles, but nonetheless confirms usage throughout the area.

Snapping Turtle: Whitney et al. (2014) found Snapping Turtles to be quite cosmopolitan in their choice of habitat, such that any part of the Cataraqui River or PSW could be used. Whitney et al. (2014) did find a preference for deeper water areas with less dense vegetation. Consequently, it is expected that Snapping Turtles will preferentially congregate in proximity to the boating channel for feeding purposes, with movements inland to lay eggs. Snapping Turtle nests have been observed throughout many shoreline areas of the river, although Blancher (1984) notes concentration areas in association with Highway 401 and the railway embankments west of the river.

Environment and Climate Change Canada (2016b) provides a good review of Snapping Turtle overwintering characteristics, and includes research conducted in Ontario. From this, Snapping Turtles prefer near shore areas and will either bury in the mud or take advantage of structures such as logs, overhanding banks, and muskrat burrows. They also show site fidelity and will hibernate in groups. Similar to some of the other species found in the Cataraqui River, Snapping Turtles will start to settle into overwinter sites in late October, and once the water temperature reaches around 5ºC they tend to stay in that general area (Obbard and Brooks, 1980; Ultsch and Lee, 1983). Similar to the other species a congregation of Snapping Turtles appears to occur south of Belle Island, which coincides with the deeper less vegetated description noted above. Further to those, observations of Snapping Turtles using the western embankment for basking and western inland areas for nesting have been recorded by Friend of the Kingston Inner Harbor, all of which corresponds will with Parks Canada observation data of Snapping Turtles immediately north and south of Belle Island along the western shores, as well Golder’s observation of a predated Snapping Turtle nest along the west shore.

As outlined in Table 3.8 the wetland on both sides of the proposed causeway provides various habitat requirements for the known species within the Cataraqui River. The entire Study Area is either known, assumed or potential turtle habitat with various potential impacts related to nesting, movement, and overwintering in addition to the general habitat disruption during construction.

General habitat disruption is applicable to all SAR turtles, and will remain unavoidable despite mitigation measures, however the overall potential effect is considered relatively minor with the total construction footprint representing <0.7% of the total turtle habitat available within the PSW estimated at 504 ha. This does not include the navigation channel or potential overwintering habitat south of the PSW.

All other potential effects to turtles are presented as a continuation of Table 3.8, in Table 3.9, Table 3.9 also places a likelihood rating for each potential effect (ranging from very low to very high).

Table 3.9: Turtle Impact Assessment

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
Blanding's turtle (Great Lakes/St. Lawrence population)	S. 32 Individuals	Harm by Construction	Vehicle Strike	None	Low	Yes
			Entrapment within Construction Area	None	Low	Yes
			Nest excavation during construction and causeway removal	Reduce Suitability of Causeway Material	Low	Yes
	N/A	Connectivity	Reduced Movements as a result of Increased velocities or reduced connectivity	Causeway Opening Sized to equal downstream Belle Island, three causeway openings with natural; light, substrate and	Low	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
				vegetation maintained		
Eastern musk turtle (Stinkpot)	S. 32 Individuals	Harm by Construction	Vehicle Strike	None	Moderate	Yes
			Entrapment within Construction Area	None	Moderate	Yes
			Nest excavation during construction and causeway removal	Reduce Suitability of Causeway Material	Moderate	Yes
			Crushing During Hibernation	No end dumping or casting of material.	Moderate	Yes
	Section 33 – Residences	Nesting	Potential Reduction in Available Nesting Habitat	None	Very Low	N/A
	N/A	Connectivity	Reduced Movements as a	Causeway Opening Sized to	Low	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
			result of Increased velocities or reduced connectivity	equal downstream Belle Island, five causeway openings with natural; light, substrate and vegetation maintained.		
	Section 33 – Residences	Overwintering	Potential loss in Overwintering Habitat	No	Low	Yes
Midland painted turtle	N/A	Harm by Construction	Vehicle Strike	None	High	Yes
			Entrapment within Construction Area	None	High	Yes
			Nest excavation during construction and causeway removal	Reduce Suitability of Causeway Material	Moderate	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
			Crushing During Hibernation	No end dumping or casting of material.	High	Yes
		Nesting	Reduction in Available Nesting Habitat	None	Moderate	N/A
		Connectivity	Reduced Movements as a result of Increased velocities or reduced connectivity	Causeway Opening Sized to equal downstream Belle Island, 5 causeway openings with natural; light, substrate and vegetation maintained.	Low	Yes
		Overwintering	Potential loss in Overwintering Habitat	None	Moderate	Yes
	S. 32 Individuals		Vehicle Strike	None	Moderate	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
Northern Map Turtle		Harm by Construction	Entrapment within Construction Area	None	Moderate	Yes
			Nest excavation during construction and causeway removal	Reduce Suitability of Causeway Material	Moderate	Yes
			Crushing During Hibernation	Exclusionary curtain. No end dumping or casting of material.	Moderate	Yes
	Section 33 – Residences	Nesting	Reduction in Available Nesting Habitat	None	Moderate	N/A
	N/A	Connectivity	Reduced Movements as a result of Increased velocities or	Causeway Opening Sized to equal downstream Belle Island, five causeway	Moderate	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
			reduced connectivity	openings with natural; light, substrate and vegetation maintained.		
	Section 33 – Residences	Overwintering	Potential loss in Overwintering Habitat	None	Low	Yes
Snapping Turtle	S. 32 Individuals	Harm by Construction	Vehicle Strike	None	High	Yes
			Entrapment within Construction Area	None	High	Yes
			Nest excavation during construction and causeway removal	Reduce Suitability of Causeway Material	High	Yes
			Crushing During Hibernation	No end dumping or casting of material.	Moderate	Yes

Common Name	Potential SARA Contravention	Cause of Potential Adverse Effect	Effect Description	Design Avoidance Measures	Likelihood Prior to Mitigation	Mitigation Proposed?
	Section 33 – Residences	Nesting	Reduction in Available Nesting Habitat	None	Low	N/A
	N/A	Connectivity	Reduced Movements as a result of Increased velocities or reduced connectivity	Causeway Opening Sized to equal downstream Belle Island, five causeway openings with natural; light, substrate and vegetation maintained.	Moderate	Yes
	Section 33 – Residences	Overwintering	Potential loss in Overwintering Habitat	None	Moderate	Yes

As identified within Table 3.9 above, there are a number of mitigation measure to be implemented in reducing the potential for adverse effects to SAR Turtles within the Study Area. These are presented in Section 4.

3.1.6.4.2 Eastern Milksnake

Milksnake are habitat generalist occurring in a wide variety of the habitats throughout Southern Ontario and are expected to occur within the Study Area with a moderate to high probability of inhabiting or moving through the Project Location. No potential hibernacula's have been noted within the any of the baseline investigations nor have any occurrences been recorded indicating a relative low use of the Project Location. Reptile exclusionary mitigations are currently required for other reptile species and these combined with the environmental management plans should negate most potential Project effects. However, at 37 m from the proposed pile driving, sound levels of 105 dB are predicted to exceed the 104.5 dB temporary threshold-shift for snakes (Appendix I, Table 4), which means that within that distance from the pile, snakes could temporarily lose their hearing sensitivity. A temporary threshold-shift risk to milk snakes thus exists for pile driving close to shore. Alternative construction methods have been selected in the Project development process to lessen noise emissions. This alternative includes vibrating pile driving for the majority of the pile to bedrock with traditional pile driving used to ensure contact with bedrock was achieved (driving for approximately one to 14 minutes per pier in total).

3.1.6.4.3 Western Chorus Frog

As stated within the (COSEWIC, 2008) assessment report, Western Chorus Frogs usually breed in small or shallow aquatic habitats, mostly temporary ponds and wetlands that become dry in the summer. Western Chorus Frogs are very rarely found in permanent ponds. Breeding habitats include ditches, marshes, flooded fields and pastures, temporary ponds and pools, and swamps. These noted habitat are expected to occur within the Study Area, however are not associated with the Cataraqui River. The northern or inland portions of the PSW are likely to possess suitable habitat, however are well outside the Project Location and therefore would not be expected to be impacted by the Project. Mitigations to be implemented to exclude turtles from the Construction areas would also be expected to exclude any Western Chorus frogs.

3.1.6.4.4 Monarch Butterfly

Monarch, like all butterflies, have a life cycle composed of four stages: egg, larvae (or caterpillar), pupa (or chrysalis), and adult. To successfully complete these four stages the Monarch has four habitat types: breeding, nectaring, staging and overwintering (ECCC, 2016a). Three of these four (excluding overwintering) occur within the Province of Ontario at varying abundance. The Project is expected to affect two of the four habitat types (breeding and necturing) however, not to a measurable degree. Milkweed species are known to occur within the Project Location and would be considered a loss of breeding habitat whereas, any removal of natural flowers vegetation also would constitute a potential impact to nectaring habitat. Given the majority of vegetated habitat to be impacted is woodland, both breeding and nectaring habitat effects are minimal. Mitigation and environmental management plans will include the preservation of Milkweed where possible, as further described in Section 4. A full description of the habitat can be found below.

3.1.6.4.4.1 Breeding

Breeding occurs exclusively on one of Canada's 14 milkweed species with a preference towards Common Milkweed, Swamp Milkweed, Butterfly Milkweed and Showy Milkweed (ECCC, 2016a). Adults lay eggs on Milkweed species after which the larvae hatch, feeds, pupates and emerges an adult, the entire process ranges from 20 to 45 days. (COSEWIC, 2010). Given the species is directly tied to the success and abundance of milkweed, all milkweed found within Southern Ontario are potential habitat for Monarch. Milkweed would be expected to grow, have been observed within the Study Area and are noted in ECCC 2016a to prefer open and periodically disturbed habitats such as roadsides, fields, wetlands, prairies, and open forests.

3.1.6.4.4.2 Nectaring

Adult Monarch feed on the nectar of native and ornamental flowers throughout its range. Sources of nectar are of particular importance to build fat reserves for their southern migration to Mexico. For the Ontario population, these fat reserves are vital for the trip across the Great Lakes were there are no resting or feeding opportunities.

3.1.6.4.4.3 Staging

Staging areas on the north shore of Lake Ontario and Lake Erie are important management areas for Monarch's (ECCC, 2016a). This is not a huge concern for the Kingston Region given the presence of Wolfe and Amherst Islands provide easy passage. The closest known Monarch staging area is located at the southern edge of Prince Edward County, located approximately 60 km to the southeast of the Study Area.

3.1.7 Cultural Landscape

Effects on the cultural landscape from construction and operation are discussed below.

Site preparation and construction works and activities such as clearing of lands for installation of construction site access, staging and laydown areas; installation of temporary electrical and communications services (potentially on utility poles) for site trailers, and construction site traffic controls; installation of temporary stormwater management works; and topsoil stripping have the potential to affect the cultural landscape.

PCA's CRM Policy provides requirements for managing the wide range of cultural resources administered by PCA, the objective of which is to "ensure that cultural resources administered by Parks Canada are conserved and their heritage value is shared for the understanding, appreciation and enjoyment of present and future generations." Accordingly, the Project has been developed in accordance with PCA's CRM principles and policies.

For effects to cultural resources (including buildings, engineering works, landscapes and landscape features or historical and archaeological objects), a Cultural Resource Impact Analysis (CRIA) has been performed by PCA's CRM advisors in consultation with CRM functional specialists (e.g. archaeologists). The Statement of Cultural Resource Impact Analysis is provided in Appendix L.

Throughout the development of the Project, multiple cultural assessments have been conducted by PCA functional experts which have ensured that design choices have been taken with a full awareness of the needs to integrate with and enhance the historic landscape character to the extent possible. Accordingly, no additional mitigation measures are required to address potential effects to the surrounding cultural landscape.

3.1.8 Archaeological and Cultural Heritage Resources

Effects on archaeological and cultural resources from construction and operation are discussed below.

3.1.8.1 80 Gore Road Property

The widening of Gore Road will require the removal of the formal gardens that extend along the southern portion of the Gore Road Library property as well as the relocation of a 14 m portion of the dry-stone wall that extends perpendicular from the library into the Gore Road right-of-way on the upper plateau. These features are significant attributes of the Gore Road Library property that contribute to its heritage value and landmark status along Highway 15 and will be altered as a result of the construction and operation of the Project. As identified in Appendix E, potentially adverse effects of Project construction include:

- Use of the library and library property as a library, community centre and event facility which may be constrained or disturbed by noise and construction activity and from subsequent bridge traffic.
- A risk that vibrations from construction activity could damage Hawthorn Cottage and the Dry-Stone wall on the property.

3.1.8.2 Archaeological Site BbGc-127

Archaeological Site BbGc-127 is located within the proposed Project Location on the east shore of the Cataraqui River and on the property at 80 Gore Road. This site may be adversely affected by site preparation or construction activities. A barrier will be installed around the site to mitigate potentially adverse effects of construction on the site. Further mitigation strategies are described in Section 4.2.7.2.

Archaeological testing on the west side of the river was determined to be unnecessary due to the extent of existing disturbance to all land within the existing road right-of-way. This is further discussed in Section 2.2.8 and in Appendix D.

3.1.8.3 Survey Marker

The survey marker on the southern boundary of 80 Gore Road (Part of Lot 10 EGCR) may be adversely affected by staging or construction activities in that it may be shifted from its true position. As described in Appendix E, Sections 442 and 443 of the Criminal Code of Canada address boundary lines and markers. The Criminal Code makes it illegal to willfully pull down, deface, alter or remove anything set up as a boundary line or part of a boundary line or any boundary mark that delineates any international, provincial, county or municipal boundary including a marker placed by a land surveyor to mark the limit, boundary or angle of a concession, range, lot or parcel of land (Criminal Code, 1985).

Any adverse effect to the survey marker may be mitigated by preserving the marker in-situ, or temporarily relocating it with the assistance of a professional surveyor, allowable according to Section 443 (2) of the Criminal Code. A surveyor must be engaged prior to construction in order to document the location of the survey marker and remove it, and to prepare to replace the survey marker following completion of construction activities. More information on this process can be found in Appendix D.

3.1.8.4 Submerged Cultural Resources

As discussed in Section 2.2.8, a sonar survey of the riverbed within the Project Location was conducted to both locate buried objects and prepare a riverbed profile. Vibrocoring through the riverbed sediment at 10 locations was also undertaken to determine the potential for aquatic archaeological resources. The results of this fieldwork have concluded that:

- the riverbed is relatively featureless aside from the scour lines caused by boat traffic, which are present near the west shore and at the center of the river (mounds identified near the navigable channel were verified as spoil from previous dredging activities of the channel); and
- the paleo-environment suggests a marsh environment, similar to the existing marsh to the north, wherein small, isolated areas of raised elevations are evident as opposed to a discrete, submerged paleo-shoreline.

Accordingly, there is neither evidence of, nor potential for submerged cultural resources within the Project Location, and no mitigative measures are required.

3.1.9 Rideau Canal's Commemorative Integrity (NHSC) and Outstanding Universal Value (UNESCO World Heritage Site)

Effects on the Rideau Canal from construction and operation are discussed below.

Over the intervening years since the construction of the Rideau Canal, the Greater Cataraqui Marsh to the north of the Project Location river valley's sloped physiography and forested landscapes adjacent to the navigable channel have remained largely intact. This natural setting has contributed to the unique historical, ecological and visual environment of this section of the waterway and Rideau Canal system.

Pre-and-post bridge construction activities have been proposed to minimize the potentially adverse effects that the heritage values within and adjacent to the Rideau Canal context would be subject to as a result of the removal of the hardwood forest along the shoreline; the potential for wildlife loss and disturbance as well as habitat loss and fragmentation as on-land, in-water and above-water works advance; in addition to the related changes to the viewscape as they relate to the cultural landscape up-and-downriver. By extension of these potential effects, public use and enjoyment of this section of the Rideau Canal may also be affected.

The Cultural Resource Management Policy (in supporting the Rideau Canal's NHSC designation) and the Statement of Outstanding Universal Value (in support of the Rideau Canal's inscription on the UNESCO World Heritage List), pre-and-post bridge construction works would potentially impair the management of the historic, natural and cultural elements of this section of the Rideau Canal, in that their value is derived from the interaction of:

- Protecting its ecological and commemorative integrity (its wholeness, intactness and authenticity through use, function, location and setting).
- Enhancing public education and visitor experience of the Rideau Canal by:
  - promoting compatibility with the natural and cultural heritage character of the corridor shore lands and the surrounding built environment
  - protecting key viewscapes
  - responding to the Rideau Canal's history of engineering innovation.

As stated in Section 3.1.7 above, the Project has been developed in accordance with PCA's CRM principles and policies and a CRIA has been performed in consideration of the Rideau Canal NHSC and World Heritage Site designations, the specific values ascribed to them that are reflected in this sector of the canal and PCA's responsibilities as described in various PCA policy documents, including the CRM Policy and Rideau Canal management plans. The Statement of Cultural Resource Impact Analysis is provided in Appendix K.

As stated above, multiple cultural assessments have been conducted by PCA functional experts throughout the development of the Project, which have ensured that design choices have been taken with a full awareness of the needs to integrate with and enhance the historic landscape character to the extent possible. Accordingly, no additional mitigation measures are proposed.

3.1.10 Visitor Experience and Recreational Opportunities

Effects on visitor experience and recreational opportunities from construction and operation are discussed below.

As described in Section 2, visitor experience includes consideration of how the Project is anticipated to affect activities of visitors' enjoyment and connection to place in relation to defined objectives for the protected heritage place.

Accordingly, this impact analysis must consider the following in determining the potential for adverse effects:

- The public, including established recreational users (paddlers, anglers, boaters, photographers, etc.) may be affected by noise and particulate emissions (hearing impairment, asthma and other physical exacerbations).
- restricted area access and aesthetics may deter visitation from prospective or established visitors; and ecological and cultural landscape impacts.
- Reduced visitor safety.
- A reduction in use and/or enjoyment of the area due to the above noted effects.

Effects of the Project on the immediate acoustic environment have been assessed through completion of noise impact assessments prepared in support of this Report (See Appendices G and H). Potential effects are described in the following Section.

Potentially adverse effects as a result of particulate emissions (air quality) are addressed in Section 3.2.5, below.

Safety and operational mitigation measures, proposed in consultation PCA, DFO, TC and the Kingston Rowing Club, have been developed to protect the public in support of any bridge construction activities, including those that will be occurring over the navigable channel and adjacent rowing lanes during the navigation season. As stated in Section 1.5.6.4, across the navigation channel will be serviced with a trestle lift span; a barge may be used to ferry material or equipment across the navigation channel but will be stationed for any significant duration. Additionally, construction of the trestle lift span is scheduled during the navigational closure calendar to avoid interference. Accordingly, visitor safety has been considered throughout the development of the Bridge Design and Construction Methodology (Appendix B).

3.1.10.1 Potentially Adverse Effects as a Result of Noise Emissions During Construction

Effects on visitor experience and recreational opportunities from noise during construction are discussed below.

Anticipated noise levels would vary temporally, and spatially as different construction activities take place and change location. As discussed in the

Environmental Noise Impact Assessment in Appendix K, elevated noise levels could be annoying to the public and could cause adverse effects to public health, Health Canada recommends implementing noise controls where noise increase exceeds one year in duration and the percentage of persons Highly Annoyed by noise increases exceeds 6.5%. In light of this potential annoyance to the public, the City Noise By-Law (No. 2004-52) prohibits the following:

- The operation of any item of construction equipment without an effective exhaust muffling device that is in good working order and in constant operation.
- The operation of construction equipment or performing any action relating to construction between 1900 hours (7:00 PM) of one day to 0700 hours (7:00 AM) of the next day, with no construction on Sundays and statutory holidays.

Adherence to these hours of construction does not fully eliminate the potential for public annoyance. Construction noise could still impact the visitor experience nearby the Project Location during the allowed construction hours. In these cases, the effective muffling devices required per the by-law will mitigate the adverse effects by reducing the severity of the noise elevation. It is also important to note that the operation of municipal and utility service vehicles and related equipment is exempt, which could apply to pre-and-post bridge construction activities. It is also important to note that the operation of municipal and utility service vehicles and related equipment is exempt, which could apply to pre-and-post bridge construction activities.

In addition, as shown in Table 3.10, the MOECC Publication NPC-115 stipulates the following sound emissions limits from individual items of construction equipment.

Table 3.10: Construction Equipment Sound Emission Levels

Type of Unit	Maximum Sound Level (dBA)	Distance From NSA (m)	Power Rating [kilowatt (kW)]
Excavation Equipment	83	15	less than 75 kW
	85	15	more than 75 kW
Pneumatic Equipment	85	7	not applicable
Portable Compressors	76	7	not applicable

Furthermore, as shown in Table 3.11, the MOECC Publication NPC 119 sets the following blast vibration limits.

Table 3.11: Maximum Blast Vibration Levels

Vibration Source	Cautionary (Unmonitored Blasts)	Peak (Monitored Blasts)
Concussion (air overpressure)	120 dB	128 dB
Ground-borne Vibration	1 centimetre/second (cm/s)	1.25 cm/s

During site preparation and construction of the Project, the safety of visitors could be adversely affected. Specifically, those travelling by water (e.g. boat, rowboat, canoe, kayak) traveling near the in-water construction limits where equipment is active.

3.1.10.2 Potentially Adverse Effects as a Result of Noise Emissions During Operation

Effects on visitor experience and recreational opportunities from noise during operation are discussed below.

The MTO Noise Guide outlines requirements for noise assessments and mitigation resulting from new or expanded Provincial highways. The MTO guideline is often referenced for new and expansion municipal roadway projects. In addition, the Ministry of the Environment, Conservation and Parks (MECP)Noise Publication NPC-300 also outlines requirements for noise assessments and mitigation resulting from road traffic. MECP guidelines apply to lower volume municipal roadways. However, the MECP guideline are more commonly applied to new residential developments, where additional noise controls such as warnings, upgraded wall and window construction or provisions for air-conditioning are available on top of conventional noise barriers and berms.

For MTO guidelines, mitigation is warranted when increases in sound levels over the future ‘no-build’ ambient sound levels are either 5 decibels (dBA) or greater; or greater than 65 dBA at the Outdoor Living Areas (OLA) of Noise Sensitive Areas (NSA). Mitigation measures should achieve at least 5 dBA of attenuation, averaged over the first row of noise-sensitive receivers. For MECP guidelines, the equivalent OLA daytime limit is 55 dBA. If levels are found to be above 60 dBA, noise control measures should be implemented to reduce levels to 55 dBA unless the measures are not feasible for technical, economic or administrative reason.

For the purposes of the noise impact study, the MECP guidelines for noise limits at the OLA are followed due to the low-density municipal roadways that currently surround the study area. However, MTO guidelines for the mitigation performance are applied to dictate the technical and economic feasibility of proposed noise controls. As shown in Figure 3.5, 22 noise receptors represent the NSA within the Project Location, which is consistent with those the NSA defined during the Municipal Class EA. There are approximately 324 OLA in the following general areas:

- Six residential areas.
- A day care on the south side of John Counter Boulevard (west of Montreal Street).
- A vacant privately-owned lot adjacent to the Gore Road Library property to the north that could potentially accommodate residential development.
- The Gore Road Library. Even though a library is not defined as an NSA in the MTO Noise Guide, the MECP indoor levels would apply. To establish an indoor level, the library is marked as an NSA.

The future 'build' ambient sound levels (i.e. projected traffic volumes for the 2034 horizon year with the 2-lane bridge in place) were compared to the future 'no-build' ambient sound levels. Inputs used in this analysis were as follows:

- The OLA were evaluated as per the MTO Noise Guide but assessed at a more conservative height of 1.5 m (not 1.2 m), as per the MECP Environmental Noise Publication NPC-300.
- The expected percentage of heavy vehicles was assumed to be split evenly between 'heavy trucks'[1] and 'medium trucks'[2].

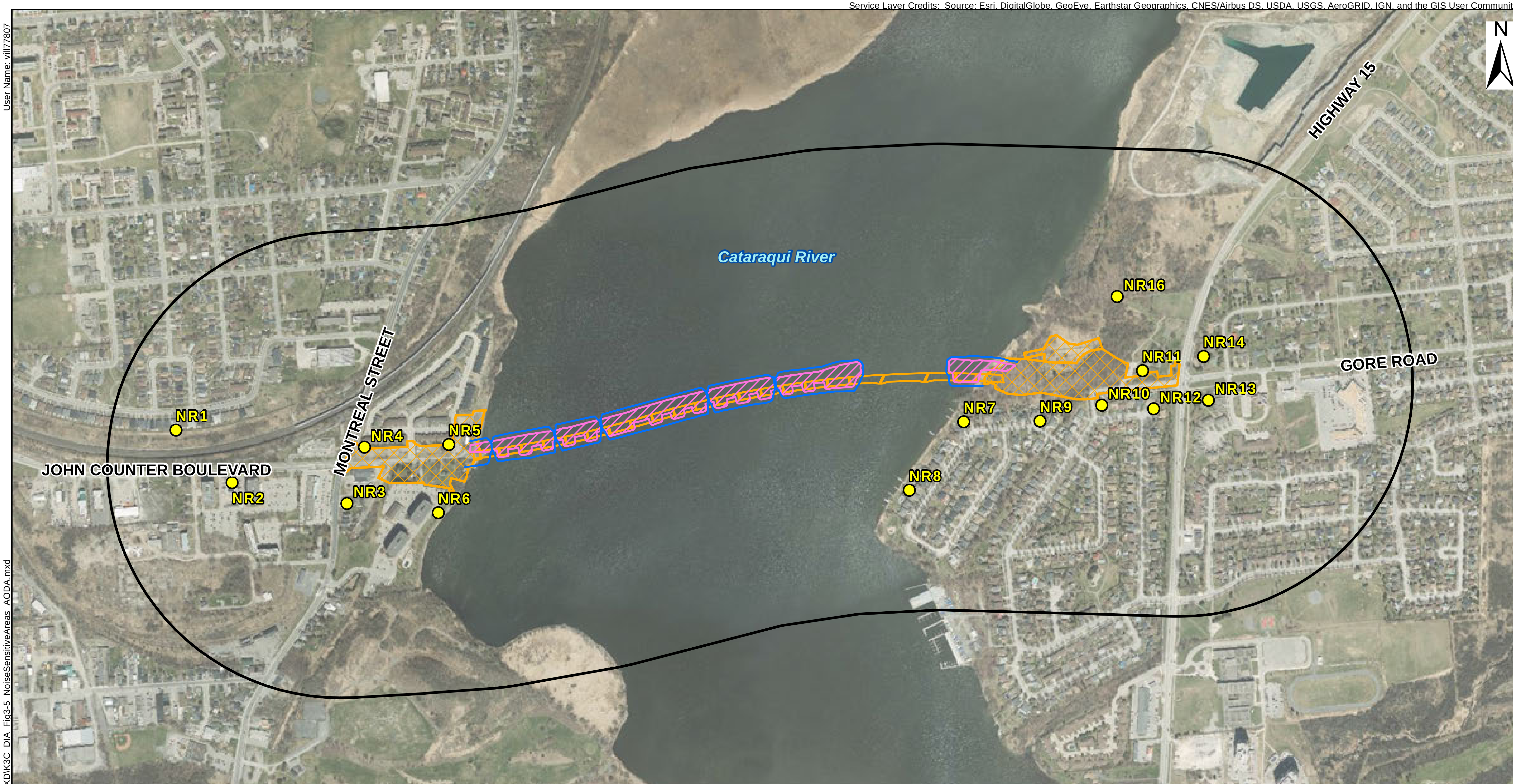
[1] The MTO defines 'heavy trucks' as all vehicles having 3 or more axles and designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 12,000 kilograms (kg). Intercity buses are also included in this category.

[2] The MTO defines 'medium trucks' as all vehicles having 2 axles and 6 wheels designed for the transportation of cargo. Generally, the gross vehicle weight is greater than 4,500 kg but less than 12,000 kg. City buses are also included in this category.

- The daytime and nighttime (D / N) breakdown of the traffic volume presumed consistency with the Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT), PIBA 1527e.
- Speed limits were assumed at 60 km/hr. within the Project Location (50 km/hr. elsewhere) on proposed road elevations with a pavement type having 'average' acoustic absorption.
- Traffic was assumed to be free-flowing, with no considerations regarding the acoustic effects of vehicles accelerating or decelerating at flow control devices.

As shown in Table 3.12, noise mitigation would be required for certain NSA where ambient sound levels are either 5 decibels (dBA) or greater or greater than 65 dBA at the Outdoor Living Areas (OLA) of Noise Sensitive Areas (NSA).

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Legend
Project Location

- Aquatic Exclusionary Turbidity Curtain (AETC)
- Temporary Construction Components
- Permanent Components
- Study Area
- Receptor

DATA SOURCES:

1. Spatial References: NAD 1983 UTM Zone 18N
2. Sources: Roads - Land Information Ontario;
3. Receptor Data digitzed from Golder 2017

0 100 200 400 Meters

1:8,000

Project:	**City of Kingston - Third Crossing**
Figure Title:	**Noise Sensitive Areas and Outdoor Living Areas Assessed**
Prepared By:	HATCH SYSTRA Kiewit KINGSTON
Date:	**November 18, 2019**
Figure: 3-5	**Page: 1 of 1**

User Name: vill77807

Document Path: T:\Maps\GIS_Data\CityOfKingston\MXD\K3C_DIA_Fig3-5_NoiseSensitiveAreas_AODA.mxd

Table 3.12: Projected 2034 Sound Levels (Unmitigated)

Receptor Location	No. of NSA's Represented	Unmitigated Future 'No-Build' (dBA)	Unmitigated Change from Project (dB)	Unmitigated Future 'Build' (dBA)
NR1 (Residential Street 132 Briceland St)	25	61	< 5	62
NR2 (Community Centre 730 John Coulter Blvd)	1	53	< 5	57
NR3 (Residential Street 901 Montreal Street)	10	62	< 5	65
NR4 (River Park Subdivision West 806 Newmarket Ln)	36	59	≥ 5	64
NR5 (River Park Subdivision East 760 Newmarket Ln)	36	54	≥ 5	63
NR6 (Apartment 67 Village Dr)	50	39	≥ 5	51
NR7 (Residential Street 82 Kenwoods Cir.)	5	43	≥ 5	58
NR8 (Residential Street 64 Kenwoods Cir.)	15	40	≥ 5	51
NR9 (Residential Street 100 Kenwoods Cir)	5	36	≥ 5	56
NR10 (Residential Street 83 Barker Dr)	10	52	≥ 5	64

Receptor Location	No. of NSA's Represented	Unmitigated Future 'No-Build' (dBA)	Unmitigated Change from Project (dB)	Unmitigated Future 'Build' (dBA)
R11 (Library 80 Gore Rd)	-	50 - 55	≥ 5	60
NR12 (Residential Street 71 Barker Dr)	3	36	< 5	37
NR13 (Residential Street 708 MacLean Court)	12	61	< 5	62
NR14 (Residential Street 6 Dagleish Ave)	12	60	< 5	61
NR15 (Vacant Land-Potential Residential)	-	48	< 5	52
NR16 (Residential Street 63 Barker Dr)	19	62	< 5	62
NR17 (Residential Street 104 Point St. Mark Dr)	5	48	≥ 5	61
NR18 (Residential Street 73 Barker Dr)	3	58	≥ 5	68
NR19 (Residential Street 88 Kenwoods Cir)	5	43	≥ 5	59
NR21 (Residential Street 746 Newmarket Ln)	1	47	≥ 5	55
NR23 (Residential Street 770 Newmarket Ln)	36	57	≥ 5	64

Receptor Location	No. of NSA's Represented	Unmitigated Future 'No-Build' (dBA)	Unmitigated Change from Project (dB)	Unmitigated Future 'Build' (dBA)
NR24 (Residential Street 788 Newmarket Ln)	36	57	≥ 5	64

In addition, it is anticipated that the bridge may serve as an emergency detour route for Highway 401, should an accident or event cause it to be closed in the vicinity of Kingston. In this instance, traffic volumes on the bridge would be expected to increase, likely to the point of causing congestion and reduced vehicle speed since the bridge would be exceeding its capacity. Such congestion events generally produce reduced sound levels from road traffic since wheel sound is largely limited by the reduced speed of the vehicles. Normally, wheel sound created by the interaction of tires with the road surface creates a large portion of traffic sound levels, which tends to increase with increasing speed. As a result, emergency detours over the bridge are expected to produce lower sound levels than those produced under free-flow conditions. This could also extend to emergency situations on the bridge itself, which are expected to result in decreased sound levels due to restricted traffic movements.

For additional supporting information, please refer to Appendix K.

3.1.11 Aesthetic Values

Effects on aesthetic values during construction and operation are discussed below.

In developing the design of the Project, PCA provided Bridge Design Guidelines for the Proposed Third-Crossing of the Lower Cataraqui Section of the Rideau Canal within their DRAFT Scoping Document for the Detailed Impact Analysis of the City of Kingston Third Crossing of the Cataraqui River Project, May 2019, which is provided as Appendix A . With respect to aesthetic values, this document provided General Guiding Principles and Functional Requirements, but relevant to this VC: Fundamental Aesthetic Strategies including Functional Clarity; Economy and Simplicity; Scale and Proportion; Harmony and Visual Balance; Contrast and Complexity; Materials and Finishes; Enduring Visual Quality and Compatibility. As well as Context-Specific Aesthetic Strategies including High Quality; Respect the Heritage Character of the Rideau Canal and Interpretive Opportunities.

As evidenced by the preferred bridge and approach roadway design, these aesthetic values have been foundational in the development of the Project. A description of how the preferred design has addressed each of the design criteria for aesthetics is provided in the Bridge Design and Construction Methodology (Appendix B). Accordingly, the Project is in alignment with expressed aesthetic values and no mitigation measures are therefore required.

3.1.12 Navigation

Effects on navigation during construction and operation are discussed below.

The potential for the Third Crossing Project to adversely affect navigation within the Rideau Canal has been acknowledged throughout the development of the Project. Potential effects include height restrictions, velocity increases, night navigational hazards and the reduction of navigable water during construction to the navigable channel. Mitigation measures to address construction timing and methodology are therefore required to ensure no significant, residual adverse effects to navigation are anticipated.

3.1.13 Hydrologic Processes

Effects on hydrologic processes during construction and operation are discussed below.

An analysis of river hydraulics was conducted at the proposed water crossing on the Cataraqui River[3]. The purpose of the assessment was to quantify potential changes specifically to water velocities, water depths, sediment erosion and transport, and river ice and spring flooding within the Project area between Highway 401 in the north and the LaSalle Causeway in the south. The assessment included the derivation of appropriate one-hour, single event, design scenarios for both temporary works (i.e. CTS) and the bridge (post-construction). These events were used to conduct comparative analyses of river hydraulic behavior.

The environmental factors influencing water movement within the study area are inflow, wind, lake levels and river ice. Currents may be induced through wind and surges in lake level and these factors, when combined, can produce significantly higher velocities and water levels within the study reach than flow (for the same

[3] Hatch Report H/357883-83-230-0005 Hydraulics Modelling Report 2019.

recurrence frequency). Therefore, an assessment of the relative influence of environmental factors on water velocities and levels within the vicinity of the proposed Kingston bridge site was conducted and revealed that wind is the primary driver of water movement in the study area with lake surge having a significant yet secondary influence. Wind from the south was the main environmental factor adopted for analysis of average water movement conditions, and the design. Three specific events were derived for the purpose of this assessment and are listed in Table 3.13.

Table 3.13: Hydraulic Modelling Scenarios

Event	Inflow		Lake Ontario Water Level		Wind (m/s)		Design (Combined) Return Period (year)
	Flow (m^3/s)	Return Period	Level (m)	Return Period	Speed and Originating Direction	Return Period	
E4	4.5	1.003	74.42	1.003	19.9 S	100	100
E7	4.5	1.003	74.42	1.003	19.1 S	50	50
A1 (average conditions)	4.5	1.003	74.42	1.003	14.5 S	1.003	1.012

The hydraulic analysis was facilitated with the use of computer models capable of simulating the dynamic and steady state behaviour of water in one and two dimensions. The assessment of river hydraulics under the three events noted above was quantitatively based and facilitated by overlaying water velocity and water depth plots to explicitly identify differences in these variables over the entire study area. All three scenarios represented a one-hour simulation.

Additional focus was placed upon potential sediment erosion and accretion of the bed. This component of the analysis included an extension of the simulations to 24 hours after the start of the event. That is, the simulation, first, included the one-hour design event, followed by additional time to determine sediment fate one day later. For the purpose of this assessment, the bed material was assumed to be uniformly distributed throughout the study domain and conservatively defined to be non-cohesive with a nominal diameter of 0.002 mm that corresponded with the geotechnical field investigation and the lower end of the silt classification.

The river hydraulic assessment also included an examination of the river ice regime. The objective of the river ice regime analysis was to determine the potential for an ice jam to form along the bridge alignment and, if so, estimate the backwater/flood levels associated with such a jam.

Simulations of the events listed in Table 3.11 were conducted and analysed to facilitate a comparison of pre-construction, construction (i.e. temporary works/Causeway), and post-construction (bridge in place) cases. In turn, changes in water levels, velocity, and bed erosion/accretion were determined. The conclusions derived from this hydraulic assessment are as follows:

- Potential changes to water level and velocity are estimated to be relatively small under open water conditions during the post-construction (bridge in place) case relative to the pre-construction (existing) case. See Figure 3.6 and Figure 3.7 for a comparison of these two cases under average and design conditions.
- Bed material within the study area is easily mobilized at very low velocities and the disturbance of bed material is equally likely with or without causeway or bridge in place; owing to the very loose organic silty peat material occupying the bed surface.
- The small changes to velocity (with the bridge in place) will, consequently, result in small changes to bed erosion, as implied by the maximum bed shear stress estimated under average and design conditions (see Figure 3.8 and Figure 3.9).
- Local scour was empirically estimated to be generally less than 2 m at all bridge piers; except pier 21 where the scour depth was estimated to be less than 4 m. Scour protection at the bridge piers is unwarranted acknowledging the bridge design includes very deep foundations; as deep as 40 m at Pier 4, for example. Therefore, the risk of undermining the bridge at these locations inconsequential.
- Changes to the bed surface with the bridge in place is estimated to be relatively small owing to the small bridge footprint with the most significant change apparent between the bridge piers. The magnitude of these changes, however, were deemed to be inconsequential and within the error of the estimate of the analysis. See Figure 3.10 for bed elevation differences between post-construction and pre-construction cases for the design event.

- The presence of the causeway will temporarily change the hydraulic regime of the study area under open water conditions. Specifically, water velocity through the bridge alignment (in a north-south direction) will progressively increase as the opening in the causeway decreases (for the same water movement events) and be at a maximum when the causeway is complete. The causeway, in its finished state, will be present for approximately 10 months and then progressively removed over the subsequent months that follow.
- With the temporary causeway in place, open water velocity (under the design event) was estimated to be higher near the navigation channel and lower, generally, west of the navigation channel both north and south of the temporary causeways. The estimated maximum velocity in the navigation channel with the Causeway in place was 1.3 or 0.8 m/s greater than the situation without the Causeway, see Figure 3.11.
- Water depths were found to be relatively unchanged when comparing pre-construction conditions to adding the Causeway, see Figure 3.11.
- Under design conditions, the presence of the causeway will increase velocity in the navigation channel (i.e. at the 230 m opening in the Causeway) beyond what is normally experienced and potentially increase erosion of the channel bed. The magnitude of these velocities is regarded to be small and this potential erosion may be mitigated by the submergent vegetation and the fibrous nature of the river bed material. See Figure 3.12 for an illustration of shear stress change to the bed under the design (50-year) event.
- Bed surface change resulting from the presence of the Causeway is expected to be most prominent immediately north and south of the west component of the Causeway and within the opening between the west and east Causeway components (i.e. in the vicinity of the navigation channel). However, the change in bed elevation is expected to be relatively small with differences in the amount of centimeters. Figure 3.13 illustrates changes to bed elevation and indicates bed erosion at the Causeway opening and bed accretion north and south of the west leg of the causeway. As noted previously for the post-construction case, the magnitude of these changes were deemed to be inconsequential and within the error of the estimate of the analysis.
- Under ice cover conditions, the low velocities within the Project area and lack of supply ice due to Kingston Mills upstream indicates the potential for ice jam

flooding during either the temporary works or post-construction (bridge in place) cases is extremely low.

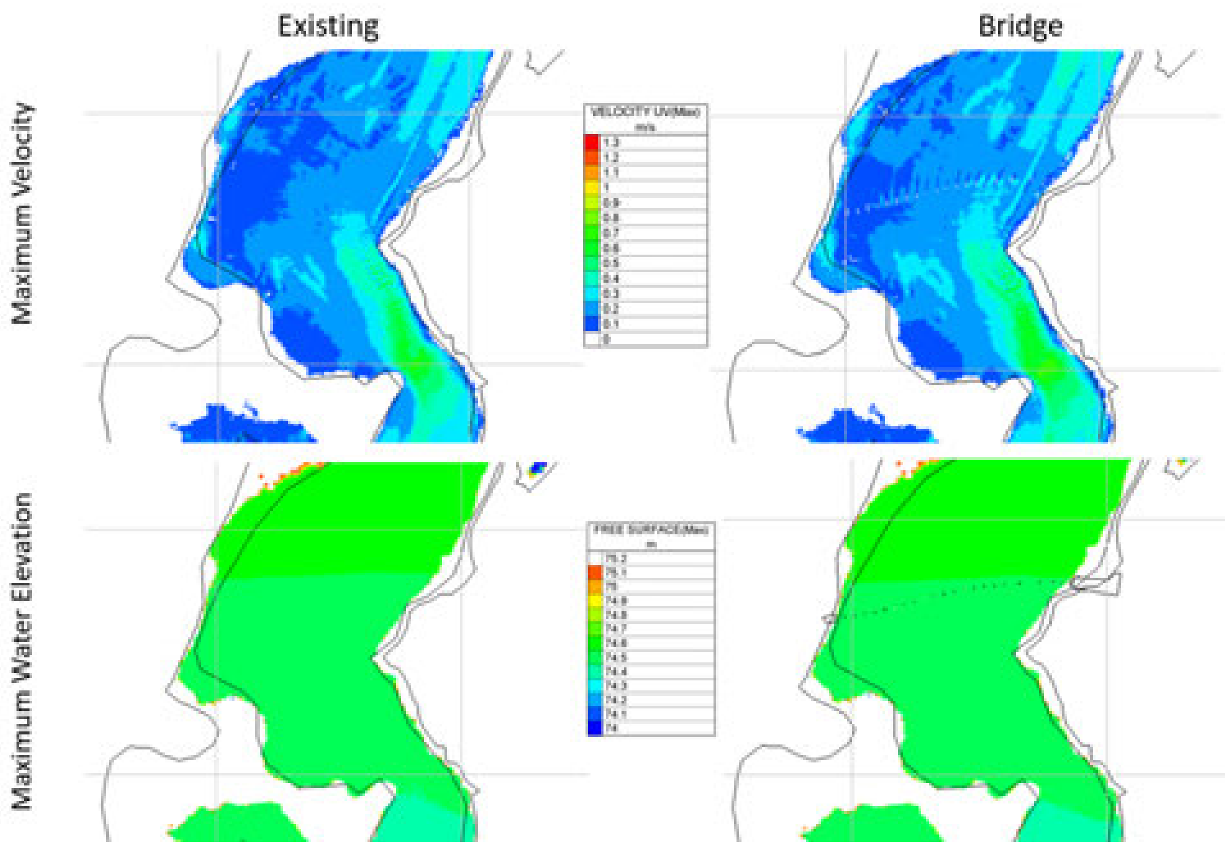


Figure 3.6: Maximum Water Velocity and Elevations under Average Conditions for Pre-construction and Post-construction Conditions

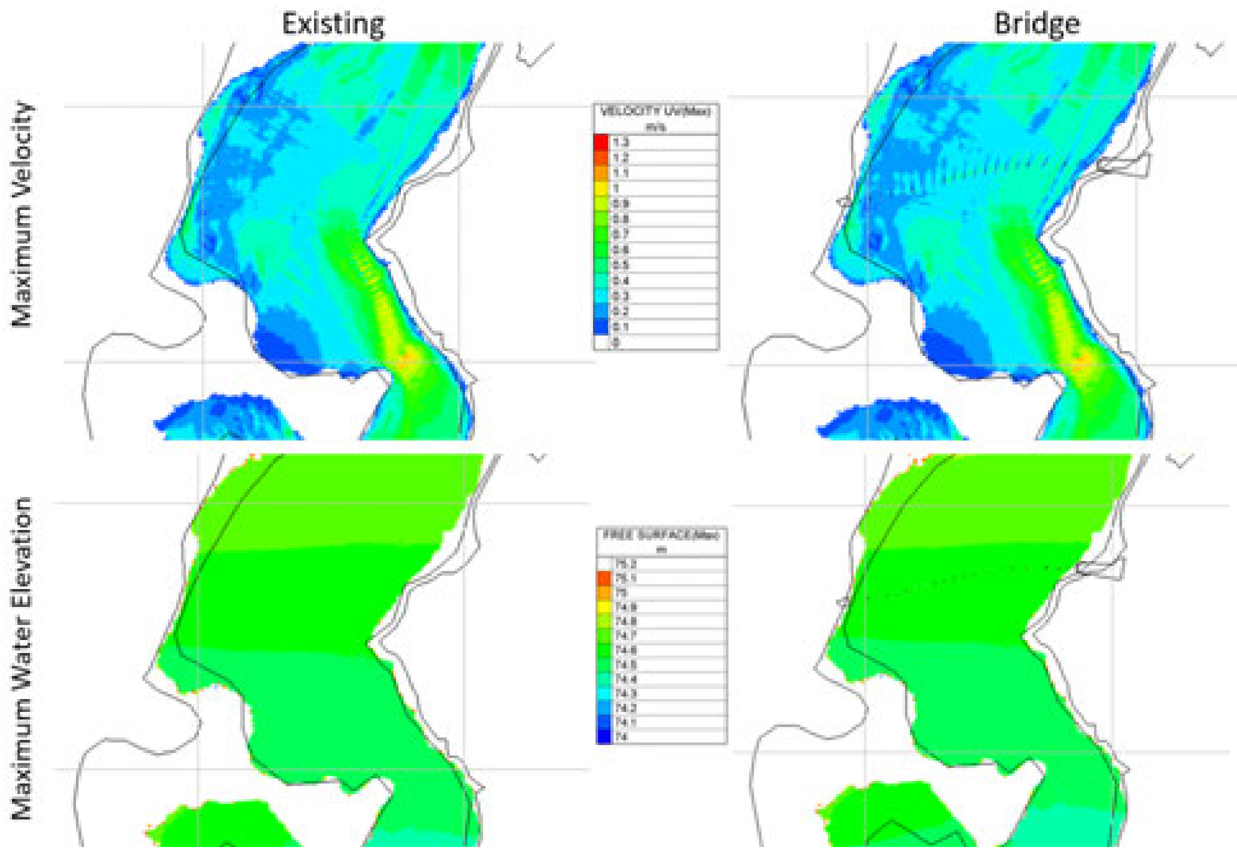


Figure 3.7: Maximum Water Velocity and Elevations under the 100-year Event for Pre-construction and Post-construction Conditions

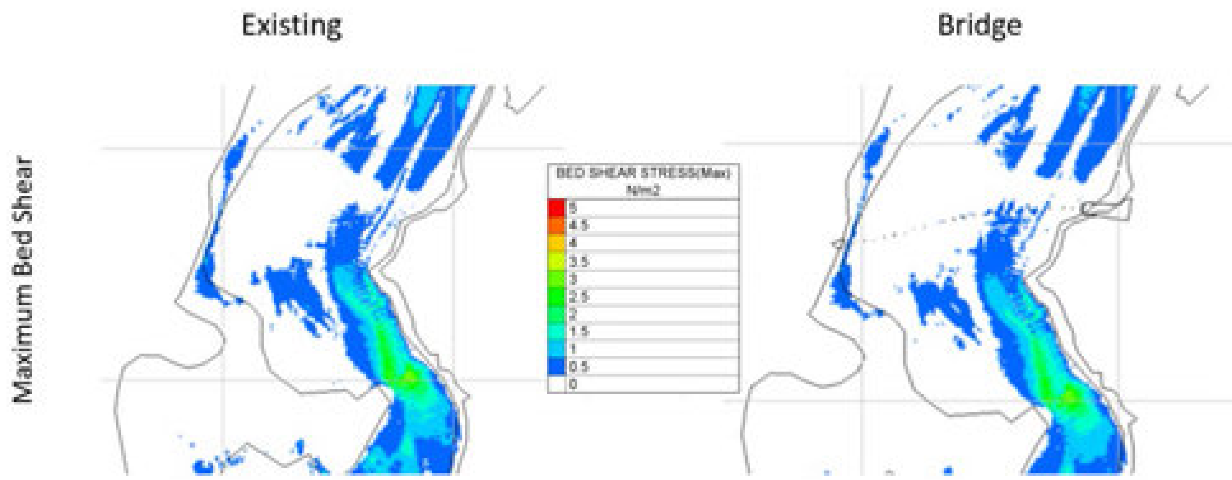


Figure 3.8: Bed Shear under Average Flow Conditions

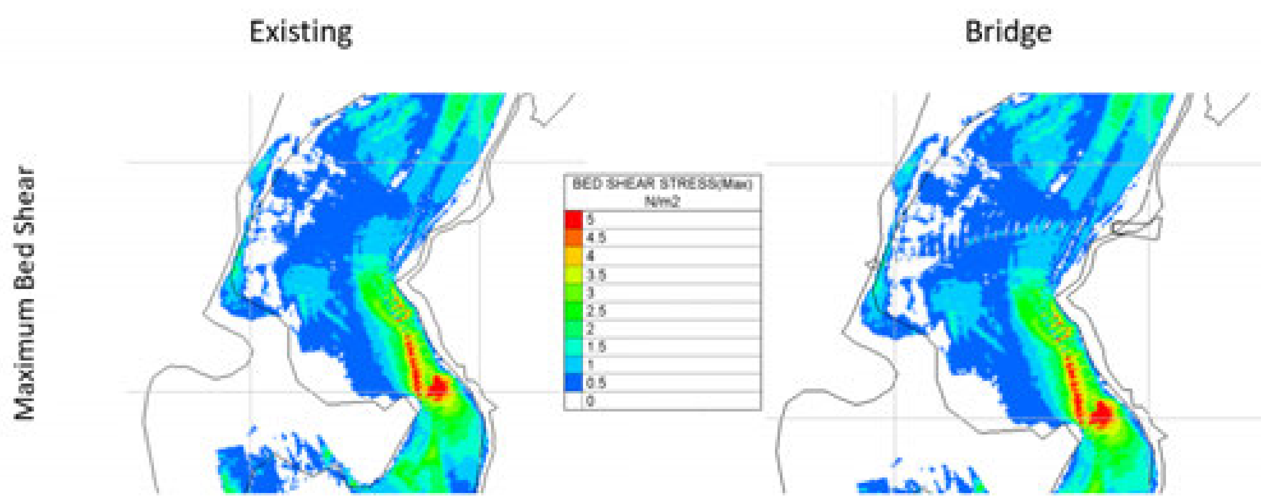


Figure 3.9: Bed Shear under Design (100-year Event) Conditions

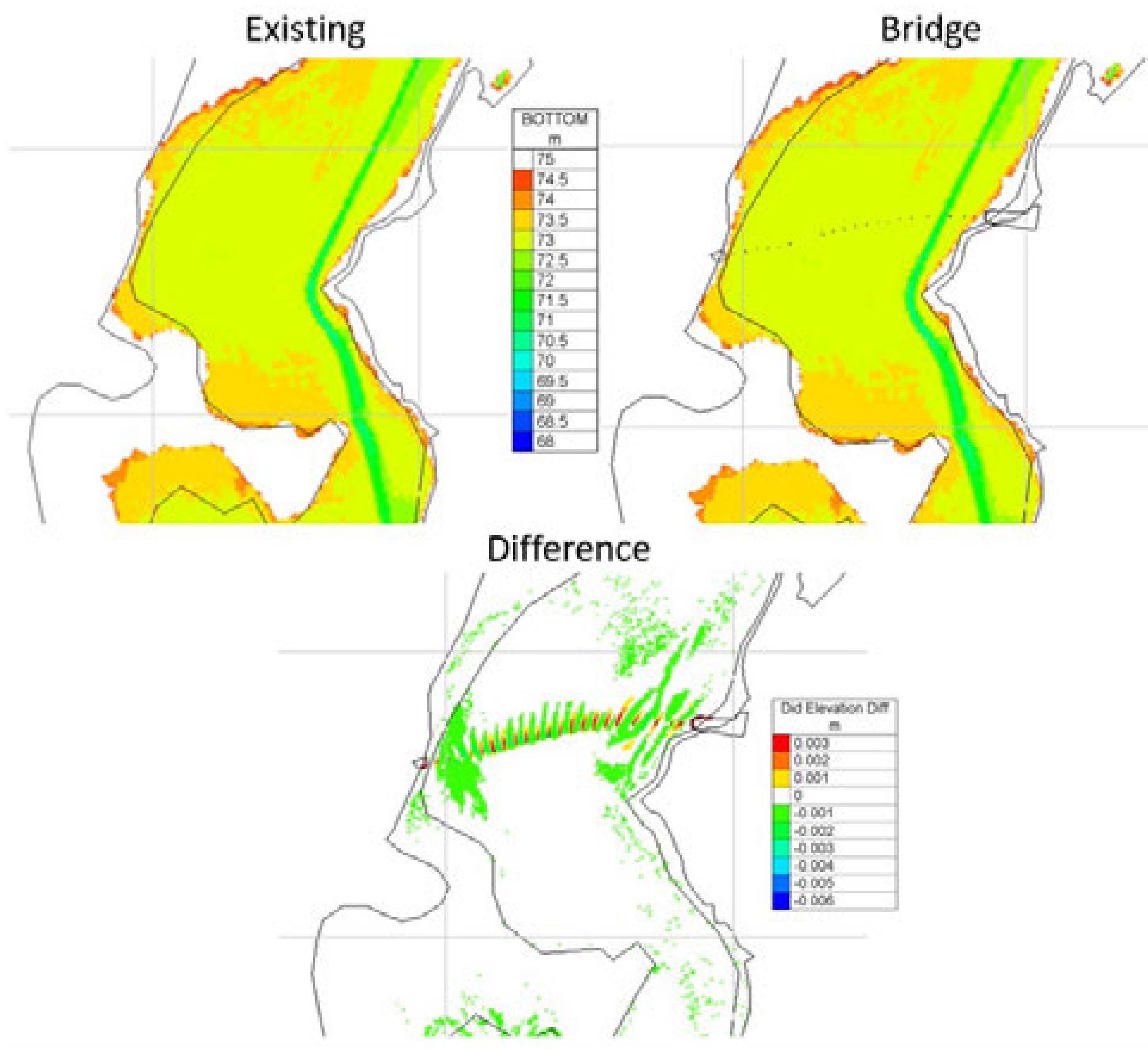


Figure 3.10: Bed Elevation Immediately After Design (100-year) Event

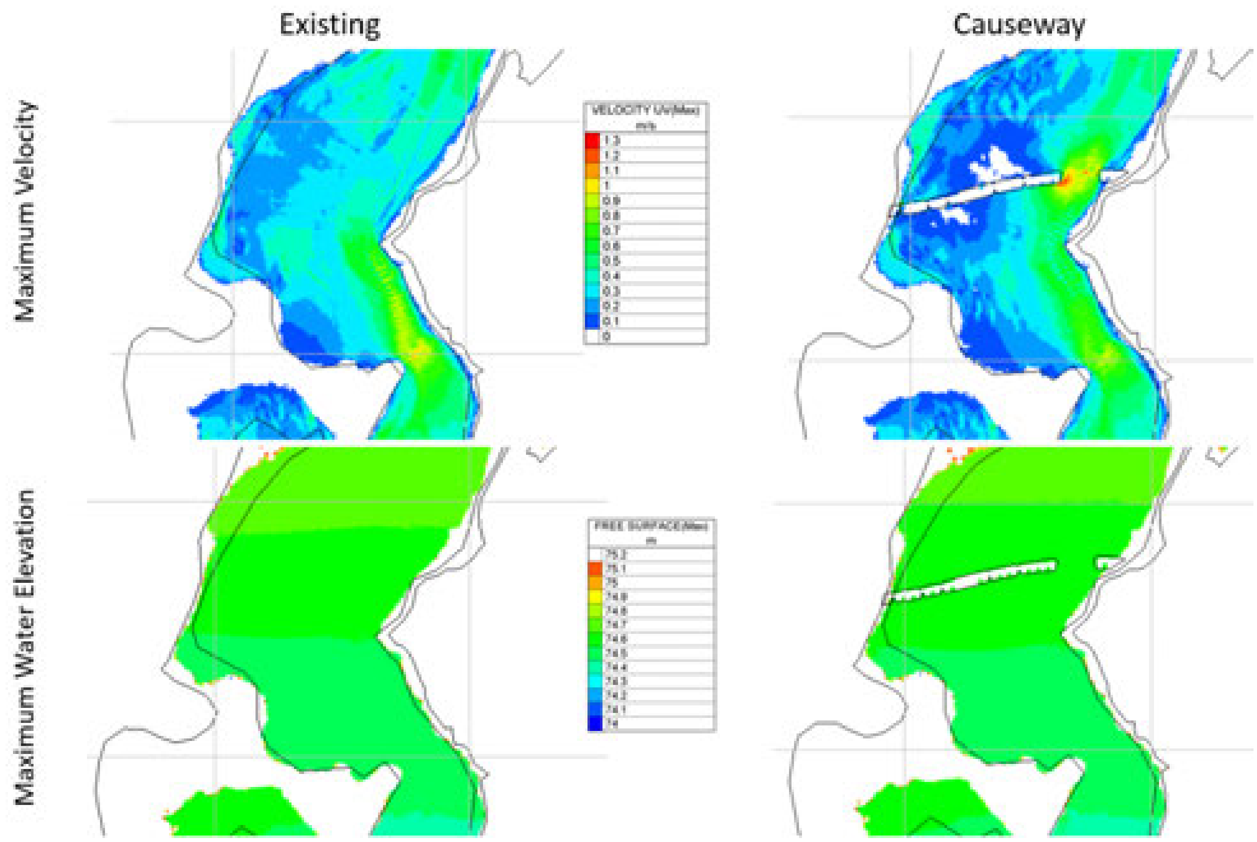


Figure 3.11: Maximum Water Velocity and Elevations under the 50-year Event for Pre-construction and Temporary Works (i.e. Causeway) Conditions

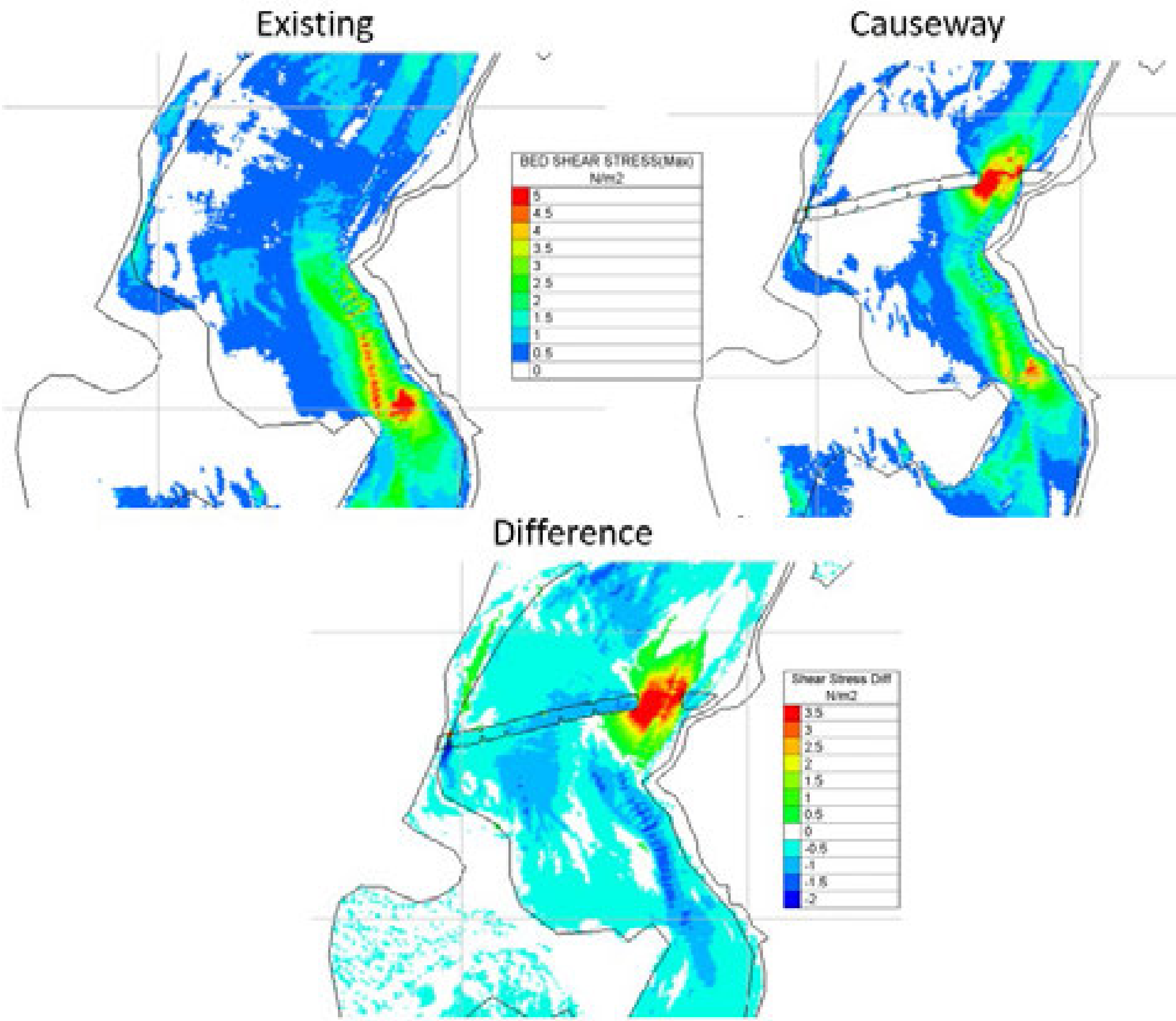


Figure 3.12: Maximum Bed Shear Stress on River Bottom During Design (50-year) Event

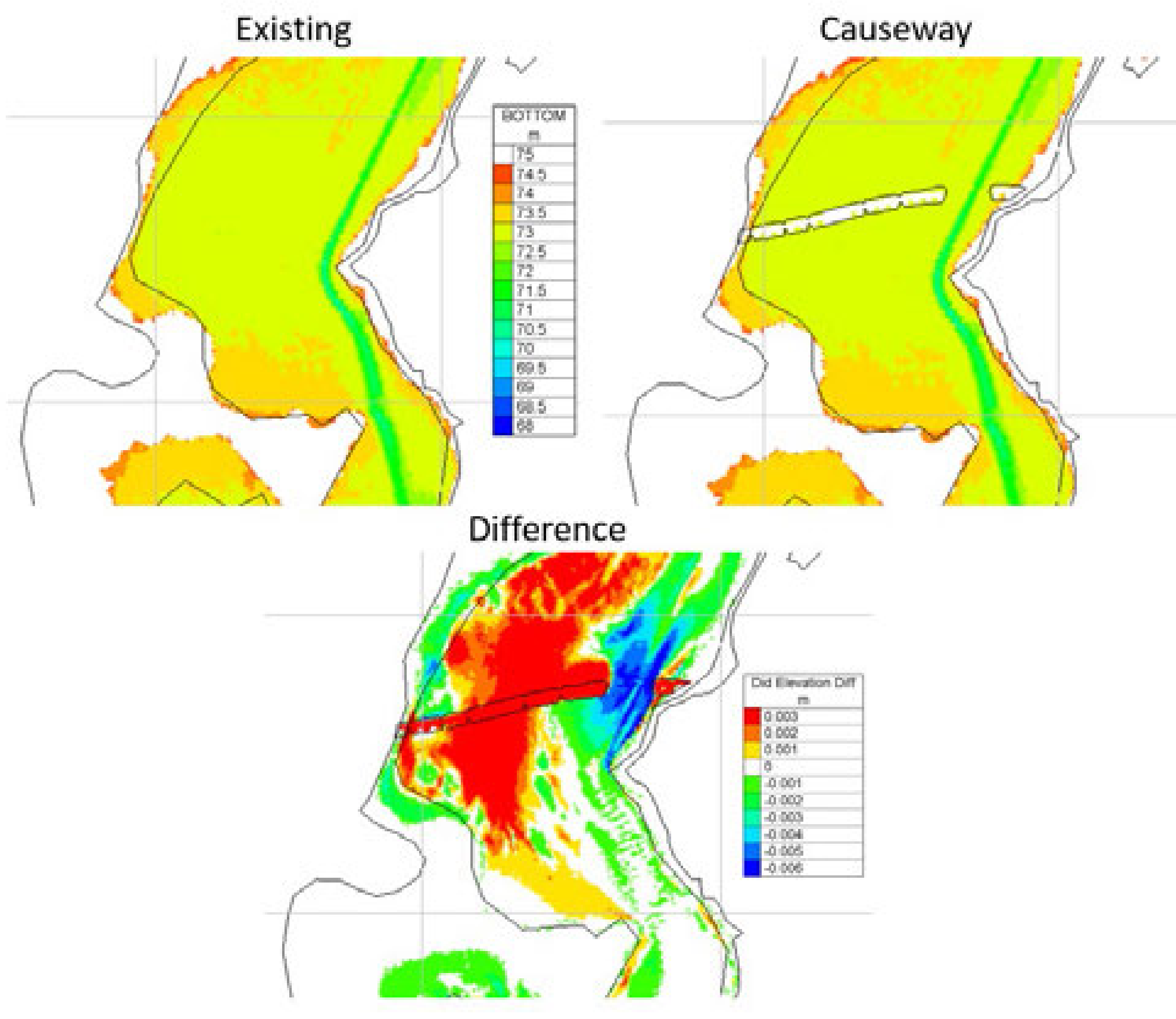


Figure 3.13: Bed Elevation Difference between Temporary Works Case and Pre-construction Case After One Hour (50-year) Event

3.2 Secondary Components

3.2.1 Groundwater Quality and Quantity

Effects on groundwater quality and quantity during construction and operation are discussed below.

Construction activities possess little potential to impact the groundwater quality or quantity provide suitable mitigations such as spill prevention are in place. The construction of the onshore road approaches' associated utility trenches and the bridge abutments are expected to interact with the shallow groundwater in the Project Location.

3.2.1.1 Quality

Effects on groundwater quality during construction and operation are discussed below.

Groundwater quality has the potential to be affected during construction activities due to contamination with various sources

- Spilled fuel and other hydrocarbons (see Section 3.4 for more information)
- Surface water/Groundwater mixing

Groundwater has the potential to come in contact with surface water during excavation for bridge abutments and utility trench excavation on the onshore approaches to the bridge. As noted, Section 2.3.2.2, the bedrock is shallow, and the bedrock is exposed a number of locations. It is expected that the groundwater is already in contact with the surface water runoff. This assumption will be monitored during construction activities through pre, during and post construction water quality sampling adjacent to the river, as outlined in Section 8.

3.2.1.2 Quantity

Effects on groundwater quantity during construction and operation are discussed below.

There is no groundwater extraction anticipated to occur as a result of the Project, this combined with the perception that the groundwater level is linked to the River water level which is equal to Lake Ontario, one could assume quantity would not be effected.

3.2.2 Terrain, Geology and Soils

3.2.2.1 Terrain and Geology

Effects on the terrain and geology during construction and operation are discussed below.

As previously indicated within Section 2.3.2.2 the terrain and geology throughout the Study Area is relatively consistent with other areas within the Napanee Plain Region of Southern Ontario. Impacts to the general topography and geology of the Study Area are not expected to occur outside of the Project Footprint. Excavation of peat, silty clay and clayey silt soil material will take place on the east and west abutments, as these materials are compressible and would be expected to settle under increased loads. These areas will be backfilled with suitable subgrade material or rock.

3.2.2.2 Soils

Effects on soils during construction and operation are discussed below.

General construction activities can impact soil quality in multiple ways if standard mitigation measures are not sufficiently implemented. Unmitigated construction activities may cause the following adverse effects to soil quality:

- Soil compaction
- Soil mixing (where excavation and stockpiling are required)
- Soil erosion (wind and rainwater)
- Quality degradation due to leaks and spills of oil and fuels
- Spreading contamination excavated from areas of degraded soil quality.

Of particular interest to this Project is the potential for degrading soil quality through the excavation, spreading or mixing of previously degraded soils. As described in Section 2.3.2, multiple areas along the west bank of the Study Area have been degraded through previous and current land use activities or spill events. It is possible that excavated soil from these areas may spread or leach deleterious substances if not properly handled or managed. Areas that have previously used for potentially contaminating activities are discussed further and mapped in Figure 3B in Appendix M - Phase 1 Environmental Site Assessment furthermore a dedicated EMP will be developed for soil management as shown in Section 8.

Surface and subsurface river substrates are expected to be compacted by the causeway, with predictions of the peat material compressing 33 to 50% of the existing thickness. Upon Project completion a layer granular material will be left behind embedded into the river substrates.

3.2.3 Other Terrestrial Wildlife

Effects on other terrestrial wildlife (snakes, semi aquatic mammals and other terrestrial mammals) during construction and operation are discussed below.

3.2.3.1 Terrestrial Snakes

Impacts to Terrestrial snakes (Dekay's Brownsnake, Eastern Gartersnake) are discussed in this section.

No snake hibernacula have been found on site to date, however the possibility of encountering habitat features for these species remains. Construction activities may result in the loss of features such as hibernacula, basking areas, shedding sites, and foraging grounds due to tree clearing. Construction equipment on site has the potential to cause road mortality to snake species, however exclusion fencing will be present onsite to mitigate these occurrences as presented in Section 4.

Noise levels on site from vehicles, heavy machinery and other equipment also have the potential to impact terrestrial snake species within the Study Area. At 37 m from the proposed pile driving, sound levels of 105 dB are predicted to exceed the 104.5 dB temporary threshold-shift for snakes (Appendix I, Table 4), which means that within that distance from the pile, snakes could temporarily lose their hearing sensitivity. As previously described alternate construction methods are being deployed to reduce the need for pile driving and reduce noise levels and frequency of pile driving to one to 14 minutes per pile.

3.2.3.2 Semi-aquatic Mammals

Impacts to semi-aquatic mammals (beaver, mink, muskrat and river otter) are discussed in this section.

Activities on site will cause construction length impacts to semi-aquatic mammal habitat, however little long-term impacts are expected to occur. Similar to turtles and fish, the construction of the Project represents a potential reduction in continuous aquatic habitat connectivity, furthermore riparian areas will be fragmented. All four species are known to use riparian and near shore areas for feeding and resting onshore. All found species would be expected to pass the construction site either through the open water passage or possibly over land as the land passed exclusionary fence would not likely be suitable to exclude mammals. The ability to enter the site would make them susceptible to vehicle strike without proper mitigation measures.

3.2.3.3 Terrestrial Mammals

Impacts to Terrestrial mammals (Coyote, Eastern Chipmunk, Eastern Cottontail, Eastern Grey Squirrel, European Hare, Longtail Weasel, Masked Shrew, Meadow Jumping Mouse, Meadow Vole, Norway rat, Porcupine, Raccoon, Red

Fox, Red Squirrel, Short-tailed Shrew, Striped Skunk, White-footed Mouse, White-tailed Deer, Woodchuck) are discussed in this section.

Proposed construction activities will result in a loss of potential terrestrial habitat for the species noted above due to tree clearing operations within the Project Location. The loss of woodland may result in the destruction of habitat features for the species such as breeding grounds, foraging grounds, hibernation areas, and dens.

During both the construction and operation phases the Project is expected to the fragment the animal movement corridor associated with the wooded area along the eastern shoreline. Which in turn may cause vehicle strikes during construction and operations.

3.2.4 Terrestrial Vegetation

Impacts to Terrestrial vegetation are discussed in this section.

To support the development of the new bridge, supporting infrastructure and overall Project Footprint, Terrestrial vegetation will have to be cleared. On the western edge of the Project Footprint the only identified vegetated community is a cultural thicket (Ecosite CUT1-1). It is anticipated that approximately 430 m^2 of the cultural thicket will be removed to support the new bridge and infrastructure. On the eastern extent of the Project Footprint, multiple treed areas have been identified, including a cultural thicket (CUT1-1), deciduous forest (FOD 5-8), and a cultural meadow (CUM1-1). The Project will require the clearing of approximately 764, 18730 and 2534 m^2 of vegetated area within these ecosites respectively. It should be noted that additional vegetated areas falling within the Project Location, within residential, commercial or disturbed areas will also be cleared but have not been accounted for within these measurements.

An analysis of potential environmental effects related to this loss of terrestrial vegetation was previously discussed in Section 3.1.3. Cultural thicket communities occur regularly within the Study Area, and the loss of this minimal amount is not expected to have any effect on the terrestrial vegetation or wildlife habitat it supports. Similarly, the area of vegetation set to be cleared from the cultural meadow community is relatively minimal and is not expected to any effect on the Study Area or regional area. The City of Kingston has evaluated the deciduous forest (FOD 5-8) partially as a significant woodland and partially as a contributary woodland (City of Kingston, 2019). The City's evaluation of the woodland as significant indicates the ecosite likely supports a wide variety of habitat types and fauna. The loss or reduction of known significant woodland is considered to be potential effect to the Study Area's terrestrial vegetation and is therefore is the only terrestrial vegetation community carried forward within this DIA.

3.2.5 Climate Change and Air Quality

Potential impacts to climate change from the Project are discussed in this section.

Pre-and-post bridge construction works would increase energy use and Greenhouse Gas emission outputs, negatively affecting climate conditions and projections, as noted earlier in the City's Climate Action Plan. The Carbon Life Cycle Assessment prepared in support of the Preliminary Design[4] expresses energy use and GHG emissions outputs with an upper limit [or standard practice -Unmitigated - as informed by the Ontario Province Standard Specifications (OPSS) and lower limit (or Mitigated). Greenhouse gas emissions outputs are measured in metric tons of carbon dioxide equivalent (MT CO_2e) whereas energy use is measured in millions of British Thermal Units (MMBTU).

The assumptions used in the life cycle assessment for an unmitigated scenario are described below:

- The OPSS do not address the use of hybrid or biofuel construction vehicles. Therefore, the unmitigated condition assumes that 0% of construction vehicles will be hybrid, use B20 fuel, use B100 fuel, or be combined hybrid/alternative fuel vehicles.
- The amount of cold-in place recycling or full-depth reclamation of existing roadway that will be used has yet to be determined. The unmitigated condition was therefore assumed to be 0%.
- The OPSS state that values up to a certain percentage of Reclaimed Asphalt Pavement , Recycled Concrete Material , and cementitious material substitutes are allowed, which means that the minimum amount of recycled and reclaimed materials that would be incorporated into a standard project is 0%. This was therefore used as the unmitigated condition.

[4] The United States Federal Highway Administration (FHWA) Infrastructure Carbon Estimator (ICE) tool was selected for the LCA because it provides approximate energy use and emissions outputs for projects that have yet to enter the detail design phase.

The energy and greenhouse gas emission outputs for the unmitigated scenario are summarized in Table 3.14 and Table 3.15, respectively.

Table 3.14: Unmitigated Construction Phase Energy Use

Energy (MMBTU)	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	1,908	1,508	15,964	3,487	22,464
Direct: Construction Equipment	618	412	6,370	584	7,984
Routine Maintenance	-	-	-	-	33
Total	2,709	1,920	22,334	4,071	31,067
Percent Contribution	8.7%	6.1%	72%	13.1%	-

Table 3.15: Unmitigated Construction Phase GHG Emissions

GHG Emissions (MT CO2E)	New Road Construction	Road Rehabilitation	Bridges	Rail, Bus, Bike, Pedestrian	Total
Upstream: Materials	124	97	1,627	201	2,049
Direct: Construction Equipment	58	30	464	43	595
Routine Maintenance	-	-	-	-	3
Total	182	127	2,091	244	2,647
Percent Contribution	6.8%	4.7%	79%	9.2%	-

For additional supporting information, please refer to the Lifecycle Analysis (LCA) included as Appendix N.

Adverse effects to air quality from the site preparation, construction and site restoration/rehabilitation phases are possible, however the Project will present opportunities to improve transportation network connectivity; enhance public transit and other municipal services; promote active transportation; and accommodate planned future growth. The Project will contribute to the City of Kingston's Climate Action Plan goals of reducing GHG emission from 2011 levels. As after construction, the 14,000 metric tonnes per year reduction provided by the Project represents approximately 7% of the City's 2020 reduction goals and approximately 21% of the transportation sector goal as identified in Kingston's Climate Action Plan. Further, the Project will result in beneficial effects on transportation related vehicle emissions and air quality.

3.3 General Considerations

3.3.1 Proliferation of Invasive and Alien Species

Impacts to the proliferation of invasive species from the Project are discussed in this section.

Numerous (64) invasive, alien or non-native plants and wildlife have been confirmed or thought to have a high probability of occurring within the Study Area and Project Location (Tables 2-19 and 2-20). In order to better facilitate the Environmental Management Plan (EMP) that will be developed to manage any undesirable invasive or alien species 19 target species have been identified, with each species habitat preference used to group them into upland (Table 3.16) riparian, shoreline or wetland (Table 3.17) and aquatic (Table 3.18) with aquatic further broken into flora and fauna. These three table also indicate the way that each plant propagates and recommended removal methods. As stated, these species will be considered during the production of the EMP with each species best management practice guidance document embedded within the EMP to reduce the potential of further spread or gaining any further advantage over native species. The following areas were identified in the 2019 site investigation for non-native vegetation:

1. West approach gravel parking areas (WAP).
2. West approach lay down area (WAL).
3. West approach shoreline and near-shore aquatic area (WAS).
4. East approach woodland (EAW).
5. East approach shoreline and near-shore aquatic area (EAS).

Table 3.16 Upland Terrestrial Invasive and Alien Species

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
Dog-strangling Vine	Ravines, hillsides, waste areas, fence lines and hedges	Out competes native vegetation Threat to Monarch Butterfly recovery	Seeds ≤ 28,000/m² (Late July – September)	Digging. Mowing, Tarping, Herbicides,
Giant Hogweed	Along roadsides, ditches, streambanks, old fields and open woodlands	Out competes native vegetation Harmful to Humans, pets and livestock	Seeds Seeds viable ≤15 years in soil	Hand-pulling or Digging (small infestations), Herbicides (large infestations)
Japanese Knotwood	Gardens, around old buildings or former building sites, waste places and roadsides, riparian or wetland areas	Out competes native vegetation Displaces native fauna Damages infrastructure	Stem/Rhizome can regenerate from up to 1 m depth Seeds Uncommon in North America	Mowing, Digging, Excavation, Tarping, Herbicides
Spotted knapweed	WAP, WAL, WAS. Colonizing much of the disturbed sites on the western side.	Out competes native vegetation	Seeds >1000/plant, (August – November) Seed remain viable up to 5 years in soils	Pulling Mowing Tilling Herbicides
Tansy	WAP, WAL. Common. Stream banks, grasslands, roadsides	Out competes native vegetation Harmful to grazers, livestock, and wildlife.	Seeds Seeds viable ≤25 years in soil Rhizomes	Mowing, Hand-Cutting, Herbicides

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
Wild Parsnip	Abandoned yards, waste places, meadows, old fields, roadsides and railway embankments	Out competes native vegetation Harmful to Humans, pets and livestock	Seeds (August – November)	Pulling Mowing Tarping Herbicides

Table 3.17: Shoreline, Wetland and Riparian Invasive and Alien Species

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
European Common Reed (Phragmities)	Shallow waters in freshwater wetlands, stream banks, shorelines and ditches.	Out competes native phragmites/ vegetation Loss of habitat Changes in hydrology Increased fire hazard	Seeds >1000/plant (April-May) Rhizomes can grow several metres /year Stolon fragments	Herbicides, IPM Only: Mowing, Hand-Pulling, Rolling, Flooding, Tarping
Flowering Rush	Shallow freshwater (2 m depth) systems and often found in ditches	Out competes native vegetation Displaces native wetland fauna	Rhizomes 12-43 bulblets/ plant Turions ≤300/plant	Hand-Cutting, Herbicides,
Purple Loosestrife	Marshes, floodplains, edges of waterbodies and ditches	Out competes native vegetation Accelerates downstream eutrophication	Seeds Seeds can remain viable for many years	Digging, Mowing, Herbicides

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
		Displaces wetland flora and fauna		

Table 3.18: Aquatic Invasive and Alien Species

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
Aquatic Vegetation				
Curly Leaved Pondweed	All water systems in silt, clay and sand	Out competes native vegetation Can accelerate eutrophication	Seeds Turions >100/plant	Herbicides, Hand-Pulling, Cutting
European Frog-bit	Slow moving waters such as sheltered inlets, ponds, slow-running rivers and ditches	Out competes native vegetation Accelerates eutrophication Impedes water flow	Seeds Turions	Hand-Pulling
European Water Chestnut	Found in freshwater bodies that are less than 4-5 m deep	Out competes native vegetation Accelerates eutrophication	Seeds/Nuts Viable seeds sink	Hand-harvesting, Herbicides
Eurasian watermilfoil	WAS, EAS. Common. Ditches, irrigation canals, wetlands.	Out competes native vegetation Impedes drainage works Fosters mosquitoes	Plant fragments	Hand-Pulling, Herbicides

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
Aquatic Fauna				
New Zealand Mud Snail	Silty sand sediments of freshwater systems; Cannot tolerate freezing waters but can survive at 0°C in low salinity	Out competes native snails and other substrate dwelling wildlife	N/A	Chemical, Substrate drying/freezing
Quagga Mussel	Freshwater areas (shallow, warm or deep, cold) and attaches to hard surfaces	Out competes native organisms Increases water clarity Biofouls water intake pipes	N/A	Chemical (molluscicide)
Round Goby	Waters with rocky and sandy bottoms; Found throughout the Great Lakes	Out competes native fish species Predates on native fish larvae/eggs	N/A	Chemical, Electrical Barriers
Rusty Crayfish	Wetlands, ponds, lakes, rivers in areas of rock and woody debris	Out competes native organisms Breeds with native crayfish species Predates on native fish eggs	N/A	Trapping

Common Name	Habitat Description	Impact	Propagation Method	Removal / Control Techniques
Sea Lamprey	Young lampreys found in silt rivers and streams, and adults found in open areas or large lakes and rivers	Parasitic to host fish (native species) Decimates large predatory fish stocks	N/A	Chemical (lampricides), Barriers, Trapping, Pheromones
Zebra Mussel	Rocky shorelines, natural debris, or in-water manmade structures in colonies; Found throughout the Great Lakes	Out competes native organisms, Smoothers Native Mussels Increases water clarity Bioaccumulates high levels of contaminants Biofouls water intake pipes	N/A	Chemical (molluscicide)

Through proper management which will be outlined within the EMP, all upland and shoreland species can be managed to lessen their likelihood of proliferation within the Project Location and vicinity as a result of the proposed Project. All three species are expected to recolonize in any disturbed aquatic areas along with other native species, returning the construction area to preconstruction form and function.

European Water Chestnut is expected to occur immediately south of the Project Location. It is currently unknown how or if this species will compete with other aggressive colonizers for the open space created during causeway removal, however is not expected to be as adapted to colonizing granular substrates compared to other species in the vicinity. Aquatic vegetation monitoring is planned within the Project Location. If this species is encountered, they will be removed, and regulatory agencies informed immediately for advice or corrective action.

In addition to aquatic vegetation, several invasive or alien aquatic fish and wildlife species have been identified. The Project is not anticipated to help nor hinder the proliferation of New Zealand Snail or Sea Lamprey. However, the increase in hard granular substrates following causeway removal is expected to increase suitable habitat for Quagga Mussel, Round Goby, Rusty Crayfish and Zebra Mussel (Cataraqui Region Conservation Authority, 2017). All four species are already expected to be prolific within the Study Area, occupying any available habitat and impacting local biota. The increased habitat suitability would not be expected to increase pressures elsewhere within the Study Area as recruitment is already available through species and larvae movement from Lake Ontario during southerly winds, and from the Cataraqui Watershed upstream which also hosts these four species. Suitability of the causeway base would be expected to diminish for all four species as sediment infill occurs and vegetation becomes re-established.

3.3.2 Lighting

Construction lighting will be required to ensure worker safety throughout the construction period as the installation of the causeway, and other construction activities progress from the shore across the Cataraqui River. As per the construction schedule described in Section 1.6, construction activities are proposed to progress year-round (Figure 1-2), through the various restricted activity timing windows (subject to approval by relevant authorities). Accordingly, there is a potential for the use of lighting during construction to affect fish and wildlife, including during these sensitive periods.

Specific to fish, construction lighting has the potential to affect a number of life processes due to the disruption of the circadian rhythm. Research from Brüning (2016), indicates that melatonin levels are supressed within the perch (*Perca fluviatilis*) and the roach (*Rutilus rutilus*) at the lowest intensity of 1 lx white light (full moon is approximately 0.3 lx). Brüning (2016) also determined that artificial light can cause the suppression of reproductive hormones in both perch and fish within the month of August, which corresponds to the preparatory phase within the reproductive cycle for fish. As construction is proposed to occur during sensitive timing windows for fish, for example the spawning seasons, construction lighting on the bridge has the potential to affect spawning and egg hatching. In addition to reproductive effects on fish, artificial lighting also has the potential to alter feeding and food web processes as many organisms on a low trophic level, such as *Daphnia retrocurva* (a source of food for many fish) show altered diel vertical migration patterns caused from artificial light (Moore *et al*, 2000). Alterations in movement and behaviour of organisms on low trophic levels can have cascading effects up the food web and alter feeding patterns, which may result in behavioural, physiological or developmental alterations. Lastly, general fish movement as well as migration patterns have the potential to be altered due to artificial light during construction. Many fish species use the lunar calendar to regulate the timing of migration (Hanson et al, 2008). As construction is expected to continue through sensitive timing windows, such as fall migration for select species, activity patterns have the potential to be altered during migration seasons. Altered movement patterns additionally have the potential to affect general fish behaviour and activity, particularly the predator-prey relationships (Parks Canada, 2008). It should be noted that construction lighting on the causeway will have a limited effect on fish due to the AETC exclusion zone around the causeway, however some impacts are still expected to occur. Areas around the trestle will not have an exclusion zone, therefore impacts from lighting may be increased in this area.

Similar to fish, sea turtles' hatchlings have also demonstrated impacts from artificial light; some individuals become distracted when making their way to the water and have therefore been more susceptible to predators (Witherington & Martin, 2000). Though the study analyzes behaviour in sea turtles, as opposed to the freshwater turtles located in the Cataraqui River, evidence suggests that artificial lighting still has potential to affect freshwater turtle behaviour and predator prey relationships. In terms of overwintering, Crawford (1991) found that photoperiod or circannual rhythm was not a proximate cue for arousal in overwintering Painted Turtles (*Chrysemys picta*), rather increasing temperature and vertical temperature gradient were the driving factors. As such, construction lighting within the sensitive overwintering period for turtles is not likely to cause impacts to turtle overwintering arousal but does however have the potential to affect many other behaviours such as movement and predator-prey relationships.

It is well known that light pollution from artificial light disrupts the circadian rhythm of birds and leads to disorientation during flight (Cabrera-Cruz et al., 2018; Van Doren et al., 2017). As construction is proposed to occur throughout both the breeding bird window and throughout migration season, artificial light from construction has the potential to affect bird movement for these sensitive life processes. Birds tend to exhibit different responses to various wavelengths of light pollution. For example, red lights have been shown to affect the navigational abilities of migrating birds, while blue-green lighting had no effect, and nesting birds tend to find white light most disruptive. As such, construction lighting may potentially affect birds differently according to seasonality, furthering the potential effects of working within sensitive timing windows.

In addition to construction lighting impacts to the species listed above, other terrestrial and aquatic wildlife also have the potential to experience similar behavioural, physiological and developmental alterations as a result of increased artificial light causing disruptions in circadian rhythm.

Mitigation measures will be employed to minimize light pollution. These are identified in Section 4. To address lighting during operation, the following provides a summary of PCA's design criteria for aesthetics specifically lighting requirements for the operation of the Project from Appendix A (DIA Scoping Document, May 2019):

- Provide functional, high quality, attractively designed tow lighting directed and limited to the bridge.
- Lighting should be kept simple and subtle, in harmony with the Project setting.
- Avoid using constant-on lighting and flood lighting directed to the sky to minimize avian fatalities; white strobe or flashing lights, of a minimum number, intensity and number of flashes is recommended at night.
- Include provision of above-deck pedestrian-scale lighting at appropriate intervals.
- Minimize number of pole systems on bridge by integrating support of roadway lighting, and possibly pedestrian scale lighting.

The City's Facility Accessibility Design Standards (FADS), which are currently under review, apply mainly to the design of accessible exterior circulation routes such as sidewalks and pathways, and other associated elements. The City's FADS include the following, relevant to lighting and will be incorporated into detailed design as required: exterior lighting is to be in compliance with Illuminating Engineering Society of North America (IESNA) Standards, except in outdoor park settings where routes are not normally illuminated, additional illumination is not required.

As described in Appendix B (Bridge Design and Construction Methodology), the intent of the lighting design within the Project corridor is to provide safe, effective illumination that is focused on the roadways, multi-use pathway and navigation channel (including the adjacent rowing lanes), while at the same minimizing any potential impacts to wildlife, navigation and visitor experience. The design includes:

Roadway Illumination: As per City standards, as an urban arterial, the illumination design level for the roadway has an average, maintained, horizontal illuminance level of 17 lux with an average to minimum ratio of 3:1. This is achieved by pole mounted lights spaced along the median throughout the length of the bridge and its approaches.

Multi-Use Pathway Illumination (on the bridge): The multi-use pathway illumination on the bridge has an average, maintained, horizontal illuminance level of 5 lux, as per City and IESNA guidelines. This is achieved with a smaller wattage luminaire mounted on the same poles in the median, as noted above.

Intersection Illumination: The intersection of illuminated roadways, whether signalized or not, require additional illumination levels. As per City standards, all intersections within the project corridor have 50% higher illumination.

Bridge Navigation: Provisions are in place to accommodate navigational lighting on the north-and-south-facing sides of the bridge deck, directly above the navigable channel. This lighting would be used to supplement the buoy markers currently in use for the portion of the navigable channel affected by the bridge footprint.

Effects of lighting from natural sources, primarily the moon through its phases, along with the anthropogenic sources on both shores, as well as lighting from the bridge have an additive effect. Change in light level is expected to occur through the addition of the bridge deck lighting. Development of the lighting design is expected to minimize the extent of light trespass, but some light may reach the river surface in the direct vicinity of the bridge. All lights are equipped with full cut off shrouds, mitigating upward effect, and focussing light downward onto the bridge decks and the local vicinity. Ambient light monitoring will be conducted, as proposed in Section 8, to confirm the amount of light trespass beneath and adjacent to the bridge structure. Levels will be discussed with PCA and ECCC, with additional mitigation measures developed if needed.

As described in Section 2.4.2, guidance provided during agency consultation has also recommended that the Project should use minimal lighting to reduce the impact on nocturnal wildlife, while still meeting safety requirements and aesthetic goals described above, in accordance with the Parks Canada Guidelines and Specification for Outdoor Lighting at Parks Canada, February 2016. Further, it was also recommended that the Project develop a Lighting Plan specifically engineered to meet operational requirements while also considering wildlife, navigation, and visitor experience.

Given the Plan will be developed in accordance with PCA's design criteria for aesthetics and outdoor lighting, as well as the City's FADS, no mitigation measures are proposed, nor required to reduce the potential for adverse effects of lighting on the existing landscape. Potential effects to aquatic and terrestrial wildlife are addressed in their respective sections of this impact analysis.

3.4 Accidents and Malfunctions

The following section provides an assessment of the potential adverse effects on the environment resulting from accidents and malfunctions during Site Preparation, Construction, Site Rehabilitation and Operation phases of the Project. Accordingly, Project Plans, such as an Environmental Management Plan, Spill Prevention and Response Plan and Fire Protection Plan are identified in Section 8 and will be developed and implemented to address site-specific Project requirements.

3.4.1 Site Preparation, Construction, Site Rehabilitation and Restoration

Accidents and malfunctions have the possibility to occur throughout the Site Preparation, Construction and Site Rehabilitation Phases of the Project. The contractor's Environmental Manager will proceed to ensure environmental compliance and preparedness prior to each operation, using the Environmental Management Plan as reference. The following procedures should be in place prior to starting work:

- Detailed protocols are in place for workers regarding emergency response (agency notification; implementation of environmental protection measures; clean-up and disposal measures) as well as equipment maintenance and inspections procedures
- Proper on-site construction signage and controls (including traffic and in-water navigation markers) are installed and maintained for designated areas and to ensure safe and efficient construction traffic circulation on-land and in-water.
- Proper in situ conservation or excavation and removal measures as well as notification protocols are in place regarding the discovery of previously undocumented natural heritage and cultural heritage resources.

- Using only licensed personnel to:
  - handle hazardous materials
  - provide regular pump-out and haulage services of temporary on-site effluent holding tanks to an approved water pollution control plant for disposal and treatment
  - haul sorted debris for recycle or disposal to approved facilities.

3.4.1.1 Spills

Spills could occur as a result of one or more of the following events:

- Discharge of sediment to aquatic environment.
- Release of petroleum hydrocarbons and/or other hazardous substances.
- Release of liquid concrete.
- Release of sewage from temporary toilets.

Accidental sediment and leaks of deleterious substances entering the river, could lead to an increased risk for additional adverse effects on aquatic wildlife, vegetation, habitats and water quality. The effects of a spill could vary, depending on the severity of the spill but would tend to be local in extent, minor in magnitude, short-term in duration and generally mitigable through the implementation of emergency spill response procedures.

Numerous activities during construction and operation will involve the use or transfer of petroleum hydrocarbons. In the event of spilled fuel and/or hazardous materials, it could potentially result in water, soil, groundwater and/or sediment contamination leading to potential adverse effects on water, soil, groundwater, sediment quality, wildlife, aquatic environment, vegetation, wetland and human health and safety.

Monitoring (Section 8) will be conducted throughout the construction period to ensure the terms and conditions of the DIA, tender specifications and relevant permits and approvals are being adhered to and that mitigation measures (Section 4) are having the intended effects in preventing/minimizing the potential for spills and associated impacts.

3.4.1.2 Other Contamination

Other accidents and malfunctions include the discovery of contaminated soils (on the west side lands) leading to increased risk for soil, groundwater and surface water contamination (with associated increased risk for negative ripple effects on wildlife, vegetation, habitats, and water quality).

The contractor's environmental management plan will be implemented upon discovery of contaminated soils on site to determine the best course of action.

3.4.1.3 Accidental Fires

Accidental fires can be started by lightning, careless smoking, sparks from construction equipment, etc. The potential adverse effects associated with an accidental fire in the Project Location are considered to have a low to high potential, depending on the nature of the fire. The effects of small, controllable fires in the work area would tend to be local in extent, minor in magnitude, short-term in duration; however, there is the potential for an event that could result in effects that are large in magnitude, particularly if a large brush fire in the eastern forest were to start in the vicinity of the proposed Project. The frequency of occurrence would be low given the requirements to monitor all activities that could result in a fire.

3.4.1.4 Particulate and Noise Emissions

Accidental particulate and noise emissions could lead to increased risk for additional negative effects as a result of sensory disturbances and reduced air quality. Mitigation measures for particulate and noise is discussed in the Air, Noise and Vibration Emissions Reduction Section. If a significant noise is made that is unforeseen, all work should cease until the issue is resolved and documented.

3.4.2 Operation

Accidents and malfunctions that have the possibility to occur throughout the operation stage are as follows:

3.4.2.1 Spills

The use of fuels and other petroleum hydrocarbons by vehicles operating on the bridge present the risk of a spill to the natural environment. Spills of such materials within the Cataraqui River or on the adjacent terrestrial lands could potentially result in water, soil, groundwater and/or sediment contamination leading to potential adverse effects on water, soil, groundwater, sediment quality, aquatic environment, wildlife, vegetation, wetland and SAR due to spills will occur.

There are no operations and/or maintenance requirements anticipated that would result in a discharge of sediment into the aquatic environment, outside the potential sediment release from bank vegetation restoration. Monitoring of restored bank vegetation following construction, will continue through operations and maintenance.

3.4.2.2 Collisions

The load design of the bridge is based on its classification as a Class 2 Bridge as well as the dimensions, draught, weight and speed of the largest water vessel that regularly uses the Rideau Canal system (the Kawartha Voyageur), therefore no bridge-vessel collisions are anticipated.

3.5 Potential Effects of the Environment on the Project

In addition to identifying the potential effects of the Project on environment, the potential interactions between the environment and the Project phases are equally valuable. As such, the environmental interactions with the Project are outlined below.

3.5.1 Site Preparation, Construction, Site Rehabilitation and Restoration

3.5.1.1 Precipitation and Flooding

Impacts to the Project from precipitation and flooding during construction are discussed in this section.

The City's Action Plan predicts that in 2020, average precipitation levels will be 980 mm. Flooding in the Cataraqui River from heavy precipitation during construction could potentially result in overtopping of the causeway and subsequent inundation of working areas. This would result in an increased risk of harm to the environment, damage to equipment/machinery and risk to the project infrastructure. Flooding of this nature may require temporary evacuation of working areas, with resulting delays in the Project schedule. The Contractor is required to have an emergency response plan that will include measures to deal with floods greater than expected during construction phase, and a health and safety plan that provides instruction on how to safely work around water and how to properly respond to the event of a flood must be distributed to and followed by workers on site.

The stormwater management design (bridge deck cross-fall and permanent on-land storage/treatment facilities) complies with regulatory requirements and also exceed MTO standards for a 10-year storm event. If a 10-year storm event is exceeded, flows will be directed down the sloped bridge deck and directed to the respective stormwater management faculties. As noted earlier, based on the preferred bridge profile design, the bridge clearance over water exceeds:

- The regulatory 76.3 m floodplain elevation.
- 2017 water levels, which were the highest levels recorded since 1918.

The bridge has also been designed to provide navigation in excess of a 1:100-year storm event. Additionally, maintenance activities should be suspended during periods of heavy precipitation.

3.5.1.2 Extreme Winter Conditions

Impacts to the Project from extreme winter conditions during construction are discussed in this section.

Construction is planned to continue through the winter period. Kingston typically experiences cold conditions in winter. Mean temperature in winter (November to February) is -6.9˚C, with -34.0˚C being recorded as the extreme minimum temperature. Since extreme cold conditions could result in health and safety risks to the labour force (i.e., frostbite, hypothermia, etc.) and could cause equipment malfunctions or breakdowns. Extreme cold conditions could result in health and safety risks to the labour force (i.e., frostbite, hypothermia, etc.).

Based on the minimum mean daily temperatures (-6.9°C) for the City, a construction temperature of 15°C is incorporated into the design, allowing for movement from expanding and contracting of materials due to temperature fluctuations and minimizing potential repairs

from concrete cracking and permanent steel deformations. Contractors and workers to be employed for this Project should be familiar in working under these weather conditions within the regional area. Contractors will also be required to provide and implement a Safety Plan that protect workers from extreme weather conditions including providing recommendations for appropriate clothing.

3.5.1.3 Extreme Icing Conditions

Impacts to the Project from extreme icing conditions during construction are discussed in this section.

Ice storms, such as the one that occurred in eastern Ontario and Quebec in 1998, could affect on-site construction activities and workers. Impacts could include loss of power to the site, unsafe working conditions, damaged/ inoperable equipment, structural failure (e.g., distribution lines) and ice damming which could lead to flooding/inundation of the work area. Ice storms of the severity of those experienced in 1998 are a relatively rare event, but storms of less severity may still have the potential to impact working conditions.

The dynamic ice force and the ice impact forces on the pier design are based on conservative dynamic (100-year) ice condition estimates at the project corridor, as per the CHBDC and the design life of the bridge (details found in Appendix B). Work will be ceased in extreme conditions to ensure worker safety.

3.5.1.4 Extreme Summer Conditions

Impacts to the Project from extreme summer conditions during construction are discussed in this section.

Extremely hot summer conditions may increase health and safety risks to the labour force (e.g., sunburns, sun stroke, heat exhaustion and dehydration etc.). The maximum mean daily temperature in summer (June, July, August, September) is 23.5˚C, with 35.0˚C being recorded as the extreme maximum temperature. By 2020, mean temperature in summer is projected to be 21.5˚C, with 36.4˚C as the extreme maximum temperature. Extremely hot summer conditions may also pose health and safety risks to the labour force (e.g., sunburns, sun stroke, heat exhaustion and dehydration). Contractors will be required to implement a Safety Plan that protect workers from extreme weather conditions.

Based on the maximum mean daily temperatures (23.5˚C) for the City, a construction temperature of 15°C is incorporated into the design, allowing for movement from expanding and contracting of materials due to temperature fluctuations. Work will be ceased in extreme conditions to ensure worker safety.

3.5.1.5 Severe Weather (Storms, Tornados, High Winds)

Impacts to the Project from severe weather during construction are discussed in this section.

High winds caused from storms could result in unsafe working conditions, damaged/inoperable equipment, power outages, and debris to enter the Cataraqui River. Strong winds from a storm present minor issues for the worksite, however, high winds from events such as tornados or downbursts may result in severe damage to infrastructure and high risk of injury to workers.

As per the CHBDC and minimum 100-year design life of the bridge, the design is based on the wind pressure associated with a return period of 100 years for a structure having a maximum span length of up to 125 m at the project corridor (520 Pa). Maintenance activities should be suspended during periods of high winds and crane operations are to take into consideration wind speeds and temperature according to manufacturer’s recommendations.

3.5.1.6 Seismic Events

Impacts to the Project from seismic events during construction are discussed in this section.

There are two possible in-water fault zones within the Project Location where low resistivity is observed within the bedrock beneath the river, centered at distances of 320 and 970 m. These areas are most likely associated with the Frontenac Axis. The bedrock cores recovered from boreholes within these zones do not suggest that the boreholes were drilled through a historical fault. However, bridge foundation construction may encounter a fault or highly fractured bedrock within these zones or closer to the shorelines at a transition from the gneissic bedrock in the Cataraqui River to the limestone bedrock at the east shore and the dolostone bedrock at the west shore.

Historically, the Kingston region has a very low occurrence rate of seismic activity (Government of Canada, 2019), therefore it is not anticipated that the area will experience any seismic events throughout the Project duration. In the case of a chance seismic event, impacts could increase the risk of harm to personnel, include loss of power to the site, unsafe working conditions, damaged/inoperable equipment, structural failure (causeway, bridge, on-site structures) and damaged power lines. In a large-scale seismic event, the Cataraqui River may experience high wave action that may lead to degradation of the causeway, flooding and significant erosion into the Cataraqui River. Damage of this nature may require temporary evacuation of working areas, with resulting delays in the Project schedule.

The seismic design is based on the Performance Category 2 properties at the project corridor and as such, complies with performance level requirements under 475-year event, 975-year event, and 2475-year event scenarios. In addition, should faults or highly fractured bedrock be encountered, the bridge foundation design will be reviewed, with modifications as needed to accommodate a reduced axial geotechnical capacity, either with deeper rock sockets or post-grouting to improve the side wall shear resistance.

3.5.1.7 Fire

Impacts to the Project from fire during construction are discussed in this section.

Fire on or near the construction area poses a threat to infrastructure and equipment, in addition to creating danger to workers. Potential impacts could include damage to infrastructure and equipment (i.e.: infrastructure collapse), damage to the natural environment, health and safety threats to workers (i.e.:

severe burns, smoke inhalation, etc.), and possible explosions from heat and fuel.

To reduce the danger that fire conditions pose to workers, the contractor will be required to develop and implement health and safety measures to reduce the risk of fire (see Section 3.4), in addition to the provision of fire extinguishing equipment, and the development of a fire evacuation plan.

3.5.2 Operation

3.5.2.1 Climate Change

Future impacts to the Project from climate change are discussed in this section.

Climate change in Canada will result in warmer temperatures according to the City's Action Plan. By 2050, average temperature are projected to increase from 7.8˚C to 11.1˚C, average precipitation levels are projected to increase across the seasons (a total annual average increase from 951 to 1,024 mm), as are the number of days related to extreme precipitation (an increase from 4.6 to 8.1 days) and events related to ice storms (from 1.5 to 3.2 events). Rising Lake Ontario water levels could also be expected. Government of Canada (2006) predictions indicate that for many regions of Canada, warmer winter temperatures would likely increase the frequency of mid-winter thaws and rain-or-snow events, thereby increasing the potential for increased winter flows. Conversely, reduced winter snow cover could l result in fewer and less severe spring flooding events. However, the magnitude of the spring freshet is not dictated only by snow cover. Increased severe rain events can cause flooding within the Cataraqui River. Warmer summer temperatures would likely result in lower seasonal flows and warmer water temperatures.

In terms of economic risk to the Project, a warmer-drier climate scenario that results in less runoff and streamflow on average could result in lower river flows, which may be more pronounced during typical summer low-flow months. Environmentally, lower river flows would not be aggravated (i.e., reduced further) by the Project.

Overall, the effects of climate change on the Project are expected to be gradual in occurrence and are considered minimal in effect.

3.5.2.2 Weather-Related Effects

Future impacts to the Project from weather related events are discussed in this section.

Weather-related effects to the environment that could affect the Project include severe rain events, lightning strikes, ice storms, thunderstorms, tornadoes, hailstorms, heat waves, and droughts. These events may become more frequent due to climate change:

- flooding in the area could result in overtopping of the bridge, causing the possibility of harm to the public, damage to the infrastructure, as well as backup of traffic.
- extreme winter conditions may cause a large amount of snow to build up on the bridge causing structural instability.
- During flash freezes or other freezing events, frost wedging could possibly occur within the joints of the bridge during operation, resulting in a decline in structural integrity creating hazards to human health and the environment. Additionally, roads and sidewalks on the bridge deck may become iced over during an extreme icing event, resulting in black ice and slippery conditions for people and vehicles.
- Extremely hot summer conditions are not likely to impact the operation of the bridge but may pose a risk to pedestrians using the bridge (e.g., heatstroke, heat exhaustion).

A Safety Plan will be developed and implemented to respond to these potential weather-related events.

3.5.2.3 Seismic Events

Future impacts to the Project from seismic events are discussed in this section.

During operation, a significant seismic event may cause structural instability within the bridge, posing a risk to both human health and the environment. Seismic activity may also cause unpredictable water flows within the area, resulting in the possibility of rapid erosion of the shoreline, posing a threat to human safety. Debris from the compromised bridge or sediment loading from the shoreline into the water can cause high turbidity, damage to habitat, poor water quality and injury to wildlife.

The seismic design is based on the Performance Category 2 properties at the project corridor and as such, complies with performance level requirements under 475-year event, 975-year event, and 2475-year event scenarios.